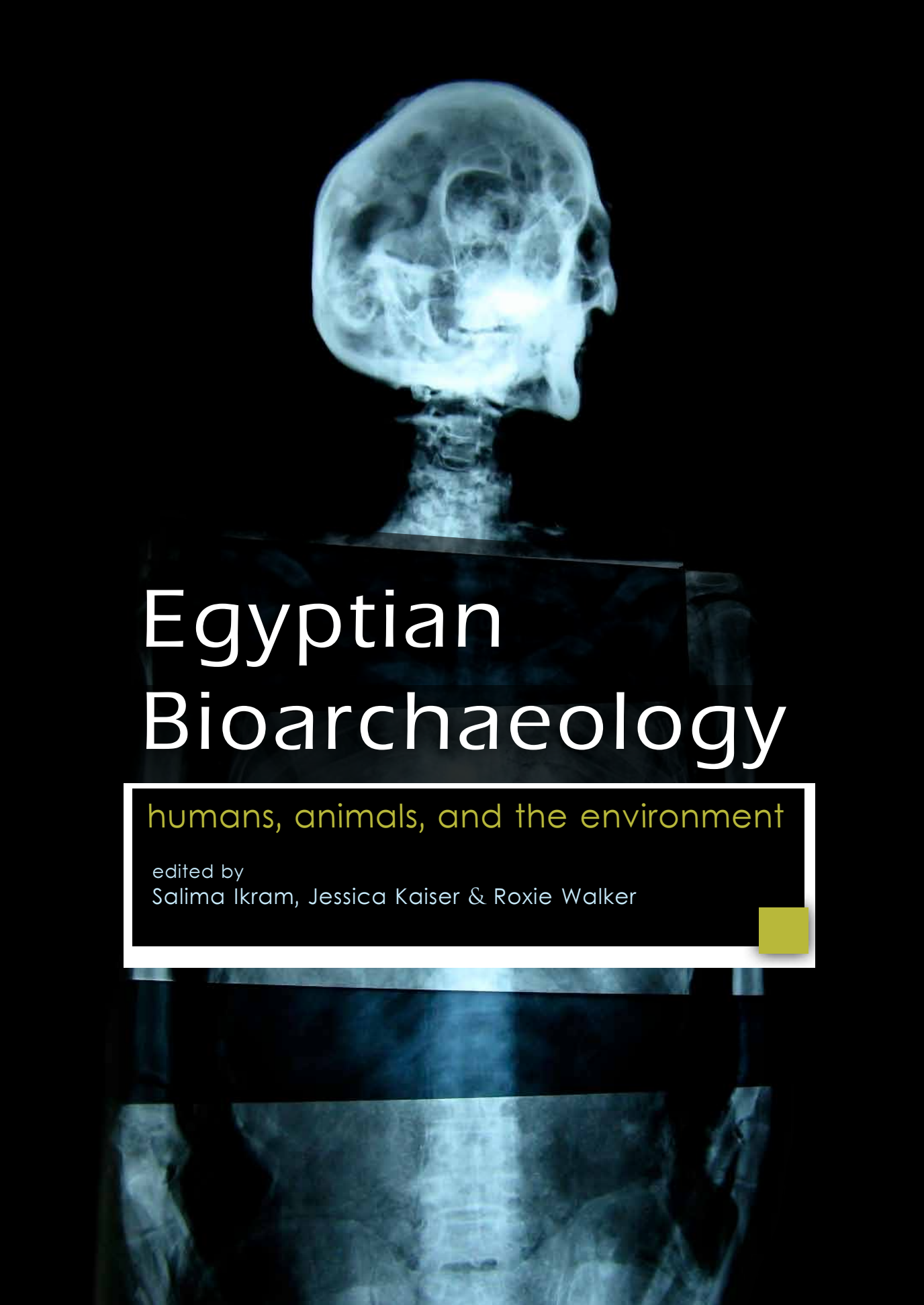

Egyptian Bioarchaeology

humans, animals, and the environment

edited by
Salima Ikram, Jessica Kaiser & Roxie Walker

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Sidestone Press

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Abstracts

Burials under the Temple of Millions of Years of Amenhotep II – Luxor, West Thebes

Giovanna Bellandi, Roberta De Marzo, Stefano Benazzi & Angelo Sesana

The area of the Temple of Millions of Years of the pharaoh Amenhotep II was partially investigated by the English archaeologist Sir W.M. Flinders Petrie in 1894-1895. Only in 1997 were excavations resumed in the area of the Temple under the direction of Angelo Sesana, president of the CEFB – Centro di Egittologia "Francesco Ballerini" (Como, Italy). The excavations, now approaching their 15th season, have permitted the development of a notably detailed plan of the temple, expanding and rendering more precise the summary data recorded by Petrie. Excavation has been continued down to bedrock and has revealed numerous funerary structures and complexes that occupied the area before the Temple and again after its abandonment and the looting of its stones. Prior to construction of the Temple of Amenhotep II the area was occupied by a necropolis dating back to Middle Kingdom. Two underground tomb complexes from this pre-temple cemetery consisting of a ramp, a hallway and several chambers are still being studied. The tomb-fill has provided unexpectedly rich finds: vessels of many different types and sizes, terracotta offering trays, faience beads and semi-precious stones amulets along with skeletal remains. The whole area was again used as a necropolis from the Third Intermediate Period onwards. To date 22 tombs in the necropolis have been investigated but only 14 still contained human remains: each has a square shaft of 2 to 6 m depth with one or more small irregularly shaped rooms leading off it. Most of the graves had already been looted in ancient times or, in some cases, were identified and cleared by Petrie. In other cases, however, elements of the funerary assemblages remain. The use of the area of the temple complex as a cemetery continued into the Ptolemaic-Roman period. The human remains found in the tombs of the Temple of Amenhotep II are currently being studied. We are focused on reconstructing the health status and life-stories of the individuals buried in two specific contexts:

- The large tomb, consisting of a ramp, a hallway and several chambers, in area A17 that was used in the Middle Kingdom and again in the Late Second Intermediate Period-early New Kingdom. It contained the partially or fully articulated skeletons of 19 individuals along with some other scattered remains. The remains are still being analyzed so as to provide a more precise number of individuals and data on sex, age and pathology.

- The tomb in area C3 dating to the post-temple period (Third Intermediate Period) divided into two chambers which contained six articulated skeletons and scattered fragmentary remains.

The picture that emerges from a preliminary anthropological study is of a very precarious state of health with high infant mortality and degenerative joint disease amongst almost all adults. The frequently very pronounced muscle insertions suggest intense daily physical labour, sometimes so heavy as to induce the formation of osteophytes and enthesophytes in tendon insertions at the margins of the vertebral bodies.

Bioarchaeology, TT 65 Project, Hungarian Mission in Thebes

Jerome S. Cybulski, Robert J. Stark & Tamás A. Bács

TT 65 is a private tomb in the Theban Necropolis on the west bank of the Nile opposite Luxor, Egypt. Our poster presents a contextual overview of human remains from five burial locations studied on site during the 2010 (14th) field season of the Hungarian Mission in Thebes. Highlighted are Shaft 1 in the forecourt of TT 65, which held the known latest burial occupant, and Shafts 3 and 4 on the eastern slope of the forecourt, which held the earliest. Shaft 1 was intended for the original 18th Dynasty owner of TT 65 but never used by him and the tomb itself was abandoned for reasons unknown. Instead, the remains of a naturally preserved Coptic period half-mummy was found in the shaft, possibly disturbed by looters of a nearby grave and hastily discarded. We descended Shaft 4 to study its lone occupant, an 18th Dynasty mummy that had obviously been damaged by looters. The estimated length of this probable male, a reasonable proxy indicator of stature during life, was 165 cm. Shaft 3 provided a challenging mix of at least 17 individuals, some represented only by one or a few bones, others by limbs wrapped in high quality linen plus loose bones matched during the analysis. The latter may have been the original 18th Dynasty occupants: three adult males, a female, a child and an infant as determined from the skeletal remains. Possible later intrusions, accidental or intentional, included three infants, three children, a juvenile, two adult males and two females. Pathology in the overall collection was minimal: porous orbital roofs in youngsters and foci of bone spicules and joint surface erosion in adults that did not resemble the usual scars of degenerative joint disease.

The Bioarchaeology of Akhetaten: Unexpected Results from a Capital City

Gretchen R. Dabbs, Jerome C. Rose & Melissa Zabecki

The short-lived capital city of Akhenaten, Akhetaten (modern Amarna), is unique among ancient Egyptian cities in that it was built, occupied, and abandoned in an narrow temporal spectrum during Akhenaten's reign (c. 1349-1332 BC) and a brief aftermath that ended during the reign of Tutankhamun. The city, as home to Akhenaten and his court, swelled quickly to perhaps as many as 30,000 residents as the officials, soldiers, artists, manufacturers, and others responsible

for its construction, and those in service to higher officials arrived and began the process of building lives in the new capital city. As Egypt's most accessible urban archaeological site, Amarna has long been a source of information on the domestic architecture and material culture of life during the Amarna Period. The addition of bioarchaeological data from the ongoing excavations of the South Tombs Cemetery (STC) at Amarna has enhanced the understanding of life at Akhetaten by providing data to examine not only the conception of death and spirituality through burial treatment, but also the biological ramifications of living during this period of religious and social upheaval through analysis of human skeletal remains.

While probably never intended to reflect the lives of the non-elite public, the themes portrayed in the daily life scenes on the walls in the rock cut tombs of the Amarna elites are dominated by depictions of abundance and opulence, with offerings to the Aten consisting of heaping piles of bread and grain, shanks of meat, and vessels of hearty drink. The ready interpretation of this is the suggestion that life at Akhetaten was of a life full of dietary diversity and surplus. The analyzed skeletal remains from the non-elite STC at Amarna (n=274) reflect the antithesis of this dominant theme, presenting a contrasting picture of a life filled with high levels of general, nutritional, and workload stress. General indicators of stress include the mortality profile (high post-infancy subadult mortality in some areas of the cemetery) and adult stature (Amarna adults are the shortest of any known ancient Egyptian population). Nutritional stress is directly reflected in the skeletal lesions of cribra orbitalia (22.4%), porotic hyperostosis (3.1%), and those lesions characteristic of scurvy (3.1%). Workload stress in adults (n=175) is manifest in the frequency of spinal trauma (Schmorl's nodes 34.9%; compression fracture 20.6%), and degenerative joint disease (overall spine 47.4%). These health patterns are hardly what one would expect for any group of people living in the capital of Egypt during the prosperous New Kingdom. Perhaps the social, religious, and political upheaval caused by Akhenaten's devotion to the Aten extended into the realm of individual health as well.

Birth in Ancient Egypt: Timing, Trauma, and Triumph? Evidence from the Dakhleh Oasis

Tosha L. Dupras, Sandra M. Wheeler, Lana Williams & Peter Sheldrick

The mortuary landscape and inclusion of all individuals, no matter age or pathological condition, in the Kellis 2 cemetery in the Dakhleh Oasis presents a unique situation allowing for examination of birthing practices to better understand maternal and infant mortality in relation to childbirth during the Romano-Christian period in Egypt. Results of bioarchaeological investigations indicate a pattern of seasonal infant birth occurring during March-May, which correlates directly with the seasonal mortality pattern for birthing age women. In addition, evidence of skeletal trauma linked to the birthing process, including cases of humerus varus deformity, and fractures of the ribs, clavicles, humeri,

and cervical vertebrae, demonstrate that in many cases birth was a difficult and dangerous event that most likely required the aid of a midwife. While ancient epigraphic sources provide sparse evidence of birthing practices, the evidence from Kellis 2 suggests that the majority of birth traumas in individuals from the cemetery are most likely due to factors such as prolonged labor, compression and traction forces, and extraction practices during the birth process. Also, the difficulties surrounding childbirth directly relate to the patterns of maternal and infant mortality seen within the Kellis 2 population.

Studying Egyptian Mummies in the Field

Salima Ikram

Although many people have studied mummies, dig directors and excavators often are not aware of all the information that can be derived from these artefacts and how they can be studied in order to provide the maximum of information.This paper emphasises what is possible to do in the field with a minimum of funding and the least amount of technology, and aims to provide investigators with the range of possibilities of information that can be derived from mummies. This includes an overview of the evidence that can and should be obtained from a mummy, both in the field and in ideal storage/museum situations; the different methods that can be employed to extract the material; and a recording sheet that facilitates the recording.

A Case of Metastatic Carcinoma in an Old Kingdom-Period Skeleton from Saqqara

Iwona Kozieradzka-Ogunmakin

Intensive study of ancient Egyptian human remains over the past 100 years has produced undisputable evidence for the presence of primary and secondary malignancies in this past population. A secondary malignancy was identified in the skeletal remains of an older female recovered from the Old Kingdom necropolis at Saqqara West. Macroscopic examination of the human remains revealed an extensive osteolytic lesion in the neurocranium and further smaller perforations surrounding the lesion. Additional focal destruction that involved only the endocranial surface was revealed through radiographic imaging of the skull. Visual examination of the post-cranial skeleton revealed an osteolytic lesion that developed in the lateral body of the fifth lumbar vertebra. These lesions are consistent with metastatic carcinoma, a malignant neoplasm that can spread to bone directly from an adjacent soft tissue tumour, or indirectly via the blood or lymphatic systems. As a result of the poor preservation of soft tissue, including the viscera, identification of the primary site of cancer in the present case was highly problematic and speculative. However, taking into consideration the distribution and morphology of the observed lesions, the individual's sex and age at death, as

well as modern incidence rates of metastatic carcinomas, the Saqqara case is likely to be a metastasis from carcinoma of the breast. This is reported to be the most common cause of metastatic bone disease in females, according to modern clinical studies.

Study of Growth Arrest Lines upon Human Remains from Kharga Oasis

Roger Lichtenberg

Since 1982, almost 300 mummies and far more numerous skeletal remains belonging to three cemeteries of Kharga oasis, Douch, Ain el-Labakha and El-Deir, have been studied by X-rays on the sites. The study of Growth Arrest Lines (GAL) was part of the whole work. These lines occur inside bones after a long disease or periods of malnutrition. It is possible to see them only by X-rays (otherwise by looking at sections of bones under a microscope). The research was initiated after I had knowledge of the works of Gray who X-rayed a lot of mummies housed in some European museums (mainly British Museum and Leiden Museum). Gray found about 30% of GAL upon mummies. From the start, at Douch, I was astonished to find almost twice the number of GAL. It was the same at Labakha and Deir with some variations. GAL are undoubtedly in connection with the standard of living, so they seem to be an excellent criterion to evaluate health and social level inside populations.

From Egypt to Lithuania: Marija Rudzinskaitė-Arcimavičienė's Mummy and its Radiological Investigation

Dario Piombino-Mascali, Lidija McKnight, Aldona Snitkuvienė, Rimantas Jankauskas, Algirdas Tamošiūnas, Ramūnas Valančius, Wilfried Rosendahl & Stephanie Panzer

Important findings have recently been revealed concerning a mummy in the collection of Marija Rudzinskaitė-Arcimavičienė, the first Lithuanian Egyptologist. From 1922 onwards, she lectured at the Vytautas Magnus University, Kaunas. As a consequence of her three visits to Egypt during the early 20th century she amassed a small collection of Egyptian objects which she bequeathed to the National Museum of Art in 1940. The collection included a mummy acquired from the Egyptian Museum in Cairo during her 1924 trip, together with the inner coffin, but without a lid. Although the exact provenance of the artefact is not known, it was reported to come from Thebes. According to Rudzinskaitė-Arcimavičienė the coffin was associated with the mummy, and in the coffin inscriptions, the individual concerned is referred to as a singer of the god Amun. However, one cannot be absolutely sure of this, as there are no inscriptions associated with the mummy itself. The coffin has been approximately dated to the 21st Dynasty or slightly later (c. 1050-900 BC) although the exact date has

not yet been established. The name of the owner is not mentioned in the coffin inscriptions. Seemingly, it was made for any woman of rank rather than for a specific individual. The owner's name may have been recorded on the coffin lid; however, this has now unfortunately been lost or at least separated from the base at some point in history. During conservation attempts of the mummy in 2011, a complete CT investigation was carried out. This revealed no evidence of craniotomy, the absence of the cervical spine, as well as approximately 38 ribs indicating that more than one individual was represented. Furthermore, post-mortem tooth loss was reported with the dislodged teeth visible intracranially and within the chest and abdominal area. The skeletal elements represented appeared embedded from the head to the pelvis and at the proximal femoral level within a inhomogeneous mass consistent with sand. Very little soft tissue was visible and disarticulations were also noted. Radiocarbon dating obtained from analyses of linen removed from the wrappings was compatible with the archaeological dating of 21st Dynasty (2843 a BP +/- 27,1 = cal BC 1041-941). The authors propose two possible hypotheses: either the body was wrapped when the body had become partly skeletonized, or that ancient linen was reused to produce a fake mummy at some point in history to be sold as a tourist souvenir. Scientific analysis of this mummy is ongoing in the hope of providing clarification to this mystery.

Canopic Jars: A New Source for Old Questions

Frank J. Rühli, Abigail S. Bouwman & Michael E. Habicht

Canopic jars and their contents are a major part of the ancient Egyptian mummification tradition. Surprisingly, they have been widely neglected for modern paleopathological analyses. Very few histological and CT-based studies exist. With advances of diagnostic imaging as well molecular technologies, the content of canopic jars shall become a major research object. The aim of this presentation is twofold: First, the known filled canopic jars currently stored in Egypt will be presented. Second, we raise some specific research questions, which give a hint to the enormous potential of canopic jar contents for future analyses of human remains in Eygpt. As examples, the canopic equipment of Heteperes I (4th Dynasty), Hor I (13th Dynasty) or Kia (18th Dynasty) will be shortly presented. Some research questions, such as tissue identification and pathologies by CT-scanning and histology or kinship analyses and matching with "corresponding" mummies by molecular techniques, will be explored theoretically.

A Decade of Advances in the Paleopathology of the Ancient Egyptians

Lisa Sabbahy

The study of human remains from ancient Egypt has made great strides in the last decade, for the most part due to advances in medical engineering and biomolecular techniques. Ancient DNA has been retrieved from bacteria, viruses and parasites, giving specialists an entirely new method for recognizing disease. For example, this has totally changed our perspective on tuberculosis in ancient Egypt, not only concerning the extent of its presence in the ancient Egyptian population, but in identifying the specific *Mycobacterium* strains causing the infection. Recent CT-scan studies have identified atherosclerosis and heart disease as a significant problem among the upper class of ancient Egypt, particularly the priestly families. Also, the question of whether or not cancer is an old disease has been brought up again because of a recent identification of metastatic prostate cancer in an Egyptian mummy. This paper will present an overview of recent discoveries in ancient Egyptian paleopathology, made both in medical studies and excavations in the field.

Resolving a Mummy Mismatch

Bonnie M. Sampsell

The Wayne County Historical Museum in Richmond, IN (USA) owns an Egyptian mummy in a decorated wooden coffin. The coffin and its mummy were purchased by the museum's founder, Mrs. William Gaar, from the Cairo antiquities dealer, E. Hatoun, on her trip to Egypt in 1929. The design of the coffin allows it to be dated to the early 22nd Dynasty with confidence. Coffins of this type were made in great quantities for the priestesses at the Theban Temple of Amun (Karnak). The mummy, however, has no distinguishing mummification features that would allow it to be dated. X-rays revealed that the bones are disarticulated and disarranged. An experienced Egyptian physical anthropologist studied photos of the skull, which is unwrapped, and concluded that the mummy belonged to a man. Mismatches of gender or period between mummies and their coffins are fairly common in museums around the world with many of them arising from efforts of 19th century dealers to make up attractive combinations. Two lines of evidence now suggest that the Wayne County combination of coffin and mummy was ancient: First, the presence of an intact set of tenons shows that the coffin was opened carefully (probably by employees of Hatoun, rather than by tomb robbers) and second, carbon dating of samples of the mummy and its bandages are consistent with the date of the coffin's manufacture arguing against a reburial or recycling of funerary goods.

The People of Sayala During the Late Roman to Early Byzantine Period

Eugen Strouhal

The site of Sayala was excavated by the Austrian mission to Egyptian Nubia in scope of the International Action of Saveguarding Nubian Monuments of UNESCO. Besides several archaeological publications, an anthropological one concerning the C-Group and Pan Grave Culture was published by Strouhal and Jungwirth (1984). After a delay caused by political and professional reasons, a second volume dealing with Late Roman-Early Byzantine Period has been currently pepared for print. in the Austrian Academy of Sciences, Vienna, in English. It contains 12 chapters on the archaeological backgroud, survey of preliminary anthropological reports, methodology, list of the examined individuals, demographic analysis with vital statistics, craniometry, osteometry, cranioscopy and osteoscopy, analysis of infant and child skeletons, paleopathology, paleotherapy and dentition. Main results and a few examples will be presented.

Royal Musical Chairs: To Whom Does the New Pyramid in Saqqara Belong?

Afaf Wahba

The Teti funerary complex is located in Saqqara to the northeast of the step pyramid and the funerary complex of King Djoser. The site has been under excavation by an Egyptian mission directed by Zahi Hawass and Hakim Karar since 2006, and to date approximately 100 burials have been unearthed, ranging in date from the Late Period (664-332 BC) in the later phases of the cemetery, to the reign of King Teti (c. 2345-2181 BC), the founder of the 6th Dynasty, in the phase related to the Old Kingdom structures. Some of these burials were *in situ*, and some were disturbed by later activity at the site. The osteological analysis of the burials is ongoing. In 2008, the team discovered a small pyramid in an area of the cemetery directly associated with the pyramid of King Teti. While a cartouche or other means of positively identifying the owner of this pyramid is yet to be found, it has been suggested that the tomb may be that of queen Sesheshet, the mother of King Teti and grandmother of the 6th Dynasty King Pepi I. However, the osteological analysis of the remains found in the burial chamber may suggest otherwise. This paper will provide a brief historical background of the period surrounding the reign of King Teti, and discuss a possible identification of the woman found in the new pyramid.

"Behind Every Mask there is a Face, and Behind that a Story." Egyptian Bioarchaeology and Ancient Identities

Sonia Zakrzewski

Bioarchaeology in Egypt has frequently focussed upon one site or one aspect of health and disease. This paper develops from these excellent foundations, and demonstrates the potential of integrative research into skeletal and mummified human remains and its use in further developing and modifying current ideas as to social identities within Egypt. The paper debates the theoretical aspects of archaeological identity and personhood. Biological expressions of identity are analysed and discussed, and the interactions with Egyptological expressions of identity are then evaluated. Studies of Egyptian identity have included aspects of ethnicity, gender roles and disability. This paper attempts to demonstrate the biological expression and interplay of these multiple strands of identity within past Egyptian populations.

Dogs at El Deir

Françoise Dunand, Roger Lichtenberg & Cécile Callou

Hundreds of mummies and skeletal remains of dogs have been discovered inside three tombs of the Ptolemaic-Roman necropolis at El-Deir (Kharga oasis). Human tombs had been reused to bury dogs which, obviously, had been offered as *ex voto* to a canine deity, whose temple has not been discovered till now. Other dog remains have been discovered at Dabashiya, not far from Deir. On this site, about 80 well-preserved mummies have been X-rayed, showing some off hand practices of embalmers, even though the mummies were carefully wrapped and painted. A thorough study of the dogs has been pursued by Cecile Callou, from the Museum of Natural History in Paris, in order to establish as far as possible their breed, physical conditions and possibly circumstances of death. The purpose of this contribution is to present the discovery and main results of our researches upon these remains which seem to be rather rare, as the last important discoveries of dog remains date from early 20th century in Middle Egypt.

Feline Descendant of the Red or the Black Land: A Multidisciplinary Investigation of an Unusually Large Ancient Egyptian Cat Mummy

Carolin Johansson, Geoffrey Metz & Margareta Uhlhorn

The present investigation demonstrates the difficulty of securely determining the species of certain ancient Egyptian cat remains with regards to discussions on the possible presence of the Jungle cat (*Felis chaus*) among the tame and/or domestic cats of ancient Egypt. An exceptionally large and well-preserved cat mummy was studied by means of X-ray computed tomography and molecular

methods. The skeletal remains revealed by radiology displayed a severely damaged cat with features characteristic of both the *F. chaus* and the ancestral species of the common domestic cat, *Felis silvestris*, as well as attributes with values intermediate between the two candidate species. Together with the results of the analyses of ancient mitochondrial DNA extracted from a caudal vertebra belonging to the cat mummy in question, and a review of quantified ancient Egyptian cat remains in the literature, it can be concluded that species identification is not always straightforward. We argue that more reference material is needed to precisely describe the taxonomic positions of the different kinds of cat remains of ancient Egypt and that a possible impact of occasional hybridization between the Jungle cat and the domestic cat kept by the ancient Egyptians may be considered. This study has also shown that multiple major matrilines, perhaps from more than one domestication event, existed among the mummified cats of ancient Egypt, at least by Roman times.

The Potential of Dendrochronology in Egypt: Understanding Ancient Human/Environment Interactions

Pearce Paul Creasman

Basic tree-ring analyses have been applied to wooden archaeological remains around the world for nearly a century and with great success, but only rarely and incompletely to Egyptian material. When tree-ring studies are applied to archaeology (known as "dendroarchaeology"), they are most often employed to address chronological questions, for which there is a great need in Egypt. Although building the appropriate tree-ring chronologies for Egypt will require the cooperation of numerous stakeholders and will take many years, there are also immediate contributions to be made, as dendroarchaeological interpretations are not limited only to questions of time. This contribution introduces the enormous potential of dendrochronology for enhancing our understanding of such ancient Egyptian human/environment interactions, in addition to stating its clear chronological benefits (compared to radiocarbon dating) and providing a brief introduction to the methods of dendrochronology.

Preface

Salima Ikram, Jessica Kaiser, Roxie Walker

Bioarchaeology, the study of biological remains in an archaeological context, has great potential in Egypt as the dry climate has successfully preserved a plethora of bone, tissue, and plant remains which are able to add considerably to our understanding of the environment of the ancient Egyptians as well as to the people themselves. Although mortuary archaeology has long been a focus of Egyptian archaeology, actual skeletal remains have historically had a very marginal role in Egyptian archaeology, often being discarded after, or even without study. The same holds true for zooarchaeological (ancient fauna) and archaeobotanical (ancient plant) remains, which have traditionally often been overlooked in favour of more "valuable" artefacts, an attitude that was current until the 1980s.

Recently, the attitude towards these bioarchaeological remains has changed, and researchers have begun to realize their tremendous value as an archaeological resource. These direct links to past populations offer a wealth of information on ancient lifestyles and behavior, diet and nutrition, health and disease patterns, migration and demography, animal husbandry, the ancient natural environment and human variability. As a result, several specialized research projects and publications have appeared. However, the potential of these bioarchaeological resources can only be fully realized if the results of recent research are integrated with archaeological and historical findings. Unfortunately, the varying backgrounds of bioarchaeological researchers in Egypt (biology, zoology, osteology and medicine for example) have created a lack of a common starting point for bioarchaeological research, and it is difficult to get a complete overview of available data. In addition, full integration of bioarchaeological and Egyptological data is somewhat problematic, since scholars with a background in biology or anthropology are often somewhat isolated from the existing network of Egyptologists and archaeologists.

In January of 2010, the American Research Center in Egypt, in collaboration with the American University in Cairo and the Institute for Bioarchaeology, organized the first international meeting of human remains specialists working in Egypt, the 2010 Conference of Human Remains in Egypt, in an effort to address some of these concerns. The two-day conference provided a venue for scholars from ten different countries to present their research. The success of the conference, coupled with issues raised at the Round Table discussions that concluded the meeting, prompted us to host another meeting in 2013, and to expand the scope of the conference to include not only human remains, but also zooarchaeology and archaeobotany.

The main aim of the conference and this resulting volume is to stress the importance of such studies, and to help integrate the bioarchaeological, archaeological, and textual materials in order to elucidate the history, environment, and culture of ancient Egypt in a holistic manner. A second objective, and the reason for holding the conference in Cairo, was to provide a local venue for Egyptian scholars to meet and present their research. The conference theme of integration is further reflected in the variety and international spread of the papers submitted for publication by scholars from thirteen different countries, which in addition to several contributions on bioarchaeology and paleopathology also cover topics as diverse as dendrochronology, DNA- and X-ray studies of animal mummies, examination of the organic contents of canopic jars, the investigation of ancient identities and birthing in ancient Egypt. We hope that this volume will spur further discussions and collaboration between scholars from different disciplines, creating a synergy that will help advance our study of ancient Egypt.

The conference could not have gone forward without the financial and logistical support of the Wenner-Gren Foundation, the American University in Cairo, the Institute for Bioarchaeology, the American Research Center in Egypt. and the Council of American Overseas Research Centers. Staff members of these institutions, Lilian Boulos, Iman Shehata, Mary Sadek, and Jane Smythe were particularly helpful and we owe them a debt of gratitude. Thanks are due to André J. Veldmeijer for producing the abstract booklet, assisting with the publication process of the proceedings, and providing moral support, Mahmoud Tawfik of the Flamenco Hotel for his patience and professionalism, and to the American University in Cairo group (Ariel Singer, Darcy Hackley, Nicholas Brown, Kenaya Camacho, Amy Wilson, Taylor Woodcock, Natalie Marquez, Emily Layton, Louise Bertini, Emmy Malak, and Sarah Marei) whose tireless efforts contributed significantly to the success of the conference.

Burials under the Temple of Millions of Years of Amenhotep II – Luxor, West Thebes

Giovanna Bellandi, Roberta De Marzo, Stefano Benazzi & Angelo Sesana

Introduction

The present study forms part of the larger investigation of the necropolis located within the Temple of Millions of Years of Amenhotep II (18th Dynasty, 1428-1397 BC) on the west bank of the Nile at Luxor (Thebes). The excavation of the temple has been ongoing since 1997 under the direction of Angelo Sesana of the CEFB – Centro di Egittologia "Francesco Ballerini" (Como, Italy). The main focus of the project has been unearthing the remains of the temple's structure and completing the work begun during 1894-1895 by British archaeologist Sir W.M. Flinders Petrie (1896), expanding and rendering more precise the summary data that he recorded. The excavations (15 seasons to date) have permitted the development of a detailed plan of the temple (Sesana 2010). Excavation has continued down to bedrock and has since 2007 revealed numerous funerary structures and complexes that occupied the area both before the temple was constructed and again after its abandonment and the looting of its stones.

The cemetery occupied the whole precinct of the temple, forming part of a wider group of burials extending from the temple of Tuthmosis III to that of Tuthmosis IV and including the still-impressive remains of the Ramesseum. The tombs of this broader necropolis belong to three distinct phases between the Middle Kingdom (2055-1650 BC) and the Ptolemaic Period (305-30 BC).

Prior to construction of the temple, the area was occupied by a necropolis dating back to the period between the Middle Kingdom and the end of the Second Intermediate Period/beginning of the 18th Dynasty. These burials were disturbed by temple construction. Two underground tomb complexes from this pre-temple cemetery, consisting of a ramp, a hallway and several chambers, are currently being studied. The tomb-fill has provided unexpectedly rich finds: many types and sizes of vessels, terracotta offering trays, faience beads and semi-precious stone amulets, along with skeletal remains.

After the temple was abandoned, the area was again used as a necropolis from the Third Intermediate Period onwards. Twenty-four tombs of this phase have been investigated (17 containing human remains): each consisting of a square shaft two to six meters deep with one or more small irregularly-shaped rooms leading off it. Most of the graves had already been plundered in antiquity or, in some instances, identified and cleared by Petrie. In other cases elements of the funerary assemblages remained. Funerary use of the area continued into the Ptolemaic-Roman period.

This article is a report both on the preliminary analysis of a sample of 103 individuals found in the various tombs at the temple and the contents of two particular tombs. During the most recent field season, we focused our efforts on reconstructing the health status and life-stories of individuals buried in tomb A17 (studied by G. Bellandi) and shaft-tomb C3 (studied by R. De Marzo) (Fig. 1). These two tombs will be addressed in depth as examples of the two most common burial types at the site.

Methods

Each burial was treated individually, taking into account general information about the excavation of the skeletal remains and taphonomic considerations (Duday 2005). Determination of sex was based on discriminatory characteristics of the skull and pelvis (Acsadi and Nemeskeri 1970; but see also Buikstra and Ubelaker 1994). Estimation of age was based on several methods: degree of tooth wear (Lovejoy 1985); ectocranial suture closure (Meindl and Lovejoy 1985); morphology of the auricular surface of the ilium (Lovejoy *et al.* 1985); age-related modification of the pubic symphysis (Suchey and Brooks 1988); variations of the surface and margins of the sternal ends of the ribs (Iscan *et al.* 1984, 1985); the acetabulum-surface headset method (Rougé-Maillart *et al.* 2004; 2009) and the stages of fusion between the bodies of the sacral vertebrae (Belcastro *et al.* 2008). Sub-adults were aged according to the level of ephiphyseal closure and/or fusion of ossification centers (Scheuer and Black 2000), dental eruption and development (Ubelaker 1989) and long-bone length (Stloukal and Hanáková 1978; Scheuer and Black 2000). Goodman and Rose's (1990) regression equation was used to calculate the age of onset of enamel hypoplasia. Anthropometric measures were taken using the guidelines established by Martin and Saller (1957). Stature was estimated using the method of Trotter and Gleser (1977) and the new method of Raxter *et al.* (2008) for ancient Egyptian remains. Sjøvold's formula (1990) was employed for those individuals where it was not possible to determine sex. Non-metric traits were evaluated according to Buikstra and Ubelaker (1994).

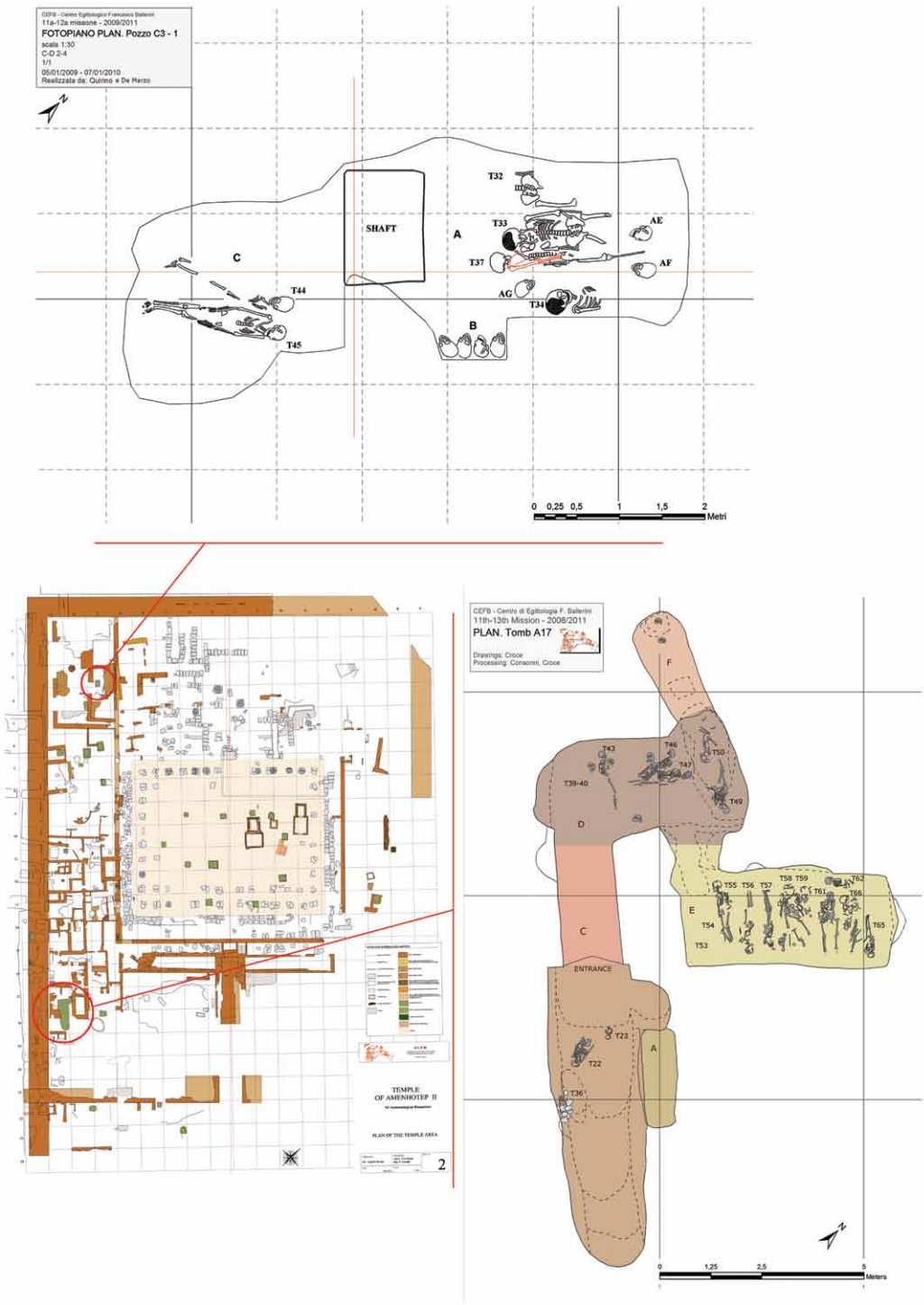

Fig. 1. General plan of the temple (drawing: E. Negri) and the two burial contexts: tomb A17 (drawing: E. Croce and A. Consonni) and shaft-tomb C3 (map: T. Quirino, S. Benazzi and R. De Marzo).

Results

General Palaeodemographic Results: Entire Site

Overall, we analysed 23 tombs of various types and from different periods that returned a minimum number of 198 individuals (MNI: the minimum number of individuals represented determined from the cardinality of the most numerous category of skeletal elements recovered; White and Folkens 2005: 339), of which 69 were fully or partially articulated. Our estimates of sex and age percentages also included skulls and isolated postcranial remains attributable to single individuals (on the basis of their relation to a specific burial context). We were only able to establish age-range and/or sex for a total of 103 individuals. For 71 individuals we were able to establish sex and for 86 we were able to establish age (Tables 1 and 2).

Tomb A17

In 2009, a large tomb consisting of a sloping ramp ending in a small open courtyard with a niche (designated chamber A) on the northern side and a hallway and several chambers cut into the bedrock (C, D, E and F) was discovered in area A17, in the southeastern part of the temple (Fig. 1). Study of morphological, spatial and functional aspects of the large pottery assemblage recovered from the excavation allows us to define different stages of occupancy of this tomb, ranging from the early Middle Kingdom to the early New Kingdom (Consonni and Sesana in press).

Sex	Number	Percentage
Male	31	30%
Possibly male	5	5%
Female	28	27%
Possibly female	7	7%
Undetermined#	24	23%
Not determinable*	8	8%

*Table 1. Estimated sex - overall sample. #Cases in which skeletal elements necessary for sex assessment were absent; *Generally juveniles where sex-dependent characteristics are not evident.*

Age range	Number	Percentage
Infans I (age fetus/0-7 years)	13	13%
Infans II (age 7-13 years)	8	8%
Juveniles (age 13-21years)	9	9%
Young adults (age 21-35 years)	20	19%
Mature adults (age 35-60 years)	34	33%
Old (age >60 years)	2	2%
Not determinable	17	16%

Table 2. Estimated age ranges - overall sample. Table adapted from Sheuer and Black (2000) after Knussmann (1988).

The tomb contained the remains of at least 50 individuals, 22 of which were fully or partially articulated skeletons. In addition, 28 further individuals were represented by crania and other scattered remains. In chamber E we were able to identify nine primary burials. Based on associations between pottery and skeletal remains and the stratigraphic location of the remains at the time of discovery, it was possible to identify two distinct phases of tomb use, the earliest at the beginning of the Middle Kingdom and the later phase dating from the end of the Second Intermediate Period, to the beginning of the New Kingdom. Thirty-two individuals could be dated: 11 to the Middle Kingdom and 21 to the Second Intermediate Period/New Kingdom. The results for sex and age determination are summarized in Tables 3-6.

Funerary Practices

The extensively studied practice of embalming (Peck 1998; Ikram and Dodson 1998; Macke *et al.* 2002) was used from the earliest dynasties when changes in burial customs led to the introduction of methods for the artificial preservation of bodies, and the custom continued until the Christian era. During the period that tomb A17 was in use (early 12th Dynasty and early 18th Dynasty) embalming practice must have been well established, but no direct traces of bandages or materials for the preparation of bodies (e.g. traces of resins, common from the 12th Dynasty on) have been documented. The poor condition of the skeletal material made it impossible to identify perforation of the cribriform plate of the ethmoid bone for the removal of the brain, a practice described as occurring from the end of the Old Kingdom, which became standard from the 18th Dynasty (Ikram and Dodson 1998; Macke *et al.* 2002). However, the rich grave goods, especially from chamber E, suggest that the individuals buried in the tomb were sufficiently high on the status scale that they likely received some form of embalming treatment. It is hard to ascertain exactly how the bodies in tomb A17 were originally placed and treated: nevertheless some skeletons showed evidence of having once been wrapped in bandages even when other evidence of mummification was not present. In some cases the joints of the hands and feet as well as general skeletal articulation suggested wrapping, especially in the individuals found in chamber E. The vertical position of the clavicles (which suggests a compression or bandaging of the chest) allows us to hypothesize that the bodies were originally interred supine or, in some cases, on their sides, tightly bound, with hands on their hips.

Anthropometric Data

Measurements of the skulls were more often possible for the Second Intermediate Period/New Kingdom burials in the sample analyzed from tomb A17, due to the poor preservation of the skeletal material. Furthermore, not all measurements were possible on every skull. The measured skulls generally appear long and high (42% N=7 dolichocephalics; 75% N=8 hypsicephalics; 86% N=7 acrocephalics) often with wide noses (63% N=11) but without prognathism. Such characteristics are

Sex	Number	Percentage
Male	3	27%
Female	6	55%
Undetermined	2	18%

Table 3. Tomb A17 Middle Kingdom sex data.

Age range	Number	Percentage
Infans I (age foetus/0-7 years)	2	18%
Infans II (age 7-13 years)	0	0%
Juveniles (age 13-21 years)	1	9%
Young adults (age 21-35 years)	1	9%
Mature adults (age 35-60 years)	6	55%
Old (age >60 years)	0	0%
Not determinable	1	9%

Table 4. Tomb A17 Middle Kingdom age ranges.

Sex	Number	Percentage
Males	11	53%
Females	2	10%
Undetermined	5	23%
Not determinable	3	14%

Table 5. Second Intermediate Period/New Kingdom sex data.

Age range	Number	Percentage
Infans I (age foetus/0-7 years)	3	14%
Infans II (age 7-13 years)	2	10%
Juveniles (age 13-21 years)	1	5%
Young adults (age 21-35 years)	1	5%
Mature adults (age 35-60 years)	6	29%
Old (age >60 years)	0	0%
Not determinable	8	37%

Table 6. Second Intermediate Period/New Kingdom age ranges.

similar to those described in other recent studies (Zakrzewski 2007a). The data are insufficient to give a truly reliable assessment, but in the future it should be possible to expand the sample.

Observations on the stature of the individuals assigned to the Middle Kingdom phase of tomb A17 revealed very low averages: 153.1 cm for women and 160.6 cm for men (Fig. 2). This tends to support the hypothesis of a reduction in stature in Middle Kingdom times, being similar to other published estimates (Zakrzewski 2003). For the skeletons of the most recent phase in tomb A17 stature estimation was not possible due to the poor condition of the skeletal material.

Reconstruction of Health Conditions and Functional Stresses

In the samples from tomb A17, spinal osteoarthritis is the most common pathological condition among adults (75% N=12). This pathological condition, often documented in ancient Egypt (Macke *et al.* 2002; Nerlich and Zink 2003; Rose 2006) is here mainly presented as arthritis of the spine (spondylosis), and is often associated with marked vertebral osteophytes on cervical and lumbar (with two cases of fusion) vertebral bodies. Even though intrinsic and extrinsic factors (e.g., genetic predisposition, obesity, age, sex and even diet and ethnic origin) are instrumental in the development of osteoarthritis the high frequency of

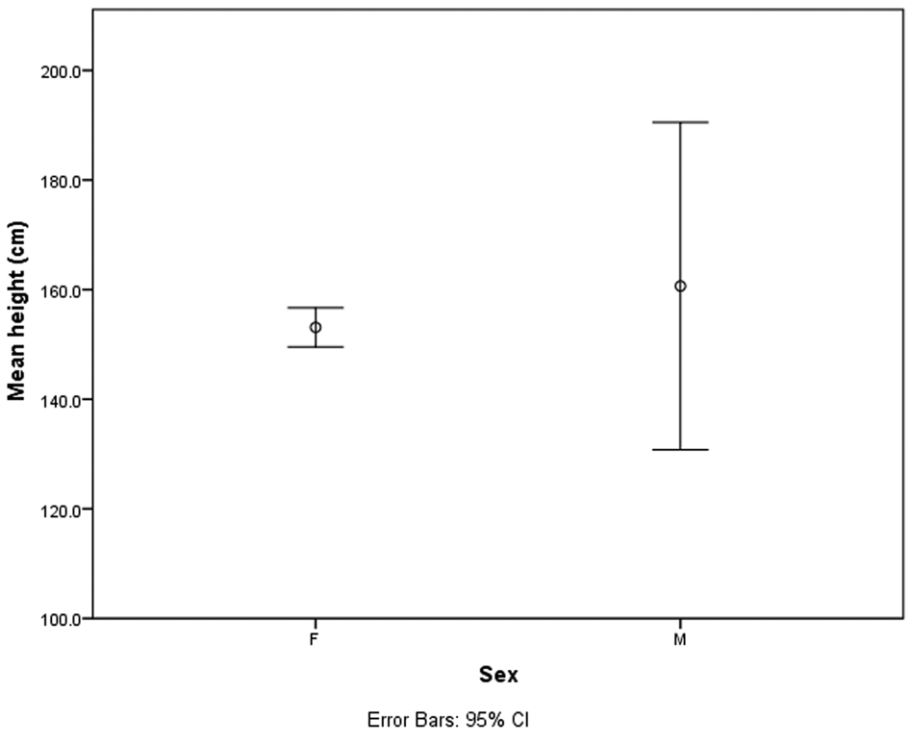

Fig. 2. Middle Kingdom period sample average stature – error bars are 95% CI for mean stature (analysis: C. Alexander).

osteoarthritis in our sample (it is found in almost all individuals above forty years of age), might suggest that its pathogenesis is closely related to the stress load and physical work undertaken during an individual's life.

The presence of porotic transformation of the orbital bone and on the external surface of the cranial vault (five cases for cribra orbitalia and one for cribra cranii, respectively) in five individuals (two women and three children) is probably due to some form of chronic anaemia: perhaps a result of malnutrition or parasites such as schistosomiasis (Sandison and Tapp 1998: 40). The presence of episodes of stress, especially among children (possibly as a result of malnutrition, disease and parasites), is also attested by the frequent cases of Linear Enamel Hypoplasia, (LEH): i.e. a dental defect caused by periods of enamel deficiency occurring during the formation of permanent teeth in early childhood (Hillson 1996: 291). Based on the regression formula in Goodman and Rose (1990) the onset of LEH tended to occur around three years of age with three individuals displaying a second event around 5-6 years of age.

Four individuals also showed evidence of post-traumatic bone remodelled following fractures. In two cases, involving a rib and a nasal bone, respectively, the remodeling was incomplete, suggesting the individuals had died before the injuries were completely healed. In the other two cases it was clear that the repair was completed, meaning the individuals in question survived for a significant period of time after their injuries despite the severity of the fractures: a blunt force trauma to the skull in one individual, and a perforation of the scapula in the other. Three cases of benign tumors of the skull (osteoma) were also recorded.

An interesting case of pathology found in A17 was skeleton T46. The biological profile of T46 resembles other remains found in similar geographical and chronological contexts (Sandison and Tapp 1998; Nerlich and Zink 2003): a young person (13-14 years) with a spinal pathology manifested in lytic lesions of the vertebrae (especially evident in the bodies of the lower thoracic vertebrae and the first lumbar; Fig. 3). T46 can likely be assumed, even in the absence of further and more precise molecular investigations, to be a juvenile case of tuberculosis, analogous to that found at Abydos (Buikstra *et al.* 1993; Baker 1999).

The characteristic that truly unites all the individuals analyzed in tomb A17 (sometimes even the children) is heavy dental wear. It is a phenomenon widely documented in skeletal remains from ancient Egypt (Rose *et al.*1993; Harris *et al.* 1998; Nerlich and Zink, 2003; Forshaw 2009), which appears to be independent of social class or age, although there is some regional variation (Rose *et al.* 1993). The heavy wear has been attributed to various factors, including the strong abrasive effect of Egyptian food, due to the mode of preparation of the flour (containing debris from millstones), the type of cereal used, and also to environmental factors, since the all-pervasive Egyptian sand was likely part of everyday life in ancient times (Rose *et al.* 1993). Heavy wear is often associated with other dental conditions such as infections caused by exposure of the pulp chamber, abscesses, periodontal disease and the ante-mortem loss of teeth (Fornaciari and Giuffra 2009). Besides, the incidence of caries in Predynastic and Dynastic Egypt seems to be low (Harris *et al.* 1998, Forshaw 2009). This situation changes over time: by the Ptolemaic

Fig. 3. Juvenile case of tuberculosis, T46, A17 chamber E (photo: G. Bellandi).

age we see an increase in the presence of caries (Forshaw 2009), due to changes in eating habits (with the increase in use of leavened bread, honey, dates etc.; Forshaw 2009). A similar pattern is also seen in the remains from tomb A17. Of particular interest is the difference in the prevalence of caries in the samples belonging to the two different burial phases. For the individuals buried in chamber E (Middle Kingdom) the fraction with caries was 22.2% of the nine cases available for evaluation, while in the next phase which contained five individuals available

for evaluation, the disease is more prevalent (40%). It should be noted, however, that the sample is definitely too small to allow statistically valid conclusions (a test for equality of proportions fails to reject H0) and it should also be noted that this phenomenon of changes in the occurrence of caries across time should be approached with caution since considerable variation has been observed across samples (Rose *et al.* 1993).

Shaft C3

Tomb C3 is a shaft burial (Fig. 1), dated to the Third Intermediate Period (1069-664 BC) based on artifacts found during the CEFB excavations in 2009 and 2010. The tomb entry – 3.5 meters deep – is in the northwest of the temple area. In addition to the Third Intermediate Period artifacts, the shaft also contained later New Kingdom and Coptic ceramic sherds along with sandstone blocks apparently robbed from the abandoned temple (Sesana and Quirino 2010), suggesting the re-use and/or looting (and subsequent backfilling) of the tomb some time after its construction.

At the base of the tomb shaft are the entrances of chambers A and C. The north-eastern chamber, A, was found still sealed with blocks of mudbrick, limestone and sandstone. At the entrance of the chamber there were several beads and fragments of human crania. The backfill, consisting of a sandy matrix, was very compacted. Inside were two poorly preserved sarcophagi. Three fully articulated skeletons – designated T32, T33 and T34 – were recovered from chamber A, all interred with the cranium to the SSW. Remains of a fourth individual – designated T35 – were found mixed with ovi-caprid bones. In the same stratigraphic level two isolated crania (designated AE and AF) were recovered, oriented towards the north. Beneath skeleton T33 we found the remains of a fifth individual, designated T37, and another isolated cranium (AG), again oriented towards north. Additional ovi-caprid remains were found on the west side of the chamber.

On the southeast side, near the entrance, we identified a recess (designated chamber B) that was closed with a mudbrick wall. Within the recess two ushabtis were found, both intact and fragmented. Moreover, the recess contained four crania (designated AH, AI, AL and AM) and scattered ovi-caprid remains.

The entrance to chamber C, on the southwest side of the shaft, was closed by an irregular wall of large bricks and sandstone blocks (about 13 in total, of which three bore traces of decoration). The southern corner of the shaft contained two fragments of a limestone stela depicting an offering scene, accompanied by a hieroglyphic text. The stela fragments appear to have formed part of the wall closing the entrance to chamber C. The compact sand backfill of the chamber yielded a number of globular and tubular beads along with ceramic sherds. Inside the chamber, we found the fully articulated remains of two individuals with their heads oriented towards the northeast, designated T44 and T45. The latter showed signs of partial mummification, evidenced by the remains of bandages and bituminous material preserved in the pelvic region. In sum, the shaft contained a minimum number of 20 individuals, the majority of which could be assessed with respect to age and sex (Tables 7 and 8).

The absence of "old" (over 60) individuals is noteworthy, and could possibly be a reflection of the numerous pathologies and stresses related to daily life encountered in the material, which may have led to a fairly low average age-at-death of the individuals in the sample, even though methodological issues (i.e., methods for age determination have been developed on recent populations, and might underestimate the real age at death of archaeological populations) cannot be ruled out.

Anthropometric Data

Calculation of stature was only possible for five individuals: three male individuals, one female individual and an individual whose sex was indeterminable. In the male individuals, the average height was calculated as 169.5 cm (Raxter *et al.* 2008). The only female individual instead is between 156 and 161 cm. The stature of the individual of indeterminate sex was estimated with Sjøvold's formula, resulting in a height estimation of 163-168 cm.

The result of the anthropometric analysis were inconsistent. There were no substantial differences between the individuals recovered from the two chambers and the recess – the overall sample was fairly homogeneous. Postcranial indices, on the other hand, yielded more uniform results: indeed almost every individual showed a more developed upper body relative to the lower body (Olivier 1960). This may have been due to work stress (heavy loads on the shoulders), a view supported by the robustness of the clavicles and the presence of enthesophytes. This theory has been further supported by palaeopathological analyses: vertebrae showed osteophytes in addition to Schmorl's hernias and crushing of the vertebral endplates (Nerlich *et al.* 2003).

Sex	Number	Percentage
Male	8	40%
Female	5	25%
Not determinable	1	5%
Undetermined	6	30%

Table 7. Tomb C3 Estimated sex.

Age range	Number	Percentage
Infants I-II (age 0-13 years)	3	15%
Juveniles (age 13-21 years)	1	5%
Young adults (age 21-35 years)	7	35%
Mature adults (age 35-60 years)	6	30%
Old (>60 years)	0	0%
Not determinable	3	15%

Table 8. Shaft C3 estimated age ranges.

Reconstruction of Health Conditions and Functional Stresses

Paleopathological analyses showed the presence of anaemia in several individuals (cribra cranii and cribra orbitalia), almost certainly attributable to a hemolytic and megaloblastic anemias due to loss and compensatory over-production of red blood cells (Walker *et al.* 2009: 109-125). The few – but very obvious – cases of linear enamel hypoplasia are also likely attributable to malnutrition and disease (Canci and Minozzi 2005: 211).

There were also several more uncommon pathological conditions in the material. Cranium AM presented a lytic lesion measuring a couple of millimetres on the right parietal bone. Such a lesion may have been caused by Histiocytosis X, a rare disease. Histiocytosis has three different clinical manifestations: cranium AM's case appears to be eosinophilic granuloma. This disease is the most common form of Histiocytosis that develops in children, males in particular, and is characterized by single or multiple bone lesions. The course is often self-limiting and benign. Skull lesions are common, as in the case of cranium AM (Pagavino and Pace 2001: 125-126, Ortner 2003: 361). Cranium AH showed a type of craniostenosis: a congenital abnormality of the cranium, caused by a premature fusion of one or more sutures, with resultant deformation of the skull. In this case occipital plagiocephaly was noted, caused by the premature closure of the ipsilateral lambdoid suture. This anomaly has a congenital etiology that is still not well understood, and can either be produced by a genetic anomaly or be secondary to other disease processes (Fornaciari and Giuffra 2009: 276-277).

One of the individuals recovered from chamber C, T45, had been the victim of either violence or an accident in life, suggested by a depressed fracture of the skull on the right parietal bone, indicating that the individual, a male, was alive when this happened as the tissues were elastic when it occurred (Fig. 4). The fracture was most likely caused by a blunt instrument such as a stone or even a mace or club. The same individual had also suffered a trauma on the distal part of the left tibia, inflicted transversely and, resulting in an "open" fracture which led to osteomyelitis, an inflammation caused by pus-producing bacteria that involves both the bone and the marrow cavity, identifiable by the presence of a cloaca or channel through which the pus can drain, and the formation of new bone with subsequent deformation of the tibia and talus (Fig. 5). Furthermore, the individual showed signs of possibly work-related stress involving not only the cervical vertebrae but also the lower limbs, which showed signs of eburnation, porosity and slight periostitis.

Many of the individuals in the sample displayed severe dental wear, typically associated with periodontal diseases and, at times, abscesses, caries and ante-mortem tooth loss. There were also rare cases of calculus. Tooth wear was a widespread problem afflicting 90% of the population of ancient Egypt and mainly caused by inorganic particles such as sand in food – particles which caused friction and abrasion during mastication, leading to the exposure of the dentin (Forshaw 2009). The extreme dental wear made it impossible to calculate age based on the degree of wear. Thus, it would seem useful to create a collection of dental samples specifically for use in age determination for such populations.

Fig. 4. Depressed fracture of the skull on the right parietal bone, T45, from shaft C3 (photo: R. De Marzo).

Fig. 5. Probable "open" fracture leading to osteomyelitis, T45, from shaft C3 (photo: R. De Marzo).

The general picture that this analysis paints of the lives of these individuals is one of heavy daily physical labor from childhood into adulthood. In addition to the effects of heavy, repetitive, physical activity the people also suffered from malnutrition, parasitic diseases, trauma, and congenital anomalies. It must, however, be noted that only nineteen subjects were analyzed. Further research on this necropolis – using scientific methods unavailable to us in a field context in Egypt – will almost surely reveal more information about the lives of those buried there.

Finally, a good number of subjects display epigenetic or non-metric characteristics, in particular parietal foramina (28%) and trochlear notch form (24%). Other epigenetic characteristics were also observed, including lambdoid ossicles on the sutural bones (16%), accessory transverse foramina on the cervical

vertebrae (12%), infraorbital foramina or notches (8%), supratrochlear spurs (8%) and sternal foramina (4%). Though these features can be environmentally influenced, they are usually transmitted genetically, suggesting some degree of kinship amongst the people in tomb C3.

Conclusions

The anthropological and palaeopathological analysis involved 52 individuals from tombs A17 and C3. The analysis has provided a wealth of information, mainly related to the lifestyle and health status of the individuals analyzed, but has also left many questions unanswered. The percentages below are all measured against a base of these 52 individuals.

It is noteworthy that most of the individuals – without marked differences with regards to age or sex – suffered conditions such as spinal osteoarthritis. In association with very marked muscle insertions this finding indicates a high level of intense physical labor, especially involving the upper body. Further, around 12% of the individuals under study suffered traumatic injuries such as fractures of the tibia, ribs or nasal septum; such injuries may have occurred in the course of the heavy labor hypothesized above.

The work also revealed eight cases (15% of the sample) of cribra cranii (N=2) and cribra orbitalia (N=6), evidence of malnutrition-related anaemia or parasites in childhood. Some individuals exhibit linear enamel hypoplasias – further evidence of stress – in some cases more than one episode per individual.

Finally, almost all skeletons exhibited significant dental wear. This condition appears to have been widespread in Egypt across all classes, sexes and ages and is most likely related to sand and millstone debris in food, leading to the exposure of dentin and periodontal disease.

In conclusion, analysis of this small sample of skeletal remains has yielded interesting information. As more of the human remains from the Temple of Millions of Years of Amenhotep II are analyzed, these early results will be expanded so that one can develop a solid understanding of the lives of the people who, most likely, lived nearby and were laid to rest in the area occupied by the temple.

Acknowledgements

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Bioarchaeology, TT 65 Project, Hungarian Mission in Thebes

Jerome S. Cybulski, Robert J. Stark & Tamás A. Bács

Introduction

The TT 65 Project entered its 14th field season in 2010 with an analysis of human remains from five interrelated burial locations associated with Theban Tomb (TT) 65, the tomb of Nebamun/Imiseba in Sheikh Abd el-Qurna: Shaft Tomb 1 and a 5 by 5 meter test unit in the forecourt of TT 65, Shaft Tombs 3 and 4 on the eastern slope of the forecourt, and the sloping passage inside TT 65 (Fig. 1). At least twenty-three individuals were represented in the assemblage, the majority of which was recovered from Shaft Tomb 3. This tomb was originally constructed and used during the 18th Dynasty, but also contained remains from later periods. Tomb robbing, reuse of the shafts, and 19th c. AD antiquities' hunters had greatly disturbed the remains. Our goal was to separate individuals from the commingled remains and to construct a biological and demographic profile of the material according to the archaeological and Egyptological contexts of TT 65 and its vicinity. This paper highlights some of our findings.

Fig. 1. Panoramic view of TT 65 (looking west) showing the locations of the entrances to Shafts 1, 3, and 4 (photo: L. Czifrák).

Setting

TT 65 is located on the west bank of the Nile opposite modern Luxor. It is one of over 100 'Tombs of the Nobles,' in the area of Sheikh Abd el-Qurna near Deir el-Bahri and the famous mortuary temple of Hatshepsut (Bács 1998; 2011a). TT 65 appears to have been built by Nebamun (Scribe of the Royal Accounts and Overseer of the Granary, among other titles) around Year 16 of the reign of Queen Hatshepsut (c. 1472-1457 BC). It was abandoned and then structurally altered and redecorated during the rule of Ramesses IX (c. 1123-1104 BC) by Imiseba (Chief of the Altar-Chamber and Chief of the Temple Archives of the Estate of Amun). Several paintings from the era of Imiseba on the walls of the tomb-chapel are attributed to the artists Amenhotep and Hormin, who are known to have also produced paintings in several royal tombs in the nearby Valley of the Kings (Bács 2011b).

Materials and Method

In keeping with permit requirements, all of the human remains were studied on site. Issues with logistics limited the study to 17 working days. The initial task was to set up a laboratory in the chapel of TT 65 where the majority of the analysis and photography could take place (Fig. 2). The human remains from four of the five locations considered here had been previously excavated and kept in wooden trays inside the chapel of TT 65. The Shaft 3 materials consisted of wrapped body segments (dubbed "mummy parts" by the human remains team), bones with attached dried soft tissue, and bags of bare bones, all collected and labeled by level of excavation. Shaft 3 extended to a depth of 11.65 m with a 1.7 m high burial chamber at its base (Bács 2009). There were 46 numbered levels, levels 40 through 46 encompassing the burial chamber and containing most of the remains and all of the wrapped segments.

The mummy parts included linen-wrapped legs, arms, torsos, or portions thereof and were temporarily identified as "mummy bundles" 1 through 8 for the purposes of our analysis. The bare bones and packaged groups of bones were temporarily identified as "persons" and numbered consecutively as the bones within were sorted and studied. The remains were classified according to similarities and differences in preservation qualities, absolute and relative characteristics of development, differences and similarities in robustness, and anatomical duplication of parts at the same (or similar) level of development, with matching of skeletal elements whenever possible. Occasionally, it was possible to match loose bones with mummy bundles. Ultimately, our cataloguing system for the purposes of the anthropological identification and analysis was a numerical sequence of "Person(s)," each identifying a separate individual. Person 2, for example, was initially identified by the study of the loose bones of a child comprised mainly of upper body parts but also including a right femur diaphysis, both distal femoral epiphyses, and the proximal epiphysis of the right tibia. The latter was fitted to the right tibial diaphysis inside Mummy Bundle 2, which also contained the left tibia,

Fig. 2. Anthropology laboratory in chapel of TT 65 (photo: J.S. Cybulski).

fibulae, and feet (Fig. 3). All of these bones were identical in substance and color and complementary in development.

As the individuals of Shaft 3 were separated, their anatomical inventories were recorded on previously prepared data forms on which detailed observations were made concerning age and sex identification, metric and nonmetric cranial and postcranial skeletal morphology, and gross indicators of skeletal pathology. We used various sources as guidelines: Cybulski (2001) and Saunders (1978) for the nonmetric observations, and Bass (1995), Brothwell (1981), and Olivier (1969) for measurements. The "Standards for Data Collection from Human Skeletal Remains" (Buikstra and Ubelaker 1994) were consulted for age at death and sex determination complemented by details on the status of the cranial sutures, os pubis, and auricular surfaces of the os coxae culled from the methods of Lovejoy *et al.* (1985), Meindel and Lovejoy (1985), and the sources identified in Suchey and Katz (1998). For immature individuals, our assessments were checked against dental development times and long bone diaphyseal lengths provided in Scheuer and Black (2000). Further refinements for the immature individuals were made

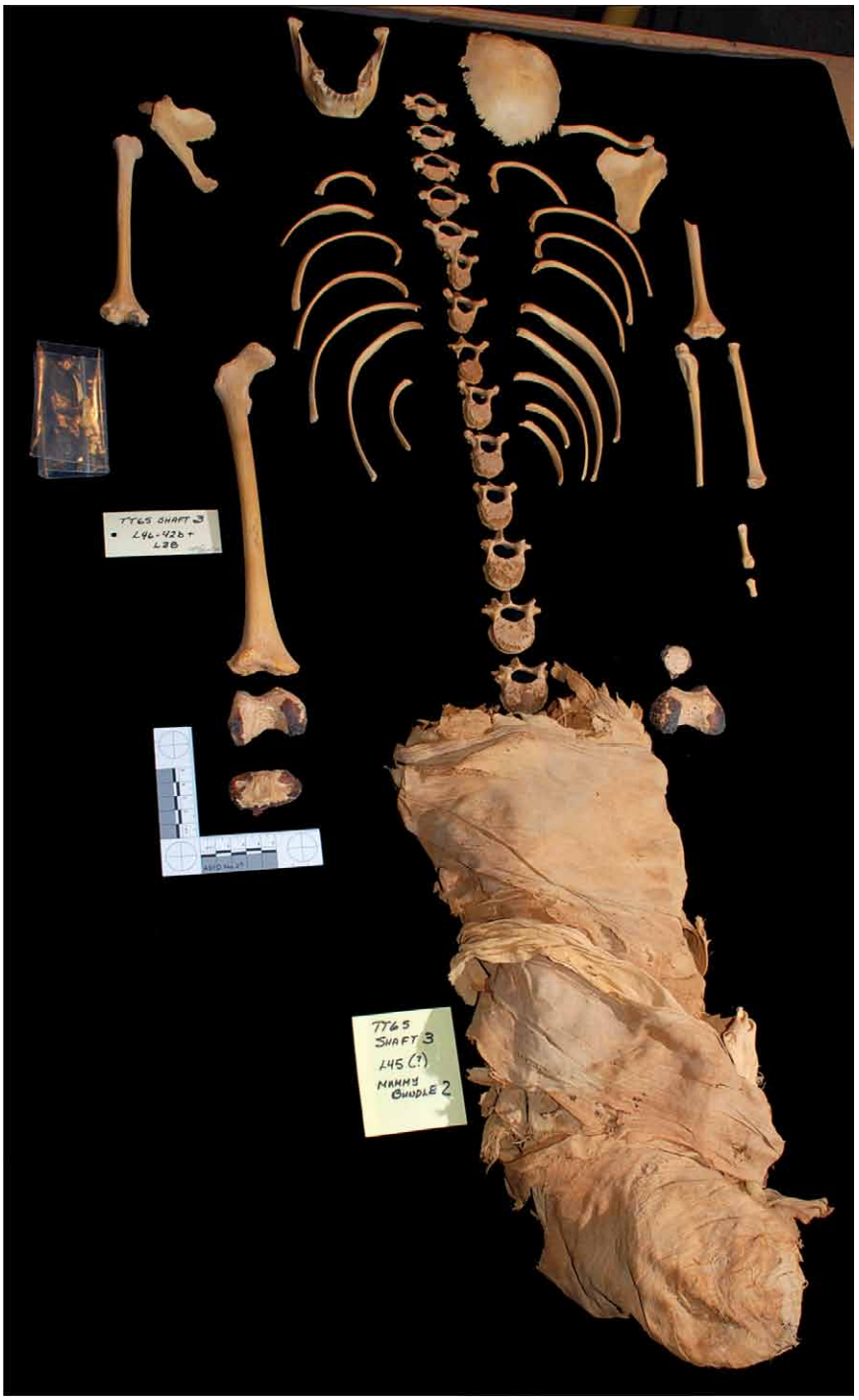

Fig. 3. Person 2, the remains of a child assembled from loose bones and a mummy bundle which had been excavated from Levels 46-41b and Level 38 of Shaft 3. The photo shows an early stage of assembly. Other parts of the neurocranium were later matched to the occipital shown in the figure and added to Person 2 (photo: J.S. Cybulski).

after the field season by consulting studies specific to ancient Egyptians and Nubians (e.g. Hummert and Van Gerven 1983; Tocheri *et al.* 2005).

Most of our observations were osteologically oriented. However, we noted any unusual or outstanding soft tissue features where possible and recognizable. This was also true for the remains from the other four locations. These consisted mainly of wrapped individuals and/or individuals with substantial soft tissue preservation with some exposed skeletal elements or parts. Included here was an individual from the four meter deep Shaft 4, who was analyzed *in situ* (Fig. 4).

Result Highlights

Shaft 3

This tomb was in use before TT 65 was built, possibly by the "king's son, overseer of southern foreign lands, Penre". Inscribed funerary cones and canopic fragments indicated that Penre and a number of other individuals were indeed interred in the burial chamber (Bács 2009; Bács *et al.* 2009: 79-81). The names of two further individuals were provided by recovered textual evidence, but their relationship to either the king's son Penre or to each other remain unknown. The name Sennefer appears on canopic equipment as well as mummy shroud fragments, albeit without any associated titles. Canopic jar and Book of the Dead papyrus fragments have also preserved the name of a lady, Sitamun (Bács *et al.* 2009: 82-93).

In contrast to the textual material, a minimum of 17 individuals were osteologically identified among the remains collected from Shaft 3. Based on their recorded excavation levels and the presence of high quality wrappings in these instances, the original occupants of the tomb may have included:

- Person 2 (Mummy Bundle 2), a child of 7 years ± 24 months,
- Person 5 (Mummy Bundle 4), a male of 35-44 years,
- Person 8 (Mummy Bundles 1 and 3), a male of 50-plus years,
- Person 10 (Mummy Bundle 8), an infant/child of 2.5 years ± 10 months,
- Person 15 (Mummy Bundle 5), a male in his early to mid-twenties.

A substantial amount of preserved soft tissue was encountered in Person 8. Most of the right hand was preserved and the proximal end of the third finger bore the distinct impression of a ring. Could this have been the official, Penre, himself?

Three adult females, two additional adult males, a juvenile of 12 years ± 30 months, three children between two and six years of age, and three infants (c. birth to two years) were also represented among the Shaft 3 remains. One of the males, Person 3/3a, exhibited pathological lesions in the pelvis and some long bones that may have stemmed from an iliacus abscess with subsequent septic arthritis. These manifestations, however, are still under investigation as are probable pathological lesions in the orbital roofs of Person 2.

Fig. 4. Analysis of mummy in the burial chamber of Shaft 4 (photo: M. Nagy).

Select Other Locations

Shaft 4 (the tomb of the scribe Reniseneb) held a severely damaged 18th Dynasty mummy (possibly that of the original tomb owner) whose limbs and torso were still tightly wrapped. The upper limbs had been separated from the torso by looters, and the face had been cut through and smashed. The individual was adult, perhaps in the fifth decade of life, and likely male. The length of the mummy, a plausible proxy indicator of stature during life, was 165 cm.

Shaft 1 (the burial apartment of Nebamun) was originally intended for Nebamun but apparently never used by him. It was partially cleared in 1900/1 and consequently refilled with debris from various other areas under clearance at the time (Bács 1998). Among other debris, it contained wrappings from Late Antiquity (c. AD 250-800). An intact mummy of an anchorite (Prominska 1986) from that period, when TT 65 formed part of a monastery, was found in a nearby double grave dug into the forecourt, one space of which was empty (Bács 2000; Bács *et al.* 2009: 148-149). A half-mummy with a rope belt excavated from a nearby 5 x 5 m test unit may have been the missing second occupant (Fig. 5) of the grave. Naturally preserved tissue indicated an obvious male, aged 50 years or more.

Discussion

Study of the human remains from TT 65 and environs has shown that significant post-depositional displacement and disturbances took place after the tomb and shafts were first used, particularly in Shaft 3, thus dictating our "mixing and matching" approach to the analysis of these materials to identify individuals. In addition to the remains mentioned in this synopsis, we also briefly examined remains temporarily stored in the chapel of TT 65 that had been collected during the excavation of the newly discovered Saff-tomb 1 in Sheikh Abd el-Qurna, a tomb type typical in Thebes during the early part of the 11th Dynasty. This was a collection of mummies found buried adjacent to the northern corner of that tomb-chapel's forecourt, before the northernmost inter-columnation that was at some point in the past re-cut to serve as a secondary entrance. The mummies appeared to have been dragged by tomb-robbers from the interior of the tomb and deposited in the forecourt after being stripped of their cartonnage cases and coffins and broken up.

The mummies have been provisionally assigned to the 22nd Dynasty by finds associated with them, mostly cartonnage coffin fragments. Seven individuals were counted from skulls, wrapped heads, and skull parts. We noted in these cases that the mummification process seemingly incorporated large amounts of resinous material, manifested as blackened or smoky glass on many of the remains. By contrast, the remains in Shaft 3 showed little evidence of resinous material even in the wrapped remains, the wrappings largely being dried linen which was colored light orange or tan, and containing dried, dusty bones. Anthropological details of the Saff-tomb 1 remains are the subject of future work on that group.

Fig. 5. Wrappings from the Late Antique period (above) were found in Shaft 1. The half-mummy (below) is naturally preserved and includes a rope belt (photos: J.S. Cybulski).

Aside from Persons 3/3a and 2 in Shaft 3, skeletal pathology appears to have been minimal, although it remains too early in the project to speculate about overall health. Of the number of individuals recovered from Shaft 3, the large number of immature (9 of 17 or 53%) may indicate high rates of subadult mortality in the contributing populations, an avenue of research to pursue in a comparative context with other studies of ancient Egyptians.

Acknowledgements

Salima Ikram was instrumental in initiating the bioarchaeology of TT 65 and is undertaking the faunal analysis. The Supreme Council of Antiquities (SCA) permitted this work and we acknowledge the assistance of Abdul Rahman Ahmed Hasan, local SCA inspector. Hungarian Expedition crew members included László Czifrák, Andrea Hasznos, Kata Jasper, Eszter Mátyás, Marcell Nagy, and Krisztián Vértes. Financial support for the 2010 season came from the Hungarian Mission (National Scientific and Research Fund, Hungary) and the Canadian Museum of History in Canada.

The Bioarchaeology of Akhetaten: Unexpected Results from a Capital City

Gretchen R. Dabbs, Jerome C. Rose & Melissa Zabecki

Introduction

While probably never intended to reflect the lives of the non-elite public and possibly only reflecting an idealized version of elite life, the themes portrayed in the daily life scenes on the walls in the rock cut tombs of the Amarna elites are dominated by depictions of abundance and opulence, with offerings to the Aten consisting of heaping piles of bread and grain, shanks of meat, and vessels of hearty drink. The ready interpretation of this is the suggestion that life at Akhetaten was of a life full of dietary diversity and surplus. The analyzed skeletal remains from the non-elite South Tomb Cemetery (STC) at Amarna (n=274) reflect the antithesis of this dominant theme, presenting a contrasting picture of a life filled with high levels of general, nutritional, and workload stress. General indicators of stress include the mortality profile (high post-infancy subadult mortality in some areas of the cemetery) and adult stature (Amarna adults are the shortest of any known ancient Egyptian population, comparative samples from Zakrzewski 2003). Nutritional stress is directly reflected in the skeletal lesions of cribra orbitalia (22.4%), porotic hyperostosis (3.1%), and those lesions characteristic of scurvy (3.1%). Workload stress in adults (n=175) is manifest in the frequency of spinal trauma (Schmorl's nodes 34.9%; compression fracture 20.6%), and degenerative joint disease (overall spine 47.4%). The decidedly poor health status of the non-elite population at Amarna suggests that the social, religious, and political upheaval caused by Akhenaten's devotion to the Aten and his consequent activities extended into the realm of individual health as well. In or around his fifth regnal year, Amenhotep IV (c. 1349-1332 BC) created dramatic religious, social, and economic upheaval in New Kingdom Egypt by closing the major temples dedicated to Amun and relocating his capital city to land in middle Egypt that fulfilled his requirements of belonging to no one and being unspoiled by the worship of other gods. The capital city, which would grow to house perhaps as many as 30,000 individuals (Kemp 2012), would be known as Akhetaten and the king, Akhenaten, both reflecting his devotion to the once relatively minor deity the Aten (Van Dijk 2000).

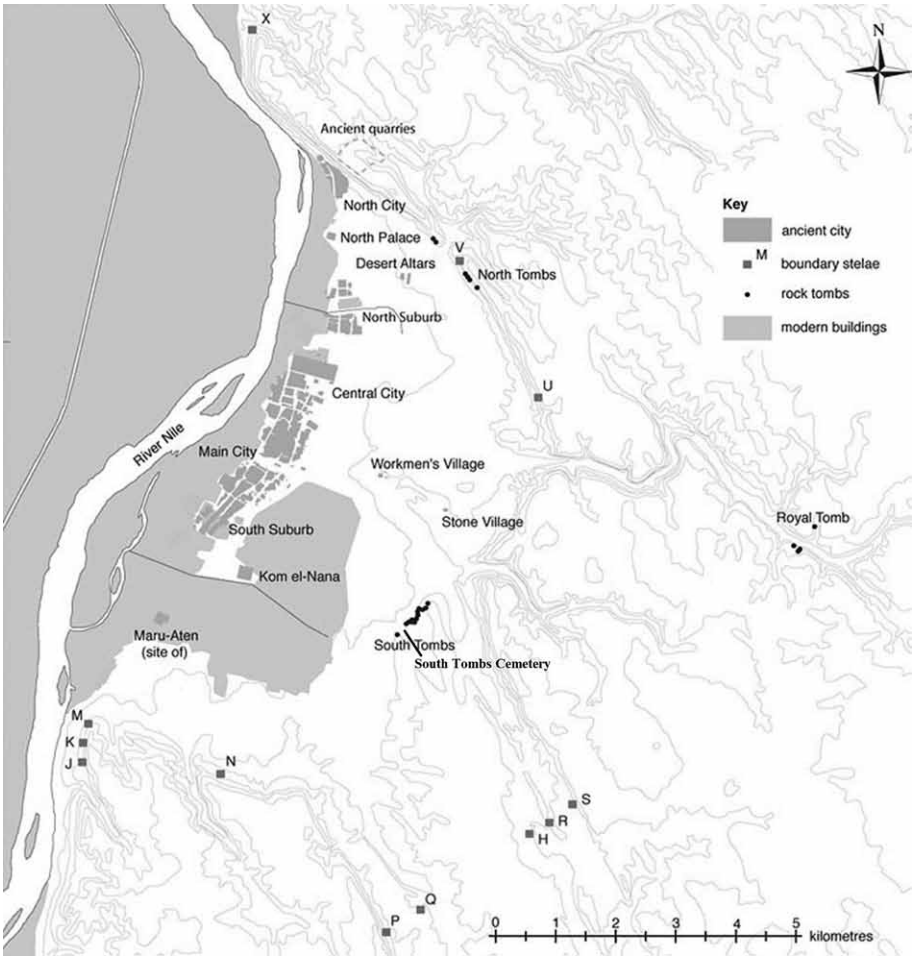

Fig. 1. Map of Amarna with inset showing the location within Egypt (map: K. Underwood).

The period of occupation, now called the Amarna Period, was not only marked by major changes to the state religion, but also to the artistic canon of Egypt. Akhenaten proclaimed the visual sun disc, the Aten, to be the singular god of Egypt. Images of no other gods figured into the official royal artistic representations, and most of the human figures possess appearances unlike any other period in Egyptian history, with elongated heads and unrealistic body shapes.

Amarna sits nearly equidistant from the traditional New Kingdom capitals of Memphis and Thebes in Middle Egypt (Fig. 1), a location that had both political and religious meaning. Archaeological investigations over more than a century have revealed a city complete with several palaces, temples, and commoner residences of various sizes (Kemp 2012). Within the boundary stelae that mark the limits of the city, Amarna even has two workers' villages thought to be similar to Deir el-Medina (*Ibidem*).

The rapid growth of Akhetaten can be at least partly attributed to the innovation of the talatat block, a modest sized (1 cubit by ½ cubit; ~70 kg) building block that could be maneuvered by a single individual. These identically sized building elements promoted a more systematic building procedure than was possible with sledges and monumental architecture of previous times (Kemp 2012). Akhetaten was abandoned quickly after the death of Akhenaten, perhaps as early as year one of his successor's reign (Van Dijk 2000). The total period of occupation of the city spanned just 15-20 years and provides a glimpse into the ancient world rarely available in the archaeological context. This short occupation and rapid abandonment has rendered Amarna the most archaeologically accessible ancient city site in Egypt, access to the structures being uninhibited by decades to centuries of subsequent occupation (Kemp 1977; 1989; Kemp and Stevens 2010a; 2010b). With the exception of the removal of the stonework during the reign of Horemheb and some modern encroachment by farms and local villages, Amarna maintains the integrity of the ancient city.

The current bioarchaeological analysis focuses on the STC, which is the largest and least taphonomically compromised of the three to five large cemeteries identified at Amarna during Geographic Information System (GIS) surveys of the desert (Fenwick 2005). Situated along and within a desert wadi cutting the eastern desert plateau, the STC is thought to be the resting place of as many as 5,000 individuals representing all of the economic strata save for the highest of elites. The varied mortuary treatments, ranging from no burial goods and/or wrappings all the way up to and including a single mud-brick tomb-like structure suggest those individuals interred in the STC represent a variety of social and economic classes at Amarna (Kemp *et al.* 2013). The location of the STC, with high-officials' tombs carved into the desert facing cliffs at the entrance to the STC wadi, suggests the spatial orientation of the burials at Amarna may reflect the overarching organization of the city itself, with high ranking city patrons having large houses surrounded by the smaller houses of the lower ranks (Kemp 2012).

Burial treatments within the STC vary widely. Some very degraded fabric has been found in many graves, but unfortunately not enough remains to determine whether it stems from shrouds or clothing. Various forms of organic matting were

used to cover the majority of the individuals in a flexible coffin type container of sorts. Some of the covering mats were made out of fine fibers and good preservation allows us to see the careful work it took to create them. Mat coffins, made of as of yet unidentified sticks, are also common, in which the sticks were bound together by thin plant-fiber rope. Thicker rope was also often present, used to bind the entire stick coffin around the deceased. This thicker rope was then tied to produce carrying handles, which would have eased the task of carrying the individual from the city center. A second, and presumed higher class of burial treatment is represented by wooden coffins, of which there is a relatively small number (n=20) within the entire cemetery (Kemp *et al.* 2013). Even within this small sample, however, there is considerable variation, with some individuals having plain, undecorated coffins while others have beautifully decorated, but unreadable coffins with random hieroglyphic characters, and a third category includes finely made and decorated coffins with readable text (Kemp and Stevens 2008; Kemp 2010). The most exclusive burial treatment is that of the mud-brick tomb structure discovered in 2006, which remains a unique treatment (Ambridge and Shepperson 2006) (Fig. 2). The presence of these few economically taxing burials suggests that high status individuals were buried at the STC. Conversely, the presence of some individuals with no burial treatment at all or a minimal fabric covering suggests the inclusion of individuals with low economic resources.

Mostly, burial pits are single, being not much larger than the space necessary to lay the body. However, in certain areas of the cemetery multiple burials occur, most commonly an adult female and one or more children. Depending on the area of the cemetery, multiple burials are either side by side, with the grave cut being

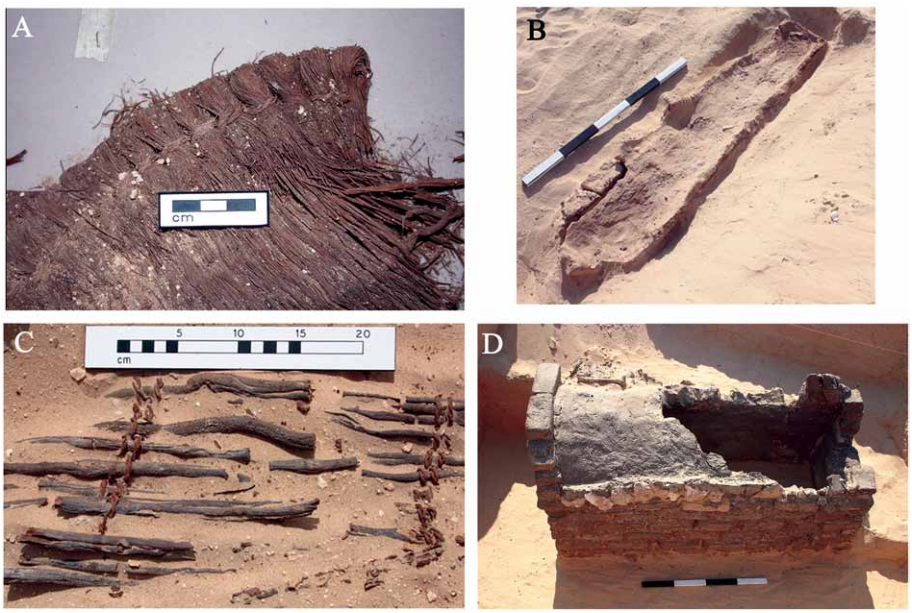

Fig. 2 Collage of burial treatments observed in the STC; A) Fiber matting; B) Wood coffin; C) Stick coffin; D) Mud-brick structure (photos: Amarna Trust).

wide enough for two individuals (suggestive of burial at the same time), or stacked, with grave cuts being similar in size to single burials. Thus, the latter case may represent either single or subsequent burial events (King-Wetzel 2010; Shepperson 2010).

As is common in most ancient Egyptian cemeteries, the majority (c. 60%) of graves were disturbed by grave robbers. Most frequently, the shallower burials were the ones affected by the robbing events, though depth of burial is not reflective of status in any identifiable way, seeming instead to be more of a function of the depth to bedrock. Commonly, bodies removed from the burial shaft during robbing events were found articulated on the ancient surface near the grave shaft, suggesting the robbing occurred relatively close to the time of interment, before the soft tissues were completely decomposed. While the grave robbing certainly has had a detrimental effect on the overall recovery of material goods, the articulation of the skeletal elements and careful excavation of the remains by the archaeological team (led by Anna Stevens and Barry Kemp of the McDonald Institute for Archaeology and the Amarna Trust) has led to the recovery of nearly complete sets of skeletal remains in most cases (Kemp *et al.* 2013). The common disassociation of cranial remains from the post-cranial remains and loss of cervical vertebrae is lamentable, and makes rejoining of the two body sections impossible without destructive DNA typing. However, season after season, similar numbers of headless bodies and bodiless heads are recovered, making the researchers confident that the recovered crania and post-crania represent the same individuals, even if they cannot be definitively matched. Overall, the preservation of skeletal remains at the STC is remarkable, with most of the remains excavated in excellent condition. Most individuals are fully skeletonized. However, partial organic preservation is frequently found, with the recovery of full heads of hair, desiccated brain matter, finger and toenails, and large sections of desiccated soft tissue being not uncommon.

The thoroughness of the grave robbing at the STC precludes assessment of the exact quantity of material goods included within burials during the Amarna Period, but a sufficient number of completely undisturbed graves have been excavated to suggest that scarcity of grave goods was the rule, rather than the exception. However, the relatively few items that have been discovered in the STC are often quite lovely and include bracelets, rings, necklaces, earrings, amulets, and pottery (Kemp *et al.* 2013).

While the adornments of the elite tomb walls were likely never intended to be seen by the general public, and may not represent the living conditions of the average person at Amarna, the representation of large shanks of meat and overflowing baskets of grain (Davies 1903-1908) do suggest that the larders of Amarna were stocked well enough to provide a sufficient diet for the citizens of the city. It seemed that abundance was the theme at Amarna, judging by the typical scenes of 'food-a-plenty' covering the walls of the elites' tombs and the hundreds of offering tables flanking the Small Aten Temple. Nevertheless, the ongoing bioarchaeological analysis of the skeletal remains from the STC suggests that the

average citizen at Amarna may not have been enjoying the common theme ideal of ancient Egypt that includes life, prosperity, and health.

Materials and Methods

As of Fall 2012, 274 individuals (175 adults; 99 subadults) have been excavated from the STC and analyzed. Further excavations have occurred (analysis ongoing) and are planned, however, this paper is based on the sample excavated from the inception of the STC project in 2006 through 2012.

Skeletal analysis is conducted by a team of researchers associated with the University of Arkansas Bioarchaeology of Tell el-Amarna field school, which includes instructors, students, and Egyptian inspector trainees. Data collection is based on macroscopic examination using published standards, with focus on those standards specifically applicable to ancient Egyptian samples. Standard adult age and sex estimates are made using the guidelines prescribed by Buikstra and Ubelaker (1994). The age of subadults is estimated using dental age (AlQahatini *et al.* 2010), long bone length (unpublished Amarna metric standards and Maresh 1970), and epiphyseal fusion (Schaefer *et al.* 2009), with greater weight given to dental age estimations. Observations for trauma, degenerative joint disease of the spine, and nutritional deficiencies (cribra orbitalia and porotic hyperostosis) are scored as prescribed by the "Global History of Health Project" (Steckel *et al.* 2011). Stature estimates are based on maximum long bone length (preference to femur, then lower leg bones, followed by arm bones) using Raxter and colleagues' formulae for ancient Egyptians (2006).

Results

The demographic profile of the STC strays from the expected profile for an ancient sample (Fig. 3). Of the total sample, age estimates are possible for 222 individuals. As is expected, high levels of infant and subadult mortality are observed, with 26.1% of the individuals excavated dying before age seven. The expectation is then that mortality would drop off significantly and until mid to late adulthood there would be few deaths observed. However, at Amarna, the mortality rate actually rises through the childhood and young adult phases, peaking during the 15-25 year age range, precisely where the lowest rate of death should be observed. No significant differences in the age structures of males and females have been identified ($\chi 2=0.63$; $p=0.4274$).

The maximum femoral length, which can be used to estimate stature at Amarna is small. Adult males (n=37) have average femoral length of 42.9 cm. Adult females (n=50) average slightly shorter (as is expected), at 41.1 cm. These lengths are shorter than any other reported sample from either Egypt or Nubia during any period of ancient history (comparative samples from Zakrzewski 2003 and Buzon 2006) (Fig. 4).

Lesions indicative of nutritional deficiencies (Iron, Vitamin C, Vitamin D) are fairly common. At the STC, 36.4% of the subadults and 12.7% of the adults have evidence of some stage of cribra orbitalia, suggestive of a severe, possibly

multifaceted, nutritional deficiency resulting from either intake or uptake (Walker *et al.* 2009). Skeletal lesions of porotic hyperostosis, and those characteristic of Vitamin C deficiency (Ortner and Ericksen 1997) are less common in the sample, being observed in only about 3% of the individuals.

While it is known that the formation of osteophytes in the spine is at least somewhat related to age and hormonal changes, the presence of osteophytes in a sample such as Amarna that is skewed toward younger individuals is notable. Osteophytes have even been identified on the spines of individuals in their teens, a clear indication that the formation results from stress, not age-related hormonal changes. Of the 165 adult individuals with vertebral bodies available for observation, 47.4% presented osteophytes.

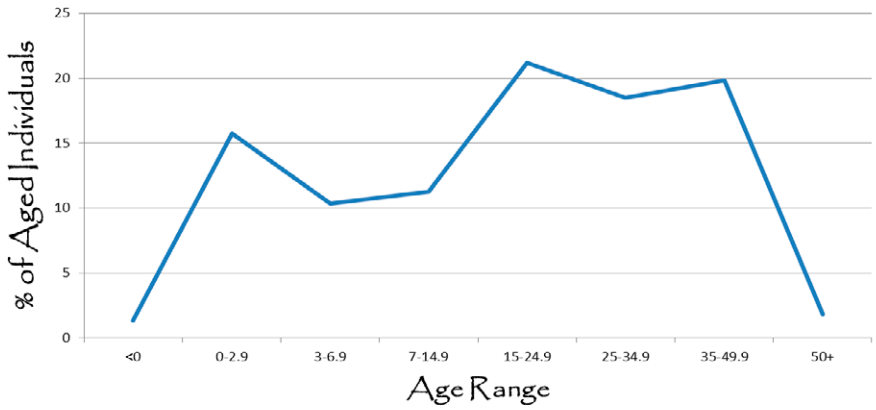

Fig. 3 Demographic profile of the STC (includes only individuals for which age estimations were possible).

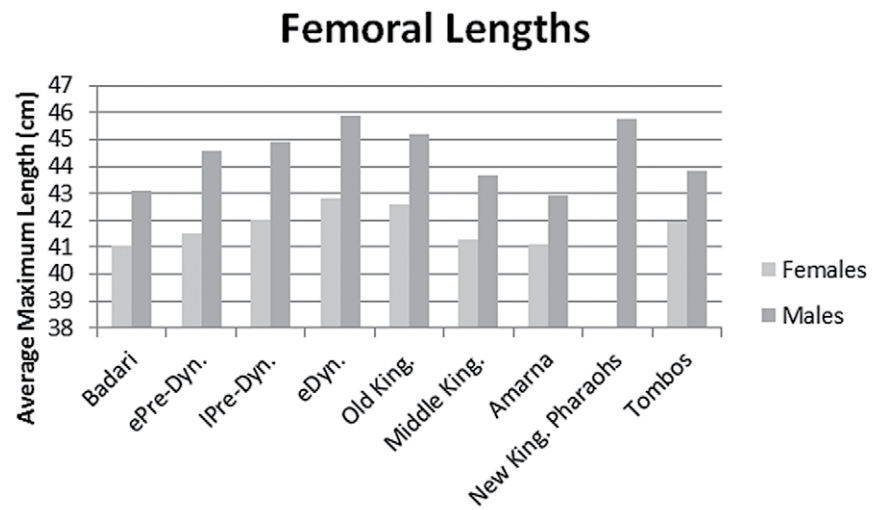

Fig. 4 Femoral lengths of ancient Egyptians (non-Amarna data provided by Zakzewski 2003 and Buzon 2006).

Total trauma rates are exceptionally high in the STC sample. Two-thirds (66.7%) of adults and 10.5% of subadults exhibit some form of antemortem trauma somewhere on the skeletal remains. Most commonly, the spine was affected, and a number of different pathological conditions were observed on the vertebrae. Compression fractures of the vertebral bodies were observed in 20.9% of the adults. Schmorl's nodes were observed in 34.9% of the sample, with individuals often having more than one node. The maximum number of Schmorl's nodes observed in any one individual was 22. Additionally, spondylolysis (either bilateral or unilateral) was common among the STC sample, with 10.9% of adults exhibiting this fracture. Other types of trauma are also common within the Amarna STC sample. Overall, 22.2% of the adults exhibit antemortem fractures beyond those reported in the spine. The Amarna sample has a very low frequency of injuries suggestive of interpersonal violence. Just four adult individuals (2.1%) exhibit traumatic injuries consistent with weapon wounds and a similarly low frequency (3.7%) of trauma to the head and face was also observed. In total, fractures observed on the trunk region (including spinal) are the most common injury, with 35.8% of adults exhibiting either a spinal fracture or a fracture to the clavicles, ribs, scapulae, or pelvic elements. Limb trauma is less common, at 18.0%, with fractures of the arms (13.8%) being more common than those of the legs (7.3%) (Fig. 5). Unlike other sites within and around Egypt that have high frequencies of cranial trauma and "parry" fractures (Nerlich *et al.* 2000; Judd 2004; 2006; Buzon and Richman 2007), the trauma at Amarna is largely consistent with accidental trauma and with a few notable exceptions (Dabbs and Schaffer 2008), are not indicative of interpersonal violence.

Discussion

The overarching picture presented by the bioarchaeological analysis of the STC sample at Amarna is of a population experiencing high levels of stress. Indeed, life at Amarna must have been a vortex of stressors, converging on the individual from at least four sides, including economic, social, environmental, and cultural venues. These stresses manifest in the skeletal sample in a number of different, often non-specific systemic, ways.

The demography of Amarna is striking. When compared to a typical demographic profile for ancient populations, Amarna exhibits an uncharacteristically high rate of death among older children and young adults. Multiple lines of evidence suggest that the ancient city may have been beset by an as of yet unidentified epidemic disease. Both the "Plague Prayers" of Mursili II and the Amarna Letters support this suggestion. Mursili's prayers are a plea to be relieved of the "plague of Egypt" that was brought upon his people after contact with the Egyptians during battle (Singer 2002). Further supporting evidence for an epidemic at Amarna can also be found in the Amarna Letters, a series of communications to and from the rulers of surrounding kingdoms to Akhenaten (EA 11, 35, 96, 932). Although badly damaged, EA 11 mentions that an unnamed individual has died of "the plague"

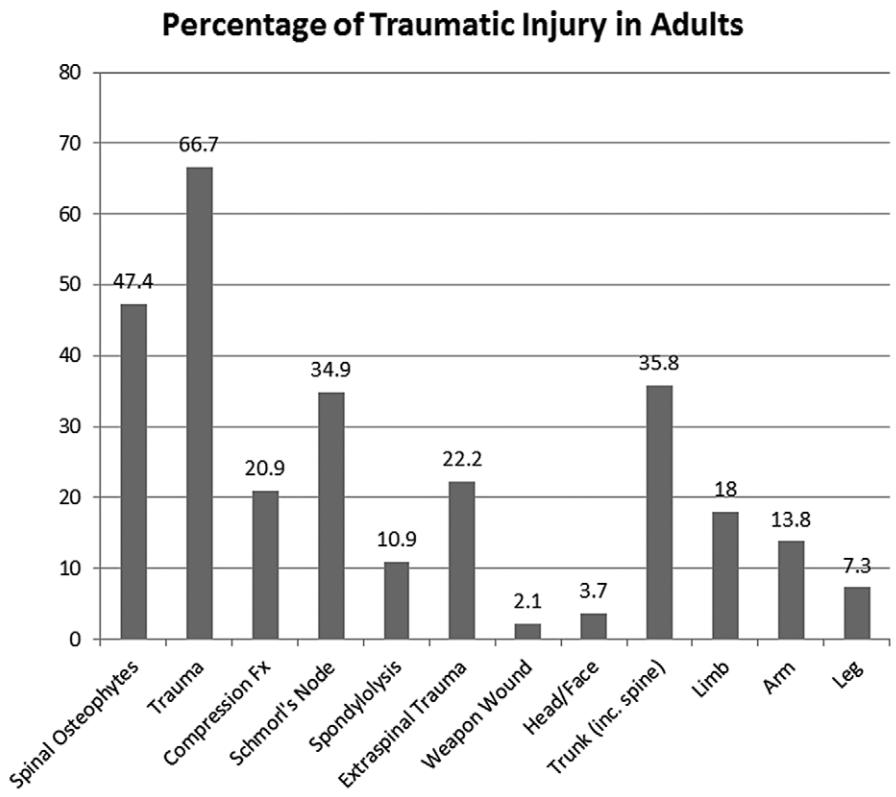

Fig. 5. Frequencies of traumatic fractures in the adults of the STC sample.

and EA 96 extensively discusses how the king should replace donkeys killed by a "pestilence" attacking people and donkeys (Winckler 1896).

Nutritional and dietary stresses are evidenced by the presence of skeletal lesions indicative of deficiency of several micronutrients and low average adult statures. Previous research has demonstrated the diet at Amarna was likely extremely low in meat proteins (Kemp, personal communication to MZ). Analysis of the microwear present on the human incisors and molars has demonstrated textural fill volumes and complexity consistent with modern diets reliant on grain-based resources and lacking meat as a staple food (Scott *et al.* 2009). Additionally, the general lack of butchered animal remains from the city (Payne 2006) suggests that the citizens of Amarna did not consume meat on a regular basis. A protein reduced or deficient diet would certainly inhibit growth, development, and maintenance of cellular tissues. The extremely short stature of the Amarna residents further supports arguments that diets at Amarna may not have been sufficient to fuel all needs for a healthy body.

Environmental stresses would have arisen from the harsh environment, the desert landscape being rather unforgiving, even into modern times. Workload stresses, reflected in the high levels of pathological lesions observed on vertebral elements and other work related trauma, suggest that the daily energy expenditures

were high. The archaeology of Amarna is consistent with a program of self-built houses that were constructed extremely rapidly (Kemp 2012). The citizens of Amarna were tasked with not only building the city, an undertaking that would have involved substantial effort and danger which is reflected in the trauma rates and development of osteophytes in the spinal column of the population, but also with maintaining life at the city. Ancient Egyptians normally saw themselves as living amid a backdrop of plants growing from fertile soil and being surrounded by birds and animals (*Ibidem*). In contrast, situated as it was at an elevation above the typical annual inundation of ancient times, the city of Amarna offered a stark landscape on which to build a life year-round. In order to support the vast gardens and orchards known from Amarna reliefs and paintings and provide potable water for consumption, cooking, and other daily tasks, the residents of Amarna expended considerable energy capital in obtaining and distributing water. Water at Amarna was drawn from deep wells within many house enclosures in the city via a steep staircase and shaduf (*Ibidem*). Alternately, water could also have been drawn directly from the Nile, but as the river is an archaeologically invisible source, this remains mere speculation. The number of wells within the city suggests the Nile was likely a secondary source, if used at all. Regardless of how it was obtained, ancient roadways lined with broken fragments of water vessels attest to the transport of water throughout the city, sometimes as far as five km to the Workmen's Village, which lacked a well. Given the average size of these vessels and the weight of water, the load on any given individual could have been as much as 35-45 kg (80-100 lbs) (calculation based on estimated vessel size from Kemp 2012; calculations by GRD).

Finally, Amarna fits the classic profile of a population under the stress of uncertainty (Moss 1973). As an entirely new city, built on virgin desert, the social, religious, economic, and political systems operating at Amarna may have been dramatically different from those the citizens were accustomed to, resulting in psychological stress, which causes the same physiological stress response in the parasympathetic nervous system as physical stresses. Even if all social systems were exactly as experienced in the cities of origin of the residents, an unlikely proposition given the nature of the new capital city, the exposure of individuals to new people via the migration of residents from other areas of Egypt and surrounding lands, as is suggested by cranial morphology (Dabbs and Zakrzewski 2011), would have resulted in increased psychological stress via social uncertainty. This would have arisen on an individual level upon meeting new people, despite the cosmopolitan and multicultural nature of New Kingdom Egyptian capital cities (Moss 1973).

In summary, while one could assume the residents of the capital city of Egypt during one of the most economically sound periods of ancient history would have enjoyed healthy and privileged lives, as is suggested by the depictions of plenty in the tombs of the elites at Amarna, the skeletal remains of the Amarna citizens excavated from the South Tombs Cemetery suggest otherwise, with evidence of both nutritional deficiency and physically taxing workloads; coming up just short of the goal of "life, prosperity, and health".

Birth in Ancient Egypt: Timing, Trauma, and Triumph?

Evidence from the Dakhleh Oasis

Tosha L. Dupras, Sandra M. Wheeler, Lana Williams & Peter Sheldrick

Introduction

Childbirth is generally a subject that was not well documented in antiquity, and ancient Egypt is no exception. The scant evidence that we do have from Egypt is related either to the deities or to the nobility and royalty of Egyptian society, and information regarding how this process was dealt within the lower classes is almost nonexistent. It should also be noted that the time period of ancient Egypt covers over 3000 years of history, and although many sources make sweeping generalizations concerning ancient Egyptian child birthing practices, it should be remembered that these practices most likely varied over time and with geographical location. The majority of evidence is drawn from documentary or archaeological evidence, and only on rare occasion is biological evidence considered. The Romano-Christian period Kellis 2 cemetery in the Dakhleh Oasis (Fig. 1) provides an opportunity to explore this question from a bioarchaeological perspective.

Obstetrics and Midwifery in Ancient Egypt

It is generally accepted that the ancient Egyptians were advanced in medicine compared to contemporaneous cultures (Nunn, 1996). In The Histories (1954: 114, translation), Greek historian Herodotus wrote:

> *"The practice of medicine they split into separate parts, each doctor being responsible for the treatment of only one disease. There are, in consequence, innumerable doctors, some specializing in diseases of the eye, others the head, others the stomach, and so on; while others, again, deal with the sort of troubles which cannot be exactly localized."*

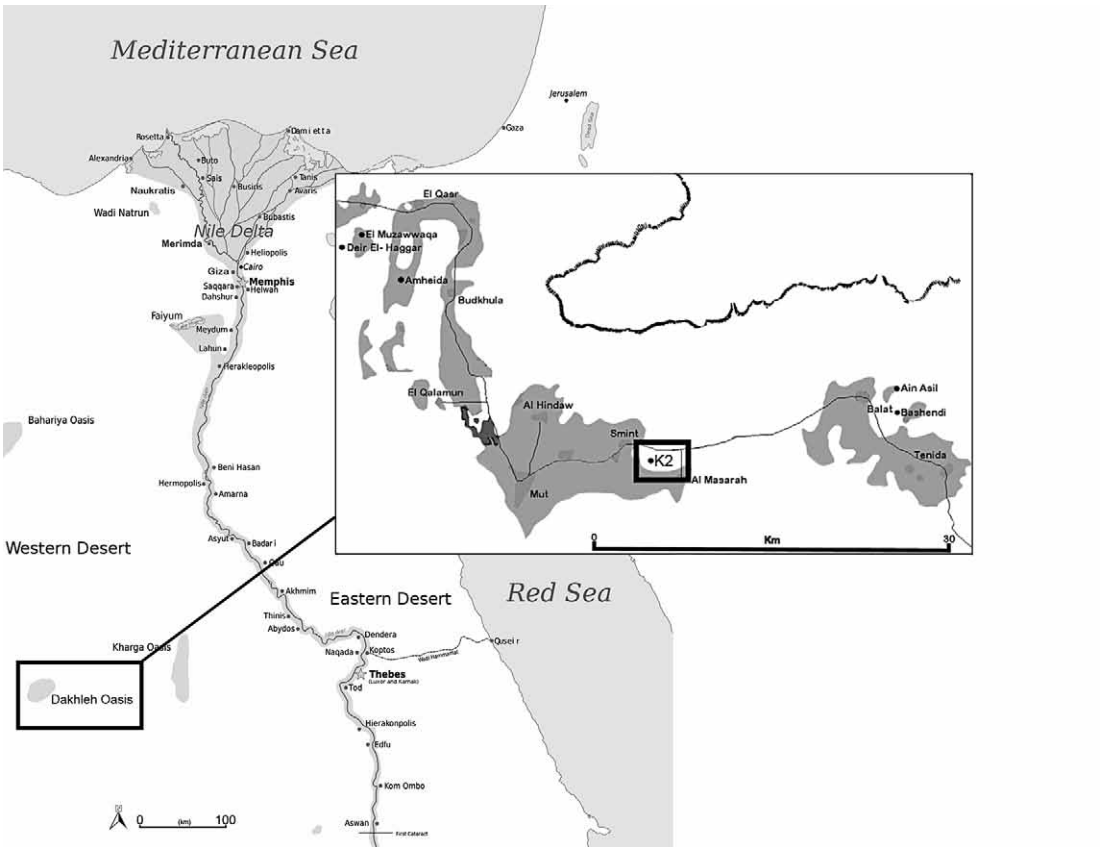

Fig. 1. Location of the Dakhleh Oasis within Egypt, and the location of the Kellis 2 cemetery within the Dakhleh Oasis (map: DOP Bioarchaeology Team).

What is glaringly missing from this and other medical literature from ancient Egypt is the mention of a medical specialty concerning obstetrics, or specifically midwives. While there does not appear to be Egyptian terminology recognizing these specific professions, there are two references to women who served this function in the ancient texts: *-rini*, used in 3rd c. AD (Sullivan 1997), and a reference in the Bible (Exodus 1:15-22) that refers to the Hebrew midwives Shifra and Puah (Rand 1970). It does appear in the ancient medical literature, however, that a recognized midwifery system was in place to assist women with childbirth, and that this was purely a woman's affair. Although a few publications (e.g., Jauniaux 2001; Haimov-Kochman *et al.* 2005) suggest that two or three women would assist during labor, particularly if the woman was of high status, the source of this proclamation is never mentioned. It is possible that this idea was perpetuated from ritual depictions of deities or royalty engaged in the birth process in which the goddesses Isis, Nephthys, Heqet, and Meskhenet are assisting in the birth (Haimov-Kochman *et al.* 2005). Others suggest that, if a woman was of lower status, then it may be a village elder or the woman's mother or sisters that would assist with the birth (Graves-Brown 2010: 82).

It is also important to consider contemporaneous sources on midwifery from Rome and Greece. Although it is impossible to know the extent to which these sources may have reached and influenced practices in Egypt, and particularly in the Dakhleh Oasis, these sources may give some insight into how obstetrics was practiced. One source in particular, Gynaecology by Soranus of Ephesus (98-138 AD), specifically addresses childbirth. Soranus was educated in Alexandria, and his treatise, translated into Greek and Latin, was widespread throughout the Roman Empire (Todman 2007). Soranus recognizes the midwife, or obstetrices, and proclaims that ideally the midwife should be:

> *"Literate, with her wits about her, respectable, possessed of a good memory, loving work, respectable, sound of limb, robust and according to some people, endowed with long slim fingers and short nails at her fingertips."* (Soranus, Gynecology Book 1:5)

Birthing Place and Position in Ancient Egypt

Even though there is very little direct evidence of how ancient Egyptian women experienced childbirth, there is a specific hieroglyph as a determinative for birth (Haimov-Kochman *et al.* 2005). This hieroglyph shows the head of the infant (and perhaps the arms/body) emerging from the woman's body, and may also indicate the accepted birthing position of squatting or kneeling on some sort of platform. While it is not known if women were secluded during birth, ostraca from Deir el-Medina (Sullivan 1997) and wall paintings from Amarna (Kemp 1979) show women using either a "birth arbor", or a separate room within the home for birthing. Although once thought to be for birthing (e.g. Jauniaux 2001), the "mammisi", or birthing rooms associated with temples are now understood to have been used strictly for the gods and goddesses (Chamberlain 2004).

Most sources (e.g., Robins 1993: 83; Nunn 1996: 194) describe women as delivering their infants while in the squatting position, with their legs on two bricks, or seated on a birthing chair. There are well-known physiological and anatomical advantages of giving birth in this position, including, according to Haimov-Kochman *et al.* (2005: 6):

> *"…(i) the added force of gravity to the baby's weight, (ii) reduced aorto-caval compression known to affect fetal pH values, (iii) improved alignment of the fetus, and (iv) contribution to stronger and more efficient contractions."*

The squatting position may also increase the pelvic outlet diameter, and increase the speed of labor, particularly in the second stage of labor (Smith 2010). However, in cases of abnormal birth, this position may not have been optimal particularly if assistance was necessary. While a birthing brick has been discovered in a Middle Kingdom context at the site of Abydos (Wegner 2010), there is very little evidence from the Ptolemaic and Roman periods to indicate how women gave birth. Contemporaneous evidence from Roman and Greek sources suggest that there may have been many different positions used for birthing (Todman 2007),

although Soranus recommends a birthing chair or stool (Soranus, Gynecology Book 2). A Roman period (c. AD 100-150) clay rattle discovered at the Egyptian site of Antinoe (Ashton 2004: 156-157) shows a pregnant woman in labor with her legs splayed up in the air, suggesting the possibility of different birthing positions being used in this period.

Remedies, Spells, Gods and Goddesses Associated with Childbirth

Much the same as our meager knowledge about normal labor, there is sparse information concerning how the ancient Egyptians dealt with the process of birthing an infant through a difficult labor. There are only a few references made in the medico-magical papyri concerning pregnancy and childbirth, none of which deal with the related possible complications. The Ramasseum IV papyrus has several sections pertaining to childbirth:

> *"To separate [him] from his mother… who is giving birth"* (Nunn 1996: 194)

but these only concern magic and appear to describe a normal delivery. The Ebers papyrus presents remedies for stimulating labor (Nunn 1996: 194). The only treatment of a possible birth complication comes in an obscure note in the Kahun Papyrus which mentions the:

> *"Bringing together (ndry) of the vagina."* (Sullivan 1997: 637)

This passage has been interpreted as possibly referring to the postpartum stitching of a perineal tear (Sullivan 1997).

Although there are few textual references to the process of birthing, it is evident that the ancient Egyptians did acknowledge the dangers of childbirth. In addition to spells and remedies there are several Egyptian gods and goddesses that were invoked for the protection of the mother and child during pregnancy and labor (Table 1). The god Bes is a particularly prominent god associated with both pregnancy and delivery, and was thought to ward off evil spirits or demons. Tawaret was also a popular goddess associated with pregnancy and children, and was also invoked to ward off evil spirits. Often statuary or depictions of these two deities were found in homes, and in particular in the birth arbor (Sullivan 1997). In addition, Bes and Tawaret are often found depicted on "birthing wands", apotropaic objects made from carved ivory, most from hippopotamus tusks, and decorated with additional fierce creatures and deities (Graves-Brown 2010: 62). Hathor, often associated with Bes, appears in papyrus prayers to invoke a speedy and pain-free birth. Royal and deity births are also often depicted with the goddesses Isis, Nephthys, Heket, and Meskhenet in attendance. Evidence from Deir el-Medina indicates that birthing amulets, most probably depicting these deities, may also have been purchased to aid in delivery, with this practice also noted in the Greco-Roman period (Graves-Brown 2010: 63).

God or Goddess	Appearance	Associated duties
Bes	God with dwarf proportions, and leonine features.	Protector during childbirth, warding off evil spirits/demons. Often associated with Taweret and/or Hathor.
Hathor	Goddess in either human or cow form.	Gave overall protection to the infant.
Heket	Goddess with a frog appearance.	Protector of women during childbirth, whose role was to speed-up the last stage of labor.
Isis	Female figure with throne on her head, and often depicted with her young child Horus on her lap.	Among many other associations, she is known as the Goddess of children.
Khnum	Ram-headed god	Responsible for keeping the fetus in a normal position during delivery.
Meskhenet	Female headed goddess with cow's uterus on her head	Goddess of labor who presided at childbirth to ensure a safe delivery.
Nephthys	Female with hieroglyph of her name on her head, or as a bird of prey.	Devine assistance and protective guardianship.
Taweret	Hippopotamus headed goddess, with limbs of a lion, tail of a crocodile, pendulous human breasts, and a full belly.	Protector of women during pregnancy and childbirth by deterring evil forces.

Table 1. Gods and goddesses (in alphabetical order) associated with childbirth in ancient Egypt (after: Sullivan 1997; Jauniaux 2001; Chamberlain 2004).

Obstetric Instruments

There is minimal evidence suggesting the development or use of obstetric instruments in ancient Egypt to assist in the delivery of infants during difficult labor. To date no definitive obstetric instruments have been identified from archaeological sites or described in the medical papyri (Döderlein 1973). However, there has been some suggestion that a scissor-like instrument on the lower panel of a relief at Kom Ombo (2nd c. AD) and a special knife called a "peseshkef" (also associated with the goddess Meskhenet) were used to sever the umbilical cord (Sullivan 1997).

Childbirth in the Dakhleh Oasis

Kellis 2, a Romano-Christian cemetery, is located east of the ancient community of Kellis in the Dakhleh Oasis (Fig. 1). Although numerous radiocarbon dates from the Kellis 2 cemetery indicate use between AD 100-450 (Stewart *et al.* 2003), archaeological evidence suggests consistent use from AD 50-360 (Hope 2003). At present 770 individuals have been excavated, and of those 725 have been analyzed (Fig. 2). Individuals in this cemetery are interred in single burials, some with superstructures and substructures, and others with burial inclusions such as botanicals, ceramics and jewelry (Wheeler 2009: 21-23). Most individuals are wrapped in a burial shroud, and all are placed in an extended position with the

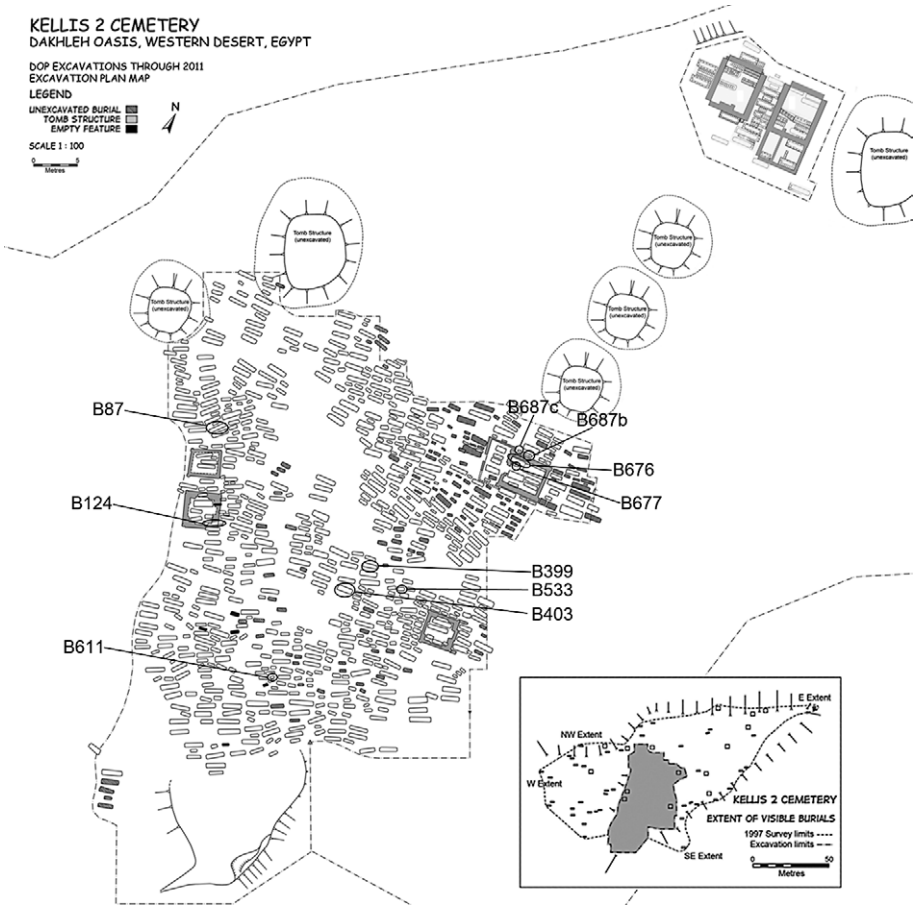

Fig. 2. Map of the Kellis 2 cemetery. Circles indicate the location of the burials with birth trauma (map: DOP Bioarchaeology Team).

head facing west, indicating a Christian style burial (Birrell 1993; Bowen 2003). It appears that the cemetery population was comprised of all individuals (Tocheri *et al.* 2005), including burials of fetuses as young as 16 weeks gestation and infants with lethal and disfiguring congenital conditions, such as neural tube defects like anencephaly, and iniencephaly with possible encephaloceles (Cope 2008; Mathews 2008), and osteogenesis imperfecta (Cope and Dupras 2012).

It is commonly recognized that infancy and childhood in the past were dangerous times in life, and that only a small percentage of individuals made it to adulthood. Analyses of the Kellis 2 population have supported this, revealing that the highest percentages of individuals interred in Kellis 2 are children (66%). Of those classified as children, 39% are fetuses (aged 16 to 41 weeks gestation), 25% are infants (aged 42 weeks gestation to 1 year postnatal), 9% are young children (aged between 1 and 4 years), and 16% are older children (aged between 5 and 10 years) (Wheeler 2009: 21). Also important to note is that over half (53%) of the adult females within the Kellis 2 population (N=146) are of childbearing age, equating to 20% of the overall population.

Given the high number of females of childbearing age in the cemetery, it is likely that many would have died due to complications during pregnancy and childbirth. Two noted exceptions to the pattern of individual interment within Kellis 2 are instances where a young adult female was buried with a neonatal infant. In the first example, Burial 318 (Fig. 3A), the infant (318b) is buried beside the lower legs of the adult female (318a). In the second example, Burial 513 (Fig. 3B), the remains of a newborn infant (513b) are located between the femora of the adult female (513a). In this instance, the very wide position of the female's pelvic bones, the atypical position of the infant on its side with the feet toward the pelvis and head towards the adult's knees, and the lack of evidence of an infant burial shroud, all suggest that this female died around the time of or during childbirth. Based on the position of both individuals, the infant was most likely expelled during the decomposition process, indicating a coffin birth. There is also evidence that women experienced multiple births, as indicated by Burial 685 (a & b), which possibly represents fraternal twins (Fig. 3C). This is a condition, even in modern times, that places both the mother and the infants at higher risk of mortality.

Seasonality of Conception and Childbirth at Kellis

The configuration of the Kellis 2 cemetery is somewhat unique, with a defined accretionary pattern of grave orientation. Of the burials in the Kellis 2 cemetery, 98% were oriented at an angle between 63 and 117 degrees east of north, corresponding to the orientation of the rising sun along the horizon throughout the year (Williams 2008: 137-138). By combining results of grave orientation (*Ibidem*: 136-142) and stable isotope analyses of short-term tissues such as hair and nails (Williams *et al.* 2011), it was determined that the majority of fetuses, newborns, and women of child-bearing age were dying at a specific time of the year, in particular March and April (Williams *et al.* 2012). Ancient and modern populations typically experience annual phase maxima and seasonal maxima in births convergent to the annual phase maxima in mortality for infants and reproductive-age women, reflecting the link between the difficulties of childbirth and survivability of newborns (Williams 2008: 154).

To further evaluate the significance of this timing in birth, the age at death for fetuses and newborns was used as a starting point for determining the month of conception, by counting back gestational weeks. The results from this analysis indicate that conceptions were at the highest during the months of July and August (Williams *et al.* 2012). These months of seasonal maxima in conception correlate with the timing of Roman-Egyptian fertility festivals in Dakhleh (Kaper 2001). In addition, months of seasonal minima in conception, December and January, correlate with the timing of early Christian behavioral and sexual prohibitions throughout the Advent and Lenten seasons (Brown 1990: 378). This timing of the birth process suggests a social and spiritual foundation for one of the most fundamental and enduring phases in life's rhythms and may also contribute to percentages reflected in the Kellis 2 cemetery population, as seasonal timing of childbirth can contribute to a greater risk of mortality for mother and infant.

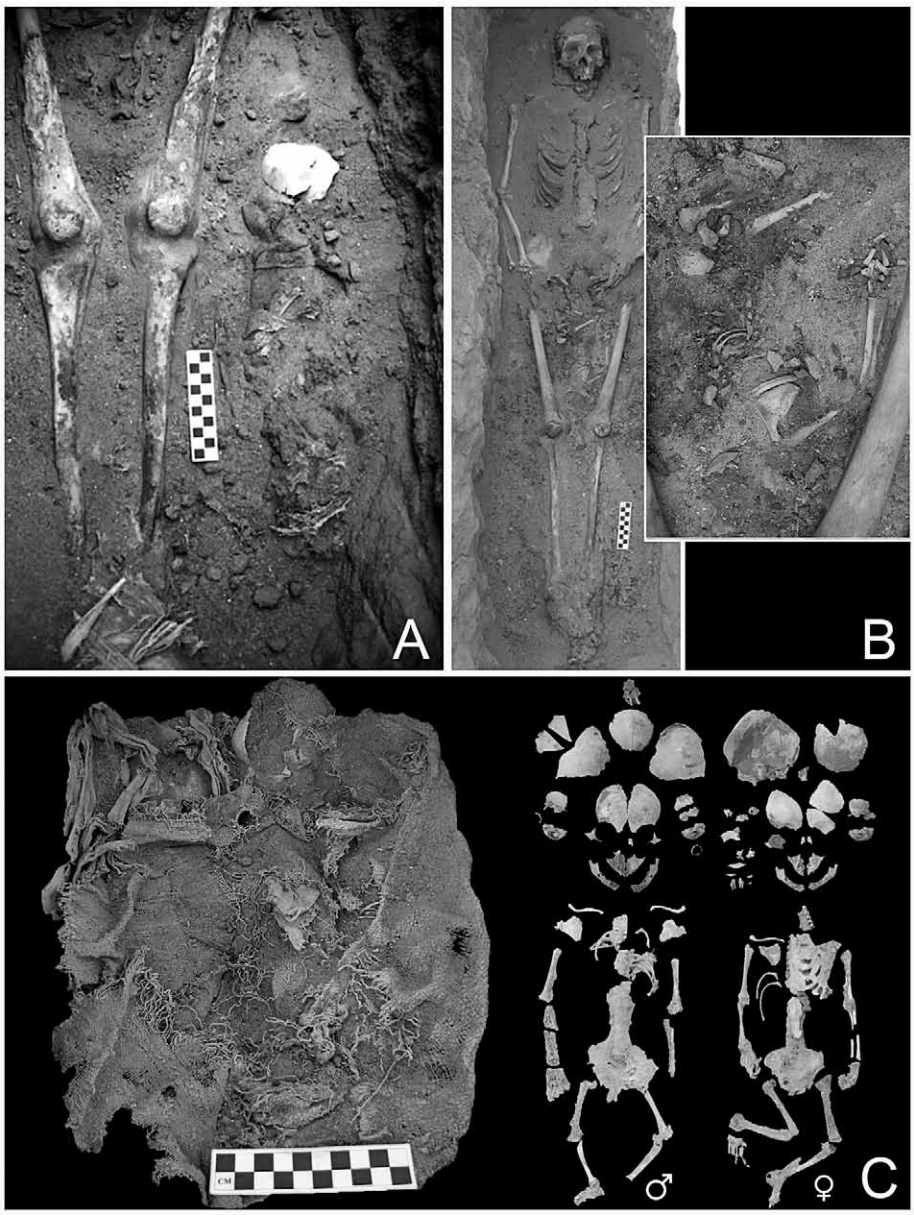

Fig. 3. A) Burial 318 showing an infant (318b) placed beside the lower legs of an adult female (318a); B) Burial 513 showing an infant (513b close-up, inset) between the femora of an adult female (513a); C) Burial 685, two infants together (left), and the respective skeletons (right) showing a probable set of fraternal twins (photos: DOP Bioarchaeology Team).

Material Evidence Related to Childbirth at Kellis

While the Kellis 2 cemetery does contain burial inclusions, only two instances of material remains relate directly to childbirth. A ring with a faience figure of Bes (Fig. 4A) was recovered from the associated context of the floor of Tomb 4 of the

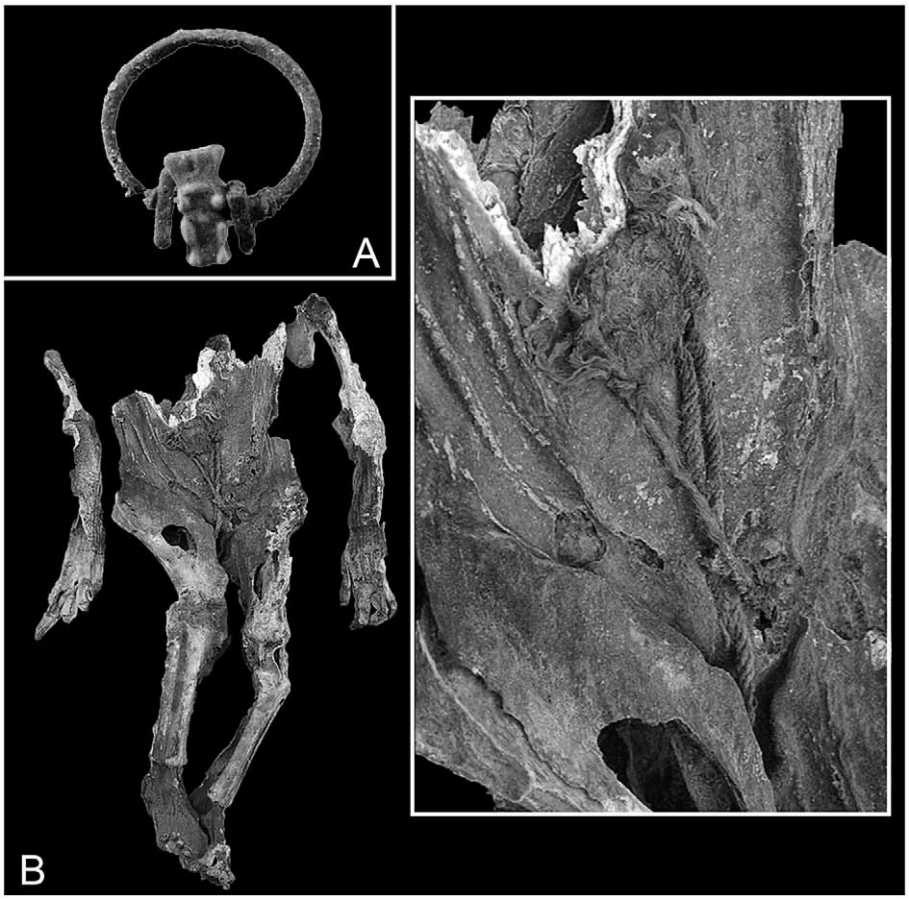

Fig. 4. A) Bronze ring with a faience figure of the god Bes; B) Burial 83 showing a string/cord used to tie the umbilical cord (photos: DOP Bioarchaeology Team).

Kellis 2 cemetery. Interestingly, several of the individuals exhibiting birth trauma are located in close proximity to this tomb structure (Fig. 2). Also, evidence of rope/cord used to tie off the umbilical cord has been noted on Burial 83, a 33 week-old fetus, from the Kellis 2 cemetery (Fig. 4B).

Skeletal Evidence of Childbirth Related Trauma at Kellis

Many of the mothers and infants from Kellis who died during childbirth may not exhibit any evidence of skeletal trauma, particularly if only soft tissue structures are affected, such as when an infant dies of suffocation, or a mother dies from hemorrhaging. There is, however, skeletal evidence from Kellis 2 individuals who did suffer from childbirth-related trauma, and those who survived in spite of it. Dystocia, literally meaning "difficult birth", includes uterine inertia (prolonged labor) and obstructions that can occur during the birthing process. Clinical data indicates that women experiencing their first pregnancy are at higher risk

for dystocia than women who have had previous births (Selin *et al.* 2008). This correlation may help explain the high number of fetuses and newborns documented in the Kellis 2 cemetery.

A normal delivery involves what is known as the "Cardinal Movements of Labor" (Allen *et al.* 2007). This refers to the changes that occur in the position of the fetal head throughout the labor process. These changes usually occur in the following sequence: engagement, descent, flexion, internal rotation, extension as the fetal head progresses through the birth canal, external rotation, and then shoulder rotation after the head has delivered. Any changes to the Cardinal Movements can result in dystocia. This can lead to prolonged labor, which puts the fetus at risk for hypoxia (lack of oxygen) and death. Shoulder dystocia and other forms of obstructed labor have similar consequences (*Ibidem*). Breech birth also predisposes birthing to dystocia, particularly of the after-coming head. These conditions can have an impact on the fetal skeleton, particularly when assistance is used to aid in a difficult delivery. On occasion it may be necessary to use force to free the infant from the pelvic outlet, occasionally causing trauma to the newborn. The most common areas of skeletal trauma during childbirth are the clavicle, humerus, cervical vertebrae, and ribs, although other skeletal elements may also be harmed (Moczygemba *et al.* 2010).

Fractured Clavicle

Fractures to the clavicle, particularly the lateral portion, are the most commonly documented birth injuries and account for as much as 90% of modern birth trauma fractures (e.g. Kaplan *et al.* 1998; McBride *et al.* 1998; Monjok 2008). This injury is often the result of shoulder dystocia, and is thought to be caused by excessive lateral-to-medial pressure on the shoulders during passage through the narrow birth canal. Large fetal size and weight, small obstetric dimensions, and delivery maneuvers may contribute to the incidence of this fracture (McBride *et al.* 1998; Lurie *et al.* 2011). This type of fracture, normally unilateral, is usually located on the midshaft or on the lateral portion of the clavicle (Kanik *et al.* 2011). Two individuals from the Kellis 2 cemetery, Burials 677 and 687b, both 1.5 years of age at death, display typical birth related fractures on their left lateral clavicles, each in the process of healing (Figs. 5A, B). The age of the individuals and the presence of healing fractures indicate that each individual survived the birth process and the associated fractures, but later died due to other unknown causes.

Humeral Fracture

Fractures of the proximal humerus are the most common obstetric long bone fracture (Sherr-Lurie *et al.* 2011). Birth related humeral fractures may occur in the diaphysis, and the distal and proximal ends. While Madsen (1955) found transverse diaphyseal fractures to be more common, Sherr-Lurie and colleagues (2011) found equal distribution among bone locations. Two individuals from the Kellis 2 cemetery showed humeral fractures most likely related to birth trauma. Burial 399, a 10-year old, displays a well-healed fracture of the right proximal humerus

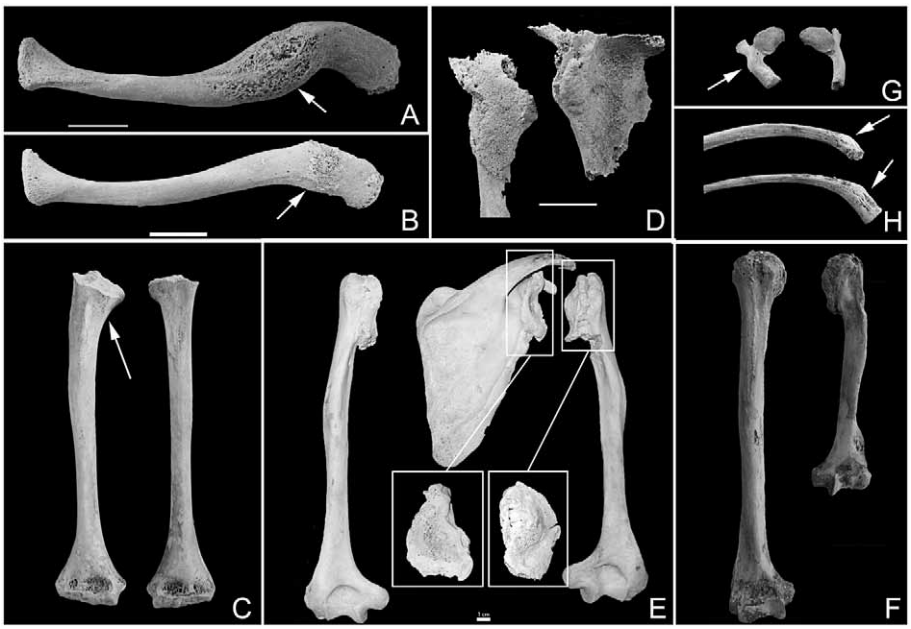

Fig. 5. Examples of skeletal birth trauma from the Kellis 2 cemetery. A) Burial 687b displaying a healed fracture with bone remodeling on the lateral end of the left clavicle; B) Burial 677 displaying a healed fracture on the lateral end of the left clavicle; C) Burial 399 displaying a well headed fracture of the proximal right humerus; D) Burial 687c displaying a healing fracture of the proximal right humerus with new bone formation; E) Burial 124 displaying a case of bilateral humerus varus; F) Burial 676 displaying a case of unilateral humerus varus of the left humerus; G) Burial 533 displaying a healed fracture of the left vertebral arch of the 1st cervical vertebra; and H) Burial 611 displaying green-stick fractures of the anterior ribs (photos: DOP Bioarchaeology Team).

(Fig. 5C). Burial 687c, a 1-month old, exhibits a healing fracture of the proximal right humerus with new periosteal bone formation and corresponding new bone formation on the right scapula (Fig. 5D). Fractures of this type are thought to be caused by rotation or hyperextension of the arm during the birth process, and occur more frequently with larger fetuses, or during breech presentation when significant force is used to free the infant from the pelvic outlet (Caviglia *et al.* 2005). Given the stage of healing and the age of the individuals, these injuries (particularly those on 687c) most likely occurred during the birth process.

Another form of complex birth-related humeral fracture is humerus varus deformity, marked by a decrease in the angle of the head and significant shortening of the humeral diaphysis (Molto 2000). Although there can be other non-traumatic causes of humeral varus deformity, such as mucopolysaccharidosis, thalassemia, rickets, and osteomalacia (Kacki *et al.* 2013), differential diagnosis of the four adult cases from the Kellis 2 cemetery (Burials 87, 124, 403, and 676, Fig. 5E and 5F), suggests a cause linked to birth trauma (see Molto 2000 for in-depth discussion of differential diagnosis). Birth trauma to the shoulder related to large infant size and breech presentation has been suggested as a possible cause of humeral varus

deformity (proximal humeral epiphysiolysis) (Ellefsen *et al.* 1994), and is a likely cause of the cases from the Kellis 2 cemetery, suggesting long-term survival of birth-related trauma.

Cervical Fracture

Fracture to the cervical vertebrae has been noted in cases of difficult deliveries where there is hyperextension of the fetal head, particularly in cases of breech presentation (Stanley *et al.* 1985; Caird *et al.* 2005). Burial 533, a 3-month old, exhibits a healed fracture of the left neural arch of the first cervical vertebra (Fig. 5G). Given the stage of healing and the age of this individual, this fracture is most likely related to birth trauma, and may indicate a breech delivery.

Rib Fracture

Rib fractures sustained during the birth process are rare. However, during a difficult delivery, the fetus may suffer rib fractures due to a combination of large birth weight, circumferential forces caused by combined factors such as labor contractions, the passage through a narrow birth canal, additional rotational forces, and leverage over the pubic symphysis (Van Rijn *et al.* 2009). Rib fractures are also reported to occur in up to 2% of preterm infants due to the early stage of development and inadequate mineralization of bone (Lucas-Herald *et al.* 2012). Burial 611, aged 25-weeks gestation, exhibits greenstick fractures at the anteromedial end of two ribs (Fig. 5H). Although pediatric rib fractures can be indicative of non-accidental trauma (Barry and Hocking 1993), given the very young age of Burial 611 and the location and type of rib fracture, it is most likely that these fractures occurred during the birthing process possibly due to inadequate skeletal mineralization or labor contractions.

Conclusions

The majority of the birth injuries recorded in individuals from the Kellis 2 cemetery are most likely due to prolonged labor, and compression and traction forces during the birth process. Earlier work by Tocheri and colleagues (2005) suggest that fetal size should not have been an issue during delivery, as the infants from the Kellis 2 cemetery were not comparatively large. Therefore, obstetric dimensions and breech presentation should be closely examined as the possible cause of serious problems during delivery. All of the birth injuries documented from this skeletal collection suggest that a midwife or trained birth assistant would have been present, and in some cases would have resorted to damaging maneuvers to deliver the infant. These include applying pressure to the shoulders and potentially fracturing the clavicle or damaging the proximal humeral epiphysis, twisting the arm and causing humeral fracture, or pulling on the skull or assisting a breech delivery and causing cervical fracture. As noted earlier, several of the individuals with birth trauma are located in the same part of the Kellis 2 cemetery (Fig. 2), perhaps suggesting a particularly rough midwife, or possibly that females linked to this part of the

cemetery had problematic obstetric dimensions. The perils of birth related to problematic obstetric dimensions as a primary contributor to the high number of newborns and child-bearing aged women included in the Kellis 2 cemetery will be a subject of future research.

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Studying Egyptian Mummies in the Field

Salima Ikram

Mummies, the artificially preserved bodies of humans or other animals, are commonly found on excavations and have been studied in a variety of ways for centuries (Ikram and Dodson 1998; David 2000; Aufderheide 2003; Ikram 2012). Several publications – too numerous to list here – have resulted from these varied examinations. The way in which mummies have been studied has changed over time, moving from unwrapping and "autopsies" (Aufderheide 2003; Ikram and Dodson 1998) to the use of sophisticated techniques that decrease the damage to the artefact, and provide significant information with regard to the body and the individual, as well as the method of mummification. As a result, there is a plethora of individual articles spread throughout diverse journals (relating not only to archaeology and palaeopathology, but medicine, chemistry, radiographic imaging, and textiles) with information about extracting information from preserved bodies, as well as more holistic studies of these artefacts (David 1979; Cockburn and Cockburn 1980; Taylor 1995; Aufderheide 2003; Teeter and Johnson 2009; Corcoran and Svoboda 2010; Taylor and Antoine 2014). Different papers have been written with regard to how best to image and study mummies in the ideal condition of a museum (Adams and Alsop 2008; Lynnerup 2009), but few address the practicalities, both physical and legal, of what can be done when in the field in Egypt, especially with limited funds. Some basic methods have been presented (Aufderheide 2003: 331-33; Ikram 2009; although this former publication supports "autopsy" methods), but perhaps it is time to revisit this issue and to provide some basic information to excavators who do not have an expert on staff, and to students of Egyptology/archaeology/physical anthropology who do not have a background in mummy studies. Thus, this article attempts to provide a basic outline of how mummies can and should be studied in the field, what information can be derived from them, and the various expertise required for this. It should be noted that, while the protocol for what can be accomplished in the field will probably remain static for some time, the scientific tests that can be used to extract information from mummies will change and advance rapidly.

The Ethics of Studying a Mummy

It should be remembered that the unwrapping of mummies, a common way of studying mummies until the early 20th century (Ikram and Dodson 1998: 61-102), is a destructive process and should be avoided, if at all possible. However, if a mummy is only partially preserved and if solid information can be derived from unwrapping fragmentary remains, only then should such a course be taken after due reflection, taking not only the destruction of the wrapped bundle into consideration, but the fact that one is dealing with a human body. The views of the deceased to being party to such an investigation cannot be established, but the least the investigator can do is to treat the body with all due respect. Increasingly the ethics of studying mummies has been a subject of discussion and investigators should be aware of the current thoughts on this, and should take these into account when embarking on the analysis of a body, together with considering how much information is to be gained by such destructive analysis (Aufderheide 2003: 2-3; Kaufmann and Rühli 2010; Marchant 2010; Taylor and Antoine 2014; Fletcher *et al.* 2014; Swiss Mummy Project).

The Different Stages of Studying a Mummy

The first stage in studying a mummy is a visual examination *in situ*, and thorough documentation. When recording a mummy the need for documentation is paramount, both visual and textual (appendix). This is one of the most important parts of the process. Photographs and videos as well as verbal/written descriptions of what is observed and what happens should be made throughout the mummy's life, from discovery and excavation to removal to storage. Often, despite ones best efforts, mummies do not emerge intact, and thus it is best to record as much information as possible as soon as possible. Of course, when the mummy is *in situ*, only a limited amount of information can be extracted from it, especially if it is in a coffin. In the initial phase, one should record whether it is bandaged or not, patterns of bandaging if visible, if flesh, skin, and hair survive or not.

Extraction/Excavation

After establishing the orientation of the burial in detail, the first challenge is the removal of the mummy (Ikram 2009). How this is accomplished depends on several issues, the most salient of which are: the type of mummification employed, the matrix in which the bodies lay, whether the bodies are in a container, and the type of research to be carried out on them. Ideally, a conservator will be on hand to help with the logistics of removing the mummy from its matrix (Garcia *et al.* 2008). Thus, when a mummy is discovered, prior to its removal, the excavators, together with the conservator, should think of how best to clear it, lift it, move it, and store it. This planning stage might take more time than the actual removal, but is conducive to a smooth and successful operation. Patience and planning are key to the success of the endeavor.

If relatively intact, the mummy should be extracted as one unit. If it lies straight in the ground, this can be achieved by placing flexible metal sheets (best) or chipboard beneath them, to move them to their study/storage area. Depending on the robusticity of the mummy, even cloth (and wood) stretchers can be used for transportation. Also, bands of cloth can be passed beneath the mummy and these can be used to lift it by two teams on either side, working in unison; this is particularly useful when the mummy is in a coffin. In some instances, in rectangular coffins, and very much depending on the state of conservation, one wall of the coffin can also be temporarily removed and the mummy extracted.

In cases where the mummy is in poor condition, cyclododecane can be used to consolidate mummies. This wax-like substance is impermanent; unless sealed with foil or plastic, it evaporates, leaving the object intact. If sampling is to be carried out on the mummy, it is best that this be done before extraction takes place, especially if cyclododecane is being used, although this does not affect all types of tests. Whenever possible, those who actually handle the mummy should use gloves and masks to avoid contamination and to protect the mummy as much as possible.

Examining the Mummy

There are several steps involved in studying a mummy, not all of which can be achieved in the field, or indeed at all, due to financial and legal restrictions that might apply. However, the basics can be carried out, regardless of the location and the budget. The first step is a visual examination accompanied by photo documentation. If possible, once the body has been moved, both the recto and verso should be examined and photographed. This is followed by radiography, ideally both X-rays and CT-scans, and finally by a variety of tests that can be carried out to determine the materials of mummification, diseases that the deceased might have suffered from, genetic information, and possibly when the deceased died. Aufderheide (2003: 331ff) has provided a form for studying mummies in the field, and below, there is a more detailed version that this author uses in the field when no unwrapping takes place; it can be adapted for each site and the different situations that are encounted.

Visual Examination

The most basic and important part of examining a mummy is a visual examination. After photography (overall and detailed), this should include measurements of the entire body, or whichever parts are being examined (length, length of arms and/or legs, width at shoulders, width at hips, width at feet, if possible circumference of head), with a notation being made as to whether it is wrapped or unwrapped. A basic description of the state of the mummy, linked to the photographs, should follow. This should include information about whether it is wrapped or unwrapped, details about the bandages (see section on bandages), the presence of bead nets or other adornments of cartonnage, garlands, and amulets if they are visible.

The Bandages/Wrappings

Records should be made of any patterns that the bandages follow – or if they follow none. The quality of cloth used should also be noted, and definitions provided for how the quality is being judged. Fineness of the threads and number of threads in the weft and/or warp of one cm^2 is an acceptable way of defining qualities, or clearly illustrated (photos are preferable to drawings) examples of each type can be provided as a guide. If any of the bandages have woven or colored patterns, these should be recorded. A textile specialist is useful for such investigations. The number of layers of bandages should also be noted, as should the average widths of the strips, and the presence of fringed bandages, complete or partial garments used in wrapping should also be recorded when possible. If a shroud is used, its dimensions and measurements, if possible, should be documented. If pads of linen cloth are encountered as part of the wrappings, their dimensions and quality should be registered. The knots used in tying together bandages to secure and lengthen them should also be recorded and photographed. Some bandages bear inscriptions, and all loose mummy bandages should be examined for these; however, in a well-preserved, wrapped mummy these cannot be detected unless they are easily accessible. Unwrapping mummies is not encouraged unless it is disintegrating or is only a partial body, as mentioned above.

If one is examining the body where the wrappings have fallen off, one should note the presence of tampons of linen in the nose and ears. The eyes and sometimes the mouth also contain textile, which should be noted.

The colors of the linen – particularly relevant in mummies dating from c. 500 BC to AD 400 – should also be recorded, possibly using a Munsell or paint chart, although the use of the former is still somewhat controversial as different people see the variations in colour in a variety of ways. Photographs taken with a spectrum scale should solve this issue. In mummies of an earlier date, colored bands, generally blue, are found forming a border, and these too are noteworthy. Some bandages bear texts, and thus care should be taken to examine each piece of loose linen carefully.

Sometimes cords of linen or even papyrus or halfa grass are used to secure mummies. These should be recorded and studied. Such materials are frequently found in the wrapping of animal mummies, and even within mummies or as garlands. The involvement of an archaeobotanist is important for these identifications, which can provide evidence for the time of year when mummification occurred, and could also hint at the location in which it took place.

The Body

If the body itself is visible, then it should be described with attention paid to its degree of preservation of skin, nails, and hair: on the head, face, and body. Its overall color and odour should be noted, together with the overall degree of preservation. The nostrils should be examined to see if one can tell if the ethmoid was broken and the brain extracted. Plugs of linen in the nostrils and ears should also be recorded. If the neck is visible, one should check to see if excerebration

might have occurred via the atlas. The left side of the torso should be checked for the embalming cut and subsequent treatment. If the interior is exposed its packing should be documented. Care should be taken in examining the whole body as sometimes tattoos are found on some of the limbs.

The presence of oils is difficult to detect, but stains of oils, resins, or body juices, particularly on the back of the mummy (or where it was positioned after preparation, in the case of animals), should be noted and described. These materials are also found on the body itself, and manifest themselves as a dark (black) material. Furthermore, remnants of natron should be recorded. Further information can be extracted from these materials by carrying out tests on them (see section on testing).

Insects or their larvae that are found in the mummy provide information about the making of the mummy – if there is an abundance of fly larvae and poor preservation, clearly there was an insufficiency of natron used during the desiccation process. Using insects, an entomologist (forensic or other) can shed light on the body's exposure to the atmosphere after death.

A physical anthropologist can establish the sex, age, and health of the mummy by a visual examination of the bones, and some information can be derived through endoscopy if the mummy is not too tightly wrapped. However, if the mummy is wrapped radiography is needed to study these.

Radiographic Imaging

In field conditions a portable X-ray machine should be used to image the body without damaging it. These images can provide some information about the wrappings, but mainly show the bones within the wrappings, as well as any amulets or papyri. The bones can show the position of the body, age and sex of an individual, and certain aspects of the individual's health (nutrition, broken bones, diseases that are manifest on the bone) can also be revealed. Furthermore, an X-ray is useful as a guide if the mummy is CT-scanned, as it allows one to place the slices along the body and to target specific areas for more detailed study (the ideals of imaging in a controlled environment are outlined in Adams and Alsop 2008 and Lynnerup 2009; it should be noted that these technologies are always advancing).

CT-scans provide a more comprehensive view of the mummy as they consists of several "slices" of X-rays of an object. These enable one not only to examine the bones, but also the layers of bandages and their contents. However, CT-scanning is expensive and it is not always possible to remove mummies from the site to take them to a CT-scanner, which makes the X-rays all the more important. It should be noted that if the CT-scans are made and if they are of a high enough quality, these images can be used to create a virtual unwrapping of the mummy, revealing the body and its contents. Facial reconstructions can also be based on the information derived from the scans (Figs. 1, 2).

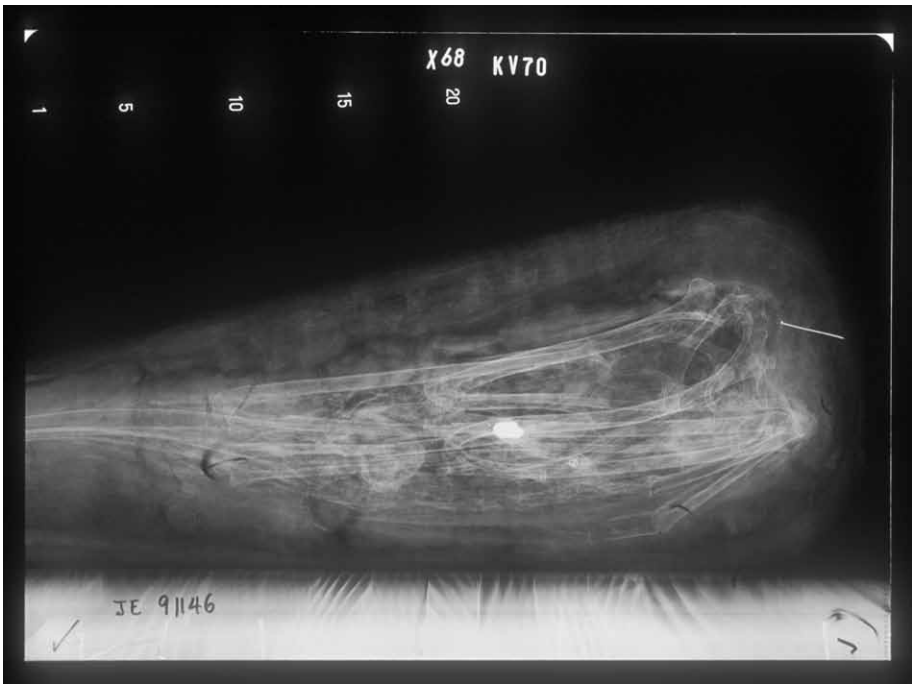

Fig 1. An X-ray of an ibis in profile showing the bones and some of the details of the wrappings (photo: S. Ikram).

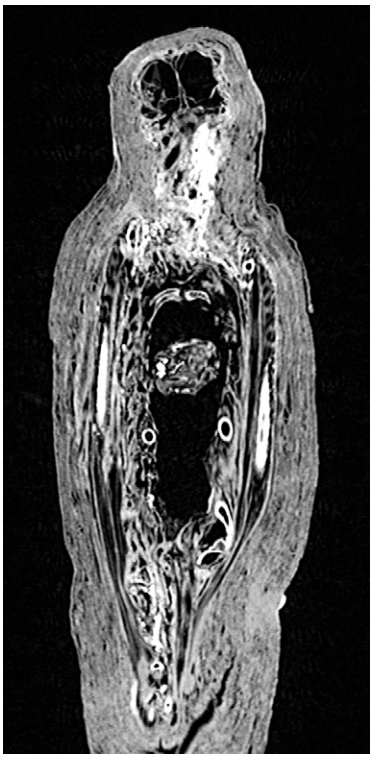

Fig. 2. A CT-scan of a falcon mummy, showing it frontally. The details of the bones and wrappings are clear, as well as an inclusion within the body of the bird, perhaps the heart (photo: C. Prates).

Chemical and Other Tests

Several tests can be carried out on the bandages, bodies, and embalming agents to flesh out ones understanding of the mummy. Tissue samples can be used for histological tests, the identification of different diseases, including malaria, leishmaniasis, schistosomiasis, tuberculosis, trichinosis, as well as other diseases (Millet *et al.* 1980; Miller 1990; 1992; Miller *et al.* 1994; Zink *et al.* 2006; Sabbahy 2015). C-14 dating might also be used on flesh, as well as on some of the other materials associated with mummies, such as the bandages, although these might date to considerably earlier than the body itself.

Bones and teeth can be subjected to isotope and strontium analysis (Thompson *et al.* 2005; Buzon *et al.* 2007; Thompson *et al.* 2008; Abbate *et al.* 2010) in order to establish the origins, diet, and movement of both humans and animals. These anatomical elements can also be used for C-14 dating, as well as for DNA. Although DNA can be extracted, its accuracy remains a vexed question (Pääbo 1985; 1986; Cooper and Poinar 2000; Zink and Nerlich 2005; Hawass *et al.* 2010; Lorenzen and Willerslev 2010). Nonetheless, it is useful to sample the mummies and to keep these as part of the finds, or in a storage bank, either the Manchester Mummy Storage facility, or by creating one in Egypt.

Additionally, simple tests, such as solubility, or more complex ones, such as gas chromatography, mass spectrometry, and XRF can be carried out on many of the materials used in preparing the mummy, so that they can be identified (Buckley *et al.* 1999; 2004; Buckley and Evershed 2001). Such identifications not only shed light on how a mummy is made, but also about the socio-economic background of the deceased, and the trade networks present at the time that allowed for different materials to be used in mummification.

Storage

The excavators' and researchers' responsibility to a mummy do not end with documenting and studying it (Garcia *et al.* 2008). They also need to ensure that they provide a basic level of individual storage to protect the mummy. Thus, planks of wood with straps for securing the mummies, or shallow coffins are good options. The mummy should be protected from dust and dirt by a covering, ideally of acid free paper, but even some kind of textile sheeting is acceptable. Insect threat is a major problem, and insect traps should be placed in strategic locations around the mummy. Camphor and creosote are also possible pest deterrents, but would need to be renewed.

In Egypt, the Ministry of Antiquities is responsible for providing and maintaining the storage space. Storage of mummified remains is difficult due to practical issues of space, climate, conservation, finance, and security. An ideal solution would be a room dedicated specifically to mummy storage with climate control, but this is rare and not always feasible. Thus, a room (or tomb) with a relatively constant climate is ideal, with regular checks being made to ensure that there are no leaks or insect infestations.

Publication

The study of a mummy is not complete until it has been published. After excavation, a basic publication should be made, as soon as possible – without this, the work of the scholars is no different from that of the grave robbers. The initial publication can provide the visual results of the examination if no imaging has taken place. Subsequently, if imaging or testing is carried out on the mummy, the results of these can be published. A useful mode of publication for a group of mummies is illustrated in Raven and Taconis (2005), which has individual entries as well as a table that should be used as a template for mummy publications.

Final Remarks

Mummies are composite artefacts that give one a rare chance to study and come to know individual ancient Egyptians, as well as being a source of evidence that allows one to better understand Egypt's history, culture, religion, economy, and trade. They unite the reasearch of a variety of scholars: excavators, physical anthropologists, palaeopathologists, archaeobotanists, textile specialists, entemologists, chemists, mummy specialists, and Egyptologists. It is hoped that excavators and scholars will use all possible means to study mummies holistically in order to extract the maximum amount of information from them, and will be able to store and protect them for future generations to study as new technologies become available.

Site Name **Date**
Investigator(s)

Area Tomb No. Mummy No.
Photograph Nos:
Drawing Nos:
Body orientation
Condition

Length **Width** **Other**
Wrapped Yes__ No___ Partial____

Wrappings

General description

Colour
Length(s)
Width(s)
Knots

Hands
Feet
Nose plugs Y__ N__ Ear plugs Y__ N__

Eyes Y__ N__ Mouth Y__ N__

Other observations:

Body
General Description

Position
Colour
Resinous materials
Length
Width
Insects Y__ N__

Insect types
Evisceration
Evisceration cut
Excerebration
Natron
Hair (head) Y__ N__ Hair (body) Y__ N__

Hair (face) Y__ N__ Nails Y__ N__

			Head___
Gilding	Y__ N__	Location:	Nails____
Penis	Y__ N__	Circumcised	Y__ N__

Other body treatment

Species (for animal mummy)

Age (and basis)

Sex (and basis) M___ F_____ Unknown____

Pathologies

Other observations

X-rays

Samples

Other

Plant material

Amulets & Jewellery

Cartonnage

Appendix: Field recordig sheet.

A Case of Metastatic Carcinoma in an Old Kingdom-Period Skeleton from Saqqara

Iwona Kozieradzka-Ogunmakin

Introduction

A recently published paper by David and Zimmerman (2010) has served to highlight a number of issues concerning the incidence of cancer in antiquity. The authors argue that the more common occurrence of the disease in modern societies compared with past populations could be due to the abundance of carcinogenic environmental factors that are the result of modern habits, discoveries, and technological advances. Although it is uncertain whether descriptions provided by the ancient Egyptian medical texts pertain to cancer or other conditions that could produce similar symptoms (Nunn 1996: 81; Veiga 2009), undisputable evidence for the presence of the disease in this particular population is available from the human remains (e.g. Vagn Nielsen 1970; Strouhal 1976; Torre *et al.* 1980; Strouhal and Vyhnánek 1981; Ghalioungui 1986; Strouhal 1993; Zink *et al.* 1999; Reddie 2003; Nerlich 2006; Veiga 2009; Prates *et al.* 2011). To date, a small number of cases of diagnosed neoplastic conditions from various historical periods have been reported in ancient Egyptian human remains; however, more evidence is still forthcoming (e.g. Dupras *et al.* 2013). With regards to metastatic bone cancer, the most recent evidence of this condition was reported in the skeletal remains of a 45-year-old female recovered from a 3rd Dynasty burial at Dayr el-Barshā, and another female, aged 45-50 years, recovered from the Kellis 2 cemetery site in the Dakhleh Oasis, dated to the Romano-Christian Period (AD 100-300) (Dupras *et al.* 2013).

Whether cancer was indeed a rare disease in antiquity in contrast to modern times (David and Zimmerman 2010) should not be determined exclusively by the number of cases reported in the ancient Egyptian human remains, as this is highly unlikely to reflect the real prevalence of cancer in the population in question. Admittedly, the incidence of cancer increases with age, and would therefore be less common in past populations with low life expectancy, such as the ancient Egyptian. First, the human remains recovered from archaeological sites and subjected to appropriate pathological examination represent only a small fraction of the total ancient Egyptian population. Second, in archaeological material the identification

of the disease is often hindered by inadequate preservation and completeness of the human (usually skeletal) remains. Not all types of cancer affect or spread to bone, and many bone lesions can only be detected radiographically. This diagnostic method is usually applied only to selected specimens, likely resulting in many cases of bone metastases going undetected. For these reasons a declaration of cancer rarity in ancient Egypt and its causative factors should be considered with caution.

Specimens and Methods

The present case of metastatic carcinoma was diagnosed in the skeletal remains recovered from an Old Kingdom-period shaft-tomb (Burial 554) at the Saqqara necropolis (Kuraszkiewicz 2013; Fig. 1). The necropolis is located approximately 40 km southwest of the capital city of Cairo and extends over six km north-south and 1.5 km east-west, forming the largest part of the ancient Memphite necropolis. The cemetery site from which the skeletal remains were recovered is located immediately to the west of the Step Pyramid complex of Djoser, and is comprised mainly of inhumations dating to the late Old Kingdom (5th-6th Dynasties; 2494-2181 BC) and the Ptolemaic Period (332-30 BC) (Myśliwiec *et al.* 2004; Myśliwiec 2008; Myśliwiec and Kuraszkiewicz 2010). Since 1996, the cemetery site has been under archaeological investigation by the Polish Archaeological Team of the Polish Centre of Mediterranean Archaeology, University of Warsaw.

During the 2008 campaign, the team uncovered several subterranean funerary structures. One of these was Shaft 111, which contained a burial chamber with a primary late Old Kingdom burial and an intrusive later-date inhumation (Fig. 2). The former, Burial 554, consisted of a skeletonized body of an adult individual interred in a rectangular reed coffin. The burial showed evidence of

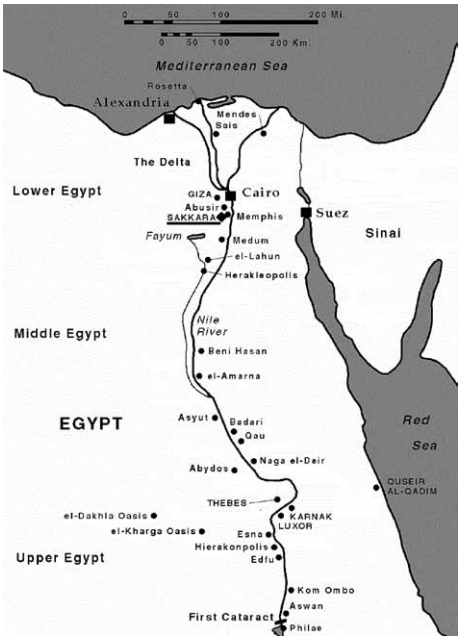

Fig. 1. Location of the Saqqara necropolis (map: Modified from the original Egypt site map of the Oriental Institute of the University of Chicago (oi.uchicago.edu/research/lab/map/maps/egypt.html).

Fig. 2. Late Old Kingdom Burial 554 (coffined) and intrusive later-date Burial 553 (photo: W. Wojciechowski).

post-depositional disturbance. However, this had little effect on the completeness and preservation of the body, which remained largely intact except for its upper part. The body rested on its left side with the legs fully flexed. The individual's skull was displaced but still contained within the coffin. Taking into account the arrangement of the body and its north-south orientation in the burial chamber, the head would likely have originally faced eastwards.

Large fragments of linen wrappings still covered the skeletonized remains of the individual's upper body. The skeletal remains were in a very good state of preservation and completeness, with only a few elements of the hands and feet missing. The uniform color of the bones, lack of discoloration of the wrappings, and the lack of evidence for excerebration would suggest that the post-mortem treatment of the body was likely limited to external desiccation alone.

The excellent preservation and completeness of the skeletal remains and the satisfactory preservation of the dentition allowed for the application of several standard methods to estimate sex and age at death. The former was based on the assessment of the size, shape and robusticity of selected morphological characteristics of the cranium and the bony pelvis (Ferembach *et al.* 1980; Krogman and Íşcan 1986; Schwartz 1995), as well as on selected measurements of dimorphic dimensions of long bones, such as the humeral and femoral head diameters, the bicondylar width of the femur, and the maximum length of the scapula (Steele and Bramblett 1988; Mays and Cox 2000: 119). Age at death was estimated based on the macroscopic observation of degenerative changes of the pubic symphysis (Brooks and Suchey 1990) and auricular surface (Lovejoy *et al.*

1985), closure of cranial sutures (Buikstra and Ubelaker 1994: 32-36), and dental attrition (Brothwell 1965: 69; Smith 1984: 45).

Individual skeletal elements were examined macroscopically for evidence of pathological changes in order to assess physical health at the time of death. Due to time constraints and the limited availability of radiographic equipment on site, the cranium was the only skeletal element selected for imaging.

Skeletal Findings

The skeletal remains recovered from Burial 554 belonged to a female aged 50 to 60 years at the time of death. Macroscopic examination of the cranium revealed an extensive perforating crater-like lytic lesion (60.5 by 53 mm) that developed on the right parietal bone at the junction of the sagittal and lambdoid sutures (Fig. 3). The lesion had irregular and scalloped borders, and in the border extending across

Fig. 3. Extensive lytic lesion in the cranium, superior-posterior view (photo: IK-O).

the right parietal bone the diploë was partially or completely occluded by compact bone. No uplift of the outer table or osteoblastic response (involving the formation of new bone) was observed at the lesion border. Several smaller secondary lesions were present around the primary extensive lesion on the right parietal bone and beyond the sutures on the left parietal and superior occipital bones. The lateral radiographic image of the cranium (Fig. 4) revealed a further small focal destruction on the endocranial surface, located approximately at the temporo-parietal suture. The image also revealed the vascular grooves of new blood vessels that branched off from the anterior branch of the middle meningeal artery, and were formed to supply oxygen and nutrients to the cancerous tissue. No further osteolytic or osteoblastic lesions were identified in the female's cranium. A large ectocranial depression (32.5 by 22 mm) observed in the left parietal bone resulted from bone thinning, most likely associated with menopausal osteoporosis (Epstein 1953; Lodge 1967; Phillips 2007).

Macroscopic examination of the post-cranial skeleton revealed a single longitudinal cavitation (20 by 4 mm) in the left lateral body of the 5th lumbar vertebra, exposing smooth trabecular bone (Fig. 5). No further osteolytic lesions were observed in the vertebrae or the remaining post-cranial elements.

In addition to the solitary cancerous lesion observed in the lumbar vertebra, the spine demonstrated mild to severe degenerative changes consistent with advanced age. Mild osteoarthritic changes were also observed in the major joints, including

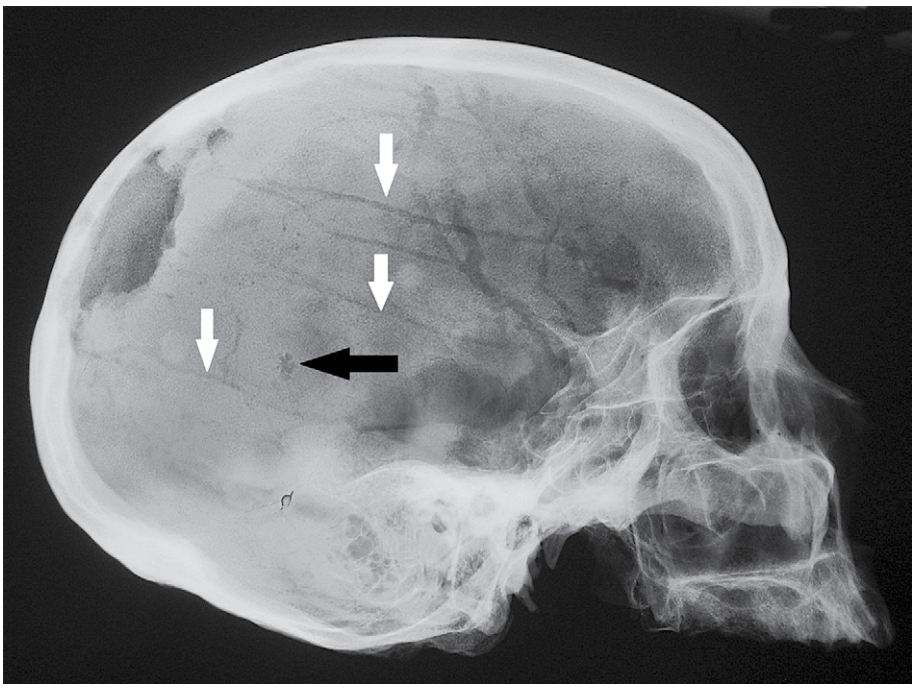

Fig. 4. Lateral radiographic image of the cranium revealing a non-perforating lytic lesion in the endocranial surface (black arrow) and new vascular grooves (white arrows) (photo: S. Ikram).

Fig. 5. Lytic lesion in the body of the 5th lumbar vertebra (photo: W. Wojciechowski).

the gleno-humeral, the elbow and the knee joints. Further post-cranial pathological findings included new periosteal bone formation on the lateral tibiae and medial fibulae. The articular surface of the lateral malleolus of the left fibula displayed an intra-articular fracture that most likely occurred due to impact or stress that affected the ankle joint (Carr 2003; Koulouris and William 2005).

Differential Diagnosis

Osteolytic lesions are characteristic of malignant neoplasms, such as multiple myeoloma and metastatic carcinoma. The former is the most common of the primary malignant tumours of the skeleton, and results from malignantly degenerated plasma cells in the blood-forming tissue of the bone marrow (Roberts and Manchester 2007: 258). Metastatic carcinoma, on the other hand, is the most common secondary cancer found in bone (Dorfman and Czerniak 1998: 1009). The condition is caused by the metastasis of malignantly degenerated epithelial cells from a primary site in an internal organ to numerous secondary locations in the skeleton (Strouhal 1991: 219-220). There are four main paths through which cancerous cells metastasize: the blood vascular system, the lymphatic system, directly from a tumour adjacent to bone, and in cases of brain tumours via the cerebrospinal fluid (Waldron 2009: 184-185). Multiple myeloma and metastatic carcinoma demonstrate many similarities that often make the differentiation between the two conditions highly problematic, particularly in skeletal material (Strouhal 1991; Ortner 2003: 532). Both conditions manifest multiple lesions that are exclusively

or predominantly lytic in character. These lesions originate in the bone marrow and progress through erosion of the compact bone. The most common location for the lesions to occur is in the axial skeleton, but they also commonly occur in the humerus and the femur. The conditions affect predominantly individuals aged 40 years and over (Strouhal 1991: 223).

Some general differences, however, including the quantity and patterning of the lesions, may allow for differentiation between the two conditions. According to Strouhal's compilation of diagnostic differences between multiple myeloma and metastatic carcinoma (1991: 223), the former is characterised by a great density and number of lesions that are scattered throughout the skeleton. Furthermore, the lesions have a regular round outline, and macroscopically they demonstrate sharp edges and appear "punched out". The lesions are small to medium in size, and usually not larger than several millimetres in diameter, with the exception of those that have merged together. The surface of the surrounding bone demonstrates no pathological changes. The occurrence of osteoblastic reaction in multiple myeloma is reported to be non-existent or extremely slight. The sites that are more commonly affected in this particular condition in comparison to metastatic carcinoma include the scapula, clavicle, radius and ulna. Finally, multiple myeloma affects twice as many males as females.

In comparison to multiple myeloma, metastatic carcinoma is characterised by fewer but more localised lesions that demonstrate an irregular outline with denticulations and scallops, and a greater variability in size ranging from several millimetres up to several centimetres in diameter (Strouhal 1991: 223). The surface of the surrounding bone might be pitted with further small perforations indicating an area where the central lytic lesion has expanded by merging with other foci. Osteoblastic remodelling is more likely to occur in metastatic carcinoma than in multiple myeloma; however, the majority (75%) of the metastatic carcinomas affecting bone are osteolytic, with only 15% being osteoblastic, and the remaining 10% being mixed osteolytic and osteoblastic (Greenspan and Remagen 1998: 368). The most common causes of osteolytic lesions are carcinomas of the kidney, lung, breast, gastrointestinal tract, and thyroid. Breast carcinoma, however, can also cause osteoblastic or mixed osteolytic and osteoblastic lesions. In men, osteoblastic lesions are most commonly caused by prostate carcinoma. The most common sites affected by metastatic carcinomas are those of the axial skeleton and proximal long bones of the limbs. These include the spine and sacrum, the proximal epiphysis and metaphysis of the femur, ribs, sternum, skull, pelvis, and proximal humerus (Ortner 2003: 533). Furthermore, the neural arches of the vertebrae and their processes are more commonly affected in metastatic carcinoma than in multiple myeloma (Strouhal 1991: 223). Contrary to the latter condition, metastatic carcinomas are reported to affect females more frequently than males. The most common cause of metastatic bone disease in females is breast cancer. According to clinical studies, up to 90% of patients with breast or prostate cancer develop bone metastasis (Berrettoni and Carter 1986; Resnick and Niwayama, 1988: 3617; Body 1999).

The lesions encountered in the Saqqara skeleton were exclusively osteolytic, with no osteoblastic remodelling. The localised distribution of the lesions on the cranium and a single vertebra, the varying sizes of the lesions ranging from just several millimiters to several centimeters in diameter, and their irregular and scalloped outline are consistent with metastatic carcinoma. Although the distribution of the lesions in the present skeleton corresponds with other known archaeological (e.g. Torre *et al.* 1980: pl. 2 d-f; Strouhal and Vyhnánek 1981; Grupe 1988; Strouhal 1991; Ortner 2003: 539-544; Marks and Hamilton 2007; Roberts and Manchester 2007: 262-263) and clinical cases (e.g. Geschickter and Copeland 1949: 474-531; Ohmori *et al.* 1997), their very limited distribution and the absence of soft tissue for comparative histological studies make the identification of the primary cancer site highly speculative.

The presence of the extensive lesion in the parietal bone could possibly indicate that the primary neoplastic growth site was the brain, specifically the parietal lobe or the meninges. However, malignant meningioma is very rare, and the spread of this disease to other organs or bones has an incidence of only 1 in 1,000, with the lungs being the most frequent sites for metastasis (Fabi *et al.* 2006: 3835). Therefore, taking into consideration the distribution of the lesions in the Saqqara skeleton, their lytic character and morphology, the individual's sex (female) and advanced age (50-60 years), as well as the modern incidence of metastatic bone cancer, it could be speculated that the primary cancerous site was the breast.

Discussion and Conclusions

In the Saqqara female described in the present study, the two skeletal sites affected by metastatic cancer were the cranium and a single vertebra. The presence of this disease was determined macroscopically, and in the case of the cranium, also by radiographic imaging. The latter diagnostic technique revealed an additional non-perforating lesion in the cranium, which was undetectable by macroscopic examination. Since osteolytic lesions originate in the marrow cavities inside the bones and only later progress causing destruction and perforation of the bone cortex, it is possible that the distribution of the lesions was in fact more extensive in the post-cranial skeleton than it appeared to be by macroscopic inspection alone. Thus, a comprehensive radiographic imaging analysis of the skeletal remains, particularly bones with haematopoietic marrow sites where the lesions are most likely to occur, such as the skull, ribs, spine, bony pelvis, and the proximal humerus and femur, would need to be undertaken in order to determine the full extent of the distribution of the lesions in any individual under examination.

The presence of exclusively lytic lesions in the Saqqara skeleton would suggest the condition was very aggressive, likely causing the individual a high degree of pain; indeed, this is often identified as the first symptom of bone metastases in modern clinical patients (Coleman 2006). The pain would likely have increased with progression of the disease. In addition, the Saqqara female would probably have experienced other symptoms, notably those caused by hypercalcaemia (high calcium level in the bloodstream; Solimando 2001; Bower and Cox 2004), which would have had a profound impact on her quality of life, inevitably necessitating some form of palliative care.

In archaeological cases where the primary cancerous site often remains at best speculative, it is almost impossible to determine the survival time for individuals with bone metastases. According to clinical studies (Coleman and Rubens 1987; Ohmori *et al.* 1997), the survival time after the detection of bone metastases would vary depending on the primary site. Of the four types of cancer investigated in these studies, the patients with prostate and breast cancer had the best prognosis with the survival time measured in years, in comparison to the patients with lung and stomach cancer whose average survival time was limited to several months (Ohmori *et al.* 1997: 265). However, if the speculative diagnosis of bone metastasis from breast cancer in the Saqqara female is to be considered, it is unlikely that her survival time would be as long as several years, considering the lack of modern-day cancer treatment available to her. Furthermore, if she subsequently developed metastases at extraosseous sites, her survival time would most certainly decrease further. However, both survival estimates and the diagnosis of the primary cancer site remain speculative, as no soft tissue survived for verification of the hypothesis.

Acknowledgements

The author wishes to express her gratitude to Karol Myśliwiec, Institute of Oriental and Mediterranean Cultures of the Polish Academy of Sciences and Polish Centre of the Mediterranean Archaeology of the University of Warsaw, for granting access to the human remains at the Saqqara necropolis, and to Salima Ikram, American University in Cairo, for radiographic imaging of the skeletal remains.

Study of Growth Arrest Lines upon Human Remains from Kharga Oasis

Roger Lichtenberg

Since 30 years the Strasbourg University team, directed by Françoise Dunand, has worked in Kharga oasis on the cemeteries attached to three sites: Dush, Ain el-Lebekha and el-Deir. These sites were inhabited in Ptolemaic and Roman times (possibly el-Deir was inhabited since the Persian period). Large settlements occupied these sites, notably at Dush. The populations of these sites were mostly fellahin (peasants and craftsmen) with, of course, well-to-do people, priests and civil servants. In late Roman times, small garrisons were also lodged inside the temple at Dush and inside the fortresses of Lebekha and Deir. Intensive farming was possible in all three areas, due to a good water supply accessed by artesian wells and the system of qanats. Now these areas are surrounded by desert, with huge barchans dunes covering the once fertile fields. On all three sites the sepulchres are family tombs, roughly dug in the ground or in the small ridges that surround the settlements (Fig. 1).

Human remains, adults and children buried in the same tomb, were normally mummified. However, due to severe and repeated looting – as well as poor mummification in many cases – many of the corpses that the team discovered had become skeletonized. However, good quality mummies were also found at the three sites. At each site, many of these were studied visually, and some samples were X-rayed. At Dush, the number of bodies studied was 763. Of these 50 mummies and 44 skeletons were X-rayed. At Lebekha, about 450 individuals were examined; of these, 64 mummies were X-rayed. At el-Deir the number of people belonging to South, North, North-East and East cemeteries was at least 850. Of these 45 mummies and 145 skeletons were X-rayed. Thus, the total number of individuals who were X-rayed amounts to more than 10% of the population on each site, providing a reliable sample size.

Growth arrest lines, also known as Harris Lines, were described by Harris in a 1931 study he performed on the skeletons of children with stunted growth and rickets (Harris 1993). These lines on X-ray look like dense lines appearing mainly on the diaphysis of some long bones, notably on the lower third of the tibias, to a lesser degree on the femurs, and more rarely on the humerus. It should be noted that it is impossible to identify these lines on living subjects except through radiological study. Of course, on a corpse, one could always make sections of the bone and study them under a microscope or even directly. The precise origin of

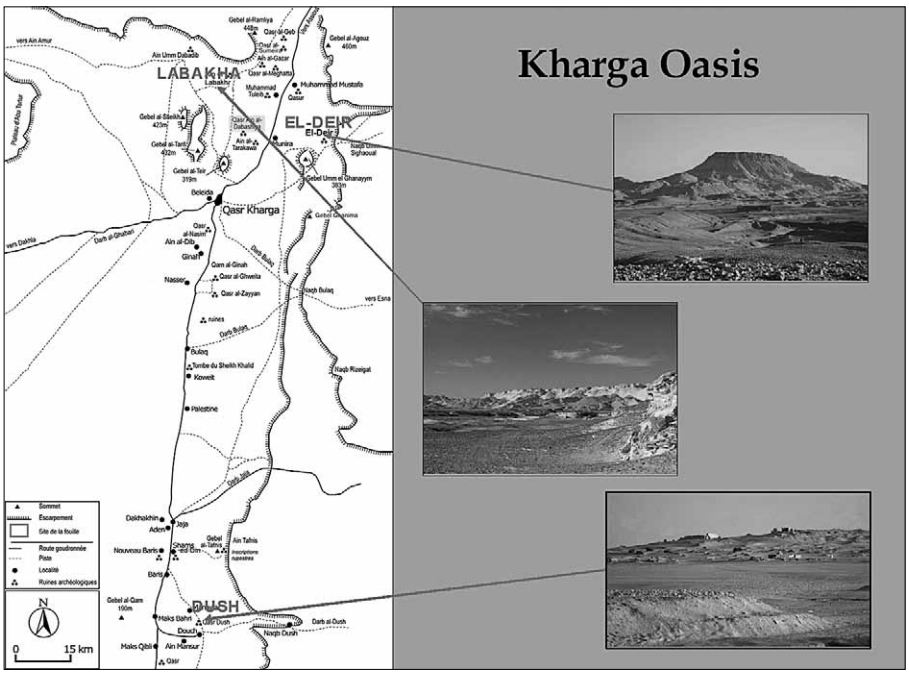

Fig. 1. Map of Kharga oasis with pictures of the three sites explored by the French team (map: R. Lichtenberg after Garcier; photos: R. Lichtenberg).

these lines is controversial. For some authors, they are anomalies that occur during the course of growth arrests caused by rather lengthy illnesses or malnutrition. For others, they are markers of a resumption of growth after a hiatus (Heim and Lichtenberg 2000). In any case, these lines constitute a good indication of an individual's state of health or, more exactly, of his/her life experience during the period of growth. In this way, the proportion of these lines within a population reflects its nutritional and pathological status (Figs. 2, 3).

When I began studying mummies *in situ* exactly thirty years ago, I had no experience in the sphere of radiographing mummies: in fact, I had X-rayed only one mummy: the mummy of Pharaoh Ramses II when it was brought to Paris in 1976! I had, however, learned a lot about this rather special type of radiography by reading, amongst others, the work of Gray who had X-rayed, during the 1960s, many of the mummies preserved in European museums. He had studied, notably, growth arrest lines (Gray 1966; 1969; Dawson and Gray 1968).

Fortified by these readings, in 1982 I travelled to Kharga oasis where, I was put in charge of the human remains at Dush, located in the south of the oasis. (Dunand *et al.* 1992; 2005). As part of the examination of human remains, I focussed on pathology and mummification, and Harris Lines in particular. To this end I X-rayed not only mummies, but dry bones too, so as to obtain a statistically valid sampling. It was possible to X-ray the inferior extremity of tibias and femurs of four individuals together on a single plate (Fig. 4).

Fig. 2. Harris Lines (arrow) on a broken femur found close to a tomb at el-Deir (East Cemetery) (photo: R. Lichtenberg).

This technique made it possible to increase in a meaningful way the number of subjects studied. Of course, this number was not very high because working in the desert is a slow process due to the poor quality of the radiological device and the power sources. The "X-ray department" was very basic. The X-ray device was an old, portable one, a Massiot-Philips 90-20, built during the fifties. It was used to X-ray people in the home, or wounded soldiers in the field. As mummies were stiff, it was possible to hang them with straps, along a wall, with the films behind them. This allowed me to turn them without damaging them in order to obtain frontal and lateral views. The development of the films was achieved in a very primitive laboratory. The whole was fitted out at Dush inside a wooden kiosk, at el-Deir inside an old building built by the British Army in 1912 when they occupied the site. The mummies from Lebekha were X-rayed inside the taftish at Kharga (Fig. 5).

The study of mummies at Dush, on my first mission, raised a problem of interpretation. The work of Gray established that Growth Arrest Lines (GAL) were present in 30% of the cases, while my own results were higher, more than 50%. The quality of Gray's results was well established; as for my results, the lines were very clear on the images. Thus I thought of possible explanations for the very

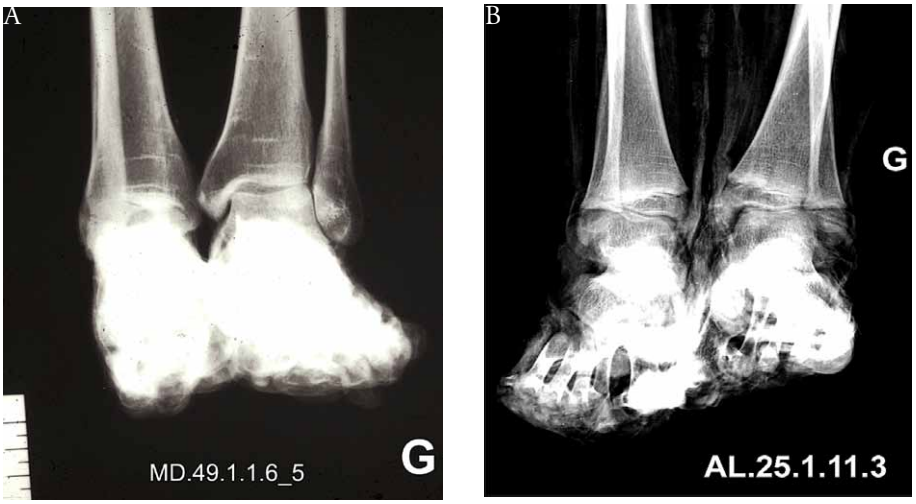

Fig. 3. A) MD.49.1.1.6: man from Dush cemetery, between 30-40 years old; B) AL.25.1.11.3: small boy from Labakha, about 5 years old (photos: R. Lichtenberg).

Fig. 4. These four individuals belong to the North and East Cemeteries. Arrows show Harris Lines on the bones of the skeleton of an adult man (ED N25.3.05) (photos: R. Lichtenberg).

high percentage of GAL on the Kharga mummies. It finally occurred to me that Gray's mummies had arrived in Europe during 19th century, inside high quality sarcophagi or cartonnage coverings which justified the choice of these special "souvenirs". At that time, too often people were not interested by the mummies

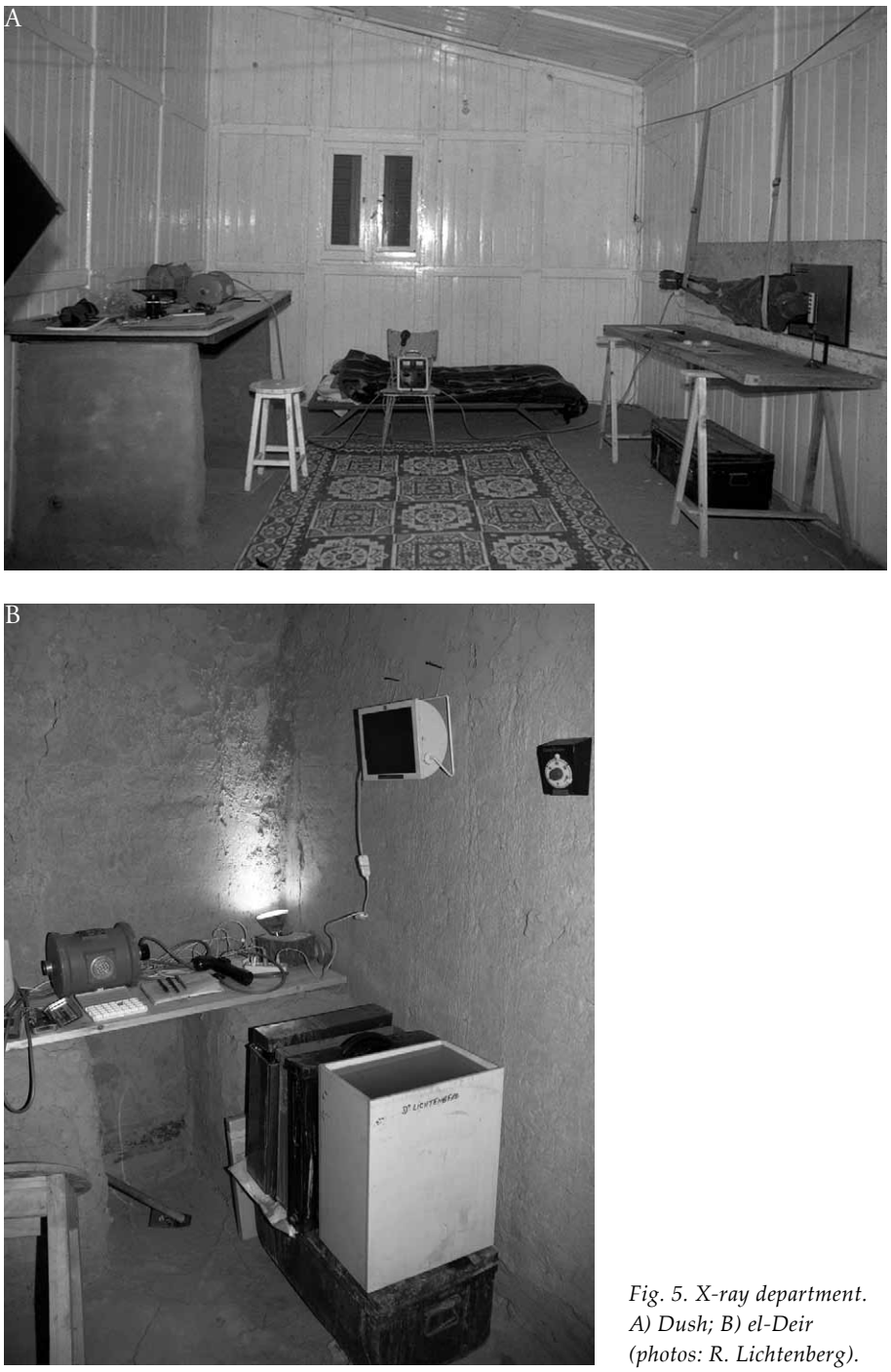

Fig. 5. X-ray department. A) Dush; B) el-Deir (photos: R. Lichtenberg).

themselves: most of the collectors and museum curators were interested in the sarcophagi, cartonnage, and jewels adorning the body. Thus, the artefacts that Gray had studied belonged to particularly well-to-do people. The mummified individuals studied by Gray were members of a social class superior to that of the

mummified peasants of the Kharga oasis. It should be noted that in the Ptolemaic and Roman periods, almost all people were mummified to some degree or the other (Dunand and Lichtenberg 2006).

Thus I realized that the study of GAL would allow not only an individual study, but also an overall sociological approach to populations. With the notable work, "An X-ray Atlas of the Royal Mummies" (Harris and Wente 1980), my speculation was confirmed. In the royal mummies, the book's authors recorded that these individuals showed GAL in less than 5% of cases. Even during a period when medical care was of a poor quality, the pharaohs of course benefited from higher quality food and better hygiene.

Therefore, the study of GAL appeared to be a true indicator of the quality of life of a population. These findings encouraged me to pursue the study of these lines at other sites with diverse populations.

The study of mummies and skeletons of the Dush necropolis was pursued during the course of five missions from 1982 until the early 1990s. During this time I obtained a series of 52 mummies and 44 skeletons. In the first instance, when all the individuals of both sexes were taken together, statistical results revealed that the incidence of growth arrest lines was 52.08%. But a more refined study looking at each sex separately showed that the greatest incidence of growth arrest lines was to be found among women: 68% versus 46% among men. The probable cause of this difference is in the frequency of pregnancy (girls married very young and their first pregnancies took place before they finished growing). Another cause probably would be distinct differences in workloads and the amount of food accessible to women (Table 1, 2).

On the site of Ain el-Lebekha, explored subsequently from 1994 to 1997, I observed that growth arrest lines appeared significantly more frequently, and that the difference between the sexes was less marked. Although there were some "rich" tombs, the standard of living seemed to be of lesser quality than at Dush.

	Individuals	**GAL**	
Mummies	50	31	62%
Skeletons	44	19	43,18%
Total	94	50	**52,08%**

Table 1. GAL at Dush.

	Individuals	**GAL**	
Mummies + skeletons females	40	25	**62,5%**
Mummies + skeletons males	54	25	**46%**

Table 2. GAL at Dush females and males separated.

Only 64 mummies were X-rayed at Lebekha: 39 showed evidence for GAL, a total of 61%. There is no significant difference between females and males in terms of the appearance of GAL at this site (Bahgat Ahmed Ibrahim *et al.* 2008) (Table 3).

As a demonstration of the relation between health and living conditions, Tombs 20 and 51 at el-Lebekha are useful. A study of the grave goods, including burial containers, textiles, jewellery, amulets, and ceramics, showed that the occupants of Tomb 51 were relatively rich, while those of Tomb 20 was relatively poor.[1] This observation is confirmed by the study of human remains. The mummification used for the person in Tomb 51 was far more costly that that used for the occupants of Tomb 20. 50% of Tomb 51's occupants were eviscerated abdominally, oils and resin applied to the skin, and finally, the skin was gilded. Few people in Tomb 20 enjoyed either treatment. Although some incidence of disease (bilharzia) occurred among the peope in tomb 51 (5%), more examples were found in tomb 20 (50%). Tuberculosis was observed in the remains from Tomb 20, but not in Tomb 51. Almost every individual buried in Tomb 20 suffered from GAL (90%), but its incidence was much lower on the bodies interred in Tomb 51 (40%). Interestingly, tooth decay is most frequent inside Tomb 51 than Tomb 20. This is probably because honey, which was expensive and the chief source of sweetness in the ancient world, was more available to the wealthy inhabitants of Tomb 51 than their poorer neighbours (Fig. 6)

The site of el-Deir, studied from 1998 to the present, offers comparable data and, indeed, it is even more reliable due to the huge number of individuals studied. There is evidence for considerable water in this area, meaning good crops and comparatively "rich" people (Dunand *et al.* 2010; 2012). This idea of a more wealthy population is supported by the presence of stone sarcophagi as well as high quality mummification overall. Out of 190 people studied (45 mummies and 145 bones), 44.7% showed evidence for GAL (Tables 4, 5).

	Individuals	**GAL**	
Mummies	64	39	**61%**
Mummies females	25	14	56%
Mummies males	39	25	64%

Table 3. GAL at Lebekha.

	Individuals	**GAL**	
Mummies	45	24	53,3%
Skeletons	145	61	42,07%
Total	190	85	**44,7%**

Table 4. GAL at el-Deir.

1 For a discussion on wealth and status linked to funerary goods, see Richards (2005).

	Individuals	GAL	
Mummies + skeletons females	98	50	**51%**
Mummies + skeletons males	94	36	**38,3%**

Table 5. GAL at el-Deir, females and males separated.

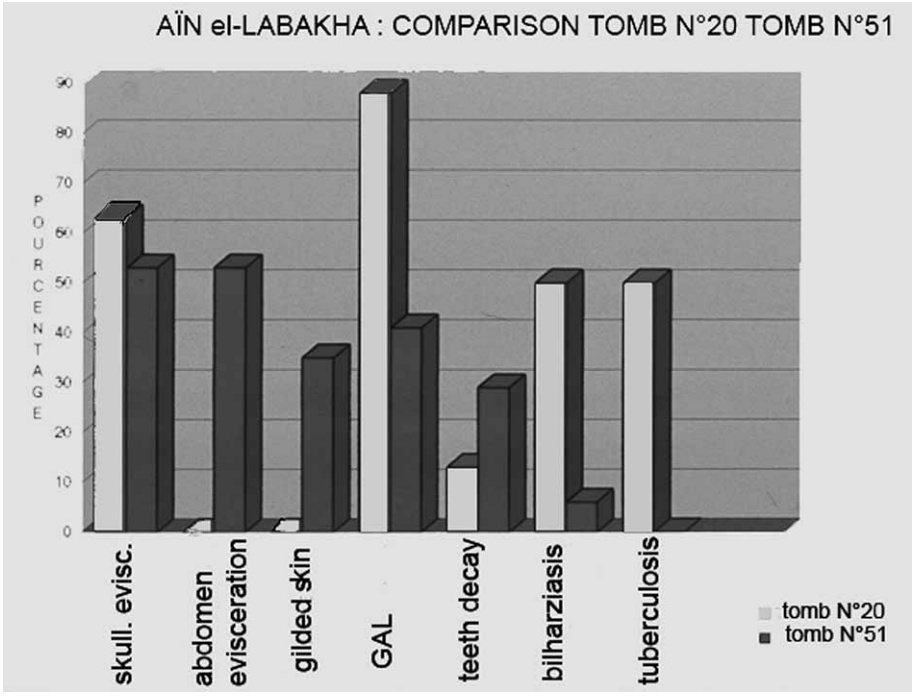

Fig. 6. Pathology and mummification compared between tombs 20 and 51.

Conclusion

Harris Lines are only one source of information that can be used to assess the "wealth", standard of living, or overall health of a population. However, it is noticeable that the presence of GAL confirms the other more standard archaeological means of evaluating the "wealth" of a population, and, as a result, might even be used independently to postulate the relative status of an individual burial that might be removed from its proper context. No doubt future work in the oasis as well as elsewhere will help to test the reliability of Harris Lines as markers of socio-economic status; for the time being the Kharga studies provide a baseline of sorts for using the lines for such analyses.

From Egypt to Lithuania: Marija Rudzinskaitė-Arcimavičienė's Mummy and its Radiological Investigation

Dario Piombino-Mascali, Lidija McKnight, Aldona Snitkuvienė, Rimantas Jankauskas, Algirdas Tamošiūnas, Ramūnas Valančius, Wilfried Rosendahl & Stephanie Panzer

Introduction

A student of the famous Russian Egyptologist Boris Turayev (1868-1920) Marija Rudzinskaitė-Arcimavičienė (1885-1941), the first Lithuanian Egyptologist, collected antiquities for educational purposes during her travels to Egypt (Snitkuvienė 2009; 2011). An entry in her travel diary dated 1924 reads:

> *"So far, the Cairo Museum's "Archaeological commission" still allows [us] to export mummies and various antiquities, of course, only those that the museum has in excess*" (Rudzinskaitė-Arcimavičienė 1933: 62).

By taking advantage of these opportunities, Rudzinskaitė-Arcimavičienė bought a demotic papyrus and a few fragments of a hieratic papyrus from the Russian Egyptologist Grigory Lukyanov (1885-1945). Lukyanov worked as a personal secretary for the Czechoslovak envoy in Cairo (Rudzinskaitė-Arcimavičienė 1936). Whilst at the Cairo Museum – most probably assisted by Lukyanov – she also acquired a unique mummy inside the trough of a sarcophagus. Sadly, there was no accompanying lid (*Ibidem* 1924). It was customary at the time for antiquities removed from the Egyptian Museum in Cairo to be accompanied by a stamped certificate, guaranteeing their authenticity; however, there is no extant document of this nature (*Ibidem* 1935). Had the document survived, it may well have indicated that the sarcophagus was discovered in the Luxor area (Deir el-Bahari) and, together with the mummy, might be attributed to the 11th/12th c. BC.

According to the repository registry of the Kaunas National Museum of Art (1940: 1.59), where the item is presently accessioned, Rudzinskaitė-Arcimavičienė was convinced that the sarcophagus was made specifically for the mummy. In a

letter written by the scholar to that museum on February 2 1937, the deceased was referred to as the "Egyptian princess Shemait" or "sky goddess - priestess". For the deceased's name and titles, the scientist probably relied upon the inscription painted on the sarcophagus. According to her, the mummy purchased from the Cairo Museum was the wrapped remains of an Egyptian princess and priestess of the god Amun. The body, in its entirety, was contained within a mat made of sticks or palm ribs – something she believed was a special burial custom used in certain parts of southern Egypt (Rudzinskaitė-Arcimavičienė 1933). After inspection of the sarcophagus, Evgeny Bogoslovsky (1941-1990) revised the name of the deceased to Shemait-imen-peri-Heru, further adding the information that she was a married woman or "housewife" (Snitkuvienė 1990).

Egyptologist Svetlana Hodjash (1923-2008) subsequently re-dated the sarcophagus to the 21st Dynasty or later, claiming that it was not possible to deduce the deceased's name or any further details that had previously been ascribed to it as information of this kind is generally recorded on the lid. Since the sarcophagus lid has not survived and the mummy has no shroud, the name of the deceased should be regarded as unknown. According to Hodjash, the hieroglyphic text on the sarcophagus indicates that it is intended for a married woman or "housewife", who has the title of highest priestess – chantress of Amun (Berlev and Hodjash 1998).

Recently, the sarcophagus and the mummy both underwent restoration at the Lithuanian Art Museum Pranas Gudynas Restoration Center, Vilnius (Žičkuvienė *et al.* 2011). Following the restoration, a bio-anthropological investigation of the bundle was permitted (Aufderheide 2003). The main scope of the investigation was to answer questions about the mummy's identity and features: does this mummy really belong to the sarcophagus? Is it really the singer of the god Amun? What is the quality of preservation of the individual? How old was the subject when she died? What form of mummification treatment did she receive? To answer these questions, a radiological examination of the body using computer tomography (CT) was conducted in July 2011. C-14 dating of organic material and linen samples was performed at the Curt-Engelhorn Center for Archaeometry, Mannheim, Germany. The results from this were compatible with the stylistic dating of the coffin to the 21st Dynasty (organic matter - 2842 a BP +/- 20 = cal BC 1037-941; linen - 2843 a BP +/- 27.1 = cal BC 1041-941).

Materials and Methods

The mummy under consideration here, Tt 2797, is allegedly associated with the polychromous anthropoid sarcophagus, Tt 2798. The dimensions of Tt 2798 are approximately 187 cm (length), 29 cm (height) and 50 cm (width). The body is completely wrapped in bandages that vary approximately between 12 and 16 cm in width, which is supported by a mat constructed from sticks. This support, in turn, is fastened to the wrapped body using additional linen, constructed from cloth measuring eight cm in width, folded in two, and tied at the rear of the bundle with a knot. No shroud is visible (Fig. 1). The mummy bundle measures 157.7

Fig. 1. The Kaunas mummy at the Lithuanian Art Museum Pranas Gudynas Restoration Center, Vilnius (photo: Lithuanian Mummy Project).

cm (length), 42 cm (width) at the chest level, and 22 cm (height) at the level of the feet making it appear to be much shorter that the coffin (Vedrickienė, personal communication 2013).

The remains were examined at the Central Branch of Vilnius University Hospital using a Philips Mx8000 Dual CT scanner (Best, The Netherlands) with a slice thickness of 1.3 mm, at increments of 1.3 mm, and dose of 120 kV/90 mA. In total, the procedure produced 1188 individual axial slices. DICOM data were later processed using a workstation (ADW 4.3, General Electrics, Milwaukee, USA) in the Department of Radiology, Trauma Center Murnau, Germany.

Since the first X-ray studies of human and animal mummies, performed at the close of the 19th c. AD (König 1896; Londe 1897; Böni *et al.* 2004), mummy investigations have benefited from the use of radiological methods. Technical innovations in Radiology, most notably the introduction of computed tomography (CT), have enhanced the possibility of investigating ancient remains and enabled the diagnosis of pathological conditions (Chhem and Brothwell 2008). Specifically, in this case, the Hounsfield Units (HU) Scale – a quantitative scale used for describing radio-density that is applied by radiologists in routine CT investigations – was usefully employed to investigate the presence of any foreign bodies and anomalous areas. Hounsfield Units represent the density values of the single voxel elements and can prove useful in identifying anomalies lying within wrapped bundles (Gostner *et al.* 2013). Water, considered as a reference value, measures zero HU, while air has a value of -1000 HU and compact bone has a value up to 3000 HU (Laubenberger and Laubenberger 1999).

Radiological Findings

Skeletal Elements

Upon examination, the remains were found to consist of a skull, all long bones of the upper and lower extremities, bones of the hands and feet, sternum and both clavicles, 25 vertebral bodies – 7 cervical, 18 thoracic/lumbar – and in excess of

24 ribs. Sex and age estimation obtained through skull and pelvis observation (Buikstra and Ubelaker 1994) revealed that the body belongs to a middle-aged adult male, rather than a female (Fig. 2). The head was in a slightly oblique position compared to the rest of the skeleton and most teeth had been lost post-mortem. The spine was completely disarticulated. Vertebral bodies, ribs, both clavicles and the sternum were completely disarticulated and positioned in the anatomical region of the chest and abdomen, framed by the upper extremities; the latter appeared folded, with the hands in the region of the pelvis, the pelvic bones were not in the correct anatomical position and the hips were disarticulated. The long bones of the lower extremities were predominantly in the correct anatomical position, but the individual distal phalanges of the toes were dislocated or absent (Fig. 3). From the skull to the pelvis and proximal femora the skeleton appeared to be partially embedded within an inhomogeneous mass which partially fills the skull and paranasal sinuses: parts of this mass lay as clots between the ribs and vertebral bodies. Inside this mass, five teeth or bigger tooth fragments could be found intra-cranially, while 16 of them were observed in the area of chest and abdomen (Fig. 4). An estimation of stature in life of approximately 159 cm (Raxter *et al.* 2008) was calculated from the humeral and femoral length.

Soft Tissues and Body Covering

Some capsular structures were evident around both proximal femora; the patellar ligament and parts of the capsular structures of the knees were preserved bilaterally, along with most of the tendons of the feet. The mat of wooden sticks was wrapped around the mummy, open at the chest and abdomen and overlapping at the lower extremities; both upper extremities appeared to be separately wrapped, with defects of the material in the region of both elbows. The chest and abdomen were held together by different wrapping materials containing gaps and defects; the lower extremities were separately surrounded by one thin layer – either part of the skin or preserved tissues, and, apart from that, they appeared to be wrapped together by several layers of different material. No craniotomy – either trans-nasal or trans-sphenoidal – could be identified.

Fig. 2. 3D reconstruction of the left hemi-pelvis indicating sex and age of the subject (reconstruction: Lithuanian Mummy Project).

Fig. 3A) Topogram of the CT examination providing an overview of the mummy and wrapping; B) 3D-reconstruction of the head and body of the mummy showing marked anatomical dislocations of vertebral bodies, ribs, sternum, both clavicles and the pelvic bones. Note the small bottle and the cap on the right side next to the skull (images: Lithuanian Mummy Project).

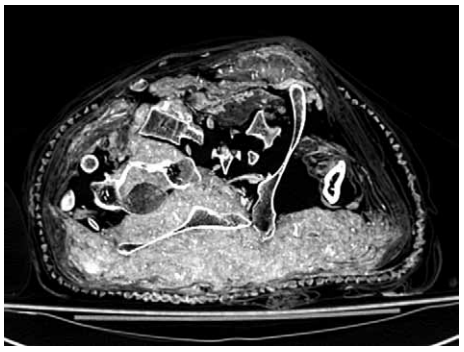

Fig. 4. Axial slice of the CT examination at the height of the elbows illustrating the mass lying under the body, most probably consisting of sand (image: Lithuanian Mummy Project).

Foreign Bodies

The investigation highlighted the presence of a small bottle (height: 2.7 cm; length: 2.4 cm; width 1.4 cm) with a mean HU value of approximately 1500, slightly damaged at one edge, which was positioned at a distance of 1.4 cm from the right side of the skull, at the inner edge of the mat (Fig. 5). A cap with HU of at least 3000 was visible within the mat at the rear right hand side, at the same level laterally as the small bottle, producing metal artifacts. Small linear radiodense structures were also seen inside the wrapping material distally to the feet. No ornaments, jewels or amulets were identified.

Discussion

The CT investigation of the specimen enabled a number of important conclusions to be drawn. Firstly, if we are to rely upon the linen dating, the mummy looks very different from good quality mummies dated to the 21st Dynasty (Ikram and Dodson 1998; Giuffra *et al.* 2001). It is widely accepted that during this period, the embalmers went to great lengths to ensure that the mummy portrayed the lifelike appearance of the individual, making stark parallels to the idealized representations favored during the Old Kingdom, although in the latter case the portrayal was more external than internal. Subcutaneous packing using mud, sand and sawdust was routinely employed to "plump up" the body following the evisceration process. The number of incisions made in the body vary and, although the Rhind Magical Papyrus (c. 200 BC – some 700-850 years after the presumed date of this mummy) describes the location of seventeen such incisions, the majority of mummies display far fewer. Generally, the areas of the body "packed" by the embalmers could be accessed through carefully positioned incisions and the use of sticks to push the packing material into hard-to-reach areas. Visceral packages were returned to the body during this period, often with the addition of small wax and faience figures. Bungs made from linen were commonly used to plug the orifices and prevent the packing material from escaping whilst the body was moved (Ikram and Dodson 1998). The use of such vigorous subcutaneous packing often led to "over-stuffing" as the skin simply could not stretch to accommodate the volume of packing material used by the embalmers. As the skin desiccated, it split, creating a number of mummies with a rather bizarre appearance such as the well-known Henttawi, mother of Pinudjem, whose cheeks display noticeable cracking (*Ibidem*).

Mummies dating to the 21st Dynasty continue to display evidence of the use of resin during the mummification process. The cranial cavity was generally filled with resin following the evisceration process. The body was generally positioned with the arms to the sides and the hands placed over the pubic region. Following mummification, the body was traditionally painted – red for men and yellow for women. The addition of false eyes made from stone, glass or painted linen and the use of wigs was also reported from this period, enhancing the lifelike appearance of the body. The use of amulets is prolific (Ikram and Dodson 1998).

Fig. 5. The small glass bottle containing lavender oil, seen in (B) at the moment of removal (A) (photos: Lithuanian Mummy Project).

The Kaunas mummy does not appear to fit the "standard description" of a preserved human body dating to the 21st Dynasty. Externally, the plain linen wrappings and the use of a mat tied in place using rope are already documented in the New Kingdom (18th-20th Dynasties, c. 1549-1064 BC). Some parallels can be drawn with mummy 3496 from the Manchester Museum collection – a child mummy which displayed almost identical linen bandaging wrapped within a reed mat and tied with rope at both ends (Isherwood *et al.* 1979). This particular child mummy is from Gurob and dates to the New Kingdom (18th Dynasty). No exterior coffin was located so the child's name, affiliation and family details remain unknown. Burials incorporating palm mats were common during the Greco-Roman era (c. 332 BC-AD 395) (Ikram, personal communication 2014). A notable fact about these mat coffins is that they were not generally employed in elite burials. This is a further indication that the Kaunas mummy is unlikely to belong to the coffin in which it is now presented.

A further point of interest is the lack of soft tissue, the dislodging of the teeth, and the disarticulations, which suggests that the body was at least partly skeletonized at the time of wrapping, possibly due to an initial burial. In fact, the material in which the skeleton is now embedded seems to be consistent with sand, a considerable amount of which was lost from the bundle during the recent restoration attempts (Vedrickienė, personal communication 2013). The wrapping of a partially skeletonized subject, however, is not totally surprising. A comparison can be made with the bundle found in the coffin of priest Ankhpakhered, currently kept at the Archaeological Museum of Asti, Italy, which has been tentatively dated to the 21st-22nd Dynasties (Malgora 2012). The remains, belonging to a middle-aged adult male, show several dislocations including the positioning of the feet between the femora, the pelvis at the scapular level, and the vertebrae scattered in the thoracic cavity, interspersed with the bones of the hands. The bones were carefully wrapped, and a number of sticks located beneath the skeleton – a feature typical of the Greco-Roman Period – to provide rigidity and support (Ikram and Dodson 1998). The absence of amulets and funerary ornaments, as well as some other bio-anthropological features, were considered suggestive of a low status subject. Subsequent archaeo-metric investigation revealed that the mummy was actually produced between 360 and 200 BC, confirming that the sarcophagus was reused in antiquity (Malgora 2012). In addition, anatomical details may also contribute to the understanding of this case: while the presence of 25 vertebral bodies could be an anatomical norm variant, this, coupled with the presence of more than 24 ribs increases the likelihood that more than one subject was involved.

Composite mummies from ancient Egypt are indeed well-attested, and seem to be a feature of the Greco-Roman Period, when the art of embalming appears to decline following its peak in the New Kingdom (Aufderheide *et al.* 2004; Giuffra *et al.* 2006). For example, one such example comes from Kellis, a site located in Dakhleh Oasis, 400 km west of Luxor. This mummy appeared to be a linen-wrapped adult, but when autopsied it was revealed to be a mélange of four subjects, whose ages spanned from early childhood to old age. All the skeletal elements

were held together by linen straps attached to a frame composed of palm-leaf ribs (Aufderheide *et al.* 1999).

The data suggest that our mummy was either fabricated from older remains, perhaps following looting of a cemetery, or that the embalmers were a little careless in their workshop and allowed parts of a second body to be included accidentally. The rather haphazard nature of the remains, particularly in the torso region, points to at least partial skeletonization and a distinct lack of care prior to wrapping. CT images highlighted the bandaging methods well and it would appear that the mummy has been rather hastily produced. One explanation is that this is a non-elite New Kingdom individual whose remains were disturbed and wrapped with linen also dated to the the 21st Dynasty (Ikram, personal communication 2014). Other possible scenarios include the addition of the palm mat during the Greco-Roman period to act as a supportive frame for an older mummy or at a later date for aesthetic reasons to make the mummy more attractive for sale.

Lastly, it is worth commenting on the small glass bottle highlighted during the radiological investigation, which was later removed from the mummy. This is essentially a modern bottle containing lavender oil, produced in Simferopol, Russia. A letter written by the Head of the Museum to the Lithuanian Ministry of Education dated January 8 1927 indicates that only the owner had access to the mummy and that, because she trusted nobody, it must be locked away at all times. This suggests that it was Rudzinskaitė-Arcimavičienė herself who inserted the bottle of lavender oil into the bundle. It is possible that the Egyptologist wished to create a mystifying odor. If so, the desired goal was achieved as the press reported:

> *"In the room where the embalmed dancer's body is located there is a peculiar aroma, reminiscent of dried flowers smell"* (Anonymous 1937: 15).

Lavender oil has long been used for scenting people, clothing, rooms and bathrooms, and is effective against insect infestations. Rudzinskaitė Arcimavičienė loved incense (Lomsargytė-Pukienė 2004) but incense sticks burn quickly, while the smell of oil lasts far longer. Given the Egyptologist's fondness for incense, it is unlikely that lavender oil was employed as a pesticide, but rather for its distinctive odor, or perhaps both.

Conclusions

The recent bio-anthropological investigation of the Kaunas mummy has enabled new light to be shed on this intriguing case. Firstly, because of the smaller dimensions of the bundle, and because the remains appear to be male, probably of low social status, the mummy is not associated with the sarcophagus in which it was purchased. The presence of exogenous elements such as the extra ribs is a feature shared with burials from the Greco-Roman period, as is the presence of the palm mat. During this period, the art of embalming was extended to a wider demographic, and the resulting mummies became less accurately and more hastily prepared. Paradoxically, radiocarbon dating of the linen wrapping indicates a much earlier date within the the 21st Dynasty. This would suggest that such anomalous

preparations were already present at a much earlier date. The authors suggest that the bundle represents fabrication of a composite mummy from ad hoc skeletonized remains based on the radiocarbon results. The presence of a large amount of sand adhering directly to the remains themselves and as an inclusion within the bundle suggests that the remains may originally have been interred. It is plausible that the palm mat was added later for practical or aesthetic reasons.

Acknowledgements

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Canopic Jars: A New Source for Old Questions

Frank J. Rühli, Abigail S. Bouwman & Michael E. Habicht

Introduction

Ancient mummified human tissue and bodies have attracted attention for many centuries, both as objects of curiosity, as well as scientific research. The English physician, Thomas J. Pettigrew, published the first scientific report on mummification (1834). It was followed by anatomical examinations of the royal mummies from the cachettes in Deir el-Bahari Tomb 320 and Valley of the Kings tomb 35 by G. Elliot Smith (1912). In 1925 Douglas Derry examined the body of King Tutankhamun for the first time, and many more investigation followed (Derry 1927). The most complete investigations of many royal mummies, using X-ray technology were undertaken in the late 1960s (Harris and Weeks 1973; Harris 1980). Another landmark in mummy research was the Manchester Mummy Project (David 1979). It focused on non-royal mummies and used different examination techniques, some of which were applied for the first time. These studies remain of great importance, but none answered detailed medical questions nor gave definitive proof of the family interrelationships among the kings of Egypt.

A new approach in mummy studies was opened by the testing of mummified tissue for ancient DNA by Svante Pääbo (1985). An overview on the current technologies and methods of investigating mummies was published by Niels Lynnerup (2009). More recently, the Tutankhamun Family Project (2005-2010), was launched by the Supreme Council of Antiquities (SCA; now Ministry of Antiquities [MSA]). Its aims were to identify the ancestors and pathologies of Tutankhamun (Hawass *et al.* 2007; 2010). The research was interdisciplinary, including epigraphy, archaeology, history, radiological imaging, and molecular genetics. The results were widely reported in the world media and caused an impact on Egyptology, starting a new tradition of genealogical research.

While ancient mummies have been a main focus of research, very little has been done with canopic jars and their contents. The jars were often examined solely from the artistic point of view, with no mention or analysis of their contents. Since aDNA-testing is possible for mummified tissues, these mummified viscera should emerge into the spotlight in the future, both in Egyptology and medicine.

Ancient descriptions on the treatment of the viscera are rare. Herodotos of Halicarnassos (484-425 BC) gives us no information at all, while Diodorus Siculus (90-30 BC) wrote:

> *"They assemble to treat the body, after it was opened, one grasps with the hand through the opening in the thorax and takes everything out except the kidneys and the heart, another one cleans every organ, washes them with palm wine and spices"* (Diodorus, Bibl. Histor. I, 91).

Further treatment of the viscera in mummification is not described and therefore our knowledge is based on medical investigation and archaeological evidence only.

Definition

Canopic jars are defined as different type of containers for holding the mummified viscera. The general term "canopic equipment" covers all forms of containers, such as the "canopic chest" with four compartments, the well-known four "canopic jars", and from the New Kingdom onwards, "miniature coffins" or "coffinettes" in the form of a small anthropoid coffin, notably found in the burials of Tutankhamun, Sennedjem (c. 1281-1260 BC), and Sheshonq II (c. 895-895 BC). From the 21st Dynasty, the separately dried and wrapped viscera, placed back in the abdomen can be described as "internal canopics." Beside real canopic jars, there are also solid canopics known as "dummy canopic jars", often used in instances when the viscera had been returned to the body cavity or placed on the body (Ikram and Dodson 1998: 289-291).

Traditionally canopics are described as containing liver, lungs, stomach and small intestines, while other organs remained *in situ* or were removed and thrown away. The exact criteria for this selection are not yet fully understood (Taylor 2001: 64). In reality, the evisceration is less consistent: often the heart is missing; in other cases are the lungs still present in the mummy (Wade and Nelson 2013). From the New Kingdom onwards, the absence of the heart became more frequent, though the reasons for this are unclear (Wade and Nelson 2012).

Traditionally, four protective goddesses and the Four Sons of Horus were connected with the removed organs (Table 1). In the earlier periods of Egyptian history most of the containers were unmarked. From the Middle Kingdom onward, in some cases the containers were inscribed with the name of one of the sons, thus indicating what the contents were supposed to be. In later periods each jar was sealed by a lid decorated with one of the sons, indicating what it ought to have contained (Ikram and Dodson 1998: 281). However, this was not always consistent; during the Third Intermediate Period, Qebehsenuef often is jackal headed, while Duamutef has a falcon head (Taylor 2001: 66). All these variables make it difficult to be certain of the contents of any given visceral package, thus this can only be established by the histological identification of the mummified tissue (Table 1).

Protection Goddess	Son of Horus	Appearance	Putative content
Isis	Imseti	Human	Liver
Nephthys	Hapy	Baboon	Lungs
Neith	Duamutef	Jackal	Stomach
Serqet	Qebehsenuef	Falcon	Intestines

Table 1. Religious connection of Godesses, Children of Horus and appearances and content.

Very few publications focus on canopic jars (Reisner 1967; Dodson 1994; Willems 1988), and these tend to deal exclusively with the container rather than their contents, leaving a notable gap in the literature. Histological investigation is missing in most cases.

Resources: Some Important Examples of Canopic Equipment

The oldest canopic chest that can be connected with a known individual comes from the burial of Queen Hetepheres I, wife of Snefru and mother of pyramid builder Khufu (Cairo Museum JE 52452). Her putative tomb, Giza G7000X, contained an impressive collection of furniture, a sealed canopic chest and sarcophagus, which was empty and never used (Reisner and Smith 1955; Lehner 1985, Münch 2000). The lack of the mummy causes problems in interpretation of this tomb: was it an actual burial, reburial or depot of funerary furniture? The sealed canopic chest was divided in four compartments, each containing a wrapped package, which

> *"almost certainly contains viscera"* (Lucas 1932: 127).

According to the chemist Alfred Lucas, who examined the canopic chest, three of the four compartments were filled with a solution; one was drained dry, supposedly by leakage. Lucas analyzed the solution, which consists of a 3% solution of natron with the usual impurities, namely common salt (NaCl) and sodium sulphate (Na_2SO_4) (Lucas 1932). Since Lucas dismisses the idea of a natron bath for making a mummy based on his investigations of several mummies, the solution in the canopic chest of Hetepheres I must be questioned. This may be caused by humidity, since a 3% solution probably would lead to intense putrefaction.

Another 4th Dynasty (c. 2663-2195 BC) canopic jar with contents is that of Queen Meresankh III, wife of Khafre, from her mastaba Giza G 7530A, now in the Museum of Fine Arts, Boston (MFA 27.1551.1). Other canopics with intact viscera, also dating from the Old Kingdom, include those of Ranefer, found at Meidum, and of King Pepi I's pyramid in Saqqara, which is now displayed in the Imhotep Museum in Saqqara (Lehner 1997: 22). A Middle Kingdom (c. 2066-1650 BC) example of note is that of King Hor I Wa-ib-Ra from the 13th Dynasty, buried in shaft tomb No. 1 on the north of the pyramid of Amenemhet III. This is of interest as it raises the possibility of comparing the very fragmentary remains of the mummy, now in the Egyptian Museum, Cairo with the viscera, which were

found in a sealed chest (Imseti CG 4019, Hapy CG 4020, Duamutef CG 4021, Qebehsenuef CG 4022 [Reisner 1967]).

The canopic jars of Tuya (housed in the Egyptian Museum, Cairo; JE 95244) were found *in situ* together with her mummy (the viscera were found with miniature masks and prepared as "miniature mummies") in the tomb that she shared with her husband in the Valley of the Kings (KV 46). Since the mummy of Tuya tested positively for malaria (Hawass *et al.* 2010) the histological inspection of the viscera would be of great interest, to see if diseases can be confirmed, or other illnesses could be identified, since many pathologies (Tuberculosis, Malaria) are concentrated in internal organs.

Also in the Valley of the Kings, tomb 55 yielded a coffin complete with a body a set of human-headed canopic jars. The coffin was defaced and altered so that the name of its owner is disputed, as is the case for the inscriptions on the four canopic jars (see below). Three of the jars came to the Egyptian Museum, Cairo (JE 39637 A-C), the forth was given as a present to Theodore Davis (1837-1915), while its content remained in Cairo (TR 26 19 38 1a+b). This was later donated to the Metropolitan Museum of Art in New York (Inv. 30.8.54). Lucas investigated the three jars in Cairo in the early 1930s (Lucas 1931). According to him, they still contained the original filling, mostly a black bitumen-like mass with a different, brown and friable material in the centre, including a fatty material, which was in his opinion

> *"almost certainly the remains of viscera"* (Lucas 1931: 121).

This is vitally important for obtaining a genetic profile. The inscriptions were altered in a first stage by removing carefully name and titles of Kiya. The names of the Aton and King Akhenaton were left in place and inlays adapted accordingly (Gabolde 2009) when the jars were used for the burial of the male mummy in KV 55, identified as Akhenaton by some scholars but still as Smenkhkare by others (for a full discussion see Dodson 2014, appendix 4 in particular). Royal uraei were added to the female heads of the jars. Later, the remaining inscriptions were erased from the jars, and the face and names removed from the coffin. Assuming that the extant contents are from their originally planned use, rather than their ultimate use, the organic content of the KV 55 jars would be the only mummified remains which possibly could be attributed to Kiya so far. During the Tutankhamun Family Project one jar was CT-scanned (unpublished, only in TV documentary Discovery Channel), but apparently no further testing was performed. Analyses might establish whether these viscera belong with the body or with the earlier burial.

The canopic miniature coffins from Tutankhamun's burial also contained wrapped organic content. They were stored in beautifully made golden rishi-coffins with longer inscriptions, including texts from the book of the dead (Beinlich and Saleh 1989). Many cartouches show signs of alteration from Ankh-khepru-Ra to Neb-khepru-Ra. As Gabolde (2009, Fig. 10) convincingly proved, a Son-of-Ra name was changed also (JE 60691), from Nefer-Neferu-Aton ("Who is beneficial to her husband") to Tut-Ankh-Amun (Table 2). This clearly

JE No.	Goddess	Child of Horus	Alteration from Ankh-khepru-Ra	Alteration from Nefer-Neferu-Aton
JE 60688	Isis	Amset	1 of 4 cartouches	0 of 1
JE 60690	Nephthys	Hapy	1 of 7	1 of 4
JE 60689	Neith	Duamutef	4 of 7	1 of 5
JE 60691	Serqet	Qebekhsenuef	3 of 7	1 of 3

Table 2. Alterations in the miniature coffins from Tutankhamun.

shows that the miniature coffins were originally made for Queen Nefertiti and not for Smenkhkare (or Smenkhkare and Nefertiti is one and the same person – see Dodson 2014 for discussions). A genetic investigation of the viscera may bring additional information on the health status of the individual.

Another attractive collection of canopic containers was found in the 19th Dynasty tomb of Senedjem (TT 1). According to Reisner (1967) they still contain viscera; three of them are reportedly still sealed and therefore should not be contaminated by modern DNA.

Since 1985, aDNA testing has become possible and nowadays science can achieve more conclusive results regarding kinship, as well as the identification of pathogens, which would establish the health of the individuals. Although, at the moment there are still some limitations in the identification of certain diseases (e.g. syphilis) (Bouwman and Brown 2005). The aDNA analysis of mummified remains can still identify many diseases; thus, bilharzia (schistosomiasis) (Miller *et al.* 1992; Ruffer 1910), tuberculosis (mycobacterium tuberculosis) complex (Lalremruata *et al.* 2013), or malaria (plasmodium falciparum) (Hawass *et al.* 2010; Zink *et al.* 2008), and Leishmaniasis (Zink *et al.* 2006) have been found in mummies.

Aim, Results and Discussion

The authors consider it useful to focus on mummified internal organs, since many pathogens concentrate in the viscera. The Canopic Jar Project was launched in October 2012 at the Centre of Evolutionary Medicine (ZEM, Institute for Anatomy, University of Zurich, now IEM, Institute for Evolutionary Medicine). to investigate canopic jars with putative original filling. A greater number of Late Period canopic jars with organic content are known. Since they belong to unknown owners or cannot be attributed to a family or mummy, they are of less use. The Zurich team used these to establish extraction procedures ("canopic Guinea pig"). The preliminary results on the canopic jars were published (Habicht *et al.* 2013) (Table 3).

Multiple samples from the filling were taken, including the black material that is often dubbed "bitumen" that contained traces of biological material. Traces of DNA were discovered with Qubit analysis of extracts with lighter coloured samples yielding more DNA and Polymerace Chain Reaction (PCR) was attempted for mtDNA and genomic DNA. Inhibition of the amplification limited the aDNA analysis. The jar from Munich SMÄK was putative the first canopic jar positively

Museum	Inventory No.	Owner (dating)	Content and Actions
Burgdorf, Völkerkundemuseum	BU_53_07668	Unknown (Late Period)	Entrails expected Imprint of linen and remains of histologically the putative 'ileum' found. Histology section and staining
München, SMÄK	ÄS 0026	Unknown (late period)	DNA was found

Table 3. Canopic jars used in the pilot study.

tested for ancient DNA (December 11th 2012). The data are published here for the first time (Table 4).

Sample numbers are identical to those in Fig. 1. The highest concentrations of DNA are in the "middle" of the jar, especially where there is a significant colour change, indicating that not only organic material survive, but also that it still contains these important biomolecules.

In contrast, the jar from Burgdorf, Museum für Völkerkunde was examined using CT-scanning at the Institute of Forensic Medicine UZH before sampling in the dry-lab of ZEM. The falcon headed jar lid indicated mummified intestines. The filling consist of "glass like", very hard "bitumen", broken in several pieces. On a flat, thin piece of bitumen the team observed the reddish imprint of the linen wrappings, and near the bottom of the jar a shred of organic remains was discovered. Initially, it was taken for the remains of papyrus. The histological investigation and staining revealed it as remains of the ileum, the final section of the small intestines, which would concur with the expected content, indicated by the falcon head (Qebekhsenuef) (Figs. 1, 2).

The diagnostic investigation by CT allows high-resolution analyses of whether there is any content (in case of still sealed jars). In case of non-availability of CT scanners or the lack of transport approval for precious jars, the use of portable X-rays is beneficial. Based on such radiological investigations, a better planning for extraction areas is highly recommended. The differentiation of soft tissue has been investigated by members of ZEM previously (Wanek *et al.* 2011). The

Sample	1	2	3	4	5	6	7	8	10
Notes	**Surface**					**Side of jar**	**Lighter colour**		**Black 'sooty'**
DNA concentration (ng/µl)	1.05	0.859	1.72	2.31	0.835	0.805	3.07	1.88	Too low

Table 4. DNA concentration of samples taken from the Munich canopic jar.

Fig. 1. CT-based cross-section images of a canopic jar (Völkerkundemuseums Burgdorf, Inv. BU_53_ 07668; Siemens Somatom Definition Flash 512x512 matrix. 0.6mm slice thickness, 120KV, 140mA) (image: IRM, Institute of forensic medicine, University of Zurich).

use of dual energy CT at this stage is the best solution; our study needs to have more original data to address this important issue of correlating radiological and histological/morphological data. Radiology may also reveal objects like amulets inside a canopic jar filling (Fig. 3).

Another method to investigate content of canopic jars would be light (LM) and electron microscopy (EM). Standard histology staining should include HE (Haematoxylin-Eosin) as general stain, Masson-Goldner for an improved distinction of cells from surrounding connective tissue (collagen) and van Giesson for staining of muscle and collagen tissue. Gas chromatography-mass spectrometry will give information of type and amount of embalming substances.

Thus, using viscera to learn more about ancient remains provides us with another source for understanding the past, and also keeps the mummies intact. This hitherto untapped resource shows much promise for future research.

Acknowledgements

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submitted work in the previous five years and no other relationships or activities that could appear to have influenced the submitted contribution. This article is based on Habicht *et al.* (2013) with additional information.

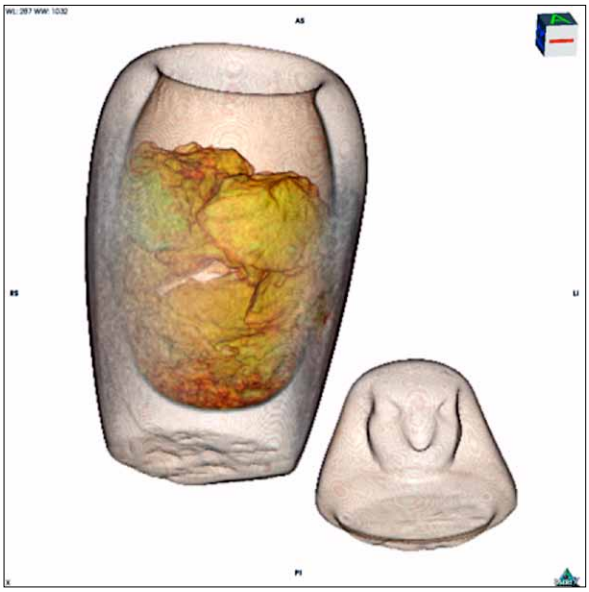

Fig. 2. 3D-reconstruction (CT- based, OsiriX) of canopic jar (Völkerkundemuseum Burgdorf, Inv. BU_53_ 07668) (image: ZEM [Center for Evolutionary Medicine] 2013).

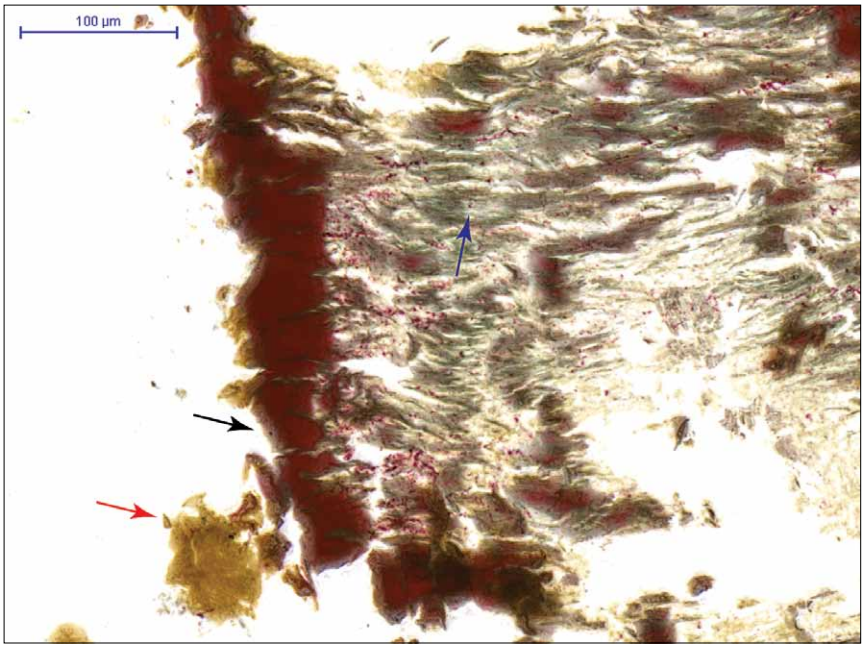

Fig. 3. Völkerkundemuseum Burgdorf, Inv. BU_53_ 07668: The tissue has been stained with Masson-Goldner (180X) used to demonstrate collagen. The red arrow indicates resin and the black arrow above points to the muscle layer. The green-grey stained material under the blue arrow is probably collagen in the submucosa. Based on the histology findings the tissue is most likely intestine (image: ZEM [Center for Evolutionary Medicine] 2013).

A Decade of Advances in the Paleopathology of the Ancient Egyptians

Lisa Sabbahy

Our understanding of disease in ancient Egypt has changed substantially within the last decade or so. This has been made possible by dramatic advances in medical engineering and biomedical techniques, particularly the growing sophistication of computed tomography (CT) and the ability to recover DNA from ancient bacteria and viruses. This paper will present the latest discoveries about tuberculosis, cancer and heart disease in ancient Egypt, three diseases about which our evidence and understanding have changed the most.

The study of ancient human remains has always gone hand-in-hand with the technology used for study of living patients. When X-rays were discovered in 1895, the technique was tried out in Frankfort on the mummy of an ancient Egyptian child just four months later (Adams and Alsop 2008: 21). By the 1970's computed tomography (CT) had been developed, and CT was first successfully used on a mummy in Toronto in 1976 (David 2008: 42). Now CT-scans are standard in any mummy study.

DNA was first recovered from an ancient Egyptian mummy in 1985 (Pääbo 1985), and with the development of polymerase chain reaction, informative sequences of DNA can be specifically targeted. Although the amount of ancient DNA that can be recovered is limited, it is now recovered from bacteria and viruses, and this is changing our understanding of ancient disease. Specifically, our understanding of tuberculosis in ancient times has changed remarkably since the late 1990's due to work with ancient DNA. Not only has *Mycobacterium tuberculosis* DNA been recognized in ancient Egyptian human remains, but also particular strains of *Mycobacterium* have been distinguished (Zink *et al.* 2002: 142-144; 2003b).

Bones are mainly what have been studied for evidence of past disease, and for *Mycobacterium tuberculosis* that means identifying bone lesions, particularly in the thoracic and lumbar vertebrae, although these bone changes can also be caused by other pathological conditions (Brown and Brown 2011: 851-853). But, in their most destructive form, these lesions cause vertebral collapse and fusion, producing the curved spine often called "Pott's disease", named after Sir Percival Pott, a London surgeon who first described it in 1779. In 1909, Derry (1909: 31-32) published the first description of Pott's disease in ancient Egyptian and Nubian remains.

The physical evidence used for a tuberculosis (TB) diagnosis did not change until 1979, when Zimmerman published microscopic confirmation of pulmonary TB. He was able to identify TB bacteria in the vertebrae and red blood cells in the trachea and lungs from a hemorrhage, he assumed was the cause of death, in a post New Kingdom mummy of a child from Thebes (Zimmerman 1979: 606-607). The next development came in 1997 when Nerlich and Zink announced the retrieval of a DNA sequence from the lung tissue of a New Kingdom Egyptian mummy, a 35-year old man from the West Bank of Thebes that showed

> *"homology to the DNA of* M. tuberculosis*"* (Nerlich *et.al.* 1997: 1404).

This molecular evidence backed up a macroscopic examination, showing evidence of pulmonary tuberculosis (Nerlich *et al.* 1997).

In 1998, a team, working with Crubézy at Adaima in Upper Egypt, was able to retrieve a DNA fragment from bone samples from a Predynastic Period child with Pott's disease that was:

> *"sequenced and is consistent with an original* Mycobacterium *sequence"* (Crubézy *et al.* 1998: 941).

Subsequent work suggested that this DNA was an ancestral form of *Mycobacterium tuberculosis* that existed when urban life emerged in Egypt beginning around 3400 BC (Crubézy *et al.* 2006). The skeleton of another young child with multiple bone tuberculosis from the same cemetery was published in 2011, providing a similar picture of a period where tuberculosis must have been endemic (Dabernet and Crubézy 2011).

Zink and Nerlich and their team continued to extract DNA from bone and tissue samples from three groups: Early Dynastic Period burials at Abydos, Theban burials dating to the Middle Kingdom to Second Intermediate Period, and Theban burials of New Kingdom to Late Period date. A total of 83 samples were taken. Out of these, 18 of them tested positive for *Mycobacterium tuberculosis* complex DNA. Of these, six came from individuals with macroscopic evidence of "tuberculous spondylitis" (Pott's disease), five from individuals with "non-specific pathological alterations" (lesions that could be from TB or something else), and seven from individuals with "normally appearing vertebral bones"(no osteologic sign of TB) (Zink *et al.* 2001; Zink *et al.* 2003a: 242-244). They concluded that for about 2500 years the frequency of tubercular disease in ancient Egypt remained the same, roughly about 25% (Zink *et al.* 2003a: 248). Two years later the team had analyzed a total of one hundred and sixty bone and tissue samples, and thirty-eight of the samples, coming from all three different time periods,

> *"tested positive for the presence of mycobacterial DNA"* (Zink *et al.* 2005: 85).

These samples were

> *"further characterized by spoligotyping"* (Zink *et al.* 2003b: 365).

The Early Dynastic material produced evidence for an ancestral strain of *Mycobacterium tuberculosis*, while the Middle Kingdom samples were characterized by *Mycobacterium africanum* strains. The samples from the New Kingdom to the Late Period revealed

> *"a modern strain of* M. tuberculosis*"* (Zink *et al.* 2007: 388).

No evidence for the strain of *Mycobacterium bovis* was found in any of these samples. It has always been thought that *M. bovis* was ancestral to M. tuberculosis, and that the disease passed to humans at the time they domesticated cattle in Egypt, approximately 4500-5000 BC (Roberts and Manchester 2005: 184). It has now been shown by a 2007 publication of Iron Age skeletal material from southern Siberia, that the earliest evidence of *M. bovis* DNA in human remains dates from the late 1st c. BC to early 1st c. AD, suggesting a somewhat late and Eastern origin for this strain of tuberculosis (Taylor *et al*. 2007).

Nerlich and Lösch (2009) reviewed these findings, and discussed the possible interaction of climate and pathogen in the evolution of a "modern" strain of *M. tuberculosis*. The question of climate change at the end of the Old Kingdom is an on-going one, and the latest core sample from the Nile Delta, published in July 2012, gives further evidence of a drought with "a sustained effect" in the Nile Valley 4,200 years ago, perhaps providing the environmental pressure necessary for such a change (Bernhardt *et al.* 2012: 617).

One last development in the search to identify ancient tuberculosis is the technique that can detect mycolic acids in the *Mycobacterium tuberculosis* cell wall. Mycolic acid can be extracted, and examined by high performance liquid chromatography, to identify what type of cell it came from (Gernaey *et al.* 2001). This technique was used in the recent re-examination of the Granville mummy, a Late Period older female named Irtyersenu from Thebes. This mummy had been first autopsied by Granville in 1825 who declared that ovarian cancer was the cause of her death (Granville 1825: 298 and pl. 22, 1). A new study in 1994 concluded that her tumour was a benign cystadenoma (Spigelman and Bentley 1997: 107; Sandison and Tapp 1998: 51). Histological study of the mummy found evidence of a pulmonary exudate, so samples from her lungs, gall bladder and membranous tissues were tested for *Mycobacterium tuberculosis* DNA, and samples from her femurs and lung were tested for mycolic acids of *Mycobacterium tuberculosis*. All DNA and mycolic acid samples were positive, and it appears that an active tuberculosis infection was the cause of Irtyersenu's death (Donoghue *et al.* 2010)

The question of whether or not cancer is an "old disease" has been brought up again in recent studies discussing the evidence for cancer from ancient Egypt (David and Zimmerman 2010). CT-scans of a Ptolemaic Period male mummy 50-60 years old showed bone lesions in his pelvic bones and vertebrae, characteristic of metastatic prostate cancer. This is the first time that prostate cancer has been found in an ancient Egyptian mummy, and the authors suggested that the cause of death was

> *"osteoblastic metastatic disease"* (Prates *et al.* 2011: 101).

Most scholars have considered cancer in ancient Egypt to be rare, or "meager". But in a study of 280 Late Period individuals, Strouhal and Vyhnánek (1981: 184) found four examples of metastatic carcinoma, which they stated is "not negligible". Zink and others found four cases in 325 adult individuals dating New Kingdom to Late Period, which they said, "provides clear evidence that malignant tumors were not a rare event" (Zink *et al.* 1999). In a later, related article they stated that the rate of tumor frequencies from ancient Egypt was found to be comparable with that found in bones from a southern German ossuary dating AD 1400-1880, as well as with the frequency expected when compared to an early 20th c. AD English control population (Nerlich *et al.* 2006).

Evidence for heart disease in ancient Egypt is also being reevaluated. Artery calcifications in the mummy of an elderly female had been first recognized in 1852 (David 2010: 107). Later in 1909, sections of the aorta of King Merneptah were taken, and its plaque formations discussed in the Royal Society of Medicine (Shattuck 1909). So, the existence of the disease was known. The latest and largest CT study of ancient Egyptian mummies, called the Horus Study, identified atherosclerosis and heart disease as a significant problem among the upper class of ancient Egypt, particularly the priestly families. So far they have published the results for 52 mummies, 45 in the Egyptian Museum, Cairo and seven from two museums in the US, ranging in date from the early New Kingdom to Roman times (Allam *et al.* 2009; 2010; 2011). Of these mummies, 44 had "identifiable cardiovascular structures", and 20 of these, or 45%, had "definite or probable atherosclerosis". Calcifications were found in the arteries of the pelvis and legs, as well as the aortic and carotid arteries. These 20 mummies had an average age of 45 years, and were fairly evenly divided by sex: 55% male, and 45% female.

Not only does atherosclerosis seem to be related to age, therefore, but also diet. These people scanned were elite, so they could afford to be mummified, and in life they had daily access to "luxury" food such as beef, which was offered in temple rituals, and then reverted to the priests for food (David 2010: 111-114). A high beef diet has been clearly shown by the food refuse outside the priestly quarters of the mortuary temple of Senusret III at South Abydos, where beef bones made up roughly 95% (Rossel 2004). The refuse is described as

> *"an immense pile made from the leftovers of choice cuts of juvenile cattle"* (Rossel 2006: 43).

The latest conclusion of the Horus study, after doing CT-scans of mummies from ancient Peru, ancient Puebloans of southwest America, as well as the Unangan of the Aleutian Islands, is that atherosclerosis was

> *"common in four preindustrial populations",*

and therefore may be

> *"an inherent component of human ageing", rather than a disease of modern life* (Thompson, et al. 2013: 11).

This conclusion has also come from much older evidence than that in Egypt. Ötzi the Iceman, was found in the Italian Alps in 1991, and dates back to around 3300 BC, or contemporary with the Egyptian late predynastic. His DNA showed that he had a predisposition to cardiovascular disease, and CT-scans showed he had atherosclerosis (Murphy *et al.* 2003: 627)

A follow up to the Horus Study discussed the cardiovascular disease of Lady Rai, who was CT-scanned as part of the Horus study, and that of modern women in Egypt (Abdelfattah *et al.* 2012). Lady Rai was a royal nursemaid in the very beginning of the 18th Dynasty, and may have taken care of the future King Amenhotep I. She died between the ages of 40-50. Her coronary arteries could not be clearly seen, but she had an area of calcification in the posterior wall of her heart that might have been from a prior heart attack, and calcifications could be clearly seem in her thoracic aorta. In terms of modern Egyptian women, the article concluded on the basis of patients presenting to Cairo University Hospital, that they are suffering from

> *"an epidemic of atherosclerotic cardiovascular disease"* (Abdelfattah *et al*. 2012: 1),

and although women present with heart disease at an older age than men, they are more likely to be obese and diabetic. Not only does heart disease seem to be a part of the human condition, but also, it should not be considered a health problem that mainly affects males.

Resolving a Mummy Mismatch

Bonnie M. Sampsell

Introduction

A mismatch exists when the gender of a mummy differs from that of its coffin, as depicted figuratively on the coffin lid or in names or titles inscribed on it. A mismatch may also involve a coffin and mummy (of the same gender) but differing in their dates of origin. Many museums have such mismatches in their Egyptian collections. A case at the Wayne County Historical Museum (WCHM) in Richmond, Indiana (USA) took the form of an anonymous male mummy in a coffin intended for a woman. The recognition of this mismatch led to an investigation employing methods from Egyptology, physical anthropology, radiology, and archaeometry.

Acquisition of the Coffin and Mummy

The Wayne County Historical Museum is a small regional institution whose collections and exhibits focus primarily on its local history. These include items from the pioneer period in the first half of the 19th c. AD, as well as the industrial era in the last half of that century and the early decades of the 20th century.

Like many wealthy women of her day, Mrs. William Gaar, the museum's founder, enjoyed both traveling and collecting. On her trips, she purchased objects for her museum that would bring the world to the residents of Richmond. In 1929, she traveled to Egypt where she purchased a decorated coffin containing a mummy from E. Hatoun, a well-known Cairo antiquities dealer of the period (museum object numbers and other information about all items mentioned here will be found at the end of the article).

There is a business card from Hatoun's establishment in the WCHM archives. It lists a wide variety of Egyptian and Arabic antiques for sale including carpets, textiles, ceramics, jewelry, and furniture. It was clearly a respectable business, and the coffin was offered for its artistic quality, not as a sensational curiosity. According to Museum lore, Mrs. Gaar was told that the coffin had been in the Cairo store for 40 years and had come from the Valley of the Kings. She was also informed that the mummy was that of an 18th Dynasty princess.

Gender and Date of the Coffin

The WCHM anthropoid wooden coffin has a yellow background with polychrome decoration. The coffin lid depicts a woman wearing a wig covered by a vulture headdress. A deep floral collar surmounted by crossed red bands covers the chest (Fig. 1). These red bands imitate the so-called "mummy braces" of red leather sometimes found on contemporary mummies (Niwinski 1988: 15; Ikram and Dodson 1998:175). Van Walsem (1997) has suggested that these braces be called "stola" and the coffins "stola coffins". However, mummy braces appears to be the term preferred by most authors. Dozens of coffins with a design similar to this have been found in tombs throughout the West Bank at Luxor. Many of them carry the

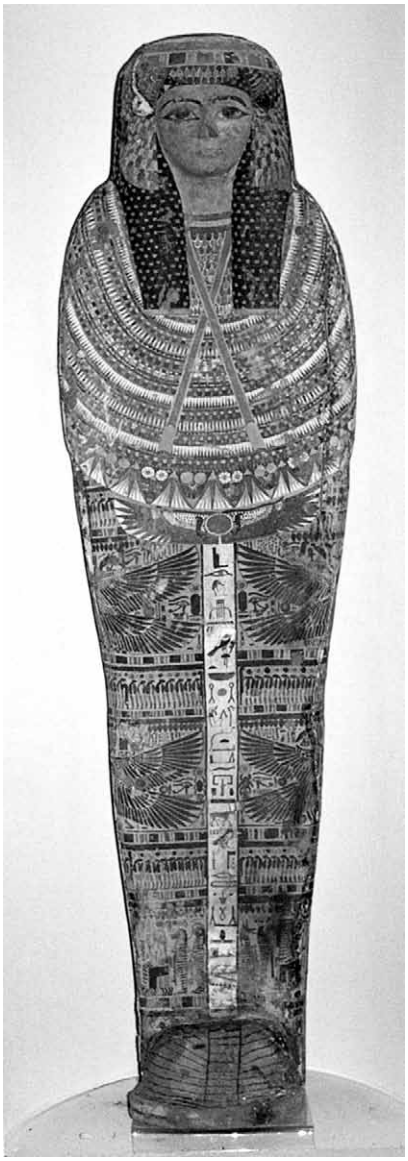

Fig. 1. Lid of 22nd Dynasty coffin at the Wayne County Historical Museum, Richmond, IN (photo: B.M. Sampsell).

names and titles of priests or priestesses at the Temple of Amun. References in their inscriptions or on their associated mummies to the pontificate of a particular High Priest allow certain examples to be dated with some precision within the 21st/early 22nd Dynasty, with others datable by comparison (Niwinski 1988).

High quality 21st Dynasty/early 22nd Dynasty burials employed sets consisting of an outer coffin and lid, an inner coffin and lid, and a full-length mummy board usually with coordinated designs. The WCHM coffin represents an inner coffin. There apparently never was a mummy board, since Mrs. Gaar bought a mummy mask from Hatoun after discovering that the "mummy did not have one." This observation, along with her report that the mummy was intact when she purchased it, suggests that the coffin was opened for the first time since antiquity in the Hatoun shop. Support for this conclusion comes in the form of seven intact tenons that perfectly fit into the slots hand-cut into the rims of the basin and lid. Such care in removing the lid is not consistent with the action of tomb robbers, who would be more likely to pry open the lid with a chisel or cut through the tenons.

Andrzej Niwinski has studied the development of coffin design during this era; he placed the stola coffins into his Yellow Coffin Group V (Niwinski 1988: 69-70, 80-82). He observed that this pattern appeared late in the 21st Dynasty (around 975 BC) and persisted into the early part of the 22nd Dynasty, with most of the Type V lids belonging to the latter period (Niwinski 1988). Niwinski graciously examined photographs of the WCHM coffin and suggested that it was

> *"produced in the 22nd Dynasty, towards the end of the reign of Osorkon I or a bit later, in any time in the 9th Century B.C. in [a] rather secondary workshop in Thebes or in a provincial town not far from Thebes"* (Niwinski, letter to author, April 2007).

Coffin styles changed during the reign of Osorkon I: the flat mummy board was replaced by a cartonnage case that entirely enclosed the linen-wrapped body (Ikram and Dodson 1998; Taylor 2003). The iconography found on these cartonnage cases and their associated coffins also changed fundamentally. The absence of hands and a single vertical line of text, comprising only a simple offering formula, along the lower body are among the features that indicate that the WCHM coffin was manufactured in the 22nd Dynasty (Taylor 2003: 107-108; Niwinski, letter to author, 2007).

Thus while the upper part of the Wayne County coffin lid continues the stola design introduced in the later part of the 21st Dynasty, the lower part includes images that would become common later in the 22nd Dynasty. I am grateful to Aidan Dodson for bringing the unusual mixture of motifs on this lid to my attention. He writes (Dodson, personal communication 2013):

> *"Below the collar the decorative scheme diverges entirely from anything found in any type of 'Yellow' coffin. Rather, the pattern found here of a winged sun-disk, followed by a central column of text flanked by a series of registers of winged divine figures is more typical of cartonnages of the type introduced under Shoshenq I and Osorkon I than actual coffins. Indeed, the only other coffin known to me with this pattern appears to be British Museum EA30721 (Ankhefenkhons –*

Taylor 2001: 232, fig 171). On the other hand, the Wayne County piece lacks the 'sunrise' elements found on EA30721 and the cartonnages that are so typical of them (see Taylor 2003: 104-107), having a simple winged sun-disk of the 'Yellow' type; it also continues the 'Yellow' practice of attempting to fill all available spaces with hieroglyphs. All this reinforces the view that the Wayne County coffin was manufactured during the transition between 'Yellow' and 'Dynasty 22' funerary ensembles – perhaps under Shoshenq I."

Like other coffins of this period, the deep, flat-bottomed basin of the WCHM coffin has a design that coordinates with, rather than continuing, the pattern on the lid. The basin's pattern is very simple, consisting merely of vertical lines of offering texts interspersed with hieroglyphs representing the djed pillar, the *imn.t* sign for The West, a meandering snake, and the four sons of Horus on a yellow background like that of the lid. Although, I have not found any exact parallel to it in the literature, I am grateful to Niwinski (letter to author) for providing some examples in which a meandering snake and The West appear on the 22nd Dynasty cases. There is no decoration on the interior of the basin. Neither the basin nor the lid was varnished, again associating them with the "22nd Dynasty" rather than "Yellow" ensembles.

In the Third Intermediate Period, coffins were sometimes prefabricated to supply the large religious community at the Amun Temple (Niwinski 1988: 55). The name and titles of the deceased would be added when a coffin was purchased for a particular individual. There is no name where one might be expected on the foot end of the Wayne County coffin lid, and the foot region appears to have been altered in a crude manner. The wood grain is only painted on, not real. Whether this was done to cover a previously-inscribed name has not been determined. It occurs to this author that coffins that had been pre-fabricated in the earlier yellow design may have been available cheaply and to a wider audience at this time as people preferred the new styles if they could afford them.

Condition of the Mummy

When the coffin arrived in Richmond, Mrs. Gaar found that the Egyptian authorities had "opened" her mummy, presumably to search for valuables. Mrs. Gaar's purchase occurred only three years after Howard Carter unwrapped the mummy of King Tutankhamun and found 143 pieces of exquisite jewelry on it. Although thousands of ancient mummies had been wantonly destroyed in earlier centuries by being used for paints, medicines, and even locomotive fuel, in 1929 the Egyptian authorities were taking no chances of losing valuables.

As a result of their searches, the mummy's head was completely unwrapped and separated from the body. The bandages are now missing from the neck upwards but appear undisturbed from the neck down; the absence of bandages around the head creates a large hole into the interior of the bundle. Initially the skull was missing its mandible, but that was discovered in 2009 in the narrow space between the mummy bandages and the side of the coffin. It seems likely that the jaw had come loose in the hand of one of the Egyptian searchers in 1929, who had tucked

it back in beside the mummy – to our great good fortune. Both parts of the skull are bare of skin and soft tissue within; there is no hair on the head.

Scientific study of the WCHM mummy began in 1974 when it was X-rayed locally at Reid Memorial Hospital. The X-rays revealed all the bones of an adult skeleton although they were considerably disarranged (Fig. 2). The Richmond physicians observed that the third molars had erupted and said the mummy's age-at-death was at least 20 years. They could not see enough of the broken pelvis on the X-rays to use it to determine gender. And although they could examine the unwrapped cranium directly, they could not agree on its sex. Additional X-rays and CT-scans were performed at Reid Hospital in 2000, but again local physicians could not reach a consensus.

New investigations on the coffin and mummy began in 2006 when this author was invited to catalogue the objects in the WCHM's small Egyptian collection and prepare a new exhibit to feature the mummy. At this time a careful study of the CT-scans was initiated.

Fig. 2. X-rays (taken in 1974) of the mummy at the Wayne County Historical Museum (photo: B.M. Sampsell).

These CT-scans revealed that there was no soft tissue preserved essentially anywhere in or on the body of the mummy. Cavities remaining within the bandages, however, indicated that the body was still fully-fleshed when it was wrapped. This is especially apparent on scans through the upper and lower legs, where the major leg bones remain close to their original positions. Comparisons of scans from the WCHM mummy to ones from well-preserved Third Intermediate Period mummies such as those from Leiden, for example, were helpful in estimating the variation in mummification procedures employed in the different cases (Raven and Taconis 2005).

We finally concluded that the body of the Wayne County mummy had not been desiccated to a satisfactory degree of dehydration; as a result essentially all of its soft tissue gradually decayed. Eventually nothing held the individual bones together, and they were free to slide about within the stiffened "carapace" of the bandages when the coffin was reoriented during transport and display. Collapse of the rib cage also permitted the many layers of spiral bandages to subside in the region of the torso.

Gender of the Mummy

Since several Richmond physicians had not been able to determine the mummy's gender, it seemed desirable to consult a physical anthropologist with more experience dealing with skeletons of ancient Egyptians. Azza Sarry el-Din, from the National Research Center in Cairo, obliged us by studying photographs of the bare skull (Fig. 3). The following information is from her correspondence with the present author (emails in 2007 and 2012).

She scored seven features on the cranium using a scale of 1 = typical female, 2 = slightly feminine, 3 = indeterminate, 4 = slightly masculine, and 5 = typical male. Her scores were Nuchal crest 5, Mastoid 4, Glabella 4, Superciliary arches 2, Orbital shape 3, Zygomatic arch 5, Temporal ridge 4, Average 3.86. About the mandible she remarked: its size appears large, width of ascending ramus is large, shape of chin is broad, and gonial angle is more than 135 degrees. She concluded that the skull was from a male. It can be seen that the ethmoid and bones of the nose are intact, so the brain was not removed through the nose.

Sarry el-Din also studied the still-wrapped and broken pelvis on copies of the 1974 X-rays. She was able to score the following five features and judged them to all be male: pubic symphysis, ramus, obturator foramen, shape of pelvis, and acetabulum. Her examination of the mummy's sagittal suture, degree of tooth wear, and the femur head allowed her to estimate its age at death as 30 to 35 years.

Possible Causes of Mismatches

The investigations on the WCHM mummy and coffin, described so far, revealed a mismatch between the gender of the mummy (male) and that of the woman depicted on the coffin lid. This led us to consider some of the situations that could produce a mismatch; these can be divided into ancient causes and modern ones.

Fig. 3. Skull of the mummy at the Wayne County Historical Museum (photo: B.M. Sampsell).

Either reburial or reuse could have occurred in ancient times: reburial would produce an old mummy in a newer coffin, while coffin reuse would combine an old coffin with a new mummy. The most notable examples of reburial involved the New Kingdom kings and queens whose mummies – identified by inscriptions on their bandages – were collected in several caches by 21st Dynasty officials. Some were found in tomb TT 320 at Deir el-Bahri and others in KV 35 in the Valley of the Kings, places that were considered more secure than their original violated tombs. These famous mummies were found in various "ramshackle" coffins because their original elaborate coffins were usurped or simply stripped of their precious gilding and inlays (Daressy 1909; Reeves 1990). Evidence for the reburial of a private individual in the 21st Dynasty consists of a hieratic label – now separated from its mummy and coffin – giving the deceased's name and the name of the embalmer (Dodson 1991).

Other mismatches have been traced to the widespread practice of coffin reuse during the Third Intermediate Period (Niwinski 1988: 54; Cooney 2011). Recycled coffins could have a new name added, could have the gender altered by changing the wig and hands (clenched fists for males, open hands for females), or could have new layers of plaster and painted design applied. One of the coffins purchased from a small museum in Niagara Falls, Ontario and now in the collection of the Michael C. Carlos Museum at Emory University provides an example. An elaborate 21st Dynasty coffin was first inscribed for Lady Tanakhtenttahat, a chantress in the Temple of Amun. But CT-scans of the mummy inside revealed that it had not been mummified in the manner used for most Third Intermediate Period elites; in fact, the well-preserved body had not been eviscerated at all. On closer examination of the coffin, it appeared that the original names on the coffin, as well as some of the decoration, had been altered for a woman named Taaset and whose family evidently could afford neither a new coffin nor an elaborate mummification procedure (Lacovara 2002).

A large number of the mismatches detected in modern studies are doubtless the results of 19th century tomb robbers or antiquities dealers making up new combinations of mummies and coffins from separate objects found in disturbed tombs. Perhaps any mismatch without a clear provenance from a documented excavation should be suspected as modern. A 21st Dynasty coffin inscribed for Tawhenut, a chantress of Amun, is in the collection of the Bolton Museum in Bolton, England. CT-scans of the mummy indicated it was a man, whose head shape resembles that of a Ramesside king, suggesting a New Kingdom date for the mummy several hundred years older than the coffin. Museum officials propose a pairing by 19th century tomb robbers rather than a reburial (Gordan-Rastelli 2010: 76).

Resolving mismatches generally requires that both coffin and mummy be firmly dated. With coffins, this can usually be done based on its design. With mummies, the best approaches involve an analysis of mummification methods and/or carbon dating. Sowada *et al.* (2011) carbon-dated a mummy in the collection of the Nicholson Museum at the University of Sydney. The mummy was acquired in a coffin with a 25th Dynasty design, but carbon dating of samples of the bandages revealed that its burial occurred around AD 68-129.

Dating the Mummy by Mummification Methods

The Third Intermediate Period saw the apex of mummification procedures in ancient Egypt with the adoption of some new practices such as returning the visceral packets to the body and stuffing of body cavities and under the skin (Ikram and Dodson 1998). These were designed to restore the body to a life-like appearance. Mummies can be dated to that period using evidence of the features listed below. The ones that are underlined are definitely, or very likely, present in the Wayne County mummy. It is apparent that only a few of the diagnostic features of that period are found in this mummy, and that its overall preparation for burial was cursory:

- Removal of the brain through the nose
- Internal organs removed and dried separately
- Viscera wrapped and returned to body cavity rather than canopic jars
- Stuffing of sand, mud, etc. in body and under skin
- Use of an abdominal prop
- Artificial eyes
- Amulets in the wrappings
- Arms extended, hands on thighs
- Limbs wrapped separately, then with torso
- Spiral bandages with longitudinal shroud
- Longitudinal and horizontal ties or bands
- Mummy braces or stola around the neck

Elite Third Intermediate Period mummies usually show a constellation of these features, and this allows them to be assigned to that period with some assurance. The presence of mummy braces on the mummy is especially valuable, since the tabs on the ends of these braces give the name(s) of the king and/or the High Priest

of Amun in office at the time of burial. In this way the date of the mummy itself can be determined independently of its coffin. Mummy braces have been found with names ranging from Ramesses XI through that of Osorkon I; they occur on mummies buried in all kinds of yellow coffins, not only in Type V or stola coffins (Niwinski 1988).

The Abdominal Prop

Third Intermediate Period embalmers employed various artificial materials to make a mummified body look as lifelike as possible. Another trick-of-their-trade, the abdominal prop, may have been identified recently by this author who found one in the WCHM mummy as well as on the website of the Metropolitan Museum of Art (MMA) in New York City.

In their 1923-1924 season, Metropolitan Museum excavators under the leadership of Herbert Winlock discovered several 21st Dynasty burials in a tomb on the northern boundary of the Hatshepsut temple's courtyard (Winlock 1942). In the poorly-preserved mummy of a man named Tabakmut, who lived during the reign of Psusennes II, Winlock and Douglas Derry found an X-shaped object consisting of two linen-wrapped sticks (this item was given to the MMA in the 1925 division of finds; its accession number is 25.3.174, and it is displayed in Gallery 130). Their contemporaneous comments were recorded on tomb cards, now archived at the MMA and kindly provided to me by Catharine Roehrig of the Department of Egyptian Art. These say:

> *"No attempt was made to return the viscera to the body. The only thing being found in the body cavity, except natron, with which it was filled, was a cross made of two sticks tied together with a rag."*
>
> *"This was presumably a jack [prop] to hold up the anterior abdominal wall while the embalmer was working in the body. It could be entered through the embalming incision in the left side folded up, then opened and erected inside the body."*
>
> *"These sticks would give great distension to the anterior abdominal wall, and this may explain why the skin is often separated from the lower ribs in other mummies in this series. It would also lift skin of groin from pelvis and facilitate packing the legs."*

The object has not been described in any publication this author has found, but it can be taken to represent one more device that was used during this period as part of the elaborate embalming procedures and which may serve to link a mummy to this period of Egyptian history.

A nearly-identical item was found inside the WCHM mummy in 2009 during a search inside the bandages for the first cervical vertebra (Fig. 4). For this artifact to have been located inside the body of this man, an incision must have been made. And there seems to be no reason for making an incision unless the intention is to eviscerate the corpse. But there is no evidence in the CT-scans that the viscera were

Fig. 4. Abdominal prop: an object found within the mummy at the Wayne County Historical Museum (photo: B.M. Sampsell).

desiccated and returned to the body cavity, nor that any other form of packing was inserted in the body cavities or under the skin. This author proposes, therefore, that this "prop" may have been used to support the body wall of the empty abdomen during the bandaging process.

Dating the Mummy by C-14

Since it had not proved possible to conclusively date the WCHM mummy based on mummification procedures, we decided to attempt carbon dating. Two samples of linen bandages from the inner torn edge at the neckline, along with a small piece of bone and a piece of cartilage from the mummy itself were sent to a laboratory at the University of Arizona in 2009. The calibrated C-14 dates of the burial (linen samples) and the mummy's body appear to be consistent with the coffin's date of manufacture (Fig. 5).

The top bar in the figure indicates the beginning of 22nd Dynasty, with the darker region indicating Niwinski's proposed date for the coffin's production. The darker portion of the age range for each sample shows the mean and ± one standard deviation, while the lighter bar indicates + two standard deviations. There is excellent agreement between the ages of the coffin and three of the samples. As yet it is not known why the cartilage date is much older; the greater age range for that sample derives from the shape of the calibration curve which is much flatter for that period.

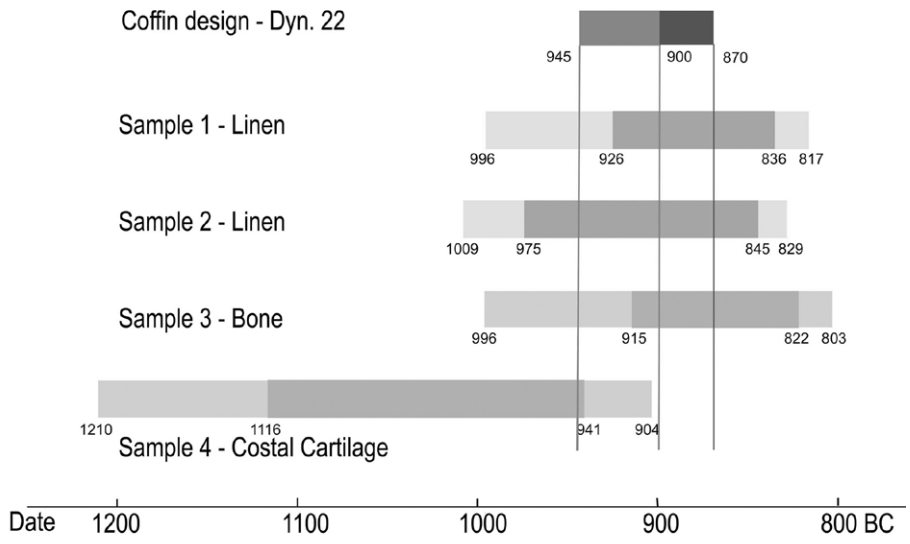

Fig. 5. Results of the C-14 dating of samples from mummy at the Wayne County Historical Museum.

Conclusions

The C-14 test results and mummification methods (especially the use of an abdominal prop) indicate that the WCHM mummy dates from the same period as the early 22nd Dynasty coffin. The intact tenons suggest that the coffin was opened with care for the first time since it was buried – probably at the Hatoun shop in Cairo in 1929. It does not seem likely to this author that the Hatoun shop itself could have been the origin of the mismatch (by adding or replacing the mummy in the WCHM coffin) because it was unlikely that Hatoun had a supply of mummies at hand in 1929. In fact, the condition of the mummy suggests it had a long association with this coffin: the bandages are broken in the back and layers of the bandages have sunk into the cracks of the coffin floor where one board is missing. Because of the deterioration of its body and wrappings, the mummy could not be shifted around outside of a coffin without falling apart.

We conclude, therefore, that the mismatch between a male mummy and a coffin for a woman is ancient, dating to the original burial, and hypothesize that the family of this anonymous 22nd Dynasty man purchased a pre-fabricated coffin, which was going out of style. They could not afford to have it inscribed or to provide the deceased with more than a modest embalmment lacking most of the elaborate techniques employed on the bodies of Third Intermediate Period elites. His burial and modern exhumation occurred somewhere near Thebes, the source of other coffins of this type.

More modest interments of this type may come to light as more museums study coffin and mummy combinations in their collections. And it is likely that many other mismatches will be resolved using advanced technologies in combination with traditional Egyptological methods.

Object Identification

The following items referred to in this article belong to the Wayne County Historical Museum (WCHM) in Richmond, Indiana (USA).

Item	WCHM number	Dimensions
Coffin Lid	06.03.2	85.4 cm x 47 cm x 26.7 cm high at foot
Coffin Basin	06.03.3	89.2 cm x 51.4 cm x 22.2 cm high
Mummy	06.03.4	82.9 cm x 47 cm wide (head unwrapped)
Abdominal Prop	06.03.4a	15.2 cm x 8.3 cm
Mummy Mask	06.03.5	3.2 cm x 19.1 cm
X-rays from 1974	06.03.6	Five sheets of X-ray film
E. Hatoun, Cairo Business Card	06.03.7	10.8 cm x 7.6 cm

The People of Sayala During the Late Roman to Early Byzantine Period

Eugen Strouhal

One of the greatest collections of anthropological remains, dating from the Late Roman to Early Byzantine Period, and coming from Nubia, is kept in the Museum of Natural History in Vienna. The material originates from10 different cemeteries which were discovered and excavated by the Austrian missions in the area of Sayala, about 120 km south of Aswan, during the UNESCO action of saveguarding Nubian monuments in the 1960s. The assemblage consists of 650 individual skeletons. It was offered to Austria by the Egyptian authorities in gratitude for their participation in the Nubian campaign. As an anthropologist of the Czechoslovak mission to Nubia, I was invited by the late director of the Anthropological Department, Johann Jungwirth, to collaborate with him in this project, which was realized in four seasons between 1969 and 1990.

From the 10 cemeteries excavated in the area of Sayala, material from the two oldest ones belonged to the C-Group and Pan Graves cultures (Strouhal and Jungwirth 1984). Some results from the five Late Roman-Early Byzantine cemeteries and three Christian cemeteries (6th to the 11th c. AD) were published by Jungwirth and the present author in several preliminary journal reports. After a delay caused by political changes in Czechoslovakia and my return from the National Museum to Charles University, work could resume on their elaboration and work commenced on the second Sayala volume. In the present contribution some highlights of the book, which is in preparation, are presented, primarily those concerning demography, skull morphology and paleopathology.

Demography

The Late Roman-Early Byzantine anthropological material was excavated in five cemeteries, of which four were on the east bank of Nile (A, C I-III) and one (N) on the west bank. Cemetery A consisted of a few individual burials scattered in three areas of the previous C-Group cemetery. The tombs of the three (originally four) large cemeteries C I-III and N were built of stone, circularly, from a central nucleus, forming large tumulus-like structures. In tombs with standard dimensions of 100-200 cm in length, 40-70 cm in breadth and a depth of 15-70 cm, stretched bodies were lain in supine position.

Cemetery A yielded 24 skeletons (including three children). Conversely, burial complexes C I contained 65 (including five children), C II 139 (six of which belonged to children) and C III 167 skeletons (including 13 children) respectively, in total 371 skeletons (comprising only 27 children in total). At the west bank cemetery N 56 tombs were excavated, which in contrast to C I-III complexes contained 21 adults, but a surprisingly high number of 35 children.

In addition to the tombs with single burials, a peculiar feature of the C/I-III and N cemeteries was that strikingly many tombs contained more than one body, seemingly interred at different times, suggesting successive burials. Multiple burials occurred in 69 tombs (19.2%), yielding 161 bodies (35.6%). There were 52 double tombs, yielding 104 individuals, 13 triple tombs which together held 39 individuals (Fig. 1), two quadruple tombs yielding eight bodies, and finally two quintuple burials, adding ten individuals to the total. In tombs of adults with double burials, about half (48) were males and females, possibly married couples, about a fifth (22) contained two males, perhaps brothers, or father and sons, and a tenth (10) contained two females, possibly sisters. The remaining 81 individuals were interred in various combinations.

Individual cemeteries differed significantly in their demographic composition. The large burial complexes contained a very low number of child and infant burials. Cemetery C/III completely lacked burials of infants and children up to 7-8 years. This might be explained by the idea that these populations used to bury only older children and juveniles after they had reached an age of initiation, and were accepted members of the society. Younger children and infants were either disposed of, or were buried in a separate children cemetery, which has been subsumed by the rising Nile level. On the other hand, the excavations of cemetery N revealed an almost "normal" demographic composition, with burials of people of all age ranges.

In cemeteries C/I-III the mean age at death of adults and juveniles over 15 years of age was 35.1 (s = 9.5) years in males, 33.3 (s = 8.6) years in females, and with men and women taken together 34.2 (s = 12.3) years. In cemetery N the mean age of death for males was 37.4 years, in females 37.1 years. However, this result can be a chance one due to the low number of individuals. Indeed, Cemetery A proved its chance character showing a mean age of 30.8 years, in males, but 33.1 years in females, which is rather unusual, as women, due to frequent deaths during childbirth commonly have a lower mean age at death than men in ancient samples (Wells 1975).

According to the life expectancy tables prepared for the skeletal sample, the life expectancy of newborns coming from the joint C/I-III cemeteries was as high as 34.2 years (due to a low number of immature burials), while in the N cemeteries (due to a overwhelming number of children) it was as low as 17.4 years. At 20 years continued life expectancy was 21.1 years in adult males, and in adult females 19.9 years. Life expectancy at 30 years dropped, surpringly, quicker in males (to an expected 12 more years) than in females (who at the age of 30 would be expected to live another 16.2 years). This unfavorable male data surpassing that of the females endangered by childbirths may suggest male loss of life by fighting, at least for the

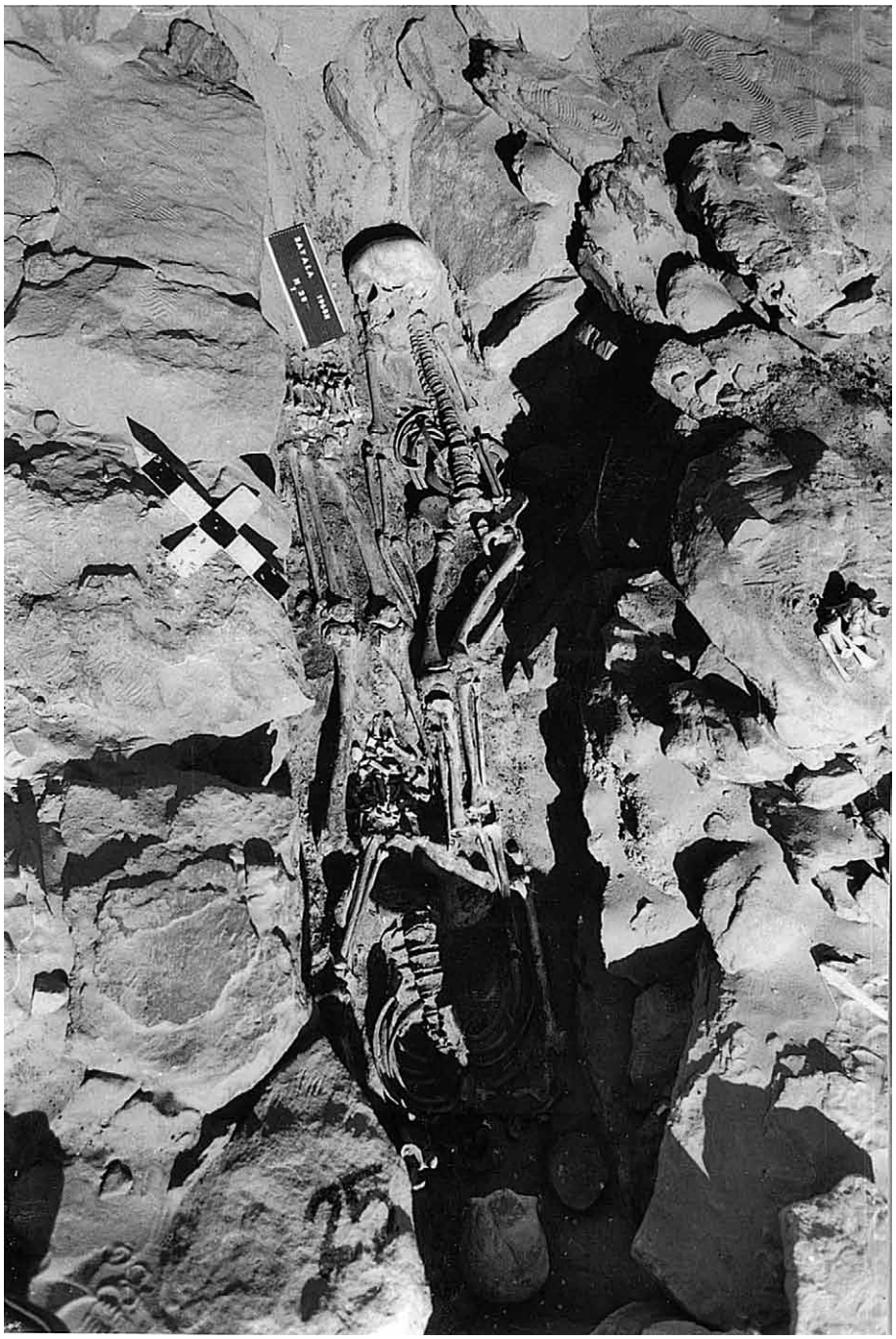

Fig. 1. Triple burial (25/1-3) from Cemetery N consisting of an 8-9 year old boy (?) oriented to northeast, a 40-50 year old female to southwest and a 0-1/4 old infant on northeast side (photo: Austrian Mission to Nubia).

individuals buried at the joint C/I-III cemeteries. The people of cemetery N could expect at 20 years to live on for a further 17.9 years, and at 30 years an additional 10.9 years of life.

Craniometric Study

Skull morphology remains a basic tool for discrimination of the genetic background of anthropological populations, although there has been some debate about this (Brown and Armelagos 2005; Williams *et al.* 2005). The relatively good preservation of the Sayala material enabled us to perform craniometrics (78 features and 49 indices[1], analyzed separately for both sexes) using Student's t[2] and F[3] tests and analysis of variance (Martin and Saller 1959).

Surprisingly, the three large burial complexes (C/I, II and III) were the ones that yielded the highest levels of statistically significant ($P < 0.05$) variance of craniometric features, in both the male (52.8%) and female (50.9%) groups. The same sample also yielded statistically higly significant ($P < 0.01$) variance in 36.6% of the males and 60% of the females. The results of the craniometric analysis thus suggest that the sample from complexes CI-III do not belong to a single population group, but three genetically separated tribes, perhaps with some mutual proximity through exchange of genes by occasional matrimonial bonds.

When the two smaller population samples were compared to cemeteries C/I-III, cemetery N yielded the lowest amount of statistically significant (males 15.1%, females 21.1%) and highly significant (males 6.5%, females 20%) craniometric features dissimilar to cemeteries C/I-III, thus adding an argument to the archaeologically stated similarity between the groups.

In contrast to cemetery N, the sample recovered from the Roman tombs in Cemetery A yielded a higher frequency of statistically significant (males 32.1%, females 28.1%) and highly significant (males 58.7%, females 20%) different craniometric features in comparison with the C cemeteries, attesting their greater distance from the individuals in the C/I-III burial complexes.

Craniometry was complemented by analyses of descriptive features by use of the "chi-square method" (Martin and Saller 1959). The morphology of the individuals is typically Nubian, showing a blend of Mediterranean (Egyptian) and Sub-Saharan African features such as narrow and prominent nasal bones and orthognatous facial profiles in the case of the former, and broad and flat nasal bones and prognatous facial profiles in the case of the latter, which can be shown by comparing two of the skulls side by side (Fig. 2).

For comparison of the Sayala joint complex C/I-III with other Nubian samples from the same or preceding periods, five cemeteries/skeletal series were selected. These were as follows:

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1 The percental relationship between two measurements, using the smaller number as the numerator and the larger number as the denominator.

2 A statistical test used to compare the means of two samples.

3 Used for testing for difference in sample variance.

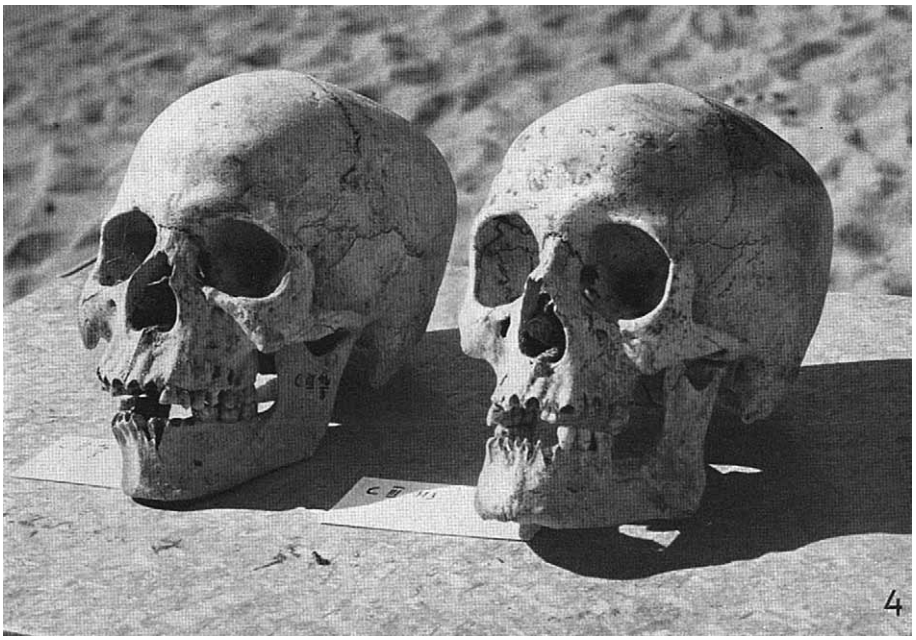

Fig. 2. Contrasting adult male skulls from Cemetery C III, one (right) showing Mediterranean (Egyptian) features, the other (left) Sub-Saharan African features (photo: Austrian Mission to Nubia).

The first was the cemetery comprised of large tumuli at Wadi Qitna, located 65 km south of Aswan and 60 km north of Sayala on the west bank of the Nile. It was excavated in 1965 by the mission of the Czechoslovak Egyptological Institute (Strouhal 1984, Strouhal and Neuwirth in press). All 420 tumuli yielding a total of 559 individuals were investigated. The archaeological culture was determined as being the northern variant of the X-Group (Ballana) Culture. The cemetery was dated from the second part of the 3rd to the end of the 5th c. AD (Strouhal 1984).

A second (small) skeletal sample came from soundings made at the southernmost edge of the tumuli cemetery on the west bank of Nile at Kalabsha South, only six km north of Wadi Qitna. It too was identified as the northern variant of the X-Group (Ballana) Culture. The cemetery was dated from the second part of the 3rd to the end of the 5th c. AD (Strouhal 1984).

The third and fourth sources came from two unpublished craniological series originating from excavations at Qustul, part of the second Archaeological Survey of Nubia, led by Brian Emery in the thirtees of 20th century. Qustul lies on the east bank of the Nile, 170 km south from Sayala. In the vicinity of the large tumuli of the local nobility, small tombs of common people were excavated. They were dated partly to the X-Group (QX), and partly to the Late Merotic Period (QM). Well-preserved skulls were deposited by Ahmad Mahmoud el-Batrawi in the Anatomical Institute of Cairo University Medical Faculty at Qasr el-Aini. In 1965-1967, prior to the devastation of part of this collection in the 1970s, the present author studied them in collaboration with Mohammad Fawzi Gaballah.

The fifth source was the southernmost Egyptian site of Aksha, lying on the west bank of the Nile about 10 km south of Qustul, where a Meroitic cemetery dated to between the 3rd c. BC and the 3rd c. AD was excavated during the UNESCO Action of the 1960s. An anthropological study on the population of this cemetery was subsequently published by M.-C. Chamla (1967).

Forty-three features were chosen for comparison, using t-tests and variance analyses (Table 1). The results of the analysis showed that male skulls from Wadi Qitna differed statistically significantly by about a quarter of features from all three Sayala cemeteries, while females only from C/I, but more from C/II and mostly from C/III. Thus only a general "Nubian" similarity can be admitted in males, but females are as distant as to suggest an external origin.

Comparison between Sayala and Kalabsha South showed surprisingly their close similarity, but the small number of cases from Kalabsha South prevents any final conclusion. Only a small sample from the southernmost edge of the cemetery could have been excavated during the UNESCO operation because of time shortage due to rising Nile level.

From the two Qustul samples, the X-Group one, contemporary with Sayala cemeteries, revealed their close similarity in males especially with C/I cemetery. A hypothesis of their possible genetic relationship, however, suffers from the small number of cases and bad preservation of Qustul skulls, as well as the far distance between Sayala and Qustul.

The Qustul Meroites appear less similar to the Sayala people (except in males with C/II). In females the distance is accentuted with C/II and C/III. Such result seems logical with respect to the geographical as well as chronological distance between the two localities.

The smaller skulls from Aksha proved to be craniometrically mostly dissimilar to the Sayala cemeteries (except for males C/II), being geographically distant and chronologically older than the cemeteries from Sayala.

Cemetery	Sayala Males							Sayala Females						
		C/I		C/II		C/III			C/I		C/II		C/III	
	N	n	%	n	%	n	%	N	n	%	n	%	n	%
WQ	43	12	27.9	11	25.6	13	30.2	43	11	25.6	17	39.5	19	44.2
KS	47	6	12.8	3	6.4	6	12.8	46	5	10.9	4	8.7	6	13.0
QX	31	1	3.2	5	16.1	6	19.1	30	2	6.7	3	10.0	2	6.7
QM	32	6	18.8	5	15.6	7	21.9	31	5	16.1	13	41.9	10	32.3
AK	36	16	44.4	8	22.2	14	38.9	36	14	38.9	13	36.1	16	44.4

Table 1. Results of craniometric comparison of Sayala C/I-C/III cemeteries with other Meroitic and X-Group cemeteries from Lower Nubia. Explanations: N = total number of compared craniometric features; n = number of statistically significant features on P level of 0.05; % = percentage of significant features; WQ = Wadi Qitna X-Group cemetery; KS = Kalabsha South X-Group cemetery; QX = Qustul X-Group cemetery; QM = Qustul Meroitic cemetery; AK = Aksha Meroitic cemetery.

To sum up, the eight compared groups from Sayala (3), Wadi Qitna, Kalabsha, Qustul (2) and Aksha appear to represent inhabitants of a series of small isolated hamlets along the Nile with a genetic background originating in the so-called founder's effect, i.e. the decrease of genetic variation in a group stemming from the effect of a new population being established by a very small number of individuals from a larger population, with minimum genetic flow from outside.

Paleopathology

The paleopathological pattern of cemeteries C/I-III and N is dominated by traumas over all other pathological changes, while cemetery A showed fewer traumatic changes. Altogether 184 injuries were found in the whole corpus of 394 individuals aged from 14 years up. Of these, 46 (25%) were located in the skull, 45 (24%) in the vertebral column and 93 (50%) in the remaining bones of the poscranial skeleton.

The percentage of skull injuries related to the number of skulls examined shows an increase from cemeteries C/I through C/II, C/III to N with a clear predominance of males showing cranial trauma over females. The relatively larger proportion of males in cemetery A is most probably a chance result, which, together with the lack of injured females, is a result of the limited number of bodies examined.

The three kinds of injuries on the skulls were unevenly represented. Impression fractures occurred mostly in males of cemetery N (19.2% – none in females), followed by males of cemetery A (8% – none in females) and cemetery C/II (5.6% – none in females), as well as both sexes in cemetery C/III (1.7% in males, 2.3% in females); such injuries were absent in C/I. Cuts were limited in both sexes mostly to cemetery C/III (14.1% in males, 4.5% in females), followed by cemeteries C/II (3.1% in males, 1.9% in females) and C/I (none in males, 4.7% in females), and were absent in cemeteries A and N. Stab wounds were confined almost exclusively to males, being inflicted mostly in cemetery N (9.5% in males, 19.6% in females), followed by cemeteries C/II (3.0% in males, 1.9% in females) and C/III (0.7% in males, none in females).

With regard to the distribution of skull injuries (sex combined), along the single regions of the skull, the majority were found in the frontal region (43.9%), followed by the parietal region (24.4%), nasal region (14.6%), occipital region (7.3%), mandible (7.3%) and both temporal regions (2.2%).

Left side injuries (53.7%) occurred more often than right side (31.7%) and mediosagittally located ones (14.6%). These findings clearly suggest that the majority of injuries originated from hand to hand fighting, with an enemy holding a weapon in his right hand.

Trauma in the vertebral column was more often inflicted on males than on females. It consisted of compressive fractures of the vertebrae, reaching the highest percentage in cemetery N (exaggerated by chance), in the males of cemetery C/I (not in the females), and in both sexes of cemeteries C/II and C/III. Other trauma included post-traumatic synostoses of the vertebrae. These occurred only in the males of cemeteries N and C/II, as well as in both sexes of C/III.

In the vertebral column, compressive fractures were mostly located (sex combined) in the lumbar (37.0%) and lower thoracic regions (19.6%). Less affected were the lower cervical (6.5%), and the upper thoracic regions (2.2%). In both sexes the upper cervical region was devoid of fractures; this was also true for the lower cervical region in females. The difference in levels of vertebral trauma between the single cemeteries of CI-III was tested for both sexes with the Chi-square method, but found to be statistically insignificant. Cemetery A did not reveal a single case of traumatic compression.

Most fractures from the mid-thoracic region downwards were mostly due to falls in a sitting position. According to this discovery, we may assume that the Sayala people were often subjected to danger of abrupt falls in sitting position, possibly while riding camels.

Only the above mentioned five cases of compressive fractures affecting the lower cervical spine and the upper thoracic spine could have been connected with headlong falls. Only five males and a single woman were thus afflicted. This may reflect the danger of falling down from camel's backs during (military) actions.

Posttraumatic synostoses (secondary blocks) of the vertebrae were more evenly distributed. Most appear in the lower (10.9%) and upper thoracic regions (8.7%), fewer to the lower (6.5%) and upper cervical regions (6.5%), and fewest to the lumbar region (2.2%). In males they were present in all locations, with a maximum number occurring in the lower thoracic region, and a minimum number in the upper thoracic region. In females these were found exclusively in the latter region.

Traumas of the remaining parts of the postcranial skeleton related to the number of investigated persons shows a similar pattern as that of the traumas to the skull and spine (Fig. 3).

The lowest frequency was observed in males from cemetery A (the females of which did not have these injuries). In the three large complexes on the east bank of the Nile, the incidence of postcranial and extraspinal injuries was high in males and similar in cemeteries C/I (21.8 %), C/II (20.8%) and C/III (24.0%), while only 12.6% of males from cemetery N and 7.7% from cemetery A were wounded. Trauma in females appears rather differently: C/I (20.8%), less in cemetery C/III (17.0%) and least in cemeteries N (9.0%) and C/II (7.4%) respectively, being completely absent in cemetery A.

Fractures were the most common trauma (except for none in N females), followed by cuts in C/III and C/I males, stabs in N and C/III females and traumatic synostoses in males C/II and C/III.

Distribution of injuries according to individual bones reveals an even pattern, except for their highest incidence in both antebrachial bones, in which the ulna was more afflicted (in males in 16.3%, in females in 7.5% of the sum of traumas respectively) than the radius (in males 14.1%, in females 5.5%). The sexual difference in this finding is connected mostly with parry fractures of the ulnae, most probably due to fighting. Whereas some bones were wounded more often on the right rather than the left side (ribs, clavicle, humerus, femur, foot phalangae), or evenly on both sides (tibia), the injuries on the radius, ulna, metacarpals, pelvis and fibula prevailed on the left side, also indicative of fighting.

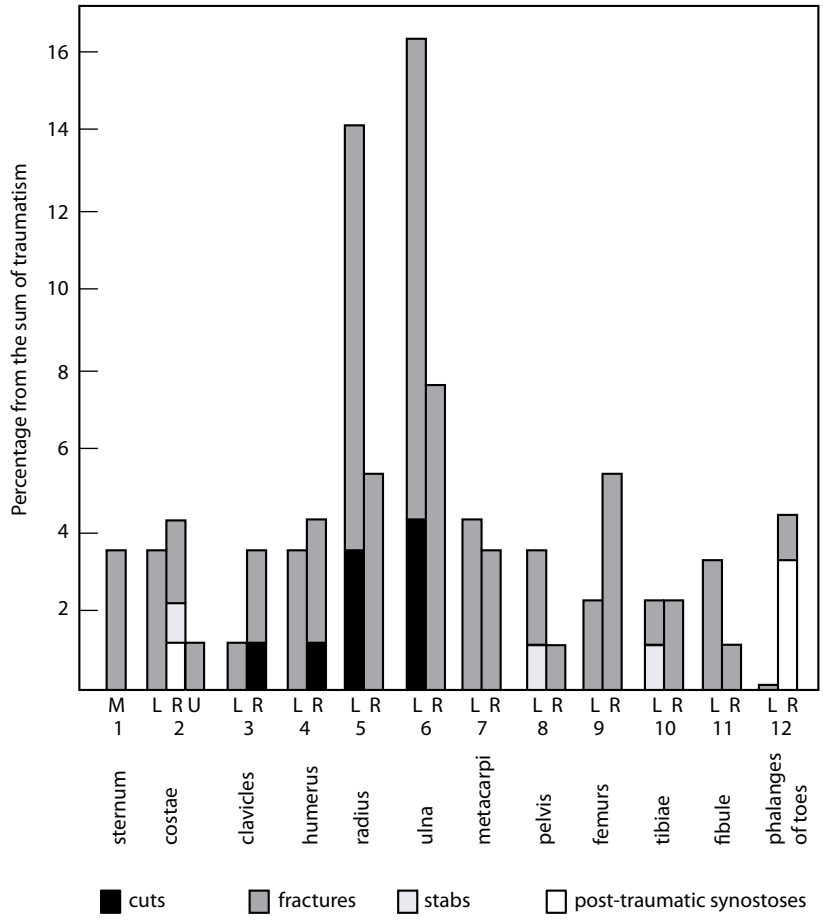

Fig. 3. Traumas of postcranial skeletons (except spines) according to individual bones (cemeteries and sexes joint) related to sides and types. M = medium plane, L = left, R = right, U = undertermined. 1 = sternum, 2 = costae, 3 = clavicle, 4 humerus, 5 = radius, 6 = ulna, 7 = metacarpals, 8 = pelvis, 9 = femur, 10 = tibia, 11 = fibula, 12 = phalangae.

Out of the 18 fractures of the ulnae, the majority (11, equalling 61.1%) were typical parry fractures of the distal thirds or middle of the diaphysis, usually showing only a slight post traumatic dislocation towards the radius, which was not broken, as a rule. A rare example shows a case in a 60 to 70 year old fighter from cemetery C/III, grave 97, whose parry fracture healed by malunion – pseudoarthrosis. This kind of fracture was the result of a blow, either on the shield held with a flexed left arm, or directly on the ulna raised in parry position. Out of the 14 fractures of the radius the majority (8, equalling 57.1%) also occurred in the distal third of diaphysis. According to their position and form, they were mostly the result of a blow, less often of a fall with the hand in dorsal flexion (Colles' fractures), or in volar flexion (Smith's fracture).

Some of the men were afflicted by several injuries of the type that would indicate that they were "warriors". Ten of these were indentified among the 99 males burried in cemeteries C/II and C/III. Of them, half suffered from severe fresh wounds with no signs of healing, suggesting that they died not long after being engaged in a battle. One of them was a 35 to 45 year old male from cemetery C/III grave 6, with four likely fatal cuts in his skull.

One of the rare stab wounds was identified in the left ilium of a 25 to 35 year old male from cemetery C/III, grave 84. The tip of the arrow remained *in situ* at the left sacroiliacal joint (Fig. 4).

No malignant tumours were found in the assemblage, but a rare case of a benign one was found. This consisted of osseous fragments found in the small pelvis of an individual buried in cemetery C/III grave 75. They were carefully removed by the excavators, and restored by the present author to a strange cone shaped formation, now held in the Museum of Natural History in Vienna. The age of the afflicted individual was assessed as being between 35 and 45 years, based on cranial sutures that were open from outside except for the incipient obliteration of parts of C1 and C3 of the coronal suture, the edentuolous and atrophic upper and lower jaws, the facies symphysialis of the pelvis assessed to grade VII (Todd 1920), and the grade 1 osteophytosis of the spine (except for grade 2 on vertebrae T4, 5 and S1, most probably connected with spondylolysis of T5). The gracile skeleton belonged to a female.

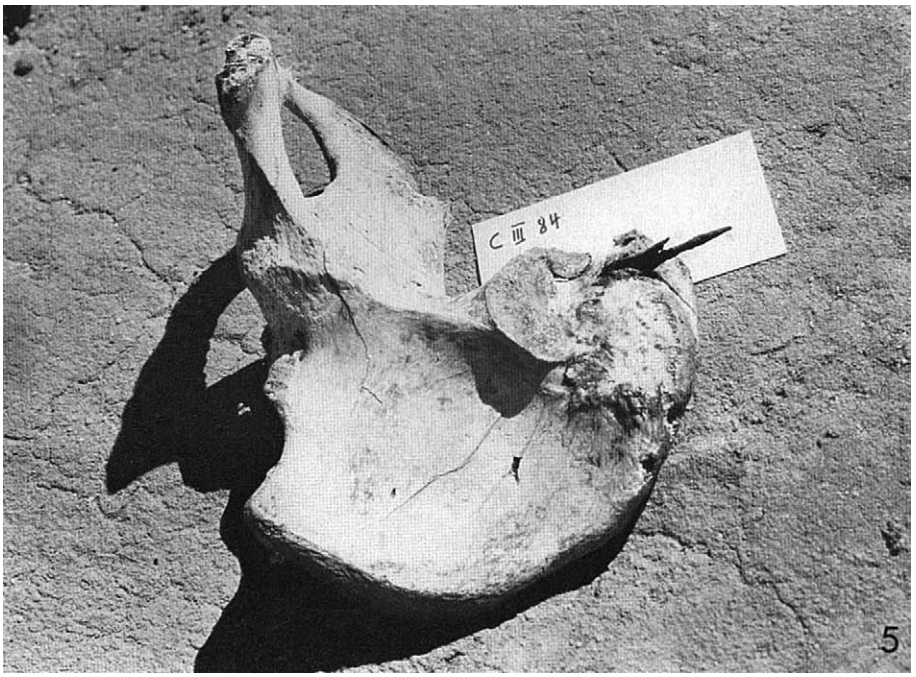

Fig. 4. Arrow inserted at the left sacroiliac joint of a 25-35 year old male from Cemetery C/III grave 84 (Austrian Mission to Nubia).

This tumerous cone shaped formation reached a height of 123 mm. It is rather compact in ventral and dorsal views (Fig. 5). In in the middle (vertically), the sagittal diameter is 65 mm (including a dorsal projection 79 mm), and the transversal diameter is 62 mm. The cranial end viewed from above is deeply broken off and irregular with the left part missing. It measures sagittally 80 mm and transversally 95 mm (with a reconstructed missing part 105 mm). The caudal end is roundish and flattened, partly broken off, with a diameter of 30 mm. The round form of the caudal end in the cranial direction gradually enlarges more transversally than sagittaly, so that the cone is anteroposteriorly flattened. The conical formation has an irregular structure of a thick knotted nodulated mass of calcified tissue permeated by a labyrinth of empty spaces. In the X-rays the well delimited calcified formation shows lumpy to cornlike structure, thickening as they go upward.

Traces of a junction of the formation with the normal bone of the small pelvis were not found anywhere. Therefore, it cannot be an exostosis, and its origin has to lie in soft tissue organs inside the pelvis. The growth has been diagnosed as being benign based on its irregular, but mostly compact surface, the absence of spiculae, trabeculae, and the lack of features indicative of an invasive growth into the surrounding bones. There are no signs of a pressure atrophy in surrounding bones. The formation had enough space to grow up as a relatively big, subserotic calcified myoma from the lower part of the uterus in the cranial direction, resting against the entrails of the belly.

Refined preparations show an irregular lobed structure with a condensation zone of parallelly oriented belts on its edge, which suggest a capsule. In greater magnification the fibre-like structure of this portion is obvious.

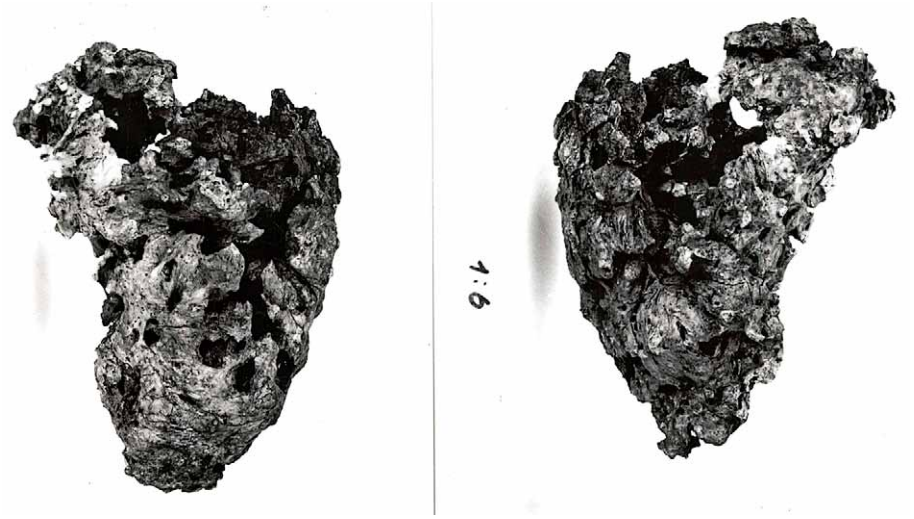

Fig. 5. Ventral and dorsal view of an ossified myoma uteri found in a 35-45 years old woman from Cemetery C/III, grave 175 (photos: Austrian Mission to Nubia).

To reveal the possible organic remains in the calcified tissue a sample was decalcified in Schultz' solution for eight hours, embedded in parafine and dyed with hematoxilin and eosin. By histological examination eosinophilic substances, partly compact, partly fibre-like, were recognized. In the compact parts, remnants of calcification, made apparent by turning yellow were found. No traces of cells were detected. The microscopic examination by Alena Nemeckova did not bring any evidence as to the origin of the organic structure, but its resemblance to the connective tissue is apparent.

Localization of the calcified formation in the small pelvis of this 35 to 45 year old female, its benign character, origin in soft tissues, its conical shape, and microscopic evidence of fibre-like appearance permit the diagnosis of a dystrophic calcified subserotic fibroleiomyloma of the uterus. The conical form of the tumor, widening from the bottom up, transversally broader and sagitally flattened, recalls most probably one of the common localisation of a myoma in the dorsal side of the uterus, close to its origin.

The frequency of myomas in modern females is 15%. In those aged under 35 years it is only 2.5%, from the age of 35 on it increases to 17% to 20%, reaching a maximum between 40 to 50 years of age. Data on frequency of calcified myomas are not accessible (László and Gaál 1969: 296-300). This myoma was the first such example to be described in the palaeopathological literature (Strouhal and Jungwirth 1977). Further finds of calcified myomas were published later by Kramar *et al.* (1983), Brobeil Jimenez *et al.* (1992; 1994), Capasso *et al.* (1994), and La Verghetta and Capasso (2001).

Thus, as can be seen from the evidence presented above, the cemeteries of Nubia remain rich sources of data about how these populations lived and died during the Romano-Byzantine era.

Royal Musical Chairs: To Whom Does the New Pyramid in Saqqara Belong?

Afaf Wahba

Introduction

The transition between the Old Kingdom's 5th (c. 2494-2345 BC)[1] and 6th Dynasty (c. 2345-2181 BC), and particularly the origins of the latter is unclear as the relationship between Unas (c. 2375-2345 BC), the last king of the 5th Dynasty, and Teti (c. 2345-2323 BC), the first ruler of the 6th Dynasty, is uncertain. Manetho, an Egyptian historian who lived and worked during the 3rd c. BC, tells us in his lost history of Egypt that King Teti was the victim of a palace conspiracy. Though contemporary evidence for the purported coup is lacking, the short rule of the ephemeral king Userkare (c. 2323-2321 BC), who may have usurped the throne for a brief period after Teti's death before it was returned to the rightful heir Pepy I (c. 2321-2387 BC), appears to support Manetho's charge (Kanawati 2003: 3-4).

In order to shed new light on this little-known period of Egyptian history, a team from the Ministry of State for Antiquities[2] (MSA) has been excavating in the Teti Pyramid Complex and associated cemetery since 1992. This work has culminated in the discovery of a previously unknown pyramid in 2008. Unfortunately, no inscriptions or cartouches revealing the identity of the owner of the pyramid have been found, but based on the location and architectural style of the monument, it has been suggested that the pyramid belonged to the mother of King Teti, Queen Sesheshet (Hawass 2011). In addition to the archaeological and stylistic evidence, we also have the actual physical remains of the pyramid's occupant, as the sarcophagus still contained a disturbed, but mostly complete skeleton. This paper will provide a brief historical background of the early 6th Dynasty, against which to present the results of the recently completed anthropological investigation of the bones found in the burial chamber, and a discussion of the identity of this individual.

1 Chronology following Shaw (2000).

2 Formerly the Supreme Council of Antiquities.

Historical Background and the Royal Family of the Early 6th Dynasty

Teti was the first king of the 6th Dynasty, but exactly how he ascended the throne is unclear. The length of his reign is also uncertain, and estimates range from 12 to 23 years, depending on whether an annual or biannual cattle census is assumed (Baud 2006). That Teti's mother was Queen Sesheshet seems reasonably certain, as she is attested on more than one monument with the title *mwt-nswt*[3], "King's Mother" (Seipel 1980: 226-228; Altenmüller 1990). In addition, a "Queen 'Sesh', mother of King Teti", is also mentioned in the Ebers papyrus in connection with a remedy for baldness, likely referring to the same queen (Seipel 1980: 228; Stadelmann 1994; Dodson and Hilton 2004: 71). Though some scholars believe that Sesheshet was indeed a wife of King Unas, making Teti the rightful heir to the throne (Seipel 1980: 229-231; Verner 2001: 343), the general consensus is that he claimed a genealogical link to the previous Dynasty through his wife Queen Iput I, who is believed to have been a daughter of Unas and who was definitely the mother of Pepy I (Kanawati 2003: 148). This view is supported by the circumstance that the title born by Queen Sesheshet is only that of "King's Mother" (*mwt nswt*), but not that of "King's Wife" (*ḥmt nswt*). In addition, Queen Sesheshet also appears to have carried the specific title of *mwt nswt bjtj* (Leclant 1971), a title sometimes described as propagandistic as it reinforced the status of the queen mother, and through her, strengthened the claim to the throne of her son. It was carried by queens whose sons either founded a new dynasty, needed to emphasize their legitimacy for political reasons, or who succeeded a relative other than their father on the throne (Callender 1992: 35). In addition, the majority of the fourteen queens who carried the title appear to have been commoners (Callender 1992: 35-36). Conversely, a block found in Teti's mortuary temple in Saqqara (Quibell 1909, Pl. LIV) refers to a Queen Sesheshet with the title of *ḥmt nṯr ḥḏ-spf*, "Priestess of Tiasepef", an obscure title possibly connected with a royal fertility cult, which was apparently only conferred on queens and wives of kings, particularly those who were in a mother-daughter relationship with another queen, who also held the title. This seems to suggest that Queen Sesheshet was indeed a wife of Unas (Callender 1992: 139). However, as the name Sesheshet became fairly popular in the reign of Teti and later, it has also been suggested that this block refers to another queen with the same name (Seipel 1980: 253-255). In the end, the most commonly held view is that Teti himself was not of the royal bloodline (Altenmüller 1990; Stadelmann 1994).

In addition to the aforementioned Queen Iput I, another wife of Teti, Queen Khuit (A), was also buried next to his pyramid complex. In most historical overviews of the period, Queen Iput has been considered the principal wife of the king, by virtue of being a daughter of Unas and the mother of King Pepy I (Malek 2000; Kanawati 2003: 184). However, recent excavations of the two queens' mortuary complexes suggest this view should be reevaluated. Between

3 Namely on pillar fragments from the mortuary temple of Pepy I, as well as in the tomb of the official Mehu in Saqqara.

1992 and 1998, a team from the MSA under direction of Zahi Hawass undertook a re-excavation of the area, as neither tomb had been completely investigated during previous explorations (Loret 1899: 85-86; Quibell 1909; Firth and Gunn 1926; Firth 1929). The excavation revealed that the tomb of Queen Iput was initially built as a mastaba, and only later converted into a pyramid complex by Pepy I following his first Heb-Sed festival, while the tomb of Queen Khuit was conceived as a pyramid complex from the start (Hawass 2000; Verner 2001: 348-351). In addition, Khuit's carefully finished gabled roof burial chamber contained a fine granite sarcophagus, while Iput's smaller and more roughly finished chamber held a much simpler limestone sarcophagus (Hawass 2000; Callender 2002). Taken together, this implies that Khuit, not Iput, was King Teti's first or favorite queen. Though most scholars have seen Iput as the genealogical link to the previous dynasty (Grimal 1992; Malek 2000; Kanawati 2003; Dodson and Hilton 2004: 71; Dodson 2013), it is possible that Khuit, too, was a daughter of Unas (Stadelmann 1994). Another possible explanation for Khuit's higher social standing and Iput's later social elevation may also have been uncovered during the MSA mission, in the form of the tomb of the "king's eldest son of his body" Tetiankh-kem, which was uncovered in 1992-1993 just to the east of the pyramid of Iput. Reliefs from the tomb suggest that Tetiankh-kem was the son of Queen Khuit, and the anthropological investigation of his body, which was found in the sarcophagus, shows that he was between 20 and 25 years of age when he died, though no cause of death could be determined. Thus, it appears Tetiankh-kem was the original crown prince, but that he predeceased his father (Hawass 2000). Queen Khuit would thus likely have enjoyed the status of being the mother of the heir apparent for some time, while the same would not be true for Queen Iput until after Tetiankh-kem's death, which likely took place not long before the death of Teti himself, given the age of the adult son.

In addition to Iput and Khuit, three further shadowy queens, about whom we know very little, may have been associated with Teti. The first two, Hetepheres and Tjeti, are only known from some papyrus scraps found south of Unas' pyramid by Jean-Philippe Lauer in 1939 (Hawass 2011). A third, Khent.t[…], is attested on a re-used block from Pepy I's pyramid temple (Leclant 1971), and may have been the mother of Teti's immediate successor Userkare (see below), although this is far from certain (Jánosi 1996: 43-44).

Teti's Horus-name, Seheteptawy, 'He who pacifies the Two Lands', may suggest that his ascension to the throne was not entirely smooth, as similar Horus names with the same prefix, 'He who pacifies …..' were adopted repeatedly by several kings during times of internal strife (Kanawati 2003: 148). Nevertheless, that there was considerable continuity between Teti's reign and that of his predecessor can be seen in the number of officials that served under both kings, and the break between Unas and Teti in the Turin Canon (and later their placement in different dynasties by Manetho) may have more to do with a move of the royal residence further south of Memphis than any contentious claims to the throne (Malek 2000).

There does appear to have been a shadow hanging over the end of Teti's reign, however. After his death, a little known king named Userkare reigned for a brief period – perhaps as little as a year (Kanawati 2003: 4), and likely not more than four years (Baud and Dobrev 1995). Though some scholars believe this king was indeed a son of Teti's, either by Queen Khuit (Stadelmann 1994) or by the ephemeral Khent.t.[…] (Seipel 1980: 245-246; Callender 1992: 141; Jánosi 1996: 43), most favor the view that he was an usurper, who may have had ties to the previous dynasty, and who possibly may have been looking to restore the cult of Re to the heights it enjoyed during the 5th Dynasty (Goedicke 1986; Grimal 1992: 81; Shaw and Nicholson 2002: 286; Kanawati 2003: 147). Further, the historian Manetho tells us that Teti was assassinated by his own palace guard (Manetho, translation Waddell, 1940: 53). There are no contemporary written sources corroborating this claim, but the fact that the name of Teti's successor Userkare is conspicuously absent in the tombs of the high officials proudly stating that they served under both Teti and his son Pepy I – and therefore likely under the intervening king as well – may lend support to Manetho's assertion (Kanawati 2003: 158). In addition, a few tombs in the Teti cemetery show signs of the latter king's name having been removed but later reinstated, and an unusual number of tomb owners in the cemetery were subjected to what appears to be systematic removal of their names and sometimes figures, among them several palace guards, a vizier, an overseer of weapons and a chief physician (Kanawati 2003: 184). This *damnatio memoriae* appears to have taken place in the reign of Pepy I, and may reflect his reaction towards the officials that had supported his predecessor's bid for the throne. Of course, labeling Userkare an usurper does not automatically mean that Teti was murdered – Userkare may have simply taken advantage of the king's death by natural causes and seized the throne from the intended successor Pepy I, who must have been fairly young when his father died (Kanawati 2003: 184-185).

The Archaeological Sequence in the Teti Pyramid Cemetery

We know from the archaeological evidence that Queen Khuit's pyramid was the first subsidiary tomb to be built in the portion of the Teti cemetery that was reserved for the royal family, and that it was built as a pyramid and not a mastaba from the start (Hawass 2011). The mastaba of Queen Iput was built after the pyramid of Queen Khuit, followed by the mastaba of the king's son Tetiankh-kem. The mummy found in Tetiankh-kem's tomb, presumably that of the prince himself, was that of a young man between 20 and 25 years of age (*Ibidem* 2000). The west wall of the new pyramid abuts the east wall of Tetiankh-kem's tomb, suggesting that it was built after the completion of the prince's mastaba (*Ibidem* 2011). Finally, Queen Iput's mastaba was rebuilt into a pyramid. Judging from some of the reliefs from the mortuary temple connected with Queen Iput's pyramid which reference the Sed festival of her son Pepy I, this happened fairly late in the latter's reign, and thus some time after the death of both the queen and her husband (*Ibidem* 2000).

A fair amount of ink has been spilled on the reasons for the "upgrade" of Queen Iput's mastaba to a pyramid. Labrousse (1994) suggests that the queen's initial interment in a mastaba was not due to her lower status, but rather to changing tastes in tomb architecture at the end of the 5th and beginning of the 6th Dynasty. Labrousse points out that at least four late 5th Dynasty queens – Nubnebti, Meresankh IV, and two wives of Unas: Nebet I and Khenout – are known to have been buried in mastabas. Furthermore, a mastaba of a queen Khuit was excavated by Mariette (1889: 207) north of the funerary complex of Djoser in Saqqara, and it is possible that this tomb was the one initially built for the Queen Khuit later buried in a pyramid in the Teti cemetery (Labrousse 1994; Jánosi 1996: 42-43). Thus, Labrousse suggests that the mastaba was the proper form for a queen's funerary monument at the end of the 5th Dynasty, but when the beginning of the 6th Dynasty saw a return to the pyramidal form, Queen Khuit abandoned her mastaba further west in favor of a pyramid closer to her husband, while Queen Iput's son had her mastaba converted to a pyramid (Labrousse 1994). This would also suggest that Queen Iput was indeed, as the previous general view held, the principal queen of Teti, with a favored location close to her husband's pyramid that did not become available to Queen Khuit until after her rival's death.

Jánosi (1996: 41-44) takes this argument even further by suggesting that the monument of Queen Khuit is not in fact a pyramid, but should be reconstructed as a mastaba. He also suggests that the somewhat awkwardly positioned mastaba of the vizier Khentika, who served under both Teti and Pepy I and was likely buried early in the reign of Pepy I in a tomb just south of the complexes of Iput and Khuit at the northeastern corner of Teti's pyramid complex was usurped and originally belonged to queen Khent.t [...], who he believes was the mother of Userkare. Jánosi reconstructs the tombs of Khent.t [...] and Khuit as a double mastaba, with the freestanding mastaba of Queen Iput just to the north (Jánosi 1996: 44). This would lend support to the view that Userkare was indeed an usurper who incurred his successor's wrath to the extent that Pepy I razed the superstructure of Userkare's mother's tomb and allowed his vizier to incorporate parts of it into his own mastaba.

However, recent excavations have cast doubt on the above interpretations. As mentioned above, we now know that the tomb of Queen Khuit was indeed a pyramid (Hawass 2011), and that it thus could not have been part of a double mastaba as Jánosi suggests. The recent excavations may also explain the discrepancy in tomb form between Queen Khuit and Queen Iput – namely through the discovery of the tomb of the king's son Tetiankh-kem. Hawass (2000) points out that none of the 5th Dynasty queens who were buried in mastabas had produced an heir to the throne. If Tetiankh-kem was indeed the intended successor to Teti and Queen Khuit was his mother, this would explain why she was awarded a pyramid, while Queen Iput had to be content with a mastaba until her son Pepy I upgraded her tomb later in his reign. It is of course still possible that the mastaba excavated by Mariette further west was an earlier tomb of Queen Khuit's, built before she had born a son to secure the succession, but it seems unlikely, given that the tomb in question is located at some distance from the cemetery dedicated to the royal

family under Teti. That the tomb of Khentika incorporated parts of an earlier funerary monument seems fairly certain (James 1953: 16-20). However, there were no original inscriptions left in the re-used portion of Khentika's mastaba, so whether or not it initially belonged to a queen remains unknown.

Recent Excavations in the Teti Pyramid Cemetery

The excavations in the Teti pyramid area by the MSA have been ongoing since 1992, adding greatly to our knowledge of the cemetery and the history of the royal family. In 2006, the excavation area was expanded to include a zone to the east of the Anubeion wall (Fig. 1).

This mission was carried out under the supervision of Zahi Hawas and Hakim Karar, and is still ongoing, although the most recent seasons have been aimed at analysis of the excavated material rather than fieldwork. Initial exploration revealed an extensive post-Old Kingdom cemetery of more than 370 non-elite burials, ranging in date from the Middle Kingdom to the Roman period, some of which were coffin burials still *in situ*, and some that had been disturbed. As the main goal of the excavation was to reach the Old Kingdom structures below the later cemetery, the burials were systematically removed in stratigraphic sequence until the northern edge of what would prove to be the new pyramid was revealed (Hawass 2011). This pyramid is comparable in size to those of Khuit and Iput, with a 22 m side (*Ibidem* 2000; 2011). At the time of excavation, six steps were preserved to a height of 4.5 m, although the pyramid originally probably stood

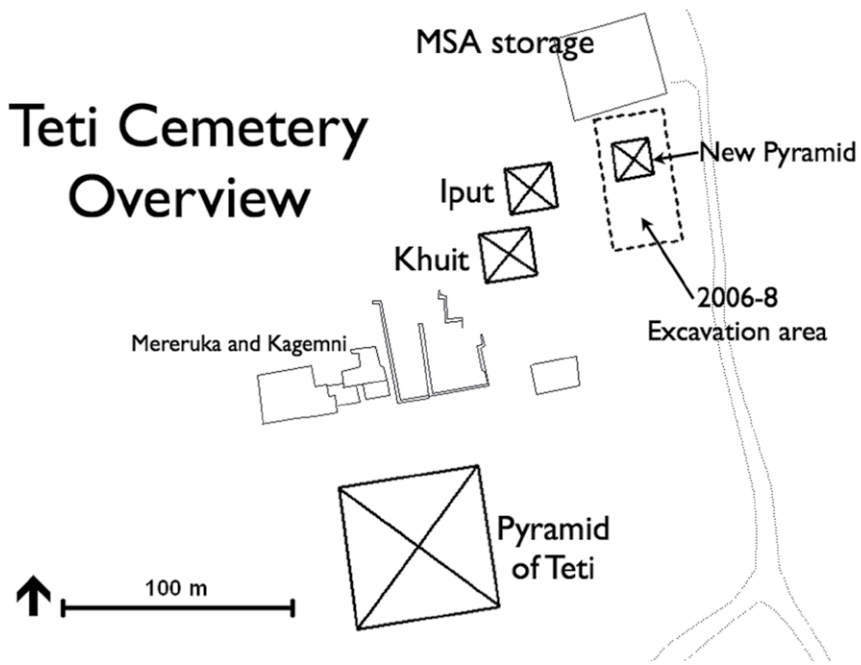

Fig. 1. Map of the excavated area and the Teti cemetery (map: J. Kaiser)

about 15 m tall (Fig. 2). It was surrounded by a limestone enclosure wall, which has not yet been completely excavated. The original entrance was on the north side, from which a descending passage, still blocked by several large slabs of granite, led to the substructure of the pyramid. Through the center of the superstructure a robber's shaft had been cut, which allowed access to the underground burial chamber of the pyramid, where a pink granite sarcophagus was still found *in situ* along the west wall of the chamber, albeit with the lid slightly pushed to the side by the tomb robbers (*Ibidem* 2011). The sarcophagus was completely plain and without inscriptions, but with a vaulted lid. This sarcophagus type was common throughout the Old Kingdom (Ikram and Dodson 1998: 245-246). The walls of the burial chamber along with most of the remaining substructure had been lined with fine Tura limestone. Though most of the limestone blocks had been robbed, enough remained to ascertain that the sarcophagus must have been lowered in place before the walls of the burial chamber were lined, as the narrow space surrounding the sarcophagus would not have allowed for the walls to be finished otherwise. To the east of the burial chamber a secondary chamber or serdab was located. Two limestone rubble walls in this chamber dating to the Late Roman period suggest that the serdab was re-used at that time. Furthermore, pottery and other material from the New Kingdom, Ptolemaic and Roman periods found in other areas of the complex suggest that it had been looted more than once. In addition to removing the blocks from the interior of the pyramid, the casing blocks, originally cut from fine white Tura limestone and polished, had also largely been taken, though exactly when this happened is difficult to determine. Perhaps

Fig. 2. The new pyramid during excavation. View from the northeast, towards the Teti pyramid, which is visible in the background (photo: W. Saleh).

not surprisingly, considering the extensive looting and damage to the pyramid, no inscriptions, reliefs or cartouches that could have hinted to the identity of the monument's owner have been found (Hawass 2011). Unfortunately, time has not allowed for further explorations to the east of the pyramid, where the associated mortuary temple, should one exist, could be expected and which may contain the name of the deceased. However, the architectural features of the pyramid proper are similar to other subsidiary pyramids of the 6th Dynasty, such as the pyramids of the queens Nubwenet and Inenek-Inti, queens of Pepy I (Jánosi 1996: 45-46; Verner 2001: 356-358), as well as to the pyramid of Queen Khuit (Hawass 2000; 2011). This and the fact that it is located in the sector of the Teti cemetery generally reserved for the king's consorts (Kanawati 2003: 139), suggest that the new pyramid belongs to one of Teti's queens – but which one?

The Skeletal Remains from the New Pyramid

Inside the simple granite sarcophagus in the burial chamber was the skeleton of the pyramid's original owner. Though the grave robbers had been able to open the sarcophagus and disturb the body, most skeletal elements were still present. The individual had been interred in an extended position, oriented north-south, with the left hand on the pelvis, and the right hand extended along the side of the body. The cranial bones and upper limbs had been disturbed, and were not fully articulated. The skull was broken into pieces but present. The pelvic bones and the lower limbs were *in situ*. Some soft tissue was preserved, and a dark material adhering to some of the bones suggests that the body was originally mummified. Four golden finger stalls were associated with the skeleton, one still on one of the fingers.

Age and sex assessment were carried out using standard osteological methods, largely following the recommendations of the Standards for Data Collection from Human Skeletal Remains (Buikstra and Ubelaker 1994). Pelvic morphology indicated a female, with a wide sciatic notch and sub-pubic angle, and pronounced sub-pubic concavity (*Ibidem*: 16-18). A prominent pre-auricular sulcus was also present, possibly indicating that the individual had given birth (Braz 2008). Cranial features such as a small glabella, nuchal crest and mastoid process and a gracile, rounded forehead with sharp supraorbital margins were also consistent with a female (Buikstra and Ubelaker 1994: 20-21).

Indicators of age all pointed to a young individual. Though the third molars had erupted, there was no occlusal wear on the second and third molars, and only slight enamel wear on the first molar, definitely suggesting an age of less than 25 years (Brothwell 1981: 72), and probably more likely between 16 and 20 years (Lovejoy 1985). The partially open iliac crest and ischial epiphyses were also consistent with this age range, as fusion of these skeletal elements generally takes place between 16 and 23 and 17 and 25 years, respectively (Brothwell 1981: 66; White *et al.* 2012: 395). The auricular surface indicated an individual between 20 to 24 years (Lovejoy *et al.* 1985), while the pubic symphysis suggested an individual between 15 to 24 years of age (Brooks and Suchey 1990). Taken together, the

skeletal indicators of age and sex thus point to a female in her late teens to early twenties, between 18 to 23 years of age.

The bones were generally slim and gracile, with small muscle attachments, perhaps reflecting a fairly sedentary lifestyle with little manual labor (Larsen 1997: 196; Ruff *et al.* 2006). Two non-metric traits were present: a Carabelli's cusp (Lauc 2003) on the upper left first molar, and bilateral fossa olecranon perforatio on the distal humeri (Tyrell 2000). In addition, the maxillary arc was unusually narrow. No cause of death could be determined, but the young woman was not in perfect health at the time of her death. Active cribra orbitalia (pitting of the orbital roof) and bilateral porotic hyperostosis (porosity of the cranial vault bones) on the parietals (Fig. 3), indicate she was under some form of systemic stress at the time of her death (Walker *et al.* 2009). In addition, she suffered from a dental abscess below her left lateral mandibular incisor, most likely causing some pain. Finally, the right frontal bone showed evidence of a possible blow to the head or fall, in the form of an area with bone necrosis surrounded by a zone of hypervascularity (Fig. 4). This type of lesion can occur when blood flow is interrupted following trauma (Ortner 2003: 129-130, figs. 8-16-8-18). However, as the bone was not fractured, the injury was likely not fatal.

Who is Buried in the New Pyramid?

When the new pyramid was initially discovered, it was suggested that it belonged to Queen Sesheshet, a logical conclusion based on the pyramid's architectural configuration and location (Hawass 2011). However, since Hawass' 2011 article reporting the discovery, the anthropological investigation of the remains found in the burial chamber has been completed, and the results suggest that Queen Sesheshet may be a less than likely candidate.

The main argument against Queen Sesheshet as the pyramid's owner is the youth of the woman found inside and the fact that the tomb was built during the later phases of cemetery's use, after the mastaba of Tetiankh-kem, but before the reconfiguration of Queen Iput's mastaba into a pyramid (Hawass 2011). If Tetiankh-kem was indeed the oldest son of the king but predeceased his father at the age of 20 to 25, Teti must have been at least 35 to 40 years old at the time of his own demise. Even with the higher estimate of a 23- year reign, Teti would then have been 12 to 17 years old at minimum when he took the throne, and as old as 22 to 27 years if the more conservative estimate of a 13-year reign is considered (Baud 2006). If the 18 to 23 year old female buried in the new pyramid is indeed Teti's mother, she must have died when Teti was very young – between 3 to 8 years of age assuming she was at least 15 when she gave birth – and certainly well before he became king. It is of course not impossible that Teti would have moved his mother's body from a more modest tomb to a pyramid after he rose to power. But why would the king have orchestrated this move so late in his reign? Taking into account the young age of the woman found in the new pyramid, the time of its construction after the mastaba of Tetiankh-kem, and the age of the king at that time, we are faced with a gap in time of 27 to 32 years between the death of the

Fig. 3A) Cribra orbitalia in right orbital roof of the queen; B) Porotic hyperostosis on the right parietal (photos: A. Wahba).

Fig. 4. Frontal bone of the queen; showing area of increased hypervascularization on the right frontal bone consistent with a blow to the head or fall. (photo: A. Wahba).

king's mother and her subsequent reburial in a pyramid, should the remains in the new pyramid be those of Queen Sesheshet. In addition, there would have been a gap of several years – perhaps as much as 24 years if the shorter reign is considered – between the death of the king's mother and his ascent to the throne if he had lost her while still a child. Moreover, if Teti himself indeed was not of royal blood, this would mean that Sesheshet would have become queen only posthumously, and would not have been a member of the royal family during her lifetime. This scenario seems unlikely, however, given the fairly numerous references to a Queen Sesheshet as the mother of a king. Finally, the reference in the Ebers papyrus (66, 16) to a queen "Sesh", mother of king Teti, seeking a remedy for baldness most likely refers to Queen Sesheshet as well (Ebers 1874; Yoyotte 1957; Seipel 1980: 228; Callender 2011: 210-211), and is suggestive of a woman who lived a fairly long life, rendering Queen Sesheshet an unlikely candidate for the identity of the young woman buried in the new pyramid.

In the 5th and 6th dynasties, pyramids appear to have been granted only to those royal consorts who produced a crown prince (Callender 1992: 210-211). Accordingly, the fact that Queen Khuit received a pyramid in the Teti cemetery while Queen Iput was provided a mere mastaba indicates that Tetiankh-kem was the intended heir to the throne. As the crown prince, it seems unlikely that he would have started the construction of a mastaba for himself in the cemetery of his father; the expected course of action would have been the establishment of his own pyramid cemetery after he ascended the throne. The small size and simple layout of the mastaba of Tetiankh-kem, as well as its somewhat awkward position in the area of the cemetery otherwise reserved for queens (Kanawati 2003) all suggest

that Tetiankh-kem's death was premature and unexpected. That the actual mother of the future king, Queen Iput, was buried in a mastaba rather than a pyramid is easily explained, as Pepy I was not the expected heir at the time the queens' tombs were built. Tetiankh-kem's tomb was also erected after the completion of the tomb of Queen Iput (Hawass 2000), perhaps suggesting that she was already dead at the time it was built.

The next event in this part of the cemetery was the construction of the new pyramid. As discussed, the pyramidal form of the monument suggests that it was built for a queen who had provided an heir to the throne. Interestingly, this implies that a third heir to the throne emerged after the death of Tetiankh-kem, presumably a son of Teti by the queen for which the new pyramid was intended. Moreover, the construction of an additional subsidiary pyramid in the Teti cemetery after the death of Tetiankh-kem but before the upgrade of Queen Iput's mastaba may also suggest that this heir was either ahead of Pepy Meryre in succession, or that he outmaneuvered him and usurped the throne. If Queen Iput was indeed already dead, this may not have been that difficult, considering what must have been the fairly young age of the future king (Kanawati 2003: 4). Given that he was the immediate successor of King Teti, the most likely candidate for this third heir to the throne appears to be Userkare.

Of the three additional possible queens of Teti, Hetepheres, Tieti and Khent.t [...], only the latter seems a viable contender for the new pyramid. The block mentioning her name, found in the foundation of Pepy I's mortuary temple in South Saqqara, also bore her title *mwt nswt bjtj*, suggesting that she was the mother of a king, most likely Userkare (Seipel 1980: 245-246; Callender 1992: 141; Jánosi 1996: 41-44). Moreover, the "*bjtj*" addition to her title also suggests that her son may not have been the self-evident heir to the throne. As mentioned above, the same queen may also have been the original owner of a razed mastaba south of Queen Khuit's pyramid incorporated into the tomb of the vizier Khentika during the reign of Pepy I. Though the theory that this mastaba was originally one half of a double mastaba constructed for Khent.t [...] and Queen Khuit has been disproven in light of the completed excavation of Queen Khuit's pyramid, it is still possible that it was the original tomb of Khent.t [...], and that the planned configuration of this part of the cemetery was a pyramid for the mother of the crown prince, Queen Khuit, flanked by mastabas of the two queens who bore sons that were not expected to inherit the throne, Khent.t [...] and Iput.

We can perchance speculate that following the death of Tetiankh-kem and King Teti – possibly in swift succession – the son of Khent.t.[…], likely Userkare, seized the throne, either by virtue of being the oldest remaining son, or because he (or his mother) managed to outmaneuver Pepy Meryre, who was probably still a child, and who may already had lost his mother. During the brief reign of Userkare, either the king himself or his mother decided to abandon the original mastaba built for Khent.t […] in favor of the construction of a new pyramid, fit for a queen mother, in which Khent.t [...] was eventually interred. When Pepy I subsequently became king, he may have resented both Userkare and his mother Khent.t. […], and set out to destroy their monuments. This would explain how the block of

Khent.t [...] ended up in the foundation of Pepy I's mortuary temple, the absence of a tomb for Userkare, and the lack of references to Userkare in the tombs of the officials serving under both his predecessor and successor, despite the fact that his reign is attested in both the Abydos and Turin King Lists. With the memory of his offending relatives thus destroyed, Pepy I then proceeded to convert his own mother's tomb into a pyramid, perhaps as a propagandistic measure around the time of his first Sed festival.

Though the above scenario would tie the various strands of evidence together rather nicely, and in addition somewhat ameliorate the view of Userkare as an outside usurper, it should of course be noted that in the absence of any titles or names associated with the new pyramid it remains pure speculation. Furthermore, the argument against Queen Sesheshet as the owner of the new pyramid based on the young age of the female in the burial chamber also applies to Queen Khent.t [...]. If the remains from the new pyramid are indeed those of Queen Khent.t [...]. the mother of Userkare, he would have been either exceedingly young when he inherited the throne with the help of his mother, who in that scenario would have been scarcely more than a child herself, or he would have been orphaned before he became king, and would have had to move his mother's body posthumously in order to provide her with a pyramid fit for a queen mother. Nevertheless, given the references to Queen Sesheshet's thinning hair in the Ebers papyrus and the construction of the new pyramid towards the very end of King Teti's reign, or perhaps even after his death, Queen Khent.t [...] appears to be the most likely candidate of the two.

Regardless of the identity of the young woman from the new pyramid, we have gained some valuable information from her remains in terms of the life of a royal woman in the 6th Dynasty. Her bones tell us that she probably led a fairly sedentary life, and that she was under some kind of systemic stress when she died, perhaps contributing to her early demise. Possible culprits for the stress lesions on her bones could be nutritional deficiencies, anemia, or parasitic infection (Walker *et al.* 2009), suggesting that not even the highest echelons of society were immune to the effects of poor diet or unsanitary conditions. In addition, she was also the victim of either an assault or a fall fairly close to the time of her death and serious enough to leave marks on her bones. Though the blow to her head was not fatal, it may have contributed to her death, and further may reflect the perhaps tumultuous times for the royal family during her brief life, whoever she was. Though the anthropological investigation could not conclusively inform on her identity, her young age, also gleaned from her skeleton, helped in narrowing the number of contenders. Hopefully, future excavations to the east of the pyramid will unearth an associated temple with preserved reliefs that can put a name to her bones.

"Behind Every Mask There is a Face, and Behind That a Story". Egyptian Bioarchaeology and Ancient Identities

Sonia Zakrzewski

What is Identity? And How Does It Relate to Bioarchaeology?

Bioarchaeology is more than "just" the study of the biological aspects of archaeology. It is more than "just" paleopathology, although this is frequently how the wider community views osteoarchaeology or bioarchaeology (Perry 2007). Bioarchaeology is the study of people who lived in the past, carried out using archaeology, but with a framework situated within, and developed from, biological methods. The key word is "people" as it is the people, or more specifically the individuals themselves, who are too often forgotten, or "lost", in the broader whole.

In contrast to Marty Rubin, the blogger and aphorist, who argues that each person has a story, for bioarchaeologists, each individual has multiple stories. Whether skeletonised or mummified, each body or burial has many stories, told or written in varying degrees of detail. These multiple stories exist as aspects of multiple identities, not only layered one on top of another, but also intercutting and transecting each other. Archaeological studies of identity have frequently comprised analyses of gender (e.g. Walde and Willows 1991; Díaz-Andreu 2005; Sofaer 2006), age (e.g. Moore and Scott 1997; Lucy 2005a; Sofaer 2006), personhood (e.g. Fowler 2004), rank or social status (e.g. Wason 1994; Babić 2005), sexuality (e.g. Schmidt and Voss 2000; Dowson 2008), ethnicity (e.g. Jones 1997; Lucy 2005b; Zakrzewski 2011) and/or disability (e.g. Hubert 2000a; 2000b). Archaeologically, these multiple strands of identity have recently begun to be brought together to form cohesive entities (Meskell 2001). Despite some notable exceptions, such as specific papers in Lucas Powell *et al.* (1991), Grauer and Stuart-Macadam (1998), Steckel and Rose (2002), Gowland and Knüsel (2006) and Knudson and Stojanowski (2009), these multiple aspects of identity have rarely been integrated within bioarchaeology.

This paper will argue that bioarchaeology and funerary archaeology can act as the mechanisms to synthesize these different categories in concert to form overarching identities. Such categories are fluid and dynamic rather than discrete, but are also relational in that their recognition will depend upon personal, individual viewpoints. Even aspects that are frequently considered completely

biological, such as circulating estrogen levels, also have individual, and hence social, variation; for example, a 60+ year-old male may have higher estrogen levels than an equivalently aged (i.e. post-menopausal) female (Greendale *et al.* 1997) despite estrogens being the primary female sex hormones. These biological factors thus need to be integrated into the broader archaeology in order to develop more nuanced interpretations.

At the Ptolemaic-Roman delta cemetery of Quesna, most individuals were interred in simple pit graves excavated directly into the sand (for details, see Rowland 2008; Rowland *et al.* 2010). The orientation of the burials varies, with twenty-one individuals oriented east-west, most with their heads towards the west, and eight buried norht-south, most with their heads to the north. In addition, there are individuals buried within multiple burials, sometimes with several individuals buried in one depositional activity, whereas others are buried in distinct and discrete burial events. Still others are buried in ceramic coffins. This diversity of mortuary treatment hints at differing aspects of identity being recognized and acted upon by the burying (surviving, living) population. It is imperative that this diversity is recognized throughout the archaeology, and that this is articulated in discussions regarding the individuals buried within the cemetery. The following sections use examples to demonstrate how this approach might be taken.

Demography

Within studies of identity, aspects of age and gender are usually considered to be relatively socially oriented. Gender, as distinct from sex, is well studied (e.g. Sweeney 2011), but the social aspects of age, other than those distinguishing childhood (Sofaer Derevenski 1997), are less broadly known (Moore and Scott 1997; Gowland 2006; Sofaer 2006). In studies of age, focus has generally been on improving the accuracy and precision of biological age estimation techniques for skeletal material, rather than on forming a nuanced approach to social aspects of age. Where such a life-course approach has been undertaken, individual biographies rather than distinct and discrete age categories have generally been developed. Of the sample of burials excavated from Quesna, less than half the adults excavated could be assigned into even broad age categories, such as young adult, middle-aged adult or older adult. Most individuals were simply classified as being "adult". But these individuals each had their own distinct life experiences. For example, did any of these individuals experience pain, such as from arthritis? Can we link their biological age, simply "adult", to their funerary contexts so as to gauge their relative social age within the assemblage?

The bioarchaeology of children has developed in Egyptian contexts (e.g. Power 2012; Wheeler 2009; 2012; Wheeler *et al.* 2013), but the link between childhood and children's identities is still not frequently contextualized. At what biological or skeletal age are children socialized into being "people"? Is there a recognized social period of childhood, and can this be identified from the mortuary bioarchaeology? This is a development of the life-course approach, focusing on the process and

experience of childhood rather than seeing absolute ageing as being the endpoint of bioarchaeological studies.

One burial from Quesna is of particular interest with regard to the life-course approach and age. The inhumation recorded as Burial B6 from Grave 1005, the best preserved of all the burials, is that of an old female (Rowland 2008). She was relatively short in stature (approximately 142 cm), edentulous, and experienced both osteoporosis and osteoarthritis. The very fact that she survived so long, despite her lack of teeth and skeletal lesions, suggests that she was a "cared for", and indeed valued, member of the community. She was thus a "person", probably even an "older woman" or "old lady", rather than simply an individual. One might also argue that she "lived" rather than simply "survived".

Ethnicity

Social identity clearly includes aspects of ethnicity. Recognizing ethnicity requires the identification of biological affinities and, although ethnicity clearly cannot be mapped directly onto population affinity from such concepts of affinity and affiliation, ethnic groupings may be hypothesized. This view of ethnicity is distinct from "race" or variation in skin colouration. Ethnicity is fluid and dynamic, whereas the traditional view of "race" has been of fixed and discrete entities. Race is thus a modern social construct. Within the folk concept of race, the traits usually used to distinguish races depend upon external and observable features such as skin colour, leading to a dichotomous concept of race, usually focusing on Black and White (Shanklin 1999). Some archaeological studies simply equate race with ethnicity and reify perceived artefact associations, thereby investing the artefacts with a static ethnicity (or race) (Orser 1999).[1]

Early biodistance studies of ancient Egyptians concentrated on the shape of certain anatomical complexes. These complexes, defined by extreme variants as geographic groups, were situated within an anthropological research milieu of fixed "racial types" and entities. For example, Randall-MacIver (1901) and Thomson and Randall-MacIver (1905) used six morphological observations, and concluded that southern Predynastic Egyptians were a hybrid population, consisting of "Negroid" and "non-Negroid" (or "Semitic") elements. They argued that the morphological patterning supported a hypothesis of the juxtaposition of two groups, which they then considered as "racial types". Mid-20th century studies, e.g. such as those of Batrawi (1945; 1946); Fawcett and Lee (1902); Giuffrida-Ruggeri (1915); Morant 1925; 1935; 1937); Risdon (1939); Stoessiger (1927), were primarily metric, but employed some of the same concepts of fixed "types". More recent researchers have employed both metric and non-metric variation to determine patterning resulting from migration and mobility (e.g. Hillson 1978; Keita 1990; Rösing 1990; 1992; Irish 1998; 2000; Zakrzewski 2001; Keita 2004; 2005; Irish 2006; Keita 2006; Zakrzewski 2007a; Keita and Boyce 2008; Irish and Friedman 2010; Zakrzewski and Powell 2011). These studies, more micro-

1 For a biological discussion of the existence or not of biological races, see Cartmill (1998).

evolutionary in framework, acknowledge aspects of fluidity in morphology, and include the archaeological or Egyptological context for interpreting the meaning of the analyses. Such approaches have been developed by Buzon (2006; 2008) and Zakrzewski (2001), using bioarchaeological methods to integrate burial patterning with skeletal morphology.

As noted earlier, ethnicity is very distinct from the popular folk-concept of 'race' with its focus on skin coloration. Ethnicity should rather be viewed as an aspect of social organisation that involves the active maintenance of cultural boundaries through social interaction. Ethnicity is a part of social processes, similar to subsistence, religion, economy, politics, etc (Trigger 1989; Jones 1997; Riggs and Baines 2012), but may be underpinned by some biological patterning. Ethnic groupings have started to be defined as groups that self-consciously unite around particular traditions. Such definitions contrast with the primordial notion of ethnicity, whereby ethnic group membership is given at birth on the basis of blood or kin. As a result, ethnicity exists within the fluid situational nature of group boundaries, with individual identification occurring within a self-defining system (Jones 1997: 64). In this sense,

> *"ethnic groups are culturally ascribed identity groups, which are based on the expression of a real or assumed shared culture and common descent"* (Jones 1997: 84).

This could be considered (as) a relational and malleable approach to the definition of ethnicity, whereby ethnicity intrinsically involves a consciousness of difference. It is this latter understanding of ethnicity that is exemplified at the New Kingdom tombs by the patterning in grave goods, funerary architecture and burial practice (Buzon 2006; 2008). Similarly, from the First Intermediate Period onwards, evidence from steles suggests that Gebelein had a colony of Nubian mercenaries (Zakrzewski 2001). For example, some steles, such as Boston MFA 03.1848 (which specifically calls the individual depicted "Nehesy", the ancient Egyptian name for Nubians (Kendall 1997)) and Leiden F 1938/1.6, suggest that Nubian mercenaries had married Egyptian women (Fischer, 1961). These steles from Gebelein indicate that Nubians lived with, and were buried near the Egyptian community they served, and although they were buried in an Egyptian manner, they were still depicted as Nubian, thus retaining their ethnic identity.

Stature

Body size and shape are important components of identity; the modern fascination with "being thin" and the body beautiful is simply an expression of this impact on modern constructions of identity. How tall were the ancient Egyptians? Can adult height be used as a proxy for social ranking in ancient Egypt? We know that the Egyptians themselves recognized differences in body size and shape between both individuals and groups. Indeed, there were three distinct Egyptian words for abnormally short people, including different types of dwarfs (*dng*, *nmw*, and *ḥwʿ*) (Dasen 1993). Given that completed adult height can be used as a proxy

for disease load, an adult who underwent several periods of prolonged stress in childhood tends to be shorter and smaller than someone who did not. Adult stature is therefore at least a rough indicator of childhood health status.

Adult heights were computed for the skeletally mature individuals recovered from the Quesna cemetery, following Raxter *et al.* (2008). Statistically significant sexual dimorphism was found between the males and females in the sample, with males being on average almost 10% taller than females. This contrasts with the ancient Egyptian norm of men being approximately 6.2% taller than women (Zakrzewski 2003; 2007b). In addition, greater variability was found for computed female statures than for males. Stature and body size, and the sexual dimorphism expressed within them, are important as not only are they effects of childhood health, but are also linked to aspects of gender relations and interactions with social hierarchy and social ranking.

Despite the criticism their methods have attracted (see Gray and Wolfe 1980; Gaulin and Boster, 1985; 1992; Holden and Mace 1999), Alexander *et al.* (1979) reported a significant association between polygyny and sexual dimorphism in stature. Similarly, Kanazawa and Novak (2005) hypothesized that polygyny may increase sexual dimorphism by decreasing female height, since females with earlier menarche tend to be shorter in modern polygynous societies. In addition, natural selection might also constrain minimum female body size so as to maintain reproductive capacity (Stini, 1975; Guégan *et al.* 2000); hence where fertility is high, sexual dimorphism may be low (Guégan *et al.* 2000). Given that growth is highly sensitive to "biocultural factors" such as social, nutritional, economic and health conditions (Eveleth and Tanner 1990; Steckel 1995; Bogin 1999; Steckel 2009), these factors may lead to sexual dimorphism if males and females are differentially affected. Furthermore, males may have been more sensitive than females to these growth stressors (e.g. Hiernaux and Boedhi Hartono 1980; Eveleth and Tanner 1990; Ortner 1998; Jantz and Jantz 1999; Zakrzewski 2003; 2007; Steckel 2009), implying that populations under environmental stress may exhibit lower sexual dimorphism. However, recent research has suggested that these patterns of sex-specific environmental sensitivity may be confounded by cultural behaviours (e.g. Silventoinen *et al.* 2001; Leonard *et al.* 2002; Dangour *et al.* 2003). Finally, differential investment and treatment along gender lines may also lead to sex differences in growth and hence sexual dimorphism, but again the evidence supporting such hypotheses is variable (Holden and Mace 1999).

The arguments presented above suggest that the high level of sexual dimorphism in the Quesna skeletal assemblage may have underlying and potentially interlinking causes. These may affect the social structure and organisation of the local population, and as such should be considered in discussions of the site and the living people. The Quesna population may have treated boys and girls differently or there may have had some polygynous nature to their social organisation.

(Dis)Ability and Paleopathology

Paleopathology and the assessment of disability are what are commonly assumed to be the primary purposes of skeletal studies. Paleopathology is relatively easy to understand, being the study of diseases and their processes in the past, but disability is rather harder to define. Disability is an umbrella term, covering impairment, activity limitation, and restrictions on participation (World Health Organisation [WHO], no date), (and) so disability or disabilities may appear sporadically, and sometimes chronically, throughout a person's lifetime.

Disability is constructed in terms of medical reductionism within the medical community but as a social phenomenon by social scientists (Thomas 2007). Adopting this latter approach, Oliver (1983) argued that disability is not caused by impairment, but rather from social restrictions placed upon individuals with bodily impairment. This social deviance focus comprises aspects of both the impaired body and the lived experience. Following this argument, disability is simply a form of limited activity; hence a disabled person is one who has some condition that prevents him/her from carrying out the full "normal" range of activities associated with a given age (Thomas 2007). Disability is therefore an age-related and universal phenomenon, with an emphasis on living with "illness". In addition, focus is placed on the changed circumstances of significant others within the local society. Disability is also considered a state of social liminality, whereby the individual is excluded from ordinary life and is therefore denied the full expression of "being human" (Murphy 1990). This construction of disability is built on both human perception and "being" as embodied phenomena, with meaning residing in the body and the body itself residing in the world (Merleau-Ponty 1962). Consequently, there is a fluid boundary between disabled and able-bodied, and identity, especially self-identity and ascribed identity, has paramount significance. Furthermore, the perceived impaired body may also be socially constructed. Following this approach, the embodied "difference" may comprise the so-called "impairment" with the external reaction to the impairment being the so-called "disability" (Tremain 2002). This socially constructed view of disability permits being "disabled" to be viewed as simply a point upon a continuum of ability rather than as a binary opposition to able-bodied. Bioarchaeology interacts both with all the above approaches to disability, and also their impact on understanding the interplay of the multiple identities upon the person.

The broad nature of some of the WHO terms, such as "restriction on participation", means that disability is a complex series of phenomena that reflect the interaction between the person and the local society (Zakrzewski in press). During certain periods of life a person may experience temporary restrictions on activities, for example, as a result of pregnancy impinging on mobility through symphysis pubis dysfunction. Following childbirth, the woman is likely to return to full mobility and therefore no longer has this form of disability, but may have some limitations on activity resulting from lactation or the care of a young infant. Similarly, following a severe injury causing long bone fracture, the limb requires stabilisation and hence a reduction in mobility. As a result, the activity patterning and use of that person's limb changes. This affects the entire community

surrounding and supporting that person. The way in which the society treats such changes in activity patterning are thus of importance for understanding the nature of the relationship between society and disability. It is for this reason that we should, perhaps, think in terms of a continuum of ability, with individuals moving backwards and forwards along it at differing life stages. As a result, any person may become disabled at some point in their life, and yet disabled people and disability have often been overlooked archaeologically or considered "hidden from view" (see Waldron 2000). These disabilities may be permanent or temporary, and may contribute to social exclusion and/or the concept of "difference" (Zakrzewski in press). Indeed, although Egypt seems to have been relatively accepting towards individuals considered (as) "different" or "other" (Jeffreys and Tait 2000),

> *"What is perceived as a 'disability' or as 'madness' in one society, in another may be considered as just one attribute among many which make up an individual, or may not be perceived as part of the individual at all"* (Waldron 2000: 7).

Unlike in Roman or Greek art, disabilities are relatively well represented in Egyptian art, with achondroplasia probably the most common. Considering dwarfing to be a disability is potentially an oxymoron, as neither dwarfism nor small stature need lead to any reduction in ability to undertake activities (Zakrzewski in press). As noted earlier, it is clear, however, that Egyptians did recognise dwarfing and abnormally short stature, as there were three distinct Egyptian words for such people, and the use of these words would usually be accompanied by a determinative depicting a disproportionate dwarf (Dasen 1993). It is therefore clear that individuals of abnormally short stature were considered different from "normal" people (for detail see Weeks 1970; Iversen 1975; Dasen 1993; Robins 1994), and some of these people were of high social ranking. For example, the 4th Dynasty dwarf Perniankhu, buried in the western cemetery at Giza (Wilkinson 2007), is depicted with symbols of authority such as a sceptre and a long staff (Hawass 1991; Wilkinson 2007). Indeed, dwarfing may have been valued as some form of divine marking (Dasen 1993), such as association with solar deities and use in cult dances (Baines 1992). Dwarves thus appear to have been viewed positively within Egyptian society (Sullivan 2001), and potentially able-bodied, although "other".

Although Egyptian artistic representation focused on the body as an entity, with each portion having its idealised or typical form (Robins 1994), and individual and personal traits potentially being downplayed or avoided (Iversen 1975), there are depictions that may represent some form of "disability" or disease process. Examples include the gardener from the tomb of Ipuy at Beni Hasan (Metropolitan Museum of Art, New York 30.4.115) and Roma's withered right leg on his New Kingdom funerary stela (Ny Carlsberg Glyptotek, Copenhagen AIN 134). The deformities illustrated by the first example are usually thought to be a representation of kyphosis resulting from Pott's disease (Reeves 1992; Filer 1995; Halioua and Ziskind 2005; Ziskind and Halioua 2007), although other putative causes have been suggested (Nunn 1996). Both congenital deformity (talipes equinus) and poliomyelitis have been suggested for Roma (Filer 1995; Nunn 1996; Halioua and

Ziskind 2005). The latter stela is of particular importance, since Roma is shown using his staff as a crutch rather than as a symbol of status and rank (Jeffreys and Tait 2000). However, in most artistic representations, physical impairments are only shown for relatively minor individuals (Dasen 1993), implying that either the physical manifestations were not considered to be part of the primary individual's persona or that only the body beautiful should be depicted.

There are aspects of disablement that can be identified from the artistic record that may not be recognised archaeologically, such as impairments to hearing or sight. Although some blindness may originate in features that leave a skeletal marker, such as blindness as a result of tumour or trauma to the optic area, most blindness is not recognisable from the bioarchaeological record. However, examples such as the potentially blind harpist from the New Kingdom tomb of Nakht at Thebes or Raia, the Ramesside chief of singers from the temple of Ptah at Memphis (Wilkinson 2007) indicate that blindness was considered of note, and it may even potentially have represented piety (Dasen 1993). Since Raia was depicted blind when playing music for his patron deities, but sighted or at least with his eyes open in other representations (*Ibidem*) suggests a duality to his social persona.[2] Given this expression of multiple identities and the frequent association of dwarfs with both malformed and/or "exotic" peoples, people with "handicaps" or "disability" may have been considered to be liminal (*Ibidem*). This argument also supports the hypothesis that multiple identities were recognised by the ancient Egyptians, and that specific aspects of identity were voiced within the material culture.

Ageing, Congenitalness and "Disability"

Advancing age frequently leads to a reduction in mobility and movement, commonly associated with the onset of arthritis and arthritis-like disorders. Without modern medicine, such reductions in mobility are likely to have been even more common and potentially more painful than are currently experienced. This would imply greater visibility within Egyptian society of individuals with reduced mobility as a result of the ageing process. This might also lead to a different understanding of disability and a potentially wider recognition of age-related reductions in mobility and ability. Overall, such a view would treat the elderly as simply being located differently on, or moving along, the continuum of ability. Following Tremain (2002), this idea may be developed so that importance is placed on considering whether the individual was in pain. This approach to disability mirrors that taken by social scientists in viewing (dis)ability as simply being one aspect of the life-course and one aspect of an individual's identity. It is clear from Egyptian texts, such as the "Instruction of Amenemope" (which includes commands such as "Do

2 There is also the idea that these performers merely had their eyes shut and were not, as a rule, blind. Indeed, in Egypt and many other countries even today musical performers shut their eyes to better hear the music. It might, in some case, be an iconographic topos (eds.).

not laugh at a blind man, Nor tease a dwarf, Nor cause hardship for the lame."), that tolerance towards people with disabilities was recommended. This has been described as

> *"a more generous attitude towards some disabilities"* (Quarmby 2011: 25).

However, questions remain in terms of which disabled people, or "others", were deemed respectable and/or viewed as "Egyptian people". It is possible that those physical changes associated with the "normal" ageing process were considered valid and permitted individuals to retain their identities, whereas those that were congenital, such as dwarfing, might have led to the social demarcation of the person as "other" or "different", but still very definitely Egyptian.

Two burials from Quesna are of particular note in this regard: burials B21 and B26. Despite their differing funerary contexts, these two individuals share certain similarities and both were clearly considered to be of some importance in the local community.

B26 was the uppermost extended supine burial in a mud-brick burial structure with five other inhumations (Rowland 2008). It was found missing its skull, potentially as a result of grave robbing. This person was very tall, with unfused epiphyses (such as both humeral heads, distal radial epiphyses). The only fused bones were the neural arches of the vertebrae and the innominates; all sacral bodies, heads of ribs, spinous processes and endplates of vertebrae were unfused. Based on the morphology of the pubic symphysis, using the Suchey-Brooks method (Brooks and Suchey 1990), the individual was estimated to have been 15-24 years old at death. However, it possesses numerous epiphyses, which should, by this age, either have fused or have started to fuse together. Given the length and relative robustness of the long bones, the individual was assumed to be male. Based on this assumption, stature was estimated to be approximately 1.7 m (following Raxter *et al.* 2008). Two objects were found in the grave fill, a Ptolemaic pot sherd and a sherd incised with a wedjat eye (Rowland 2008).

B21 was found in grave 1019, a single inhumation in a simple pit grave, cut directly into the sand. Unlike most other burials from Quesna, the extended supine skeleton of a subadult of indeterminate sex was oriented north-south (Rowland 2008). The body was missing most of the skull, and the part that was recovered was badly damaged, probably as a result of grave robbing activity. In contrast to B26, where the arms were found crossed right over left, the arms of B21 were placed alongside the body. However, like B26, this individual had completely unfused epiphyses. Based upon pubis symphysis morphology, age was estimated as 15-24 years (Brooks and Suchey 1990). The dental wear and development was also assessed as approximately similar (Brothwell 1981; AlQahtani *et al.* 2010). Like B26, the individual had many epiphyses, such as the heads of the metacarpals, metatarsals and the proximal phalanges, that should, by this age, have either fused or have been in the process of fusing. The long bones were also relatively long, leading to a stature estimate of almost 1.6 m if female and almost 1.65 m if male (following Raxter *et al.* 2008). This person was found in association with a variety of grave goods, including a Hathor plaque, a winged bird collar, a large scarab,

several small scarabs, a Djed pillar and a variety of other amulets, plaques and pieces of cartonnage (Rowland 2008).

Both burials were of unusually tall subadults. Both were of individuals who were still growing at time of death, for which there may have been a number of different causes, but the differential diagnosis is not of import to the argument here. What is noteworthy is that each of these individuals was afforded a non-normal burial, but one that suggests that the person was considered important and a valid "person" to the community. It follows that the local population recognised these two people as being "different" in some way, but that this was simply one part of their multiple identities. This implication thus links to emic constructions of "otherness" (Hubert 2000) and constructions of identity as recognized bioarchaeologically (Perry 2007; Knudson and Stojanowski 2008).

Multiple Masks, Multiple Faces, Multiple Stories, Multiple Identities

This paper has attempted to demonstrate how bioarchaeology can act as more than simply a catalogue of burials and of paleopathology. Many bioarchaeological studies, when they have considered identity, have primarily been single-issue studies (Meskell 2001), usually focusing on aspects of health or disease. Bioarchaeology should consider how the skeletal or mummified evidence for disease or trauma, or population affinity etc., may actually have an impact on both the individual person and on his/her peers. Thus bioarchaeology should interact with more traditional aspects of archaeology and Egyptology. Hawkes' (1954) ladder of inference, better described by Gamble (2007: 89-90) as an "onion of inference", can be employed as an analogy. Each layer of understanding of the person is a mask (or a burial wrapping) that must be removed to lead to the inferences underneath.

I have argued that, as already espoused in some Egyptian projects such as Amarna, Dakhleh Oasis or Abydos, bioarchaeology can be more than is often recognized externally; it involves unwrapping several layers of interpretation. After standard initial studies of burial archaeology and archeothanatology, age, sex, paleopathology etc., one might hope to explore evaluations of emic understandings of social personhood, health, disease and dis/ability etc. This involves recognising the multiple aspects of identity that are bound together in constructions of self and other. A suitable mechanism by which to proceed might be to develop multiple osteobiographies, and use these in association with more traditional population- or sample-based approaches. For each person there is an individual biography, and hence a parallel osteobiography. Each of these will reflect, to differing extents, aspects of the individual's identities. Each person thus has multiple stories behind an external mask and imprinted upon the body, which reflect these multiple and interlinking facets to the personal and social identity of the individual.

Best practice, I would argue, is thus to synthesize osteobiography with population- or sample-based approaches. This involves taking best practice from studies of the individual (e.g. see papers in Stodder and Palkovich 2012) to develop and compare differences between individuals. Wheeler *et al.* (2013), in their study of potential

child abuse at Dakhleh, have demonstrated the importance of detailed study of the individual, and have placed burial 519 into both a wider Egyptian and a wider Roman context. Robb (2002) provides one of the first excellent demonstrations of the potential for osteobiography as an aid to understanding the individual, time and the past, and Boutin (2011) demonstrates its potential as a means to understand personhood. In Egyptian contexts, however, we have the additional benefit of the excellent artistic representational record, the potential to undertake archeothanatology (Duday 2009), and so I would argue that we should attempt to synthesize this, where possible, with our multiple osteobiographies to develop emic understandings. Social conceptions and understandings can be recognised within Egyptian art (Robins 1994; Riggs 2010; Riggs and Baines 2012). It is these multiplicities of differentiation that permit the diversity within osteobiography to be contextualized. Thus Egyptian bioarchaeology has the potential to integrate and critique the differing aspects of identity through osteobiographies of both specific individuals and larger samples such as cemeteries. Egyptian bioarchaeology can therefore study and provide many faces, deliver and illuminate many stories and thereby uncover multiple identities.

Dogs at El-Deir

Françoise Dunand, Roger Lichtenberg & Cécile Callou

Since 1998, the team from Strasburg University (UMR 7044 of CNRS), with the collaboration of a member of the Museum of Natural History, Paris (UMR 7209), has been working on the cemeteries at el-Deir (Deir Mounira), in Kharga Oasis, Egypt's Western desert. The site is situated 30 km northeast of the modern town of Kharga and was an important stop on the North-South caravan road, which led from the Nile Valley to Sudan and Darfur (the "Forty Days Road"), and East-West, from the Nile Valley to the oases of the Libyan Desert (Fig. 1). At el-Deir travellers coming from the west or the south would find the last well before climbing the huge plateau which separates the oases from the Nile Valley (Dunand *et al.* 2010: 13-31).

This site had been ignored by archaeologists on the whole, but, like many others everywhere in Egypt, it had been heavily looted from antiquity until now; thus, the team started what could be called a rescue excavation. The team explored five cemeteries (Fig. 2). We were able to date some of these back to the Persian period (5th c. BC), and perhaps earlier (Dunand *et al.* 2012: 293-296), but the most important period for this site was possibly the Ptolemaic and early Roman eras. The latest occupation is testified by a small Christian cemetery, which was dated to the end of the 4th and 5th c. AD, based on the ceramics. We are not certain at what period the site was deserted; some people from the next village, Mounira, were cultivating small fields on this area untill the 1950s. Today, the land has returned to desert, with a belt of big sand dunes moving rather quickly southward.

We can affirm that the site was inhabited constantly for nine centuries at least, starting from about 450 BC. We think that the inhabitants were mostly peasants and craftsmen based on the finds from the cemetery and the whole area: vast amounts of ceramics and basketry. Water was plentiful in this area; it came from wells that supplied conduits that fed the fields, and it seems there were pools and marshes too (Tallet *et al.* 2011: 173-188). Of course there were also wealthy people living at el-Deir: civil servants or priests, who were endowed with "rich" funerary goods. The inhabitants of el-Deir followed the Egyptian traditional pagan religion untill the 4th c. AD, after which some of them were converted to Christianity.

When exploring the North Cemetery in February 2001, for the first time the team discovered a vast number of canine remains. Inside two funerary rooms of tomb N18, we first discovered four small mummified dogs that were fairly well wrapped, suggesting that these might be pets buried with their masters. But inside

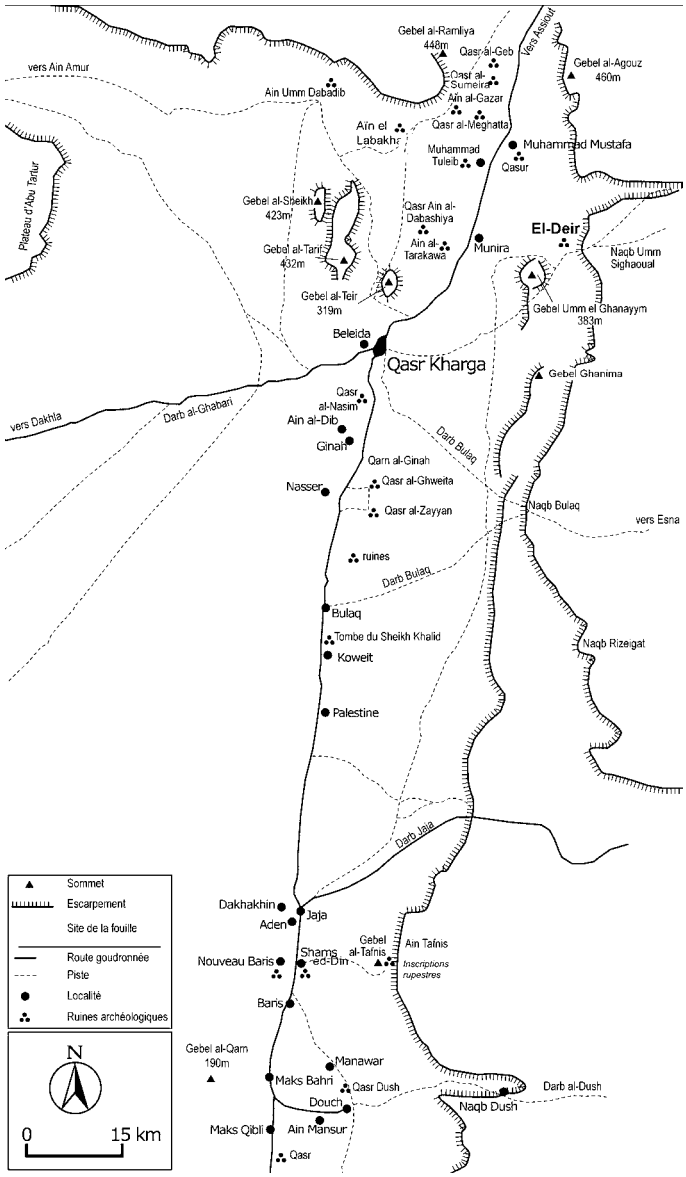

Fig. 1. Map showing the location of Kharga Oasis (map: R. Lichtenberg).

tomb N22, we found skeletal remains of about 40 or more dogs. Some team members suggested, half-seriously, that these were a pack of hounds. However, it is unlikely that Egyptians peasants, or others at that time, practised this kind of hunting. The following season, January 2002, while exploring the East Cemetery, another, more numerous deposit of dogs was discovered, about 250, some of them well mummified and well-preserved, but the majority being skeletons.

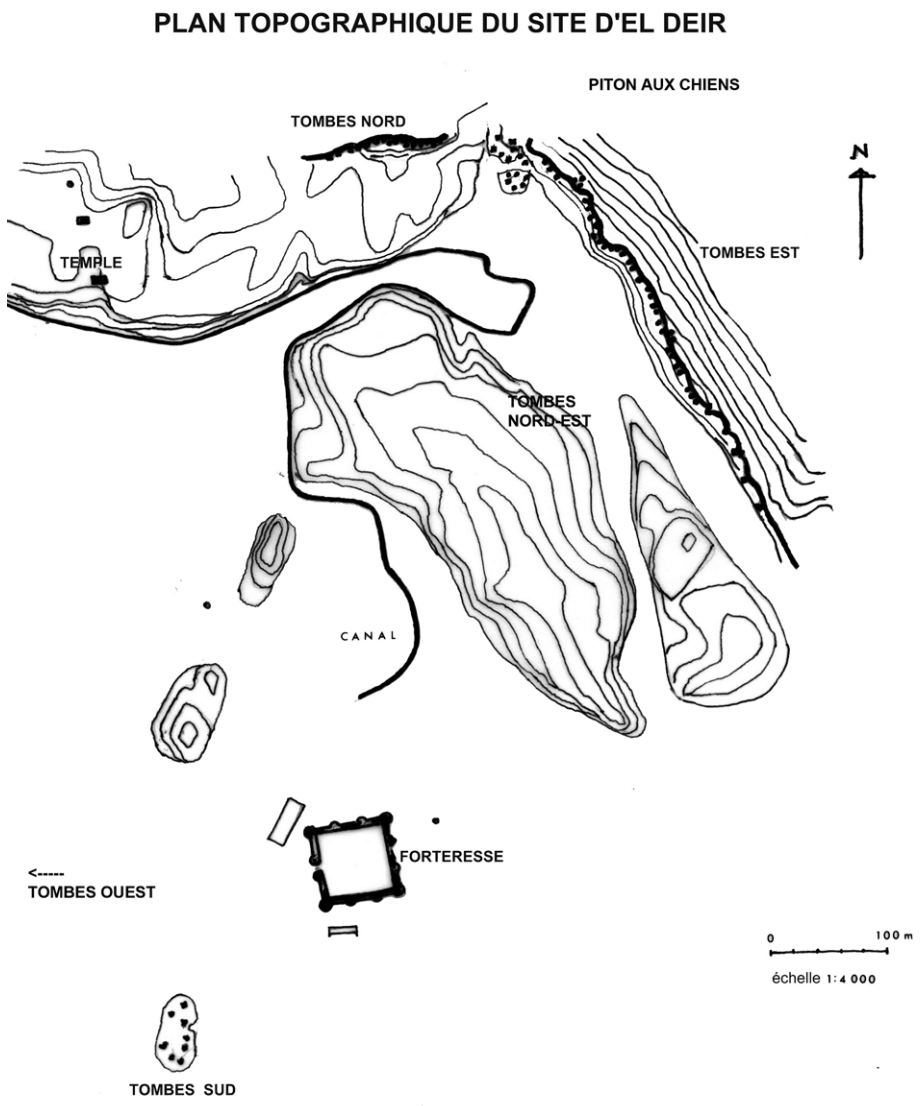

Fig. 2. Topography of the site of el-Deir (map: R. Lichtenberg).

Finally, in November 2004, it was decided to explore a small hill very near the East Cemetery; we had called it "Dogs' hill" (*Piton aux chiens*), because many bones of dogs could be seen on the surface, mixed with sand and stones (Fig. 3). Inside a very carefully cut, large tomb (funerary chamber: 2.50 m × 2.60 m, pit: 0.75 m × 1.60 m) about 200 dogs were discovered. About 80 were beautifully wrapped mummies with coloured textiles and painted faces. They had been quite miraculously preserved under a huge block of sandstone that fell from the summit of the hill into the tomb.

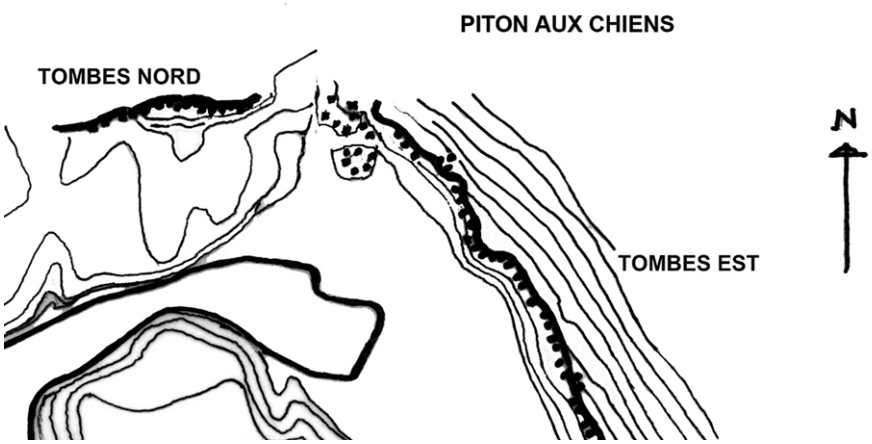

Fig. 3. Topography of the site of el-Deir with the tombs of the dogs marked (map: R. Lichtenberg).

All the well-preserved mummies were X-rayed, with some unexpected results (Figs. 4, 5). The X-ray equipment used was a portable Massiot-Philips (from the 1950s), providing 20 mA and 90 kV. Some mummies were really of mature dogs; others were of puppies, sometimes containing three very small dogs in one bundle, while still others did not contain dogs at all – rather these packages held a big bone or a small parcel of earth.

Thus, we had discovered a population of about 500 more or less mummified dogs. Unlike the animal cemeteries at Saqqara or Tuna el Gebel (Kessler 1989; Ikram 2005; Ikram *et al.* 2013), it is not exactly a cemetery exclusively for dogs: the three tombs where they had been deposited were tombs for humans. All these tombs at el-Deir are originally family tombs, which in some cases had been reused for newcomers, when the original owners had disappeared (the families possibly died out). Presumably the same process took place concerning dogs. These tombs had not been emptied of humans before the dogs were buried within: inside tomb N22 there were mummified or skeletal remains of 10 persons, among them a child; inside tomb E9 there were remains of four adults and four children; inside tomb P5 there were about 10 skulls and many skeletal remains.

We can posit a gap of two or three centuries between the human burials, which are probably Ptolemaic (there are typically Ptolemaic limestone sarcophagi inside the tombs), and the animal burials, which, through the technique and style of the wrappings are dated to the Roman era. Unfortunately, thus far it is impossible to determine the length of time that the tombs were used for the deposition of dog mummies. Discovery of animal mummies inside human tombs is not exceptional: at Salakhana, near Assiut, in 1922, many mummified remains of dogs were discovered inside the tomb of a Middle Kingdom prince of the Lycopolitan nome (with a lot of steles dedicated to Wepwawet, a canine deity); it seems that the mummies have disappeared, so there is no idea as to their number (DuQuesne 2007). Notably, for the history of canine mummies in Kharga Oasis, Salima Ikram discovered another group at el-Dabashiya, 20 km west of el-Deir. The large

Fig. 4. An array of well wrapped dogs (photo: R. Lichtenberg).

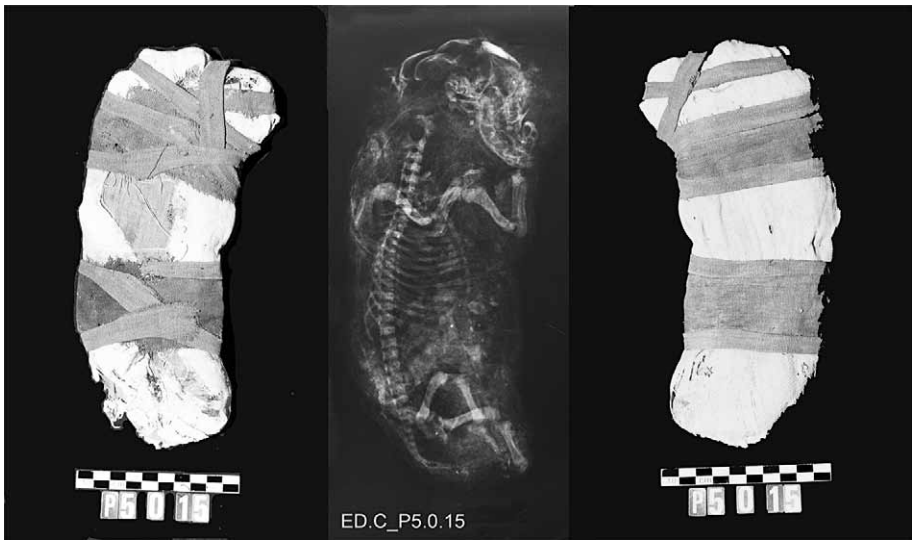

Fig. 5. Dog P5.0.15 wrapped and X-rayed. It is a juvenile (photo: R. Lichtenberg).

number of dogs, many of them carefully prepared and wrapped, must be related to religious practices. It is well-known that a lot of animal mummies were sold to people who offered them as *ex voto* to the deities with whom these animals were linked (Charron 2005). Thus far no temple at el-Deir was clearly dedicated to a canine deity. Possibly, based on the number of canine mummies, one can presume that there was somewhere between el-Dabashiya and el-Deir a temple dedicated to Anubis, or possibly Wepwawet, the main god of Lycopolis, which was connected to the north of Kharga by a well-known, much followed track.

As looters disturbed most of the mummies, it is impossible to determine whether the animals were deposited at random, or in an organized manner. It was hoped that some differences could be established based on the age or style of bandaging. However, based on the extant evidence, this does not seem to be the case.

After their discovery, the animal remains were preserved in more than forty large bags, which contained fragments of dog mummies, more or less disarticulated, mixed with unwrapped dog mummies, together with a huge quantity of loose bones. These bones, very well-preserved, also belonged to mummified animals, as is suggested by the presence of small pieces of textile or traces of resin on most of them.

The goal of this study was to find different ways of examining the finds so as to stimulate discussion, and to propose areas for potential research. The deposits of *ex-voto* raise many questions, particularly on the establishment of cemeteries in connection with a specific cult, but also on more technical and practical aspects, such as the treatment of mummies, or the choice of animals offered to the god. At el-Deir, questions of dog breeds (Saluki, Mastiff, pariah dogs), the age of dogs at death, the presence of animals which had been bred specifically to be sacrificed, or which died a natural death and were then brought by their owners to the site for burial, and other questions of animal sources can be considered.

The study of these numerous remains was carried out in different stages. First was a study of the isolated bones in the temporary zooarchaeological laboratory set up on the site, the results of which were analyzed later in a French laboratory. The significant fragments of the mummies, especially heads and necks, were X-rayed in the on-site laboratory which has been set up some years ago for X-raying human mummies. The goal was to obtain as much information as possible from the complete dog mummies, with a particular focus on understanding how these animals died, such as skull fractures, strangulation with dislocation of cervical vertebrae (as has been observed on cats mummies, Armitage and Clutton-Brock 1981: 187; Zivie and Lichtenberg 2000; Zivie and Lichtenberg 2005), or nothing to report.

The team classified the various anatomical parts, made measurements and carried out photo-documentation. It also recorded pathologies, epigenetic characteristics, discrete characteristics, and some unusual things (for example, the mandible of an adult dog which still had its deciduous teeth). The team also noted the few fractures and some osteoarthritis marks on the bones. A more comprehensive review, comparing dogs from el-Deir with dogs found in Dabashiya, should confirm the hypothesis of a local population.

Thus far, the estimated minimum number of dogs, based only on skeletal remains, is 430. In addition to these are the 82 beautifully wrapped mummies, and also fragments of X-rayed mummies that are not counted as yet. Thus, we can confirm the first estimate of more than 500 dogs being buried at this site.

This is clearly a cemetery for domestic dogs, *Canis familiaris*. However, some fox bones were identified, belonging to three individuals of the species *Vulpes rueppelli*. Of course, the question of intrusive remains arose. However, it should

be noted that one of the three individuals bore resin residue on the bones, a clear indication of mummification. Quite probably the other two were also mummified deliberately. Such a mixture of species is not unheard of (Ikram *et al.* 2013). Thus, one wild animal, at least, was placed inside a cemetery devoted exclusively to domestic animals.

All age groups are present in the tombs, with a large proportion of puppies from one to two months (25%), of young adults aged 6 to 15 months (36%) and dogs over four years (16.5%) based on stages of tooth eruption (Silver 1969), and stages of tooth wear (Horard-Herbin 2000). According to these results, it is impossible to say that any age group was preferentially selected. All are present, from the very young puppy to the very old dog – a situation found in other canine cemeteries too (Ikram *et al.* 2013).

Long bones were used to estimate the morphology of the dogs. The index calculations upon 141 humeri show that the dogs tend to be medium sized, between forty and sixty centimeters at the withers (40-50 cm: 60%, 50-60 cm: 40%) (Koudelka 1885, in von den Driesch and Boessneck 1974; Udrescu 1990). There is a certain homogeneity of dogs at el-Deir, neither small, nor large, with limbs medium (83%) and robust (16.3%), rather than slender. Unfortunately, the combination of size measurements and diaphysis proportion did not allow for distinguishing between males and females. One reason is probably the presence of several breeds or different morphotypes/phenotypes.

Principal component analysis on the "log shape ratios" were performed, with twenty-three measurements (different length, width and height) and hundred fifty-five skulls (Fig. 6). The point of this method is to study the shape of the skull, apart from the isometric size. Another focus is to objectively analyze all the skulls together, despite their significant variability.

A hierarchic cluster analysis performed on the Principal Component Analysis (PCA) gives five groups (A to E). In brief, skulls of types A and B are characterized by a lengthening of the skull, especially the muzzle, with narrowness, mainly in the frontal bones. In addition, the skull is low. The dogs of type E, however, have a shorter skull, particularly at the muzzle; at the same time the skull is higher and wider. Types C and D are intermediate of these two morphotypes.

Types A and B correspond clearly to features which are observed on modern Salukis. The second axis can better distinguish these two types. The correspondence of these types with two "breeds", which can be observed on paintings or bas-reliefs: the tail up (Saluki) and the long tail down (Greyhound), cannot yet be shown, but it is a focus for future research, as would be, of course, the distinction between male and female dogs. Type E corresponds to the modern Mastiff, while C and D correspond to the common dog which is currently found in Egypt and in Sudan, with one being slightly larger than the other. The question why there are two groups can as yet not be answered.

Obviously, the causes of death of these animals were studied. Only one skull of an adult animal showed signs of trauma. All the others are intact or were broken during looting. No skeletal evidence of cut marks exists. However, it is easy to kill

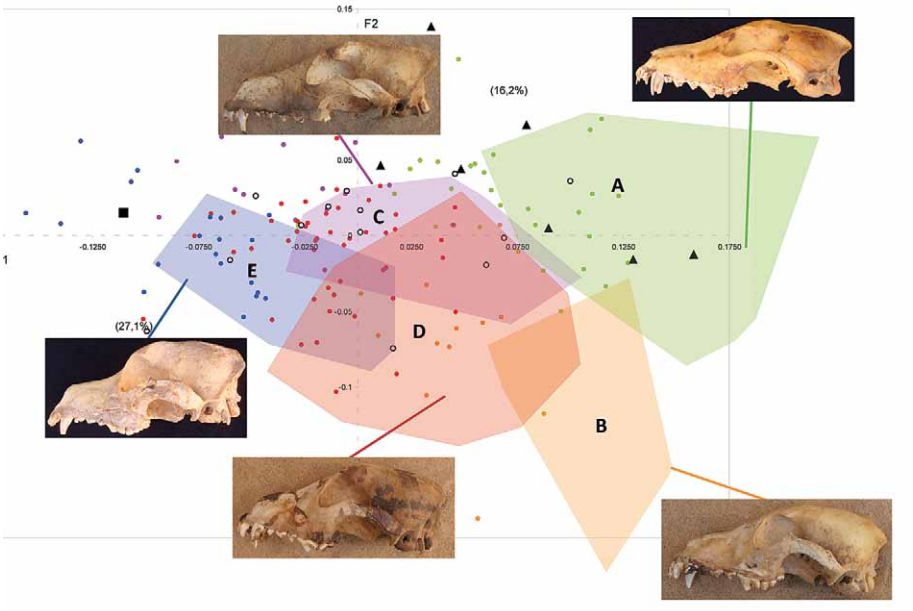

Fig. 6. Distribution of the different skull sizes and morphologies for the dogs at el-Deir (image: C. Callou).

a puppy by drowning or twisting its neck. The research program on this topic is ongoing from the analysis of the X-rayed mummies.

During the course of research another hypothesis about the death of the animals evolved. A mummy of a young dog (four to five months old) from tomb P5 shows obvious signs of a strong external parasitism. The analysis, made in collaboration with Jean-Bernard Huchet (archaeoentomologist, UMR 7209, Muséum national d'Histoire Naturelle de Paris), reveals the occurrence of louse fly remains (*Hippobosca longipennis*), numerous puparia of sarco-saprophagous flies (Diptera: Sarcophagidae and Calliphoridae), both of which are potential agents of traumatic myiasis (disease due to the larvae of various insects), as well as many ticks still strongly attached to parts of the coat, with a high concentration in the right ear. All of these species are known as potential vectors of different pathogens that might be responsible of the premature death of this dog (Huchet *et al.* 2013), and perhaps of other individuals. The research will be continued as it will shed light on the health of the dogs found at el-Deir.

Feline Descendant of the Red or the Black Land: A Multidisciplinary Investigation of an Unusually Large Ancient Egyptian Cat Mummy

Carolin Johansson, Geoffrey Metz & Margareta Uhlhorn

Introduction

The present day worldwide domestic cat population is a descendant of the African wildcat (*Felis silvestris libyca*), whose range includes parts of Africa and the Middle East (Sunquist and Sunquist 2002; Driscoll *et al.* 2007). In Egypt, this cat inhabits the margins of the Nile Delta and the Nile Valley and dwells patchily in the Western and Eastern deserts (Hoath 2003). It was long assumed that ancient Egypt was the origin of cat domestication, mainly based on the abundance of iconographic, archaeological and written sources that document the importance that the cat had both in the profane and sacred spheres in ancient Egypt (e.g. Baldwin 1975). However, later studies, based on non-Egyptian archaeological finds and phylogeny of contemporary cat populations, have argued that the domestication took place outside Egypt, prior to the Pharaonic period (Vigne *et al.* 2004; Driscoll *et al.* 2007; Vigne *et al.* 2012). Still, this is questionable as Predynastic finds at Hierakonpolis in Upper Egypt indicate attempts of taming (Linseele *et al.* 2007; 2008) or even domestication-like adaptations (Friedman *et al.* 2011) of cats. Indeed, a recent study using molecular methods supports a scenario in which domestication of cats took place both inside and outside of ancient Egypt (Johansson 2012). The issue is thus still open for debate.[1]

The cat was one of the many animals that were regularly mummified from the Late through the Roman Period (Malek 2006). Apart from the majority of the preserved and documented cat mummies which fairly resembles today's modern domestic cat, a few ancient Egyptian cat remains have been suggested to belong to other wildcat species such as the Jungle or Swamp cat (*Felis chaus*) (Morrison-

1 This paper is, however, not intended as a discussion of the possible origins of the domestic cat population of today as that is not of relevance in this particular case.

Scott 1952; Ikram, personal communication), a slightly larger and more robust cat living in less dry habitats of mainly Asia, but with a sparse distribution in the Nile Delta and Nile Valley exclusive to Africa (Sunquist and Sunquist 2002).

The cat mummy (Fig. 1) that is the subject of this study belongs to a private antiquity collection in Sweden and is of unknown provenance but was reputedly[2] excavated by Flinders Petrie.[3] The mummy package is exceptionally large and measures 58 cm in length and the mummy wrapping and decorations reflect high-quality manufacture. The linen bandages are cross-wrapped in a rhombic pattern where the core of each lozenge was originally filled by a fabric dyed in red, of which only traces remain. It is stylistically dated to the late Ptolemaic or early Roman Period as the patterned wrapping is characteristic of that time period (Ikram, personal communication).

mtDNA analysis

The issues of poor preservation of nucleic acid molecules in unfavourable conditions and the high risk of contamination have long kept alive a scholarly debate on the possibility of retrieving analysable ancient DNA (aDNA) from ancient Egyptian bioarchaeological remains.[4] However, the previously strong opposition has weakened lately (Gilbert 2011), and analyses of animal mitochondrial DNA (mtDNA) strands of up to 200 base pairs (bp) have been published recently (Hekkala *et al.* 2011; Kurushima *et al.* 2012).

An attempt to extract and analyse mtDNA from the cat mummy of this study was performed. The purpose of the experiment was to put genetic information of that cat individual into the context of a wider project on the origin of cat domestication and the position of the Egyptian domestic cat (Johansson 2012), together with resolving the issue of species attribution in this particular case.

Material and Methods

Sample Preparation

A loose vertebra which had fallen out of the base of the wrapped mummy was analyzed. The bone sample (0.46 g) was decontaminated by 1 J/cm^2 in an UV irradiation Spectrolinker™ UV cross-linker and the inner part of it was pulverised. Bones from a European Medieval cat and a Neolithic auroch were used as extraction and PCR control samples and were prepared in the same way as that of the cat mummy. Drill bits and surface cover of the working area were changed between each sample. Hair shafts from a *F. chaus* individual were prepared as a reference sample and used for extraction as in Johansson (2012).

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2 Stockholms Auktionsverk, 1990. "Kvalitetsauktion 13-16 November 1990" p. 103, Lot 330.

3 Cf. the discussion on the origin of the cat mummies in Armitage and Clutton-Brock (1981).

4 Cf. e.g. Marota *et al.* (2002), Zink and Nerlich (2003), Gilbert *et al.* (2005), Zink and Nerlich (2005) and the critique in Lorenzen and Willerslev (2010).

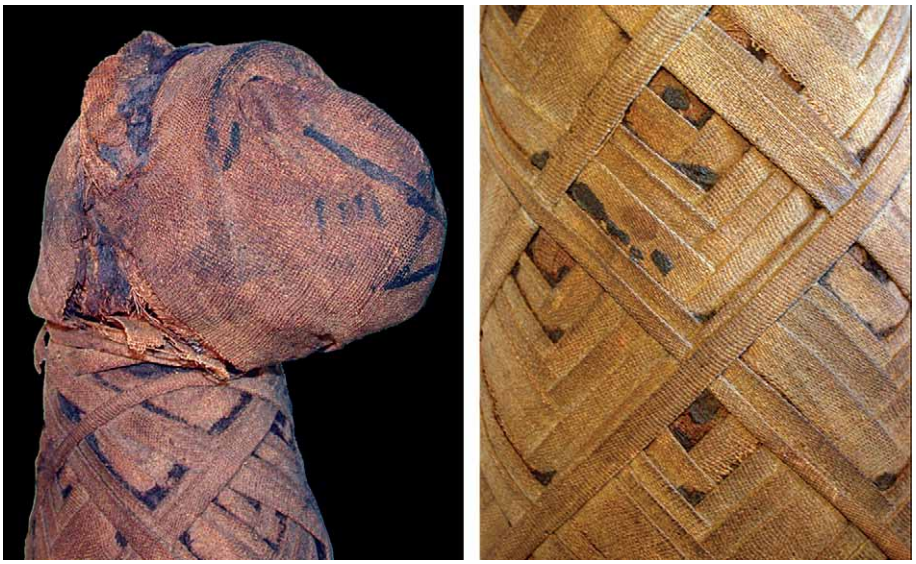

Fig. 1. External view of the cat mummy. Note the geometric wrapping pattern that is directed to the upper corner of each rhomb, detailed on the right side (photo: Uppsala Mummy Survey).

DNA extraction

100-200 mg of bone powder were used per extraction, performed according to Yang *et al.* (1998) with the exception of using 1 M urea instead of SDS in the initial incubation step.

Target Sequences and Primer Design

A region in the Cytochrome B (CytB) gene, in which Driscoll *et al.* (2007) had shown several Single Nucleotide Polymorphisms (SNPs)[5], was targeted with primer sequences[6] that would result in a gradient of amplicon sizes (78, 100, 170 and 256 bp respectively). A sequence in the NADH dehydrogenase subunit 5 (ND5) gene with one known SNP of 75 bp in length, was also targeted.[7] The first three SNPs have the power to discriminate between different clades of domestic cats (*F. s. libyca*) and the fourth between the domestic cat lineage and other subspecies of *F. silvestris* (according to the data presented by Driscoll *et al.* (2007) based on a total number of 979 wild and domestic cats). All primer sequences were optimized on contemporary cat DNA.

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5 15097, 15103 and 15104, all position numbers used in this document refer to the reference mitochondrial genome sequence with Genbank accession number NC_001700.1 (Lopez *et al.* 1996).

6 Forward: TCGAAAATCACACCCCCTTA, reverse: CATGCTGAGATGTTAGATGGG, ATAAGAACTTAATGACCAACATTCG, TGTTATCATTATTCTCACATGGAATTT and CCAAACCCACCATAAATTGG.

7 Forward: ACCTCATCAACTCCATTAAACG, reverse: GGGGGATATTATAAGAAATTAGA.

PCR Setup

25 µl PCR-reactions were prepared according to the optimized protocol in Table 1. All of the pre-PCR steps (preparation, DNA extraction and PCR setup) for the ancient samples were conducted in a clean room facility specifically dedicated to aDNA work[8] and physically separated from lab areas where contemporary samples were handled. No feline material had ever been worked upon in the aDNA lab previous to the present study. Sample preparation, DNA extraction and PCR setup of the cat mummy sample were performed at two occasions (separated in time by approximately eight months), the Medieval cat bone was prepared parallel with the second cat mummy extraction, but after that each step on the cat mummy sample was completed. All steps were monitored for contamination by the use of blank samples.

Amplification

DNA amplification was performed in a thermal cycler (Mastercycler®, Eppendorf) according to the program shown in Table 2. Amplification success was assessed by size separation in agarose gel electrophoresis followed by EtBr staining. The PCR products were washed by using a commercial purification kit (MSB®Spin PCRapace, Invitek) according to the manufacturer's protocol.

Sequencing

Pyrosequencing was performed in a PSQTM 96MA system. Different combinations of sequencing primers were used in order to evaluate the whole sequences and/or the individual SNPs.[9] The resulting pyrograms were manually checked and interpreted and the corresponding sequences constructed. The resulting SNP values and sequences were compared to the data established in Driscoll *et al.* (2007).

Results

Amplification Success

Success of a PCR run was defined by a clear band representing the sample after DNA separation through gel electrophoresis at the correct position as indicated by use of a DNA size ladder and/or positive control together with no significant indication of DNA at that position in any of the negative controls (Table 3).

8 The aDNA lab was equipped with UV lamps, positive air flow, protective disposable lab attire and direct shipping of reagents and other equipment.

9 Positions 14010, 15097, 15103 and 15104.

PCR Setup Protocol	Final Concentration (fresh sample)	Final Concentration (ancient samples)
Forward Primer	0.2 µM	0.2 µM
Reverse Primer	0.2 µM	0.2 µM
dNTPs	0.2 mM	0.2 mM
MgSO4	2.0 mM	2.0 mM
Smart-Taq DNA Polymerase	1 U	1 U
BSA (bovine serum albumin)	400 ng/µl	2 µg/µl
Template (DNA extract)	2 µl	5 µl

Table 1. PCR setup protocol.

Thermal Cycler Program	Temperature	Time
Step 1: Initial denaturation	95°C	15 min
Step 2: Denaturation	94°C	30 s
Step 3: Annealing	51–57° C, 53° C, 53° C, 57° C and 54° C	30 s
Step 4: Elongation	72°C	30 s
Step 5: Final elongation	72°C	2 min
Step 6: Storage	4°C	∞

Table 2. Thermal Cycler program. Step 2-4 was repeated 34 times for the fresh sample and 54 times for the ancient samples.

Sample	75 bp	78 bp	100 bp	170 bp	256 bp
Cat Mummy Extract 1	+	+	-	-	-
Cat Mummy Extract 2	+	+	-	-	-
Medieval Cat	+	+	+	+	+
Jungle Cat	+	+			

Table 3. Amplification success in at least one run is indicated by a cross, repeated failure is indicated by a dash. Empty cells represent amplifications that had not been attempted.

Discussion

DNA preservation

It was possible to amplify mtDNA fragments of 75 bp and 78 bp from the cat mummy vertebra. All other PCR reactions with greater amplicon sizes failed but were successful with the more moderately aged Medieval cat sample originating from a cooler (and thus more DNA preservation friendly) environment. This, together with the anti-contamination precautions taken, speaks in favour of the authenticity of the retrieved DNA.

Sample\SNP	14010	15097	15103	15104
Cat Mummy	**C** (3/3)	T (4/4)	**C** (11/11)	**G** (9/10)
Medieval Cat	**C** (3/3)	T (2/2)	**C** (2/2)	**A** (2/2)
Jungle Cat	T (2/2)	**C** (3/3)	**C** (3/3)	-

Table 4. This table lists the typing results (SNP values). Numbers within parentheses refer to the number of times the given value was read relative to the total number of successful sequencing reads. The cell with a dash represents sequencing failure (no data).

However, an inconsistency was noted in the typing of the SNP at position 15104 (Table 4) in the first of the two cat mummy extracts. This can be attributed to several possible causes: heteroplasmy (in which two or several mtDNA haplotypes occur naturally within one individual) has been noted in felines previously (Tarditi *et al.* 2011; Johansson 2012). Damage to aDNA can occur in the form of spontaneous mutations of which the A to G mutation (as in this particular case) is the most common (Stiller *et al.* 2006). Contamination is also, obviously, a possible cause. The effects of low-degree heteroplasmy, potential damage and contamination could have been enhanced by the fact that the number of template molecules is small. Given that this inconsistency was noted only once and in only one of the extracts, it was not regarded sufficient to reject the validity of the data but rather as an effect that is commonly encountered when working with degraded DNA.

Phylogenetic Information

The SNP of the ND5 gene indicated a haplotype (C) that is unique to the domestic cat clade according to Driscoll *et al.* (2007) and different from the resulting value of *F. chaus* (T). The interpretation is that this particular cat is likely to be a domestic or wild cat of *F. s. libyca*, or, possibly, the offspring of a hybridization between a female *F. s. libyca* and a male of another cat species (e.g. *F. chaus*).

The three typed SNPs in the cytB gene have the power to discriminate both between different species of *Felis silvestris* and matrilines within the domestic cat clade according to the data presented by Driscoll *et al.* (2007). The value combination retrieved in this case, TCG, is indeed a haplotype present within several matrilines of the domestic cat clade, namely C, D and E.

Interestingly, the cat mummy of this study does *not* cluster with the three Egyptian cat mummies studied by Kurushima *et al.* (2012)[10] according to the haplotype identification system established by whole mitogenome sequences in Johansson (2012: 80) where the concordance of haplotype designations based on different parts of the genome, established by the systems of Driscoll *et al.* (2007) and Grahn *et al.* (2011), is indicated. Indeed, their last common ancestor is dated to around 80-100 kY, far earlier than any reasonable date for the first possible cat domestication events indicated by archaeology. This is in contrast to the minor matrilines identified in the cat mummies of Kurushima *et al.* (2012) who share

10 Which corresponds to matriline A of Driscoll *et al.* (2007).

their last common ancestor approximately 4 000-9 500 years ago according to the authors of that study.[11] Thus we may claim, given that this cat belonged to domestic stock, that, in Roman Period Egypt, there were at least two domestic cat matrilines already present, possibly belonging to separate domestication events.

CT Examination

Material and Methods

The cat mummy was examined by X-ray computed tomography technique (CT) in a Siemens Somatom® Definition Flash CT scanner according to the following protocol: voltage: 120 kV, current: 330 mA, thickness of slice: 0.6 mm and increment: 0.3 mm. The data was visualized in the accompanying software and images and measurements were taken on-screen by orienting the different aspects parallel with the plane of view. Determination of species was attempted both through studying the morphology of the skull and by quantitative measurements of the cranial and post-cranial skeleton according to the standard in Von den Driesch (1976) unless otherwise stated. The results were compared with a large set of data published on different populations of contemporary cats and archaeological cat remains in the literature.

Results

The CT data revealed a skeleton and soft tissue of a large, tightly wrapped cat, almost completely extended within the whole length of the mummy package (Fig. 2). The cat is positioned in the most common pose of Egyptian mummified cats: the head is bent perpendicular to the axis of the body, the front legs stretched out along the body, and the tail bent between the hind legs resting against the belly (Ikram and Iskander 2002; Zivie and Lichtenberg 2005). Both femurs have been broken or cut in the diaphysis, and the distal parts of the hind legs are not included in the package (Fig. 3C). The proximal part of the left femur has been dislocated out of the hip joint. The cat exhibits further extensive damage to the head and neck region. The right mandible is fractured at the symphysis and is medially and caudally dislocated with the rostral part situated in the area of the orbit and the caudal part situated in the occipital area with a lateral 90° rotation (Fig. 3A). There is also a minor fracture in the symphysis of the palatum molle where the right side palatum molle and maxilla are dislocated approximately 3-4 mm ventrally relative to the left side (Fig. 3B). Several fracture fragments and the hyoid bones are located in the occipital area and dislocated teeth of the right maxilla are found in the calvaria. The atlas is completely luxated and ventrally rotated 90° (Fig. 3A). Subluxation is noted of the third and fourth cervical vertebrae and between several of the thoracic vertebrae.

11 The corresponding node in Johansson (2012) is approximated to 35 000 years ago.

Fig. 2. Visualization of the CT data. The image shows the skeleton of a large cat viewed from the right side. Remains of soft tissue and resin is visualised in red. Less dense material consisting of the linen wrappings indicates the extent of the mummy package (image: Uppsala Mummy Survey).

There are no remains of any deciduous teeth, indicating that the individual is older than six months. Moreover, the growth lines of the proximal femur are recently closed but those of the caudal vertebra bodies of the cervical and lumbar vertebrae are still slightly open which indicates an immature individual between 12 and 18 months of age. A penis bone was sought for but could not be identified; sex determination by other means was not possible.

The origin of the loose caudal vertebra was confirmed by identifying a gap in the sequence (position no. six) of caudal vertebrae of the tail (Fig. 3C). In addition, the hole in the bottom of the mummy package was examined in which one could see the protruding edges of the adjacent vertebrae and some soft tissue and fur of the tail.

Species Determination

Morphology

Apical and (left) profile views of the skull (Figs. 4, 5) were compared with projections of skulls of domestic cat (Osborn and Helmy 1980; Owen 2001a), female and male *F. s. libyca* (Owen 2001b; 2002) and *F. chaus* (Audouin 1826; Osborn and Helmy 1980). Notes in Osborn and Helmy (1980: 436-438) were used as guidance as well. Comparison was complicated due to the damaged condition of the skull but a few notes were made:

- The postorbital narrowing is moderate as in *F. silvestris* (Fig. 5).
- The anterior end of the zygomatic process is rounded as in *F. s. libyca* (Fig. 5).
- The sagittal crest on the occipital bone is strongly developed as in *F. chaus* but the postorbital ridges on the top of the skull are less developed, resembling *F. s. libyca* (Figs. 3D, 5).
- The dentition is large as in *F. chaus*, especially with regards to the canines, but the anterior cusp of the upper carnassial is moderate as in *F. s. libyca*[12] (Fig. 4).

Osteometry

A number of osteometrical values for which relevant comparative material has been accessible are accounted for in the diagrams below (Table 5).

Discussion

Previous investigations of collections of cat mummies have indicated that many of the cats that were presumably bred in temples for the votive mummy industry were culled by a blow to the head or by dislocation of cervical vertebrae and that there is an over-representation of sub-adult individuals (Armitage and Clutton-Brock 1981; Zivie and Lichtenberg 2005). At present, it is not possible to determine if any of the damage to this particular cat mummy is perimortem or evidence of

12 Cf. the skull of *F. chaus* in (Audouin 1826: 16, Planche 1, Fig. 3.1) where this cusp is in a size comparable to the other two cusps of the same tooth.

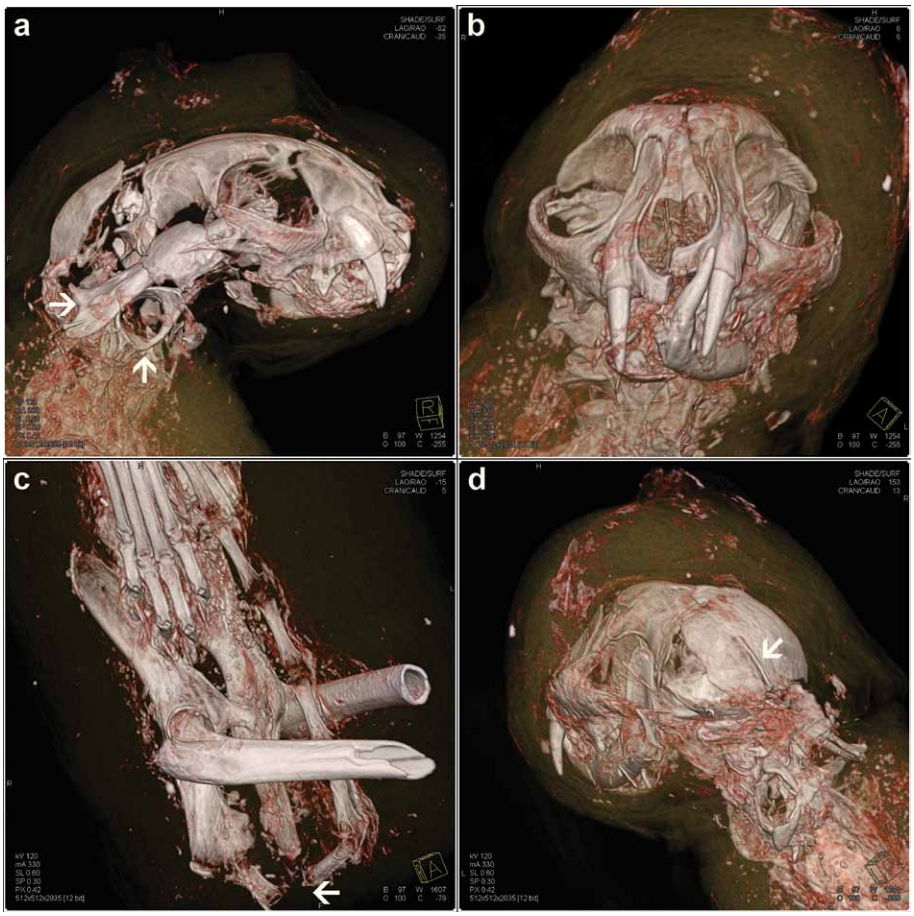


Fig. 3. The cat mummy exhibits severe damage to the head, neck and hind legs. A) Cross-section of the skull with the dislocated mandible and atlas (white arrows), note the outline of the mummy package with artificial ears; B) Anterior view showing prominent canines; C) The two femora have been broken or cut in the diahysis. Note the tail which is bent up between the hind legs and resting on the belly. The white arrow marks the spot for the sampled vertebra in the very bottom of the mummy; D) Left-posterior view with a white arrow pointing at the sagittal crest on the occipital lobe (image: Uppsala Mummy Survey).

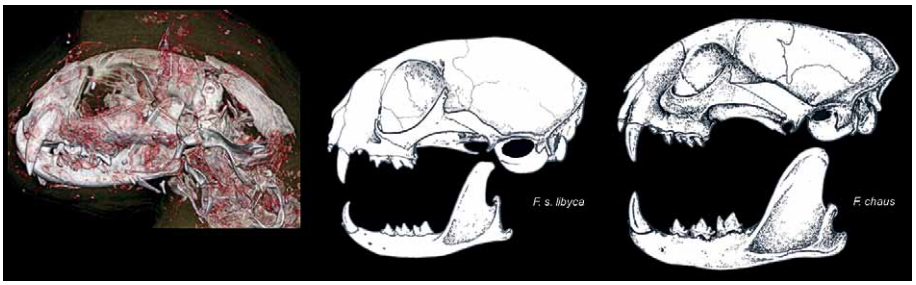


Fig. 4. Left profile view of the cat mummy head and comparisons with skulls of F. s. libyca *(middle) and* F. chaus *(right). Note: the different skulls are not in relative scale (drawings reproduced from figures 134 and 135 of Osborn and Helmy 1980: 438 and 442; image: Uppsala Mummy Survey).*

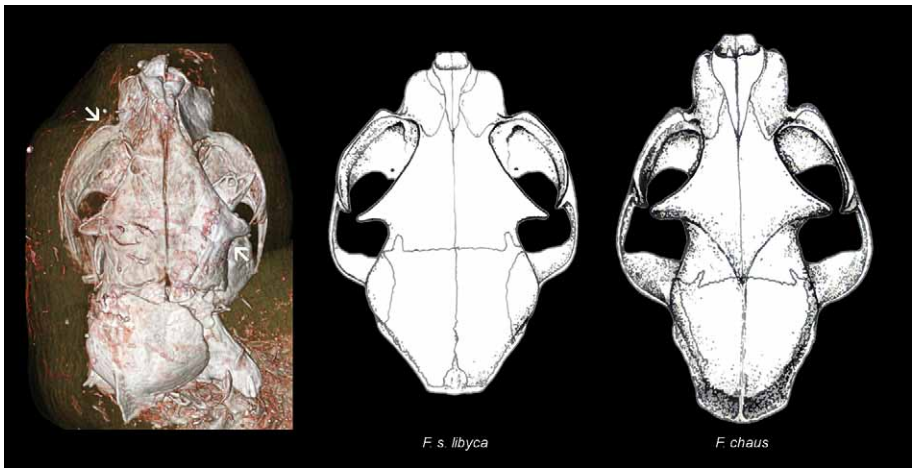


Fig. 5. Apical view of the cat mummy head and comparisons with skulls of F. s. libyca *(middle) and* F. chaus *(right). Note: the different skulls are not in relative scale (drawings reproduced from figures 134 and 135 of Osborn and Helmy 1980: 438 and 442; image: Uppsala Mummy Survey).*

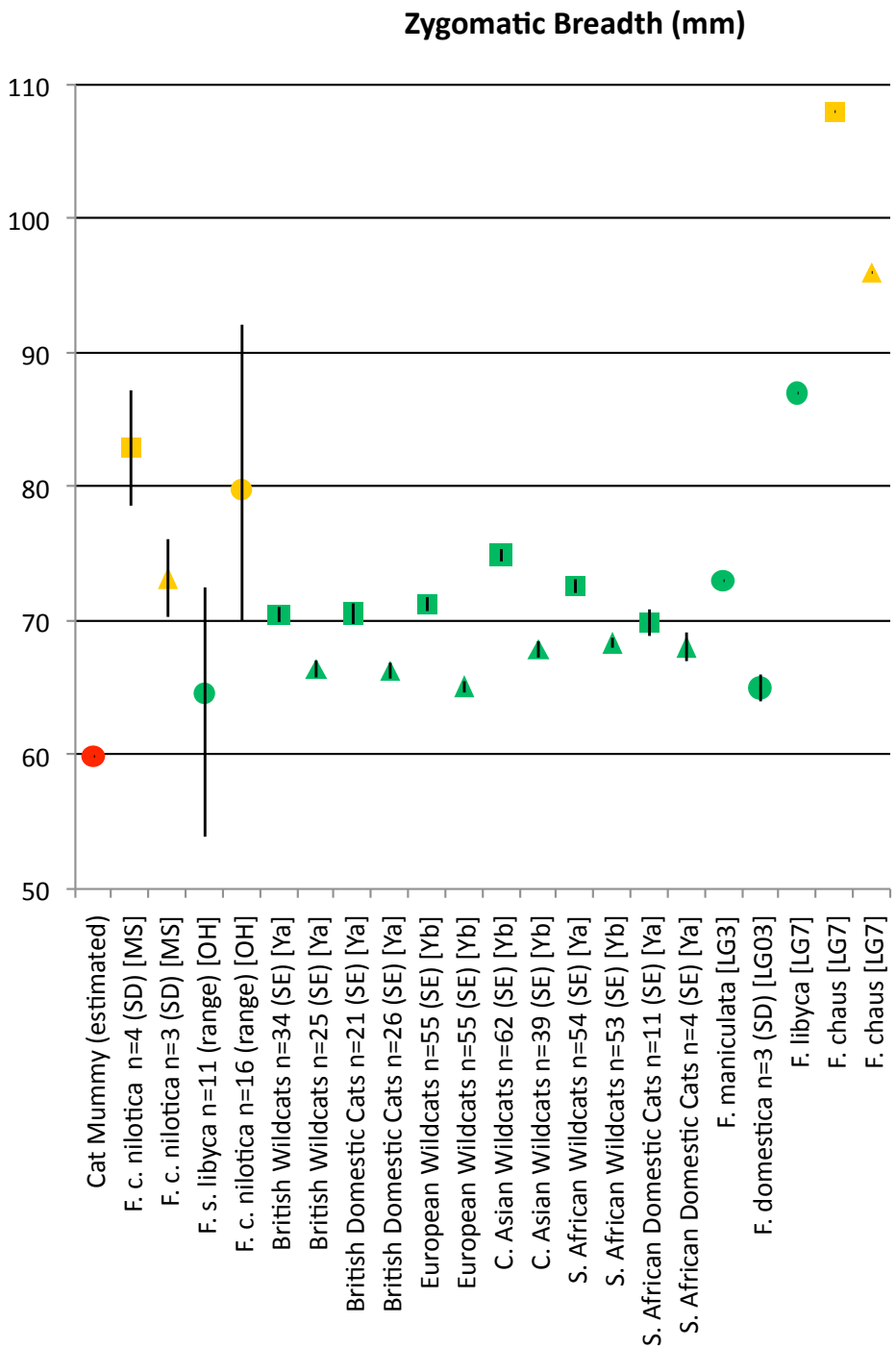
brutal handling in the mummification process or post-mortem activities, such as is also sometimes observed in human mummies (Moodie 1931: 23, pl. XIV). The hind legs may have been cut due to the difficulty of folding them along the body at the time of wrapping by the embalmers, and the damage of the neck region may be all post-mummification as it is the weakest point of the mummy package itself. Indeed, there is damage observed in the wrapping at this location (Fig. 1).

Both the morphological and osteometrical assessments yielded surprisingly inconclusive results. Four of the measurements indicated *F. silvestris* (Table 5A, 5C, 5L and 5M), four indicated *F. chaus* (Table 5B, 5F, 5H and 5K) and five (Table 5G, 5I, 5J, 5O and 5P) fell between the two. Some of the difficulties in identification are due to a lack of adequate reference material. Additionally, sexing has not been possible as many of the traits used to differentiate between the two species are also sex-specific. In particular, it is problematic to use the drawings of cat skulls in Osborn and Helmy (1980) as representatives for the two species because they are likely to be of different sex, and more importantly, the skull of the mummified cat is damaged, and most probably sub-adult. In most cases it is more similar to *F. chaus* in terms of size but lacks some of its typical morphological characteristics, notably the narrowing of the skull behind the orbits and the large size of the anterior cusp of the upper carnassials. However, the relative length of the tail, which is considered as a crucial criterion for differentiation (Pocock 1951) cannot in this case give a clear indication, but the length is closer to that of *F. chaus* than *F. silvestris* (Table 5P)[13].

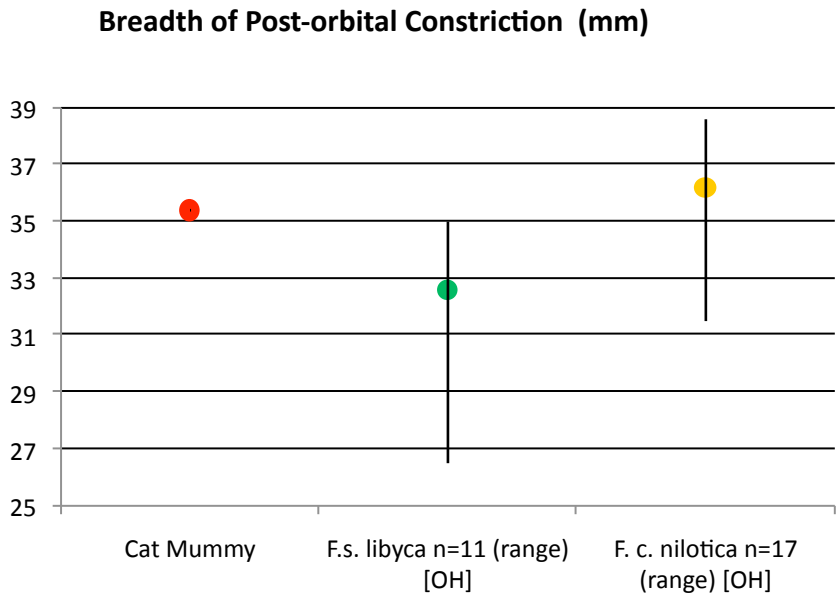
13 The "Head and Body Length" of the cat mummy is approximated as it is fixed in an unnatural pose.

Table 5A-P. Legend and caption on page 198.

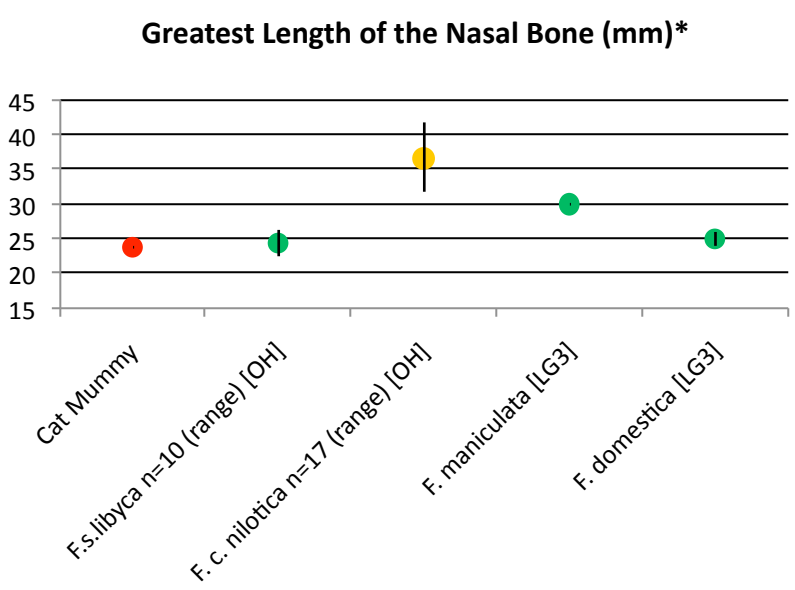
A



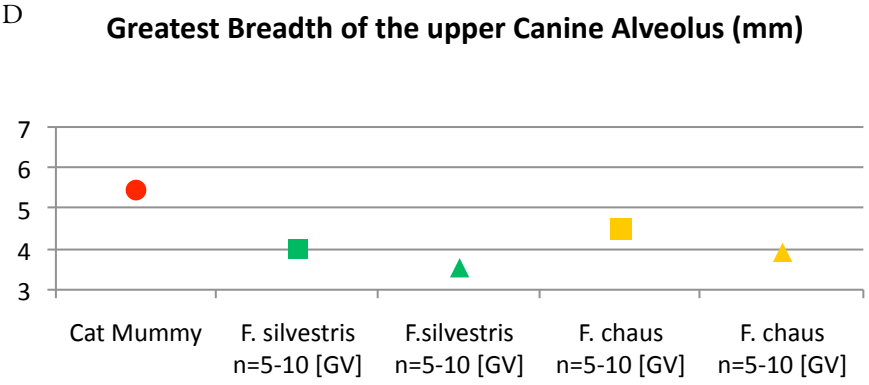
B


Breadth of Post-orbital Constriction (mm)
39
37
35
33
31
29
27
25
Cat Mummy
F.s. libyca n=11 (range) [OH]
F. c. nilotica n=17 (range) [OH]

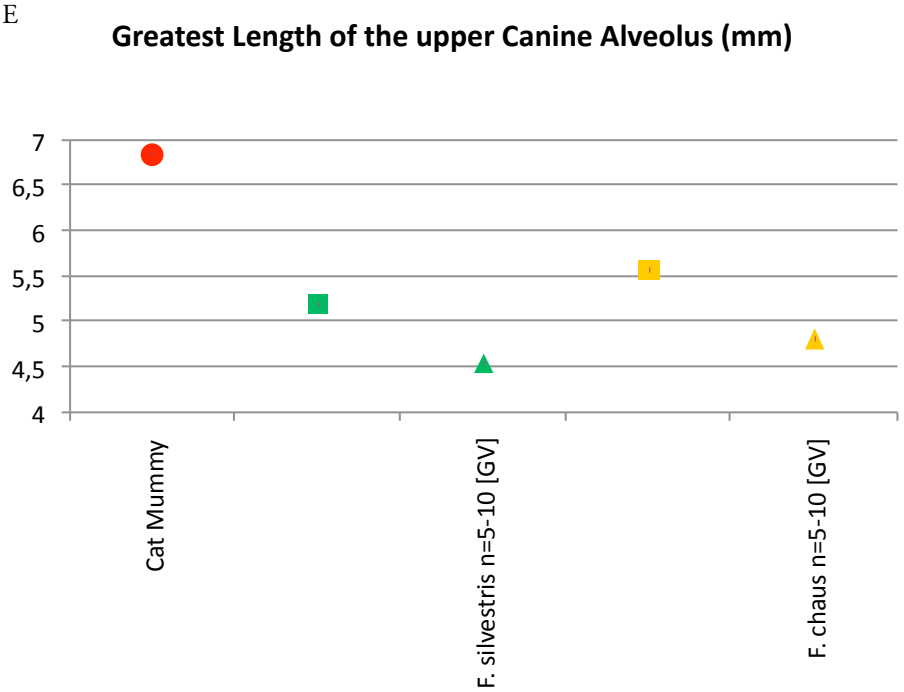
C


Greatest Length of the Nasal Bone (mm)*
45
40
35
30
25
20
15
Cat Mummy
F.s.libyca n=10 (range) [OH]
F. c. nilotica n=17 (range) [OH]
F. maniculata [LG3]
F. domestica [LG3]

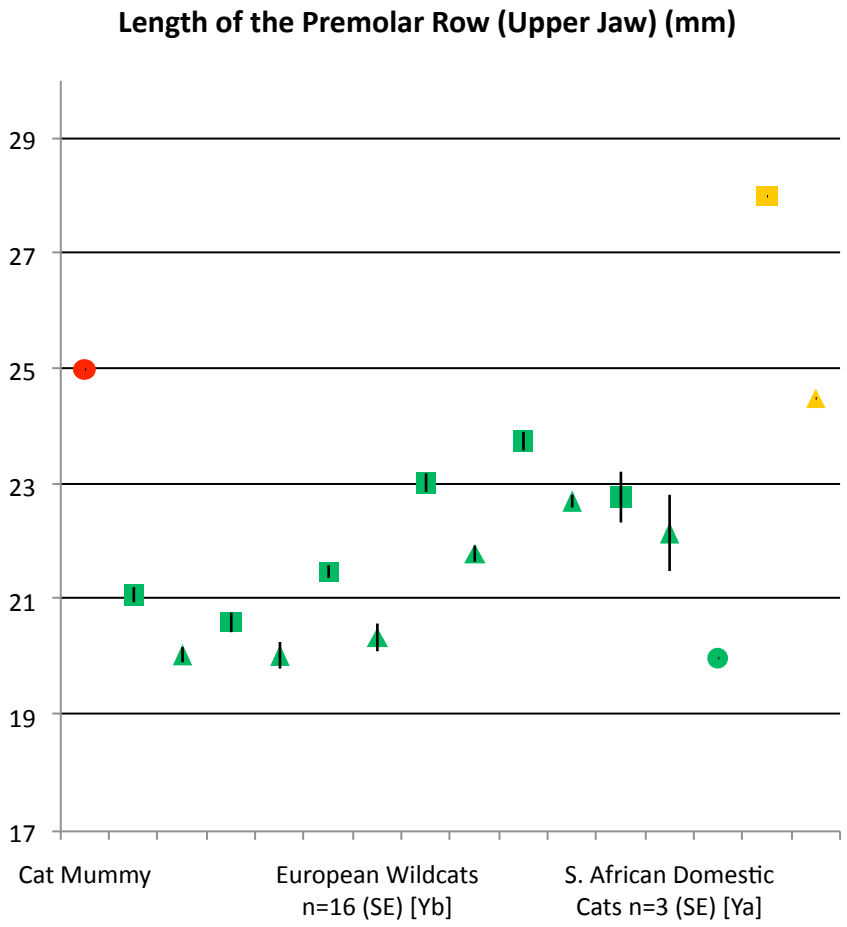
D


Greatest Breadth of the upper Canine Alveolus (mm)
7
6
5
4
3
Cat Mummy
F. silvestris n=5-10 [GV]
F.silvestris n=5-10 [GV]
F. chaus n=5-10 [GV]
F. chaus n=5-10 [GV]

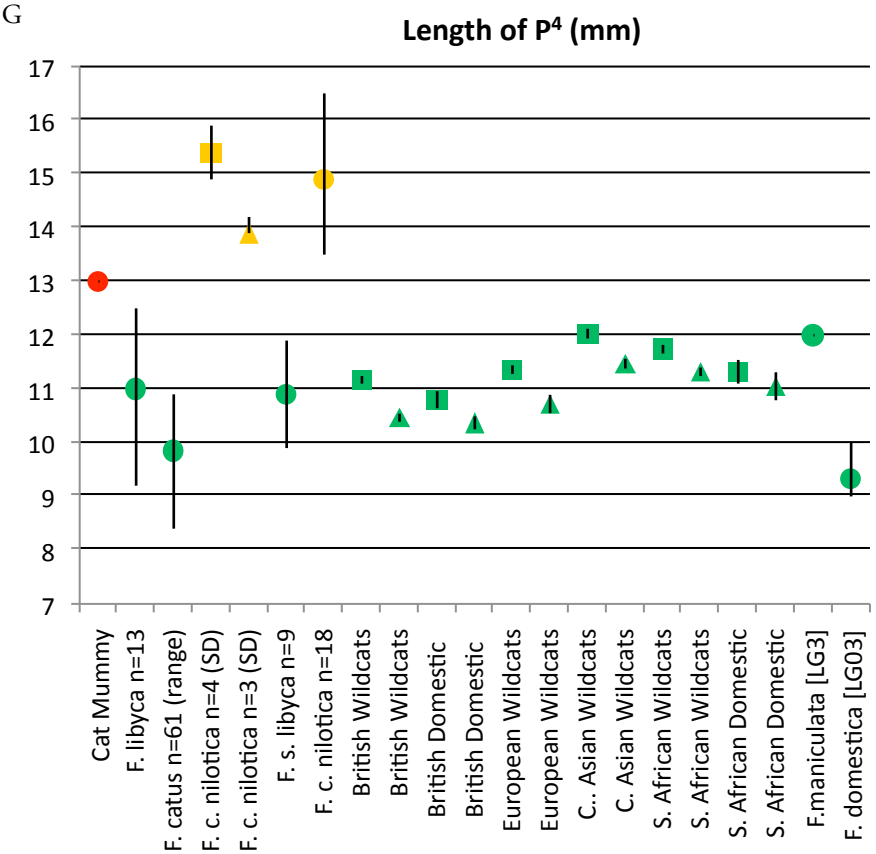
E


Greatest Length of the upper Canine Alveolus (mm)
7
6,5
6
5,5
5
4,5
4
Cat Mummy
F. silvestris n=5-10 [GV]
F. chaus n=5-10 [GV]

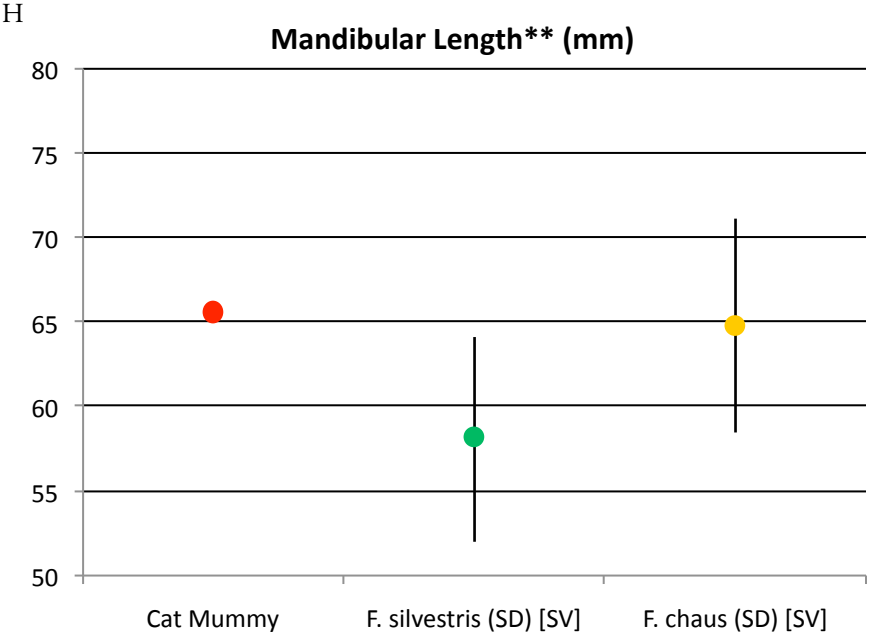
F


Length of the Premolar Row (Upper Jaw) (mm)
29
27
25
23
21
19
17
Cat Mummy
European Wildcats n=16 (SE) [Yb]
S. African Domestic Cats n=3 (SE) [Ya]

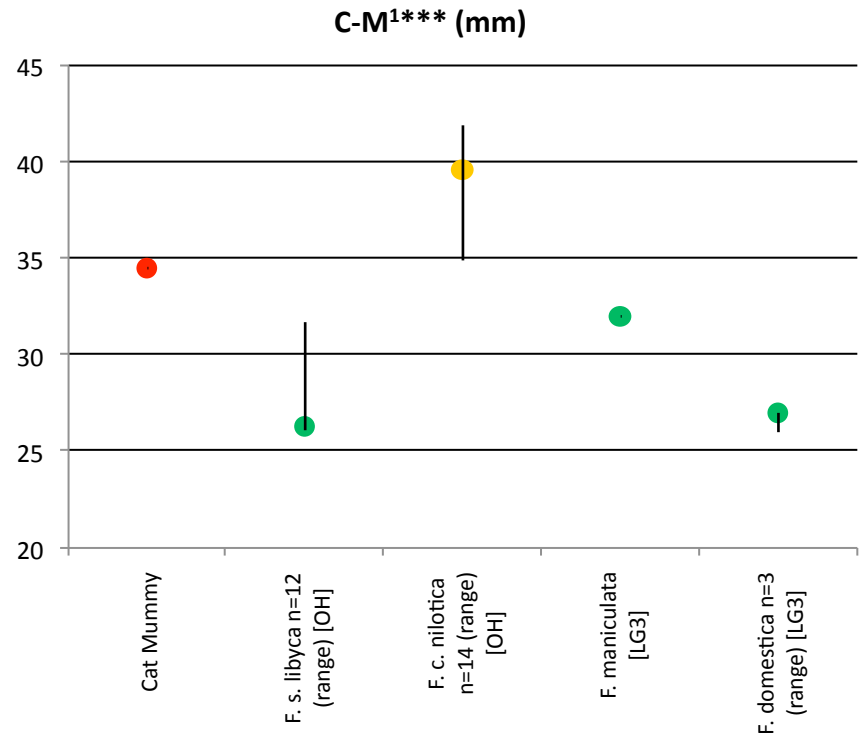
G


Length of P4 (mm)
17
16
15
14
13
12
11
10
9
8
7
Cat Mummy
F. libyca n=13
F. catus n=61 (range)
F. c. nilotica n=4 (SD)
F. c. nilotica n=3 (SD)
F. s. libyca n=9
F. c. nilotica n=18
British Wildcats
British Wildcats
British Domestic
British Domestic
European Wildcats
European Wildcats
C.. Asian Wildcats
C. Asian Wildcats
S. African Wildcats
S. African Wildcats
S. African Domestic
S. African Domestic
F.maniculata [LG3]
F. domestica [LG03]

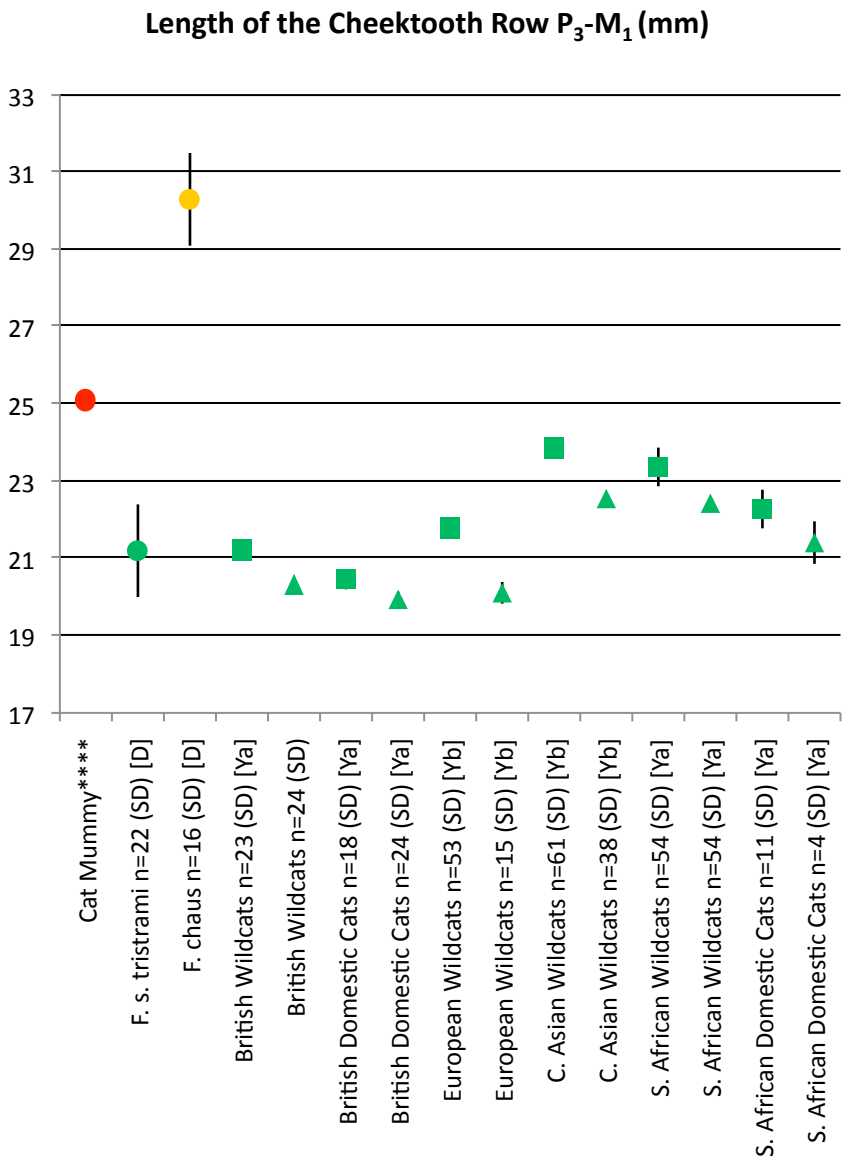
H


Mandibular Length** (mm)
80
75
70
65
60
55
50
Cat Mummy
F. silvestris (SD) [SV]
F. chaus (SD) [SV]

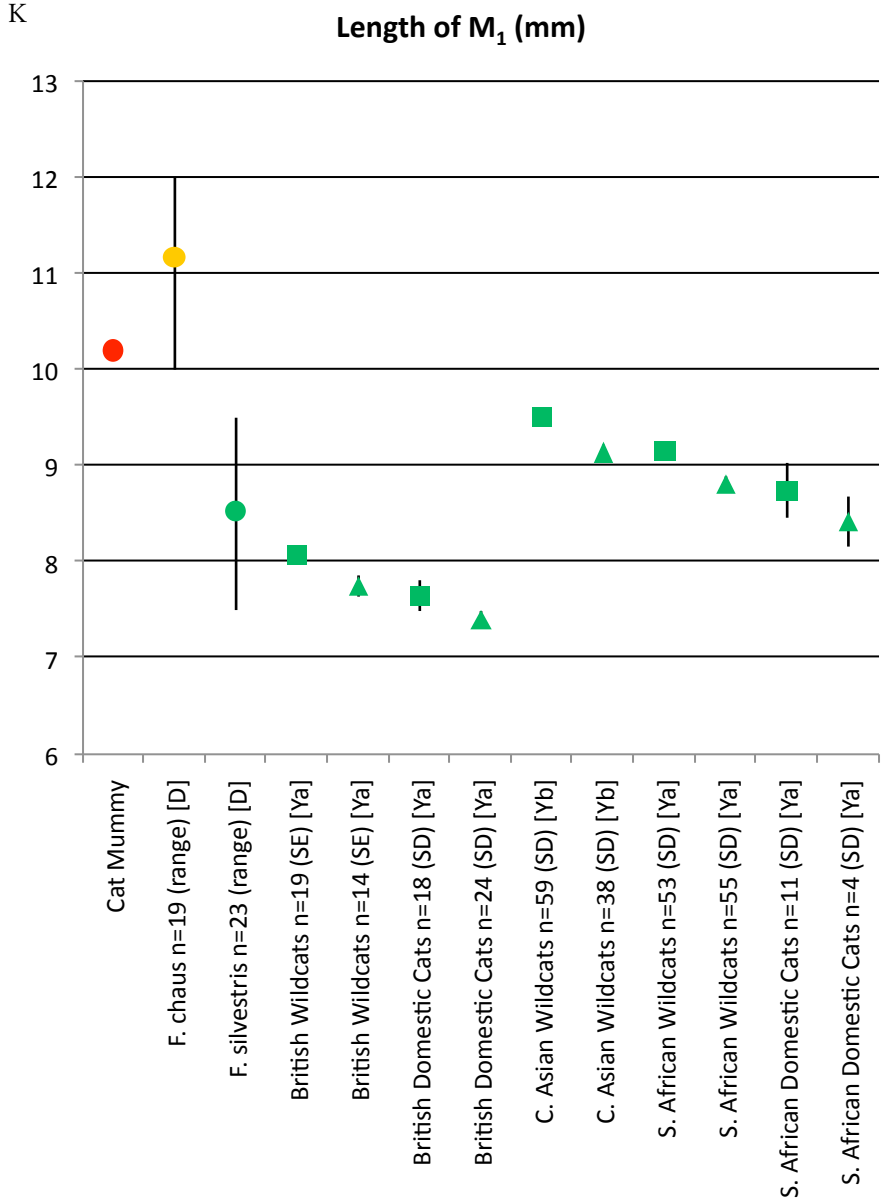
I


C-M1*** (mm)
45
40
35
30
25
20
Cat Mummy
F. s. libyca n=12 (range) [OH]
F. c. nilotica n=14 (range) [OH]
F. maniculata [LG3]
F. domestica n=3 (range) [LG3]

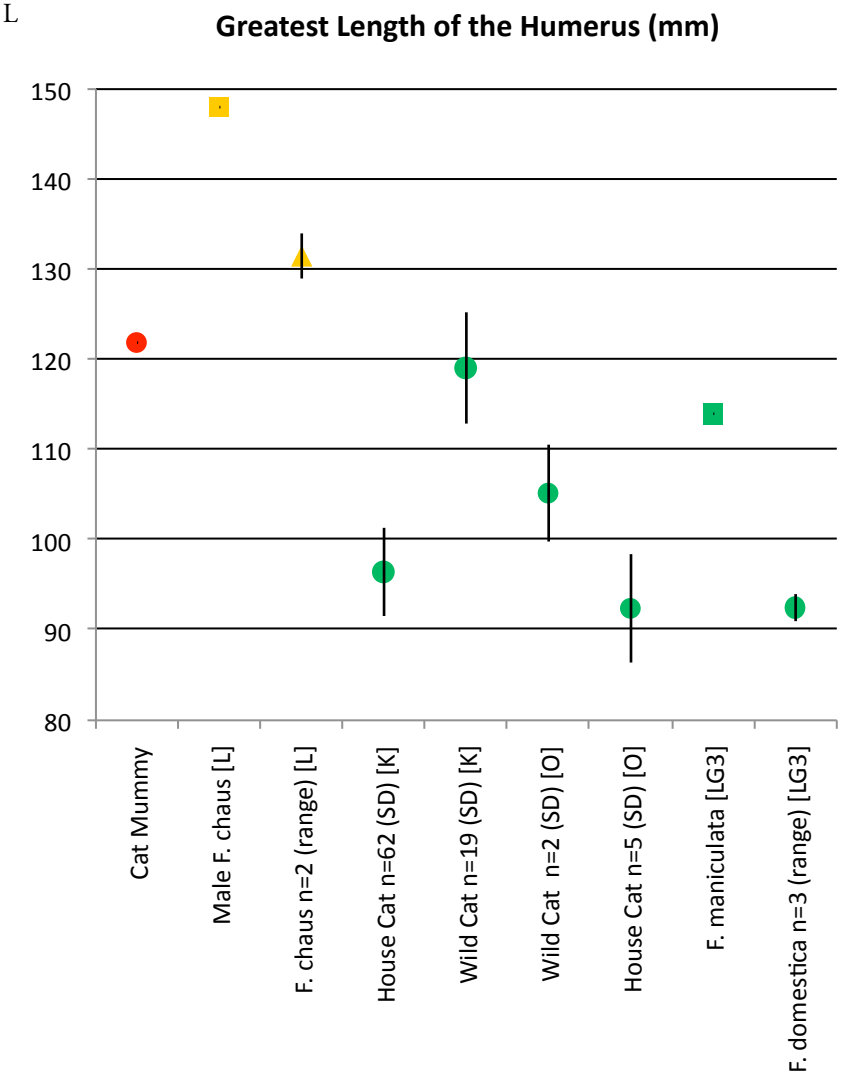
J


Length of the Cheektooth Row P_3-M_1 (mm)
33
31
29
27
25
23
21
19
17
Cat Mummy****
F. s. tristrami n=22 (SD) [D]
F. chaus n=16 (SD) [D]
British Wildcats n=23 (SD) [Ya]
British Wildcats n=24 (SD)
British Domestic Cats n=18 (SD) [Ya]
British Domestic Cats n=24 (SD) [Ya]
European Wildcats n=53 (SD) [Yb]
European Wildcats n=15 (SD) [Yb]
C. Asian Wildcats n=61 (SD) [Yb]
C. Asian Wildcats n=38 (SD) [Yb]
S. African Wildcats n=54 (SD) [Ya]
S. African Wildcats n=54 (SD) [Ya]
S. African Domestic Cats n=11 (SD) [Ya]
S. African Domestic Cats n=4 (SD) [Ya]

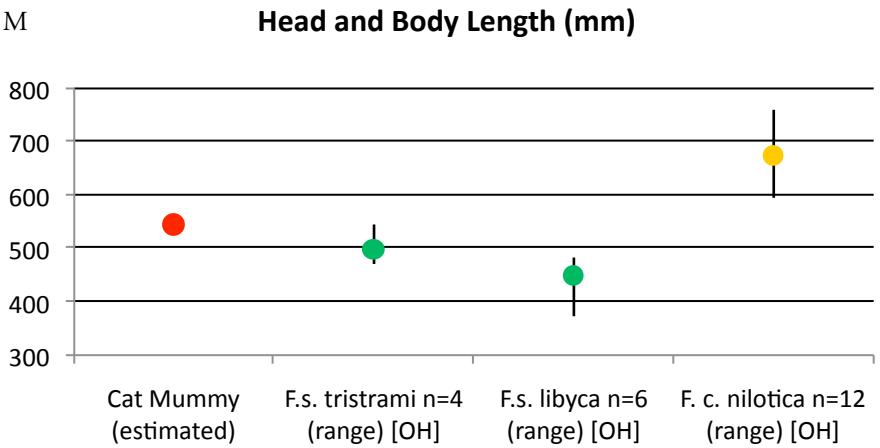
K


Length of M_1 (mm)
13
12
11
10
9
8
7
6
Cat Mummy
F. chaus n=19 (range) [D]
F. silvestris n=23 (range) [D]
British Wildcats n=19 (SE) [Ya]
British Wildcats n=14 (SE) [Ya]
British Domestic Cats n=18 (SD) [Ya]
British Domestic Cats n=24 (SD) [Ya]
C. Asian Wildcats n=59 (SD) [Yb]
C. Asian Wildcats n=38 (SD) [Yb]
S. African Wildcats n=53 (SD) [Ya]
S. African Wildcats n=55 (SD) [Ya]
S. African Domestic Cats n=11 (SD) [Ya]
S. African Domestic Cats n=4 (SD) [Ya]

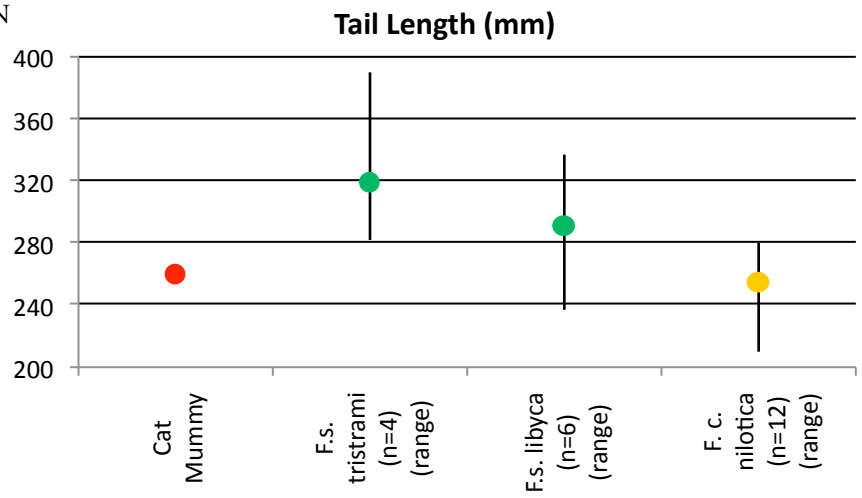
L


Greatest Length of the Humerus (mm)
150
140
130
120
110
100
90
80
Cat Mummy
Male F. chaus [L]
F. chaus n=2 (range) [L]
House Cat n=62 (SD) [K]
Wild Cat n=19 (SD) [K]
Wild Cat n=2 (SD) [O]
House Cat n=5 (SD) [O]
F. maniculata [LG3]
F. domestica n=3 (range) [LG3]

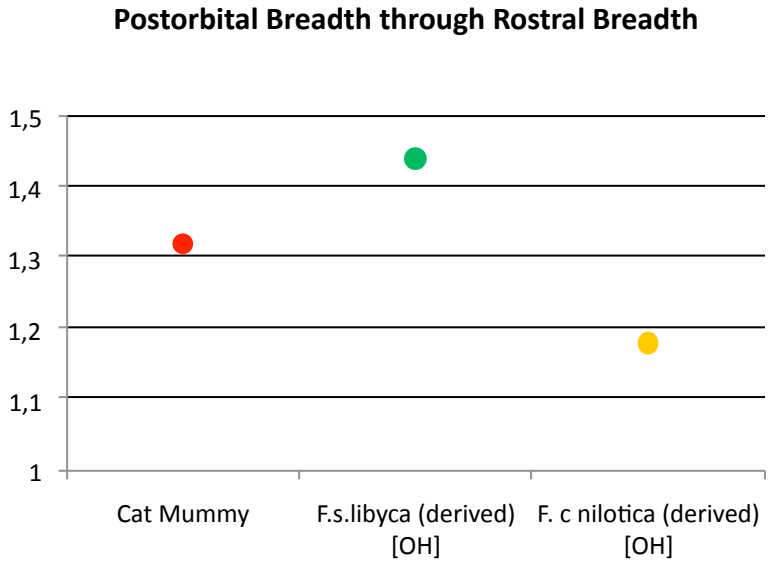
M


Head and Body Length (mm)
800
700
600
500
400
300
Cat Mummy (estimated)
F.s. tristrami n=4 (range) [OH]
F.s. libyca n=6 (range) [OH]
F. c. nilotica n=12 (range) [OH]

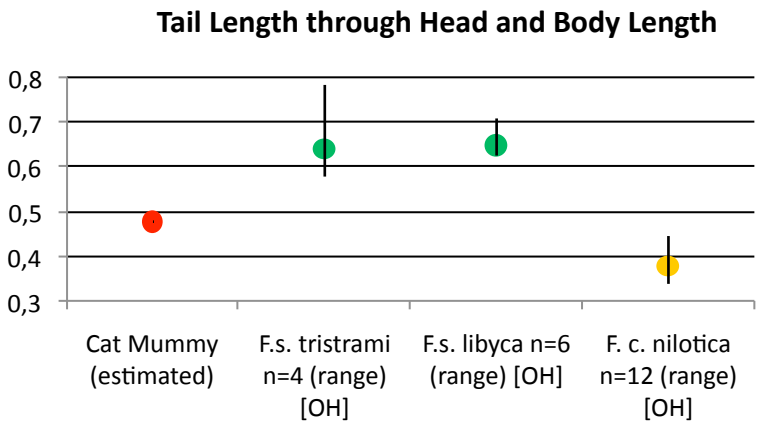
N


Tail Length (mm)
400
360
320
280
240
200
Cat Mummy
F.s. tristrami (n=4) (range)
F.s. libyca (n=6) (range)
F. c. nilotica (n=12) (range)

O


Postorbital Breadth through Rostral Breadth
1,5
1,4
1,3
1,2
1,1
1
Cat Mummy
F.s.libyca (derived) [OH]
F. c nilotica (derived) [OH]

P


Tail Length through Head and Body Length
0,8
0,7
0,6
0,5
0,4
0,3
Cat Mummy (estimated)
F.s. tristrami n=4 (range) [OH]
F.s. libyca n=6 (range) [OH]
F. c. nilotica n=12 (range) [OH]

● Cat Mummy

● F. silvestris Reference Groups

● F. chaus Reference Groups

○ Undetermined Sex

□ Male

△ Female

Table 5A-P. The diagrams on the previous pages show the different measurements plotted for the various reference groups. "n" equals the number of individuals (if more than one); range or distribution measure is indicated within parenthesis (SE=standard error; SD=standard deviation). Sources are abbreviated within square brackets as following: GV=Gittleman and Valkenburgh (1997); K=Kratochvil and Kratochvil (1976); L=Linseele et al. *(2007); LG3=Lortet and Gaillard (1903); LG7=Lortet and Gaillard (1907); MS=Morrison-Scott (1952); O=O'Connor (2007); OH=Osborn and Helmy (1980); SV=Slater and van Valkenburg (2009); Ya=Yamaguchi* et al. *(2004a) and Yb=Yamaguchi* et al. *(2004b). * Defined as in Osborn and Helmy; ** Length from the condyle process to the anterior border of the canine alveolus; *** Distance between the anterior end of the canine alveolus and the posterior part of the molar alveolus; **** The measurement was taken in a plane splitting the left mandible in two halves along its length, observed from the lingual side of the mandible.*

The large size of some mummified cats has been observed previously (Morrison-Scott 1952; Von den Driesch and Boessneck 1983). This can be attributed to the occurrence of natural breeds, lifestyle, natural hybridization, artificial breeding or a skewing in the samples brought back to museums. However, there is an obvious problem with comparing the morphology of contemporary domestic/wild cats with ancient cat remains, as we do not know how these may have evolved in shape, size and distribution over the millennia.

An additional illustration of the problematic nature of species determination is the Predynastic cat found in Hierakonpolis and published by Linseele *et al.* (2007). The authors initially claimed it to likely be a representative of *F. silvestris* based on postcranial measurements but withdrew that statement on the grounds of addition alveolar measurements of the upper jaw which they judged too large for *F. silvestris* and re-identified the cat as a probable *F. chaus.* Interestingly, the corresponding measurements for the cat of this study were generally smaller but in some cases identical to or only slightly smaller (data not shown) than the one from Hierakonpolis. Another ancient cat skeleton from Egypt that has been noted as being especially large is a Roman Period cat mummy found at Quseir (Von den Driesch and Boessneck 1983). The authors claimed, despite its robust skeleton and large size, that it was indeed a domestic cat and not a wild species. Only four out of 17 comparable cranial and post-cranial measurements of that cat were larger than the corresponding measurements for the cat mummy of the present study though. The rest were smaller or much smaller (data not shown).

Conclusion

The results of the mtDNA typing and the CT examination taken together rule out the possibility, despite its large size, of this particular cat mummy being a full *F. chaus* individual. There is still a possibility, however, that the cat is a hybrid between a *F. silvestris* female and a *F. chaus* male, or possessing another variant of mixed ancestry where the mitochondrial genome of a *F. silvestris* has been transferred through the maternal line. Cross-breeding between *F. silvestris* and *F. chaus* is indeed possible (Robinson and Vella 1999) but less common in nature where the habitats of these two species rarely overlap (Sunquist and Sunquist 2002). However, the Nile Delta and the fringes of the Nile Valley may have been a unique meeting point for wild and domestic *F. silvestris* species and the *F. chaus*. Thus, one or several hypothetical hybridization event(s) may partly explain the seemingly haphazardly mixed set of characteristics indicative of *F. silvestris* and *F. chaus* respectively, as well as the presence of the intermediate traits shown in this study. Such occasional hybridization events (natural or artificial) may have contributed to the heterogeneity observed among ancient Egyptian cat remains, regardless of the origin of the domestic cat or its domestication. However, comparative material on the morphology of such hybrids is lacking.

Given that the multiplicity of both methods and data in this case does not provide a certain species identification, it seems as a wider distribution in morphology and sizes should be considered when studying archaeological cat remains. A possible explanation for the range of characteristics of the cats held by the ancient Egyptians may be hybridization at a significant extent with another felid species other than the ancestral species of the domestic cat, where *F. chaus* is the most likely candidate. The heterogeneity of cats in antiquity is also in concordance with the presence of multiple matrilines, perhaps of separate domestication events, among mummified cats from Roman Period Egypt, at the latest.

We thus question the validity of the results of other studies in which exceptional archaeological cat remains have been classified as either *F. silvestris* (including domestic cat and other subspecies) or as *F. chaus* (Morrison-Scott 1952; Von den Driesch and Boessneck 1983; Linseele *et al.* 2007; 2008). We also argue that there is a lack of sufficient reference material at the moment to solve this issue with satisfaction, both with regards to chronology, quantity and quality of the data.

Acknowledgements

The authors are greatly indebted to the following persons and institutions: Catrin Hammer, Al Wabra Wildlife Preservation Sheikh Saoud Bin Mohd Bin Al-Thani, for providing the sample of a *F. chaus* individual; Anders Götherström, Department of Evolutionary Biology Uppsala University for providing aDNA laboratory facilities and guidance; Anders Magnusson, Uppsala University Hospital for providing access to radiology equipment and Wim van Neer, Royal Belgian Institute of Natural Sciences for helpful communication and suggestions.

Supporting Material

Complete documentation on material, methods, results and comparative data is available from the authors upon request.

The Potential of Dendrochronology in Egypt: Understanding Ancient Human/Environment Interactions

Pearce Paul Creasman

Introduction

Despite being the focus of nearly 200 years of research and thousands of archaeological excavations, together with the survival of an extensive written record, the chronology of ancient Egypt remains based on fragmented, sometimes contradictory, quoted excerpts and summaries of a 3rd c. BC historian's chronicle of the pharaonic period, Manetho's "Aegyptiaca" (Waddell 1940). Manetho divided his long list of Egyptian kings into 31 dynasties and attributed a length of reign to each king, whose correlation with kings known from the archaeological record is not always clear. To refine this most basic and imperfect framework, Egyptologists have had to rely on a variety of insufficiently precise sources and methodologies, including astronomical orientations, Sothic cycles, other ancient king lists, synchronisms with other cultures, and radiocarbon dating (e.g. Spence 2000; Hornung *et al.* 2006; Wiener 2006; Bronk Ramsey *et al.* 2010; Dee *et al.* 2012; Shortland and Bronk Ramsey 2013). It is not, however, the intent of this article to discuss the specific chronological issues in Egyptian history (which have been thoroughly treated by others), but rather to propose that dendrochronology could address and resolve these problems, as it has elsewhere.

At present, accurate absolute dating in Egyptology extends only as far back as the transition from the 25th Dynasty to the 26th: 664 BC (for a thorough review of this question, see Schneider 2010; 2012), although several scholars present strong arguments for the certainty of earlier dates (e.g. Kitchen 2013; Shortland 2013). Even this one seemingly modest conclusion has been made possible only through the herculean efforts of a dedicated group of scholars who base their work primarily on textual records, with selective inclusion of archaeological results. The entire period that the general public tends to conceive of as "ancient Egypt"– that of the great pyramid builders and the Valley of the Kings – remains unresolved and subject to reams of discussion, supposition, and approximation.

As a result, it is not uncommon to find an edited volume or journal fascicle with a variety of dates ascribed to the same reign or event, or at least littered with circas. Consistency is even less prevalent when multiple journals (or other works) are compared among each other. This is not a criticism but rather an observation of opportunity and need for improvement. One notable and continuing effort to confront this observation resulted in the recent publication of "Radiocarbon and the Chronologies of Ancient Egypt" (Shortland and Bronk Ramsey 2013).

Radiocarbon Dating

Radiocarbon dating is performed by measuring the remaining amounts of a radioactive isotope of carbon within a sample of organic matter. Plants, especially, absorb radiocarbon throughout their lifetimes, via photosynthesis; upon their death (such as the harvesting of a tree), radiocarbon is no longer absorbed and the extant radiocarbon begins to decay at a known rate. The amount remaining in a sample is measured, either by a rate ("Beta-counting") or a ratio (Acceleratory Mass Spectrometry) of decay, resulting in "BP" dates, or "years Before Present" (Before Present is defined as AD 1950). Yet, BP dates cannot be equated to calendar years, due to inconsistent levels of radiocarbon in the atmosphere throughout time (for greater detail regarding the radiocarbon method of dating, see Bronk Ramsey 2013).

To increase accuracy, radiocarbon decay rates or ratios are also commonly statistically calibrated against a known curve of radiocarbon levels. For the Pharaonic period, these known levels are primarily measured from five- or, more commonly, ten year sections of wood that have been dated to modern calendar years via dendrochronology (a method that will be described in more detail below; for the role of dendrochronology in radiocarbon dating, see Friedrich *et al.* 2004; Leavitt and Bannister 2009; Kromer 2009). These dates are known as "calibrated years" (cal or cal.), and they account for the inconsistent levels of radiocarbon.

However, even the resulting calibrated radiocarbon dates are not exact. A calibrated radiocarbon date is given as a range of years, with an indication of statistical probability – not as a precise calendar date. For example, the calibrated radiocarbon dating of a papyrus known to date from the reign of King Djedkare of the 4th Dynasty yielded a 95.4% chance of dating to 2475-2298 cal BC, a span of 177 years, or a 68.2% chance of either of two narrower, but still multi-decade, ranges: 2468-2401 cal BC (44.1%) or 2382-2347 cal BC (24.1%) (Bronk Ramsey 2013). Individual samples from Amarna, which was occupied for less than a generation during the 18th Dynasty, give radiocarbon dates regularly spanning two or three decades (or more) with accuracies hovering near 70% (Manning *et al.* 2013). Critically, even such modest ranges exceed the lengths of many kings' entire reigns: some 150 of the known pharaohs ruled for very short periods – less than ten years – presently far outside the range of precision provided by radiocarbon even in the best of circumstances. As a former Secretary General of the Supreme Council of Antiquities once acknowledged:

> *"In order to date Egyptian dynasties, we need to have specific dates; you cannot use carbon dating"* (Cattane 2010 [online: http://www.egyptindependent.com/news/egyptian-archeologists-comment-carbon-dating]).

This seems to represent the opinion of many in the archaeological administration, making it important to consider in any chronological endeavor for Egypt.

Radiocarbon dating has great utility, but providing exact dates is not and can never be one of them (for a recent critique of other problems with radiocarbon dating relative to Egyptology and related fields, see Bietak 2013). Thus, while radiocarbon can be a significant aid in adjusting "big picture" chronological issues or can assist in placing sites or artifacts in their dynastic context, it lacks the precision to resolve the essential chronological issues. The only method that offers the chronological resolution needed to understand and assign calendar dates to ancient Egyptian events and processes is dendrochronology: the study of tree-rings.

Dendrochronological Dating

Dendrochronologists study tree rings as natural chronometers and recorders of change in the environment. Tree rings provide a perspective on pre-industrial cultures and environments that is otherwise unattainable. The methodology is often compared to the assembly of a jigsaw puzzle: pieces, collected from a wide variety of sources, are painstakingly fitted together over a period of years to build up a complete (or nearly so) image with annual – and often seasonal – precision.

If the annual resolution that dendrochronology offers could be established for ancient Egypt, the impact would be similar to that of annual resolution in the American Southwest, which revolutionized our understanding of the history of this region – one lacking written records – before the arrival of Europeans (see Douglass 1929; Haury 1962), and furthermore would have broad implications for the interconnected Near East and Mediterranean world. This is not a new realization (e.g. Haury 1935; Bannister 1970; Creasman *et al*. 2012). The need for such precision in Egyptian history and that of its neighbors has been recognized for at least a century, as has the potential solution: dendrochronology.

The growth habits of many species of trees result in concentric rings that are visible in the wood. These rings are formed by growth in reaction to environmental (and human-imposed) processes, typically changes in precipitation or temperature, which encourage (precipitation, for example) or discourage (drought) tree growth. For many trees, including the prized conifers so often used in ancient Egypt, each complete annual growth ring represents one year. With a sufficiently large set of comparative materials, the year the tree was felled can be determined by matching the tree-ring patterns (Fig. 1). Although pattern matching is not, strictly speaking, how dendrochronological dating is performed, and is an over simplification of the process, it serves as a useful concept (an introductory guide can be found in Stokes and Smiley 1968).

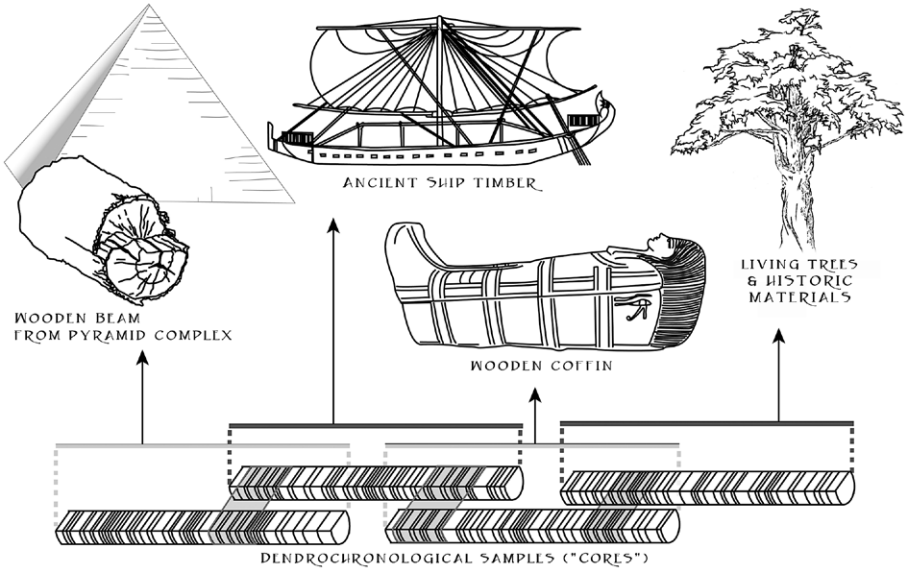


Fig. 1. Chronology building via tree-rings for ancient Egypt (drawing: R. Caroli; courtesy of University of Arizona Egyptian Expedition 2013).

The environment in which the tree has grown affects characteristics of the rings. Some trees grow in conditions that have a greater impact on the width of rings. These conditions might be the availability of water (as in the desert southwest of the USA) or, at northern latitudes and high altitude, temperature (Bannister 1963). Relatively narrower widths indicate a limitation of resource or otherwise less favorable condition to which the tree was subjected during that growing season, such as drought. Patterns of wide and narrow widths are plotted or measured, and these are compared with the plots or measurements of other specimens from a similar origin (ideally of the same species or genus) that would have been subjected to similar environmental fluctuations. Overlap of patterns between specimens of differing age, known as crossdating, results in extension of the chronology (see Douglass 1941 for a discussion of crossdating). When specimens of known date are included to anchor the chronology to the present, such as from a living tree, an absolute chronology with annual precision can be established. For some parts of the world, such tree-ring "master chronologies" have been built going back 14,500 years (Friedrich *et al.* 2004). After the establishment of a master chronology for a region or genus/species, comparing the tree-ring data of specimens of unknown date to it will often permit their placement within the timeline.

Dendrochronology is the only method of geochronological or archaeological dating that is accurate to the calendar year (see Bannister 1963; Stokes and Smiley 1968; Dean 1978); unlike radiocarbon dating, in which the answer is necessarily a span of decades or even centuries, in dendrochronology even

> *"a one-year error is […] egregious" (*Kuniholm 2002: 64).

If a tree is cut or otherwise dies during its growing season, dating accuracy can be identified to within approximately two months in the best cases – more than sufficient for correlation with the three seasons recognized by the ancient Egyptians (*ꜣḫt*, *prt*, and *šmw*) – providing the maximum level of precision possible today.

Dendrochronology and Egypt

In the 1920s, Andrew Ellicot Douglass, the inventor and "father" of dendrochronology, was in contact with prominent Egyptologists exploring the possibility of constructing a tree-ring-based chronology for ancient Egypt. By 1932, Douglass, in consultation with numerous members of the Egyptological and museum communities, concluded that a sufficient volume of material already existed in the museums of the world to make substantial progress (Douglass 1932; Breasted 1933). Since Douglass, numerous scholars have directly or indirectly called for the construction of a tree-ring chronology for Egypt or the proxy records it provides, including James H. Breasted (1933), Emil Haury (1935), Ambrose Lansing (1938), Ludlow Bull (1942), Bryant Bannister (1970; 1985), Jeffrey S. Dean (1978), Colin Renfrew (1996), Peter Ian Kuniholm (1992; 2001; 2002), Ian Shaw (2000), Otto Cichocki (2000; 2006), Nadine Moeller (2005), Kenneth A. Kitchen (2006), Malcolm H. Wiener (2006), and others.

Emil Haury, a student of Douglass's and himself a pioneer in Southwestern American archaeology and member of the (US) National Academy of Sciences, conducted the earliest fieldwork in pursuit of a tree-ring chronology for Egypt. He collected specimens from the Boston Museum of Fine Arts in the early 1930s, concluding:

> *"I believe it is not unlikely that tree-rings might well substantiate and possibly amplify"* (Haury 1935: 108)

the chronology of ancient Egypt. Fervently in agreement that the goal could be achieved, Bryant Bannister, a student of Haury's and likewise an eminent dendroarchaeologist, collected specimens from major monuments in Egypt in the 1960s (e.g. Bannister 1970). After analyzing the specimens Bannister had collected, Jeffrey S. Dean, a dendroarchaeologist and recipient of both the Alfred Vincent Kidder Award for Eminence in the Field of American Archaeology and the Society for American Archaeology's Lifetime Achievement Award, stated:

> *"a study of wood samples from an Egyptian pyramid indicates that future successes in this area are possible"* (1978: 140).

Bannister and Dean, both specialists in the American Southwest occupied with other tasks, did not advance the study for Egypt further but supported the development of Peter Ian Kuniholm's career. Kuniholm proved the utility of dendrochronology with ancient Egyptian materials by building a 523-year floating chronology from one of the four small 12th Dynasty boats from the pyramid complex of Senwosret III (1992; regarding the boats, see Patch and Haldane 1990;

Ward 2000; Creasman 2010a; Creasman *et al.* 2010). Critically, by matching an older coffin from Saqqara in the Oriental Institute Museum, Chicago (OIM 12072; First Intermediate Period) with the chronology derived from the Dahshur boat, he demonstrated that ancient imported timber (*Cedrus libani*, Lebanese cedar) from Egyptian sites can be crossdated (Kuniholm 1992; 2001). Despite the occasional collection of specimens from individual sites throughout Egypt (e.g. Gerisch *et al.* 2007), little other progress has been made toward a dendrochronology for ancient Egypt. The usefulness of native timbers, such as acacia (*Acacia nilotica*), for dendrochronological purposes has been inadequately explored, although efforts are being made for similar species in other arid/semiarid regions, including the Near East and Ethiopia (e.g. Gourlay 1995a; 1995b; Eshete and Ståhl 1999; Touchan and Hughes 2009; Nicolini *et al.* 2010, Wils *et al.* 2010; 2011). Furthermore, there has been no systematic effort to collect and analyze wood specimens spanning all periods from sites or museums all over Egypt, nor does Egypt possess a centralized wood sample repository that would be critical to this process.

There is, then, at present no fixed dendrochronology for ancient Egypt, although there may well be adequate resources to accomplish this: the wood of ships and boats, coffins, architecture, statuary, and other objects all may hold hidden pieces of the chronological puzzle. Until these are further studied and a master tree-ring chronology is built, a precise understanding of the historical (and pre-historical) timeline will remain elusive.

However, information concerning many things other than chronology can be derived from investigations of archaeological wood. Notably, tree rings serve as proxy records for environmental conditions, such as drought, and will likely be the key to evaluating environmental theories of dynastic collapse (Bell 1971; 1975; Moeller 2005; Hassan 2007; Touchan and Hughes 2009). Furthermore, there is much about human behavior in direct relation to the environment that can be learned through the study of wood.

Human/Environment Interactions

The study of archaeological wood-use behaviors and extrapolation from wood of other general behavioral knowledge is a relatively recent focus in the field of tree-ring analysis, gaining momentum with Jeffrey Dean's work (1996), although it was proposed and briefly pursued much earlier (Robinson 1967; Nash 2002). The fundamental concept, as stated by Dean (1996: 466), is that:

> *"The more we understand the behavior involved in wood procurement, use, discard and consumption, the better we will be able to assign unambiguous dates to human events."*

This is especially important for societies that made intensive uses of wood and lack reliable chronologies. One such society is, of course, that of ancient Egypt.

Although Dean addressed human/environment interactions through wooden structures other than watercraft, ships and boats are the primary case study employed here because of the importance of watercraft in ancient Egypt (e.g.

Vinson 2009; 2013) and because ship or boat timbers record a complex story of material use and behavior. A tree trunk or branch must be significantly modified for use in a hull (Fig. 2). When such timbers are imported, as was often the case for Egypt, there are additional human/environment aspects to be evaluated. Complete watercraft also tend to provide a large source of contemporaneous material with which to work.

When ships are analyzed as collections of individual artifacts (as are, for example, ceramic sherds or deconstructed architectural stone blocks), the data can extend far beyond the scope of a ship's construction and technology (the usual foci of ship studies), back to events in the shipyard where it was built, up the supply chain, and into the forests from which the timbers were harvested. Much of this information typically remains unknown through other sources, primarily because

Fig. 2. Ship timbers superimposed on a parent tree (drawing: R. Caroli; courtesy of University of Arizona Egyptian Expedition).

most aspects of ship building and supply were closely guarded trade secrets, rarely if ever recorded. But each of these stages results in modification(s) to the raw material, often leaving perceptible evidence of human interactions upon this valuable natural resource. To this end, there has been identification of at least nine investigatory categories that yield significant behavioral information, especially as relates to the acquisition, use, and management of raw materials: age clusters; assembly and construction marks; relative timber age; reuse; species identification and use; timber conversion; timber size and shape; tool marks; and wood anatomy. An explanation of each can be found in Creasman (2010b), and they are also addressed elsewhere in greater detail than is possible here (e.g. Gale *et al.* 2000; Ward 2004; Creasman 2010a; Mark 2012; Creasman 2013); however, an exemplar is provided below.

Timber Conversion

Dendrochronological analyses can be extremely informative regarding timber conversion and the amount of waste wood produced in the course of obtaining construction materials. Wood was a valuable resource in Egypt, especially when imported. The watercraft that provide the most reliable studies of timber conversion (i.e., the creation of useable timber from the raw material; Fig. 3) are the 12th Dynasty Dahshur boats (Fig. 4): five boats buried just outside the pyramid complex of Senwosret III and presumed to have been affiliated with the king's burial ritual (Creasman *et al.* 2009). The Dahshur boats are nearly complete and the most thoroughly studied Egyptian watercraft (e.g. Ward 2000; Creasman 2010a). It has been estimated that no fewer than eighteen mature cedar trees were required for the construction of a single boat, including its beams, decking, and planking (this being Newton's estimate for the boat now in the collection of the Carnegie Museum of Natural History, Pittsburgh; Ward 2000). This estimate was

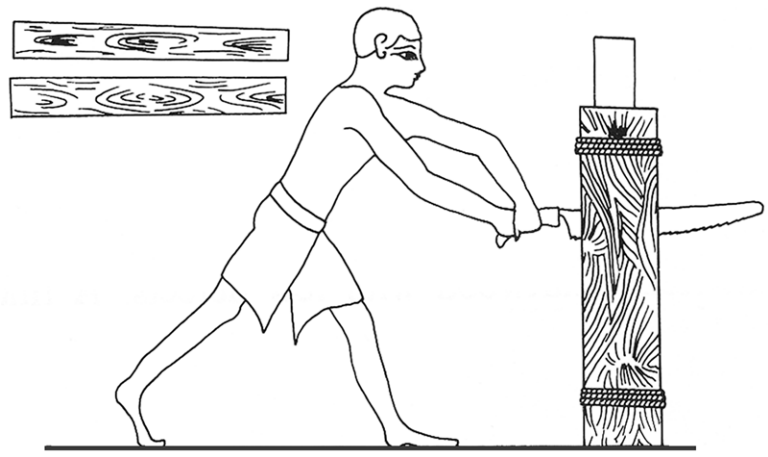


Fig. 3. 18th Dynasty carpenter from the tomb of Rekhmire (TT 100) at Thebes converting timber to planks (drawing: R. Caroli, after: Davies 1943: pl. 40; Killen 1994: fig. 7).

Fig. 4. Two views of a Cairo Dahshur boat, CG 4925, the "white boat" (photo: P.P. Creasman. Courtesy Egyptian Museum, Cairo).

achieved through comparison of timber grains and tree-ring patterns, by which portions of a single tree can be identified. If this figure holds true for the four other Dahshur boats, it would indicate the importation of approximately one hundred trees, a kingly haul and conspicuous consumption of resources.

Dendrochronological analyses have also demonstrated that opposing port (left) and starboard (right) side timbers were cut from the same tree, probably to encourage symmetry in hull shape (Ward 2000). Since watercraft were built by eye (that is, no blueprints or plans are known to have existed), using multiple cuts from the same tree could provide somewhat similar curvatures. It is not surprising that the shipbuilders employed this practice, which is probably common throughout the five hulls; however, only the vessel now in Pittsburgh has been subjected to this kind of analysis. Matching distinct knot and grain patterns in the remainder of the hull suggests that symmetry was practiced elsewhere on the Pittsburgh boat (*Ibidem*). The Chicago boat, being the least studied but best preserved of the Dahshur group, would be an ideal candidate for such analyses.

Timber conversion studies can also reveal the methods used to shape the timber and the quality of cuts. Gale *et al.* (2000) and Killen (1994) offer thorough analyses of ancient Egyptian timber preparation methods. Kuniholm's (1992) analysis of the Pittsburgh Dahshur boat suggested not only that a great percentage of wood was wasted in the boat's construction but also that much of the wood employed was reused. These two practices would seem contradictory. It is possible, even

likely, that these timbers were imported significantly before Senwosret III's reign and harvested from other vessels or structures. Their initial use(s) or application(s) and the associated repetitive trimming would be the cause of what appeared to be one event of "extraordinary" waste, with each subsequent reuse explicable as the product of an intention to conserve materials. Thus this observation is very likely the result of serial reuse, not a single thriftless event that produced much waste (Creasman 2013).

On the other hand, the 11th Dynasty Lisht timbers, which came from one or more disarticulated work boats, were cut so that an

> *"economy of wood use is evident" (*Ward 2000: 110).

The carpenters cut these native acacia and tamarisk timbers strategically to avoid major knots and compression wood (see Pulak 2001 for a discussion of compression wood and its issues in ship construction) and to take advantage of the natural grains and curvatures, presumably to maximize strength and minimize weaknesses in construction.

Conclusion

Archaeological wood, whether from ships or otherwise, when examined with behavioral and environmental contexts in mind, offers great insight into human/environment interactions. As a result of favorable preservation and the ancient Egyptian practice of ritually provisioning individuals for the afterlife, it is likely that hundreds of tons of human-modified wood have been recovered from archaeological excavations in Egypt. Ancient ships, coffins, furniture, and architectural timbers provide a robust source of material for tree-ring-based investigations. Dendrochronological methods offer opportunities to extract vast amounts of information – be it chronological, environmental or behavioral – from excavated materials that are filling valuable space in magazines and museums and may otherwise receive little attention.

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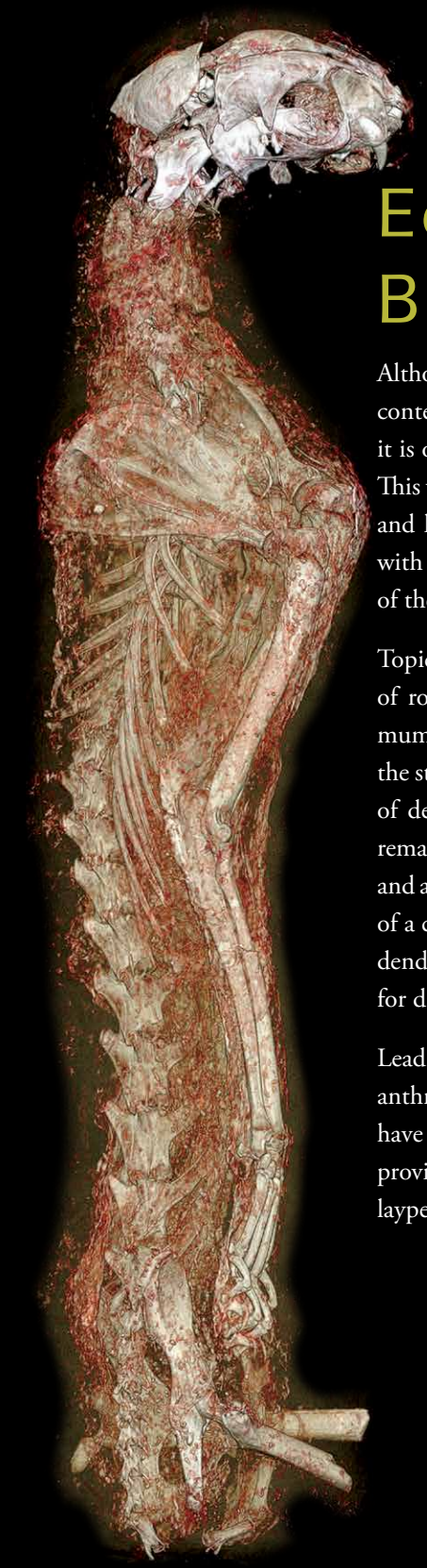

Egyptian Bioarchaeology

Although the bioarchaeology (study of biological remains in an archaeological context) of Egypt has been documented in a desultory way for many decades, it is only recently that it has become an inherent part of excavations in Egypt. This volume consists of a series of essays that explore how ancient plant, animal, and human remains should be studied, and how – when they are integrated with texts, images, and artefacts – they can contribute to our understanding of the history, environment, and culture of ancient Egypt in a holistic manner.

Topics covered in this volume relating to human remains include analyses of royal, elite and poor cemeteries of different eras, case studies on specific mummies, identification of different diseases in human remains, an overview of the state of palaeopathology in Egypt, how to analyse burials to establish season of death, the use of bodies to elucidate life stories, the potential of visceral remains in identifying individuals as well as diseases that they might have had, and a protocol for studying mummies. Faunal remains are represented by a study of a canine cemetery and a discussion of cat species that were mummified, and dendroarchaeology is represented by an overview of its potentials and pitfalls for dating Egyptian remains and revising its chronology.

Leading international specialists from varied disciplines including physical anthropology, radiology, archaeozoology, Egyptology, and dendrochronology have contributed to this groundbreaking volume of essays that will no doubt provide much fodder for thought, and will be of interest to scholars and laypeople alike.

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