

Multidisciplinary approach for the study of the Ptolemaic coffin of Ankhapy from the Egyptian collection of MANN in Naples

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Abstract— In this paper we report the results of the analysis and the conservation treatment conducted on an Egyptian polychrome wooden coffin coming from Akhmim and dating back to the beginning of the Ptolemaic Period (332-200 B.C.). This work has been carried out thanks to the collaboration between the National Archeological Museum of Naples (MANN), a team of restorers and scientists from “Università Suor Orsola Benincasa” and the research center CIRCE. The analysis allowed us to not only identify the materials constituting the coffin, and its state of conservation, but also to correctly plan the conservation treatment. The results of C14 analysis confirmed the dating of the coffin to the Ptolemaic period, while the optical microscope and SEM identified both the genus and the species of wood used for the boards and the joints. We also determined the components of the ground layer and the painted layer through X-ray diffraction (XRD) and X-ray fluorescence (XRF) analysis; in particular we observed that the wig of the coffin wasn’t black, as reported in the catalogue[1], but it was actually painted with Egyptian blue. We also analyzed the thicknesses of the different layers through stratigraphic analysis and Dino-lite photos. The UV light allowed us to highlight the lack of varnish, and to reveal traces of previous restoration works, especially on the gilded mask. Finally, a conservation treatment has been carried out on the coffin: the surface has been disinfested and consolidated, the wig has been cleaned and the missing parts of the ground layer have been integrated along the joining lines of the boards.

Keywords— polychrome wooden coffin; pigments; Egyptian Blue; wood identification; archaeometric analysis

I. BACKGROUND

Historical context

The antropoid coffin, NI 114313, dating back to the beginning of the Ptolemaic Period (332-200 B.C) was discovered in the archeological area of Akhmim. In 1884, Gaston Maspero, director of the Cairo Museum, was conducting archaeological excavations at Akhmim and in 1885 he gave the coffin to the archaeologist Emilio Stevens, who donated it to his friend and director of Archeological Museum of Naples, Giulio De Petra. The coffin and its mummy, named Ankhapy, arrived at the Museum in May 24th 1885. It’s interesting to note that in the various archival documents the dating of the coffin was different than the one reported in the new catalogue of MANN in 2016 [2]. Indeed, in the entry documents, letters and official documents of 1885, the coffin was dating back to the XXVI Dynasty (664-525 B.C.), while in the Ruesh guide of 1908 and in the official catalogue of MANN of 1989 the coffin was dating back to the Late Period (664-31 B.C.). Comparing the coffin decorations with other ones from Akhmim and dating back to the beginning of the Ptolemaic Period, and considering the studies by Dr. Ruth Brech [3], we can confirm that the coffin of Ankhapy is dating back to the Ptolemaic Period.

Executive technique

The coffin is composed of two parts: the box and the lid, and is closed with tenon and mortise joints, while the boards are held together by dowels. The length of the coffin is approximately 181 cm, while the width is approximately 48 cm. The wood is covered by a ground layer that consists in two different layers: the first one is directly spread on the wood and

is more coarse, while the second is finer and is applied on the former. The ground layer is also spread along the joining lines of the boards, both in the interior part of the lid and in the box of the coffin. The paint layer is very fine and is composed by different pigments. The decoration is only on the exterior surface of the coffin and it has the characteristic elements that can be found in all coffins belonging to the type E, as classified in [1]: the head on the lid has a gilded mask and a wig with two long lappets; under the neck, decorated with a multi-tiered necklace, there is a falcon-headed broad collar which extends over the entire chest, whose background is red. Below, there is a representation of the goddess *Nut* with her wings spread, protecting the body. Under the goddess there is a representation of the deceased on the embalming bed, flanked by mummiform deities, and behind the bed, there is the embalming god *Anubis*, holding an heart in his hand. Under this decoration there are three vertical strips of hieroglyphs: two white ones on the side and a red one in the middle. There are also other representations of mummiform deities on the sides of the lid and atop the feet there are two jackals lying on shrines. On the sides of the box, on a black background, there are two stretched cobras, called *urei*, wearing an *atef* crown on their heads.



Fig.1 Coffin and mummy of Ankhaapy; Ptolemaic Period; Akhmim; height 181 cm, maximum width 48 cm

State of conservation

The main problem of the coffin was the degradation of the wood caused by a strong xilophagous attack, that mainly damaged the terminal part of the right lappet of the wig, the right shoulder and the upper part of the feet. One piece of the left lappet of the wig, and the wooden block on the left side of the feet were absent and the gilded mask was damaged during the naval transport from Egypt to Naples. In some areas, mainly along the joining lines of the boards, the ground layer and the paint layer were missing and some parts of the decoration lost cohesion. There was also a general chromatic alteration caused by dirt deposited on the surface.

II. MATERIALS AND METHODS

The aim of the analysis was to identify the wood type used to build the coffin, to reveal the chemical composition of both the ground layer and the paint layer and to examine the state of conservation of the coffin. Analysis were carried out either by taking small samples from the coffin or using non-invasive techniques. All the samples were taken from fragments that had previously fallen or in hidden areas of the coffin and they have been studied using different methods.

Wood identification

The samples taken from the lid, the box and from a dowel were observed both under an optical microscope and a scanning electron microscope (SEM). The wood was observed in radial, transversal and tangential section with an optical microscope Zeiss Axiolab, with a digital system Nikon Digital Sight DS-L1 and with a scanning electronic microscope ESEM quanta 2000. For this last analysis, samples were glued with graphite-based conductive adhesive tape on a support with an aluminum base with a locking pin. The samples have been aurized with a thin sheet of gold and then analyzed.

C14 dating

To further investigate the coffin dating, C14 dating has been conducted on two samples, one from the box, and one from the lid. The analysis was executed by researchers at CIRCE (Center for Isotopic Research on Cultural and Enviromental heritage) using accelerator mass spectrometry (AMS). The database INTCAL as been used to perform the so-called age calibration, a procedure that, exploiting a huge dataset of radiocarbon datings, allows us to get more accurate datings of the samples.

X-ray Diffraction (XRD)

Samples from the ground layer of the lid and from the inside of the box, properly grinded and pulverized in order to improve the counting statistics, have been analyzed using a Miniflex Rigaku X-ray diffractometer with a cobalt tube operating at 30 KV and 15 mA, with a counting time of 3600 s, in order to provide good statistics.

X-ray Fluorescence (XRF)

The X-ray fluorescence measures have been executed using a XRF-Q Assing portable spectrometer, with a tungsten tube, PiN diode detector with beryllium window, operating conditions at 40 kV and 0.5 mA, and a counting time of 60 s. The elemental composition of various pigments on the coffin were analyzed through the x-ray fluorescence (XRF).

UV light

UV light analysis have been executed to study the surface above the painting layer, in order to investigate the presence of varnish, and to reveal any previous restoration works.

Dino-lite

The Dino-Lite is a digital microscope which exploits the technique of coaxial lighting. This analysis allows to investigate the details of the surface using three different microscopes with different lights (visible light, UV and IR).

Stratigraphic section

Some samples were prepared in stratigraphic section using a Buehler EpoxyCure®, a two-component resin that exploits the capacity of diepoxide to harden if in contact with a hardening catalyst, the diamine. The two substances were mixed together in a 1:3 ratio inside a cylindrical mold where the samples were inserted. After this treatment the samples were observed with a Nikon Eclipse L150 reflected light optical microscope, with a magnification of 50x and 100x.

III. RESULTS

Wood identification

From the analysis carried out on the samples, we could establish that the coffin was built with boards of *Acacia* held together with dowels of *Tamarix*. The diagnostic allows us to identify only the genus as there are no elements to discriminate within the species of *Acacia* and *Tamarisk* in the various regions of Egypt; we got over this problem through comparison of known samples of *Acacia* and *Tamarix* species[4].

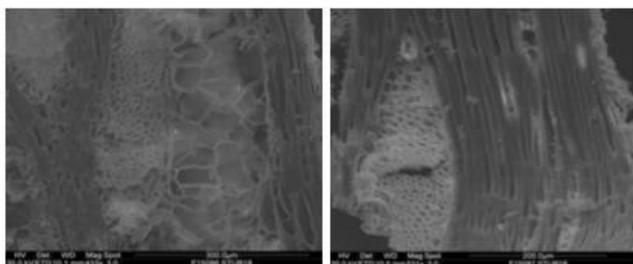


Fig.48 e 49 Campione coperchio S5. Sezione longitudinale tangenziale di legno di *Acaciasp.* osservata al microscopio ottico a scansione. Raggio parenchimatrico pluriseriato e tille.

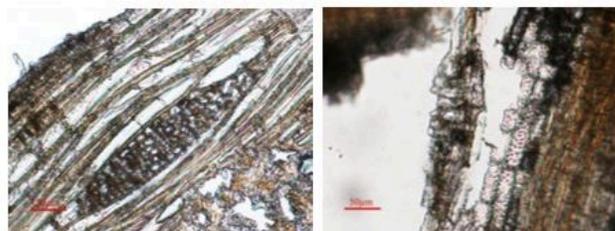


Fig.50 e 51 Campione coperchio S5. Sezione longitudinale tangenziale di legno di *Acaciasp.* osservato con il microscopio ottico a campo chiaro. A sinistra raggio parenchimatrico pluriseriato e fibre. A destra parete della trachea



Fig.52 e 53 Campione cavicchio S2. Sezione longitudinale tangenziale di legno di *Tamarixsp.* osservato con il microscopio ottico a campo chiaro. Raggi 6-20 serati, bande di parenchima tangenziale, trachea

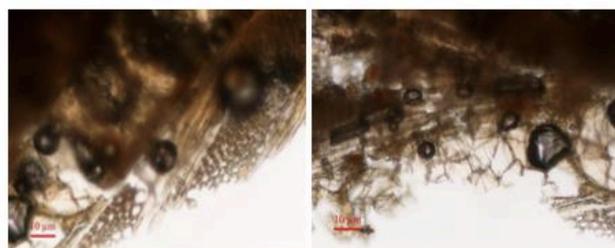
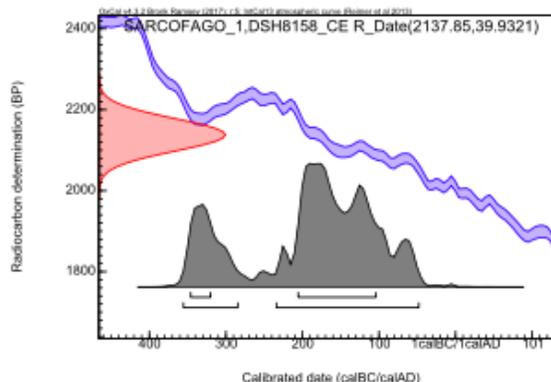
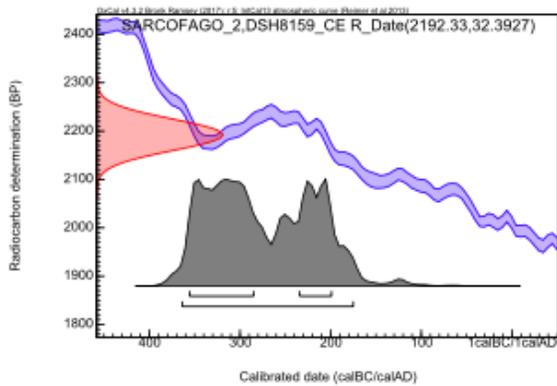


Fig.54 e 55 Campione alveo S3. Sezione longitudinale tangenziale di legno di *Acaciasp.* osservato con il microscopio ottico a campo chiaro. A sinistra, raggio parenchimatrico pluriseriato. A destra, tilla e raggio parenchimatrico

C14 dating

The results of the calibrated radiocarbon dating confirmed that the samples date back to the Ptolemaic Period: indeed, the age of the sample taken from the lid can be estimated in the interval ranging from 346 B.C. to 104 B.C. with the 68% probability (sigma 1 interval), and to the interval 356-48 B.C. with 95 % probability (sigma 2 interval), while the sample taken from the box can be estimated in the range 356-200 B.C. with the 68% probability (sigma 1 interval) and in the range 364-176 B.C. with 95 % probability (sigma 2 interval).





X-ray Diffraction (XRD)

The analysis revealed that the ground layer is composed of a mixture of calcite (CaCO₃), gypsum (CaSO₄) and quartz (SiO₂) with small traces of iron oxides, dolomite and feldspars. All samples contain mainly calcite (CaCO₃) and gypsum (CaSO₄), but the percentage of the latter is different: on the sample from the lid the percentage of gypsum is higher than in those from the box, since that's the only part that presents a coarse ground layer.

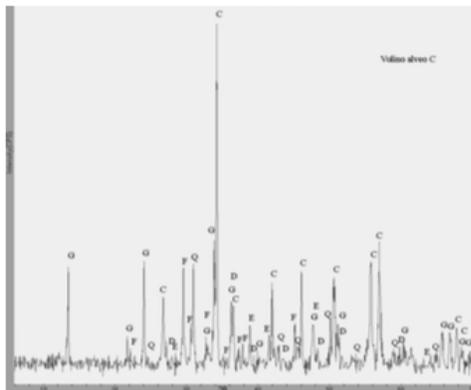
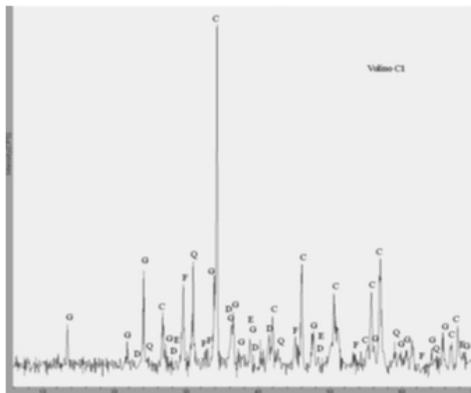
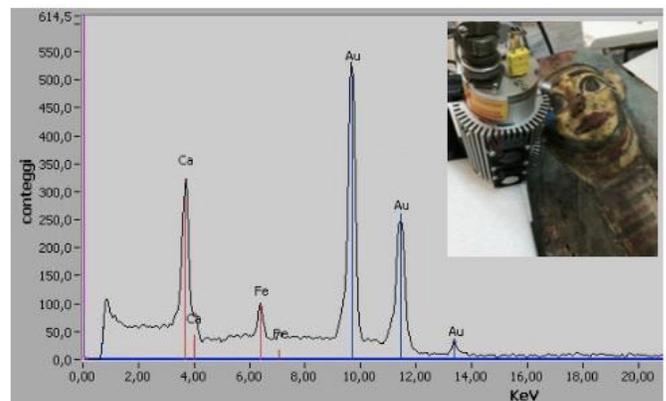
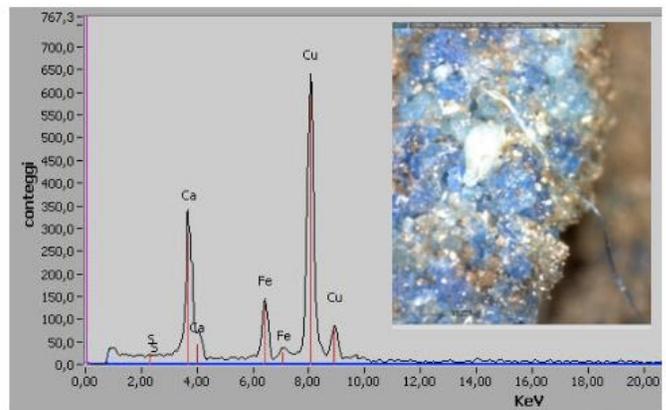


Fig.69 e 70 in alto, lo spettro del campione prelevato dai piedi del coperchio; in basso, lo spettro del campione di preparazione prelevato dall'alveo

X-ray Fluorescence (XRF)

The spectrum of XRF shows that the elements constituting the blue pigments, confirm the use of Egyptian “fritta” to paint the wig and other decoration details. This is an artificial pigment composed by calcium and copper tetrasilicate, and it is achieved by heating calcium oxide, silicon and copper, made from metal alloy or malachite, together with an alkaline product such as potassium (K). Chemically, these elements, once heated together, produce cuprorivaite (CaCu)Si₄O₁₀, carbon dioxide and water vapor. Regarding the mask, the spectrum of XRF shows a high percentage of gold (Au); on the left side of the mask, where there are the green spots, the spectrum shows traces of copper (Cu) and chrome (Cr) which confirms that the mask was partially restored with purpurin. In the red and yellow pigments there are a high percentages of iron (Fe) which confirms that the pigments are yellow ochre (2Fe₂O₃•H₂O) and red ochre (Fe₂O₃). The XRF spectrum of the black pigment reveals a small percentage of iron (Fe); taking into account that the percentage of iron (Fe) is too small to be considered, we have come to the conclusion that the black parts were made with an organic pigment, such as coal. In all the spectra of XRF we found different percentages of calcium (Ca) belonging to the ground layer.



UV light

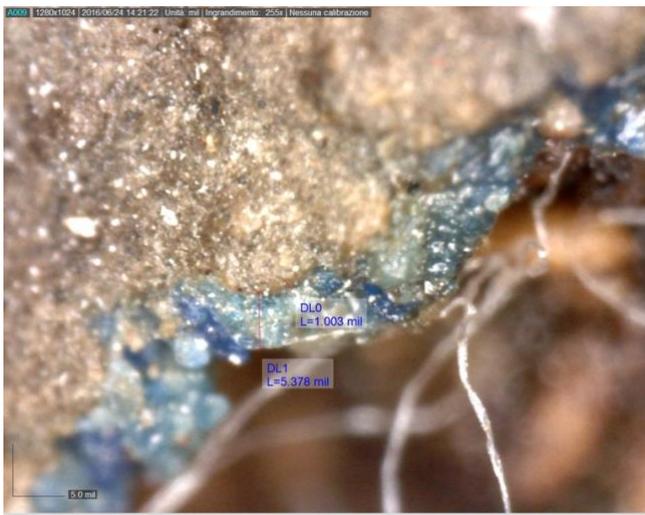
The observation of the coffin with ultraviolet light showed the absence of a protective varnish on the surface of the lid. Furthermore, on the left side of the gilded mask there were traces of green spots which, when viewed in UV light, do not emit fluorescence. This led to the hypothesis that the left side of the mask may have been restored before. Other evidences of a probable restoration are the more marked black lines on the left side of the eye, the eyebrow and the line under the wig, while the left ear has a different and more realistic shape than the right one.



Fig. 159 e 160 Particolare della testa esaminato in luce visibile a sinistra e in luce ultravioletta a destra

Dino-lite

Exploiting the many gaps of the coffin, it was possible, in some points, to obtain stratigraphic images and to measure the thickness of the layers. The thickness of the ground layer varies from 6 mm to 1 mm, the coarse ground layer is thicker than the fine one whose maximum thickness is of 1 mm, while the thickness of the paint layer varies from 262 μm to 136 μm . Furthermore, the analysis allowed to observe the dark layer that was covering the paint layer of the wig: it appeared to be on the paint layer and partially incorporated in it, and had a thickness of 25 μm .



Stratigraphic section

The stratigraphic analysis carried out on three samples shows that in the ground layer there are traces of a red substance, that could be the ematite that we found in the XRD analysis. Among the pigments of the most external part it is possible to observe the presence of a darker substance which probably belongs to the superficial layer of dirt.

IV. CONSERVATION TREATMENT

Main phases

First of all, the coffin has been disinfested using a liquid biocide. Then it has been consolidated by means of an acrylic resin. The ground layer and painting layer were fixed on the wooden support using a different acrylic resin. The wig has been mechanically cleaned from the thick layer of dirt using a bistoury. Finally the gaps along the joining lines of the boards were filled with a compatible plaster.

First of all, the coffin has been disinfested using a liquid biocide, Xilores[®], which contains 2,85 g/l of pure permethrin. Then it has been consolidated by means of a 5% concentration of an acrylic resin, Paraloid B72[®], dissolved in Acetone. The ground layer and painting layer were fixed on the wooden support using a 30% concentration of a different acrylic resin, Acril 33[®]. The wig has been mechanically cleaned from the thick layer of dirt using a bistoury.



Figura 2 particolare della pittura; a sx dopo l'intervento, a dx prima dell'intervento



REFERENCES

- [1] AA.VV, *La collezione egizia del Museo Archeologico Nazionale di Napoli*, Soprintendenza archeologica per le province di Napoli e Caserta, 1989, p 185
- [2] AA.VV, *Guida alla collezione egiziana del Mann*, Napoli, 2016, p 118
- [3] Brech. R. *Spätägyptische Särge aus Achmim. Ein typologisches und Chronologisches Studie*, Agyptica Harburgensia, 2008, pp 172-175, 188
- [4] Bdrabou A., Abdallah M., Kamal H. M., *Scientific investigation by technical photography, OM, ESEM, XRF, XRD and FTIR of an ancient Egyptian polychrome wooden coffin*, Egypt, 2017, p 4