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The Mummies of the Archaeology Museum of Palmyra

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Introduction

Anthropological collections, particularly those of mummies, constitute invaluable material for the reconstruction of human history. Therefore, efforts to protect these museum collections are a priority. These efforts must include particular care and attention in the study of the specimens and application of the most sophisticated techniques to acquire precise information without causing damage.
The mummies in the Archaeology Museum of Palmyra are a cultural and biological patrimony of inestimable value for the Syrian city, since they are the only ones remaining after past dispersions.
Because of the great historical and biological value of these mummies, a preliminary investigation was carried out in 2004 by the Anthropology Laboratory of the Department of Animal and Human Biology (University of Turin, Italy), the CNRS UMR 6578, Laboratoire d'Anthropologie Biologique et Culturelle de l'Université de la Mediterranée (Marseille, France) and the CNRS UMR 5197, Laboratoire de Parasitologie Environnementale et Paléoparasitologie de l'UFR de Pharmacie (Reims. France), in collaboration with the Palmyra Museum.
The study involved a program of interventions aimed at maximizing both the future conservation of the specimens and their use by the museum. It was very important to evaluate the state of preservation of these historical remains and to control any physical, chemical or biological changes by means of histological tissue analyses.
Histological examinations are useful to assess the general tissue characteristics (type of mummification and preservation methods). They also allow specific evaluations of possible tissue degradation and the presence of inorganic or organic contaminants. Indeed, a careful investigation of fungi and bacteria is particularly important before deciding on actions to be taken to preserve the specimens and to provide them with the optimal storage environment.
At the same time, a paleoparasitological study was conducted on the mummies. Paleoparasitology is a discipline that attempts to identify the fossilized remains of parasites (helminths, endoparasites) in historic and prehistoric archaeological samples. Research on parasites informs us about parasitic infectious diseases circulating in the chronological periods concerned, as well as about food behaviours, provisioning techniques and culinary practices closely associated with the social and economic organization of human groups.

Palmyra and its ruins

Palmyra provides an image that captures all the magic of the east in its traditions and art. This image has been admired by everyone who has visited the ancient city, the bride of the Syrian Desert, since its magnificent ruins tell the great stories of the past. Indeed, there is a story in every stone of the temples, tombs, streets, walls, markets and theatre. The Archaeology Museum of Palmyra represents the richness of a civilization that stood for three centuries between the two great powers of the time, Rome and Persia, playing an important role in world trade and leaving traces that have persisted until today.
Palmyra is situated in the middle of the Syrian steppe beside a spring that was the main resource of its inhabitants. This spring made Palmyra an oasis, a primary stop for caravans between the east and west on the Silk Road. However, the site was inhabited by humans starting from the early Paleolithic, as shown by excavations in caves around Palmyra, especially at Jourf al-ejla, about 22 km from Palmyra. There is evidence of a very abundant Levallois-Mousterian lithic industry (75,000 B.C.).
The ruins of the city cover an area of more than 10 square kilometers, containing remains of a period between the 1st and 3rd centuries AD. Further remains lie below, dated to the 4th century BC and to the third millennium BC. Palmyra's most prosperous period yielded a very civilized artistic production, including civic, religious and funerary sculpture. Numerous examples of funerary sculpture have been found in funerary towers and hypogea. They consist

of small stelae with a representation of the deceased set on the stone covers of the individual burial niches, busts of the family members or domestic scenes on the fronts of sarcophagi, and panels placed above sarcophagi representing the deceased lying on one elbow on a banquet couch with his spouse seated at his feet and their children standing between them.

There are four types of tombs in Palmyra: house-tombs, underground-tombs, individual-tombs and tower-tombs. The last type is the most important and is where the mummies were found. It is the oldest type of tomb in Palmyra and is an architectural creation peculiar to the Palmyrenes, consisting of a square building of several stories with a staircase leading to its top. Mummies were only found in tower tombs that were ventilated. Many mummies were stolen from Palmyra, and today there are only the four housed in the Palmyra Museum and a fifth in Denmark.

Fig. 1 - Mummy 1.

Mummification in Palmyra

In Palmyra, mummification was reserved for the rich, who were able to pay for the experts. Thus far, we do not have any evidence about religious connections with mummification.

Past studies on the embalming methods revealed similarities with the embalming practices of the ancient Egyptians. The ancient Palmyrenes and Egyptians were the only people of the Middle East to embalm their corpses. Although the Palmyrenes knew the embalming techniques used by the Egyptians, there were differences in the various phases of the process (Rahmo, 1993).

The first stage was decerebration, carried out in the same way by the two peoples, either by introducing an oblong tool through an opening made in the upper part of the nose (at the level of the ethmoid) or by detaching the head from the body so that the brain could be removed through the foramen magnum (a method rarely used at Palmyra before the Greek period). Unlike the Egyptian mummies, all the Palmyrene ones were decerebrated and the nasal cavity and mouth were left open. For evisceration, the Egyptians made a longitudinal cut in the abdomen if the deceased was of high social rank, while for the poor they introduced cedar oil through the anus, which destroyed the internal organs within several days. In contrast, the Palmyrenes made a transverse incision in the lower abdomen, extracted all the organs and threw them away or burnt them. Hence, the organs were not preserved as in Egypt. The eyes were always removed and replaced with plant material. The genitals were not removed.

The next stage was the application of chemical substances to embalm the cadaver. The choice of these substances depended on the abundance or shortage of natural products. Lime was used at Palmyra, *natron* (sodium bicarbonate) in Egypt. The body was then bandaged, in Egypt exclusively with thin or thick linen, while at Palmyra silk (Palmyrene or Chinese) and coloured wool were also used.

Fig. 2 - Mummy 2.

Materials and methods

The study was carried out on four dehydrated and partially bandaged mummies currently in the stores of the Archaeology Museum of Palmyra (Figs. 1, 2, 3, 4).

The general condition of each mummy was evaluated by careful macroscopic observation and analysis of the exposed surfaces. Compromised or altered areas were quantified and described. This phase was documented with detailed photographs. Mummified tissues, powders, plant fibres, sediments, incrustations, insects and other substances were sampled in the most damaged areas. Histological analysis allows specific evaluation of possible tissue degradation and the presence of contaminants. All the mummies were suitable for histological testing since they were only partially bandaged or not bandaged at all; hence, fairly large areas of mummified tissues were exposed. Small tissue pieces (5 mm) were removed from fractures or lacerations without damaging the remains. This yielded four samples from mummy 1, four samples from mummy 2, one sample from mummy 3 and four samples from mummy 4. The histological analyses used specific histochemical staining to reveal bacteria and fungi (Culling *et al*., 1985; Bancroft and Gamble 2002); these techniques are routinely used in the study of mummified tissues (Fulcheri *et al*., 1985; Boano *et al*., 1999; Fulcheri *et al*., 1999; Boano *et al*., 2000).

Fig. 3 - Mummy 3.

Fig. 4 - Mummy 4.

Paleoparasitological examinations were also carried out. The first goal of these analyses was to evaluate the use of paleoparasitological techniques on archaeological material housed in a museum and potentially «parasitized» by foreign agents. The second goal was to study current and past parasitoses to understand how parasitic agents interfere with the conservation of archaeological materials in the particular context of a museum. The third goal was to provide preliminary data on the pathologies and health of Palmyrenes.

This work was carried out on five samples taken from the four mummies: 1, 2, 3a, 3b and 4. The samples were prepared according to the physico-chemico-micrometric protocol for the extraction of parasites. The material was rehydrated using current paleoparasitological methods. Each sample was placed in a 0.5% trisodium phosphate solution supplemented with 5% glycerinated water for 15 days. The samples were then crushed in a mortar and treated with ultrasound for 3 min at 50°C. They were then filtered in a column of 4 calibrated sieves, with mesh sizes of 315 μm, 160 μm, 50 μm and 25 μm. The refuse from the 50 μm and 25 μm sieves was used for light microscopy. Eggs and other organic remains were measured and photographed. The morphological and morphometric characters of the fossil eggs allowed a generic and/or specific identification.

Finally, conservative treatments of the specimens and controls of the surrounding environment were performed. This involved mechanical cleaning of exposed surfaces with appropriate tools (brushes, forceps, etc.) and the creation of supports and protections to preserve the most fragile parts. Particular attention was given to protection against atmospheric dust and sources of direct illumination by means of special sheets of antacid paper. Chemical substances were used to preserve the specimens, according to current laws regarding museums (use of thymol). Constant monitoring of environmental parameters, such as temperature and humidity, was also initiated.

Results

The histological analyses generally revealed limited histological and cytological degradation; evident and diffuse

destructuring was only observed in sporadic cases.
The fairly good state of preservation of the tissues was confirmed by the presence of corpuscular components of the blood (probably erythrocytes), which are the object of ongoing histochemical investigations, as well as the sporadic presence of blood vessels with easily identified structure and natural skin pigments (probably melanin) in epidermal tissue.
In some specimens, the tissues were infested by fungal colonies (spores) and eggs of parasites. However, the lack of strong vitality suggested the past occurrence of serious infestations that were now exhausted or in decline.
The histochemical staining did not reveal any bacterial contamination. Traces of carbon powders were present in almost all samples.
The paleoparasitological study yielded only one positive result: mummy 2.

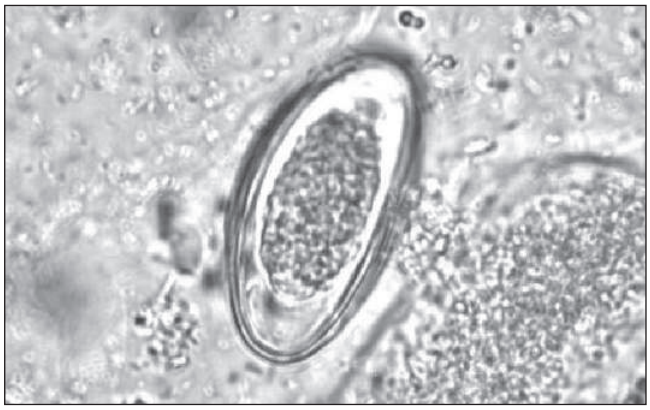


Fig. 5 - egg of Enterobius vermicularis, 50-60 mm X 30-20 mm, G = X 600.

Endoparasites

Enterobius vermicularis (Fig. 5): The eggs of *Enterobius vermicularis* are ovoid, asymmetrical and, in profile, flattened on one face and bent on the other. The hull is thick and smooth. The size varies from 50-60 μm X 30-20 μm. *Enterobius vermicularis* (Linné, 1758) is closely associated with humans and is very widespread in children. Infestation occurs by oral ingestion. The fertilized females then migrate to the rectum where they lay thousands of eggs. The human host can then be re-infested by ingestion of the eggs. Thus, poor hygiene is responsible for the enterobiosis, which does not cause serious illness but produces uncomfortable symptoms in parasitized individuals.

***Hymenolepis* sp.** (Fig 6): The eggs have two envelopes. The external one is globulous or round, thin, smooth, persistent and hyaline. With this envelope, the egg measures 50-40 μm X 30-40μm. The second envelope is oblong, lemon-shaped and bears a nipple (polar plug) at each pole with 4 to 5 flexible filaments (chalazae) that are stretched between the two envelopes. This internal envelope protects the embryo. The embryo and internal envelope measure 20-22 μm X 30 μm. The morphology and morphometry of the eggs suggest that we are dealing

Fig. 6 - egg of Hymenolepis, 50-40 mm X 30-40 mm, G = X 1000.

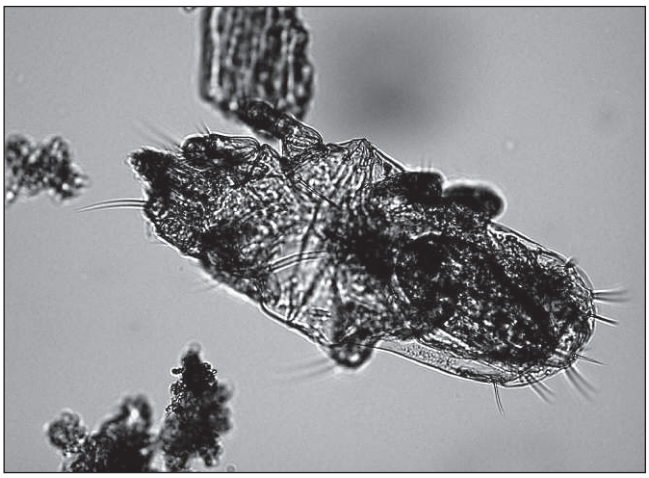


Fig. 7 - adult Acarina.

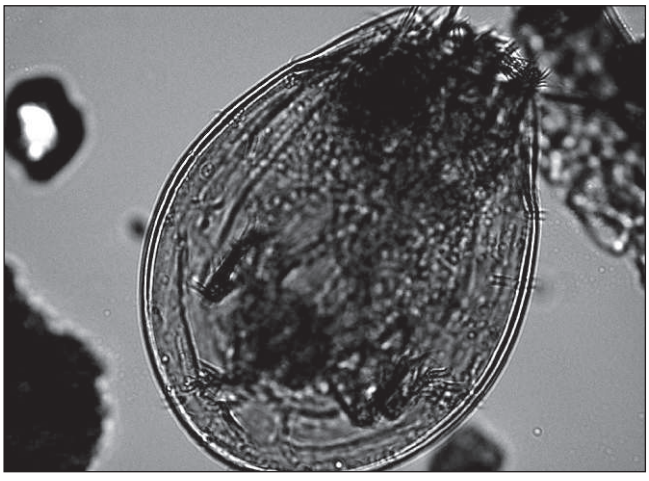
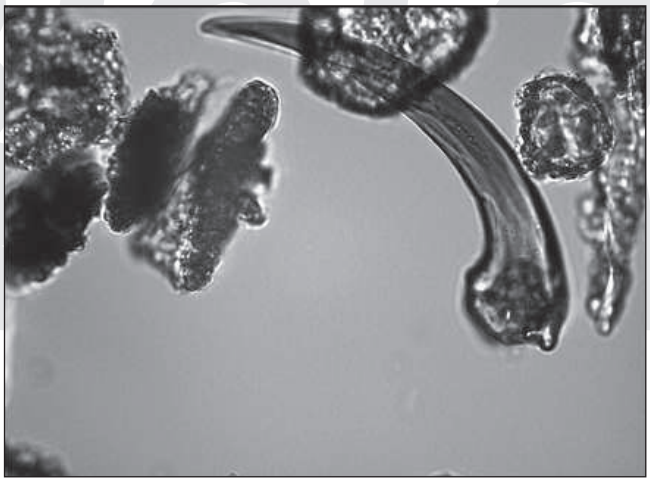


Fig. 8 - Acarina egg.



Figg. 9 and 10 - unidentified insect fragments.

with *Hymenolepis nana*, a tapeworm that infests humans and also rodents.

Ectoparasites
Acarina: From the Latin *acarus*, Greek *akari* = mite, small insect (Figs. 7, 8).
The order Acarina (mites and ticks) belongs to the class Arachnida (also including spiders and scorpions). There are 5 families, divided into 18 genera and 48 species. The most common species are: *Dermatophagoides farinae* (DF), especially present in North America, and *Dermatophagoides pteronyssinus* (DP), mainly found in Europe.
Fragments of unspecified insects.
Mandibles and grips of unidentified insects were found in various samples (Figs. 9, 10).

Discussion

In general, there were no evident states of degradation serious enough to compromise the integrity of the specimens in the near future. However, direct interventions on the specimens and the surrounding environment must be planned in order to control the riskiest situations.
Our finding of the parasite *Enterobius vermicularis* (2 eggs) is a new record for this geographical area and time period. In a chronic state, this pathology becomes handicapping but is seldom fatal to the parasitized individual. This is the first observation of an infectious parasitic pathology in relation to the personal hygiene and food of Syrian mummies.
The eggs of *Hymenolepis* (3) can be interpreted in two ways:

– they are markers of a human parasitosis related to infestation by the tapeworm, *Hymenolepis nana* (von Siebold, 1852). Several hundred *H. nana* adults can live in the human intestine. Contamination occurs by the ingestion of food carrying the eggs and re-infection is possible. Symptoms are digestive disturbances and abdominal pains. This parasitosis is usually found in children in an urban environment.
– they are evidence of a parasitosis associated with rodents. In view of the imprecise nature of the studied samples (human organic matter or faecal deposits of rats or mice), it is possible that these eggs are due to contamination of the mummies by rodent faeces during their conservation.

The eggs and adults of Acarina, and the unidentified insect fragments, suggest an old and/or sub-current contamination of the mummies by ectoparasites. By consuming their support (the mummy), these parasites hinder its conservation and cause damage that is not easily repaired.
In view of these findings, regular checks should be carried out to determine whether «parasites» like rodents, insects or mites interfere with the conservation of the mummies.

Proposals for future interventions

The following non-invasive diagnostic investigations and conservative/protective interventions are proposed:

- radiographic surveys and three-dimensional reconstructions using Computerized Axial Tomography. This will allow better definition of the internal structure of the bodies to complete the studies carried out thus far. These techniques will also provide excellent exhibitional and educational material for use by the museum.
- Recomposition of damaged parts of the skeleton using non-aggressive glues.
- Creation of supports and specific protections to preserve the most fragile parts.
- Construction of appropriate showcases to protect against atmospheric dust and sources of direct illumination.
- Use of natural substances and/or chemical substances for preservation of the specimens, according to current laws.

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