

## **STUDIES REGARDING THE DETERIORATION AND DEGRADATION OF OLD PANEL PAINTINGS UNDER THE INFLUENCE OF ENVIRONMENTAL FACTORS**

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### **Abstract:**

*This paper presents different progressive effects of deterioration and degradation of panel paintings, a result of environmental factors' action during exhibition or storage. It has been analyzed both the support and the components of the painting layer. There have been studied panel paintings from XIX - XX<sup>th</sup> century, whose panels are made of few planks, joined with dowels and crossbeams. The dimensional changing through swelling and shrinking or the modification of panels flatness, determined by the variation of environmental factors, led to tensions which created cracks, fractures of the wood, affecting also the painting layer. The microclimate fluctuations affected physical (deteriorated) and chemical (degraded) the painting layer. The results are cracks, cleavages, embrittlements, discolorations. The paintings exposed to harsh climate conditions reached a pre-collapse and even collapse state. The observations took into account the interactions between the different structural elements of paintings under the influence of environmental factors, and also the way of display, storage and manipulation.*

**Key words:** panel paintings; deterioration; degradation; microclimate; display; storage.

## INTRODUCTION

Panel paintings are complex structures, made of organic and inorganic materials. The wooden panel, made of one or multiple planks, joined with dowels and strengthened with crossbeams, was abraded and coated with animal glue, so the surface permitted the adhesion of the ground layer over which was applied the paint layer and the varnish. The ground layer, made of hide glue and calcium carbonate or gypsum, was used to cover the wood fibers texture and to offer a plane surface for the painting (Uzielli 1995). Its thickness varied depending on the period the painting was made, beginning with the XIX<sup>th</sup> century the ground layer had 1,00mm or less, while the oil paintings usually had imprimatura (a layer of white, grey or green color that covered the panel surface).

The paint layer, applied in a thin or thick layer, was made of pigments combined with egg emulsion or drying oil. The varnish, used for aesthetic and protection purpose, was made of resins, oil and solvents (alcohol or turpentine) (Sandulescu-Verna 2000).

All this elements answer differently at humidity and temperature variations, the panel movements playing the most important part in the painting layer deterioration. Also, the storage and display in improper conditions affect the paintings (Moldoveanu 2010).

Wood is a hygroscopic anisotropic material, its swelling and shrinking, under the influence of environmental factors, has different values on the three axis, which vary in the series: longitudinal (L)< radial (R)< tangential (T). The variations in radial and tangential plan are greater, because of S2 cell wall thickness, whose fibrils are oriented almost longitudinal. The dimension of swelling in radial and tangential plan depends on wood species and density (River *et al.* 1991, Hoadley 1998).

The wood fixes water molecules at the hydroxilic groups from the cell wall, until its moisture content reaches the equilibrium with the environment in which is placed. The thicker the panel, the more difficult is to gain equilibrium, a thinner panel responding easier to the environmental fluctuations (Monfardini 2009). This way, the stress upon the painting layer is stronger and the risk of cracking and cleavage is greater. The wood structure is also an important feature. A wood that has cells with large lumens (therefore it has a coarser texture) fixes better the ground and the paint layer, due to a better penetration of glue and gesso (Hoadley 1998).

Humidity and temperature variations modify the mechanical properties of wood. For example, increasing the temperature with 1°C will reduce the mechanical properties up to 1% (Unger *et al.* 2001). The increment of the atmospheric humidity determines a growth of the wood moisture content and of wood plasticity (River 1991). The differences of wood moisture content between the panel's surface and interior will create tensions and compressions which will lead to cracks and fractures in the support (Hoadley 1998, Jakiela *et al.* 2008). When the panel is reinforced with crossbeams, the warping can dislocate them of their place or the hardness of the crossbeams wood can force the planks to stay in place, but they fracture along the joint.

The ground also responds to humidity and temperature variations, but differently. The yield point for wood and glue is 0,004, and for ground is 0,002 (Łukomski 2012). When the wood shrinks it compresses the ground layer, and when the support swells, it tenses the gesso (Kozłowski online at <http://www.cyfronet.krakow.pl/~ncbratas/eea/publikacjaLosAngeles>). The result is a series of cracks parallel and perpendicular to the grain (Hoadley 1998), due to strong tensions or to cumulation of small, but repeated tensions (Łukomski 2012). These will develop in cleavages, delaminations, lacunae of ground and painting layer (Sandu 2008). Factors that influence the evolution of cracks, beside panels movements, are the type of calcium carbonate or gypsum, the binder (glue, oil), the thickness of paint or ground layer (Sandu 2005).

The varnish cracks, but also suffers processes of alteration under the influence of humidity, light, corrosive gases, microbiological agents. Thus it changes its colour, it darkens or it gets a whitish appearance (if the humidity is high) (White 2001). The adherent or non-adherent dirt, accumulated on the painting's surface or on the back of the panel, modifies the aspect of the painting and favors the growth of microorganisms, especially when humidity is high. The fungi degrade the wood (making it brittle and cracked (Sandu 2008), but also the ground layer, the varnish (they oxidate the substrate (Romero-Noguera 2010)). The xylophagous insects influence the strength of the panel, an extensive and intense attack leading to support failure and to the necessity of transposing the painting layer on a new panel.

The old icons used in liturgical rituals are encased with wooden frames and glass or other transparent polymeric materials, to protect them against excessive use through manipulation, touching kissing or just for climatic protection. These boxes, due to recently processed, hydric unstabilized wood, create a cryptoclimate which leads to oxidation processes that change the varnish structure and aspect (Moldoveanu 2010).

Regarding the information presented above we will submit to your attention different cases with evolutive effects of degradation and deterioration, as a result of the action of microclimate and anthropic factors when paintings are in storage or incorrectly displayed.

### CASE STUDIES

#### *Icon Holy Virgin with Child*

The icon, painted in tempera on lime tree wood, belongs to the church “the Descent of Holy Spirit” from Iassy, dated approximately the beginning of XIX century, unknown painter (**Figs.1 and 2**).



**Fig. 1**  
**Icon Holy Virgin with Child:**  
**a - general view obverse and b - general view reverse.**



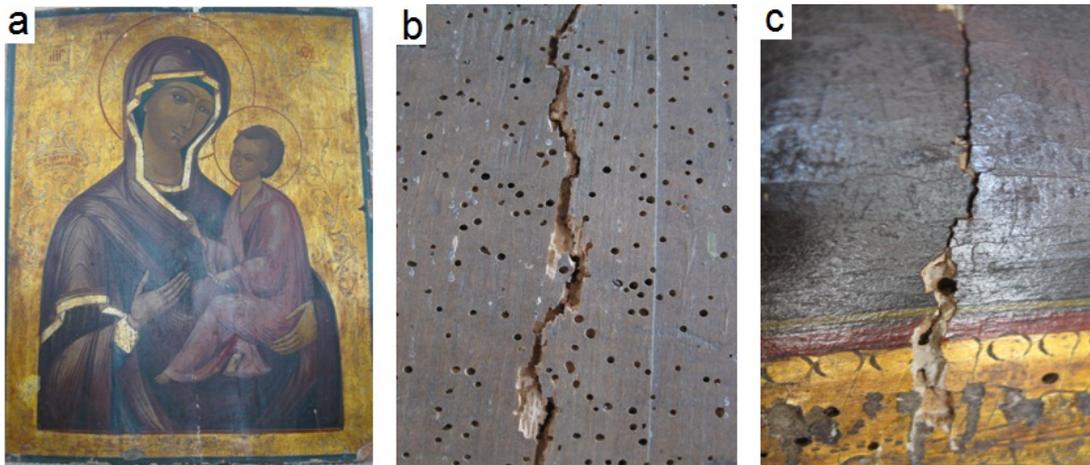
**Fig. 2**  
**Icon Holy Virgin with Child:**  
**a - detail of the fractured panel showing the traces of xylophagous attack and**  
**b - nails, dust traces, lacunae observed at the frame removal.**

The panel of the icon was made of two planks fixed with dowels and glued together. The icon presented a frame fixed with modern nails on the obverse and edges. On the reverse it had two crossbeams with dovetail section (Fig. 1b). The microclimatic variations (high humidity due to infiltrations in church's walls, and anthropic factor; variable temperature depending on the season and the frequency and duration of rituals in the church),

the frame and crossbeams led to the stress of planks and panel's fracture (Fig. 2a). Also, there were observed cleavages and losses of painting layer in the fractured area and randomly, on the surface. The frame favored the accumulation of non-adherent dirt (Fig. 2b), and the developing of lacunae in the painting layer. The intense xylophagous attack made the support very fragile on certain areas, and it needed in-filling.

### ***The Holy Virgin of Tikhvin***

XIXth Century icon, painted in tempera on lime tree wood, russian style, unknown author, private collection (Fig. 3).



**Fig. 3**

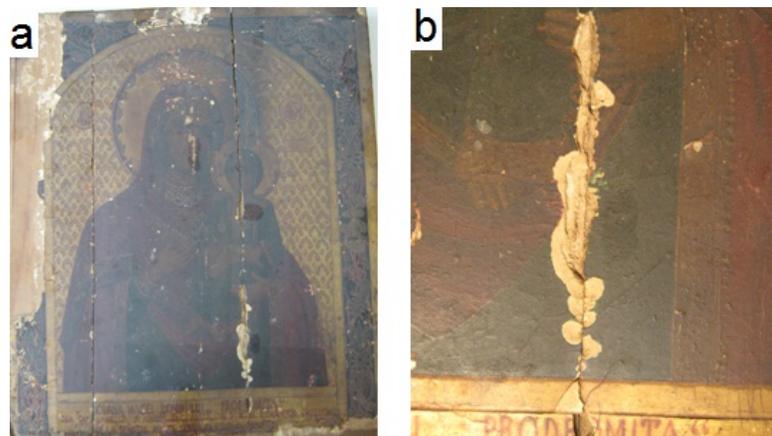
### ***Icon The Holy Virgin of Tikhvin***

***a – general view; b – fracture of the frail support; c- cleavage with lacunae of the painting layer, in the area corresponding to panels fracture.***

The icon presented a panel made of two boards glued together, with grooves for crossbeams, but with the crossbeams missing. The wood was very brittle because of the xylophagous attack and presented a longitudinal fracture due to incorrect manipulation on the reverse of the support, partially visible on the obverse. The ground layer, 1,00mm thick, made of calcium carbonate, was frail. The support fracture led to cleavages and lacunae in the painting layer.

### ***Icon Holy Virgin of Prodromu***

XXth century icon, oil on fir wood, neoclassic style, author unknown, private collection (Figs. 4 and 5).



**Fig. 4**

### ***Icon Holy Virgin of Prodromu:***

***a - general view; b - detail of the lacuna in the painting layer.***



**Fig. 5**  
**Icon Holy Virgin of Prodomu**  
**crossbeams removal; the nails that fixed the crossbeam are visible.**

The icon was painted on a panel made of three boards joined with glue and nails. Also, the crossbeams were fixed with long nails, which came out on the obverse of the panel. In time the wood shrunk and tensioned and led to the appearances of cracks in the painting layer. The rigid and frail ground (made of calcium carbonate) had detached on certain areas of the panel and had been lost. The image was hardly readable because of the adherent dirt.

**Icon Holy Virgin with Child, Vovidenia Church (The Presentation of the Blessed Virgin Mary), Iassy**  
XIX<sup>th</sup> century icon, tempera on lime tree wood, neoclassic style, author unknown (Fig. 6a).



**Fig. 6**  
**Icon Holy Virgin with Child**  
**a - general view; b - the reverse of the panel painted in brown; c - the contact area with the iconostasis frame.**

The icon, painted on a panel made of two planks, joined with dowels and glued together (Fig. 6b), was installed in the church's iconostasis with screws, this way the normal movements of wood being restrained and leading to support fracture. On the left side, because of the iconostasis frame and due to microclimatic variations (heating used only in liturgical days, variable relative humidity) numerous cleavages and lacunae were formed on the painting layer (Fig. 6c). The darkened varnish presented whitish traces, probably the effect of a failed attempt of cleaning with inadequate solutions. This icon also presents signs of a quite intense xylophagous attack.

## CONCLUSIONS

The panel paintings are objects sensitive to external factors, their integrity being affected by microclimatic variations, whose actions cumulate in time. Providing a balanced environment and also a fast specialized intervention in case of deterioration, degradation, are necessary measures to prolong the existence of these art objects. The microclimatic variations must be monitored so the extreme values could be avoided by using different devices that reduce or enhance the humidity, temperature (humidifiers, dehumidifiers, air conditioners). Also, the xylophagous and fungal attack must be prevented through periodical treatments.

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