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The difficulties identifying materials used in preserved traces of decorations on wooden artefacts from the Old Town in Elbląg, 26 Bednarska Street, site XXXII (north of Poland). Remarks on multi-analytical non-destructive studies

Abstract. In medieval archaeological material, artefacts with traces of decorations on the surface are rare; this caused researchers to conduct multiple analytical studies on objects unearthed in Elbląg. In 2022, in the Old Town at 26 Bednarska Street, site XXXII, an oval box with a colourful floral motif and fragments of a stave-built bowl painted light pink on the inside were found. The difference in the colour of the wooden surfaces was revealed only after conservation procedures.

Non-destructive and non-invasive studies were performed by means of an X-ray fluorescence micro-spectrometer, a scanning electron microscope coupled with an EDS spectrometer, a portable spectrometer, a digital X-ray machine, and two CT scanners. Various minerals were recognised as pigments: cinnabar (pink ornaments), lead white

(white decorations) and copper and iron substances for darker, almost black ornaments on the wooden box. Iron oxide could have been stored inside the stave vessel.

Keywords: pigment composition, containers, archaeology, Middle Ages, wood conservation, non-destructive studies.

Introduction

Elbląg's characteristic situation and history that led to an almost complete annihilation of the Old Town in 1945 created conditions suitable for carrying out extensive archaeological studies that have been continued with interruptions for over three decades (Marcinkowski 2011; Fonferek *et al.* 2012). High groundwater levels maintained a constant humidity level. Objects retrieved from latrines were deposited in a humid, soft mass composed of plant and animal remains turned to peat, rich in nitrogen and phosphorus, as well as other items, including those made of metals, mainly iron and alloys of bronze, tin, and lead. The permanent environmental conditions contributed to the preservation of organic artefacts to a varying degree (Grupa *et al.* 2008; 2009; Grupa 2014).

In 2022, archaeologists of the Archaeological and Historical Museum in Elbląg continued the archaeological studies in the Old Town. This time, the examination covered in total seven plots at 25–31 Bednarska Street and three plots at 8–10 Studzienna Street. The studies sought to grasp the oldest traces of development in this part of the city. The exploration involved backyards of the plots bounded by rear walls of tenement houses, firewalls, and boundary walls. In the course of these works, modern and medieval layers with relics of wooden residential and utility buildings have been uncovered.

Bednarska Street and Studzienna Street were one of the key streets of Elbląg's Old Town due to their commercial nature. They were connecting the quay with Stary Rynek Street, the main artery of the city. In the 15th century, the plots were the property of aldermen, merchants, and wealthier craftsmen. The oldest revealed structures dated by means of the dendrochronological method[1] show that the investigated plots were developed within less than twenty years after the city had been founded (1237). In the plot at 30 Bednarska Street, a fragment of a narrow alley was unearthed along with a fragment of a weaved fence delineating the oldest division of this plot from the first half of the 13th century. In the plot at 26 Bednarska Street fragments of a floor made in alder wood were revealed, dated to the first half of the 13th century, likewise.

[1] The dendrochronological analyses were conducted by Nicolaus Copernicus University in Toruń – Prof. Tomasz Ważny, Ph.D.

In the course of the conservation procedures or, more specifically, in their final stage, that is, during the cleaning of an excess impregnant off of the surfaces, attention was drawn to a subtle pinkish discolouration on the inner surface of fragments of the stave-built bowl and black and pink spots on one side of the oval flat object that is an element of a wooden box.

The artefacts marked out for the studies were found in a stone-and-brick latrine in the plot at 26 Bednarska Street. The fill of this feature comprised organic matter, post-consumption animal remains, ceramic and glass materials of a wide chronological horizon from the 15th to the 18th century, iron objects, and items made in hide and wood.

Our main goal was to recognise the preserved traces of colour depositions on the wooden artefacts from Elbląg with respect to the high historical value of the investigated objects. The paper provides identification of the raw-materials used and some remarks on the applied technology.

Conservation of wooden artefacts

Immediately after unearthing, archaeological wood is extremely vulnerable to changes in humidity and temperature. Only instantaneous preventive measures aimed at securing these objects ensure success in the final stage of conservation procedures (Drążkowska, Grupa 1998, pp. 13–43; Grupa 2000, pp. 211–213; 2014, pp. 300–302). Due to the varying thickness and shapes of the wooden artefacts, a decision was made to apply polyethylene glycol 4000 (PEG 4000) (Grupa *et al.* 2008, pp.136–140; 2009, pp. 163–174). During previous conservation works, it has been already noticed that once introduced into wood, PEG 4000 maintains the proper oval shape and with a stabilised impregnation treatment, wood shrinkage is the smallest (Grupa 2009, pp. 123–125). This is extremely important for wooden walls that are 1–2 mm thick.

The material that was provided to the laboratory in Toruń was partly covered in matted straw, which acted as an extra factor preventing water loss from the wood structure. Each object was delicately washed in warm water and placed in a metal tub in such a way that one artefact would not crush the other when put on top of it. Impregnation began in a 3% aqueous solution, heating it up to 50°C. Every third day (on average), the PEG 4000 concentration was increased by 1%. The impregnation took 12 months. Having been retrieved from the tub, excess impregnant was cleaned off of the surface of each artefact and, once cooled, the items were placed inside a polyethylene bag and put in a freezer. After two days, objects with small thickness of walls were taken out from the bags and put on frozen shelves in a vacuum chamber. A pump was turned on twice a day. Once the accurate parameters inside the chamber had been reached, the pump was turned off. In the course of the drying of the artefacts at a lowered temperature a *freeze-drying* process takes place, with ice turning into vapour, while the impregnant remains within the object. After about a week, the objects could be removed from the chamber, the impregnant remaining on their surfaces could be cleaned off, and a typical analytical work could begin (describing, measuring, taking post-conservation photographs). It was during these activities that traces of painted decorations were noticed on the surface of two objects, namely, a bottom of a small bowl and a cover of an oval box.

Material and methods

Non-destructive studies (Borgwardt, Welles 2017) involved two wooden items, specifically, an incomplete bottom of a stave-built bowl preserved in two fragments and part of an oval box with an ornamental cover (a preserved trace of floral decoration) and almost invisible triangles on the outer wall (Fig. 1). As mentioned above, the artefacts were forwarded for non-invasive studies due to their high historical value, therefore no samples were taken. The tests were made after the conservation treatment had been completed, which can always be of significance for the planned study and affect the results obtained. For this reason, the artefacts were subjected to microscopic observation in visible light using the Olympus SZX 9 microscope equipped with the ImagingSource DFK 33UX264 camera. The received artefacts have a matt surface, which is due to the waxy gloss of polyethylene glycol 4000 (PEG 4000), the substance used as an impregnating agent. Due to the presence of conservation layers on the artefacts' surface, it was decided to subject the items to testing with an X-ray fluorescence micro-spectrometer Spectro Midex SD fitted with collimators with a variable diameter of the measuring spot (0.2–3.0 mm) and operating in normal atmospheric conditions at the excitation voltage of 45 kV and a current of 0.5 mA. Owing to this, it was possible to ignore analytical signals of light elements that are common in conservation substances. Signals of elements that form typical soil contamination, such as calcium and sulphur, were disregarded, too; this is not always positive since likewise, these elements can be intentionally linked to the artefacts (i.e., constitute paint ingredients). For this reason, the artefacts were also subjected to microanalyses using SEM-EDS, which verified the results of the micro-XRF. For this purpose, an electron scanning microscope, Hitachi TM4000plus, was used with an EDS spectrometer by Oxford Instruments operating in low vacuum conditions at 15 kV and fitted with a BSE detector. Additionally, the artefacts were analysed by means of a portable spectrometer, Tracer 5i (Bruker), with an 8-mm collimator exciting samples at a voltage of 40 kV and a current of 6.65 μA. The above-mentioned analytical techniques like light microscopic observations, XRF and SEM-EDS, are often employed to study mineral pigments in many historical objects due to their non-destructive or micro-invasive nature (Ganitis *et al.* 2004;

Fig. 1. Macroscopic photography of the investigated artefacts (photo by B. Miazga)

Moura *et al.* 2007; Jezequel *et al.* 2011; Nastova *et al.* 2013; Lizun *et al.* 2021; Nord, Tronner 2021). To determine further details of the presence of coloured substances and painted decorations, both objects were subjected to X-ray studies using various analytical appliances (Nobuyuki 2005; Schalm *et al.* 2014; Lizun *et al.* 2021; Pu *et al.* 2022). These included a computer tomograph Nikon Metrology Europe (XTH 225) used for 2-D and 3-D imaging, operating at the measurement conditions of 80 kV and 259 μA (Laboratory of Material Properties, Wrocław Technology Park). Additionally, two- and three-dimensional imaging was conducted using a digital X-ray apparatus Multix Impact C by Siemens (70 kV, 375 μA) and a computer tomograph 64-row 128-layers Siemens Somatom go.TOP (120 kV and 21 mA), which is part of the equipment at the Department and Clinic of Surgery of Faculty of Veterinary Medicine of Wrocław University of Environmental and Life Sciences.

Results

Bottom of the stave-built vessel (Fig. 1: a)

The bottom of the stave-built vessel, preserved in two parts, is red-pink on one side. This side is considered the inner side of the container which is presented on Figure 2: a, b. The microscopic observation showed that reddish hue appears neither on the outer surface, nor in the ring area (Fig. 2: c, d). The XRF spectral study was performed in the course of comparative qualitative analysis based on the test results for the outer side of the bottom. The obtained signals suggest that for iron and calcium, there are significant differences in the intensity of the counted signals (Fig. 3, Table 1). In the next step, the artefact was subjected to a SEM-EDS analysis. The EDS spectrum yielded by the tests shows strong signals of light elements such as oxygen, carbon, calcium, phosphorus, silicon, or aluminium, though signals of iron are also visible, somewhat stronger than in the case of the analysed natural-colour wooden surface (Fig. 4). In turn, the results of the X-ray radiographic studies show only a wooden structure and are not indicative of any presence of metallic elements of significant density (Fig. 5).

Box with painted bottom and sidewall (Fig. 1: b)

The artefact was preserved practically in its entirety, though split in two. The bottom of the box measures 12.8 cm by 7.3 cm and the side wall is 2.7 cm tall.

One side of the bottom – considered the inner side – bore remains of a floral decoration, most likely, a depiction of a flower bouquet (Fig. 1: b). The microscopic study showed that rather than a clear representation of flowers, the painted surface is preserved to a small degree as spots of a pinkish and white hue in the same

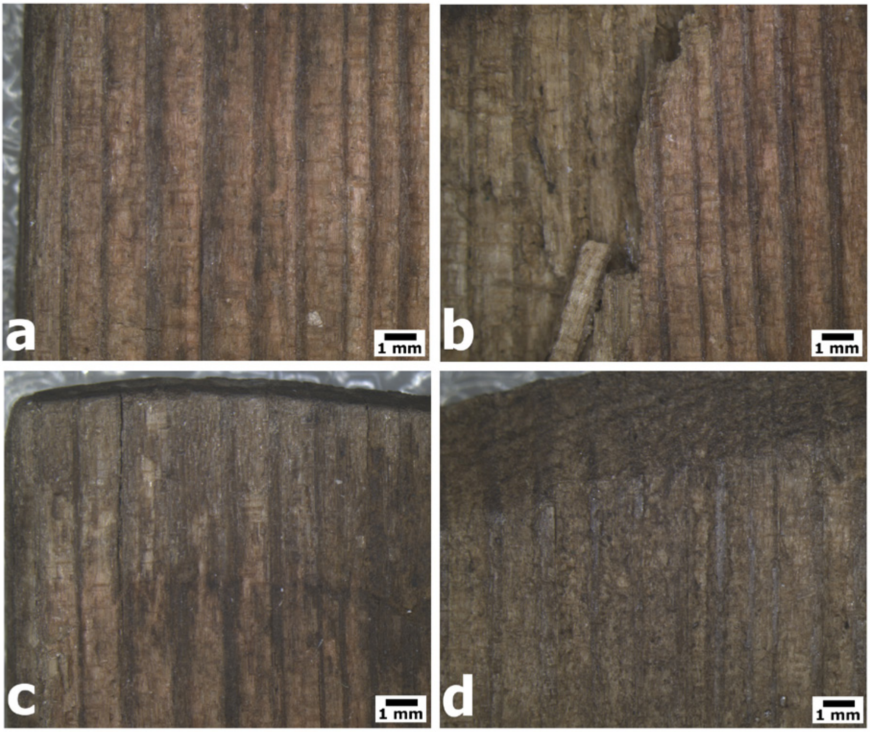


Fig. 2. Bottom of the stave-built vessel with a visible reddish hue (a–c) and the lower side unpainted (d); magnification 6.3x (photo by B. Miazga)

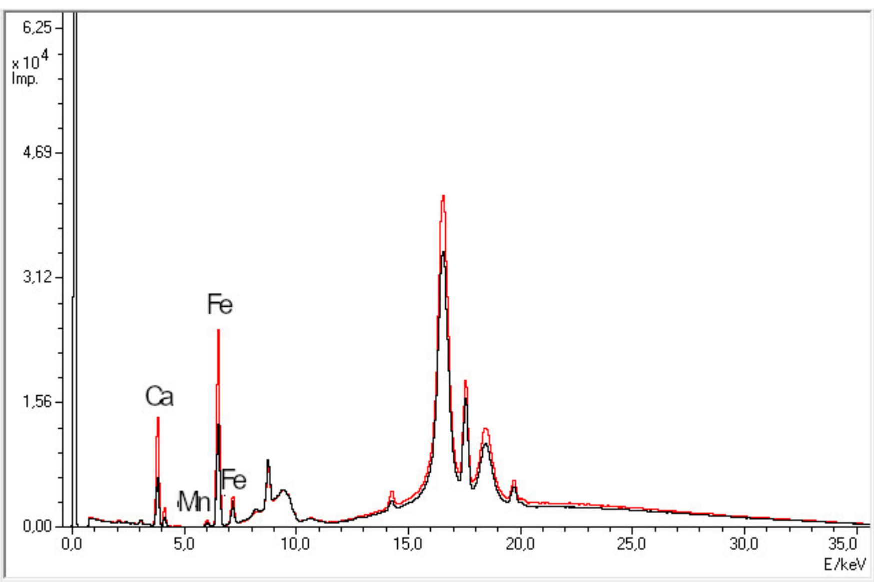


Fig. 3. Bottom of the stave-built vessel. XRF comparative analysis of both sides of the bottom (red line – inner side, black line – outer side of the bottom of the container) (developed by B. Miazga)

Table 1. Bottom of the stave-built vessel. The number of counted impulses for iron and calcium on both surfaces suggests the intentional presence of both elements on the surface of the bottom

Number of counted impulses (XRF studies)	Outer surface	Inner surface					
Fe Kalpha	13,714	24,546	22,557	21,104	21,850	19,775	21,553
Ca Kalpha	7,768	16,286	10,751	12,427	12,773	15,786	12,214

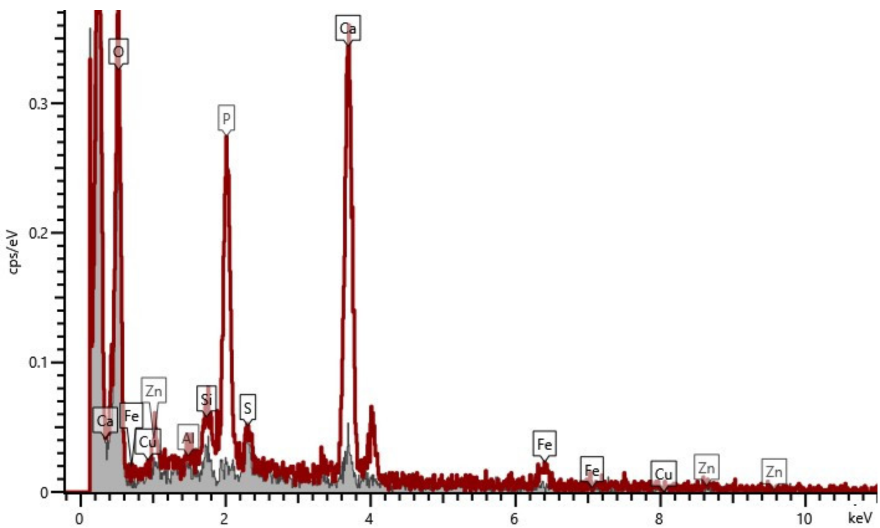


Fig. 4. Bottom of the stave-built vessel. EDS comparative analysis for both sides of the bottom (red line – inner side, grey line – outer side of the bottom of the container) (developed by B. Miazga)

Fig. 5. Radiographic image of the bottom of the stave-built vessel. Visible wood structure and defects of the artefact (dark areas are a metal handle) (developed by B. Miazga)

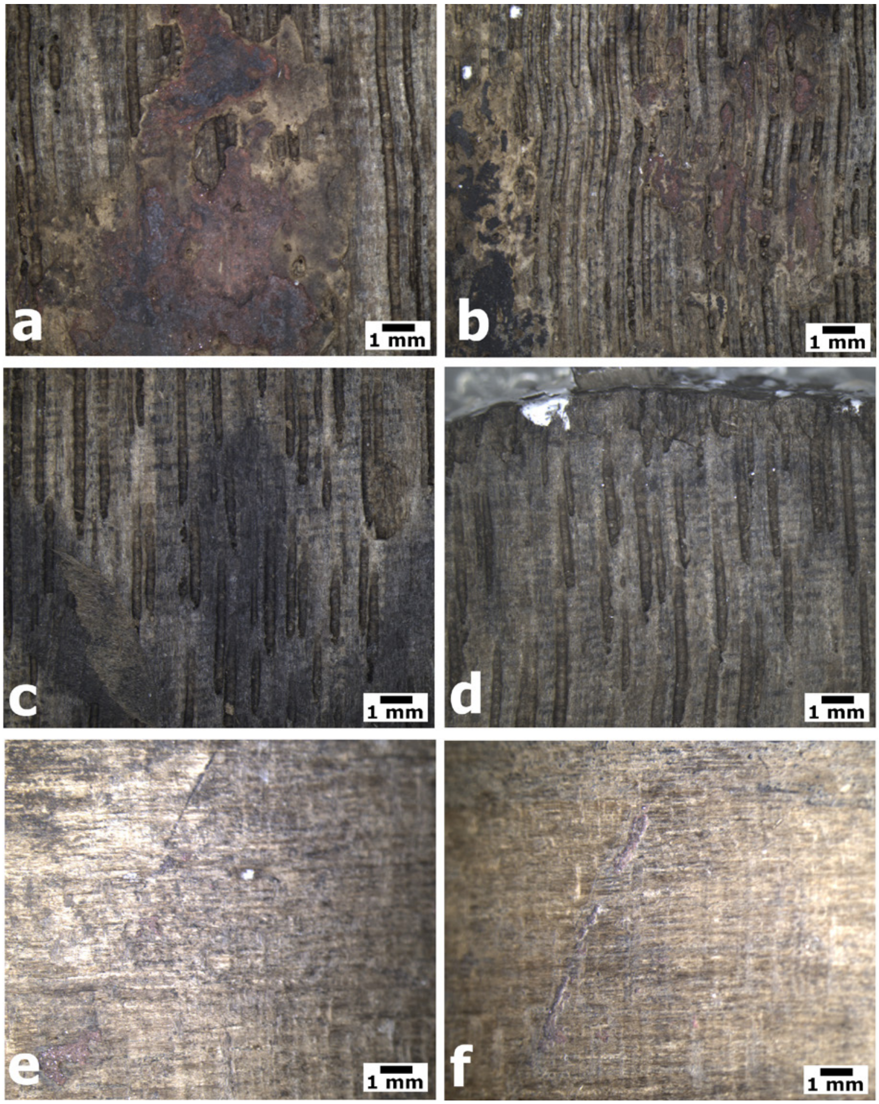


Fig. 6. Box with painted bottom. The state of preservation of the decoration is visible; magnification 6.3x (developed by B. Miazga)

area, and a black hue (Fig. 6: a–c). The microscopic observation allowed us also to determine the stratigraphy of the decoration, pointing to the white layer as a primer underneath the pink paint (Fig. 6: a). A non-painted surface of the bottom with visible remains of a substance used for strengthening the structural wood was also presented (Fig. 6: d). Deposits of this substance can be seen also in the other photographs. As for the sidewall, its state of preservation is even worse, with the

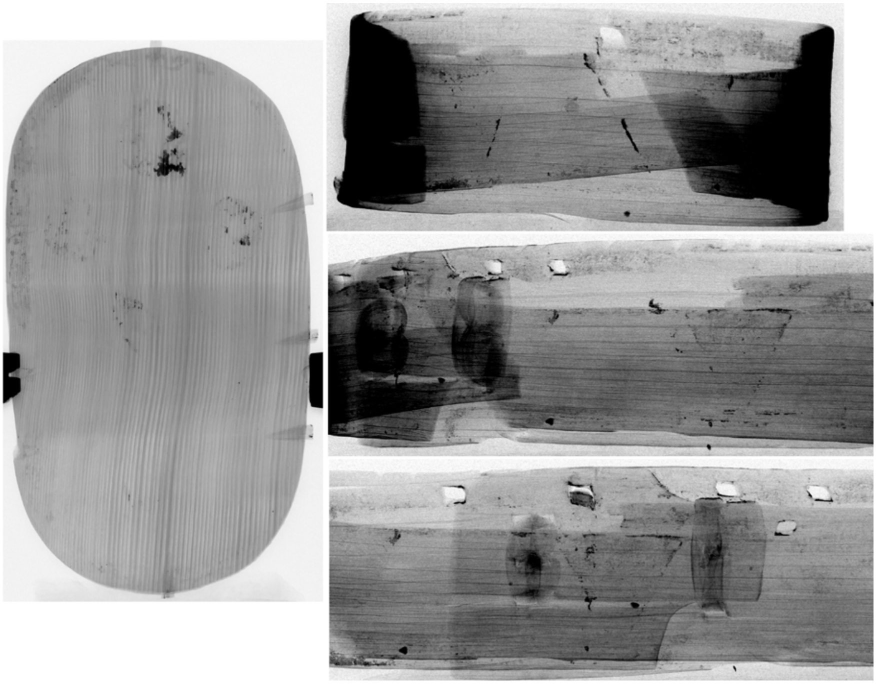


Fig. 7. X-ray images of the wooden box with visible remains of a painted decoration: triangles on the wall and three areas on the bottom (most likely flower heads) (developed by B. Miazga)

outline of a geometric decoration visible in the form of two lines of triangles readable only owing to the drawn lines. Importantly, in the upper line, the triangles seem brighter while those outlined by the bottom of the vessel are darker and, at a closer look, one can notice that they bear pinkish deposits (highly contaminated, obviously; Fig. 6: e, f). The X-ray radiographic study and CT scan conducted for the artefact yielded interesting results. The obtained X-ray image emphasise the presence of the geometric decoration well, which takes the form of triangles visible across the entire wall of the vessel. In turn, the study of the bottom of the container can indicate that not only various substances were applied for making the painted decoration, but also overlaid layers of paint of different thickness that are noticeably thinner in the flower stem and leaves areas compared to the ones in the flower head areas, which has been very well readable in the studies of three-dimensional images, presented as flattened images (Figs. 7, 8). In the course of the spectroscopic studies of the bottom, attention was focused on identifying the pinkish and whiteish paint layers. The study of the pink paint showed that the strongest analytical signals can be attributed to mercury (Fig. 9: A), while other intense peaks are linked to lead (Fig. 9: B). This result has been also yielded by the XRF analysis conducted with

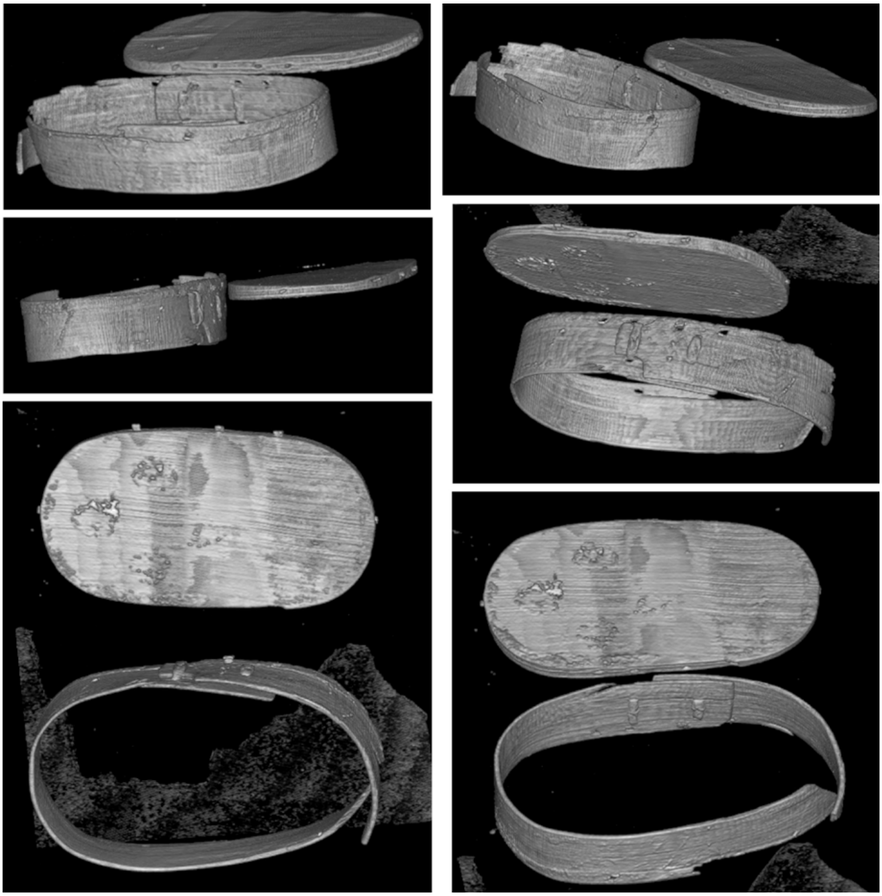


Fig. 8. 3D reconstructions in CT scan with residual painted decorations (developed by B. Miazga)

the Tracer spectrometer, which drew attention to the occurrence of mercury, lead, iron, copper, calcium, sulphur, and phosphorus (Fig. 10). The identification of components of the pink and white paints was facilitated by the EDS spectrometry coupled with a scanning electron microscope. Although sampling was not possible, the bottom of the vessel was successfully introduced into the SEM chamber and selected micro-areas were analysed. Test results for the pink paint confirmed that the most intense peaks belonged to mercury and, these aside, there were visible signals of calcium, sulphur, phosphorus, silicon, and aluminium (Fig. 11: A). In turn, the findings obtained for the whiteish primer (Fig. 11: B) proved positive as for the presence of lead, calcium, carbon, phosphorus, as well as sulphur, silicon, and aluminium. This probably suggests that the white primer – presently somewhat contaminated with mercury compounds – was made using lead white, most likely

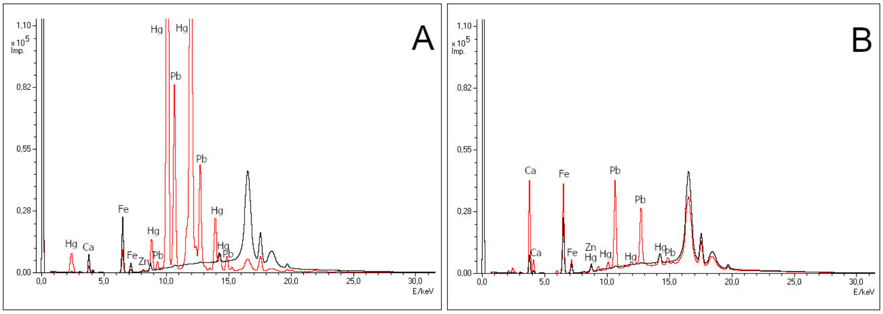


Fig. 9. Painted bottom of the box. XRF comparative analysis: A – pink paint coat (red line), outer side of the container's bottom (black line); B – white primer (red line), outer side of the container's bottom (black line) (developed by B. Miazga)

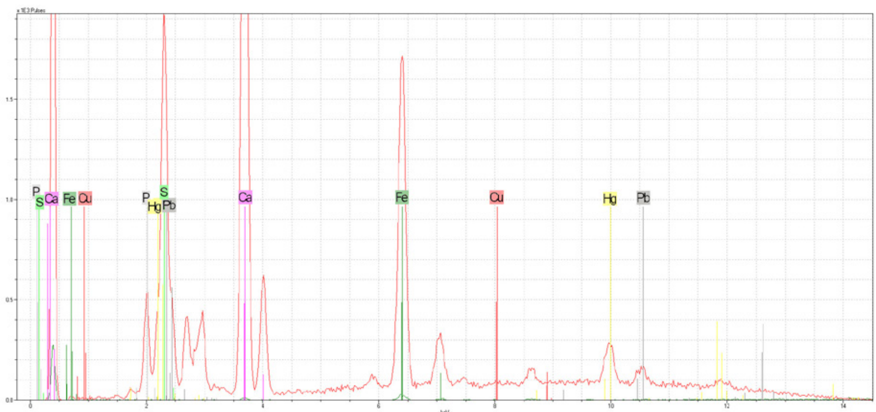


Fig. 10. Painted bottom of the box. XRF comparative analysis conducted using the Tracer spectrometer: pink paint coat (red line), outer side of the container's bottom (green line) (developed by B. Miazga)

mixed with bone white (or that lead white is mixed with calcite and contaminated with the phosphorus present in the soil). The identification of the substance used for making the decorations that are currently black (stems and leaves?) proved highly difficult, while the obtained results are inconclusive. During the comparative XRF studies, it has been identified that the increased intensity in these areas pertains to iron and copper (Fig. 12: A, Table 2). Owing to the conducted SEM-EDS analysis, data were collected about the presence of elements such as sulphur, copper, calcium, lead, and iron in the examined micro-area, albeit of varying signal intensity, particularly for copper and iron (Fig. 12: B). In the course of the analysis, micro-areas of a significantly elevated copper content were identified as well as those where its level was not particularly high. Analytical difficulties in

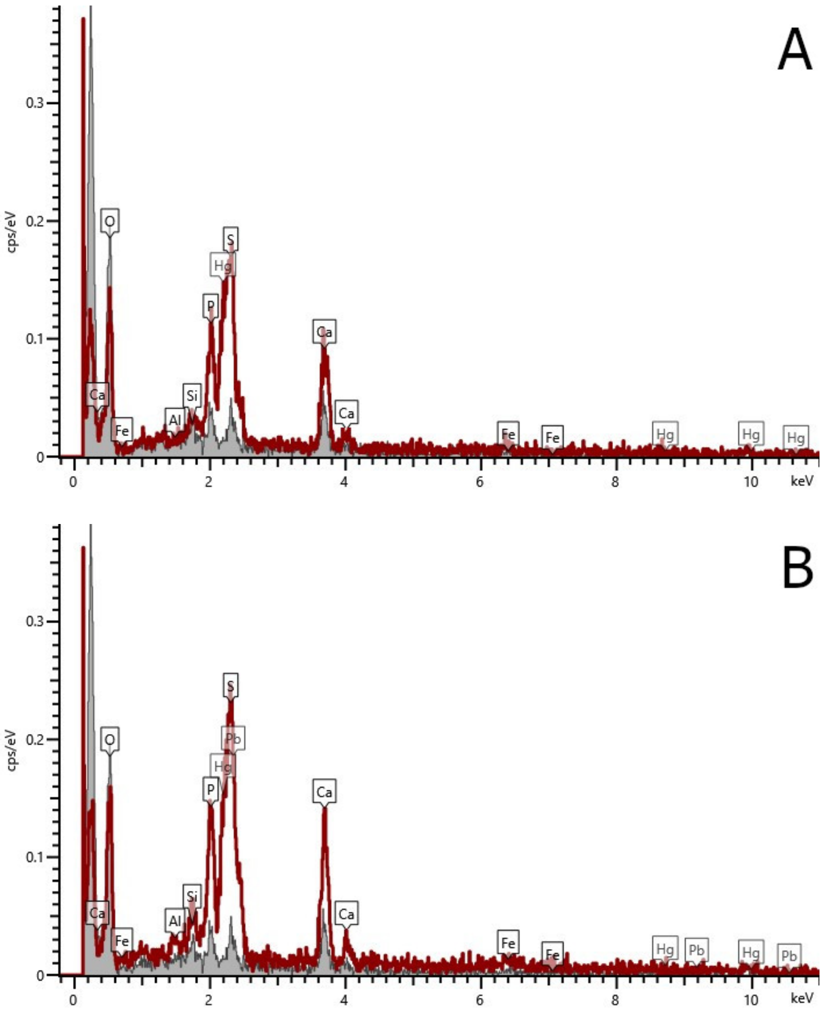


Fig. 11. Painted bottom of the box. EDS comparative analysis: A – pink paint coat (red line), outer side of the container's bottom (grey line); B – white primer (red line), outer side of the container's bottom (grey line) (developed by B. Miazga)

drawing these conclusions arise from the size of the artefact and the fact that it was examined without sampling. For this reason, once again, the portable Tracer spectrometer proved helpful; internal calibration for measuring copper compounds (the *Copper Alloys* method, *SMARTGrade 2* app) allowed us to determine elevated copper intensity in the investigated dark areas (Fig. 13). Given the above, it is possible to venture to suggest that the possibly, copper and/or iron pigment was used for making the ornament in the form of flower stems and leaves. When identifying the

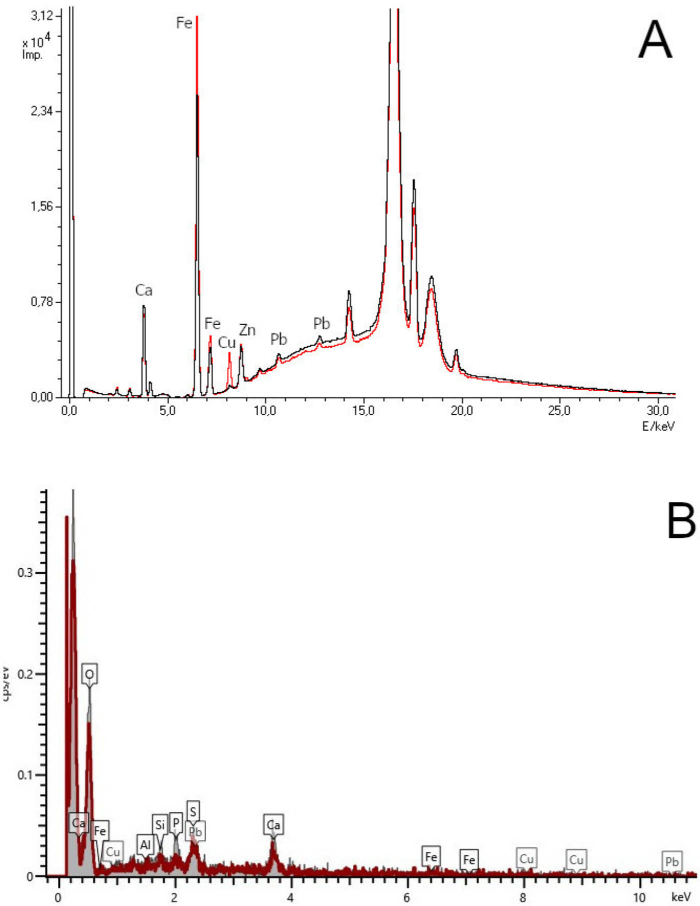


Fig. 12. Painted bottom of the box. Comparative analysis: A – XRF- dark decoration (red line), outer side of the container's bottom (black line); B – EDS- dark area (red line), outer side of the container's bottom (grey line) (developed by B. Miazga)

Table 2. Bottom of the container. The number of counted impulses for iron and copper on both surfaces obtained using the X-ray fluorescence spectrometer confirms the higher Fe and Cu intensity

Number of counted impulses (XRF study)	Outer surface	Surface with a dark decoration		
Fe Kalpha	26,179	30,620	29,323	29,105
Cu Kalpha	1,112	3,154	3,069	3,562

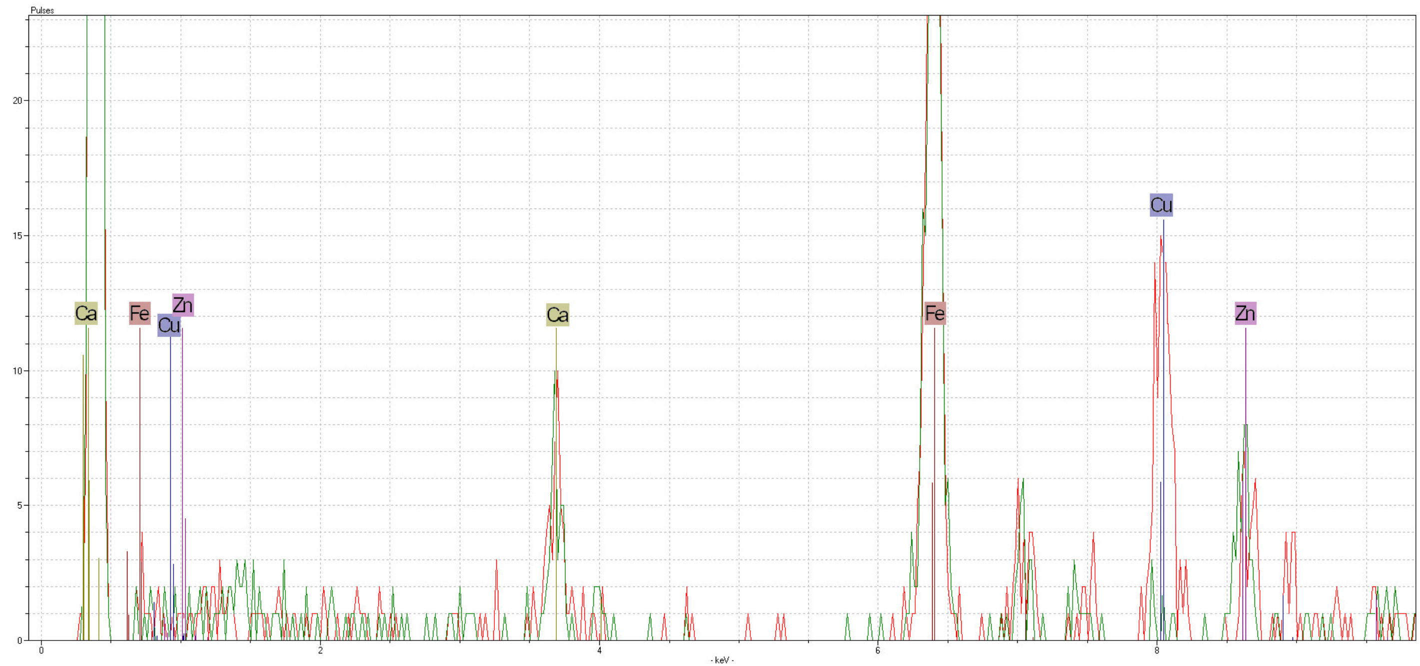
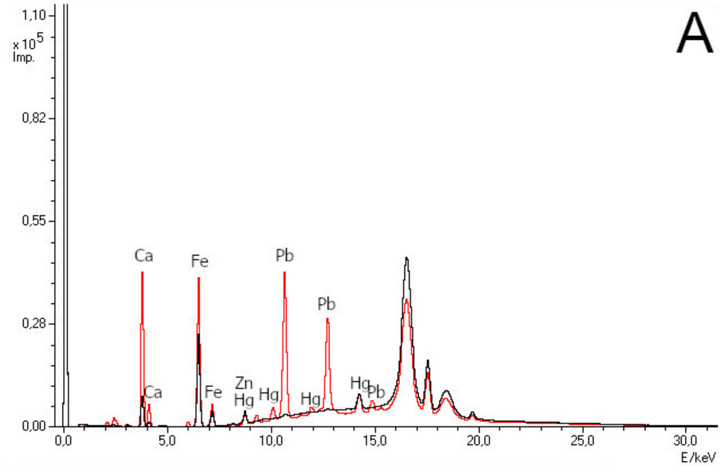


Fig. 13. Painted bottom of the box. XRF comparative analysis conducted using the Tracer spectrometer: dark painted decoration (red line), outer side of the container's bottom (green line) (developed by B. Miazga)



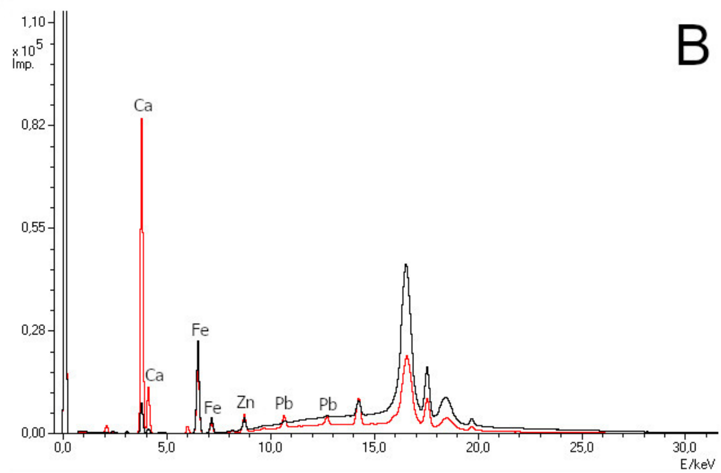


Fig. 14. Sidewall of the box with painted bottom. XRF comparative analysis: A – pinkish triangle (red line), outer side of the container (black line); B – whiteish triangle (red line), outer side of the container (black line) (developed by B. Miazga)

possible source of the colour in this ornament, one cannot forget that the artefact possibly got contaminated with iron formed when the object was deposited in the soil layers, particularly given the data shown in Table 2, where iron signal intensity in the decoration is not particularly high in the relation to the unpainted area of the bottom of this vessel.

As for the decoration of the container's wall, the testing was done using an XRF spectrometer only due to the size and geometry of the artefact. The comparative analysis of the areas of the "upper" and "lower" triangles outlined on the sidewall indicates that the decorations were made using a palette similar to that on the bottom of the container. The pinkish triangles are characterised by a strong signal for mercury that cooccurs with peaks pertaining to lead and calcium (Fig. 14: A), while on the surface of the brighter triangles, only strong signals of lead and calcium were identified (Fig. 14: B). This is consistent with the hypothesis that the same paint was used for making the decoration on the bottom and the wall of the container. Unfortunately, SEM-EDS analyses that would fully confirm this fact could not be performed due to the geometry and the size of the walls of this container.

Discussion

Bottom of the stave-built vessel

The XRF spectral study made on the inner part of the bottom confirmed the presence of iron analytical signals and, therefore we suggest that, this colouration can be related to the product that was stored in it. The obtained results can indicate that some iron compounds were kept in the container, perhaps used as a mineral pigment, possibly mixed with chalk (?) given the bright red hue of the surface and the presence of calcium signals. Using iron pigments in the past was very popular and is well recognized. Many authors study not only the objects decorated by iron paints, like icons or wall paintings (Ganitis *et al.* 2004; Murat 2021) but also try to find and explain the sources of such mineral pigments (Siddall 2018; Kostomitsopoulou Marketou *et al.* 2019). A very interesting paper was published by Nanna Friis Hellstrom and a team (Friis Hellstrom *et al.* 2024), who studied Viking Age pigmentation by the investigation of many wooden objects like interior panels from the North Mound in Jelling, Denmark, a hammer brace from Horning Church, the shield from Trelleborg and the Ladby Ship. The process of preparing the wood for decoration and using an iron ore red pigment to make a paint were presented as well as the use of chalk as a white background to provide a surface suitable for further, more colourful, painting. In our case the white background was also prepared but with lead white probably mixed with bone white.

Importantly, when commenting on the presence of iron compounds in the examined stave-built container, one should note the fact that Fe and Ca were present on both surfaces of the bottom, including the one with no reddish hue. This could be linked to the artefact deposition in soil layers and its contamination with iron and calcium compounds, which are common minerals. Nonetheless, the comparative XRF analysis of the intensity of iron signals on both surfaces of the bottom showed that on the reddish surface, the measured quantity of counted impulses for iron and calcium is almost twice as high as was shown in Table 1.

Moreover, the results of the X-ray radiography do not confirm the presence of metallic elements such as lead or mercury, due to the lack of clear signals in the form of a difference in the intensity of white and grey (Padfield *et al*. 2002; Žemlička *et al*. 2014). This excluded the possibility of the storage of red lead (minimum, Pb_3O_4) or vermilion (cinnabar, HgS) in the fragment of the vessel analysed.

Box with a painted bottom and sidewall

As the main result of the microscopic observations, a rather poor state of preservation of the box decorations was confirmed, as well as the stratigraphy of the ornaments (Fig. 6: a). The technology of the paintings could be inferred, while on the base, the preparation of a white background as the first step was indicated. A pink paint is the next layer visible in the microscopic studies. For the sidewall, as a result of OM, on the geometric forms of the decorations no stratigraphy were primarily recognized. These geometric patterns are aggregated in two lines: one made of white paint and the second prepared by pink paint. The final identification of these two rows of triangles was done by X-ray images, both 2-D and 3-D. The next interesting fact is the evidence of various thicknesses of the decorations, indicating that the dark part of the floral painting is significantly thinner than the pink one, which can suggest different technology used in their production. The spectral research of paintings confirmed the presence of mercury and lead. This can indicate that mercury sulphide was applied (HgS – cinnabar, vermilion); in the past, it was used quite often for decorating various objects, not only wooden ones, but also for painting medieval leathers (*Teofil Prezbiter* 1998, p. 6; Ganitis *et al*. 2004, pp. 349–360; Miazga 2017, pp. 211–215; Pérez-Diez *et al*. 2023, p. 207). The presence of lead signals can be linked to a primer made using lead white, as confirmed by the local analysis of the whitish area. Elevated calcium signals in this layer possibly evidence that the sample has been contaminated or that chalk or bone white was used as an additive in the white paint (Clark 2002, pp. 7–20; Friis Hellström *et al*. 2024). The inconclusive results were obtained for the dark part of the decorations in which signals from copper and iron – the popular ingredients of various colour paints – were identified. In the case of this decoration, the interpretation is twofold and takes due account of its original colour, which was either black or green. The use of a green hue would be justified in this case, too. The local analysis applied in the studies on this artefact is not clearly conclusive (the examined surface shows both areas yielding a stronger signal for Cu and Fe, in addition to areas whose intensities are similar to those of the non-decorated surface). Having collected this information, potential pigments that had possibly been used for making these decorations were identified, covering both green and black substances. Among the possible green substances, one can list malachite and other copper greens or green earth (which contains hydrated iron – II and III – potassium silicate containing small amounts of aluminium and magnesium, calcium and numerous trace elements) (Scott 2002, pp. 102–106, 114–115, 137–138, 270–293, 306–316; Dymowska, Olszewska-Świetlik 2021, pp. 36–67; Kosiv *et al*. 2021, pp. 68–111). It was also taken into account that mixtures of green pigments could have been applied, which was reflected in the subject literature, likewise (Rejman 2021, pp. 112–139). The use of different copper and iron pigments for creating green decorations is reported also by scientists from various research centres worldwide (Devos *et al*. 1995, pp. 153–162; Clark 2002, pp. 7–20; Hradil *et al*. 2003, pp. 223–236; Moura *et al*. 2007, pp. 299–306; Platania *et al*. 2020; Paz *et al*. 2023, pp. 217–230). However, if the dark shade of the decoration does not result from contamination or deterioration of minerals, and the ornament was originally black, then the use of tenorite CuO, chalcocite Cu_2S (Scott 1997, pp. 93–100; 2002, pp. 95–97, 227), and also magnetite Fe_3O_4 (Clark 2002; Sinhababu *et al*. 2021) and their mixtures is also likely.

Wooden boxes in the Middle Ages and the modern era

In Elbląg, as many as 7 oval boxes and 2 round boxes have been identified. The round containers were taller and bigger than the oval ones. They all shared the same design, namely, the bottom and the cover were made using small strips of wood with rounded corners, while the phloem walls were bent to fit the size of the base. Simple and light, these boxes seem objects that should be quite common (unless there were conditions that encourage deposition of organic material) in the archaeological material of medieval cities in Europe. In Elbląg, these objects are unearthed together with stave-built and turned vessels that occur in high volumes.

Nonetheless, the search for elements of boxes in the published materials failed to yield the expected results (e.g. Kołobrzeg, Lubeka, York). Perhaps their thin walls had been destroyed, whereas the bottoms and covers were considered fragments of small strips of wood.

The search for similar boxes was extended to include iconographic materials. Owing to the analytical meticulousness of some Renaissance painters, it was possible to notice that inside studios and living premises there were boxes of different size designed in the same way as the presented Elbląg box. They were both oval and round. In a painting by Colantonio[2] *Saint Jerome in His Study,* in the left corner on the bookcase an oval box can be seen (Bucci 2010, p. 319). In turn, another one, which is taller and round, is found on the upper shelf next to the right corner of the bookcase. The impulse of collecting among 16th–17th-century travellers and a wide range of humanists contributed to the formation of diverse collections of

[2] The painting was made ca. 1445. At present, it is kept at Museo del Capodimonte in Naples.

items brought primarily as a result of trips to America and Asia. This called for arranging a space to accommodate them and finding a way to store them. Boxes of a design similar to that of Elbląg boxes were used for this purpose, too. Probably, they appear most numerously in a 1599 engraving depicting a cabinet of Italian collector Ferrante Imperato. The boxes have been stacked on the lower shelves of bookcases. Depending on the size, there were at least 4 up to about 12 of them (Samida 2002, pp. 593–597, Fig. 2). Collector's cabinets or, more specifically, small museums were becoming more and more common. Obviously, there was a growing demand for reliable containers.

One hundred years later, the boxes had the same structure and still served for storing jewellery, ribbons, balls of wool, and threads[3], as well as small tools such as scissors and lace bobbins. Examples of such containers can be found in paintings by Johann Georg Hainz *A collector's cabinet with ivory cup*[4], or *A collector's cabinet* from 1664, as well as many other works of that era (Bartoschek 2005, p. 87).

Usually, boxes are presented in the iconography in the side view and bear no traces of a paint coat. The surfaces of covers and bottoms are not visible to the viewer. If they were painted, then only those who were using them and lived back in that time knew about this. In the light of the obtained information, the painted box is a unique find on a European scale.

Stave-built bowls are known from various sites in Poland and abroad. However, we can only guess what they were used for. As for the fragments of the bowl with a pinkish discolouration, its inner side was undoubtedly in contact with a red powdery dye. The same excavations yielded a bowl that contained various fruit stones (of apples and cherries, among others), as well as an entire egg. This material shall be presented in a separate study.

Conclusions

The studies of wooden artefacts found in Elblag confirmed the presence of a colourful pigment inside the wooden vessel (now only partially preserved) and almost completely destroyed floral and geometric ornaments on both parts of the wooden box, recognised during the careful conservation treatment. Due to the fact, that both finds are unique and their historic value is high, no samples were taken and completely non-destructive and non-invasive studies were made. Inside the partially preserved stave vessel, represented only by its bottom – a red Fe-oxides

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[3] A similar arrangement of boxes on bookshelves is found, for instance, in paintings by Barthélemy d´Eyck from the years 1443–1444; https://pl.pinterest.com/pin/442619469634479579/.

[4] KMSsp768, Statens Museum for Kunst; https://commons.wikimedia.org/wiki/File:Georg_Hainz,_Kunstkammerskab_med_elfenbenspokal,_,_KMSsp768,_Statens_Museum_for_Kunst.jpg?uselang=pl.

substance was stored, probably mixed with chalk. All pink ornaments are made by cinnabar and white decorations with lead white. Lead white mixed with bone white was probably the background for pink flowers. The results of dark ornaments are ambiguous; however, the iron and copper minerals are suggested. The organic substances used for colorization and/or as binders cannot be identified with used methods due to two facts: the conservation works introduced PEG 4000, which can cover the less intense analytical signals of the historic probably more decomposed substances. The second reason is the lack of agreement for more specialist but more destructive studies. If such acceptance can be obtained, the studies could be continued in the future.

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