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Old Friends, New Tales

The Mummies and Coffins of the Denver Museum of Nature & Science

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Napoleon Bonaparte is often credited as the causal factor in the worldwide interest in mummy studies. During his 1789 invasion of Egypt, the emperor brought with him 100 scientists to document Egyptian society. Accounts from these studies, along with the discovery of the Rosetta Stone, fueled enthusiasm in the Western world for all things Egyptian and catalyzed an interest in artifact and mummy collecting. A corollary of this zeal was the development of the fashionable entertainment practice of "unrolling" ancient Egyptian mummies in the early 1800s. Thankfully, by the 1830s this practice was eclipsed by the more scientifically minded, such as medical doctors and burgeoning Egyptologists. These scientists continued "unrolling" but for the purpose of documenting anatomy, paleopathology, and mummification techniques (Dawson 1938; Moodie 1923; Murray 1910; Pettigrew 1834; Ruffer and Moodie 1921; Smith 2000 [1912]).

Two mummies and three coffins—the primary focus of the volume—emerged from these murky antiquarian practices; through a series of extraordinary events, archival research, and new technological applications, they stand prepared to tell and retell their stories.

Relatively little was known about the two women who now reside at the Denver Museum of Nature & Science (DMNS). They lived in ancient Egypt, died in their thirties, were mummified and interred. We do not know where they lived or died, but by the early 1900s both the mummies and their associated coffins, as well

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as a third coffin lid (EX1997-24.5), had made it to Cairo. Sometime in 1905 they were purchased by Andrew McClelland, a Colorado entrepreneur, and shipped to his home in Pueblo. Nicknamed the "Poor Mummy" and the "Rich Mummy" (among other unfortunate names) over the next century, the two mummies were subject to a variety of scientific and unscientific analyses, none of which were published. By the early 1980s, both the mummies and three coffins had been moved again to the DMNS, where they reside today.

During preparations for updating the Egyptian Hall at DMNS in 2016, scientists at DMNS and affiliate institutions recognized the understudied nature of the mummies and coffins and elected to undertake a series of technologically advanced analyses, both as a supplement to prior work and to take advantage of innovative new analyses. Among initial analyses conducted on the mummies—now known as EX1997-24.1 and associated coffin EX1997-24.2 and mummy EX1997-24.3 and associated coffin EX1997-24.4—were new AMS radiocarbon dates. These data were the first in a series of newly acquired information that enabled a variety of researchers from numerous backgrounds to view the two mummies with new eyes. Additional analyses included pigment analysis of the paints on the coffins using X-ray florescence; analysis of the coffin wood; coffin style and decoration analysis; analysis of varnish and resin samples from one mummy and two coffins with gas chromatography, X-ray diffraction (XRD), and other destructive and non-destructive methods; isotope analysis of tissue from one mummy; linen analysis; and updated conservation efforts.

This volume organizes and presents this work in nine subsequent chapters. Each describes different analytical techniques and how they were employed. The techniques are relatively inexpensive and readily accessible. This volume is intended to serve as a guide for other institutions or individuals who wish to perform holistic studies on extant museum collections of varying material types but specifically Egyptian mummies and coffins. It also adds to the corpus of what we know about Egyptian mummies and coffins.

Chapter 2 discusses in more detail the history of the two mummies and coffins in terms of the context of their discovery and movements (as far as they can be traced) to Colorado. It details previous research on the mummies (e.g., X-rays, basic analyses, historical photos) and presents new radiocarbon dates on the mummies and their coffins. Also provided in chapter 2 is a description of the mummification and coffin manufacture practices of different periods in Egyptian history. Finally, there is a discussion of the political situation in Egypt during the Third Intermediate Period, which is relevant to analyses presented in subsequent chapters.

Chapter 3 is a look at the conservation efforts and techniques employed over the years. It also presents an account of the new treatments performed in 2016. This chapter, written by DMNS conservators Southward and Fletcher, highlights best practices when conserving coffins and discusses which treatments are preferable.

Chapter 4 by Hayes, Weinman, Humphries, Rubinstein, and Koons explores the history of paleoradiography in Colorado and presents the results of updated computed tomography (CT) scans. Although the mummies had been CT scanned in the past, sparse notes on the results were left in the DMNS archives, prompting us to re-scan the mummies with the latest technology available.

Chapter 5 by Arbuckle MacLeod highlights the creation and construction of coffin EX1997-24.4, which is from the early Third Intermediate Period. CT scans of this coffin reveal hidden features, which are explored in their historical context. She also examines material choices and construction techniques in relation to the religious significance of coffins from this era.

Chapter 6 outlines the work of Arbuckle MacLeod, Baisan, and Creasman, who extracted wood samples from the coffins for analysis. Here, the different types of woods used for the different parts of the coffins are explored. The samples will ultimately contribute to an ancient Egyptian tree-ring database, which is currently in its infancy.

Chapter 7 details the pigments used on the coffins as assessed by Cundiff, Clark, and Miller with portable X-ray fluorescence (pXRF) and scanning electron microscopy (SEM). They found examples of Egyptian blue, that the color yellow is highly variable and can be made from various materials, and that although there are some drawbacks, overall pXRF is a good tool for assessing coffin pigments in a non-invasive manner.

Chapter 8 by Price, Muros, and Barnard discusses non-destructive and destructive techniques employed to understand the composition of the black substance found on mummy EX1997-24.1 as well as the composition of pigments and varnishes from the coffins. These techniques include using UV light, pXRF, XRD, polarized light microscopy, and gas chromatography–mass spectrometry (GC/MS).

Chapter 9 by Howley, Arbuckle MacLeod, and Creasman presents an artistic and textual analysis of the decoration and inscriptions on the coffins. They provide updated translations of two of the coffins (EX1997-24.2 and EX1997-24.5) and a stylistic analysis of a third coffin (EX1997-24.4), where a black substance obscures the text. Although translations were done before, no record of them exists in the DMNS archives, making this chapter an invaluable resource for those studying and interested in inscribed coffins.

Chapter 10 presents Koons and Arbuckle MacLeod's final reflections on the studies presented in this volume.

ARCHAEOLOGICAL SCIENCE AND EGYPTIAN MUSEUM COLLECTIONS

What makes studies of this nature possible is that the field of archaeological science has rapidly grown since the early twenty-first century (Killick 2015). New and more affordable analytical techniques have greatly expanded the kinds of questions archaeologists and other specialists studying archaeological materials can ask and the methods they can employ. These questions range from an expansion of field techniques such as photogrammetry for creating 3D models of the terrain, excavated features, and artifacts (Peng et al. 2017; Sapirstein and Murray 2017) to advanced lab techniques such as ancient dental calculus extraction to understand the ancient human microbiome (Warinner et al. 2015). Advances in microanalysis include minimally invasive techniques that require the slight alteration of the object and non-invasive techniques, which do not alter the object. This increased wave of applied analytical tools to archaeological research has also moved into the museum realm where new technologies are breathing new life into old collections (Bewes et al. 2016; Forster and Grave 2012; Giachi et al. 2016; Gostner et al. 2013; Lattanzi and Stinchcomb 2015; Siano et al. 2006). Since the intrigue engendered by the Bonaparte era, this is especially true for Egyptian collections held in museums throughout the world, which includes the application of various analytic techniques to the study of mummified human remains and coffins.

Shortly after the discovery of X-rays by Wilhelm Conrad Roentgen in 1895, the technique was applied to mummy studies (König 1896). However, it was not until computed tomography (CT scan) developed in the 1970s that scientific mummy imaging became common practice (Aufderheide 2011). Human and animal mummies stored in many museums throughout the world today have been investigated with CT scanning, mainly because of the ability to see inside the wrappings without adversely affecting the contents (Bewes et al. 2016; Cox 2015; David 2008; Hawass and Saleem 2016; Hoffman et al. 2002; McKnight et al. 2015; Zesch et al. 2016). Most of these studies are undertaken to understand an individual mummy or mummies in a particular institution. These case studies often conclude that CT scanning is a significant non-invasive tool that can help us better understand what is inside the wrappings. Despite this fact, no standards have been adopted for the parameters used for CT scanners, and there is insufficient consistency on how results are

reported. Cox (2015) cautions that although it is likely that over 100 mummies have been scanned and reported on, the lack of standards makes it difficult, if not impossible, for comparative studies to be undertaken. Thus there has been little synthesis of the mummies that have been scanned to better understand patterns of ancient Egyptian life and death. This is beginning to change with databases such as IMPACT Radiological Mummy Database (Nelson and Wade 2015; Wade and Nelson 2013a, 2013b) and the University of Pennsylvania Museum's Open Research Scan Archive (ORSA), which are attempting to compile known CT data of mummies to make accessible to researchers. The CT scans from this study are available through IMPACT's website, https://www.impactdb.uwo.ca/IMPACTdb/Index.html.

Recent publications raise the bar on what information can be extracted from CT scans and how they can be used to reinterpret and better understand mummy specimens. Studies using the radiological density and structure, measured in Hounsfield units, of foreign objects inside mummy wrappings allow us to discern what materials comprise the jewelry, amulets, and other objects buried with a person (Gostner et al. 2013; Saleem and Hawass 2014). Although Cox (2015) notes that we cannot yet reliably identify postmortem taphonomic changes and effects on the body from mummification from antemortem pathologies, recent work by Bewes and colleagues (2016) shows that dual-energy CT and effective atomic number imaging can help discriminate between different soft tissues and deteriorated bone. Studies like these, coupled with more synthetic research, are helping to pave the way for future noninvasive mummy studies that go beyond simplistic identification.

In addition to CT scanning, other analytical techniques help us to understand ancient mummification practices and Egyptian life (Nicholson and Shaw 2009). Gas chromatography (GC), GC/MS, and nuclear magnetic resonance (NMR) are consistently used to identify the composition of resins, varnishes, and bitumen found in and on mummies (Nicholson et al. 2011). When organic matter such as skin or bone is exposed, samples can be extracted to perform stable isotope analysis to reconstruct diet (Macko et al. 1999; Turner et al. 2010). Radiocarbon dating of linens and exposed tissue can determine the period of mummification. Analysis of the linen tells us about the quality and manufacturing techniques. Finally, ancient DNA studies, although not consistently reliable as of yet, are beginning to advance our understanding of the royal families and population in general (Hawass and Saleem 2016; Schuenemann et al. 2017).

As a supplement to research on mummies, this volume examines the coffins associated with the human remains. Coffin research, although popular for decades, has traditionally been based on paleography and art historical

approaches. Only recently has the scientific analysis of coffin materiality gained academic attention. A number of scientific studies were recently discussed at the Second Vatican Coffin Conference in Rome (2017) and in the published proceedings of the previous meeting (Amenta and Guichard 2017). In *Death on the Nile: Uncovering the Afterlife of Ancient Egypt* (Strudwick and Dawson 2016), the authors describe the manufacture of coffins in an exhibition at the Fitzwilliam Museum at the University of Cambridge to highlight the value of material analysis and the use of CT scans for coffins as well. Pigment and resin analyses from cartonnage and coffins have also increased recently (Calza et al. 2007; Dawson et al. 2010; Scott et al. 2009; Serpico 2000). These analyses demonstrate the value of such investigations for understanding ancient Egyptian technologies and access to foreign materials.

Holistic studies of mummies have been difficult since the days of the unwrapping parties. Although the number and efficacy of scientific techniques has skyrocketed, our abilities to use these tools are limited to cost and available access to mummified remains. A priority of any museum is the preservation of the collection. The analyses presented in this volume were designed to be minimally invasive or non-invasive in an effort to maintain the integrity of the mummies and coffins and not cause unnecessary harm. Because of this, certain studies such as DNA extraction, which is still not perfected or easily performed, were omitted.

With the growing body of inexpensive and minimally to non-invasive technologies, museum collections are no longer silent. These time capsules are beginning to reveal their stories through the numerous tools and techniques available to modern science. Through these advancements, we are now able to tell and retell the stories of people and objects in more holistic and humanistic ways. The women featured in this volume did not choose to reside in Denver, Colorado. We acknowledge the colonialist circumstances under which the DMNS became their caretaker. As beloved friends of the DMNS visitor experience, we owe it to their legacy to tell their stories in the most appropriate and accurate manner. This volume presents various methods that are the first steps in unlocking their secrets. As science continues to advance, the studies of these mummies and coffins will continue to be refined, and their stories will keep unraveling.

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