STUDY OF OLD VARNISH RECIPES USED BY THE TRANSYLVANIAN ICON PAINTERS. CASE STUDY: REPRODUCTION AND CHARACTERIZATION OF VARNISHES USED IN THE 18TH CENTURY AND EARLY 19TH CENTURY ICONS FROM MUSEIKON COLLECTION*

DUMITRIȚA DANIELA FILIP
Postdoctoral researcher, ”1 Decembrie 1918” University from Alba Iulia / National Museum of Union Alba Iulia
CRISTINA CARȘOTE,
ZIZI ILEANA BALTĂ
National Museum of Romanian History, Bucharest
ELENA BADEA
Advanced Research for Cultural Heritage Laboratory (ARCH Lab), INCDTP-ICPI Bucharest / Department of Chemistry, Faculty of Sciences, University of Craiova

Studiul rețetelor vechi de vernisuri folosite de pictorii de icoane transilvăneni. Studiu de caz: Refacerea și caracterizarea vernisurilor utilizate în icoanele din secolul al XVIII-lea și începutul secolului al XIX-lea din colecția Museikon

REZUMAT

Studiul de față face parte dintr-un proiect de cercetare postdoctorală al cărui principal obiectiv rezidă în recuperarea tehnicii de pictare a icoanelor pe lemn transilvănene din secolul al XVIII-lea și de la începutul secolului al XIX-lea, prin identificarea materialelor constituente, stabilirea provenienței acestora. Informațiile obținute sunt utilizate pentru adaptarea metodologiei de restaurare în acord cu specificul și particularitățile icoanelor transilvănene.

Prezentul studiu se focalizează pe documentarea și recuperarea unor rețete de vernisuri folosite de iconarii transilvăneni în secolul al XVIII-lea și la începutul secolului al XIX-lea, precum și pe caracterizarea vernisurilor obținute prin diverse metode de analiză. Astfel, au fost reproduse cinci rețete de vernisuri în acord cu tehnica tradițională menționată în tratatele de pictură, erminii și alte documente locale. Vernisurile au fost aplicate pe o icoană nouă, pictată în tehnica tempera, utilizând, în special, pigmenți similari cu cei identificați pentru un grup de icoane transilvănene din colecția Museikon a Muzeului Național al Unirii Alba Iulia. Un protocol analitic, care a inclus microscopia optică, fotografierea tehnică, spectroscopia în infraroșu (FTIR) și spectroscopia cu fluorescență de raze X (XRF), a fost aplicat în vederea obținerii unor date de

---

* Acknowledgement: Dumitrița Daniela Filip acknowledges the support from POCU 153770 project “Accessibility of advanced research for sustainable economic development – ACADEMIKA”, co-financed by the European Social Fund under the Human Capital Operational Program 2014-2020. Dumitrița Daniela Filip is grateful to the Natural Sciene Museum from Aiud for facilitating the research of their collection and provinding the neccessary informations. Elena Badea acknowledges the support of the grant of the Ministry of Research, Innovation and Digitization CNCS-CCCDI UEFISCDI, project number PN-III-P3-3,5-EUK-2019-0211, within PNCDI III, from which the varnish analysis was performed.

referință, care să fie utilizate în următorul pas al acestui studiu, și anume îmbătrânirea artificială a icoanei noi și investigarea acesteia. Este de așteptat ca rezultatele finale să aibă, pe de o parte, un impact științific privind procesele de deteriorare a vernisurilor și, pe de altă parte, o contribuție importantă privind tehnica tradițională de pictare a icoanelor din Transilvania.

Key words: varnish, Transylvanian icons, 18th- early 19th centuries, icon painting, materials
Cuvinte-cheie: vernis, icoane transilvănene, secolul XVIII - început de secol XIX, pictură de icoane, materiale

Introduction

This study is part of a larger research project that aims, on the one hand, at documenting and retrieving the Transylvanian icon painting technique and, on the other hand, at identifying the materials used by the local masters in the aforementioned region, during the 18th and early 19th centuries. A group of icons, part of the Museikon collection of the National Museum of Union Alba Iulia[1] was used as a case study. Additionally, the research aims at providing information concerning the conservation history of these icons in order to adapt the current restoration methodology to their peculiarities due to both the artistic technique and preservation conditions. The attention will be focused on the reproduction and characterization of varnishes used by the Transylvanian masters. It is expected that the results of this case study will have an impact on art history and history, conservation science and restoration.

In order to shed light on this issue, archival and bibliographical research was performed to identify the varnish recipes and the ingredients mentioned in the written sources available at that time, such as icon painting treatises, Hermeneias, and other local records. These recipes were then compared with the results of the scientific analysis made on the varnish layer of the icons included in the case study.

***

The varnish is an important layer in panel painting. It plays a dual role: it influences the final appearance of the painting by the refraction of light (this phenomenon is called "saturation") and protects the paint surface against various damage factors. (**Fig. 1**) Varnishes are solutions of natural or synthetic resins in organic solvents that dry and form thin and transparent films on a surface. According to the composition of the solution, the films exhibit varying qualities of gloss, protective ability, flexibility, and durability. The varnishing materials change depending on the paint media and techniques throughout the history of

---

[1] The icons were painted or attributed to masters such as Grigore Ranite, Iacov from Feisa, Gheorghe son of Iacov, Nistor, Ivan and Stan from Rășinari, Simeon Silaghi Sălăgeanu, Simon from Bălgrad and other three icons were painted by anonymous masters.

painting. By the early Renaissance, a variety of materials had been used as painting varnishes, from egg white to resin. Tree secondary metabolites called resins (mastic, dammar, sandarac, colophony/rosin), fossil resins (copal, amber) and insect excretions (shellac) are among the most used resins for preparing varnishes. Depending on the solvent used to disperse the resin, historical varnishes can be grouped in solvent (turpentine, alcohol) varnishes, also known as ”spirit varnishes”, and oil varnishes. Terpenic resins can also be grouped, according to the number of C_5 units (i.e. isopentenyl diphosphate (IPP) or dimethyl allyl diphosphate (DMAPP) in: (i) diterpenic resins C_{20} (colophony, sandarac, copal, Venice turpentine), which are compounds with 20 carbon atoms, (ii) triterpenic resins C_{30} (mastic, dammar, elemi), which have 30 carbon atoms, and (iii) sesquiterpenoid resins C_{15} (shellac), which have 15 carbon atoms[2]. Most studies of varnishes carried out in the field of conservation science started from these categories of resins and varnish composition.

Several varnish recipes were recorded by some icon masters allowing us to identify their ingredients, namely the resins and solvents[3]. The historical recipes are also differentiated by the method of preparation, not only by the type of ingredients used. A wealth of information was found in the books of iconography (icon painting treatises) available at that time[4]. The analysis of the written sources pointed out that the ingredients used for preparing paint varnishes were similar to those used by famous Italian, Austrian or German luthiers, namely Stradivari, Amati[5]. It would therefore be interesting to study if local luthiers used similar varnish recipes, too. The possibility to compare the varnish of a locally manufactured violin with the varnish composition of the Transylvanian icons would also be very useful.

An interesting and rare example of a report on the materials used to paint icons comes from Grigore Ranite, a Walachian master established in Transylvania, who described, in 1766, the materials he used to paint the icon for the episcopal chapel in Blaj, in 1736[6]. Since this icon shed tears in 1764, an investigation was organized two years later to establish the veracity of the tears. Among the materials that Ranite mentioned, is also the varnish type: *vernice vulgo Firnajzs Lege artis confectis*[7]. This description could very likely refer to a linseed oil varnish.[8] Without this special case, there are no reports on the varnish

[2] Ciofini et al. 2015, p. 2.
[3] Chindriș 1997; Ghenadie al Râmnicului 1891 etc.
[4] Dyonius of Fourna 1996; Dionisie din Furna 2000; Cenini 2007. Other recipes were published by Thompson jr. 2004 and Thompson jr. 2006.
[5] Maggi 2012, https://leziodichimica.altervista.org/scuola/distillazione, consultat la 25.07.2023.
[6] SJANCJ, *Colecția documente Blaj*, nr. 449, f. 7; Chindriș 1997; Dumitran 2010, p. 83-98.
[7] SJANCJ, *Colecția documente Blaj*, nr. 449, f. 7; Chindriș 1997, p. 52.
[8] According to Istudor 2011, p. 198, „firnis” is a boiled linseed oil to which Pb and Mn oxides were added with the purpose to accelerate the drying.

ingredients and preparation methods neither about Ranite's icons nor about other Transylvanian icons.

Historical written records indicate dammar as being the most frequently used for the preparation of varnish. Dammar is a triterpenoid resin obtained from the tree family of *Diterocarpaceae* in South-East Asia, namely Malaysia, Indonesia, India[9]. It is readily soluble in turpentine. Other recipes mention mastic, a resin obtained from the *Pistacia lentiscus* tree, of the Aracardiaceae family, indigenous to the Mediterranean coastal region from Syria to Spain, and particularly the Greek archipelago. The production of this resin has been confined almost exclusively to the Greek island of Khíos (Chios) in the Aegean Sea.[10] Mastic was used to make pale varnishes. When dispersed in linseed oil, mastic is used as a colour vehicle. Sandarac resin, obtained from two species of *Cupressaceae* subfamily of the *Coniferae family* in Morocco, Tunisia, Algeria and Australia[11], could also be found in ancient recipes, as well as copal[12], a resin of natural or fossil origin, of tropical trees of South America. This resin usually took the name of its provenance: Manila, India, Zanzibar copal. It was historically used by the Flemish masters to achieve their strikingly brilliant, enamel-like glazes. Shellac, a waxy gummy exudate of an exotic female insect, *Cocus lacca, Tachardia lacca*, that lives on exotic plants in India, Ceylon, Vietnam, Cambodia, Malayzia[13] was also found in the ancient varnish recipes, as well as colophony. The latest is extracted from various pine species, namely *Pinus alba, Pinus nigra, Pinus maritima*. It is also a residual product obtained as a result of resin distillation in the process of obtaining turpentine[14]. Out of the resins encountered in manuscripts and books of icon painting technique, a special type of colophony (known in the Romanian language as *sacâz*) could have been manufactured/obtained in Transylvania and the neighbouring areas from different local species of the coniferous family (larch, spruce)[15]. This is why the study of various *Pinaceae* species preserved in the herbarium collection of the Natural Science Museum of Aiud (the oldest museum of this kind established in Transylvania, in 1796) became important. *Pinus silvestris L.* (pine tree), *Pinus nigricans Host. Nigra* (black pine tree), *Pinus montana Mill.*

[9] *Ibidem*, p. 231.

[10] The Chios Gum Mastic Growers Association, https://mastihaexperience.com/en/chios-mastiha-growers-association/, last accessed on 25 July 2023; https://mastihaexperience.com/en/the-modern-mastic-museum/, last accessed on 25 July 2023.

[11] Decq et al. 2021. https://www.sciencedirect.com/science/article/abs/pii/S0165237021001455, last accessed on 25 July 2023.

[12] https://www.vam.ac.uk/blog/projects/thinking-and-experiencing-techne-re-creating-a-sixteenth-century-copal-varnish, last accessed on 25 July 2023.

[13] Matteini et al. 2017, p. 175-176; Istudor 2011, p. 233.

[14] Matteini et al. 2017, p. 173.

[15] Dionisie din Furna 2000, p. 255.

(juniper), *Larix europae D.C.a* (larch), *Abies pectinata D.C.alba Mill.* (fir), *Picea / vulgaris L.k/ excelsa Lam. Et D.C.* (spruce) are among the species growing in the Aiud neighbouring and Apuseni Mountains which entered the museum collection at the end of the 19th century[16]. These species still grow naturally in the forests of the Transylvanian mountain areas. Their resins can be easily harvested from the tree bark. Moreover, the icon painting treatises mentioned the methodology of preparing varnish from fir tree resin (*verniu de pégola*)[17].

The written sources also recorded various resins used as secondary ingredients in the varnish recipes. One of them is amber, also known as succinite or kauri. Amber is a fossil resin originating from the Baltic Sea, Madagascar, Birmany[18]. So far, we have not found any information about the use of amber as a secondary ingredient in the Transylvanian varnish recipes. It is however worth mentioning that amber deposits were exploited in Colți village, Valea Buzăului (Buzău Valley), at the south-east limit of Transylvania with Moldavia, at the curve of the Carpathin Mountains. Interestingly, the Natural Science Museum from Aiud owns a piece of amber from Valea Buzăului (Buzău Valley) (**Fig. 2**).

The varnishes' ingredients identified by studying the historical written texts, which testimony the local technique, must then be physically identified in the materials used by the Transylvanian masters, by determining their elemental composition and spectral signature. However, due to their similar terpenoid structure, resins from various plant sources are difficult to discriminate using non-invasive analysis[19]. It is known that infrared spectroscopy does not allow a specific determination of organic materials, and implicitly of varnishes and oils. On the other hand, the ageing process of the resins causes modifications of their spectra, making the spectral discrimination even more difficult. In addition, the spectrum of the superficial pictorial layer also includes the bands of other substances / materials used for painting which overlap the varnish layer bands.

Studies made so far on varnishes focused either on the analysis of ageing and yellowing of triterpenoid resins[20], biodeterioration of diterpenoid varnishes[21], photo-oxidative kinetics of solvent and oil-based terpenoid varnishes[22] or on analysis of oleoresinous varnishes and their natural precursors[23]. On the other hand, important steps have been made in the

[16] Natural Science Museum from Aiud, Herbarium/fascicul LXIV69 and Herbarium/fascicul LXIV70, Clasa Coniferae, Grupa Antophyta/Phanerogamae, Subgrupa Gymnospaermae.
[17] Dionisie din Furna 2000, p. 41.
[18] Matteini et al. 2017, p. 175; Istudor 2011, p. 233.
[19] Daher et al. 2010, p. 1495.
[20] Dietemann et al. 2009, p. 30-40; Nevin et al. 2009, p. 2139-2149.
[21] Romero-Noguera et al. 2008, p. 427-433.
[22] Ciofini et al 2015.
[23] Kumar, Sethuraman 2004, p. 244-251.

identification and reconstruction of ancient varnish recipes using various analytical methods. Vibrational (Raman and infrared) spectroscopy was applied to identify natural organic media used in ancient varnishes[24] as well as to relate the effect of photodegradation with the type of natural resins[25]. The influence of the preparation process on the aplication properties of reconstructed historical varnishes based on linseed oil and colophony was investigated using rheological studies[26]. The aforementioned studies used raw resins, fresh or aged varnish films applied in a thin layer on a quartz using a nylon brush[27], or coated onto microscope slides[28]. None of these studies started from the composition of a real varnish to reconstruct the recipe, but reconstructed varnishes only based on documentary studies.

Experimental approach

The lack of documentary evidence on the local varnish recipes used by the Transylvanian masters forces us to approach the study of varnishes in a different manner. Our experiment started with painting a new icon using the major pigments identified in the Transylvanian icons. The icon surface was divided into five vertical strips of equal dimensions. Each strip was varnished using a specific varnish recipe containing different solvents and some of the most frequently used natural resins, i.e. dammar, sandarac, copal and shellac. The icon was then exposed to light and heat ageing cycles to identify the ageing markers specific for each type of resin/varnish and discriminate the resins based on their ageing behaviour.

***

Varnishes preparation method

Out of the numerous recipes identified in the written sources, five were selected based on criteria such as solvent type and resin type. The results of our previous analytical investigations on the materials used to paint the Transylvanian icons were also taken into account.

The next step consisted in reconstructing the recipes, as presented below. We used two methods of preparation: at room temperature and by heating. The varnish results could be grouped into two categories: fat (turpentine- and linseed oil-based) and lean (ethanol-based) varnishes. In addition to the main resins (dammar, sandarac, copal and shellac), colophony, amber and mastic were also added to the linseed oil varnish recipes (secondary ingredients).

---

24 Daher et al. 2010, p. 1494-1499.
25 Azémard et al. 2014, p. 137-149.
26 Tirat et al. 2017, p. 534-543.
27 Nevin et al. 2009, p. 2140-2141.
28 Daher et al. 2010, p. 1495.

(i) *Dammar varnish* was prepared by solving dammar resin (20% w/v) in turpentine at room temperature. The dammar resin was supplied by Kremer (no. 60001).

(ii) *Copal varnish* was prepared by solving Manilla copal resin in ethanol in a 1:2 (w:v) ratio at room temperature.

(iii) *Shellac varnish* was prepared by solving shellac flakes provided by Kremer (no. 60400) in ethanol, 1:2 ratio.

(iv) *Sandarac varnish* was prepared by solving 30 g sandarac resin (Kremer no. 60100) in 100 g ethanol, previously heated on a water bath. The composition was kept on water bath until dissolved, and the solid residue was separated by filtration.

(v) *Linseed oil varnish* was prepared by boiling the ingredients: boiled linseed oil + 50 g resin mix + 10 g turpentine. 100 g linseed oil was boiled on a water bath. When it reached the boiling point, 50 g of a resin mix (20 g dammar, 15 g colophony, 10 g mastic and 5 g amber) were gradually added and kept on water bath until dissolved. The solid residue was separated by filtration (**Fig. 3**).

Icon painting

A panel made of linden wood was prepared according to the old technique and all the steps for icon painting were completed according to the traditional icon painting technique. The pigments (lead white, red lead, vermillion, red and yellow ochres, orpiment, malachite, Prussian blue, synthetic ultramarine, azurite and indigo, magnetite black and wine black) were applied using the egg tempera traditional recipe (**Fig. 4**). Varnishes were applied in a thin layer, by brushing, on five vertical strips equally distributed on the icon surface (**Fig. 5**).

Icon pre-conditioning

The historical icons were used for public services and were stored for many years in the sacred space of churches, where both candles and incense were burnt for ritual purposes. Their surface is in almost all cases covered by layers of smoke mixed with burning residues of wax. We, therefore, exposed our new icon to microclimate conditions similar to the ones found in a church during religious ceremonies, such as intense smoke to which incense was added, and the heat and residues generated by the candles (**Fig. 6**).

Icon surface analytical investigation

In the first step, the icon was analysed using portable equipment which exploits the way in which matter interacts with the electromagnetic radiation, from infrared to X radiation, including visible light, to identify the elements and molecules. The analytical protocol includes microscopic examination, X-ray fluorescence spectroscopy (XRF), Fourier transform infrared spectroscopy in attenuated total reflection mode (FTIR-ATR) and multiband imaging analysis (CHSOS photography kit).

The second step includes various ageing cycles (UV exposure and dehydrothermal treatment) of the icon. UV exposure is carried out using a photoreactor LIB-060M- PHR (Daihan LabTech, Korea) equipped with UVA black light, UVC and VIS cool day light lamps, while the dehydrothermal treatment is performed using a Memmert UF110 oven (Germany).

The third step will consist of the comparative analyses of the data obtained throughout the ageing cycles with the aim of identifying ageing markers able to shed new light into the ageing mechanisms of varnishes and the influence of pigments on these mechanisms.

The microscopic observations of the icon surface were carried out at 50X and 200X magnification with a portable digital microscope Dino-Lite AD7013MZ, with a resolution of 1.3 Megapixels. The microscopic images collected in the five varnished areas of the icon (**Fig. 7**) will be compared with those collected in the same areas after the artificial ageing of the icon to detect changes at a visual level.

The visual appearance of the icon in visible, ultraviolet and infrared light was acquired by using the CHSOS photography kit based on a Nikon D800 DSLR (36 MP, CMOS sensor) digital camera modified for “full spectrum”, ultraviolet–visible, infrared photography (between about 360 and 1100 nm)[29]. Some multiband images which will allow us to perform a comparative examination after artificial ageing of the icon are shown in **Fig. 8**.

X-ray fluorescence spectroscopy (XRF) was employed in order to verify the elemental composition of the pigments used to paint the icon. XRF measurements were carried out using an Elio portable XRF spectrometer (Bruker) composed of a X-ray source based on a Rh anode operating at a voltage between 10-50 kV and a current up to 200 μA for a maximal power of 4 W, and a Silicon Drift Detector with an active area of 25 mm^2. The source emission is collimated creating an analysis spot diameter of 1.2 mm on the sample at a working distance of 1.4 cm. Analyses were performed at 40 kV and 80 μA, with an accumulation time of 60 s.

Some of the XRF spectra collected on icon surface are presented in **Fig. 9** a-d. It was found that the elemental composition of the commercial inorganic pigments corresponds to their chemical formula: Pb for lead white and red lead, Cu for azurite and malachite, Fe for Prussian blue, magnetite, red and yellow

[29] Cosentino 2014, p. 1-12. http://www.heritagesciencejournal.com/content/2/1/8, last accessed on 25 July 2023.

ochre, Hg for vermillion, As for orpiment. In what wine black is concerned, no distinctive chemical element was found.

Fourier transform infrared spectroscopy in attenuated total reflection mode (FTIR-ATR) has been applied to identify the spectral signature of the tree resins, shellac and linseed oil used to prepare varnishes. The relative positions and intensities of their corresponding bands will be the reference positions/intensities for comparison with the spectra obtained after accelerated ageing cycles. This comparison will allow us to assess the thermal and photo-degradation process of varnishes.

FTIR-ATR measurements were carried out using an ALPHA FTIR (Bruker Optics, Germany) equipped with a Platinum ATR module. Spectra were recorded by co-adding 32 scans in the range from 4000 to 400 cm^{-1} with a spectral resolution of 4 cm^{-1}. Opus 7.0 software (Bruker Optics, Germany) was used for the acquisition and processing of the spectra, while their graphic presentation was done with Origin 7.5 software.

The FTIR-ATR spectra of the tree resins (sandarac, copal, dammar), shellac, mastic, amber and linseed oil used to prepare the five varnishes are shown in **Fig. 10**. The spectral ranges of interest are: the OH region (3700–3200 cm^{-1}), the CH region (3200–2400 cm^{-1}), the carbonyl region (1800–1550 cm^{-1}) and the fingerprint region (1550–500 cm^{-1})[30]. **Fig. 11** presents a flowchart to aid in characterization of natural resins and oils based on their IR absorption band positions and intensities[31]. It should be mentioned that these tasks are difficult to achieve due to the presence of the other components in the painted layers as well as due to the larger number of compounds formed with ageing.

The FTIR-ATR spectra collected on the five varnished areas of the icon are presented in **Fig. 12-16**. The varnish spectra are very complex, their bands overlapping the absorption bands of pigments (i.e. Prussian blue), egg yolk and calcite. Moreover, for copal varnish, the infrared bands attributed to oil were identified suggesting the migration of the linseed oil varnish in its area (**Fig. 12**).

***

Conclusions

This study aimed at documenting and retrieving some of the varnish recipes used by the Transylvanian masters with a special focus on identifying and characterizing the materials used during the 18th and early 19th centuries. A group of selected icons, part of the Museikon collection of the National Museum of Union Alba Iulia, was used as a case study. Five recipes were reproduced, used for painting an icon according to the traditional technique mentioned in the

[30] Azémard et al. 2014, p. 137-149.
[31] Derrick et al. 1999, p. 102, 185-190.

icon painting treatises, Hermeneias, and other local records, and characterized. A multi-technique analytical protocol based on complementary analyses was employed to distinguish the various varnishes. The data collected (microscopic images, technical photography, XRF and FTIR-ATR spectra) represent the reference data set for the next step of our study, namely the artificial ageing of the painted icon and its analysis. It is expected that the final results of this case study will impact the scientific knowledge of varnishes and their ageing and deterioration processes, art history and history of icon painting traditions in Transylvania and other regions with iconographic tradition, as well as conservation and restoration of tempera on wood icons.

Lista ilustrațiilor

Fig. 1 (a), (b) – Details of the varnish layer from the icons Jesus Christ and St. Michael, Museikon collection

Fig. 2 – Amber from Valea Buzăului (Buzăului Valley), Natural Science Museum from Aiud

Fig. 3 – Details from the reconstruction of varnish recipes and details with four resins: dammar, mastic, amber and colophony

Fig. 4 – The new painted icon following the old technique and similar materials as historical ones

Fig. 5 – The new painted icon was divided into five strips and varnished with the reconstructed recipes

Fig. 6 – The icon was exposed several times to intense smoke to which incense was added

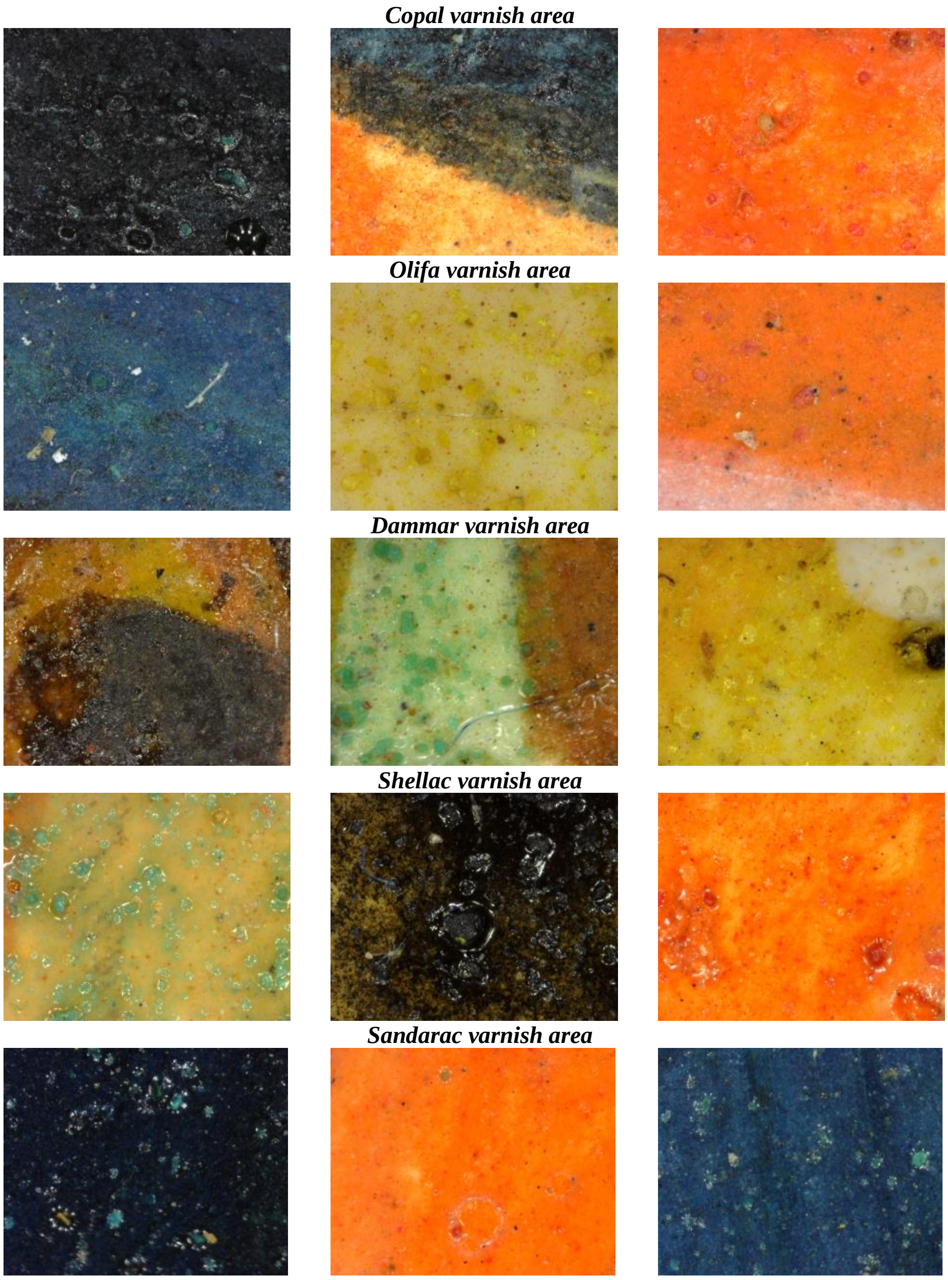

Fig. 7 – Microscopic images (200X) of the five differently varnished areas of the icon

UVR IR UVF

Fig. 8 – Reflected Ultraviolet (UVR), Infrared (IR) and Ultraviolet Fluorescence (UVF) photography of the icon showing the various vertical stripes brushed with the 5 (five) reconstructed varnishes

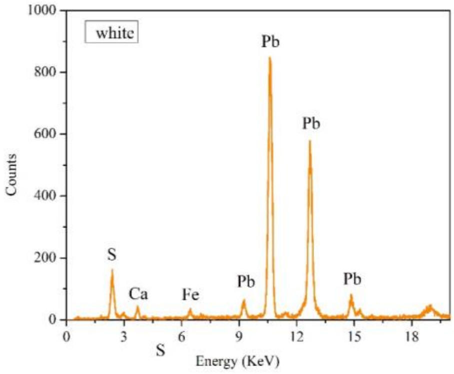

Fig. 9 (a) – XRF spectrum of white pigment

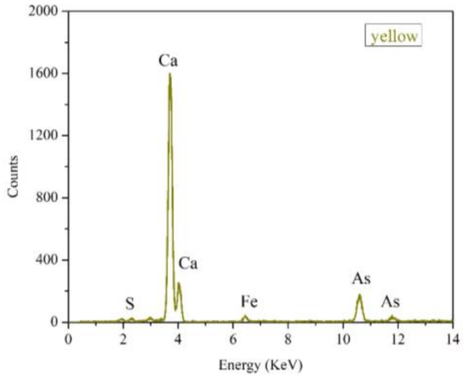

Fig. 9 (b) – XRF spectrum of yellow pigment

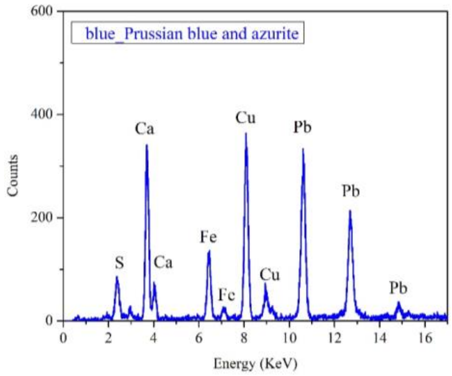

Fig. 9 (c) – XRF spectrum of blue pigment

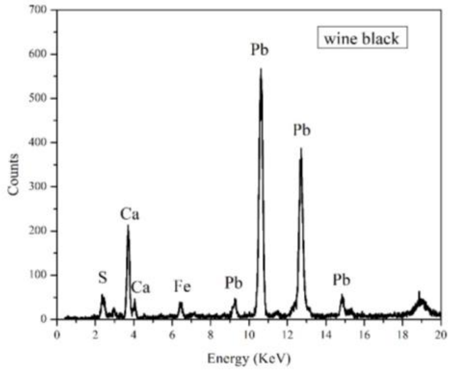

Fig. 9 (d) – XRF spectrum of wine black pigment

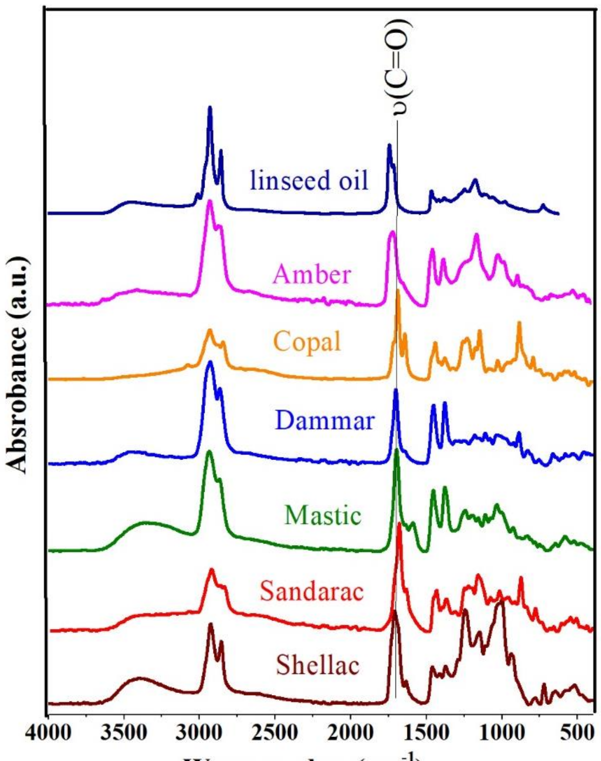

Fig. 10 – FTIR-ATR spectra of the amber, copal, dammar, mastic, sandarac, shellac and linseed oil. The specific carbonyl band - $\nu_{C=O}$ is highlighted

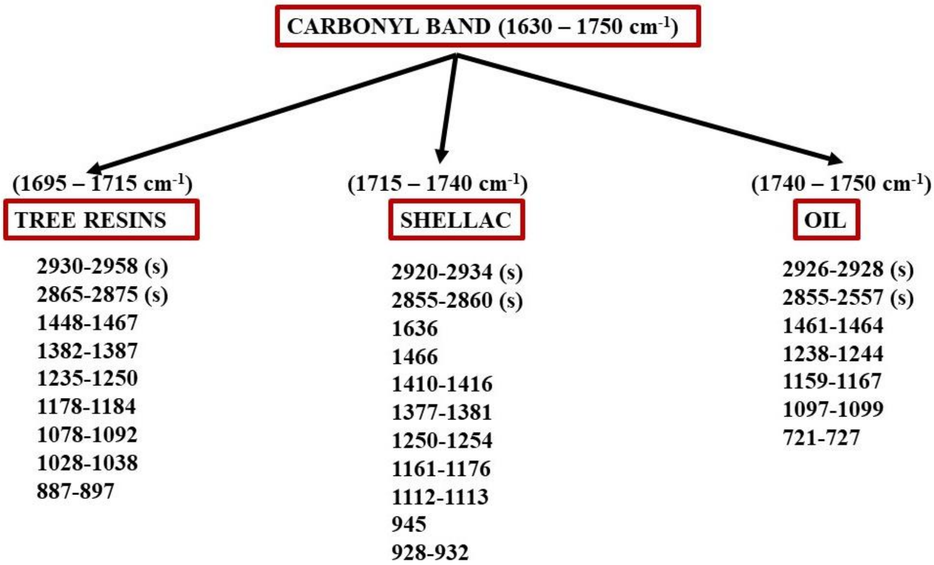

Fig. 11 – A flowchart to aid in characterization of natural resins and oils based on their IR absorption band positions and intensities (s – strong)

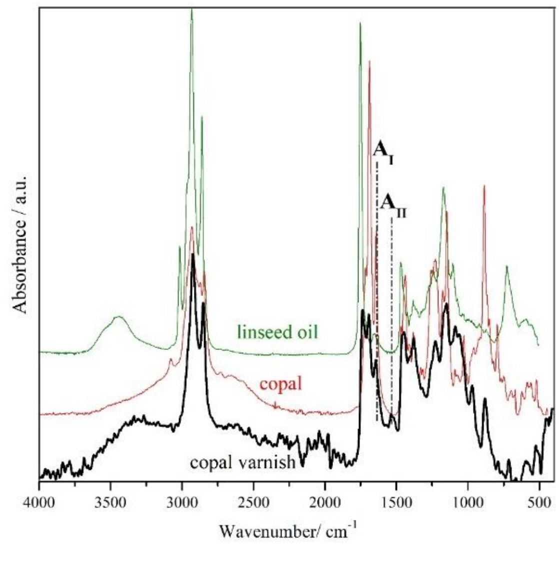

Fig. 12 – The FTIR-ATR spectrum of the *copal* varnish as compared to those of copal resin and linseed oil. The main absorbtion bands of a proteic compound (A_I and A_{II}), egg yolk or animal glue, are highligthed

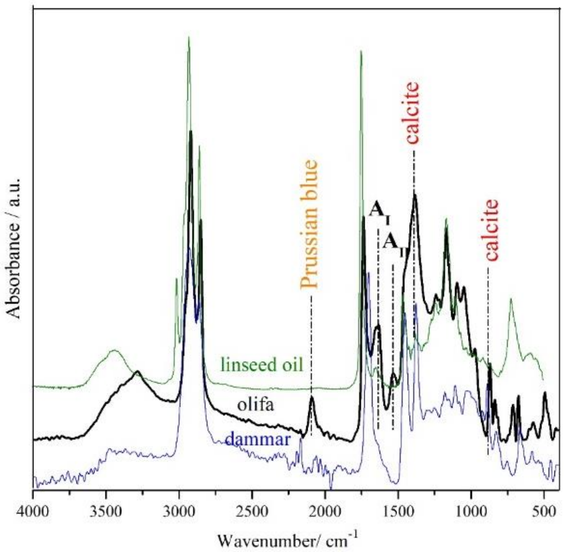

Fig. 13 – The FTIR-ATR spectrum of the *linseed oil (olifa)* varnish as compared to those of dammar resin and linseed oil. The main absorbtion bands of a proteic compound (A_I and A_{II}), egg yolk or animal glue, Prussian blue and calcite are highligthed

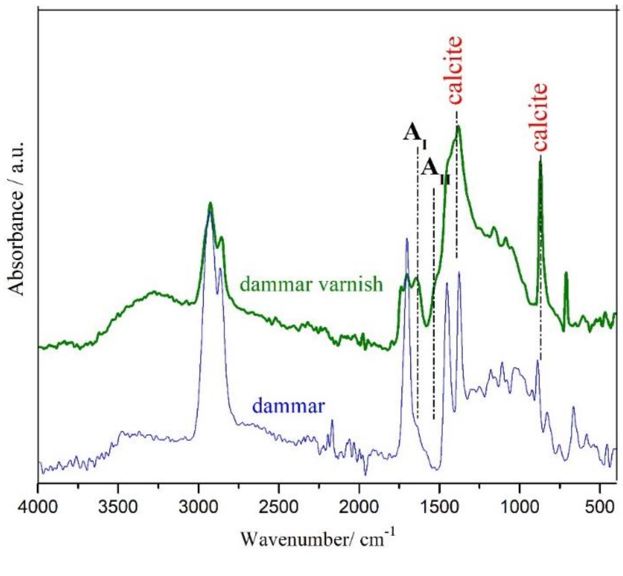

Fig. 14 – The FTIR-ATR spectrum of the *dammar* varnish as compared to that of dammar resin. The main absorbtion bands of a proteic compound (A_I and A_{II}), egg yolk or animal glue, and calcite are highligthed

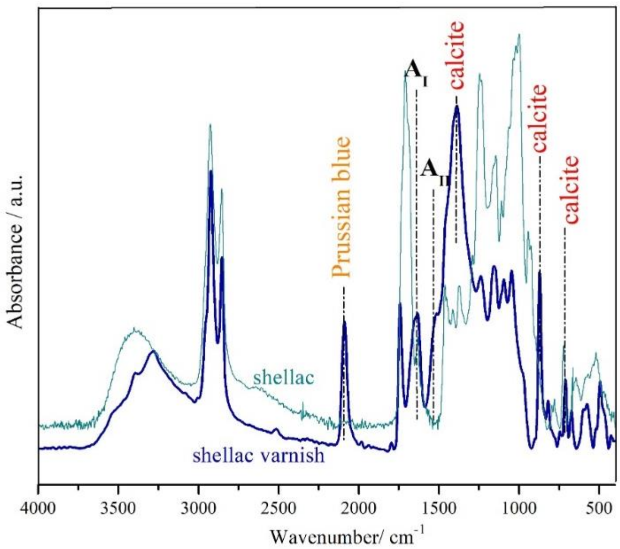

Fig. 15 – The FTIR-ATR spectrum of the *shellac* varnish as compared to that of shellac resin. The main absorbtion bands of a proteic compound (A_I and A_{II}), egg yolk or animal glue, Prussian blue and calcite are highligthed

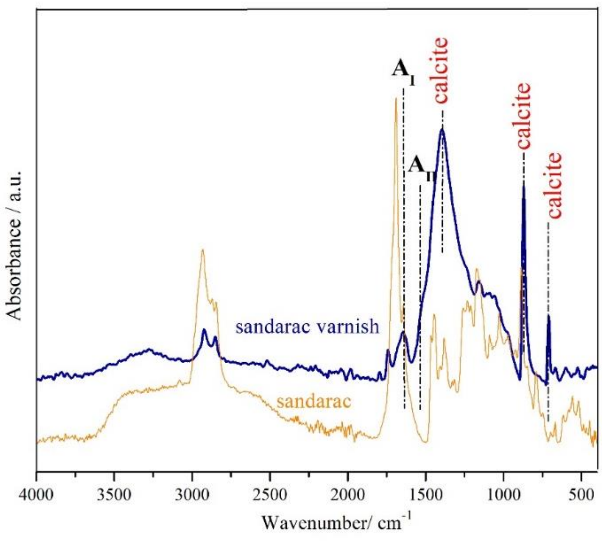

Fig. 16 – The FTIR-ATR spectrum of the *sandarac* varnish as compared to that of sandarac resin. The main absorbtion bands of a proteic compound (A_I and A_{II}), egg yolk or animal glue, and calcite are highligthed

Bibliographical references

Azémard et al. 2014 – C. Azémard, C. Vieillescazes, M. Ménager, ”Effect of photodegradation on the identification of natural varnishes by FT-IR spectroscopy”, in *Microchemical Journal*, 112, 2014, p. 137-149

Brannt 1893 – Willian T. Brannt, *Varnishes, Laquers, Printing Inks and Sealing-waxis: their raw materials and their manufacture to which added the art of varnishing and laquering, including the preparation of putties and of stains for wood, ivory, bone, horn, and leather*, Philadelphia, 1893

Cenini 1977 – Cenino Cenini, *Tratatul de pictură*, București, 1977

Chindriș 1997 – Ioan Chindriș (editor), *Icoana plângătoare de la Blaj 1764*, Cluj-Napoca, 1997

Ciofini et al. 2015 – Daniele Ciofini, Jana Striova, Mara Camaiti, Salvatore Siano, ”Photo-oxidative kinetics of solvent and oil-based terpenoid varnishes”, in *Polymer Degradation and Stability*, 2015, doi:10.1016/j.polymdegradstab.2015.11.002

Cosentino 2014 – Antonino Cosentino, ”Identification of pigments by multispectral amaging; a flowchart method”, in *Cosentino Heritage Science*, 2:8, 2014, p. 1-12

Decq et al. 2021 – Louise Decq, Piet Stoffelen, Vincent Cattersel, Joy Mazurek, Wim Fremout, Jonas Veenhoven, Frederic Lynen, Steven Saverwyns, Peter Vandenabeele, ”Quality control of natural resins used in historical European lacquer reconstructions with some reflections on the composition of sandarac resin (Tetraclinis articulata (Vahl) Mast.)”, in *Journal of Analytical and Applied Pyrolysis*, vol. 158, 2021, 105159

Daher et al. 2009 – Céline Daher, Céline Paris, Anne-Solenn Le Hô, Ludovic Bellot-Gurlet, Jean-Philippe Échard, ”A joint use od Raman and infrared spectroscoies for the identification of natural organic media used in ancient varnishes”, in *Journal of Raman Spectroscopy*, 41, 2010, p. 1494-1499

Derrick et al. 1999 – Michele R. Derrick, Dusan Stulik, James M. Landry, *Infrared_spectroscopy in Conservation Science*, Los Angeles, 1999

Dionysius of Fourna 1996 – *The `Painter`s Manual` of Dionysius of Fourna*, translated into English by Paul Hetherington, Oakwood Publications, California, 1996

Dionisie din Furna 2000 – Dionisie din Furna, *Erminia picturii bizantine*, București, 2000

Dietemann ey al. 2009 – Patrick Dietemann, Catherine Higgitt, Moritz Kälin, Michael J. Edelmann, Richard Knoechenmuss, Renato Zenobi, ”Aging and yellowing of triterpenoid resin varnishes – Influence of aging conditions and resin composition”, in *Journal of Cultural Heritage*, 10, 2009, p. 30-40

Dumitran 2010 – Ana Dumitran, „Un zugrav de elită: Grigore Ranite”, in *Annales Universitates Apulensis. Series Historica*, 14/I, 2010, p. 83-89

Ghenadie al Râmnicului 1891 – *Iconografia – arta de a zugrăvi templele și icoanele bisericești. Manuscris cu o precuvântare, descris și adnotat de Ghenadie al Râmnicului*, București, 1891

Istudor 2011 – Ioan Istudor, *Noțiuni de chimia picturii,* ed. a III-a revizuită și adăugită, București, 2011

Kumar, Sethuraman 2004 – K. P. Vinod Kumar, M. G. Sethuraman, ”Studies on oleoresinous varnishes and their natural precursors”, in *Progress in Organic Coating*, 49, 2004, p. 244-251

Maggi 2012 – Giorgio Maggi, ”Le vernici nel XVI secolo”, in *Il chimico italiano*, 23, 4, 2012 (online: http://collezionemaggi.altervista.org/vernici_liuteria_secXVI.pdf)

Manfredas et al. 2021 – Thomas Manfredas, Eleni Kouloumpi, Stamatis C. Boyatis, ”Did Dionysius of Fourna Follow the Material Recipes Described in His Own Treatise?

A First Analytical Investigation of Four of His Panel Paintings", in *Heritage,* 4, 2021, p. 3770-3789

Matteini et al. 2017 – Mauro Matteini, Rocco Mazzeo, Arcangelo Moles, *Chemistry for restoration. Painting and Restoration Materials*, Florence, 2017

Nevin et al. 2009 – Austin Nevin, Daniela Comelli, Iacopo Osticioli, Lucia Toniolo, Gianluca Valentini, Rinaldo Cubeddu, "Assessment of the ageing of triterpenoid paint varnishes using fluorescence, Raman and FTIR spectroscopy", in *Anal Bioanal Chem*, 359, 2009, p. 2139-2149

Romeo-Noguera et al. 2008 – J. Romero-Noguera, F.C. Bolívar-Galiano, J.M. Ramos-López, M.A. Fernández-Vivas, I. Martín-Sánchez, "Study of biodeterioration of diterpenic varnishes used in art painting: Colophony and Venetian turpentine", in *International Biodeterioration & Biodegradation*, 62, 2008, p. 427-433

Săndulescu-Verna 2000 – C. Săndulescu-Verna, *Materiale și tehnica picturii*, Timișoara, 2000

SJANCJ – Serviciul Județean al Arhivelor Naționale Cluj

Tirat et al. 2017 – Sophie Tirat, Jean-Phillipe Echard, Agnés Lattuati-Derieux, Jean-Yves Le Huerou, Stéphane Serfaty, "Wooden musical instruments. Reconstructing historical recipes of linseed oil/colophony varnishes: Influence of preparation processes on application properties", in *Journal of Cultural Heritage*, 275, 2017, p. 534-543

Thompson jr. 2004 – Daniel V. Thompson jr., *Practica picturii în tempera*, București, 2004

Thompson jr. 2006 – Daniel V. Thompson jr., *Materiale și tehnici de pictură în Evul Mediu*, București, 2006