Treatment and Conservation of Wood - Application on Two Coffins at the Egyptian Museum of the Faculty of Archaeology - Cairo University

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Summary

Wood has played a major role throughout human history. Even the earliest man used wood to construct shelters and later as firewood for cooking their food. Wood also provided tools, household articles and weapons. Collective societies learned very early the great values of wood, which we still recognize today; the strength, workability, wide distribution, renewability and aesthetics.

Archaeological wood may be defined as ancient wood, used by an extinct human culture, that may or may not have been modified for use, and that was discarded into a specific natural environment. Such wood has been now removed from its environment, taken out of the sequence of chemical and physical changes that would ultimately have transformed the wood either to fossil or to dust. The condition of the archaeological wood would be near normal or extensively altered. Age alone is meaningless in terms of deterioration, which depends on the type of wood, the environment and time.

Buried archaeological wood is the same as ancient wood (often called paleontological wood). Both have been deposited in natural environments and have undergone changes there. Naturally these changes would eventually turn wood to dust, humus, or coal, or would mineralize it, depending on the environment of the burial site. But occasionally the wood appears to be stabilized in strata, like a buried time capsule. It reaches equilibrium within the strata’s unique environment that allows the wood to apparently survive.

Archaeological wood is found in sites in two forms: as worked wood or as non-worked wood. The wood differs according to its state at time of the excavation. It could be in a good state because of good preservation conditions of the site or sometimes in a bad state as a result of its exposure to deteriorating physio-chemical conditions or to insect and microbiological infestation.

The present study discusses the deteriorating effect of the wood and the different techniques for preserving it according to the measures of international museum requirements.

The chemical and physical state of the archaeological wood may vary from normal to disintegrated. The variability may be explained by a number of factors, such as the wood species, the history of use and fabrication, the time buried and the burial environment.

Society today with a new awareness of the value of the objects of the past and with new technology for handling them is preserving the wood as it represents one of the main archaeological and antiquity items that man left behind over the different historical eras.
It has been used in many different industries; household furniture, funerary furniture, statues, agricultural tools, commercial equipments and in technical workshops and also as means of transport.

The aim of this study is to find and apply suitable conservation techniques for two wooden coffins at the Egyptian museum at the Faculty of Archaeology - Cairo University.

The study consists of six chapters:

Chapter 1
Evolution of wooden coffins in ancient Egypt until the Graeco-Roman Period

This chapter reviews the evolution of coffin industry since predynastic times until the Graeco-Roman period. Antique coffins have special significance because since their designs and structure reflect the chronology of historic periods, the social level of its owner and religious beliefs.

The ancient Egyptian carpenter had to master all the possible techniques to attain a high degree of perfection in designing the coffins. Carpenters were aware of the different types of wood used in this industry, and it is evident from the various types of wood used in old times, that they did not only depend on local woods, but also imported woods. It has been possible to identify the ancient wood and differentiate between local and imported wood. The tools and wood working techniques (e.g. various wood joints) which the carpenter used in this industry were recorded and also whether it was used in household furniture or funerary furniture.

The structure and design of the coffins varied during the different historic periods; for example some were long and rectangular, others were anthropoidal. Moreover, the type of wood used differed in the different coffins. Royal and noble coffins were made of the fine imported wood, but coffins of middle class or poor people were made of local wood which was less in quality and properties.

The type of wood used had its effect on the structure and the design of the coffins. The coffins of the royal and noble people consisted of few large logs of wood contrary to those of ordinary people which were usually made by joining together smaller pieces of wood.

Photographs of different wood coffins exhibited in the Egyptian museum in Cairo and the British museum in London are included in this chapter.
Chapter 2
Wood

Wood has played an important role in a nation’s economy, its nature makes it suitable material to cut, shape and sculpture into different items. The ancient Egyptian carpenter made use of the nature and texture of the wood he utilized.

The economic importance of wood mainly depends on its anatomical features and its chemical nature. The different anatomical features of the cells that characterize hard woods and soft woods are important criteria which are to be studied before conservation methods and techniques are applied. The chemical nature of the cells walls is another important criteria.

This chapter deals with the different cellular patterns and chemistry of hard woods and soft woods and how to distinguish between them.

Chapter 3
Wood deterioration factors

The different deterioration factors of archaeological wood are as follows:

1. Physical:
   They include relative humidity, fluctuating temperature, direct or indirect illumination in all its different forms and sources.

2. Chemical:
   This could be due to water dissociation, hydrolysis or oxidation process taking place in wood; or deterioration of polymers and their molecules after exposing wood to strong acids, alkales, organic solvents or enzymes.

3. Weathering:
   This includes fluctuation temperature, relative humidity and also the exposure to ultraviolet rays from the sun, wind and air pollutants (dust) which could cause severe erosion.

4. Mechanical:
   Wood breaking caused by mechanical damage could be due to external pressures or wood abrasion.
5. **Biological damage:** Biological damage is due to insect or microbiological infection. Special interest was stressed on the biological deterioration since both of the studied coffins had reached an extremely deteriorated state due to biological damage.

6. **Waterlogged wood:** Waterlogged archaeological wood refers to wood that has been excavated by archaeologists and is more or less submerged with water. Such wood is unstable once exposed to the ambient climate.

**Chapter 4**

**Wood conservation techniques**

Special techniques have to be carried out with great accuracy in order to conserve archaeological wood possibly to its natural state, otherwise the whole antique object could be lost forever. Conservation measures must not destroy the integrity of the object, its aesthetics and its research potential. In addition, the treatments should be reversible. These seem to be impossible, but objects can be treated while still adhering to a truly ethical approach.

The different techniques for treating and preserving archaeological wood and modern wood is discussed in this chapter and it includes the following procedures:

1. Mechanical cleaning.
2. Chemical cleaning.
3. Mechanical strengthening.
4. Chemical strengthening.
5. Displaying and storage.

The methods for treating or conserving archaeological wood depends mainly on the actual state of the object, which could have lost some of its solidarity. However it is not advisable to treat archaeological wood unless a thorough study of all the environmental factors (all previously mentioned damaging factors) are accurately recorded. Consolidation of archaeological wood depends on the following inverse relationship: “As more materials are introduced into the artifact, it becomes less authentic.”
Identification of wood materials used for manufacturing two ancient coffins dating back to the first or second century A.D. was carried out. Microscopical examinations and microbiological analyses were conducted. The results obtained were as follows:

1. Electron microscope and light microscopic examinations were carried out to identify the timber used in both coffins. Coffin number 852 was made of Cypress wood (*Cupressus sempervirens*), while coffin number 849 was made of Acacia wood (*Acacia nilotica*) and Tamarisk wood (*Tamarix aphylla*).

2. SEM and LM examination of coffin number 852 showed that this coffin was infested with the following fungi: *Paecilomyces variotii*, *Pencilmium aurantiogriseum*, *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus terreus*, *Emericella nidulans*, *Mucor racemosus*.
   
The same coffin was also infested with the gram positive bacteria, *Micrococcus tetragenus*.
   
Coffin number 849 was not infested with micro-organisms but unidentified traces of insect wood borer infestation were apparent.

3. The inside of coffin number 852 proved to contain traces of a black resin and mummy remains (?). By analysing the black material using FTIR spectroscopy, the results showed that the black material is presumably a plant resin mixed together with a protein containing material (mummy remains ?). The results were similar to results of FTIR spectroscopy analyses of mummy at the museum of Scotland (UK).

4. Identification of the paint media was carried out by means of FTIR spectroscopy and it is possible to assume that gum arabic had been used as a paint binder for all colours except the black colour, for which animal glue was possibly used instead.

5. X-ray diffraction analyses of the materials used in colouring the coffin number 849 proved that the following minerals had been used:
   - rough coat in wood joints : silica
   - paint ground : calcite
   - yellow colour :
   - red colour :
   - blue colour :
   - green colour :
6. Evaluation of different gap fillers used for mechanical consolidation of archaeological wood suggests that the most suitable filler was a mixture of: sawdust + filter paper (2:1) + carboxymethylcellulose sodium salt (2%).

Chapter 6
Conservation of two wooden coffins

The different stages of documenting and treating both coffins are outlined. Photographs for all stages of restoration are included.

The conservation procedures were as follows:
- Documentation of both coffins.
- Mechanical and chemical cleaning of both coffins.
- Mechanical consolidation of both coffins using the previously chosen gap fillers.
  
a) The missing wood portions which are a result of an old insect infestation in the right foot of the coffin were replaced with strong new wood. Balsa wood and gap fillers were added to replace the exterior parts which did not need much strengthening.

b) Gap fillers and balsa wood were coloured with water colours in order to match the original colours of the coffin.

c) Strips of Japanese tissue paper were secured with methyl cellulose 1% (diluted in water and ethyl alcohol 1:1) for mechanical consolidation in coffin number 852.

4. Methyl cellulose 0.5% was used for chemical consolidation of both coffins, by spraying with an airbrush.

5. All conservation stages are documented in photos number 54-132.

Discussion

The results of microscopical examinations, microbiological and chemical analyses, which were presented in chapter 5 are briefly discussed. Also the reason for choosing the consolidation materials and techniques are discussed with special reference to earlier studies and investigations.

Future experimental procedures and recommendations for conservation of archaeological wood are suggested. They include further documentation of bacteria, fungi, insects and rodents that infest archaeological wood in Egypt. Detailed studies on chemical changes of ancient wood should be conducted. Also better evaluation techniques for
gap fillers should be founded. Last, but not least further studies on the display and storage of wooden artifacts should be done.