

T HE PALERMO CAPUCHIN CATACOMBS PROJECT: A MULTIDISCIPLINARY APPROACH TO THE STUDY OF A MODERN MUMMY COLLECTION (CA 1600-1900)

Luca Sineo, Barbara Manachini, Giuseppe Carotenuto

Dipartimento di Biologia Animale “G. Reverberi”
Università degli Studi di Palermo

Dario Piombino-Mascoli, Albert Zink

EURAC – Istituto per le Mummie e l’Iceman, Bolzano

Franco Palla

Dipartimento di Scienze Botaniche, Laboratorio di Biologia Molecolare
Università degli Studi di Palermo

1. Introduction

In recent years, modern biomedical technologies have led to a great increase of knowledge concerning the study of human remain collections and their associated materials. These collections provide a substantial amount of information on the biological features, health status, nutrition and lifestyle of once-living populations, as well as on the reconstruction of the environment in which they lived. Additionally, this understanding enables the development of effective restoration and conservation programmes. In this paper we present a multidisciplinary project uniting the study of the present conditions, history, bio-anthropological features and conservation of a large collection of modern human mummies (XVI-XX centuries), which are located in the subterranean corridors (“Catacombs”) of the Capuchin Convent of Palermo (Sicily, Italy). Due to the large amount of spontaneously and anthropogenically mummified human bodies, and an abundant presence of associated artefacts, this collection provides a unique opportunity to carry out a large multidisciplinary survey useful for a thorough biocultural study of these remains, a conservation plan, and the testing of new restoration protocols.

2. The Palermo Capuchin Catacombs

The Capuchin Convent of Palermo was built at some point after 1534 on one of the western hills surrounding the city, and soon became the seat of a large ecclesiastic community [1]. At the end of the XVI century the community created a hypogeum for their own use. Over time, this site was incorrectly called “Catacombs”, a term that has remained in

use until today. According to documentary sources, the first friar to be enshrined in the Catacombs was Silvestro da Gubbio, who died on October 16th, 1599. His mummified remains may still be viewed in the first hall of the crypt. Due to natural environmental conditions which brought about spontaneous drying of the corpses, in the XVIII century, the Catacombs became a privileged burial place for the preservation and exhibition of the deceased clergy, but also a cemetery reserved for the nobles and the high-status citizens of Palermo [1]. In the Catacombs, mummification was enhanced by putting the cadavers in special preparation rooms called “drainers” (“*colato*”), where terracotta racks were constructed to accommodate bodies and collect fluid dripping. After the dehydration phase, bodies were exposed to air, cleaned with vinegar and dressed, and eventually placed in coffins or exposed in wall niches. However, during the XIX century, preservation methods become more complex and effective, due to the establishment of novel techniques based on intra-arterial injection [2]. These embalming processes were generally performed by physicians and embalming experts using different chemicals and various methods of cadaver preparation. Unfortunately, several dramatic events such as fires, flooding, and heavy bombing of the city during the Second World War, damaged the site. Furthermore, the chaotic growth and building activities that afflicted Palermo in the 1960s, together with increased urbanization and car traffic, progressively affected the soundness and stability of the whole architectonic structure, as well as the delicate ecology of this underground cemetery, leading to a gradual deterioration of the mummies, and of all goods and artefacts held there.

3. The Catacombs ecology

The Capuchin Catacombs spread out under the large architectonic complex of the Convent, of the *Santa Maria della Pace* Church and of the Capuchin Cemetery, within the *Zisa* area of Palermo. Large rooms and high-vaulted corridors branch out from the original corpus beneath the Church; the whole underground system covers a broad area. An effective ventilation system determined by a number of permanently opened windows and air conducts carved into the limestone once created an ideal place and the right conditions for mummy preservation over the centuries. Unfortunately, this is no longer the case, and drastic environmental changes are causing permanent damage to the collection. The great majority of drainers are presently closed or have been closed to light and air circulation for decades, making them microcosms with high relative humidity, deep darkness, and with a high presence of organic matter in active degradation, including human remains, tissues and wood, terrain and vegetal material.

4. The human remains

The Capuchin Catacombs host the largest known collection of spontaneous and anthropogenic mummified remains in the world. The exact number of human bodies present is unknown. According to a recent survey, there are 1852 bodies still to be investigated, 1252 of which are exposed, and 600 of which inside coffins [3]. However, one must bear in mind that some of the caskets are empty. Furthermore, some preparation rooms contain other coffins, which might be available for future investigations. The total number of people buried in the crypt over the centuries is also approximate, due to the fact that some information was lost through an accident [1]. Different types of mummies can be observed in the Catacombs, and can be further subdivided into two main categories: spontaneously (“naturally”) and anthropogenically (“artificially”) preserved bodies, the former being the earliest bodies buried in the crypt and the bodies which were drained in the preparation room, and the latter consisting of the bodies preserved by means of either evisceration, injection or immersion in preservatives [3-5]. Clearly, such different practices implicate a highly variable degree of soft tissue preservation. Apart from the mummified remains, the collection also includes a series of skulls, most of which still retain some soft tissue.

5. The Mummy Project

This important and ambitious project was suggested and supported by Father Calogero Peri, currently Ministry of the Capuchin Friars of Palermo. The goal is a multi-disciplinary approach for the reappraisal of the site and the restoration of mummies in order to create a correct protocol of conservation of this invaluable treasure of Palermo. Different qualified laboratories from departments of the Palermo University, the EURAC - Institute of Mummies and the Iceman of Bolzano, as well as specialists and local enterprise (BioNat-Italia, Palermo) are presently creating a highly qualified collaborative team. The project will focus on the historical and social aspects of mummification and embalming, the biological and pathological features of such a population, and on biological, molecular and environmental surveys on this important mummy collection. Each proposal of research, together with the methods of investigation, will be described in the subsections below.

6. Historical investigation

Archival sources are a tool of utmost importance for investigating ancient societies.

The availability of church and communal records will shed new light on the demographic dynamics of a large Sicilian population sample, pertaining to the clergy, nobility and middle-class citizens. At the same time, this information will be of great importance in revealing biographic details on many identifiable and prominent individuals enshrined in the crypt. Any possible source of information, either historical or literary, will be used and recorded for a deeper understanding of life habits, epidemics, and sanitation in Sicily during the Modern Era [6]. In particular, the relationship between disease and possible treatment will be explored on the basis of ancient treatises and local medical literature. A second important point will consist of the study of texts regarding both funerary practices and the treatment reserved for the dead, emphasising the role of embalming techniques as an essential element for both hygiene and prolonged exposure of the body [7]. The mummification phenomenon, on which only limited and somewhat contradictory research was performed [8], shall be investigated through a socio-cultural perspective, in the wider context of South Italy past mortuary treatments [9-11]. Last but not least, old records regarding the building and development of the Catacombs will be reappraised and re-evaluated for a thorough and comprehensive history of this unique mortuary site.

7. Bioanthropological investigation

Both mummies and skeletons can yield a huge amount of biological information [12]. The attempt here is to create a significant database compilation of these bodies. The data, which will be recorded according to a standard procedure set up by Aufderheide [13], will consist of a detailed description of the exterior of the body, the clothing and the items recovered on each individual. In particular, the anthropological investigators will concentrate on:

- mummification type;
- sex and age determination;
- measurements of the mummies and of available long bones and skulls;
- sampling of organic tissue from non-visible areas for the purpose of compiling a tissue archive for future laboratory investigations [13-14]. The latter shall include a histological investigation for determining tissue degree of preservation, radiographs of the great majority of the bodies, as well as stable isotopes analyses from bone collagen to reconstruct ancient diet and subsistence patterns. Additionally, a valuable part of the research will consist of the careful comparison of the bioanthropological features to the historical records and the identity of the subjects, a study which will permit a further assessment of current age and sex determination methods [15-17].

8. Paleopathological investigation

Paleopathology, the study of ancient disease, is a field of growing interest for archaeologists, anthropologists, and physicians. Although reconstructing health conditions of once-living populations is a challenging task, some conditions do leave revealing marks on both skeletal and soft tissue [18]. The most commonly investigated affections include:

- infectious diseases;
- metabolic diseases;
- degenerative disorders;
- congenital anomalies and malformations;
- dental diseases;
- trauma;
- non-specific stress markers;
- tumours and tumour-like processes [18-21]. Since mummified remains should be considered unique cultural artefacts, the approach chosen for the Palermo Catacombs project will not include autopsy or any other destructive methodology. Instead, minimal samples of tissue will be obtained through non-invasive techniques guided by x-ray imaging, CT-scans and endoscopy. Further study of these remains' pathological conditions will comprise scanning electron microscopy (SEM), histology, immunology, and immuno-histochemistry. Great emphasis will be put on the identification of ancient pathogens, a research field which will also rely on historical sources.

9. Paleogenetic investigation

Within the last decade the study of ancient biomolecules has made significant progress [22]. In particular, the study of DNA from old bones, teeth and soft tissues has revealed vital information on evolutionary processes, animal and plant domestication and the presence of pathogens in ancient populations [23-24]. Moreover, the retrieval of ancient DNA enables the determination of the genetic origins and relationships of skeletons or mummified individuals. This can help to understand population developmental processes or to reconstruct kinship relations. This project will include the extraction of ancient DNA out of tissue samples from the mummies located in the Capuchin Catacombs in order to investigate their genetic profile and to identify ancient pathogen DNA. The first attempt will comprise the amplification of mitochondrial DNA (mtDNA) of the specimens. This particular DNA is exclusively inherited from the mother side and allows the reconstruction of the maternal lineage in the mummies. More importantly, dif-

ferences in mtDNA will allow us to trace back the origins of this Sicilian population. Furthermore, we will attempt a molecular detection of infectious disease pathogens. This will be done by the amplification of specific targets of the ancient pathogen DNA. There is documentary evidence that the inhabitants of Palermo suffered from several major infectious diseases during the investigated time period, such as tuberculosis, cholera and plague. The study of pathogen DNA should provide us with important information on the occurrence, frequency, ways of transmission and evolutionary history of these conditions.

10. Biological, microbiological and environmental investigation

Biodeterioration of artefacts is a complex process involving many microbial species and thus represents a relevant problem with regard to conservation purposes of both inorganic and organic cultural heritage. This is particularly true for mummified remains stored in historical settings, such as the Capuchin Catacombs. The modification of the original environmental conditions has led to significant changes to the storage requirements of the mummies, as demonstrated by the continuing degradation of the corpses. Aim of this study is therefore to combine a detailed physical survey and molecular bioanalysis of the Capuchin Catacombs to monitor the presence of different microorganisms and to investigate the contents of biofilms colonizing the crypt and the mummies. The characterization of the microorganisms will be performed on the basis of morphological features using optical methods, such as confocal laser scanning microscopy (CLSM) and scanning electron microscopy (SEM). Additionally, we will use molecular biology techniques to further characterize the different bacterial and microbial species found in the Catacombs. For this, the microbial DNA will be extracted directly from surface and aerosol samples and will subsequently undergo further analysis. The PCR amplification and sequencing of specific microbial DNA targets, including the 16S rRNA locus and 16S-23S Intergenic Transcribed Spacer, will define a detailed picture of the presence and composition of the microbiological communities in the biofilm and aerosol specimens [25, 26]. The results of the microbiological analysis will be evaluated in consideration of the present environmental factors, such as humidity, temperature and luminance. On the basis of this results we will be able to define measures necessary to prevent the crypt contents from further decay and to determine the optimal environmental conditions for a long-term preservation of the bodies and of the cultural assets.

11. Entomological investigation

Deterioration related to animal infestation is one of the factors affecting the conservation

of these catacomb mummies. Assessing the composition of the faunal communities represents the first stage in the understanding and control of these colonisations. Many insects and other animals may be associated with the human remains or with their related environment [27-29]. The project will focus on the entomofauna associated with the mummies and, later on, it will explore the other fauna inhabiting the Capuchin Catacombs. Insects can be associated to:

- the time of death of the subject;
- different mummification processes;
- decomposition;
- parasitism before death;
- the environmental location of the mummies. Animal remains will be collected directly from the mummies or from the surrounding environment using different techniques. Dead insects and those present on the mummies will be collected with a small brush and/or vacuum pumps, live insects inhabiting the Catacombs will be sampled using different kinds of traps and devices (pitfall, Berlese, pheromone traps, sticky traps, coloured traps). Additionally, a careful direct observation and survey will be performed on the mummies and inside the Catacombs at different hours and during different period of the year. The identification of the samples will be done using various approaches: classical microscope analysis, biomolecular techniques (for some particular species), and SEM analyses. Arthropods will be the major object of this project, but attention will also be given to the nematofauna present in the preparation rooms and in the soil under the mummies. In fact, Nematodes are considered useful indicators of the biodiversity within the soil and also of the presence of fungi and bacteria. Through nematofaunal analysis we will gain clues on the complete trophic relationship present in the Capuchin Catacombs. These will be collected using a combination of the Bearman modified method and centrifugation. Identification will be done under light microscope and also using the phase contrast microscope.

12. Conclusions

The proposal above offers only a minimal idea of the spectrum of research that could be carried out on the Palermo mummies. These, indeed, represent an extraordinary material collection, the value of which has been neglected for too long time. To sum up, we are confident that a substantial and original contribution will be made through the study of these remains. Historical materials shall provide us with a deeper knowledge on the ancient Palermo inhabitants and their social and emotional responses to death; the

anthropological investigation shall focus on reconstructing their features and living conditions; modern biotechniques shall prove an instrumental tool for the study of ancient human remains, providing data which may be even useful for modern-day medicine; the environmental monitoring of the crypt shall guarantee a future preservation plan for this enormous biocultural heritage. Finally, public funding may be fully justified by the significance of this site, so important for Sicilian history and culture.

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Summary

In this paper we present a multidisciplinary project for the study of the present conditions, history, bioanthropological features and conservation status of a large collection of modern human mummies, kept in the Capuchin Catacombs of Palermo (Sicily, Italy). Due to the large amount of spontaneously and anthropogenically mummified human bodies, and to an abundant presence of associated artefacts, this collection provides a unique opportunity to carry out a large multidisciplinary survey useful for a thorough biocultural understanding of these remains, a conservation plan, and testing of new restoration protocols.

Riassunto

In questo lavoro gli autori presentano un progetto multidisciplinare il cui scopo è lo studio storico e bioantropologico, e la valutazione delle attuali condizioni di conservazione della grande collezione di mummie moderne presente nelle Catacombe dei Cappuccini di Palermo (Sicilia, Italia). In relazione all'elevato numero di corpi mummificati naturalmente o artificialmente, e alla presenza di numerosi manufatti di notevole valore storico-artistico, questa collezione rappresenta un'opportunità unica per la realizzazione di un completo studio finalizzato alla caratterizzazione biologica, per la stesura di un corretto protocollo di conservazione, oltre che per la possibilità di saggiare e implementare specifiche metodologie di restauro.

Résumé

Dans cet ouvrage, les auteurs présentent un projet multidisciplinaire dans lequel le but est l'étude historique et bioanthropologique, et l'évaluation des conditions actuelles de conservation de la grande collection de momies moderne présente dans les Catacombes des Capucins de Palerme (Sicile, Italie). Par rapport à l'élevé nombre de corps momifiés naturellement ou artificiellement, et à la présence de nombreux ouvrages de considérable valeur historico-artistique, cette collection représente une opportunité unique pour la réalisation d'une étude complète finalisée à la caractérisation biologique, pour la rédaction d'un correct protocole de conservation, outre que pour la possibilité d'essayer et d'implémenter des méthodologies de restauration spécifiques.

Zusammenfassung

In diesem Werk stellen die Autoren ein multidisziplinäres Projekt vor, dessen Ziel es ist, eine historische und bio- anthropologische Studie anzufertigen und den jetzigen Erhaltungszustand der großen Kollektion von modernen Mumien in den Katakomben der Kapuziner in Palermo (Sizilien, Italien) zu bewerten. Dort befindet sich eine große Anzahl von natürlich oder künstlich mumifizierten Körpern und von Artefakten mit einem erheblichen historischen und künstlichen Wert, aus diesem Grund ist diese Kollektion eine einzigartige Gelegenheit, um eine vollständige Studie für die biologische Charakterisierung durchzuführen, um eine geeignete Erhaltungsmethode zu finden, und um spezifische Restaurationstechniken zu testen und zu implementieren.

Resumen

En este trabajo, los autores presentan un proyecto multidisciplinar cuya finalidad es el estudio histórico y bioantropológico, así como la evaluación de las condiciones actuales de conservación de la gran colección de momias modernas que se halla en las Catacumbas de los Capuchinos de Palermo (Sicilia, Italia). En relación con el elevado número de cuerpos momificados, natural o arti-

ficialmente, y en relación con la presencia de numerosas piezas de notable valor histórico-artístico, esta colección representa una oportunidad única para efectuar un completo estudio cuya finalidad es la caracterización biológica, para la redacción de un protocolo de conservación correcto y para la probar e implementar métodos de restauración específicos.

Резюме

В этой работе авторы представляют междисциплинарный проект, целью которого является историческое и биоантропологическое изучение, а также оценка современной степени сохранности большой коллекции мумий, находящихся в Катакомбах капуцинов в Палермо (на Сицилии, в Италии). В коллекции представлено большое количество мумифицированных тел, как естественным путем, так и искусственным, а также многочисленные произведения, имеющие значительную историко-художественную ценность. Именно поэтому эта коллекция дает исключительную возможность проведения полного исследования, направленного на биологическую оценку и на создание наиболее подходящего проекта сохранения, а также делает реальным подбор новых методов реставрации.

