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Experimental Study for Treatment and Conservation of a Completely Damaged Oil Painting Applied on a Wooden Support

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Summary. This paper describes an experimental study for treatment and conservation of a completely damaged oil painting applied on a wooden support, which belongs to famous Egyptian artist Sief Wanly. This support is severely deteriorated by insects infection. The original support no longer serves its purpose and increasing the deterioration of the paint layers. So, it should be removed and a new one must be applied. Laboratory study was carried out on Mowilith DMC2 Vinyl resin as an adhesive material for fixing the original ground and paint layers to this new support. Its properties and chemical structure were determined before and after exposure to artificial ageing, the results showed its success. The components of the oil painting were determined by using Stereomicroscope, SEM, FTIR, XRD and AAS. According to the obtained results and the success of the previous material the oil painting was transferred to the new support using Mowilith DMC2 as an adhesive material.

Introduction

Many oil paintings in the collections of the Museums had been damaged by time. Many factors can cause the damage, but insects are considered the main factor for destroying the supports of painting, especially the wooden support. The insects can destroy the wooden support of oil paintings within some years; the larva for its development requires the longest period during the life cycle, which can continue for several years if conditions are unfavorable. During which time the larva may cause considerable damage to wooden supports, and leave it in a very weakened state[(1)]. Occasionally the support is so deteriorated that the ground and paint layers are actually supporting the panel [(2)]. In this case, the structural decay cannot be rectified by traditional methods, so the original ground with the paint layer should transfer to a new support to protect and safe the oil painting [(3)].

The adhesive material that can be used for fixing the layers of the ground and paint to a new support should be stable, pure, reversible, provide protection from atmospheric changes, preserve the elasticity of the oil painting, transparent, colorless and should have the capacity to be applied in a smooth layer. Many new chemical materials have been available recently, but some of them not recommended for use in restoration of oil paintings [(4)].

In this research, the adhesive material Mowilith DMC2 Vinyl resin was evaluated through an experimental study to be applied in transferring of the oil paintings. The mentioned material and the transferring method of restoration have been applied on a case of a destroyed oil painting from Sief and Adham Wanly museum, Mahmoud Saieed center of museums, Alexandria, Egypt. The name of the oil painting is "Two women on dance stage" (Fig. 1) executed by a famous Egyptian artist Sief Wanly (1906–1979 A.D.), on plywood support; registration number 384. The painting measured 99.5 × 75.5cm. The artist signed on the bottom of the oil painting.

The oil painting, the subject of this study had been suffered from bad preservation, so the insects attack the plywood support, many insects holes appeared and left it in a very weakened state (Fig. 2), and the layers of the ground and paint were in unstable case, some parts of the paint layer had fallen. Also there are some parts of the oil painting's edges were lost.

The aim of the present paper is to study and evaluate a new material for use in restoration of oil paintings, and to solve the problem of completely damaged oil paintings of wooden support through carrying out treatment and restoration.

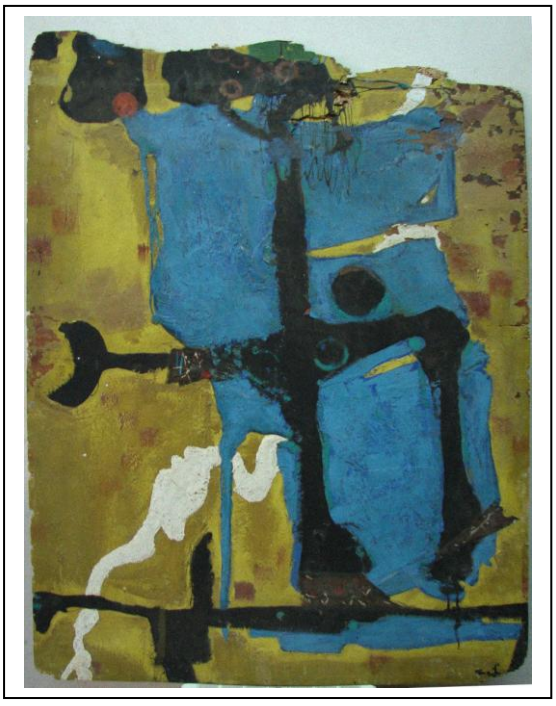

Fig. 1 The oil painting "Two women on dance stage".

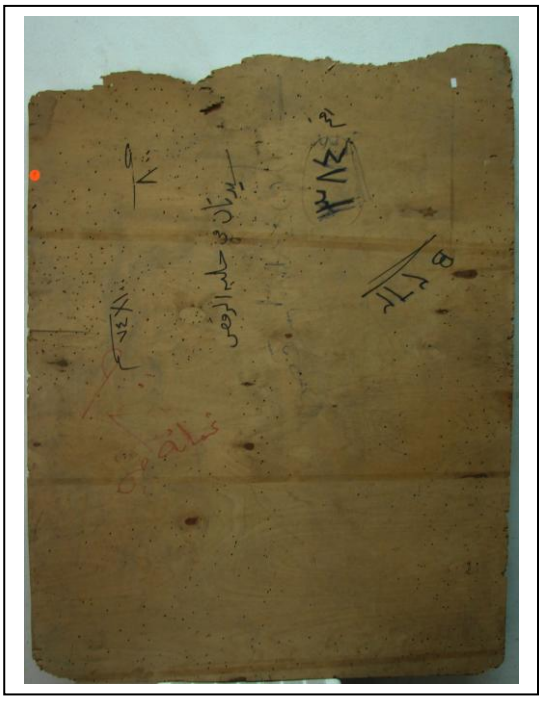

Fig. 2 The backside of the oil painting.

Experimental

Mowilith DMC2 Vinyl resin was studied and evaluated to use for transferring of the oil painting as an adhesive material. The Chemical composition is Vinyl acetate and maleate, CH(COOH):CH.COOH. The Solids content is 55%, pH value is 4-5, Viscosity, Brookfield RVT #5, 20 rpm is 5000-11000 mPa.s[(5)]. The main properties

are pure, soft, and age resistant; it could be used for conservation in adhesives and consolidation for some organic materials like archaeological wood, and provides good adhesion[6]. It was exposed to artificial ageing in oven at 75°C for 300 hours. Solar box (xenon arc lamp, I.R., V.L., U.V. radiations) at 100°C for 300 hours, and in climatic chamber (60°C, 70% relative humidity, and 360 nm U.V) continuously for 400 hours. Then the variations in yellowing rate value were determined periodically using a Hunterlab colorimeter. Also the change in chemical structure due to ageing was followed using FTIR spectrometer.

Micro samples were selected to determine the composition of the ground and paint layers. The oil painting executed without applying varnish layer. Different examinations and analytical methods were used. Stereomicroscope was used to study the surface of the oil painting, and scanning electron microscope (SEM) was used to study the cross-sections and its layers, and diagnosis of its deterioration phenomena on the painting's layers. Fourier transform infrared spectroscopy (FTIR) was carried out to identify the binder of the ground layer and to get an indication of the nature of the binding medium used in the paint layer. X-ray diffraction (XRD) and atomic absorption spectrometry (AAS) were carried out to verify the constituents of the ground layer and the pigments in the paint layer.

Results and discussion

Artificial ageing of Mowilith DMC2

The curves of changes in the yellowing rate value of Mowilith DMC2 after exposure to artificial ageing are given in Fig. 3.

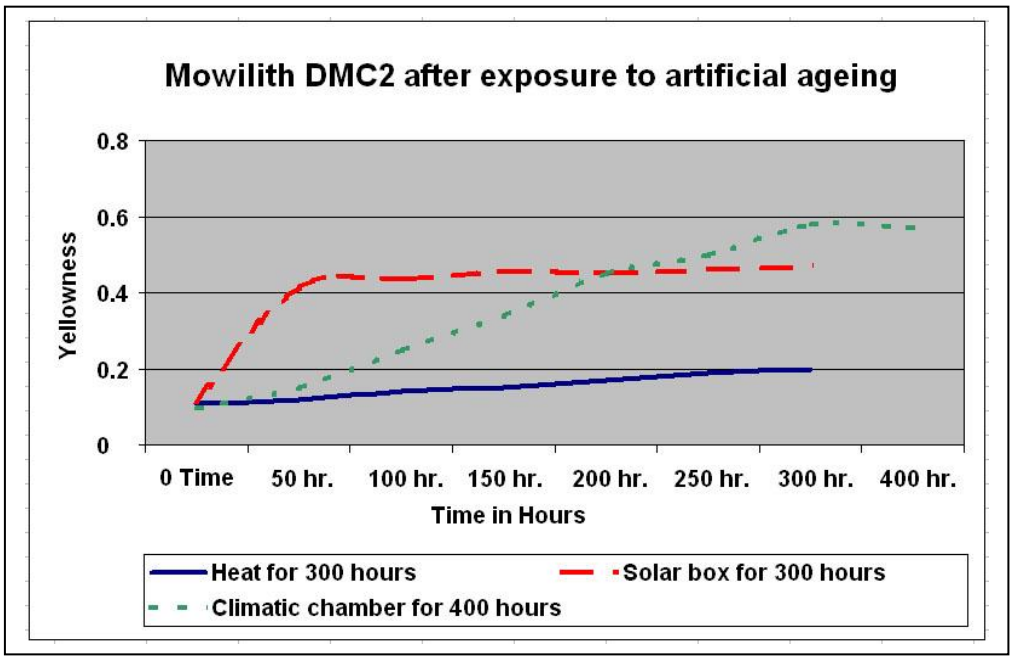

Fig. 3 Changes in the yellowing rate value of Mowilith DMC2 after exposure to artificial ageing.

FTIR patterns of Mowilith DMC2 before and after exposure to artificial ageing are given in Fig. 4. Mowilith DMC2 showed high stability against artificial ageing processes, there were no significant changes in its color and structure.

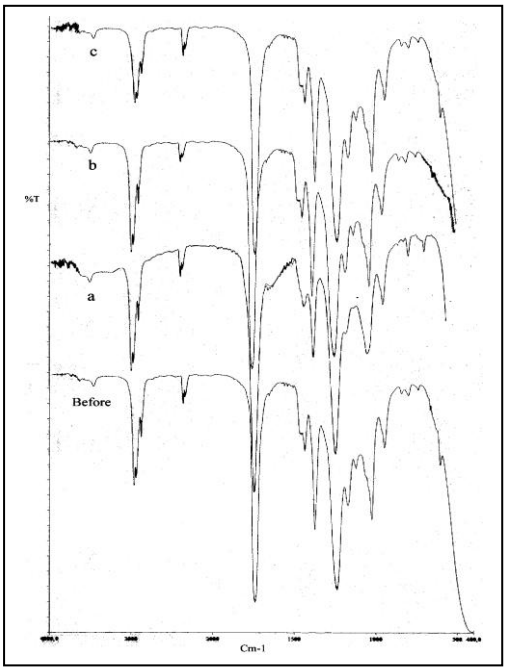

Fig. 4 FTIR patterns of Mowilith DMC2 before and after exposure to artificial ageing, (a) after exposure to heat, (b) after exposure in solar box, (c) after exposure in climatic chamber.

The identification of the oil painting layers

The observation by stereomicroscopy of the oil painting's surface reveals that there is fine cracks in the paint layer (Fig. 5). The study of two cross-sections of the oil painting by scanning electron microscope showed homogeneous thickness of the ground and paint layers, but appears some gaps, vacancy spaces and weak correlation between the layers (Fig. 6).

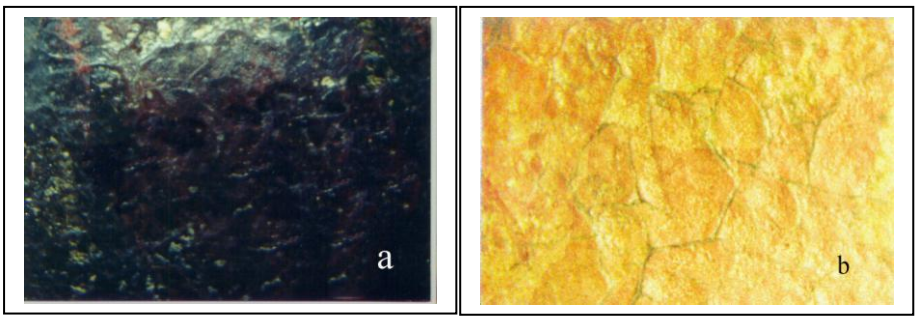

Fig. 5 The surface of the oil painting by stereomicroscope

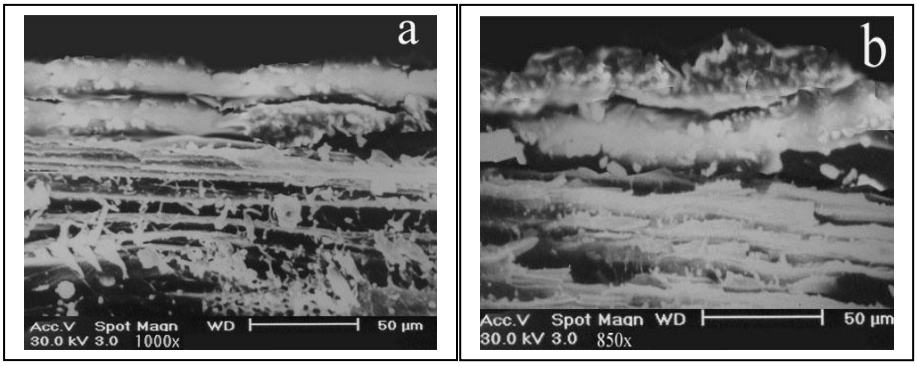

Fig. 6 SEM micrographs, cross-sections of the oil painting.

The background of the oil painting is composed of calcium carbonate, Calcite, $CaCO_3$ (05-0586) that have been confirmed by XRD analyses (Fig. 7), calcium carbonate mixed with animal glue that have been confirmed by FTIR spectroscopy [7] (Fig. 8, Table 1).

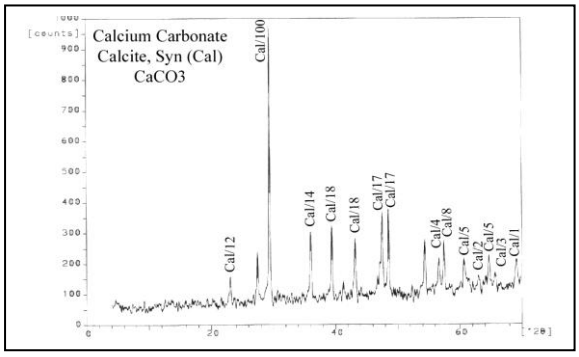

Fig. 7 XRD Pattern of the ground layer.

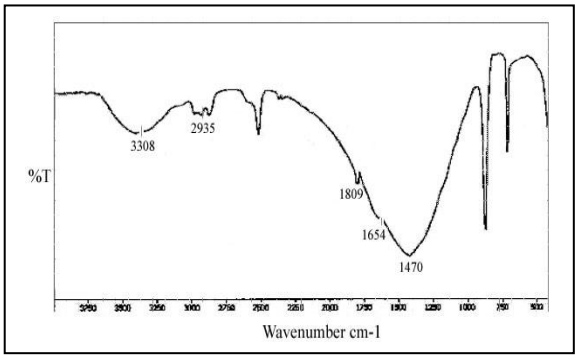

Fig. 8 FTIR pattern of the glue adhesive in ground layer.

Table 1 Characteristic groups of the glue adhesive in ground layer.

Wavenumber cm^{-1}	**Characteristic Groups**
3308	stretching ν N–H
2935	CH_3, CH_3 / CH_2 Group
1809	carbonyl group
1654	stretching ν C=O amide I
1470	combination of CN and NH vibrations; amide III

X-ray diffraction analysis was applied for the identification of the constituents of the main pigments of the paint layer (red, yellow, blue, white and black). XRD data showed that the paint layer is consisting of the following compounds (Fig. 9): The red pigment consists of iron oxide, Hematite, Syn, Fe_2O_3 (13-0534). The yellow pigment consists of antimony bromide, $SbBr_3$ (30-0077). The blue pigment consists of sodium aluminum sulfide silicate, ultramarine blue, $Na_{8.5}Al_6Si_8O_{28}S_{4.3}$ (02-0325). The white pigment consists of zinc oxide, ZnO (21-1486). The black pigment consists of manganese oxide, Hausmannite, Mn_3O_4 (02-1062).

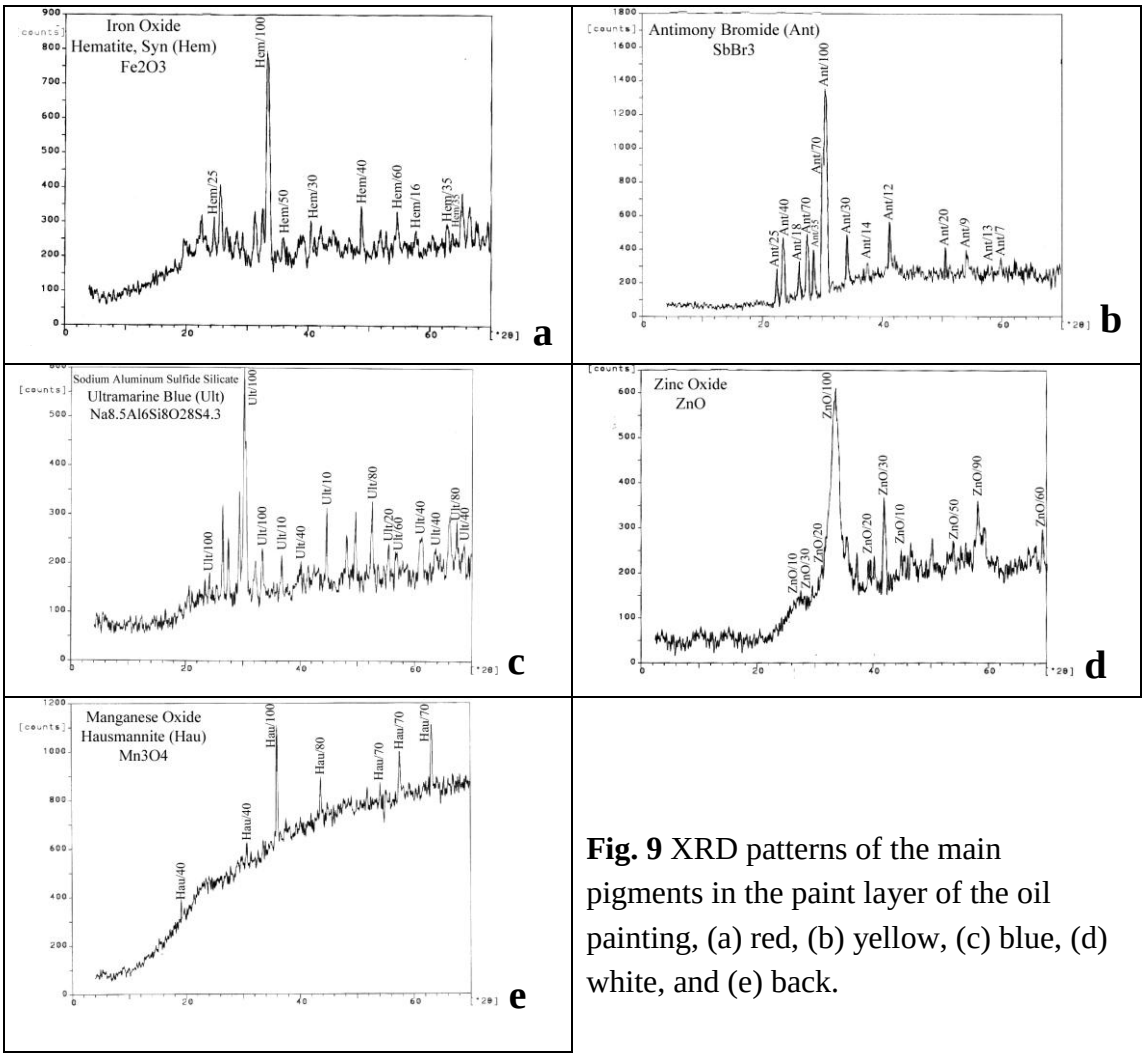

Fig. 9 XRD patterns of the main pigments in the paint layer of the oil painting, (a) red, (b) yellow, (c) blue, (d) white, and (e) back.

Atomic absorption spectrometry (AAS) was carried out to identify the elements in the background and paint layers, which were analyzed by XRD. (Table. 2). The study of the paint layer of the oil painting by FTIR spectroscopy reveals that the medium used in the paint layer is linseed dry oil [(8)] (Fig. 10, Table. 3).

Table 2 Atomic absorption spectrometry results of the ground and paint layers.

Samples		**Identified Elements**	
Ground layer		Ca	/
Paint layer	Red pigment	Fe	/
	Yellow pigment	Sb	/
	Blue pigment	Na	Al
	White pigment	Zn	/
	Black pigment	Mn	/

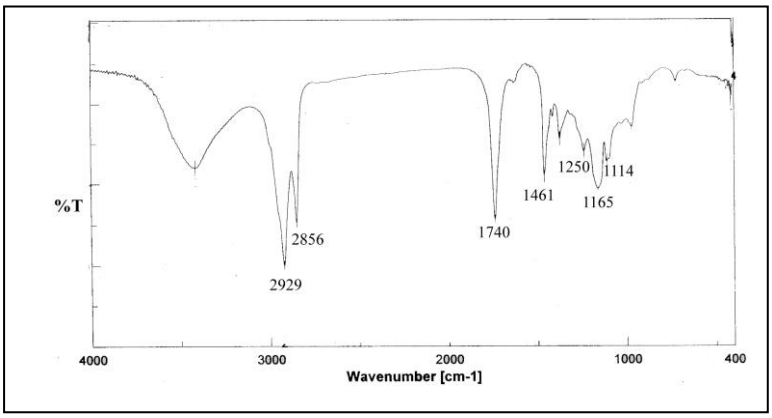

Fig. 10 FTIR pattern of the linseed oil medium used in the paint layer.

Table 3 Characteristic groups of the linseed oil medium used in the paint layer.

Wave number cm^{-1}	characteristic groups
2929	C–H Stretching
2856	C–H Stretching
1740	strong carbonyl band ν C=O
1461	C–H Bending
1250	C–O stretching pattern
1165	C=O stretching, C–O stretching
1114	Stretching of ester group

Conservation and Restoration Processes

Transferring Process

Transfer is a term used to describe removal of the upper ground and paint layers from an old oil painting to a new support [9-11]. The wooden support of the oil painting, the subject of this study was so deteriorated and extensive damaged by insects infection that the paint film are actually supporting the panel, and the oil painting cannot be preserved by any other methods. The transfer process can be done partly or totally. The transfer process of the oil painting was carried out partly [1].

At first, the picture side was protected carefully with two layers of a strong silk paper, which were smoothed with a heating tool and a mixture of unbleached beeswax and colophony (Fig. 11). When the surface protection was dried, the faced painting was laid face down on a high-density board. The whole thing was laid front side down on a table and fastened with a cushioned board and screw cramps. The solid support (3 mm) was gradually removed by cautious damping, a gouge and fine chisels were used to pare the plywood support both with and across the grain until only half a millimeter was left, working in small squares (Figs. 12, 13).

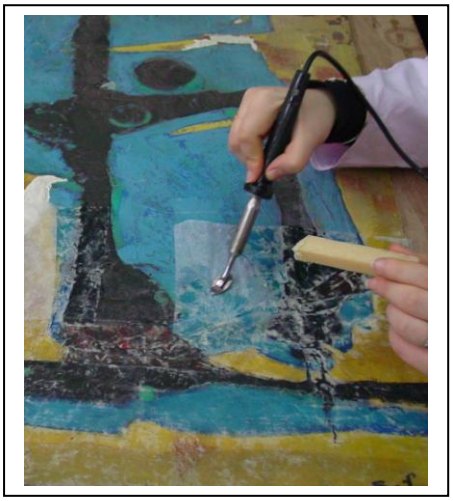

Fig. 11 The surface protection of the oil painting

Fig. 12 The removal of the wooden support of the oil painting.

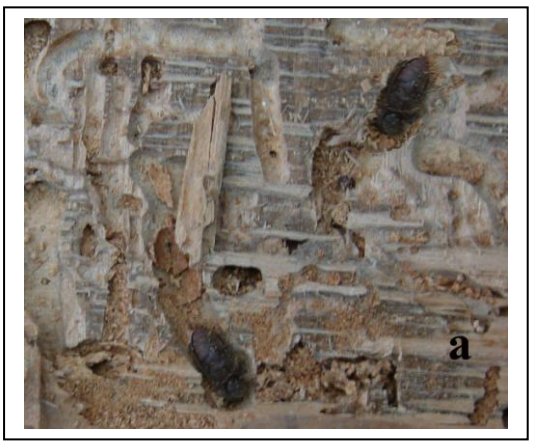

Fig. 13 The tunnels and insects on the backside of the oil painting that appeared after removal of the first layer of plywood.

The thin layer of the original support was smoothed with sandpaper (Fig. 14). The thin layer of the original wooden support and the layer of the ground and paint film were impregnated with Mowilith DMC2 to consolidate the layers and bind them more.

A plywood secondary support 6 mm thick was chosen, larger than the oil painting, fixed to the backside of the oil painting by Mowilith DMC2 adhesive material without using any source of heat. Mowilith DMC2 proved its success and stability through the previous experiments (Fig. 15). The painting was rubbed lightly and pressed down for twelve hours with a board and weight.

Fig. 14 The oil painting after removal the wooden support partly, and shows a thin layer of the original support (0.5 mm)

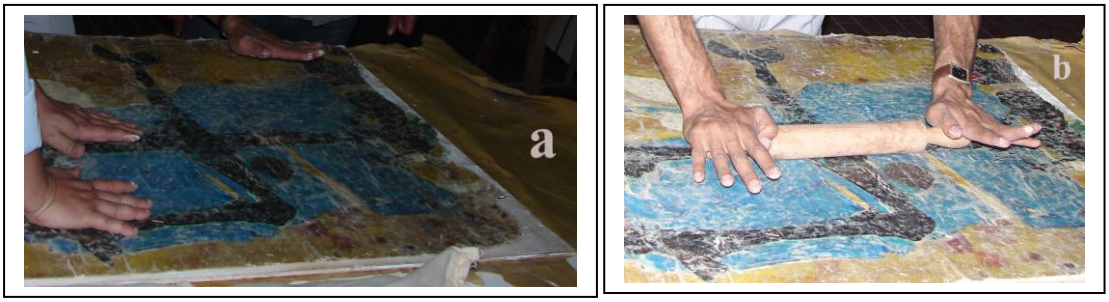

Fig. 15 Adhesion of a new wooden support to a backside of the oil painting

After that, when the adhesive thoroughly dried, the picture laid face upwards, and the surface protection removed carefully and gradually by worm iron. The next step is cleaning the surface from dirt and remains of the protection adhesive layer were removed by white-spirit by compression on small areas, the hard particles were then delicately mechanically removed by fine scalpels. Then the lost parts of the oil painting's edges were completed by a thin layer (0.5 mm) of new plywood strip which adhered to the new support by using Mowilith DMC2 (Fig.16).

Fig. 16 Completing the lost parts of the oil painting's edges by a thin layer (0.5 mm) of new plywood.

The small lost parts of the ground layer were filled by a mixture of calcium carbonate with animal glue adhesive (Fig. 17). Inpainting was completed by using the same pigments in n-butyl methacrylate resin. Then, spray of Rohm and Haas Acryloid B-72 resin dissolved in xylene was applied to the finished painting to provide vitality. The painting after treatment and restoration is shown in Figure 18.

Fig. 17 Filling the small-lost parts of the ground layer.

Fig. 18 The oil painting after completing the restoration processes.

Conclusion

The results of the present investigation indicate that Mowilith DMC2 Vinyl resin has a high stability against artificial ageing processes and safe to use for restoration and preservation of oil paintings.

The experimental study for applying the method of restoration indicates that transferring process is a suitable solution for the oil painting that its supports were completely damaged. A treatment was devised using materials that could be applied and removed without affecting one another. This method of restoration (Transferring process) is not only exclusive for the oil painting, the subject of this study, but it could be applied to other oil paintings in restoration laboratories of museums all over the world to preserve and protect the damaged oil painting.

The methods of examinations and analyses are very important for understanding the technique and the materials used by the artist, also to choice the more suitable materials and methods for restoration

Co-operation between conservators and chemists should be active to develop the materials and methods of restoration for the oil painting to create a number of treatment methods for applying in case of severely damaged paintings.

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