Study of Modifying the Level of Oxigen Inside the Cryptoclimat for Stopping the Xylophagous Attack on Old Icon Panel

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This study presents the data regarding the stopping of a xylophagous attack on the panel of "Lady from Rohia" icon, part of the cultural heritage of „Saint Mihai and Gavriil” church from Galati, by modifying the level of oxygen in the cryptoclimat. The study presents the stages and the operating systems used in stopping the xylophagous attack by lowering the value of the oxygen inside the cryptoclimat below 0.1% for a period of 14 days. The icon and the measuring devices were sealed in a polyethylene bag from which the air was completely removed and replaced with nitrogen. The cryptoclimatric factors of the nitrogen atmosphere were then monitored for a period of 14 days.

Keywords: icon, xylophagous attack, cryptoclimat, oxygen concentration, nitrogen atmosphere

It is documented that oil, tempera or acrylic paintings on wood support suffer in time the deterioration and degradation effects of the microbiological attack, especially that of the xylophag insects. Beyond this, the icons used in religious proceedings are also affected by the human factor (inadequate use, improper display, exposure to smoke, rubbing, kissing, splashes of holy water etc.).

In general, the icons from areas with a continental temperate climate are exposed to a minimum of two hatching cycles of xylophag insects. The most active species are Anobiidae and Ptiniidae, which led to the loss of resistance of the support by tunnels and fly holes and by the enzymatic action of the metabolism products, often to the faze of pre collapse, which requires doubling the old support or moving the painting layer on a new support [1-4]. In order to prevent the xylophag attack the wood panels are treated with various water or organic based solutions used as fungicides [5-6]. Because those are harmful to humans, often treatments based on natural products or less toxic solutions based on resins, tannins etc. are used [7-8].

In the last few years a special attention was given to the process of stopping the attack for a minimum of two incubation periods (march-may; august-september) with anaerobic atmospheres. The evolution and the effects of this treatment are not yet studied well enough [9-19].

The study follows the stages, the parameters and the operating systems (materials, devices and processes involved) used to stop the xylophag attack that affects the "Grieving Mother from Rohia" icon, which is painted by an anonymous artist on lime wood support, in egg tempera in the XIX-th century, and its now part of “Sfintii Mihai si Gavriil” church collection, from Moscu, Galati.

The icon is painted by an anonymous author on lime wood support, without ground layer, in egg tempera, in the XIX-th century and it is now part of "Sfintii Mihai si Gavriil" church (Moscu, Galati) collection.

The Virgin Mary is painted only bust, with her head bowed down and her eyes facing down, dressed with a dark cloak. The chromatic impression of grief and sorrow is completed by the background (a mixture of green, ochre and black), which becomes even more dark as it goes away from the face of the Lady. The face is made from a combination of white and ochre, in which the author added green and black for shadows. The structural composition of the icon is made a whole by the three lower scenes, framed by yellow borders. The scene from the right and the one from the left are the same, Saint Gheorghe killing the dragon, while the one in the middle shows the two archangels, Mihail and Gavriil (fig. 1a and b).

Fig. 1. The Grieving Mother from Rohia:
a – the front of the icon; b – the back of the icon
The icon was kept with the rest of the collection in a room inside the bell tower, which was an improper environment for keeping artworks. As a consequence, the icon was exposed to the fluctuation of atmospheric factors [20-29]. These fluctuations of temperature and relative humidity, in collaboration with the unsanitary space lead to the birth of some deterioration and degradation evolutionary processes that affect both the support, and the painting layer of the icon [27-36].

The panel structure is really weakened as a result of the xylophag attack that affects the icon and also the crossbeams that keep the panel in one piece. The effects of the attack can be seen on the back of the panel, almost 25% of it being covered in fly holes (fig. 2a) and also in the lower corners, where pieces of the panel were lost (fig. 2b).

Around 25% of the painting layer is missing and another 25% of it has very low adhesion to the panel (fig. 3a). The painting layer is also affected by cracks and blisters, both caused by the improper storage conditions, combined with the ageing of the binders used by the author (fig. 3b). The fact that the icon was kept in an unsanitary environment led to the deposit and later, to the clogging of dirt in the varnish layer, which affects the painting layer from a conservation point of view, but also from an aesthetical one (fig. 3c).

Experimental -part

The most important stage concerning the restoration of the icon is the stopping of the xylophag attack. The exact identification of the insects that attacked the panel was done by observing the biological material that was collected from the panel of the icon under a magnifying glass and the characteristics of the attack. The biological attack is defined by fly holes of 1-3mm in diameter, dark colored, from which fresh yellow sawdust kept falling and tunnels in the mass of the panel. Adult insects with a length of two to five mm, colored in brown with gold were found. Taken into consideration these facts, it was determined that the panel was attacked by insects from the Coleoptera order, Anobiidae family, more exactly: Anobium punctatum (fig. 4a) and Anobium pertinax (fig. 4b). For these insects the wood is the primary food source, and it also provides shelter for evolving. The optimum temperature for their development is 18-22°C, while the relative humidity should be above 60% [1-2, 4].

Taking into consideration the health risks, the impact on the environment and the possible further deteriorations of the icon, the classic way of stopping the xylophag attack by injecting the panel with chemical solutions was dropped and an anaerobic treatment was chosen. An anaerobic crypto climate was build and the concentration of the oxygen inside it was lowered under 0.1%. In order to make the crypto climate a sealed polyethylene bag, with a single-way valve for getting in nitrogen and a gap for evacuating the oxygen was used (fig. 5). A cylinder with nitrogen was connected through an adapter coupling with a hose to the single-way valve of the bag, to ensure a steady flow of gas (fig. 6a and b). In order to measure the oxygen concentration, Teledyne 320P oxygen monitor with batteries was used. This monitor was put inside the bag with other monitors for temperature, relative humidity and pressure [12, 15-16, 19].

The process of evacuating the oxygen and replacing it with nitrogen was done four times, in order to reach the desired oxygen concentration. During the gas exchange inside the crypto climate, the bag with the icon (fig. 7a) is placed horizontally, without moving it, to prevent the wood panel from further physical and mechanical tensions, and temperature, the relative humidity and the pressure (fig. 7b and c) were constantly monitored in order to prevent sudden fluctuation of their values, which would affect the hydric balance of the wood, leading to dilatations and contractions [37-41].
Results and discussions

The adult insect from *Anobium app.* lays eggs (ellipse shaped) in the cracks of the wood panel. After a period of three to five weeks (can go up to five years if the conditions are bad) the larvae hatch and start to affect the wood. They feed on wood and they start drilling circular tunnels in the panel, with a diameter between 1 and 10mm, leaving behind them fine sawdust mixed together with feces. The larvae stage can last years until reaching the next stage in the cycle of her life, pupae. Before transforming completely into a pupae the larvae drills a tunnel almost to the surface of the panel, where it builds a chamber clear of sawdust or feces. In this space the pupae turns in a matter of weeks into an adult (fig. 8), adult which will get out from the wood through the so-called “fly holes” [7].

The active xilophagic attack on the icon appeared as a consequence of rising of temperature and relative humidity, above the established values, in the space where the icon was kept (R.U. > 70%, T > 21°C). The attack is obvious on all surfaces, even in the gaps of the painting layer (fig. 9).

After obtaining the desired oxygen concentration and stabilizing the values of relative humidity, temperature, and pressure, the 15cm gap left unsealed to evacuate oxygen was sealed. The monitoring of the atmospheric factors continued every day along the 14 days, in order to establish the necessity of intervening inside the crypto climate in case of sudden and massive fluctuations.

A direct relation between the three atmospheric factors was observed after studying their values on the entire period. During the first six days, a constant raise of the three values was observed: the temperature went from 18 to 19°C; the relative humidity gained two percent up to
65%, and the pressure needle moved from 993 to 993.8 mmHg. One of the remaining oxygen was consumed by the xylophag insects, the values of the known atmospheric factors dropped to the initial or even lower. The pressure went back to 993, while the temperature and the relative humidity dropped at 17.2°C and 62.5% (fig. 10a-d). Because the value of relative humidity did not drop below the established conservation values, new quantities of humidified nitrogen were not required. The lack of sudden and severe fluctuations kept the icon safe from other mechanic tensions or dimension tampering.

At the end of those 14 days, the crypto climate was exposed to fresh air and the icon was removed from the polyethylene bag and inspected carefully. The active xylophag attack had stopped and the insects found were all dead. This method of stopping the attack does not present risks towards the artwork, the conservator or the environment. The icon is now ready for the next stage of the restoration process, and that is cleaning the painting layer, in order to return it to its original purpose.

Conclusions

The study presents the stages and the materials used in order to stop the xylophag attack that affected the icon "The Grieving Mother" from "Sfintii Mihail si Gavriil" church from Moscu, Galati. The attack was stopped by keeping the icon inside an anaerob crypto climate for a period of 14 days. In order to make the crypto climate the following were used: sealed bag of polyethylene with a one-way valve and a evacuation gap, an adapter coupling with a hose, nitrogen cylinder, monitors for the atmospheric factors inside the crypto climate (temperature, relative humidity and pressure). These values were monitored carefully during those 14 days in order to prevent sudden fluctuations that would have submitted the panel to further mechanic tensions. At the end of those 14 days, the icon was taken out from the microclimate and carefully inspected through micro endoscopic analysis. No evidence of an active xylophag attack was found.

References