

## **ANATOMICAL STUDIES USED IN THE EVALUATION OF A PANEL PAINTING FROM THE XIX<sup>TH</sup> CENTURY**

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#### **Abstract:**

*This paper presents a case study on the panel painting icon "God's Mother Hodigitria", painted in tempera colors on a wood panel made of spruce. The icon is part of a private collection from Slobozia, and on the back of the panel is engraved the year 1840, which on a first look seems to be a forgery. The study is focused on indentifying some archaeometric characteristics of the wooden panel, and of some authentication attributes with the use of two microscopic techniques: Optical Microscopy(OM) and Electron Scanning Microscopy connected with X-Ray Spectometry (SEM-EDX). In a later note, through corroboration with the dendrochronology dating technique, the age of the wood panel and the authenticity of the date engraved on the back, will be determined.*

**Key words:** icon; wood species; identification; Optical Microscopy (OM); SEM-EDX.

## INTRODUCTION

In art, the wood is used as prime material for paintings, sculptures, furniture, ornamental elements for indoors, musical instruments, finery etc. Romania has many ethnographic or religious artistic objects made of wood, some of them very old (Sandu *et al.* 2005). Painted wood is represented by panel painted icons, painted wood statues, painted furniture and various painted liturgical or household objects, kept in personal or national collections. Among them, the old panel painted icons are the most important due to their value, age, author or the painting studio. Furthermore, every Christian family keeps the icons as heritage (Sandu 2006).

For the valorisation of these cultural treasures the authentication expertise, the patrimonial and state of conservation evaluation where every structural component is analyzed (wood panel, preparation layer, pigment layer, varnish) as well as the framing ornaments, have a very important role (Sandu 2008).

The wood study is based on two classes of features: dendrological data (wood species, tree age, age of the panel) and technological data (harvest time, the provenance area, the cutting place in the trunk, the processing etc.) (Sandu 2007).

The macroscopic and microscopic identification of the wood species is not easy. This technique involves comparing the reference samples with samples of old wood, and it isn't always successful (Florian 1990). Most often some instrumental techniques are needed for the analysis of the structural elements (external and internal ones) which require advanced equipment to obtain the necessary anatomical information and databases (Timar *et al.* 2012).

The identification of the wood species by the analysis of the morpho-anatomical elements uses the micro and macro keys system, the most common method is the dichotomy one, based on opposite characters and using the division process by repeated bifurcation. In this method the trees of a gender, family or the ones from a certain geographic area, can be divided in consecutive groups until a single species remains (Sandu *et al.* 1998, Suci 1971). The morpho-anatomical analysis has improved so far that now specialized software or database with specific characteristics for the tree species are used, obtained using optic or electronic microscopy. In these types of analysis identification atlases are used which show the image and description of the anatomical elements in three sections of the wood (Schweingruber 2007, 2011, 2013 and Carlquist, 2001). The specialized literature has many papers which present the identification of the wood species of different artefacts (Romagnoli *et al.* 2007, Robichaud and Laroque 2011, Macchioni *et al.* 2011, Slotsgaard 2011).

In this regard, this paper presents the identification of the wood species and the estimated minimum age of the tree.

## OBJECTIVES

The purpose of this paper is to identify the wood species and the minimal age of tree, from which the panel painted icon "God's Mother Hodigitria" was made, information needed for the dendrochronological dating.

## METHODS, MATERIALS AND EQUIPEMENT

### ***The panel painting presentation and the processing area of consideration***

For this case study a panel painting icon from XIX<sup>th</sup> century from a private collection, received as a heritage of the family is used. The icon presents God's Mother Hodigitria, painted with tempera colors, on a preparation layer, without stretched canvas underneath. The painting was done by an anonymous painter respecting the Orthodox Church's canons. The general state of conservation is good, without signs of fungal or boring insects attack and no other alterations of the painting layer or of the panel.

The icon shows God's Mother above the knee, dressed in a red cloak and blue dress underneath, with three stars on the forehead and shoulders. In her arms she holds Jesus Christ child, dressed in white gown and ochre cloak. The halos are painted over the gradient background (from blue to ochre) with English red, and by the sides of the characters are the Cyrillic inscriptions of their names (*Fig. 1a*).



**Fig. 1**

**Icon God's Mother Hodigitria: a - Face of the icon; b - detail from the back of the panel with the engraved date 8-XII-1840; c - Superior edge with transversal section, prepared for the study.**

The icon God's Mother Hodigitria is painted on a single wood board, without crossbeams for support or planarity. The painted panel has 204mm in width, 274mm in length and 25mm in thickness. Underneath the painting, the wood was covered only with successive layers of animal glue without ground or canvas. Also the surface of the wood was scratched over the main lines of the drawing. The painting layer is covered with a thin layer of varnish, uneven and darkened. The edges and reverse of the panel are covered with wood stainer, but without ground underneath (Fig 1b.).

The wood panel was cut tangentially from the trunk, and it has a slightly exterior oriented curvature due to cupping (Fig 1c.). The cutting wasn't made by a professional who knows the area and the correct cutting mode, because the icon's panel wasn't cut very straight or parallel to the wood rays. Furthermore the panel has in the lower part a knot, 8,55mm wide, slightly dislocated, visible under the painting layer and on the back of the panel. The painting layer over the knot and the preparation layer from the back of the panel in that area, are deteriorated because of the knot movement, and by exposure to constant heat with low intensity, probably coming from a small candle flame. There are also some scratches on the painting layer and the varnish, a very thin layer, is darker and uneven. On the back, in the inferior right place the date 8.XII.1840 is engraved (Fig 1b.), which is accentuated with graphite pencil. Considering the artistic technique, the working way of the artist and the conservation state, the date engraved on the back is a counterfeit. To support this idea, it is imperative to determine some specific archaeometric features of the wood panel and of the painting materials. First of all the wood species is identified, then the minimum age of the tree, the cutting place in the trunk and last the dendrochronological dating is done.

For the microscopic identification of the wood species, based on the morpho-anatomical elements, first of all, the superior edge of the panel was cleaned. This was done in order to remove the preparation layer and tempera color, used for the edges and back side of the panel; aqueous solution of ethylic alcohol 5% was used, followed by the scraping with a scalpel blade of the superior edge and then sandpapered. The same treatment was applied in the superior right corner of the panel, on a small surface of about 100mm<sup>2</sup>, the minimum necessary for taking three sets of samples (from the transverse, tangential and radial sections). After the last sanding, before taking the samples, the panel edge was washed with aqueous solution of ethylic alcohol 5%, and when it dried the annual tree rings were photographed to be measured and analyzed for the dendrochronological dating.

The three sets of samples were pressed for straightening and one of each set were placed on glass slides for microscopic analysis, and the other three were graphitized for SEM-EDX analysis.

## WORKING TECHNIQUES

According to the method used by some authors (Pathan *et al.* 2008, Timar 2012, Macchioni *et al.* 2011), the wood samples from the glass slides were analysed with the Optical Microscop CARL ZEISS AXIO IMAGER A1m, with attached camera AXIOCAM, through transmission. There were increased between 50X to 500X. With the help of the electronic microscop (SEM) model VEGA II LSH, made by TESCAN Czech,

coupled with an X-ray spectrometer QUANTAX QX2, produced by BRULER/PROENTEC Germany, the graphitised samples were analysed at sizes from 100X to 700X.

Because the panel of the icon is made by only one plank and the annual rings are very well differentiated and numbered, an approximate age of the tree can be estimated as well as the cutting place from the trunk of the tree. In this regard using the mathematical relation for the geometric representation of the spheric sector, the tree radius was calculated, and by the average thickness of the annual rings, counting all the rings, including the incompleted ones from the corners of the panel edge, the minimum age of the tree was established. Thereby using the circular arc of the last whole ring (Fig. 2), measuring the segment (t) and the perpendicular to the circle (h), the age was estimated by the relation:

$$r^2 = (t/2)^2 + (r-h)^2 \quad (1)$$

where (r) represents the tree radius, (t) the length of the spheric sector and (h) the height of the cap.

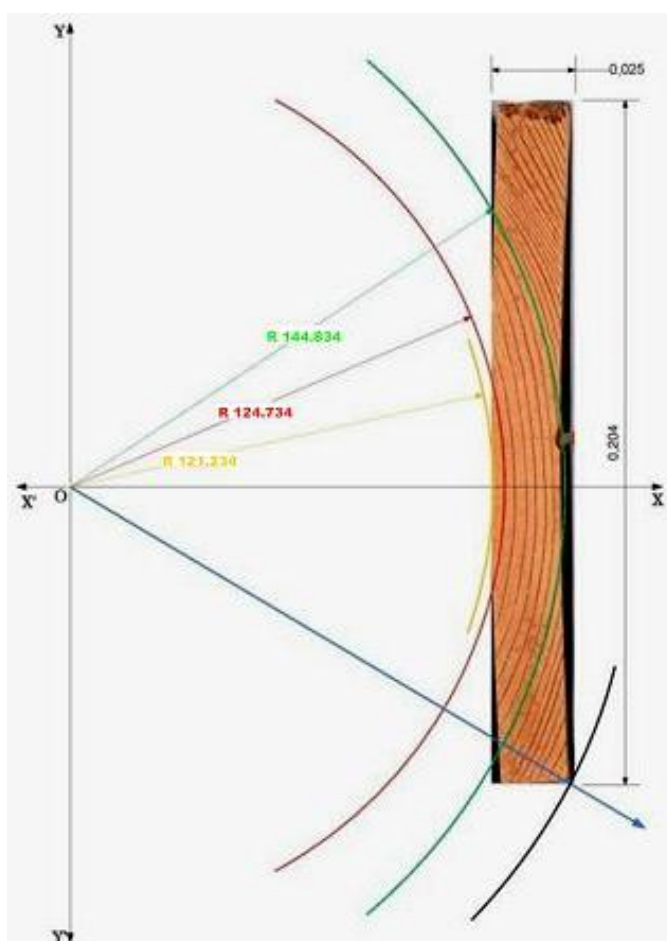


Fig. 2  
Determinating the tree radius.

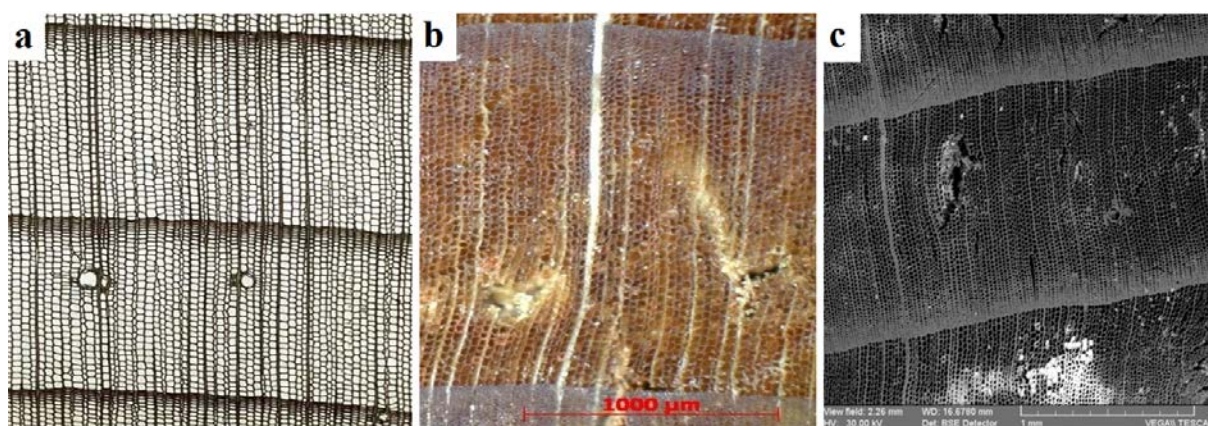
## RESULTS AND DISCUSSIONS

The microphotographs carried by the two microscopic techniques, were compared to reference pictures from Wood Anatomy of Central European Species, realized in 2004 de Schoch W, Heller I, Schweingruber FH, Kienast F, (online la <http://www.woodanatomy.ch/welcome.html> ), database.

By consulting other papers (Hoadley 1994, Safdari *et al.* 2008), both microscopic analysis (OM and SEM-EDX) have revealed the fact that the wood panel is *Picea Abies Karst.* This conclusion is supported by the macroscopic analysis as well: the light color of the wood, the big chromatic difference between the early and late wood, and even the wood design on the three sections, all of these are distinctive coniferous characteristics.

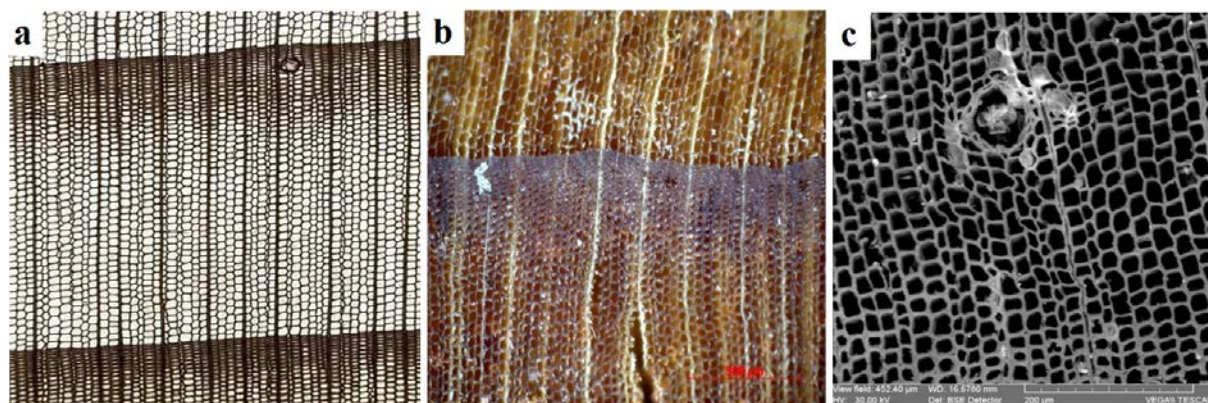
As in (Hough 2007), the microscopic analysis revealed the fact that the wood panel of the icon is made of *Picea Abies Karst*. Like fir, the spruce is widespread and intensively used in Romania mainly for making furniture but also in art. Even if it's a cheap wood, it isn't the best choice for panel paintings. Although the softwood was used as support for paintings, it's resistance to cupping is lower than for other species of wood. The cupping of the wood panel leads to the cracking, detachments of the painting layer, ultimately to the partial or total loss of the painted surface.

By examining the transversal images at two different magnifications with both techniques (Fig. 3 and 4) it can be easily seen that the transition between early and late wood is gradual, only tracheids are present and specific hardwood vessels are missing and the vertical resinous ducts are surrounded by epithelial cells. Also, the parenchymatic rays can be seen and, at a bigger magnification. The vertical resin duct is bordered by more than 8 epithelial cells (Schweingruber 2011, online <http://www.woodanatomy.ch/species.php?code=PCAB>).



**Fig. 3**

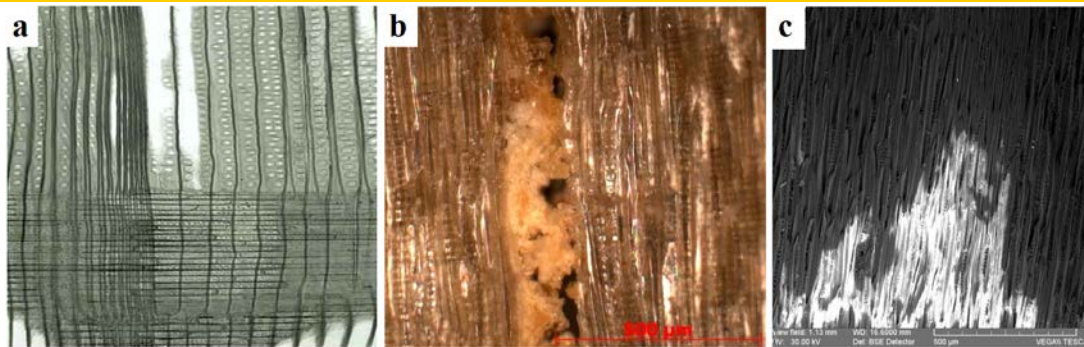
**Image of the transversal section: a - Reference image (OM), 50X, b - Analysed sample (OM), 50X; c - Analysed sample (SEM), 200X.**



**Fig. 4**

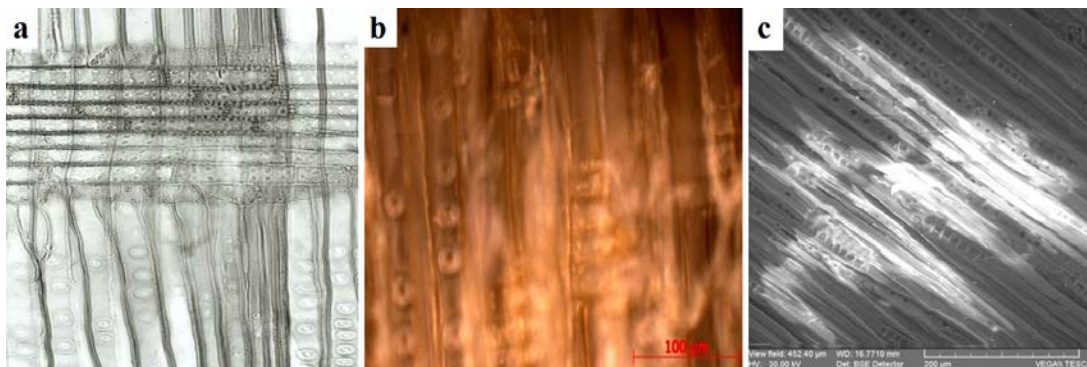
**Image of the transversal section: a - Reference image (OM), 100X, b - Analysed sample (OM), 100X; c - Analysed sample (SEM), 500X.**

Analysing the radial section as (Jones 2010), we can easily see Longitudinal tracheids with uniseriate pits and a longitudinal resin duct (Fig. 5 and 6). Likewise the radial parenchyma cells and radial tracheids can be observed placed horizontally, designating specific heterocellular rays for softwoods, as (Schweingruber, 2011, online <http://www.woodanatomy.ch/species.php?code=PCAB> ).



**Fig. 5**

**Image of the radial section: a - Reference image (OM,) 100X,  
b - Analysed sample (OM), 100X; c - Analysed sample (SEM), 200X.**



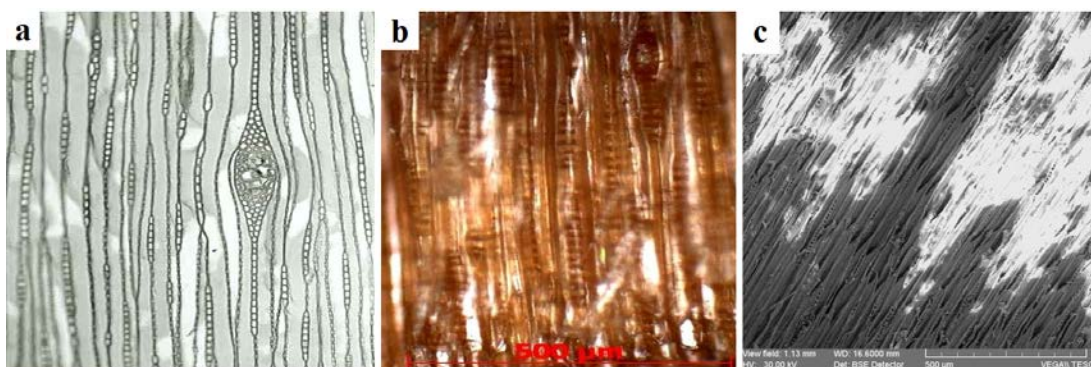
**Fig. 6**

**Image of the radial section: a - Reference image (OM,) 400X,  
b - Analysed sample (OM), 400X; c - Analysed sample (SEM), 500X.**

As (Nardi Berti 2006), in the tangential section (Fig. 7 and 8) of the wood, the tracheids can be seen in the form of woody cells, which in our samples are long with sharp ends made by 10 to 25 cells. The horizontal resin ducts bordered by epithelial cells are visible too. The epithelial cells are unspecialized parenchyma cells, which are specific to softwoods (<http://www.evolvingearth.org/mcabee/fossilwoods/part3glossary.pdf> ). In the present case they are placed as a fusiform ray which is a distinctive characteristic of the softwoods.

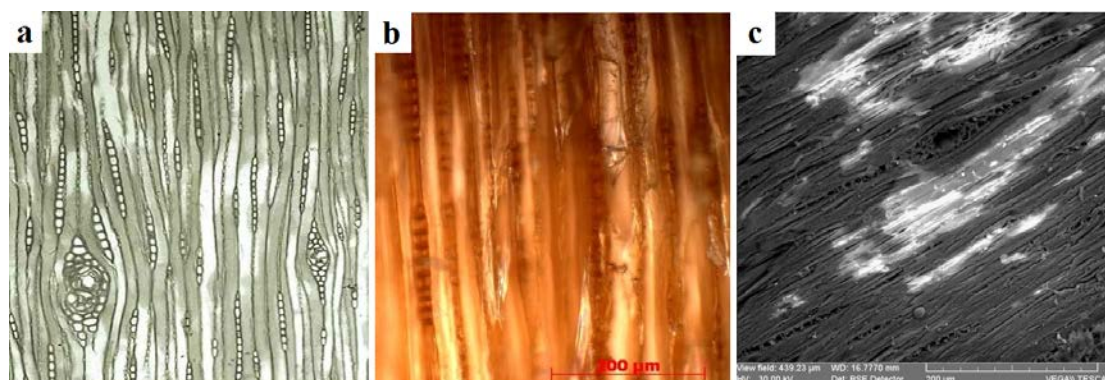
All the anatomical information was obtained with the help of the optical microscopy and with SEM, from samples taken from the edge of the panel painting processed before.

To estimate the minimum age of the tree, some measurements were taken on the transversal surface, with a digital caliper POWERFIX (0.01mm error), so the length of the circular arc of the last annual ring,  $t=149\text{mm}$ , and the panel width from the edge to the last whole annual ring  $h=20,63\text{mm}$ . The measurements were made assuming that the stem of the spruce is cylindrical, with the pith in its centre. So from the pith to the last whole ring in the panel is an estimated ray of  $144,834\text{mm}$ .



**Fig. 7**

**Image of the tangential section: a - Reference image (OM,) 100X,  
b - Analysed sample (OM), 100X; c - Analysed sample (SEM), 200X.**



**Fig. 8**  
**Image of the tangential section: a - Reference image (OM), 200X, b - Analysed sample (OM), 200X; c - Analysed sample (SEM), 500X.**

Considering the average width of the annual rings of 2mm, we can estimate a number of 73 annual rings on the length of the radius, to which a number of 12 annual rings counted from the last complete ring to the corners of the edge of the panel is added, summing a total of 85 annual rings, thereby 85 years. According to the fact that the wood panel is cut from the heartwood, the estimated minimal age is calculated from the assumed centre of the stem to the last whole ring in the panel. To this value of about 73 rings, it should be added the rest of the annual rings from the heartwood and from the sap.

## CONCLUSIONS

To establish the wood species of the icons panel, there were analyzed 6 samples taken from the superior right corner of the panel, 2 samples for every section: transversal, radial and tangential. The analysis was made with the Optical Microscope through transmission and then SEM-EDX. The obtained images were compared with references from different wood species. After investigating the anatomical details it was certain that the panel of the icon is made of spruce *Picea abies* Karst.

Using a mathematical relation, an estimative tree radius was calculated, 85 years at which it should be added the rest of the annual rings from the heartwood and from the sap.

This wood species is widely spread in Romania, but it is not recommended for panel paintings, because, as well as the fir, the spruce wood has a low resistance to the processes of expansion and shrinkage of the wood, in other words bending easily and cracking. The softwood was used for painted panels due to economic reasons, being the cheapest. Unfortunately its resistance to cupping is lower than for other species, having higher dimensional changes. The cupping of the painted panel leads to the deterioration and degradation of the painted layer, ultimately to the partial or total loss of it.

## ACKNOWLEDGEMENT

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