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Conservation and Treatment of an inlaid wooden backgammon board from the 19th Century

علاج وصيانة طاولة خشبية مطعمة من القرن التاسع عشر

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Abstract

This study is based on the conservation and treatment of a wooden backgammon board that was inlaid with mother-of-pearl, dating back to the 19th century, from the possessions of Saad Pasha Zaghloul. The study deals with photographic documenting of the damage in the backgammon board and the examination using microscopes such as digital, stereo, and optical microscopes. Analysis of the mother-of-pearl and the adhesive used to fix the inlaid materials were conducted using FTIR.

The conservation and treatment began with sterilization due to the presence of the remains of an insect molting bag inside the box, which was followed by the cleaning phases, both mechanical and chemical. Then three experiments were conducted to reduce and refine the mother-of-pearl used in the completion of the missing inlays, then the cracks were filled using a mixture of Paraloid B 72, glass micro balloon, and suitable pigment colors that match the color of the wood of the backgammon board.

Keywords:

Mother of Pearl –Nacre - Cleaning - Backgammon.

Introduction:

Historical documentation

Object is a backgammon board, one of the “fun and intelligence games” made of wood that belonged to Saad Pasha Zagloul (1858 AD - 1927 AD) (english.ahram.org.eg n.d.), the leader of the Egyptian nation in 1919. This wooden backgammon board was one of the gifts given by "Amina Hanem Elhami", wife of Tawfiq Pasha, known as “Om El Mohsenen” (the Mother of the benefactors) to Saad Pasha Zaghloul.

The foldable backgammon board is displayed at the House of Nation in Sayeda Zainab, Cairo. It dates to the 19th century, and was inlaid with mother of pearl and ebony (Figure 1-2). Inside the box were 15 white and black game checkers, two ivory dices and wooden counter with small numbered sticks made of ivory (Figure 3).

Figure 1 The inlayed exterior of the backgammon board

Figure 2 The interior of the inlayed backgammon board

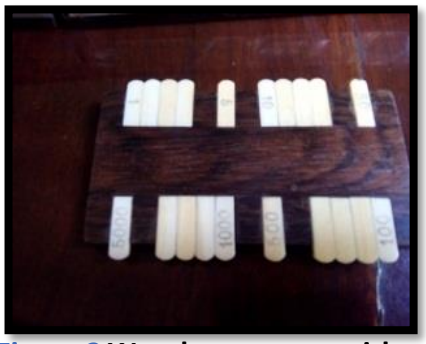


Figure 3 Wooden counter with small numbered sticks made of ivory

Technical and archeological documentation

The backgammon board is inlaid with different geometric forms that resemble star dishes and different angles of five and six pointed stars or more and different angled triangles. The manufacturer drew the design and assembled the inlaid units from mother of pearl and ebony by using animal glue adhesive and finally the surface was varnished.

The foldable backgammon board consists of two rectangular pieces; each of which is surrounded by four sides forming to halves of a bivalve box with the dimensions: 45.5cm length, 24cm width, 7.5 cm height, and the depth of the interior of the backgammon board is 2cm. The two parts were assembled by metal hinges (Figure 4). A metal lock was used for locking and unlocking the game board box (Figure 5).

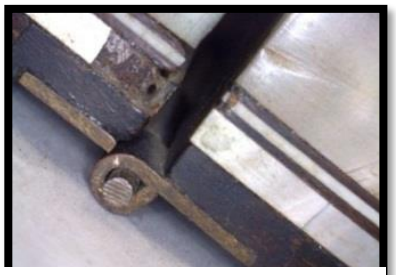


Figure 4 The metal hinge

Figure 5 The metal lock

State of preservation and visual assessment

The board was displayed in an uncontrolled museum environment, exposed to pollutants and dust that had accumulated on the surface.

The effect of any deterioration factors cannot be separated from the others, as they work together in a connected formation, linked to each other in an integrated manner to tighten their effect on damage (Salah 2023), It is therefore necessary for a conservator to understand the mechanism of wood damage through studying its chemical, physical and mechanical characteristics, using modern scientific methods during investigation and analysis, whenever there is a possibility to do so, because it may help in taking decisions for future conservation applications (Montaser 2022).

The main factors of decay on the backgammon board are:

1- Accumulation of dust and dirt on the surface

2- Biological damage in the form of spots on the wood and mother of pearl surfaces, in addition of the presence of remnants of an ecchymosis bag in the corners of the board (Figure 6).

3- Loss of some inlays (Figure 7).

4- Loss of adhesive strength and partial or total separation of inlays (Figure 8).

5- Spotting in the varnish layer and erosion in the inlayed materials (Figure 9).

6- Fine scratches and cracks in the surface of the backgammon board, in addition to slight corrosion in some parts (Figure 10).

Figure 6 **The remnants of an ecchymosis bag in the corner of the box**

Figure 7 Loss of some inlaid units

Figure 8 Detachment of inlaid units

Figure 9 Spots in the varnish layer and erosion in the inlayed materials

Figure 10 Fine scratches and cracks

USB digital microscope (at GEM-CC) with a magnification ranging between 40x to 1000x was used. to study the anatomical features of the wood, which is most likely to be red mahogany; yet due to the difficulty and unavailability of a sample, it was not possible to confirm the wood type (Figure 11).

Figure 11 Wood grain of box sides

The dovetail joint was clearly identifiable as seen in the illustrative figures, which showed the shape of the small pieces of wood used to tighten the connection (Figure 12).

Figure 12 Dovetail joints and small pieces of wood used to tighten the connection

Mother of Pearl (shells):

Seashells had special religious importance in many civilizations, especially the ancient Egyptian civilization, as shown through the actual use of shells as amulets or through simulations by making them of precious stones or metals like gold as amulets for protection. Shells also had funerary importance and were placed with the dead in the tombs among their offerings to benefit them in the other life. Many shells were found in several tombs in Egypt during the Neolithic period. They were a symbol of protection from the bad eye because of their similarity with the shape of the eye, so the early man thought that the shell prevented the "evil eye", where it was used as protection against evil, especially for women during pregnancy and childbirth. There were many other uses for shells, some seashells were used as containers for cosmetics or preserving colors. Shells were also used as a means of social exchange or swap, commonly used as a means of commercial exchange. (Khamis 2022)

Mother of pearl, also known as nacre, is the iridescent material which forms the inner layer of seashells from gastropods and bivalves. The hierarchical microstructure of this biological material is the result of millions of years of evolution (Barthelat 2007).

Shells are made of calcium carbonate ($CaCO_3$), in the mineral form of calcite or aragonite. Animals build their shells by extracting the necessary ingredients —dissolved calcium and bicarbonate—

from their environment. Shells come in many shapes and sizes, from giant clams more than a meter wide, to tiny shells that can barely be seen with a microscope. Most shells found on the beach are either bivalves (shells that have two parts connected together) or gastropods (the snail-type shells).

Results

Examination with a stereo microscope CL1500EC (at GEM-CC) of the inlaid mother of pearl at various magnifications showed the shape of the nacre crystals at magnifications of 200x and 280x (Figure 13-14). The stratigraphic structure of the nacre, as well as the thin cracks and the signs of refining the nacre are shown in Figures No. (15-16).

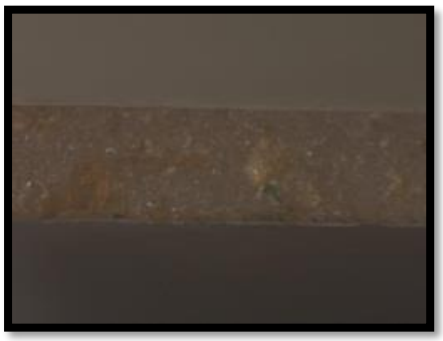


Figure 13 Nacre crystals (200x)

Figure 14 Nacre crystals (280x)

Figure 15 Stratigraphic structure of the nacre (400x)

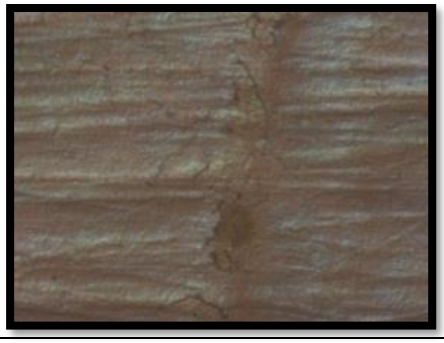


Figure 16 Stratigraphic structure of the nacre (500x)

Examination with an Optical microscope

An OptikaSZM-T Microscope equipped with TUCSEN ISH cam, 10.0MP and ISCapture software by Xintu photonics Co., Ltd was used to examine the biological remains (Figure no.17).

Figure 17 Biological remains under the optical microscope

By comparing the remains of the insects that had attacked the wood with reference collections, there is a possibility that the furniture and carpet beetle, from the family Dermestidae, which is one of the important insect groups of the order Coleoptera that feed on organic matter of plant and animal origin (Paryse 2015) had attacked the wooden board.

- **Analysis with FTIR**

Fourier Transform Infrared IR Prestige -Spectrometer 21(at GEM CC) was used to analyse a sample of the adhesive material used for gluing the inlays (Fig.18)

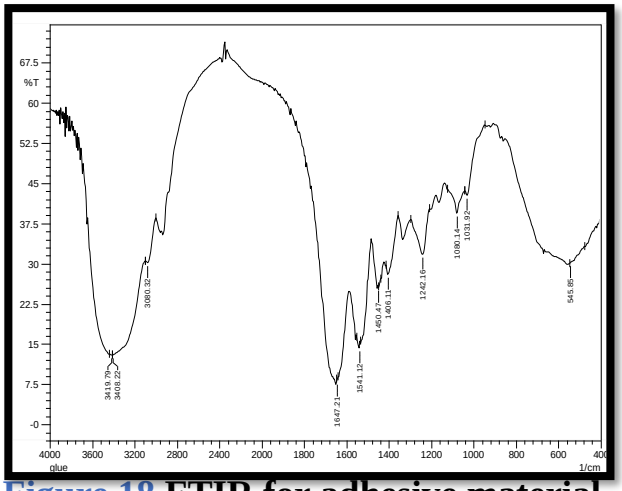


Figure 18 FTIR for adhesive material

Wave number	Control sample	Sample	Functional group
3400-3200	3288	Absence of group (3408-3419)	N-H Stretching bond
3100-2800	3078-2928	3080	C-H Stretching bond
1660-1600	1633	1647	amide I
1565-1500	1540	1541	C-N-H bending bond
1480-1300	1449-1401-1332	1450-1406	C-H bending bond

By comparing the functional groups of the glue with the standard sample of animal glue, it was possible to say that the adhesive used in the game board is animal glue. The amide I group was found at 1647-1650 (Liao 2015).

Two types mother of pearl were used in this board game, namely white and colored mother of pearl. The FTIR analysis of both types of old and new types of mother of pearl available in Egyptian markets, three species, aragonite and calcite were conducted and results were compared (Fig. 19-22).

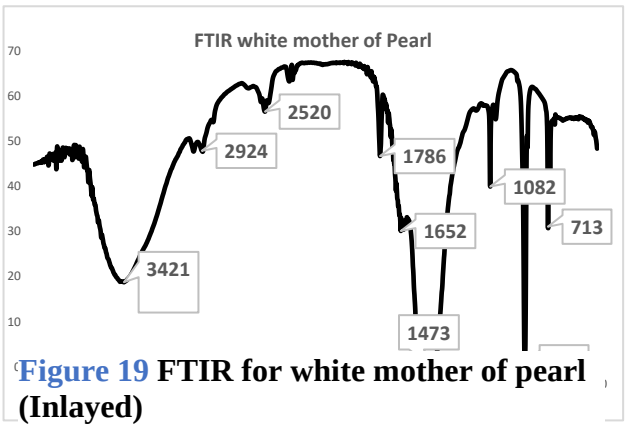
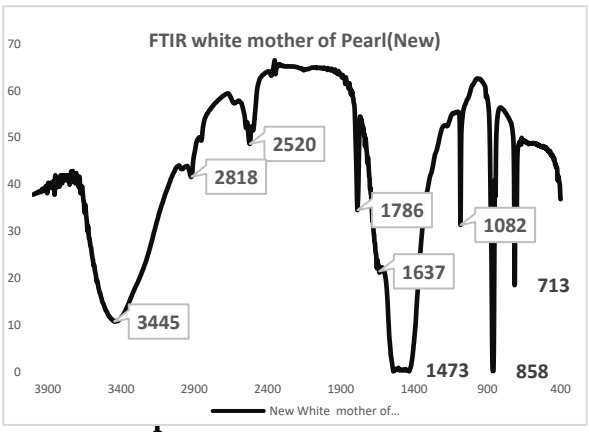


Figure 19 FTIR for white mother of pearl (Inlayed)



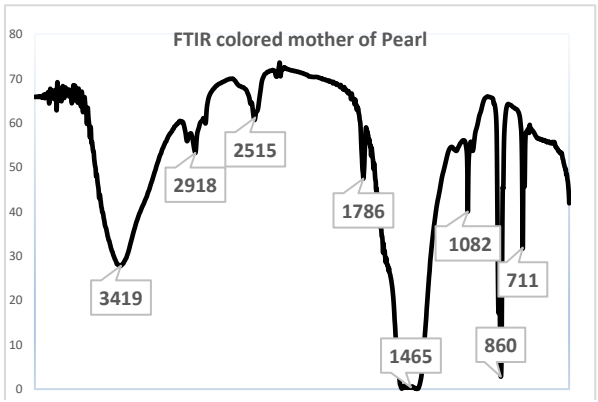


Figure 21 FTIR for colored inlayed mother of pearl

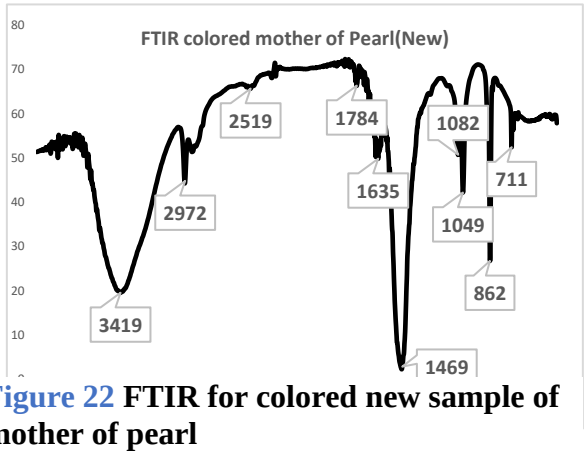


Figure 22 FTIR for colored new sample of mother of pearl

Samples	Characteristic Bands (cm^{-1})									
White inlayed mother of Pearl	713	860	1082	1473	1652	1786	-	2520	2924	3421
New sample of mother of Pearl	713	858	1082	1498	1698	1786	-	2520	2918	3423
Colored inlayed mother of Pearl	711	860	1082	1465	-	1786	-	2515	2918	3419
New colored sample mother of Pearl	711	862	1082	1469	1635	1784	-	2519	2972	3419
Nerita sp.	700	860	1080	-	-	1780	-	2520	2920	3400
Strombus sp.	700	856	1080	-	-	1785	-	2520	2920	3400
Cardium sp.	700	860	1090	-	-	-	1810	2520	2960	3400
Aragonite	714	856	1086	-	-	1795	-	2520	2930	-
Calcite	714	876	-	-	-	1785	1805	2520	2880	-

By analyzing a recent sample and the archaeological sample under study and comparing it to samples previously analyzed in previous research, it became clear that there are three main forms of calcium carbonate: calcite, aragonite, and vaterite. Calcite and aragonite are widely deposited as a vital mineral, and there are four distinct functional groups for nacre (1082-1085), (854-857), (714-699) due to the vibration of the CO_3-2 group of aragonite. It can be observed that the Amide II group was found at 1784-1789 (Liao 2015).

Conservation and restoration

The first step of treatment was the sterilization with cedar oil and traps, due to the presence of a visible insect infestation in the form of holes and the possibility of a fungal infection.

Cedar oil is often used for its aromatic properties for sterilization (Vraz 2017). The oil is extracted from cedar trees and produced from leaves and sometimes from wood, roots and tree trunks (Goel 2017). It has an insecticidal effect at doses of 0.6 mg / liter for a week or 1-2 mg / liter for a period 8-24 hours of exposure, which means that the killing effect occurs at high concentrations or after a long period of exposure, otherwise insects are only repelled (Elkhial, 2019).

The traps are equipped with an adhesive at the base as shown in (Figure 23), then covered a tightly closed polyethylene tent (Figure 24), after placing dishes filled with cedar oil and the traps (Figure

25). After finishing fumigation period and while opening the tent we should but a face mask and gloves and taking care to protect the conservator (Figure 26).

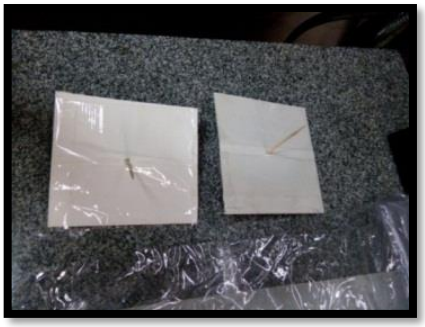


Figure 23 The sticky traps

Figure 24 Covering with polyethylene tent

Figure 25 The tent after adding cedar oil dish and the insect traps

Figure 26 Opening the tent at the end of the fumigation period

Cleaning: The cleaning for mother-of-pearl was done using scalpel and magnifier to remove any foreign materials. Overall dry cleaning and wet cleaning were conducted simultaneously. Small tools such as an air blower and a brush were used to remove light foreign materials attached to the surface, while the scalpel was used to remove yellow materials and thick dirt layers that had adhered on the wood surface, while ethanol 50 wt.% (in water) was used for thin dirt layers (Park 2019) using a cotton-wrapped stick (Figures 27-29).

Figure 27 Using Ethanol 50% in water for cleaning sea shell

Figure 28 a) Before cleaning, b) during cleaning, c) after cleaning.

Figure 29 Cleaning previous adhesive in the detached parts

Restoration and completion of missing mother of pearl inlays

Due the hardness and brittleness of the mother of pearl several steps were applied as follows:

1/ Draw the outlines of all the lost parts using pencil and paper

2/ Fourteen paper shapes were placed on thicker cardboard that was cut out and numbered.

The appropriate degree of white color of mother-of-pearl color was chosen. The cutting was carried out in one of the mother of pearl workshops in Al-Azhar region (Figure 30).

The colors of the seashells appear clearly and range from white to blue, and some shells appear in a color like the colors of the spectrum, nearer to the blue gradient.

Figure 30 Preparation steps of new mother of pearl pieces used for loss compensation.

After completing the cutting process, and reaching the size and shape of the lost inlays, reducing the thickness of the shell was done by sanding to reach the required thickness. This process requires high accuracy and careful handling due to the hard yet brittle material, that is easily scratched. Therefore, it was necessary to find a preparation method. Three methods were used to reduce the thickness of the seashell:

First: Using acidic solutions: where diluted acetic acid (6%) was used in a ratio of 1:1 to try to soften the surface. After 4 days (Figure 31) there was no change, except that external erosion occurred in the corners of the small pieces, it was also necessary to wash off any remains of the acid several times using a neutral soap.

Figure 31 Jar containing diluted acetic acid and sea shell

Second: By fixing the seashells using an adhesive on a wooden surface it was possible to sand the surface, but this method did not give a good result, especially with large thick seashells.

Third: Using an abrasion tool and rough sandpaper on the seashells that had been strengthened by gluing them to Japanese tissue paper and wood. It gave good results with some of the naturally levelled seashells, but the concave seashells did not give good results (Figure 32).

Figure 32 Using the abrasive tools

The file and sandpaper of different grades were also used. This technique gave good results, yet it took longer time and effort (Figure 33).

Figure 33 Using the file reduce the thickness of the seashell

After reachi ll to remove any powder resulting from the sanding process, prior to their gluing on the backgammon board in the vacant parts.

Preparing the places of loss in the wooden board:

Gluing: After preparing the places of loss by removing remains of old adhesive, Plexisol P550 was used for adhesion (Ali 2022) (Figure 34).

Gap filling: Fillers are classified according to two main factors: adhesives and bulking agents, but there are certain criteria that conservators need to adhere to when choosing materials for treatment (Montaser 2023)

1. The solvents do not cause swelling in the treated wood.
2. Does not emit harmful fumes or gases.
3. Do not cause damage.
4. Cheap and readily available to restorers.
5. Good adhesion to wood, allowing the expansion and contraction of wooden without causing any damage.

6. In the event that the impact is subjected to mechanical stress, the filling dough will collapse, not parts of the artifact.

7. Allow water vapor to permeate into the wood after strengthening.

8. Maintain its flexibility for a long time.

9. Resist shrinkage and maintain its dimensions after drying without change.

10. Polish ability.

11. Ability to remove after drying and aging.

12. Maintaining its good properties for a long period.

13. The ability to color using different types of colorants in the case of colored pastes.

Figure 34 After cutting and preparation of mother of pearl

Filling cracks

The cracks were filled using a gap filler composed of Paraloid B 72, glass microballoon, and a brown pigment color to match the color of the wood in the backgammon board (Figure 35) (Abd Allah 2016) Figures 36- 38 show the backgammon board after conservation.

Figure 36 The exterior corner of the backgammon board after treatment

Figure 37 The interior of backgammon after conservation

Figure 38 The exterior of backgammon after conservation

Conclusion

It is sometimes very challenging to choose an appropriate method to treat wood inlaid with mother of pearl due to limited research on this topic, therefore this case study focused on the main factors of decay on an inlaid backgammon board, by examination using a USB digital microscope, and an optical microscope for the insect infestation which was identified as the furniture and carpet beetle. By using FTIR analysis the adhesive used in the game board was identified as animal glue, and the four distinct functional groups for nacre at (1082-1085), (854-857), (714-699), (1784-1789) cm^{-1} were identified.

The preliminary treatment of the mother-of-pearl was conducted by sterilization with cedar oil and insect traps, which was followed by cleaning the mother-of-pearl. Plexisol B550 was used for adhesion of separated pieces and newly cut inlays that were used to replace the missing ones. The cracks were filled using a gap filler composed of Paraloid B 72 and glass microballoon.

The treatment steps applied in this study are similar to techniques commonly used in the conservation of wooden artifacts in Egyptian museums, but future research should be conducted on evaluating the different adhesives that can be applied for the treatment of inlaid wood.

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