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CONSERVING OF PERSIAN LACQUER PAINTING, MUSEUM OF ISLAMIC ART, CAIRO

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Abstract:

This paper presents a case study of the conservation of Persian lacquer paintings at the Museum of Islamic Art, Cairo, addressing the limited research on this topic. A microbiological study was conducted to identify the fungi responsible for the degradation of the painting. Two media were used to isolate and cultivate present fungi. Eight fungi were isolated Aspergillus niger, Aspergillus terreus, Aspergillus flavus, Aspergillus fumigatus, Aspergillus candidus, Cladosporium cladosporioides, Cladosporium herbarum, Penicilium frequetans. Visual inspection revealed a deteriorated varnish surface, missing paint layers, and non-original additions. UV radiation imaging and Reflectance Transmission Imaging (RTI) aided in identifying missing areas and assessing varnish deterioration. The conservation-restoration process involved cleaning, frame removal, label removal, varnish removal, paint consolidation, and retouching. Sustainable storage practices, utilizing acid-free and eco-friendly materials, were implemented. The study provides valuable insights into the conservation challenges of Persian lacquer paintings, offering a detailed examination of biodeterioration, varnish issues, and preservation considerations.

1. Introduction

The Museum of Islamic Art in Cairo, Egypt, boasts a distinctive collection of lacquer objects. Although lacquer objects are commonly found in Islamic museums globally, a significant challenge arises from the scarcity of conservation studies [1], underscoring the significance of conservation research. Researchers previously conducted analysis and conservation studies on lacquer [2-4]. This study focuses on new methods of conservation. Lacquer is a painting or illumination on the surface of 3-dimensional objects rather than on a sheet of paper. Lacquer comes in many forms, including bookbinding, pen boxes, mirrors, cases, caskets, vanity boxes, cases for combs, fans, arms and armor, and large objects such as game boards, doors, and tabletops [5], according to the detailed account by Comte de Rochechouart, the process of lacquer painting involved covering the support, which was either paper-mâché, wood, or leather with a thin layer of gesso or plaster. Then, a design was painted onto the surface using opaque watercolors and finished with several additional layers of transparent lacquer or varnish [6]. Lacquer refers to the transparent varnish that coats the painting and the objects. The varnish consists of sandarac gum or shellac mixed with linseed oil [7]. Persian lacquer bindings were first developed in the 15th century and became popular in the 18th and 19th centuries. They usually feature intricate floral designs, animals, birds, patterns, and other decorative elements. The spread of Islam and cultural contact influenced these designs. To create a lacquer painting, the pasteboard covers are prepared with a layer of gesso and an initial coat of varnish before being painted with water-based paint and coated with more varnish. The surface is then smoothed and polished; in some cases, inlay materials like mother-of-pearl or gold particles are added to the varnish. Some early examples combined decorated leather with lacquer painting, resulting in a distinctive sheen [8]. Bookbinder's lacquer" is a term introduced in the book "Lacquer of the Islamic Lands" (1996) and refers not only to lacquered bindings but also to other items such as pen cases, mirror and spectacle cases, and caskets. These items shared the same material basis as the bindings, which were made by layering sheets of paper and decorating the outer layer with paintings that were then heavily varnished [9]. N. Khalili mentioned that the proper technical terms and the correct words to use for a particular surface treatment are "lacquered" or "varnished" rather than "painted." The color was not mixed with the lacquer and was applied directly to the surface. The process involved applying a layer of lacquer, painting the decoration on top of it, and then applying another layer of lacquer or varnish [10].

1.1. *Objective of the study*

The studied lacquer painting is a book cover consisting of an unattached upper board and a lower board, fig. (1). The object is housed at the Museum of Islamic Art, Cairo, Egypt, with registration numbers 1/16486 and 2/16486. The museum registration book has a brief description of this book cover, and some information related to the main materials, condition, and acquisition history of the object. Based on this information and visual inspection of the object, the main information on the book cover is as follows:

- **Subject**: Two sides of a book cover
- **Materials:** Cardboard and colored lacquer.
- **Condition**: The objects have some corrosion/ abrasion
- **Acquisition history**: Purchased from Monsieur Jacob Saroff on 7th of May in1951 (invoice)
- **Description:** Both the upper and the lower board are rectangular, measuring 31 cm in width, 46.4 cm in length, and 5.60 mm in thickness. The exterior faces of the upper and lower boards are painted with pictorial scenes of a battle between two armies, probably representing the Indian Moghuls army and the Persian Afsharid army, as can be seen from the different garments and facial features. The scenes show violence and struggle between the two troops with several tools of traditional of using cannons at that time. The two scenes reflected the use of horses by the Persian troops while the Indian troops used elephants, as can be seen in the lower board scene. Rectangular lobed medallions surround both scenes with a flower shape medallion between them. The rectangular medallions contain Thuluth inscriptions in the Persian language that are executed in black over a golden background; similarly, the inscriptions inside the floral medallions, however, are painted in white over a green background. On the other hand, the two interior faces of the book cover were painted with the same design of a lobed medallion with a Bokharia shape in the middle surrounded by floral leaves in Khata'i style in gold over black ground.

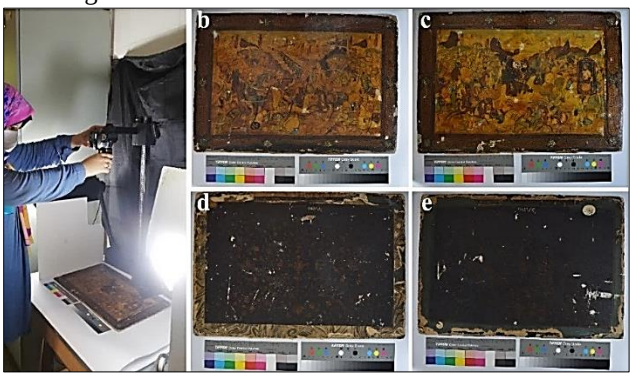


Figure (1) **a.** the photographic documentation of the painting before conservation, using indirect light to avoid the reflection of lacquer, **b.** the recto side of the painting no. 1/16486, **c.** the recto side of the painting no. 2/16486, **d.** the verso side of the painting no. 1/16486, and the verso side of the painting no.2/ 16486

1.2. *Condition assessment*

The selected object was investigated using various methods (i.e., USB digital microscope 1000X, UV radiation imaging, and RTI). Ultraviolet (UV) fluorescence is a widely appreciated method for examining artwork. By projecting UV rays onto a painting, it reveals variations in fluorescence, helping differentiate materials, assess conser-vation status, and identify non-original elements [11,12]. The Reflectance Transmission Imaging (RTI) technique was used to examine the deteriorated surface of the paintings. It is a non-invasive method widely employed in art conservation to highlight and document an artwork's surface topography [13]. Employing different light angles, it casts elongated shadows, effectively uncovering surface textures, deformities, irregularities, gaps, impastos, and incisions, along with illumination from different angles, showing details often unavailable to the naked eye [14,15]. Additional information on the RTI workflow. encompassing open-source tools and manuals for capturing data, could be found at Cultural Heritage Imaging [16].

2. Preliminary Investigation

3.1. *Measuring of the moisture content and pH value*

The GE Protimeter Mini moisture meter [17] was used to assess the moisture condition of the painting's cardboard support. The pH value of the painting support was measured using the AD1030 Professional pH/ ORP/ Temp Bench Meter [18]. The AD1030 is a professional bench meter for pH.

3.2. *Isolation and identification of fungi*

Both naked-eye examination and UV imaging did not reveal any fungal spots. Biological swabs were taken from both sides of the lacquered papier-mâché painting to perform microbiological analysis to confirm the presence of biological infection. A total of 12 biological swabs were collected, fig. (2).

Figure (2) the method used to collect a sample of biological swab un order to identify the presence of biological damage.

3.3. *Microbial cultivation and growth*

The study was conducted at the microbiology lab., administration of biological damage treatment laboratories, administeration for maintenance and restoration antiquities research and conservation center, and projects sector central Ministry of Tourism and Antiquities (Egypt).

3.3.1. Media used

Two cultural media, Sabouraud agar medium and Tryptone agar medium (i.e. Casein Soya bean digest agar), necessary for the growth of microorganisms, were utilized during the incubation period of 21 days at a temperature of 28 degrees Celsius. They have the following composition:

- Sabouraud agar medium [19] (5.0 g/l Tryptone, 5.0 g/l Peptone and 20.0 g/l Glucose)
- Tryptone agar medium [20] (15.0 Pancreatic digest of casein, 5.0 Enzymatic digest soya bean and 15.0 Agar)

3.3.2. Isolation and purification

After the incubation period ended, shoots that had emerged in the dishes were taken, and the purification process was carried out to obtain the fungus. Czapek's medium [21] was used; with the following composition: 30.0g Sucrose, 2.0g $NaNO_3$, 1.0g K_2HPO_4, 0.5g $MgSO_4$, 0.5g KCl, 0.01 $FeSO_4$. $7H_2O$, 15g Agar, 1000 distilled water. Fungi colonies were identified according to Domsch et al. (1980) [22] and Gilman (1969) [23] classifications**.**

3. Results

4.1. *Condition assessments*

The condition assessments of Persian lacquer paintings revealed extensive degradation, including dark, cracked varnish, missing paint layers, and non-original additions. Visual observation showed that the painting was covered with a dark, cracked varnish, fine dust, and slight paper remains attached to the surface. There were many missing parts in the painting layers from both sides. paper was added as a frame on the back of the painting. A white marker was used to write the registration numbers on the reverse of the painting— causing distortion due to the white paint on the reverse of the upper and lower boards. Museum registration numbers were written on three yellow self-adhesive labels. One was placed on the reverse of the upper board painting no.1/16486. The two other labels were placed on the reverse of the lower board painting (no.2/16486), fig. (1). Through the projection of a UV beam onto the surface of the painting, one can observe the illumination of certain parts. In contrast, others remain dark, fig. (3), which reflects the presence of missing small areas and non-original parts. In the upper board (no.1/ 16486), the king's cloak appears darker, suggesting that it may have been added later. The results of the USB digital microscope were beneficial in identifying various forms of damage and capturing high-quality images, fig. (4). RTI revealed many details of varnish and surface defects, fig. (5).

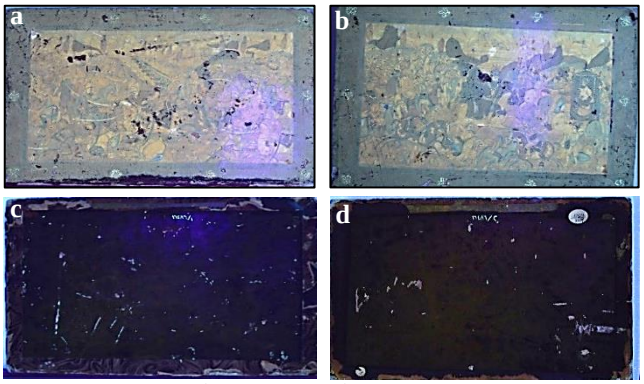
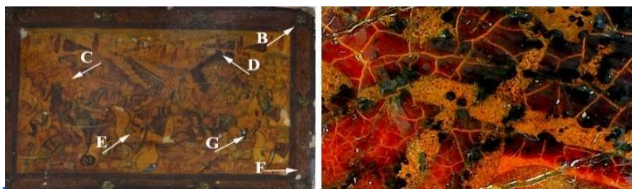


Figure (3) UV photo of the painting before conservation, **a.** the recto side of the painting no. 1/16486, **b.** the recto side of the painting no. 2/16486, **c.** the verso side of the painting no. 1/16486, d) the verso side of the painting no. 1/16486.



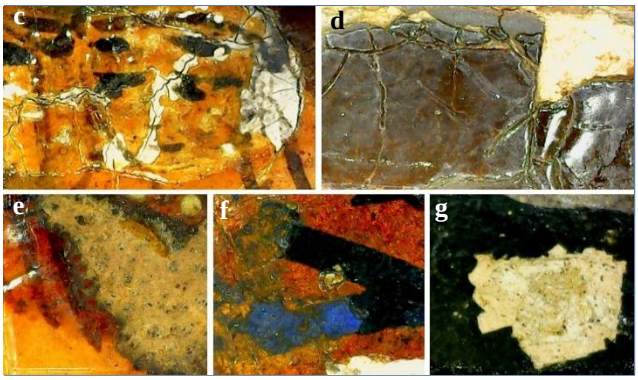


Figure (4) **a**. examination of the painting before conservation using a portable digital optical microscope of the painting, **b**., **c**., **d**. cracks and losses in the paint layer, e. slight paper remains attached to the surface, **f.** ink degradation, **g.** losses in the paint and preparation layers.

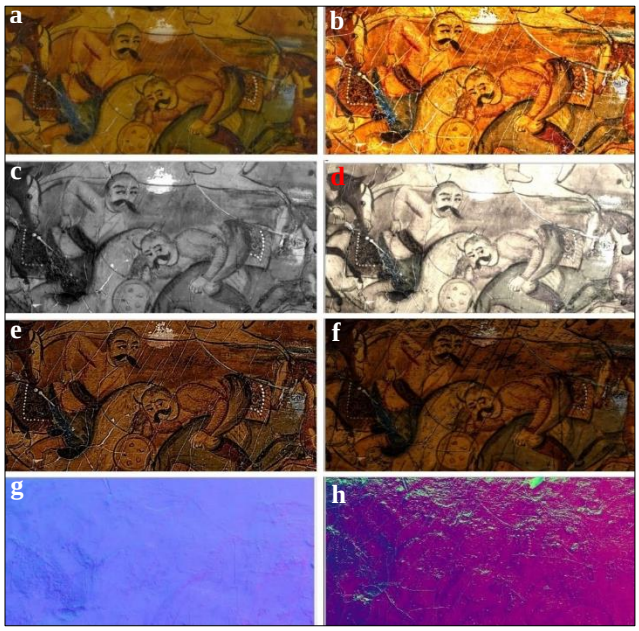


Figure (5) detail, comparison of reflected RTI visualizations captured of the painting; **a.** default, **b.** diffuse gain, **c.**, **d.** specular enhancement, **e.** image unsharp masking, **f.** normal unsharp masking, **g.**- **h.** normal visualization.

4.2. *Moisture content and pH value measurements*

The moisture content readings ranged between 9-11. They are in the green zone, which means they are in a safe air-dry condition, fig.(6-a). Moisture condition measurements indicated the painting's cardboard support was safe and air-dry. pH value measurements ranged between 5.55-6.40, and the results indicated favorable conditions for conservation, fig. (6-b).

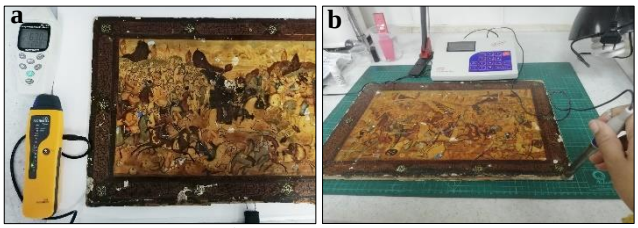


Figure (6) measurement of **a.** moisture condition, **b**, pH value.

4.3. *Isolation and purification*

The results of microbial cultivation and growth, after the completion of the incubation period, the following micro-organism were identified, fig. (7) and tab. (1). After isolation and purifycation, microbiological analysis identified eight fungi species responsible for the degradation, *A. niger*, *A. terreus*, *A. flavus*, *A. fumigatus*, *A. candidus*, *C. cladospor-ioides*, *C. herbarum*, *P. frequentans*, fig. (8). Contamination of *A. niger* was observed in the dish of *P. frequentans*, as shown in fig. (8-h).

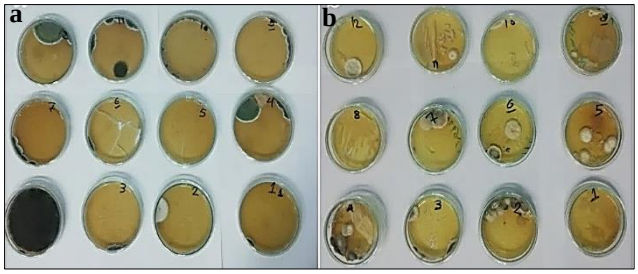


Figure (7) media dishes after completion of the incubation period; **a.** sabouraud agar medium, **b.** tryptone agar medium.

Table (1) results of media dishes after completion of the incubation period

Sample No.	Microorganisms that have been defined
1	*A. flavus - A. fumigatus - C. cladosporioides*
2	*A. niger - A. terreus- A. flavus*
3	*A. flavus - A. niger*
4	*A. candidus- C. herbarum*
5	*C. cladosporioides - C. herbarum*
6	*C. herbarum- A. flavus - A. niger*
7	*A. flavus - A. niger - A. fumigatus*
8	*A. terreus- A. candidus-C. herbarum- P. frequentans*
9	*A. terreus- C. herbarum*
10	*A. candidus- A. flavus - A. niger*
11	*C. herbarum- P. frequentanS*
12	*P. frequentans*

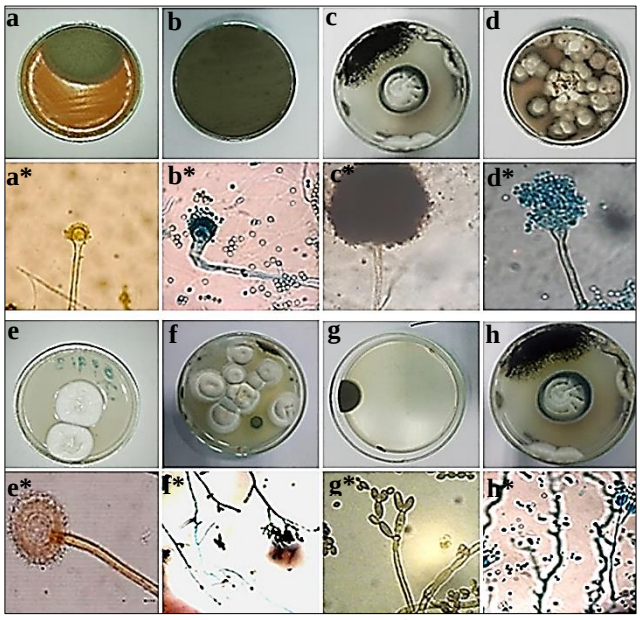


Figure (8) microorganisms that have been defined in dishes and under a microscope; **a.** & **a*.** *A. flavus*, **b.** & **b*** *A. fumigatus*, **c.** & **c*.** *A. niger*, **d.** & **d*.** *A. terreus*, **e.** & **e*.** *A. candidus*, **f.** & **f*.** C. cladosporioides, **g.** & **g*.** C. herbarum, **h.** & **h*.** *P. frequentans*.

4. Discussion

The results of the condition assessment of Persian lacquer paintings match other Persian artworks, including dark, cracked varnish and missing paint layers. Diagnostic tools like UV light, USB digital microscopy, and Reflectance Transformation Imaging (RTI) provided detailed insights into surface defects. pH and moisture content measurements indicated that the paintings' supports are stable, which will be considered in the conservation plan. Additionally, microbiological analysis identified eight fungal species, highlighting the prevalent issue of fungal contamination. These fungal species are hyphomycetes and are frequently found on materials like paper and paintings in museums. This result is based on information gathered from over 20 studies conducted in Austrian museums since 2000 and various case studies described in literature [24]. Alcohols such as ethanol, isopropanol, and butanol are efficient micro-biocides that can damage microbial cell membranes, denature essential proteins, and ultimately cause cell lysis. Aqueous alcohol solutions are more effective against microorganisms than pure alcohol, and the highest efficacy is reached with concentrations between 50% and 90% (v/v). Alcohols are effective against vegetative forms of bacteria, fungi, and viruses but not against sporulating microorganisms, and therefore, they are only considered disinfecting and not sterilizing agents. Ethanol is the most commonly used alcohol for treating mold-contaminated heritage objects, with optimal efficacy reported for concentrations between 50% and 80% in aqueous solutions, reaching a maximum efficacy of 60-70%. Ethanol disinfectant solutions can be applied by various methods, including spraying, brushing, swabbing, immersion, or exposing infected papers to the vapors of ethanol. However, the treatment may not be as effective for thicker materials such as books [25]. The three main ways to prevent fungal contamination in museums are to control the climate, clean regularly, and monitor the situation. Climate control strategies must take into account the unique architecture of the museum. Unexpected water damage can still occur in old and new museum buildings; the amount of dust carrying fungal spores is crucial in determining the extent of contamination. Surfaces heavily loaded with spores can become overgrown in just a few days, while surfaces with fewer spores are less affected. Factors such as ventilation, visitor traffic, and opening and closing of doors can impact the number of spores in the air. New storage rooms are equipped with filter systems to prevent the invasion of fungal spores, plant pollen, and dirt particles. HEPA filters are recommended for frequent cleaning with vacuum cleaners to keep the spore load low [24,26].

5. Conservation

The conservation procedures were carried out based on the above condition assessments. The conservation treatments applied consisted of the following steps:

5.1. *Cleaning*

Dirt deposition on artwork can affect its aesthetics and legibility by scattering light, desaturating hues, decreasing luminosity, altering optical depth perception, and decreasing image legibility. Dirt can also encourage the growth of microorganisms and insects, leading to the degradation and deterioration of the artwork. Dirt may also cause surface whitening effects such as blanching, blooming, or crazing.

The presence of dirt can affect subsequent treatments by preventing the adhesion of glues to the surface, inhibiting the flow of glue under lifted or flaking paint, and intrinsically bonding to original materials, resulting in permanent changes to the artwork if consolidation is carried out before dirt removal. Powdery, flaking, or crumbling paint layers may not permit dirt removal before consolidation so that compromises may be necessary. Surface dirt can also interfere with the solubility parameters of underlying coatings, such as varnish, making it essential to remove surface dirt before commencing with varnish removal [27].

5.1.1. Removal of dirt, paper frame, and registration labels

Saliva and a delicate soft brush were used to remove fine dust [28]. To remove the paper frame, a Boneco 7131 ultrasonic humidifier was used to moisten the adhesive and dissolve it [29], which was then removed by scalpel. Four layers of paper frames are glued together with marbled, green, red, and beige colors, respectively. The first layer consists of marbled paper, then a green paper frame, a red paper frame, a beige paper frame, and finally, the original ornaments. A mixture of alcohol and water (1:1) was applied to dampen the adhesive and dissolve it [30], thereby allowing the labels to be removed using a scalpel, the same techniques were used to remove paint splatter, figs. (9 & 10).

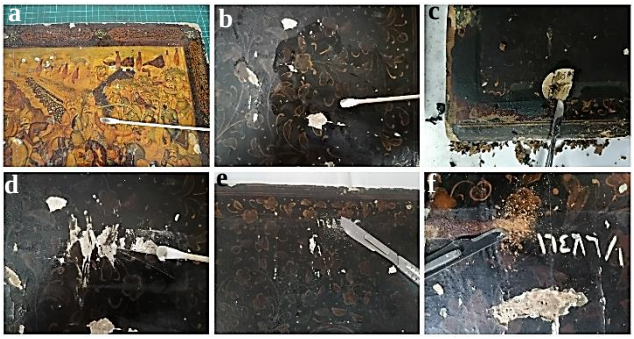


Figure (9) **a.** & **b.** removal of dirt using saliva, **c.** removal of registration labels, **d.**, **e.** & **f.** removing of paint splatter.

Figure (10) removing the paper frame using a Boneco 7131 ultrasonic humidifier.

5.1.2. Disinfection

The previous cleaning process was applied to remove fungal infestation, followed by spraying the painting with ethyl alcohol 70% [31]. Ethyl alcohol also serves as a fungicidal agent.

5.1.3. Varnish removal

Varnish was removed to eliminate surface discoloration, revealing the painting's true colors. The majority of treatments were required due to varnish deterioration. Varnishes experience a process known as autoxidation over time, which causes them to become more polar, yellowed, and brittle [32]. The appearance of a painting can be substantially altered by the severe discoloration of heavy layers of varnish, which makes it harder to interpret. Brittle cracking can also cause breaking in paint layers and changes the varnish's protective capabilities and visual characteristics. Older varnishes typically need to be removed using more polar solvents to match the damaged resin's altered (more polar) chemistry, which carries a severe risk of damaging the paint layers through swelling and leaching of paint components. The diagram referenced from Burg (2022) illustrates the simultaneous occurrence of different types of solvent action during a conservation process. It likely depicts mechanisms such as dissolution, dispersion, and penetration of solvents into the material being treated. The diagram provides a visual representation of the complex interactions involved in solvent-based conservation treatment, fig. (11) [33].

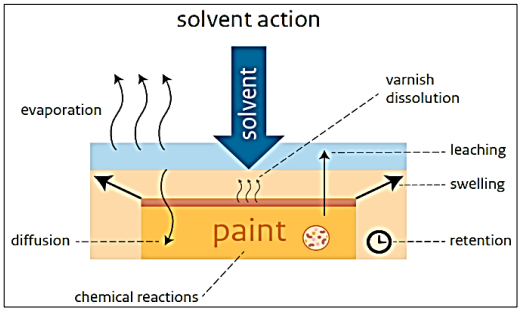


Figure (11) diagram of the different solvent actions occurring simultaneously (*After:* types *Burg, 2022*)

The decision to remove varnish and overpaint layers from artwork can be complex. Arguments for preserving original varnish include its potential usefulness for research and rarity, while arguments for removal include improving the clarity and aesthetic intent of the artwork. However, varnish removal may not be feasible when the paint layers are sensitive or have the same solubility as the varnish. Careful consideration must be taken to balance the benefits and risks of varnish removal for each artwork [34]. In 1985, Gerry Hedley [35] categorized cleaning practices into total, selective, and partial. Total cleaning involves removing all varnish and overpaint layers that the artist applied. Particular cleaning involves removing varying amounts of varnish from different areas of the painting. Partial cleaning consists of preserving a thin layer of varnish on the paint layer to maintain contact between the old varnish and the paint layer. These categories continue to be relevant in current cleaning practices. During the conservation of the painting, the authors completely removed the varnish except for a portion on the far left, which was left intact for potential future research purposes. Additionally, the lacquer from the tiny red frame was partially removed since the maker used to mix the red color with the lacquer. The traditional method conservators use to remove varnish and overpaint from paintings involves using organic solvents in liquid form and cotton swabs. However, this technique was inefficient since it required significant time and physical effort to roll or rub

the swab on the paint surface. The technique used to remove varnish, figs. (12 & 13) is as follows:

1. Isopropyl alcohol C_3H_8O was placed by brush onto cotton over the varnish. The authors found that using a makeup cotton pad was more effective for varnish removal than cotton. This suggests that the materials and techniques used for varnish removal can impact the efficiency of the conservation process.
2. A sheet of Melinex was placed on the cotton to aid absorption into the varnish and prevent solvent evaporation.
3. After a set amount of time (120:600 sec), the plastic foil was removed.
4. The varnish then became swollen and dissolved
5. A dry swab clears the swollen varnish, followed by a light dip in isopropyl alcohol to remove residues. It is important to work on small areas at a time when removing varnish since it can harden quickly. It is also necessary to work on similar areas of color to ensure consistency in the restoration process. The varnish removal process, detail-accurate cleaning, and restoration of paintings involve using a digital microscope to achieve the highest accuracy of details.

Figure (12) varnish removal from paint no (1/16486)

Figure (13) varnish removal from paint no. (2/16486)

5.2. *Consolidation of flaking paint*

Klucel G (4%) [36], hydroxypropyl cellulose dissolved in ethanol, was employed as an adhesive for fixing the papier mâché. Klucel E (2%) dissolved in ethanol was used to consolidate weak regions of the painting and the edges of losses since it provides better penetration due to its low viscosity compared to klucel G for fixing cracked paint layers. The injection was employed to ensure deep penetration. The excess adhesive was removed using cotton swabs dampened with ethanol. The consolidated areas were covered with glass weight over silicon paper until dry, fig. (14).

5.3. *Filling losses in paint*

Calcium carbonate bound in Klucel G (4%) was used to fill small missing areas. The surface was flattened using a scalpel and stainless steel spatulas. Infill is necessary to protect the object from further damage, fig. (14). It also helps to maintain the integrity of the surface, improve the aesthetics, and to improve the viewers' understanding of the object [37]. Conservators typically prioritize matching color and texture to maintain the artwork's overall integrity [38].

Figure (14) consolidation of flaking paint and filling losses in the paint.

5.4. *Retouching & varnish application*

Retouching in painting conservation refers to restoring or repairing damages to a painting by filling in missing areas or blending in colors to match the original [39]. Acrylic colors were applied using a small (000) retouching brush. The approach was to avoid extensive and intricate retouching and only touch up the areas that had been filled or added using a dotting technique (i.e., stippling) [40,41]. A natural bristle brush was used to apply a protective layer of Paraloid B-72, dissolved in toluene. This method was deemed favorable due to the desired characteristics of the Paraloid B-72, including its ability to be easily reversed. Additionally, toluene was considered a safe option, as it did not risk damaging the paint layer. The painting was entirely covered with varnish except for the space on the left side of the painting for future analysis investigation, fig. (15).

Figure (15) the painting after conservation.

5.5. *Storage*

Sustainability is an important consideration when it comes to the storage of Persian lacquer objects. Proper storage techniques can help preserve these objects for future generations. One approach to sustainable storage is to use eco-friendly and non-toxic materials. For example, acid-free paper or cardboard can be used to wrap and cushion objects instead of materials that contain harmful chemicals. In addition, storing the objects in a stable environment that is not too humid, too dry, or subject to extreme temperature fluctuations is essential. This can help prevent warping, cracking, or other forms of damage to the lacquer. A tight-fitting cardboard box with a transparent polyester cut sheet cover was made

to store the album. The box is further covered with binding cloth [42,43]. The type of cardboard used is corrugated board 5mm made from aging-resistant material. Bookmark Strip – Clear polyester was securely affixed to the box to simplify transferring the painting out of the box. The box could also be used for displaying in temporary exhibitions, fig. (16). Finally, it is essential to handle the objects carefully and avoid exposing them to direct sunlight or other sources of UV radiation. This can help prevent fading or discoloration over time. By taking these steps, we can help ensure that Persian lacquer objects remain a valuable part of our cultural heritage for many years. Future research may involve examining the colors and paint layers used and will be published in another paper.

Figure (16) steps of making the storage box and the final display, **a.-f.** step by step of box making, **g.** fixing the transparent polyester cut sheets to the upper cover, **h.** using a binding cloth to cover the box**, i.** the final box, **J.** bookmark strip – clear polyester was securely affixed to the box, **k.** final display.

6. Conclusion

In conclusion, the condition assessments of the selected object, conducted through various methods such as digital optical microscopy,] UV radiation imaging, and RTI, revealed a painting covered in dark, cracked varnish, fine dust, and non-original additions. The presence of missing parts and the added paper frame at the back were evident, while the UV ray projection highlighted restoration areas and non-original elements. Moisture condition measurements using the GE Protimeter Mini indicated a safe state of the painting's cardboard support, and the pH value ranged between 5.55 and 6.40, ensuring the support, with balanced acidity, ensures durability of the painting support. Eight types of fungi have been identified A. niger, A. terreus, A. flavus, A. fumigatus, A. candidus, C. cladosporioides, C. herbarum, P. frequentans. The findings highlight the need for effective cleaning and preventive measures in museums to `control fungal contamination. By implementing climate control, regular cleaning, and monitoring strategies, museums can better preserve cultural artifacts and prevent further fungal deterioration. The conservation treatment, involving the removal of dirt, paper frame, and labels, employed a strategic combination of techniques such as brush cleaning, humidification, and solvent application. The delicate task of varnish removal was executed to reveal the true colors of the painting using isopropyl alcohol, with careful consideration given to preserving a small portion of varnish for potential future research purposes. The conservation process included cleaning and consolidation processes; both included the use of alcohol, which ensures the sterilization process. The consolidation of flaking paint was carried out using Klucel E (2%) dissolved in ethanol; while Klucel G (4%), hydroxypropyl cellulose dissolved in ethanol was used for fixing the papier mâché filling losses using calcium carbonate bound in Klucel G, retouching, and varnish application were executed with precision to restore and protect the artwork. Sustainable storage practices were emphasized, utilizing ecofriendly materials and stable environmental conditions to ensure the long-term preservation of the Persian lacquer object. Overall, this research-driven conservation approach successfully enhanced the artwork while thoughtfully preserving elements for scholarly investigation.

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