Fish mummification
An approach to oxyrhynchite techniques
Part I

Bibiana Agusth[1] & Natalia Llach[2]

Abstract
This article presents an experimental archaeology project that aimed to reproduce the Oxyrhyncus fish mummification process. The project's main research questions were focused on understanding how several fish and mummification materials influenced the process.

Keywords: animal mummification, fish, dehydration, balms, oils.

مُلخص البحث
تَحنِيط الأسْماك: أُسلُوب وتقْنيَّات التَّحْنيط بأوكسيرينخوس. اَلجُزء الأوَّل

يُقـدِّم هـذَا البحـث مَـشرُوع تجْريبـيٍّ لِعمليَّـة التَّحْنيـط بِهَـدف مُحـاكَاة عَمَليَّـة تَحنِيـط الأسْـماك فِي أُوكسـيرينخوس. تَركـزَت الأسْـئلة البحْثيَّـة الرَّئيسـيَّة لِهَـذا المـشْروع اَلبحْثِـي التَّجْريبـيِّ عـلى فَهْـم كَيفِيـة تَأثِـير أَنـوَاع مُختلفَـة مِـن الأسْـماك وَمَـواد التَّحْنيـط عـلى عَمَليَّـة التَّحْنيـط ذاتهَـا.

الكلمات الدَّالَّة: تَحنِيط الحيوانات، الأسماك، التَّجْفيف، البلْسم، الزُّيوتُ

The Oxyrhyncus place name
The origin of Oxyrhyncus city can be traced back to the myth of Osiris which explains that, during his reign, he was killed by his brother, who cut his body into pieces and threw it into the Nile; later, Isis –Osiris' wife- recovered the chunks, except the phallus, ate by three fishes: an oxyrhynchus, a lepidot and a seabream Plutarch, On Isis and Osiris, 18, 358B). This is the origin of the sacralisation/divinisation of oxyrhyncus fish.

The depot of Oxyrhyncus fishes
The excavation of southern zone of roman thumbs 11 and 23 in Oxyrhyncus site uncovered two ritual depot of mummified fishes, wrapped in linen tissues and separated

[*] Poxyrhyncus Archaeological Mission. Anthropologist
[**] Zona Zero. Cosmetic craft

by halfa grass layers.[1] These depots, directly associated to the Saito-Perse funerary site, have been interpreted in the symbolic sense of the fishes in the Oxyrhyncys city, as sacred elements offered to the gods, coinciding with the Strabo' reference (Geography XVII, 1, 40) of a temple dedicated to the mummified oxyrhyncus fish.

The old Egyptian animal mummification and his depot in funerary context is really known, a practice that become usual during the first millennial before our era and especially during the Greco-Roman period. The typification of these mummies responds to their symbolic purpose,[2] depending on whether it is a pet, processed food for death nutrition, sacred living animals or votive animals raised on farms to be sold to pilgrims as offering in temples.

If the finality of mummification is body preservation, the method is based on dehydrating and de-fatting the body. The common procedures in all cases, and the most usual ones, are abdominal evisceration, dehydration with natron, impregnation with oils and resins and wrapping with bandages.

About of fish depots of Oxyrhyncus, the archaeozoology study[3] gives us information about the precise treatment of the bodies and the preparation of the tumulus. Thanks these observations is known that the bigger fishes have been opened at the ventral side by one or more incisions and empty, while more others, especially the smaller ones, were not eviscerated.

The bodies, completely dehydrated, have been put successively in the depot place, after being wrapped with linen tissues, with several thicknesses with decorative bands, and knotted. The outer wrap is always presented in orthogonally crossed stripes, alternating the longitudinal and transverse directions. Between fishes layers there were several grass bundles that kept the depot dry and compact. The grass kind is always the halfa grass[4] (*Desmostachya bipinnata*), that grows in North African habitats, therapeutic[5] and usual in African and Asiatic sacred ceremonies.

1 Mascort & Pons, (2015); Vam Neer & Gonzalez, (2019).
2 Ikram,S. (2013)
3 Vam Neer & Gonzбlez, (2019)
4 Desmostachya Bipinnata, Usually Known As Halfa Grass, Big Cordgrass, and Salt Reed-Grass, Is An Old World Perennial Grass, Long Known And Used In Human History.
5 Popular Treatments: Dysentery, Menorrhagia As A Diuretic.

The archaeozoologic study obtained a majority representation of elephant fishes (*Mormyridae*), specially the genus Mormyrus, two species of which are found in the Nile (Mormyrus *kannume*, Forsskel, 1775 and Mormyrus caschive, Linnaeus, 1758), and a third species, Mormyrops anguilloides (Linnaeus, 1758), that has different skull bones. There are also chunks of cat fish (Bagrus catfish), barbel (Labeobarbus bynni), Nile perch (Lates niloticus), tilapia (Haplotilapiini), clariid catfish (Clarias catfish) and pufferfish (Tetraodon lineatus). The volume of fish layers corresponding to a 6 m and 50.000 individuals are estimated.

There are common species in food use, either in dried or salted form. Since no fish hooks were found in the depot, it was be considerate that they had not been caught by using this method, logically in species that feed on the bottom of the river based on small invertebrates. The fish mummies preparation do not require the use of bitumen or resin, and also it has even been considered the possibility that they were be dehydrated only by the sun exposition, while the fluid absorption could be solved with alternating halfa grass and fish layers.

The presence of fish in funerary depots is not restricted to pharaonic periods but is also usual during the Christian period, especially in crypt n.1 of sector 29, with individuals associated to the vegetal and textile funerary adult packages.[6]

Why mummification experiment?

This work is the first part of an experiment aimed at reproducing the mummification treatment of fish from the Oxyrhynchus site, with the aim of understanding what was the mechanism used in the past. In this recreation, known data and data inferred from the general context of the topic of animal mummification are taken into account. More directly, the results obtained in the archaeological[7] and archaeozoological analysis is used,[8] with specific local data on the Oxyrhynchus fish deposit.

The second part of this work will be devoted to completing the mummification process with other specimens, varying the application of ointments and balms and the textile finish, in order to be able to extrapolate the data obtained to the techniques used on human bodies.

6 Agustн et al. (2022).
7 (Mascort & Pons, 2015)
8 (Vam Neer & Gonzalez, 2019)

The selection

In the first phase, seven fish units are selected, four from a marine habitat and three from a river, in order to approximate the type of fish available in the Bahr Yusuf (Mynia, Egypt). In the maritime case, specimens of sea bass (Dicentrarchus labrax) are selected from fish farms in eastern Iberian Peninsula (Mediterranean). In the fluvial case, trout (Salmo trutta) is chosen, coming from the Tavascan fish farm (Pyrenees). Both species fit the dimensions and weight required in this exercise, despite the fact that they do not meet the diet conditions that correspond to Egyptian river fish.

Sea bass is an osteichthyic white fish of the Moronidae family, very common in the Mediterranean coastal region. It is characterized by an elongated and stylized morphology, covered with large and regular scales, a pointed head in young specimens and a rounded head in adults. It has fleshy lips, two dorsal fins, and spiny rays on all fins, with two short spines on the upper angle of the operculum. It is a predatory species that feeds mainly on small pelagic fish, crustaceans, squid and polychaetes. It lives in a subtropical climate habitat both on the edge of rocks and on sandy bottoms. It can perfectly withstand fresh or semi-fresh water, which is why it is found in places such as river mouths, coastal lagoons, estuaries, ports and reefs up to 100 m deep.

Trout is the common name given to several species of mountain fish belonging to the family Salmonidae and the subfamily Salmoninae. The native variety or common trout, Salmo trutta fario, is a slender greenish fish dotted with red and black, with spineless fins and a small adipose fin along the back to near the tail. They like to mill in the gravel of the clean part of the rivers, especially in cold fast water streams of the head of the ranges and in mountain lakes. They generally feed on aquatic invertebrates, such as flies, mayflies, tricoptera, plecoptera and dragonflies.

The experimental mummification treatment

The starting point is an initial sample with 7 specimens (fig. 1), with similar dimensions and weight. The specimen n. 1 is a sea bass that was salted one month before the other six.

individual	species	length cm	weight g
1	sea bass (*dicentrarchus labrax*)	33	320
2	sea bass (*dicentrarchus labrax*)	33	320

3	sea bass (*dicentrarchus labrax*)	33	330
4	sea bass (*dicentrarchus labrax*)	33	371
5	trout (*salmo trutta*)	35	328
6	trout (*salmo trutta*)	35	388
7	trout (*salmo trutta*)	35	394

Table 1. Initial experimental sample

Figure 1. Initial experimental sample

The planned procedure includes these steps:

- ¬ Evisceration
- ¬ Dehydration in a saline solution
- ¬ Application of balms and wax
- ¬ Bandaged

Several materials are prepared for the mummification process:

A mixture of salts suitable for preserving organic tissues:

- ¬ Extract of spirulina maxima alga
- ¬ A mixture of oils and fats is used as a perfume.
- ¬ Beeswax
- ¬ Textile wrapping

Presentation and selection of the sample

The intended units are cleaned with a dry cloth to be cut. After making a cut on the ventral surface (fig. 2), the organs are removed and discarded: intestines, liver and stomach.

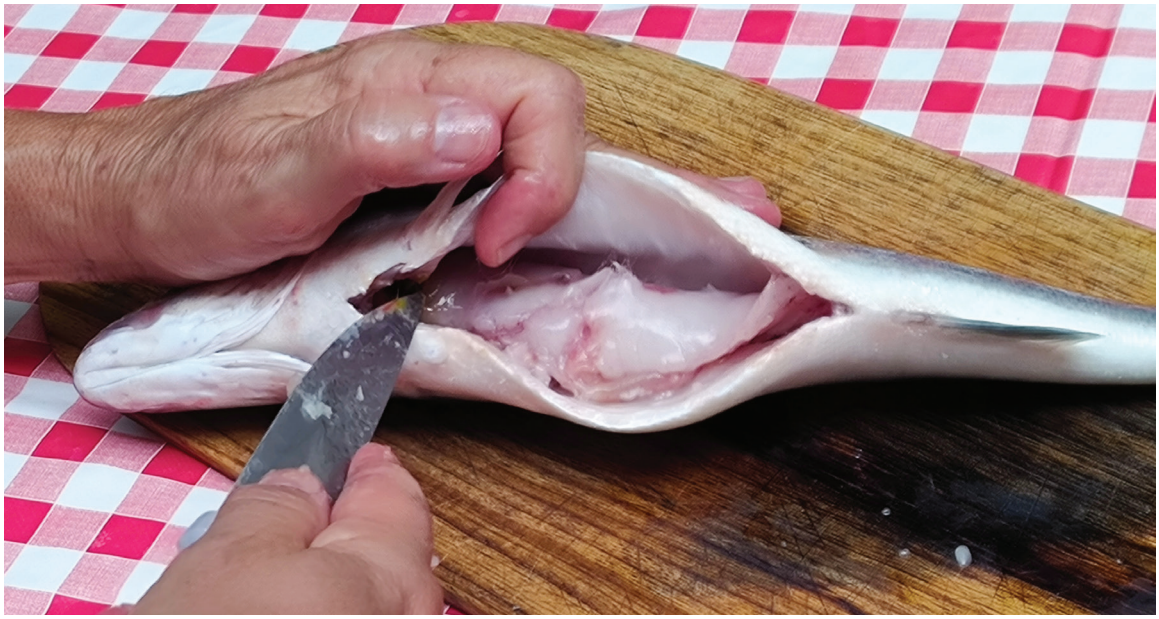

Figure 2. Abdominal evisceration

They are then deposited in a PVC container in a saline solution (a total of 500 g of salt was used) as detailed in the following table:

individual	original length cm	original weight g	evisceration	dehidratation
1	32	320	ventral	40 days
2	33	320	ventral	in process
3	33	330	ventral	in process

4	33	371	ventral	in process
5	35	328	ventral	in process
6	35	388	ventral	in process
7	35	394	ventral	in process

Table 2. Initial treatment data

Figure 3. Saline deposit

The only specimen in suitable conditions at the time to the first treatment was specimen number 1 (fig. 4, table 3).

individual	original lenght cm	original weigth g	evisceration	dehidratation	dehidrated weigth g	bams	post treatment weight g
1	32	320	yes	40 days	170	salts, oils, beeswax	190

Table 3. Fish n.1 data

Figure 4. Dehydrated seabass n.1

To remove the salt remains after the dehydration process, the selected specimen are immersed in a container with apple cider vinegar for about 30 minutes, ensuring it penetrates the eviscerated abdominal cavity as wel. Once cleaned, they are dried with a cloth and left to air dry for twenty-four hours (fig. 5).

Figure 5. Cleaned fish after vinegar depot

The deposit of perfumes and fixatives is the stage that corresponds to the anointing with oils. As a perfume, a mixture of oils and fats (fig. 6) previously stored in dark glass jars is used to protect them from light and preserve the integrity of the components. It is a strategic combination of oils and vitamins that, in addition to the aroma, plays an essential role in preserving and mainteining the integrity of the mummified fish.

- Jojoba butter: 90 g. Jojoba oil has the same PH as the skin and serves as an oily base for essential oils, keeping soft tissues flexible.
- Myrrh essential oil: 0.50 ml. It is incorporated in greater quantities. It provides a distinctive and long-lasting aroma.
- Cedar essential oil: 1.50 ml. It is incorporated in an intermediate amount and provides a woody aroma.
- Patchouli essential oil: 2 ml. In a small amount it brings a touch of earthy fragrance.

- Vitamin E alpha tocopherol: 9 drops. It is used as an antioxidant. It is a very dense substance added to the oily base to preserve the integrity of the oils and delay their oxidation. It helps maintain the quality of the mummification perfume for an extended period of time.

Figure 6. Application of essentials oil mixture

The application of the ointments first causes a pleasant smell that immediately neutralizes the organic smell of salted fish. The massage with the balms practiced on the abdominal tissue makes it flexible and easy to manipulate. This propriety and their antimicrobial effects are documented[9] and implemented in the human bodies' mummification process.

Inside the abdominal cavity, a mixture of salts is placed again to absorb moisture. The mixture consists of:

- Bath salt (*citric* and tartaric *acids*) (fig. 7) has the ability to absorb moisture.
- *Sodium bicarbonate* has deodorant properties.
- *Tartaric acid* combined with other acids helps to improve the PH of the fish.
- *Anhydrous acid* acts as an acidifier and natural preservative.
- Natural mica is a mineral that gives texture and shine to the mummified body.

9 Tomov, N. (2021)

- Corn starch is an additional absorbing agent.
- *Maxima spirulina algae* extract (fig. 8) contains the antioxidant beta-carotene pigment giving it its dark green colour, in addition to various trace elements.

Figure 7. Citric and tartaric acid

Figure 8. Maxima spirulina algae extract

The textile wrapping has used cotton gauze and strips of linen of various wefts (fig. 9), cut from a wider canvas.

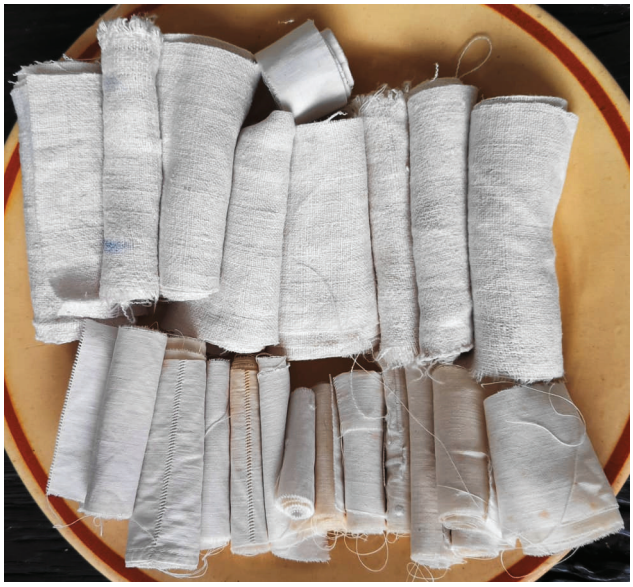

Figure 9. Linen bandages

The first layer of gauze was placed directly on the fish's skin (fig. 10) and adapted to its surface by moistening it with the oil solution. For the following layers, the body was wrapped with different linen strips impregnated with oils.

Figure 10. The first wrap is applied with oiled gauze

Beeswax is a fundamental material in mummification due to its properties in preserving biological materials. In this case, a 50 g tablet (fig. 11) is used which is melted in a water bath.

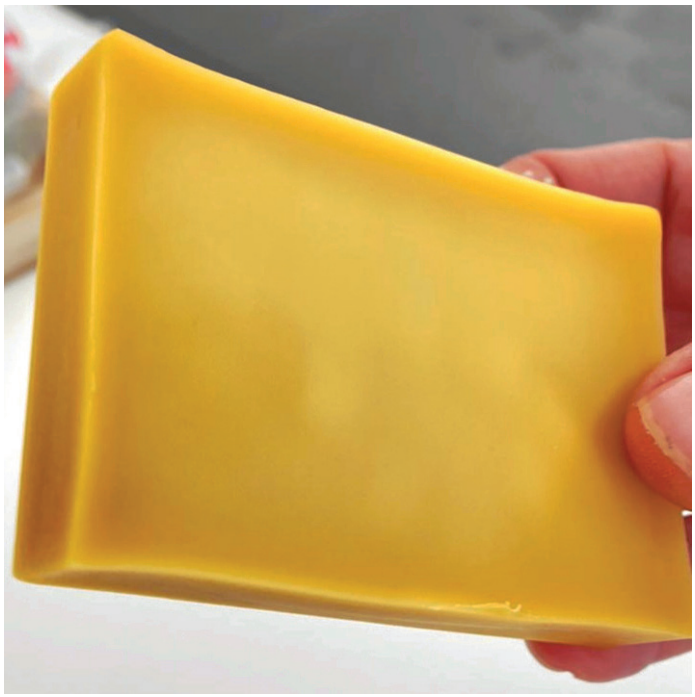

Figure 11. Beeswax tablet

Having reached the melting point between 62 C and 65 C, it becomes a manageable liquid that can be applied to the fish's surface to form a protective layer when it cools (fig. 12).

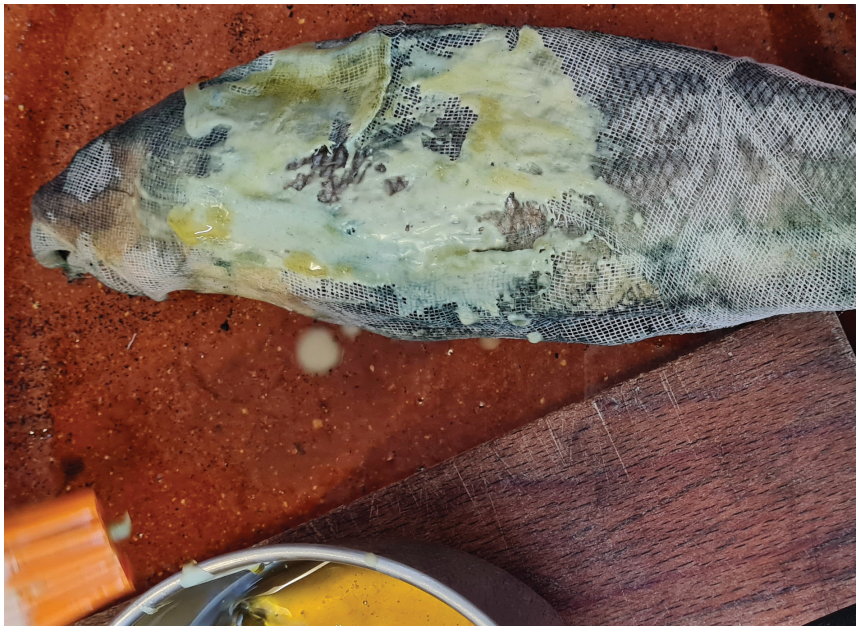

Figure 12. Application of liquid wax on the skin

Its functions are, firstly, to act as an effective barrier against moisture, preventing the body from absorbing water and preventing the proliferation of microorganisms and

putrefaction. Secondly, the wax helps maintain the structure and shape of the fish in its final appearance (fig. 13).

Figure 13. Wrapping with bandages and final presentation

Evaluation

The experimental recreation of the fish mummification process is part of the archaeological research of the Oxyrhyncus Archaeological Mission to understand conservation techniques in ritual contexts.

The initial dehydration procedure is common to all animal species and, in the case of fish, it is so similar to preservation used for human consumption (cod, herring, anchovies) that, at first, it could suggest an interpretation of the archaeological deposits at the site as simple food offerings. The large volume, the majority composition of oxyrhyncus fish, their arrangement and location give them a higher symbolic and sacred character.

The process followed in this work aimed to add specific elements to the mummification of both animals and humans using historically referenced oils and balms. The production of these ointments has allowed the revival of a set of sensations and smells, in addition to achieving a final product with an appearance similar to what the oxyrhyncus fish must have had.

Understanding that this is a first trial in this type of experimentation, we hope to soon be able to present new tests with specimens of other species and other formal variants. The data obtained will undoubtedly help to expand the knowledge about ritual mummification in Egypt.

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