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BENEFITS AND DISADVANTAGES OF SOME CONSERVATION TREATMENTS FOR EGYPTIAN MUMMIES

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Mummified remains and associated artifacts are fragile and vulnerable to several types of deterioration, including those factors which result from environmental conditions, physical damage and damage caused by previous inadequate conservation attempts. This paper considers the benefits and disadvantages of the conservation treatments in relation to the preservation of DNA in mummified remains.

Key words: Conservation of mummies, museology, PCR.

Los restos momificados y sus artefactos asociados son frágiles y vulnerables a varios tipos de deterioro, incluyendo los factores que resultan de las condiciones ambientales, el daño físico y el daño causado por intentos anteriores o inapropiados de conservación. Este informe considerará los beneficios y desventajas de los métodos de conservación mediante los cuales la mayor parte del deterioro puede ser evitada o rectificada después. También se considerará la reparación física, el apoyo y el cuidado de las momias y, en particular, los problemas asociados con su exposición en museos. Finalmente, se presentarán nuevas investigaciones que consideran las maneras en que varios tratamientos de conservación pueden afectar la preservación de ADN en restos momificados.

***Palabras claves**: Conservación de momias, museología, PCR.*

Deterioration in mummies is caused by several factors, including environmental conditions, physical damage, or damage caused by previous inept conservation attempts (David 1986). Sometimes, these factors occur in isolation, but they can also be present in combination; some are final and irreversible, but most can be avoided initially, or corrected at a later date (David and David 1995).

Environmental Deterioration

Conditions, which existed prior to excavation of a mummy (particularly flooding of the burial site), can cause deterioration. However, poor display or storage conditions in the museum environment are often responsible. High relative humidity, inadequate air movement, and darkness provide an almost ideal environment for the cultivation of fungal spores (Hino et al. 1982), microbiological deterioration, and insect attack. The effect of direct sunlight and ultra-violet light can cause a degree of thermal decay to skin tissues, the resin content in the mummy, and the associated wrappings. The bacterial attack that results from poor environmental conditions also can hinder the work of the histo-pathologist, which is undertaking microscopic studies of mummified tissue.

Deterioration Due to Physical Damage or Previous Conservation Attempts

This physical type of damage can happen at the archaeological site or in the museum, and in the past was often the result of inadequate or careless handling by early archaeologists or investigators. In addition to human mishandling, mummies are sometimes subjected to rodent or insect attack (Curry 1979). Early attempts to preserve ancient bodies have included processes such as the deposition of copper salts in aqueous solutions on the skin, which was believed to discourage further bacterial attacks, and the smoking-curing of mummified remains. Both of these treatments caused further damage.

The term "mummy" is now applied to bodies from many geographical areas; generally, it describes examples where the tissues have been preserved either through natural environmental conditions or through intentional processes (Cockburn and Cockburn 1980). However, in the examples quoted below, the studies have mainly been concerned with Egyptian mummies, which have been intentionally preserved.

The conservation of mummified remains involves two procedures. First, it is necessary to store the mummies in a suitable environment, ideally with a relative humidity, of 40-55 percent and a constant temperature of 10-15° C. Secondly, if environmental deterioration has already occurred, when the damage cannot be eradicated thorough environmental control alone, it is necessary to apply other methods to arrest the damage.

Environmental Control

a) Inert Gas Control

This is one of the most elaborate methods, in which the display case is filled with inert gas, and there is also a constant regeneration of gas to achieve a positive leak as a fail-safe measure in the event that the air tightness of the gas is not maintained. Developed for displaying the Egyptian mummies in the Turin collection, this method is only effective if the mummy shows no existing signs of deterioration. It is also expensive to install and requires continuous monitoring.

(i) The mummy is placed inside the fumigation chamber. Air is then evacuated from the chamber by vacuum pressure, and a fumigant is introduced. This chemical sterilization has to be toxic and volatile to eliminate the source of deterioration from the mummy. Ethylene oxide is very effective, and other treatments include Vikane (R) or sulfuryl fluoride (SO_2 F) and methyl bromide.[1]

(ii) The mummy is placed inside a tightly sealed polythene bag into which the fumigant is introduced. However, this method is less effective because the vacuum does not assist the penetration of the gas.[2]

b) Wet Sterilization

Fungicides and insecticides have been introduced into the mummy by applying a solution directly to the tissues. The best results are achieved by applying 1-5 percent solution of Pentachlorophenol (sodium salt) in pure alcohol. This is an effective fungicide and contact herbicide, and the alcohol acts as a dehydrating agent, which removes the moisture from the tissues. However, this method can only be used for unwrapped or partially unwrapped mummies. Also, Pentachlorophenol is an highly toxic compound, and the operator must protect himself by wearing a mask and gloves while working within a fume cupboard; the availability of this compound has been severely limited since 1994[3].

c) Controlled Drying

This method is very effective on unwrapped mummies and bog bodies (from northern Europe). The mummy or body acts as a culture on which the microorganism multiplies, and controlled drying changes the environment, thus preventing any new growth of microorganisms. The mummy is first placed in a controlled environment and the relative humidity in the atmosphere is then gradually and slowly reduced over a period of months. De-humidifiers are used to extract the moisture from the controlled volume of air. Further treatments with one of the chemical applications are required to ensure the success of this method and to prevent any renewed growth of the microorganisms[4].

d) Ultra-violet Irradiation and other Methods

Radiation can bring about physical and chemical changes in the cells of microorganisms (Belyakova 1960; Van der Molen et al. 1980). The use of x-rays, gamma rays and electron beam radiation has been employed to eliminate microorganisms in mummies, the most famous instance was the treatment of the mummy of Ramesses II in Grenoble, France [5].

The effect of Various Conservation Treatments on the Preservation of DNA in Mummified Remains

A major consideration in selecting and using the various conservation treatments for mummified remains is the effect that this may have on the tissues, by destroying evidence which may later be sought by histo-pathologists and other scientists. This is an important area for future studies. Since this problem had not previously been addressed, it was decided to establish a pilot study (Vowles 1997) to attempt to determine if DNA was still amplifiable after the application of different conservation treatments to modern and ancient tissue samples.

Blood spots on filter paper were used to provide the modern DNA samples, and fragments of Egyptian mummified tissue supplied the ancient DNA samples. The conservation techniques that were tested included gas fumigation (using phosphine, carbon dioxide, methyl bromide and nitrogen); wet sterilization (using ethanol, methanol and Industrially Methylated Spirits (IMS) or denatured alcohol); and irradiation tests using high energy electrons and ultra-violet radiation.

Using Polymerized Chain Reaction (PCR), gel electrophoresis and silver staining techniques, the results were found to show that the DNA was still amplifiable in all the modern samples that had been treated. There was insufficient time within the MSc programme for the student to analyze the ancient DNA in the mummified tissue, but there are plans to extend this study to cover this area, and also to expand the range of conservation treatments that are examined. However, within the parameters of each of the tests undertaken to date the conservation treatments were not shown to have destroyed the DNA.

Results

A range of conservation treatments are available for arresting deterioration in mummified remains; it is also possible to provide the necessary environmental conditions to ensure the continuing well-being of the objects. However, these methods can be expensive, time-consuming, toxic, or applicable only to partially

or completely unwrapped examples. Also, their effect in destroying evidence is uncertain, and future results from histology, immunocytochemistry, DNA identification, and other diagnostic methods may be impaired

Conclusions

Mummies and other preserved bodies are a unique and irreplaceable resource for the study of ancient cultural practices such as methods of mummification, for the identification of the occurrence and patterns of disease, and for genetic and population studies. It is therefore essential that conservation treatments be developed which preserve the bodies in an effective way, while not destroying their value as a source of biological and biomedical evidence

Notas

1 Editor's note: Inert gases currently recommended in the field of conservation include carbon dioxide, argon or nitrogen (See Valentín 1993, 1994; Gilbert 1990). Methyl bromide can react negatively with many materials, especially metals, and ethylene oxide has been found to off-gas after treatment and is no longer recommended.

2 Editor's note: Fumigants can off-gas for extended periods. At present conservators rarely use fumigants, instead freezing (see Florian, Mary-Lou 1986) or replacement of oxygen with inert gases are commonly used (see footnote 1).

3 Editor's note: Conservators would not recommend the use of pentachlorophenol or other biocide solutions for human remains. In general, preventing fluctuations in relative humidity from reaching above 65% will sufficiently control growth of fungi.

4 Editor's note: Again conservators would prefer to control the environment without use of biocide, fungicide or insecticide.

5 Editor's note: These techniques are considered experimental and have not been recommended or adopted for museum collections.

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