



Case study

The Virgin Enthroned with Child: Dating, attribution, and historical reconstruction of a Flemish masterpiece



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ABSTRACT

The panel painting depicting the Virgin Enthroned with Child underwent dendrochronological, multi-spectral, and stylistic/documental analyses. Dendrochronology facilitated the determination of the *terminus post quem*, which was 1492. Robust correlations with the Baltic1 reference chronology and its recent update, 2021BLT1, indicated a likely origin of the timber in the central-eastern Baltic area. Multi-spectral analyses, such as IR-reflectography and false-colour infrared analyses, aided in identifying preparatory drawings, compositional revisions, and later additions resulting from restoration efforts. By comparing the analysis results with the painting's recent history reconstruction, doubts regarding its possible attribution were effectively addressed. Based on the findings, it can be concluded that the painting was executed by the so-called Frankfurt Master around the year 1508.

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Introduction

The multidisciplinary approach in the study of works of art

A panel painting of the Flemish school has been analysed using various techniques [1,2]. Dendrochronology was used to determine the dating and potential origin of the wood used to support the painting. The first dendrochronological studies on Flemish panel paintings were published in the 1970s and 1980s [3,4]. Since then, numerous studies have been conducted, encompassing various aspects such as wood provenance [5,6], the establishment of specific reference chronologies [7], and the exploration of trade and historical/social dynamics [5,6,8].

In addition to dendrochronology, other techniques were employed, such as infrared reflectography and infrared false-colour techniques [9]. Infrared reflectography involves illuminating a painting with infrared (IR) radiation and capturing the backscattered radiation within a narrow spectral range, typically between 900 and 2000 nm. The underlying principle is the transparency of most pigments to IR radiation. This transparency allows for visualising hidden features beneath the paint layer, such as preparatory drawings and potential modifications made during the painting

process, such as contour corrections and figure adjustments. The false-colour technique aims to enhance different types of pigments that may visually appear similar but interact differently with IR radiation. As a result, subsequent retouches and repainting resulting from previous restoration efforts can be discerned. The multi-spectral mode facilitates the study of pictorial materials and their spatial distribution on the painting's surface [10].

To complement the investigation, an extensive literature review was conducted, encompassing publications related to the painting, previous attributions, resemblances, and stylistic influences from various contemporary authors. Subsequently, a comprehensive exploration of the painting's recent history was undertaken, tracing its previous owners, hereditary transfers, and auction sales.

Research aim

The aim of the research is to verify and discuss the results of a multidisciplinary approach in the study of an important panel painting. IR-reflectography and false-colour infrared analysis, dendrochronology and dendroprovenance, combined with an investigation of historical sources, will make it possible to retrace its history, restoration interventions, changes of attribution, and changes of ownership, until it is possible to identify its author with certainty and place the painting in a precise historical and cultural context.

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Material and methods

The painting

The panel painting, measuring $64.2 \times 44.5 \times \sim 0.5$ cm (Fig. 1), underwent analysis of its essential components, including the wooden support, preparation layer, and pictorial layer. The wooden support was examined using macroscopic, microscopic, and dendrochronological analysis. The preparation layer and pigments were investigated through IR-reflectography and false-colour imaging.

Dendrochronological analysis

At first, the wooden support was visually analysed to assess its construction characteristics and determine the optimal method for measuring the continuous tree rings. Through observations with a magnifying glass, the contact points between the boards comprising the support were precisely identified, along with the wood species used [5,6].

The upper part of the painted panel was cleaned with the help of a scalpel, while the growth rings were accentuated using a paste made from chalk and water. Sampling was conducted using a portable dendrochronograph equipped with a high-resolution digital camera. This instrument facilitates the measurement of tree rings *in situ* and guarantees a completely non-invasive approach, allowing for immediate assessment of sampling quality. Statistical comparisons [11] were conducted using the software programs TSAPWin (RinnTech, Germany), PAST4, and PAST5 (SCIEM, Austria). The data presented below are exclusively from the PAST4 program to ensure consistency.



Fig. 1. The panel painting depicting the Virgin Enthroned with Child.

IR-reflectography and false-colour infrared

Multi-spectral analysis images were obtained using technical digital photography techniques [12]. By manipulating light sources, employing optical filters, and applying post-production processing, various images of the artwork within the visible-infrared (Vis-IR) spectrum were obtained [9]. Two IFF Q 1000 projectors were equipped with 1000 w, 3400°K halogen lamps, and an ultrasonic distance metre for manual focus and subject positioning. The Sony Cyber-shot DSC-F828 camera was employed, featuring a night-shot system, a 2/3" type CCD sensor measuring 8.8×6.6 mm, an RGBE colour filter array with a pixel pitch of $2.7 \mu\text{m}$, and 8 Megapixels. Additionally, a Nikon D3200 DSLR camera with a modified CMOS DX sensor boasting 24.7 Megapixels was used for infrared acquisition up to 1100 nm. A B+W black IR pas 830 nm filter was also incorporated for capturing reflected infrared, effectively restricting the acquisition range to between 830 and 1100 nm.

Analysis of sources and style

The analysis of the painting's sources and style was conducted by considering a range of texts, documents, and photographs, many of which were obtained from the Netherlands Institute for Art History (<https://rkd.nl/en/>). Peter van den Brink, former director of the city museums of Aachen, Germany, played a significant role in contributing to the analysis of the sources [13].

Results

Dendrochronological analysis

The panel consists of two planks of deciduous oak wood (*Quercus* sp.) sourced from the same tree trunk and joined longitudinally. The cut of the planks is almost perfectly radial, the wood is free of macroscopic defects and there are no noticeable signs of fungal or insect attacks. No traces of sapwood were observed. Six measurements were recorded on the two boards, which comprised narrow rings with an average width of 1.04 mm (SD 0.33). The mean series of the panel, spanning 220 tree rings, was compared statistically [11] and visually to reference chronologies of oak from central and northern Europe. The highest correlation (T_{BP} 7.15, T_{HO} 8.04, Glk 68.60***) was identified with the year 1492, using the reference series Baltic 1 [7] (Fig. 2), and its updated version 2021BLT1 [4] (T_{BP} 6.99, T_{HO} 7.88, Glk 68.00**). Comparisons with other chronologies applicable to Baltic oak (Baltic 2, Baltic 3) also revealed significant albeit lower correlation values (T_{BP} and $T_{HO} > 4$, $Glk > 58.00$ **). After establishing the *terminus post quem*, further comparisons were conducted using the data, photographs, and dendrochronological series provided by the Netherlands Institute for Art History, accessible at <https://rkd.nl/en/>.

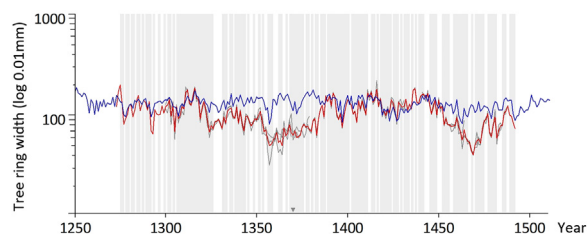


Fig. 2. Visual comparison of the six tree ring series made on the painting of the Virgin Enthroned with Child (the mean tree ring series is coloured red) and the reference chronology of Oak Baltic 1 (coloured blue) for the year 1492. The grey-coloured areas indicate the periods with the same sign of the growths (Glk). T_{BP} 7.15, T_{HO} 8.04, Glk 68.60**.

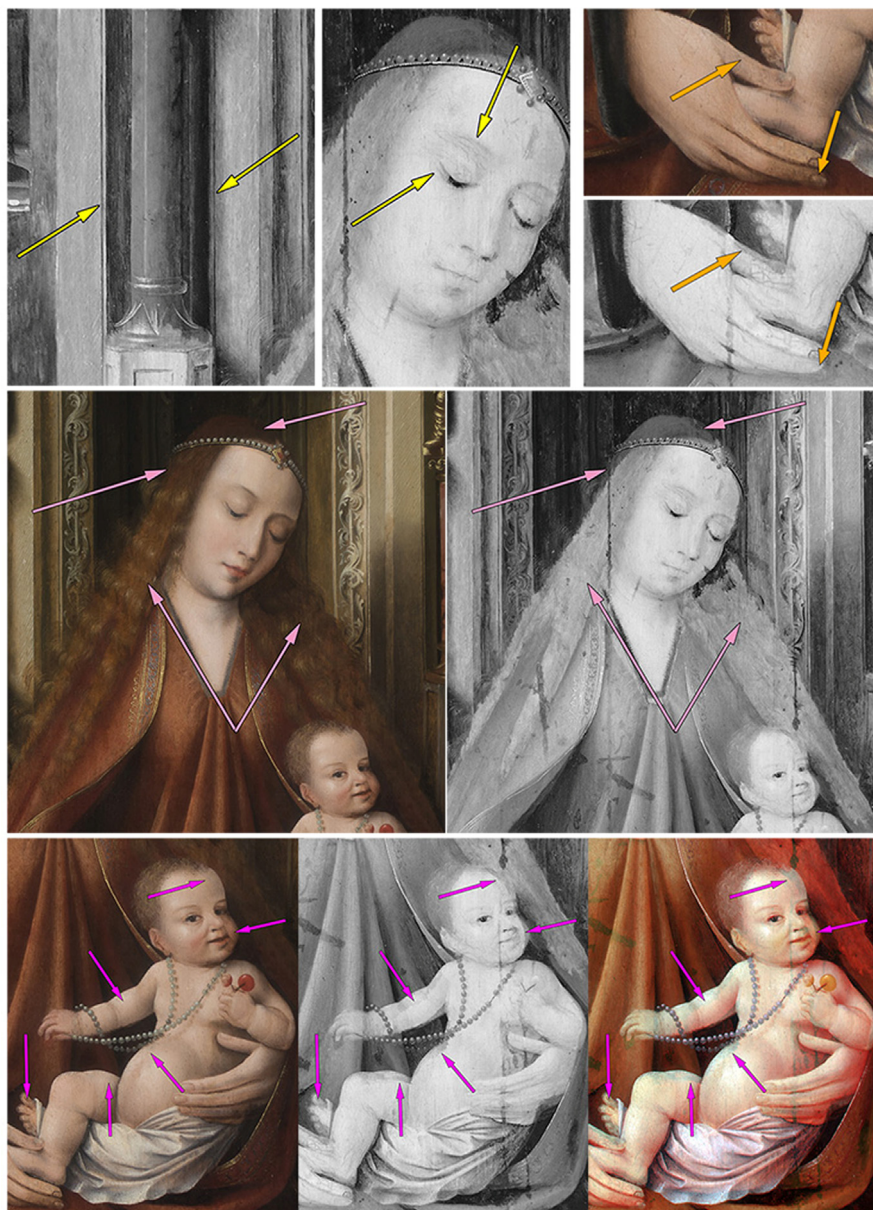


Fig. 3. Multi-spectral analysis. Yellow and orange arrows: light drawing and compositional remodelling seen through IR-reflectography. Purple arrows: later remodelling of the painting seen in white light, IR-reflectography and false-colour, respectively.

The analysis of the painting

The infrared reflection photo reveals a faint preparatory drawing beneath the painting, which becomes more discernible in certain areas, such as the Madonna's eyelids, eyebrows, and architectural elements like the small columns beside the figures (Fig. 3, indicated by yellow arrows). Evidence of compositional revisions can be observed, particularly in the fingers of the Madonna's right hand (indicated by orange arrows). Notably, the Madonna's hair exhibits two distinct phases: the first pertains to the upper part of the head, while the second is visible in the hair cascading from beneath the pearl crown onto the shoulders (marked by pink arrows). However, it is worth noting that the infrared response of this second phase may be attributed to partial panel abrasion. An intriguing aspect is the presence of multiple profiles of the child's figure. The initial drawing appears to have been resized or altered, likely later than the painting's original composition. This assertion is supported by the false-colour images, which reveal the use of a

pigment with a different composition in the area corresponding to the resizing (indicated by violet arrows) compared to the rest of the complexion (Figs. 1 and 2 Supplementary material).

The history of the painting

The earliest documented records of the painting surfaced in Cologne, where it was featured in a publication by Ludwig Scheibler [13], a prominent German art historian specialising in Old Netherlandish and German painting from the 15th and 16th centuries. According to Scheibler, the painting was held in a private collection in Cologne and it had been restored just prior to his publication (1891). Scheibler attributed the work to the artist known as the "Master of the Death of the Virgin".

An archived photograph of the painting, dating back to 1891 and stored in the Netherlands Institute for Art History (RKD), reveals slight variations compared to the current depiction of the artwork (Fig. 3 Supplementary material). Reflectographic analysis

indicates that if we eliminate all subsequently added layers (Fig. 3), the proportions of all elements align perfectly. Moreover, a crack in the wooden panel visible in the upper portion of the 1891 photograph precisely corresponds to the crack observed in our painting, as evidenced by the high-definition multi-spectral images.

During the time the photograph was taken, the painting was in the possession of Elisabeth Zimmermann-Jaffé (1865–1946). It is likely that the painting was subsequently inherited by Elisabeth Zimmermann's daughter, Maria (1899–1983), who immigrated to the United States after World War II and was auctioned in New York in 1962 [14]. Following several ownership changes, the panel was auctioned again in 1980, 1982 and 2022.

Discussion

The construction of the panel follows the traditional technique of the Flemish painters, using thin planks of deciduous oak, obtained by an almost perfectly radial cut [15,16]. Both the radial cut and the thinness of the boards are essential to limit the movement due to variations in ambient humidity of a heavy wood such as oak (~800 kg/m³ at 12% moisture content). In fact, radial cutting is much more stable than tangential or cross cutting while, in general, the greater the density of wood, the more intense and uncontrollable its movements [17]. This explains why for less heavy species such as poplar (*Populus* sp., ~500 kg/m³ at 12% m. c.), widely used in the Italian Renaissance, the panels to be painted were always cut radially but could reach a much greater thickness, even 1.5–2.5 cm or more [18].

The dendrochronological analysis of the two boards, obtained from Baltic wood (specifically Baltic 1 and 2021BLT1), indicates a *terminus post quem* of 1492. Like many wooden artworks [19], our painting contains no sapwood. Sapwood is more susceptible to biological degradation caused by insects and fungi than heartwood. Thus, it was wise to remove it while preparing the panel supports.

When all the sapwood, along with an unspecified number of heartwood rings, has been removed, as in our case, we can only determine the *terminus post quem*, which is the earliest possible date for the panel creation. Nonetheless, we have some general knowledge regarding oak trees in present-day Poland [20], indicating that they typically contain 9 and 24 sapwood rings (90% confidence interval). Furthermore, estimates suggest that an even smaller number of sapwood rings is more suitable for identifying Baltic type 1 wood [6,15].

Our panel painting shows the highest correlation with the Baltic1 series [7], followed by a slightly lower correlation with its more recent version, 2021BLT1 [6]. Other chronologies also exhibit a significant correlation for the same year. Before 1565, a significant portion of the wood used in Flemish panels shared the same origin, indicated as BALTIC1 or 2021BLT1, suggesting a substantial supply area [5]. Initially, this was believed to be the vast hinterland used by the port of Gdansk [8], but recent studies have shifted the focus further north to forests connected to the port of Klaipeda as their outlet to the sea [6]. Probably, the supply basin extended as far as Riga, encompassing a large region. This shift in the origin of timber for Baltic1 has two significant implications for our findings. First, it reduces the number of sapwood rings [15,6] that need to be accounted for in dendrochronological dating. Second, it enables us to more precisely determine the species used by the early Flemish painters for producing their supports. Only *Quercus robur* L. naturally extends its distribution range into the Baltic regions of Lithuania or Belarus [20], while *Quercus petraea* (Matt.) Liebl. is limited to Poland in its easternmost expansion (Fig. 4 Supplementary material).

As previously mentioned, the painting “Virgin Enthroned with Child” was initially attributed by Scheibler [13] to the painter

known as the Master of the Death of the Virgin, an anonymous artist from the Lower Rhine or Cologne. However, just 3 years later, Eduard Firmenich-Richartz (1894) identified the painter as Joos van Cleve [14]. Taken together, our results suggest the attribution of the painting to the Master of Frankfurt [21], an artist active in the city of Antwerp between 1480 and 1520 [13]. The Frankfurt Master was strongly influenced by Quentin Massys (1466–1530), the founder of the Antwerp School, and is known only for his painting style. Although it is unlikely that he ever visited, Frankfurt am Main, the reference to the city of Frankfurt arises from the two triptychs he was commissioned to paint for patrons from that city: the “Holy Family” in the Frankfurt Historisches Museum (c. 1503) and the “Crucifixion” in the Städelches Kunstinstitut.

From a stylistic perspective, there are notable similarities between the “Virgin Enthroned with Child” and other works by the Frankfurt Master, such as specific elements seen in the Frankfurt altarpiece or the triptych of the Adoration of the Magi in Antwerp. Drawing comparisons with the Thyssen Holy Family (Museo Nacional Thyssen-Bornemisza, Madrid), which was painted by the same artist in 1508, suggests that the painting in question may have been created around the same time [13]. This date aligns well with the dendrochronological dating of the panel. Considering the chronological gap between the *terminus post quem* (1492) and the execution of the painting (1508), which spans 16 years, we need to account for the number of sapwood rings removed during the panel's preparation, as well as a potential seasoning period. Since we know that the oaks in Poland typically have nine to 24 sapwood rings [20] and that this range decreases further eastward, it is reasonable to assume that the 16-year period includes around 13 or 14 sapwood rings. Additionally, 2 or 3 years should be added to account for wood seasoning and panel preparation [15,21,22], leading us to estimate the approximate date of the painting's creation.

Conclusions

The panel painting portraying the Virgin Enthroned with Child underwent a series of scientific analyses to determine the dating of the panel, identify the likely geographical origin of the wood used for the support, and uncovering hidden features beneath the paint layer, such as the preparatory drawing, retouches, or restoration-related repainting. These analyses were complemented by documentary research and photographic investigation, which provided insights into the work's recent history and helped contextualise its style. Combining these techniques yielded a comprehensive understanding of the artwork, surpassing the individual results. In summary, the support is believed to be constructed from *Quercus robur* wood of Baltic origin (Baltic1), dating back to 1492 as a *terminus post quem*, with the painting likely executed around 1508. Analyses are in line with a possible attribution to the Frankfurt Master. This study highlights the potential of a multidisciplinary approach in examining artworks.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.culher.2023.08.002.

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