THE CANOPIC JAR PROJECT: INTERDISCIPLINARY ANALYSIS OF ANCIENT MUMMIFIED VISCERA

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It is often believed that medicine is only about tackling diseases in the present world in which we live. Indeed, the impression of a healing art identifying with the principle of *hic et nunc* may be justified both by the tremendous advances in the medical field over the past 150 years and the necessity to effectively counter pathological processes with a relatively short reaction time. However, medicine is also about the evolution of diseases through time – the key research goal of evolutionary medicine, directly stemming from Darwinian theories. Out of the many branches of evolutionary medicine, palaeopathology represents an archaeological ramification which aims to identify the phenotype, genotype and epidemiology of pathologies at specific points in time.

The beginnings of the discipline were at once both humble and majestic: merely regarded as a pastime, or at best a lesser form of research, it managed to catch the attention of eminent scholars such as Rudolph Virchow (1821 – 1902). It was here at the University of Bologna that the renowned German pathologist attended the *V Congresso Internazionale di Antropologia e Archeologia Preistoriche* in 1871, as commemorated by a photograph taken in the central yard of Palazzo Poggi, the heart of the University, where the meeting was held. As time went by, palaeopathology grew into an internationally acknowledged discipline, attested, amongst other things, by the establishment of its own independent scientific society, *The Palaeopathology Association*, in 1973. Still, after over 100 years of practice, palaeopathology lies at a crossroads of several other disciplines that differ from one another both in nature and scope.[2] Its close connection with the historical sciences is at the heart of its multidisciplinary nature, in particular its partnership with Egyptology, reaching a peak in the legendary and controversial times of the golden age of Egyptian excavations with the discovery and scientific study of the mummy of Tutankhamun by Hower Carter (1874 – 1939) and Douglas E. Derry (1874 – 1961), and has been at the heart of decades of outstanding discoveries on Egyptian mummies.[3]

Soon after their invention by William Conrad Roentgen (1845 – 1923) in November 1895, X-rays were used in palaeopathology to visualize mummies: in March 1896 Walter Koenig (1859 – 1936) was able to produce the first radiological images of an Egyptian child mummy from the Seckenberg Museum of Natural History in Germany.[4] Despite their scientific importance, mummies consist largely of only the shrunken muskoleskeltal systems, where only a comparatively

small percentage of diseases locate, and whose traces can still be identified through conventional palaeopathological techniques (morphology, radiology, histology). As modern clinical epidemiology teaches, most pathogens and chronic diseases localize in the internal organs, which tend to deteriorate in the early phases following an individual's death.

An extraordinary exception to this is represented by mummified viscera from ancient Egypt, which have been artificially embalmed and preserved in the context of the overall mummification process. These embalmed organs are mainly stored in canopic jars, which are containers of various forms and shapes, whose modern name is derived from a misunderstanding of a Roman Period type of human-headed jar, related to the Greek hero Canopos. They first appear in the Old Kingdom and disappear around the beginning of the Ptolemaic Period.[5]

Various containers were used as canopics through time. The first canopic item attributed to an individual is the rectangular calcite box with four compartments of Queen Hetepheres I (mother of King Khufu) dating to the 26th century BC (Cairo, Egyptian Museum, CG 4023 – 4026). Three compartments still contained viscera bundles in the early 20th century AD.[6] Circular jars with flat lids became the standard for the Old Kingdom. During the First Intermediate Period, four human heads were introduced as lids. representing the four protective deities Imseti, Hapy, Duamutef and Qebehsenuef.

The Middle Kingdom continued this design with the four human heads but with the introduction of standardised texts invoking the four deities. The four jars were often stored in a wooden chest. A splendid example are the jars of Princess Sit-Hathor-Iunet (New York, Metropolitan Mus. of Art 16.1.45 – 48). The New Kingdom marks the peak of canopic tradition through the quality and historical significance of surviving material. Aside from the circular jars with human heads, another style emerged, first among kings: miniature anthropoid coffins, placed in canopic chests. The most notable examples are those found in the tomb of Tutankhamun, made of solid gold, inlaid with glass (Cairo, Egyptian Museum. JE 60688 – 91).[7] By the reign of Ramses II at the beginning of the Nineteenth Dynasty the iconic design had shifted: the heads of the sons of Horus no longer had four human heads, but one human (Imseti), a baboon (Hapy), a jackal (Duamutef) and a falcon (Qebehsenuef).

However, by the end of the New Kingdom, mummification tradition changed dramatically. Now the viscera were put back into the abdomen of the mummy and consequently the canopic jars were reduced to purely symbolic items of funerary equipment. Finally, dummy jars made of solid stone or wood, sometimes beautifully carved and painted were introduced. It was for the

Kushite kings of the Twenty-fifth Dynasty that the classic jars made a return and flourished again in the Late Period, especially in the Saite Twenty-sixth Dynasty.[8] After the Late Period, the tradition rapidly declined and disappeared in Ptolemaic times. The spells used on canopic jars were classified and dated by Kurt Sethe.[9]

Radiological, histological, and palaeomolecular examination of tissue specimens of embalmed viscera contained in these jars can yield new information about the impact of disease in ancient times, leading to a better understanding and new perspectives on diseases that are still very common today. This combined research approach is at the heart of the Canopic Jar Project of the Institute of Evolutionary Medicine at the University of Zurich. A preliminary study was conducted to test the feasability and protocols of investigation. A canopic jar in St. Gallen, Switzerland, (Burgdorf Mus. Inv. BU_53_0766), another jar in Munich (Staatl. Mus. Ägyptischer Kunst, ÄS_0026) and the viscera bundles of Shepeniset (St. Gallen, Stiftsbibliothek) were investigated.[10] Major museum collections were inspected and selected canopic jars sampled, notably at the Museo Egizio in Turin,[11] the Museo Archeologico in Florence, the Rijksmuseum van Oudheden in Leiden,[12] the Ägyptisches Museum in Berlin, the Museum of Fine Arts, Boston,[13] the soft tissue bank of the University of Manchester, and smaller collections in Zagreb and in private ownership.

In order to better describe the overall impact and evolutionary course of diseases in Ancient Egypt the Canopic Jar Project also includes selected complete mummies. During our investigations, a new study proved the feasability of successfull testing Egyptian mummies for DNA,[13] contrasting with previous studies considererd controversial.[14] The mummies of Kha (Turin N 13015, Suppl. 8431), royal architect and his wife Meryet (Turin N 13016, Suppl. 8471), were investigated at the Museo Egizio in Turin. Both mummies are still wrapped and had been investigated several times.[15,16] New digital X-rays revealed several new details of their jewellery and pathologies.[17] Their mummification is quite unusual. Although they are from the upper middle-class, their viscera had not been removed nor the brain. The brains are slightly shrunken but otherwise well preserved. The use of a liquid natron technique is suspected,[18] as it has also been proposed for royal mummies from this period (Amenhotep III and the Younger Lady from KV 35).[19] Gas Chromatography-Mass Spectrometry (GC-MS) identified the use of Pistacia resin and cedar oil.[20]

Furthermore, the alleged mummied legs of Queen Nefertari are also held by Turin's Museo Egizio (Suppl. 5154 RCGE 14467). They were found by Ernesto Schiapparelli in 1904, and generally

considered to belong to Nefertari, the favourite wife of Rameses II,[21] although they had never been investigated, except as part of an anthropological catalogue.[22] A study assessed the remains from a multidisciplinary perspective (Egyptology, anthropology, medicine, chemistry, radiocarbon dating and genetics), concluding that the remains are indeed most likely those of Queen Nefertari.[23] All objects found alongside the mummified remains are from the time of Nefertari, remnants of jewellery and a broken sarcophagus testify to her burial only. The chemistry clearly speaks in favour of a dating in the Ramesside period. Any indication of a later secondary burial is completely absent in the preserved material from tomb QV66. The genetic profiling remained inconclusive in view of contamination and the fact that the ancestry of Queen Nefertari is unknown. The radiocarbon dating result is higher (ETH-67019, cal. c.1546 – 1491 BC (69%) / 1485 – 1450 BC (15.8%) 2-sigma error) than the conventional chronological models for the Ramesside period, conventionally dating the reign of Ramses II to c. 1279 – 1213 BC.[24] This fact, that mummies often tend to date c. 150 – 200 years older than expected is a well-known phenomenon. The true cause is not fully understood, the impact of bitumen (containing no 14C isotopes anymore) or fish-diet (lower 14C embedding in the tissue) is suspected.[25]

It has also been observed that the dating of the Thera eruption and the subsequent pumice fallout found in strata of the early New Kingdom (e.g. Avaris) also produced a high dating result. A recently found olive tree buried during the eruption in Thera is radiocarbon dated to 1627 – 1600 BC, while the beginning of the New Kingdom is normally dated c. 1550/1500 BC. [26] The radiocarbon result also speaks in favour of Nefertari, as a previous burial is difficult to explain in a tomb especially built for her and a later, secondary burial is excluded entirely.

Motivated by these discoveries, it has also been proposed to incorporate more general research on the chronology of Ancient Egypt, primarily through radiocarbon dating analysis.[27]

This preliminary report on the research carried out by our team demonstrates how the correct description of ancient pathological processes can no longer rely on a single approach. Thus, the study of ancient mummified visceral remains must be complemented by a holistic assessment of mummies, mixing traditional historical methodologies with sophisticated scientific and laboratory techniques. By doing this, in the best spirit of multidisciplinary scholarship, a much clearer picture of the human past shall be attained and medical knowledge shall be greatly enriched.

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