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Silk band and metal appliqués of a child's bonnet from the northern crypt of the parish church in Gniew

Abstract

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ABSTRACT: The number of archaeological explorations of churches has increased in recent years. Inside medieval or Baroque temples, researchers report much more favourable conditions for the preservation of various kinds of artefacts which have been placed inside coffins as grave goods, in particular organic materials such as silk, leather, and wood). Exploring the northern crypt of St. Nicolas church in Gniew, the researchers' attention was focused on a child burial (aged 10–14). Despite the large number of exceptional finds supplied by this site, this one stood out as all the entire coffin space had been filled with silk bands and ribbons with green corrosion products on their surfaces. Preliminary examination showed that they were bunches of metal bands which had originally been meant to imitate plant branches. The decision was made to expand traditional technological analyses of archaeometrical tests of both textiles and metal appliqués. The material presented below is the first part of these analyses.

Key words: church, crypt, silk, metal appliqués, SEM-EDS, microscope, modern period, Gniew, Poland

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Introduction

The history of the archaeological studies in the St. Nicolas church in Gniew began with the southern crypt situated in the St. Ann chapel. The crypt was commonly called 'The Radziwiłł Family Crypt'.

Material excavated in the crypt was a great surprise for the research team, as it is the most numerous collection of archaeological silks in Poland (Grupa *et al.* 2015). It is today difficult to establish if the place was an ossuary for human remains which had been collected once or twice during clearing actions performed under the church floor. The action may have started in the second half of the 17th century, with the crypt being constructed afterwards or, alternatively, the ossuary and the crypt were built simultaneously. Both scenarios are possible. Thanks to these initiatives, the archaeologists found human remains under the floor which were still dressed in over 500 kinds of silk relics dating to the 16th and 17th centuries, as well as elements of various

grave goods (Grupa *et al.* 2016, 385–395; Grupa *et al.* 2015, 49–140). Since this situation existed in one crypt, the question arose as whether there were any other underground rooms with more relics under the floor, and if the excavated relics were indeed the remains of the ossuary from under the church. A number of related questions were asked, among others by the church's parish priest, Zbigniew Rutkowski, who was very interested in the problem. Having discussed all the issues, a plan for the archaeological exploration of the church was devised and launched in 2009, continuing for a number of subsequent seasons (Grupa 2015, 193–199; Grupa and Nowak 2017, 159–172; Majorek and Grupa 2014, 335–348; Majorek and Wojciechowska 2018, 71–81; Nowak *et al.* 2015, 425–429).

Every year, the team returned for a month of excavation work which brought the results in detailed exploration of the northern crypt in 2011 (Fig. 1).

The team excavated a brick room under the chapel floor which was 2,3 × 2,76, with a height at the coping

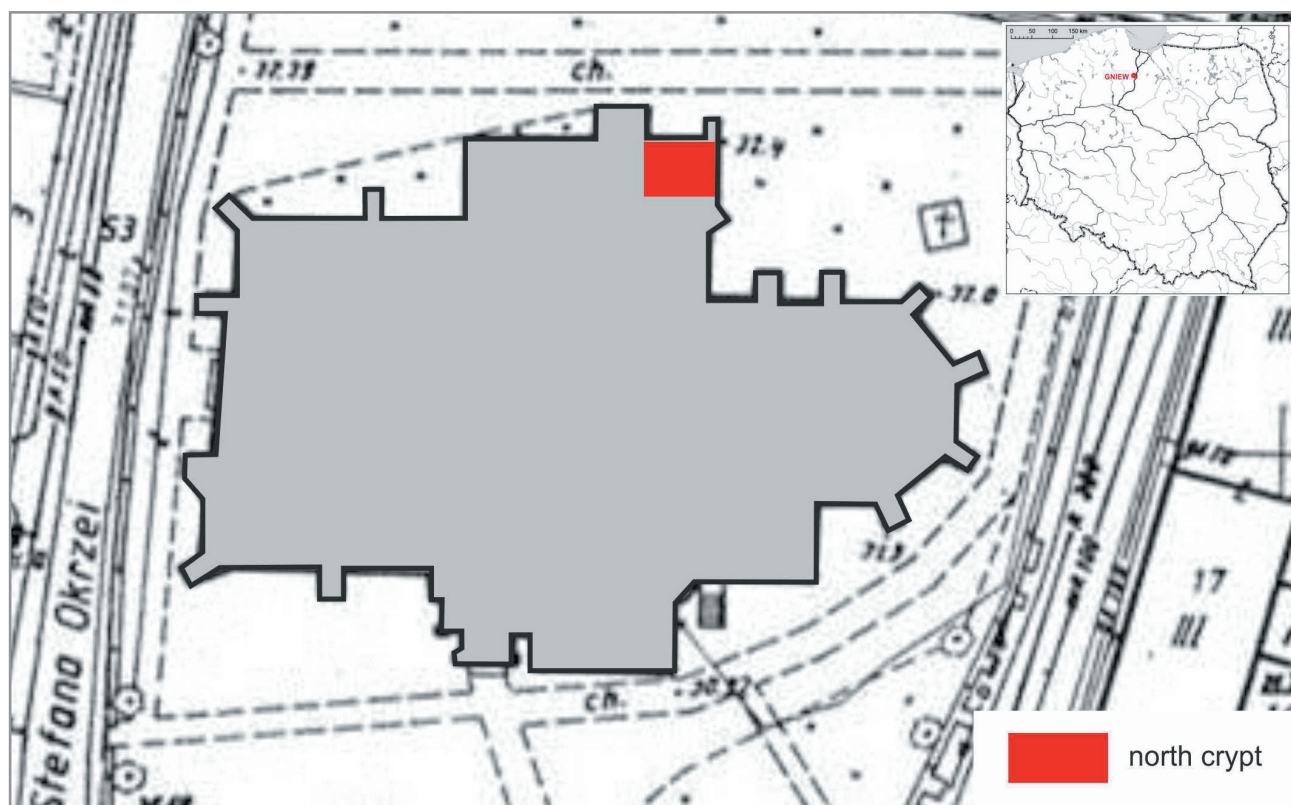


Fig. 1. Gniew, St Nicolas church, The crypt location inside the church. Gniew location on the map of Poland (dig. T. Dudziński).

of about 1,95 m, without any signs of vault construction and lacking stairs into it (Wojciechowska 2012, 15). Particular coffins must have been lowered from the church interior, dismantling floor tiles and supporting constructions such as tombstones with coats of arms, etc every time. Our suppositions were supported by the discovery of numerous fragments of broken tiles. The crypt was no longer used after the collapse of the part which held the tiles, something which probably transpired at the turn of the 17th century (one of the short coffin sides bore the date 1680, and the upper filling layer held a coin dating from 1703. The circumstances which caused the collapse of upper crypt construction are impossible to estimate based on the excavation details. It might have been a controlled collapse in order to flatten the ground before installing the floor tiles. We have been unable to establish the person responsible for the founding of the crypt, although we can suppose it may have been one of the families of the starosts or representatives of the local Catholic nobility in 17th century Gniew.

Besides the brick crypt, on the eastern side there was also an over ground brick object which was interpreted as a single tomb (Fig. 2: 4). The burial excavated there was cut in half by the chapel foundations, and its bricked floor delivered the finds of Teutonic

coins from the 14th century. All of the coins were stuck together with corrosion products and they gave the impression that they had been placed there deliberately. The person buried there might have had them in his pocket or in a sack which decomposed during deposition. The chapel builders did not clear the crypt floor, but only levelled it with sand, dismantling the brick walls. If they had transported the skeleton situated there, they would have found the coins placed near the remains' loins. These facts will be discussed in another article.

The brick crypt (Fig. 2: 2) contained a total of seven wooden coffins and eight very decomposed skeletons, belonging to adult individuals and children. The coffins may have been placed on top of one another in two rows, along an E-W axis. They were equipped with metal fittings and textile upholstery (coffin no 5 and 6), and some of them were decorated with rivets forming inscriptions and dates or, as in the case of coffin no 7, a cross along the whole lid length. The coffins were partially destroyed, and the bones placed in the burials above had mixed with the bone material in the bottom coffins (Wojciechowska 2012, 16–21). The team's attention was focused on a child burial (10–14 years old), deposited in coffin no 5 (Fig. 3).

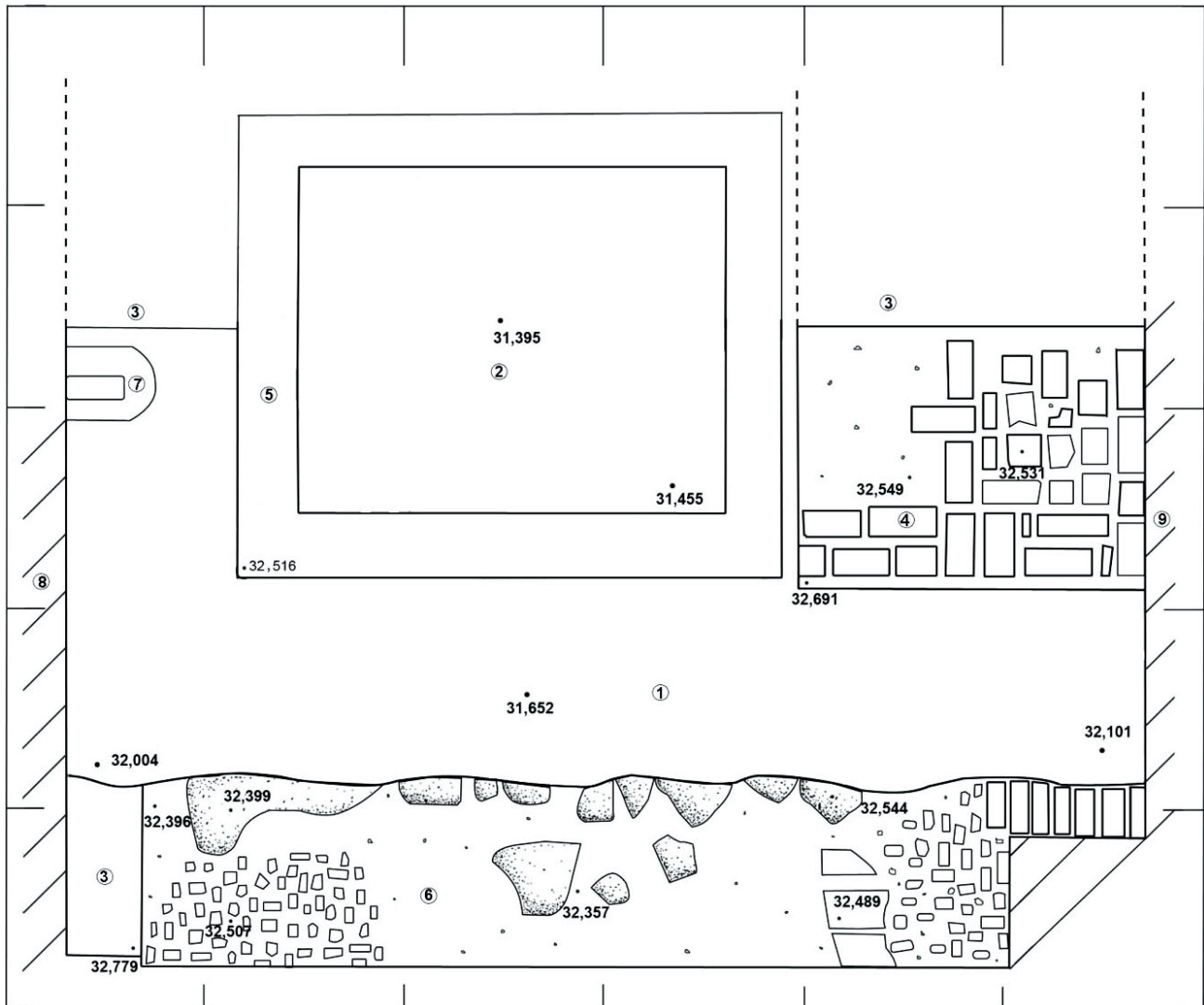


Fig. 2. Gniew, St Nicolas church, northern chapel, Projection of a trench bottom on the level (AMSL) in northern chapel after excavating architecture relics. Captions: 1. bright brown humus with sand, 2. mixed brownish humus with sand, crypt filling, 3. floor of northern chapel, 4. brick floor, 5. crypt walls – brick spotted with mortar, 6. stone-brick foundation spotted with mortar, 7. crypt ventilation hole, 8. cross-section of the chapel western wall, 9. cross-section of the chapel eastern wall (drawn by A. Kochmann, dig. M. Słomczewska).

State of the body and grave goods preservation – coffin no 5

The child bones were strongly decomposed – the skeleton poorly preserved, with recognizable small fragments of a skull bones – including the right and left parietal bones and facial bones (preserved teeth, but only dental crowns, roots nearly completely damaged), lack of postcranial skeleton (Wojciechowska 2012, 50). Coffin relics were filled with bands (belonging to haberdashery textile production) and metal elements covered with green corrosion products. The found textiles included silk ribbons and one galloon, which had probably been pinned over a grave robe, made of linen textile.

The bands have signs of brass pins. Where the skull would have been, several teeth and a bonnet decoration were identified. Bands with stylized zoomorphic pattern (Fig. 4), pinned on a grave dress decorated its front (Fig. 5). They were placed in layers on the (no longer existing) main part of a bonnet, made of linen textile and giving the impression of its rich decorative character.

The bands had bunches of artificial branches pinned at intervals which were made of thin tin (Fig. 6). The composition was fixed to the bonnet with brass pins and the same method was used for fastening ribbons and metal band bunches all along the child's gown.

There is no doubt that these metal elements distinguished the attire of the buried child. The preserved



Fig. 3. Gniew, St Nicolas church, northern crypt, a child burial, placing metal decorations on a band ornamenting the grave gown visible (photo M. Nowak).



Fig. 4. Gniew, St Nicolas church, northern crypt, A bonnet band with zoomorphic pattern (photo D. Grupa).



Fig. 5. Gniew, St Nicolas church, northern crypt, Band and metal appliqué from a child bonnet (photo D. Grupa).

band is an example of high quality textile production. Due to the significant destruction caused by the collapse of the crypt vault, the complete form of the decorations is difficult to identify, although tests enabled the technique of the production of some of the elements to be established.

Technological analysis of the band

The band width 2,5 cm was divided into three sections, and counting separated edges – into 5: edge 0,1 cm – 8 warp threads: 4 violet, 4 in natural silk colour, weave 2/2; next – a strip 0,6 cm wide, in satin weave 4/1 and warp density per 0,5 cm – 40 threads in S twist; central strip with pattern 1,1 cm wide, in plain weave 1/1, with density per 1 cm: 36 non twisted thread of warp per 24 non twisted thread of weft; and again – a strip 0,6 cm wide in satin weave 4/1 and separated edge 0,1 cm. A zoomorphic pattern was situated in the central band section which was shaped by warp threads, at present in a colour close to violet, and the

threads of the background. The pattern was formed using various lengths of warp threads interlacing from 2/1 to 9/1 (Fig. 4, 7).

On the basis of analyses and comparative tests, it was stated that the band was made of silk yarn. The tests were confirmed by means of the analysis of electronic microscopic scans (SEM) (Machnowski *et al.* 2010).

Silk textiles, including haberdashery, were made largely of silk yarn produced from a silky cocoon envelope (raw silk) (the most often *Bombyx mori* L, to a smaller extent from wild silk, called tuss silk – Beuth 1969, 37; Dudziński *et al.* 2017, 97), which are classified as protein fibres. In fifth stage of its development, the larvae starts the process of enveloping itself in silk yarn, making about 350,000 octal-shaped head movements to produce a cocoon built of a single silk thread from 500 to 3500 meters long (Kopański, 1955; Grześkowiak and Łochyńska 2017, 101). The silk thread is built of two elementary fibres stuck together with an adhesive substance and this elementary fibre creates fibrous proteins, while this gluing substance is sericin (coating gum). On the base of quantitative analyses, it was

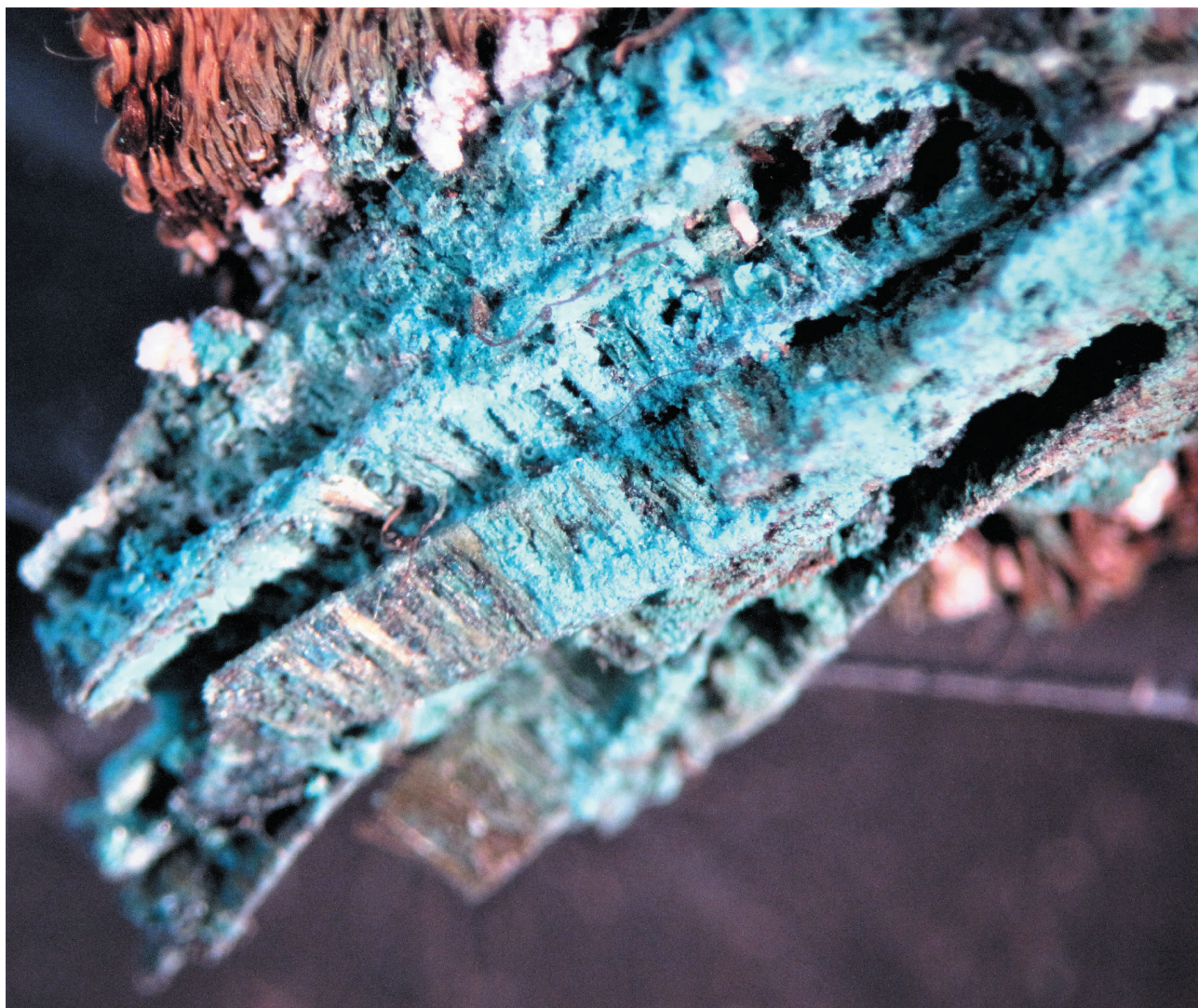


Fig. 6. Gniew, St Nicolas church, northern crypt, Metal appliqué wound round with thread from the bonnet band, magnification 10× (photo D. Grupa).

stated that the tested silk contains 72–81% of fibrous proteins and 19–28% of sericin. Apart from these two basic components, there are also waxes and fats of about 0,5–1,0%, as well as dyes and mineral substances of about 1–1,4% (Mirowska *et al.* 1992, 124–127). Both proteins are built of polypeptide chains of α -amino acids. In the fibrous protein polypeptide chain, there are sequences of 18 various α -amino acids, with the highest participation of *glycine* – 33,34%, *alanine* – 26,62% and *serine*, *tyrosine* (primary structure). These chains connect with one another with hydrogen bonds composing β -sheet (II and III – protein structure). Sericin is protein built of 16 α -amino acids and it is rich with *alanine*, *serine* and *leucine* and its function is gluing and enveloping fibroins (Mirowska *et al.* 1992, 114–115).

The chemical composition of the silk fibres determines its physical and chemical properties, and thus

influences the resistance of textiles made from them. Hence, all silk fabrics are relatively resistant to water activity, although they absorb significant quantities of it (even to 30%) simultaneously losing its glow and softness and their mechanical durability decreases. Adsorption of substances contained in water by polypeptide chains is equally dangerous (sericin present in silk is partly soluble in water). Up to temperature of 140°C, silk fibres are stable but thermal decomposition starts over 170°C. Photochemical decomposition is also very destructive. Exposure to sunlight over a 10 day period can cause a decrease of mechanical durability of 30%. Fibres are completely susceptible to oxidising agents, but resistant to reducing agents. Proteins, like all peptides, are amphoteric compounds and therefore can react with acids and alkalis. In the case of silk, fibroin demonstrates substantial resistance to mineral and or-

ganic acids, although with a low pH, high concentration of hydronium ions and raised temperature, acid hydrolysis takes place. Fibroin is very sensitive to alkaline environment and with pH 10 hydrolytic decomposition is observed.

Summing up, we must bear in mind the processes which are particularly predominant in crypts, i.e. enzymatic decomposition caused by microbiological corrosion. Enzymes cause fibroin decomposition slower than in wool, but we must remember that its speed increases greatly when silk fibres are mechanically or chemically damaged (Sapieja *et al.* 2008, 17), which is the case in the crypt deposition here (Grupa 2007, 208).

Analysis of the preservation state of metal appliqués and silk band

Metal appliqués made of narrow bands tied together and reminiscent of elongated leaves or branches were completing elements of the bonnet decoration (Fig. 5, 6).

Using SEM-EDS methods, we were able to establish the technique and technology of the making of these elements and the state of preservation of silk fibres from the examined band.

Taking into account the conditions in the crypt, the researchers stated that the silk and metal elements were affected by a corrosion process with mechanical and physical factors (the action of water, steam, metal elements corrosion products crystallization) as well as chemical ones, combined with microbiological corrosion.

The band was destroyed and this was caused by steam at various pressures, resulting from microclimate change (RH and temperature) in the crypt, and microbiological corrosion. Substantial discoloration, textile fragility in places, fibre looseness and shifts in weave and substance loss were reported in the examined band (Fig. 7).

The band state was determined by the corrosion of the metal elements in the form of a green, crystalline coating compounds on the surface and inside the



Fig. 7. Gniew, St Nicolas church, northern crypt, Forms of the band destruction, magnification 10× (photo D. Grupa).

textile (Fig. 8). It can be deduced from the colour that this was copper and, in consequence, it led to delicate but permanent discoloration (Fig. 7). Apart from the blue-green copper compounds, white crystals were also identified on the surface.

The fibres morphology and their condition were tested using SEM-EDS devices, and both the natural colour and patterned band were examined. Both kinds of fibres are similar but some differences were established as well, which in single fibres enabled their characteristics to be distinguished (Fig. 9–11). The background yarn is thicker (weft) than the yarn from ornament (warp), twist of both threads is varied (weft is thick, non-twisted), and as a result of it they are in better condition. Fibres of brighter yarn have a cross section close to a circle, with a diameter 8,5–9,5 μm . This is a somewhat low value in comparison to the data quoted

in literature, which is 13–25 μm (Sapieja *et al.* 2008, 17; Mirowska *et al.* 1992, 126), while the darker fibres are more flattened and twisted, and in their form close to a band with rectangular or triangular sections, with a thickness of about 4,5 μm and 12,2 μm wide. The surface of the bright fibres is strongly damaged with visible spectra and delamination (Fig. 9), while the dark fibres (from the zoomorphic pattern) are smooth, without destruction in the single fibres. In both cases, the surfaces are covered with single crystals of mineral substances, observed in macro scale on the textile surface.

The different morphology stated in tests of both kinds of silk fibres also indicates differences in their resistance. The fibres used for ornament making are more resistant to damage whilst the raw silk (not dyed) from the band's background was more affected by the corrosion process.

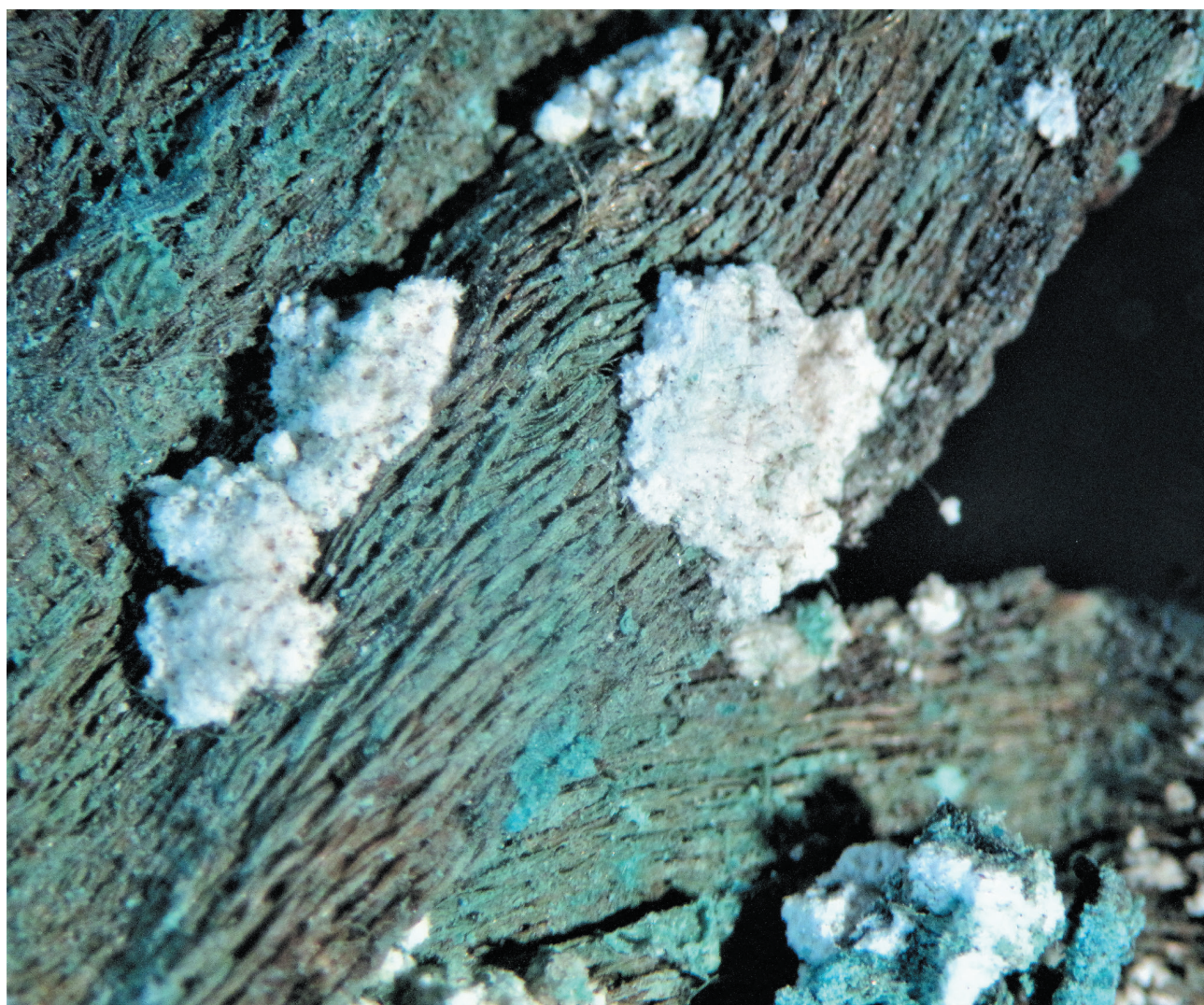


Fig. 8. Gniew, St Nicolas church, northern crypt, Coating of mineral substances on the band surface, magnification 10 $\times$ (photo D. Grupa).

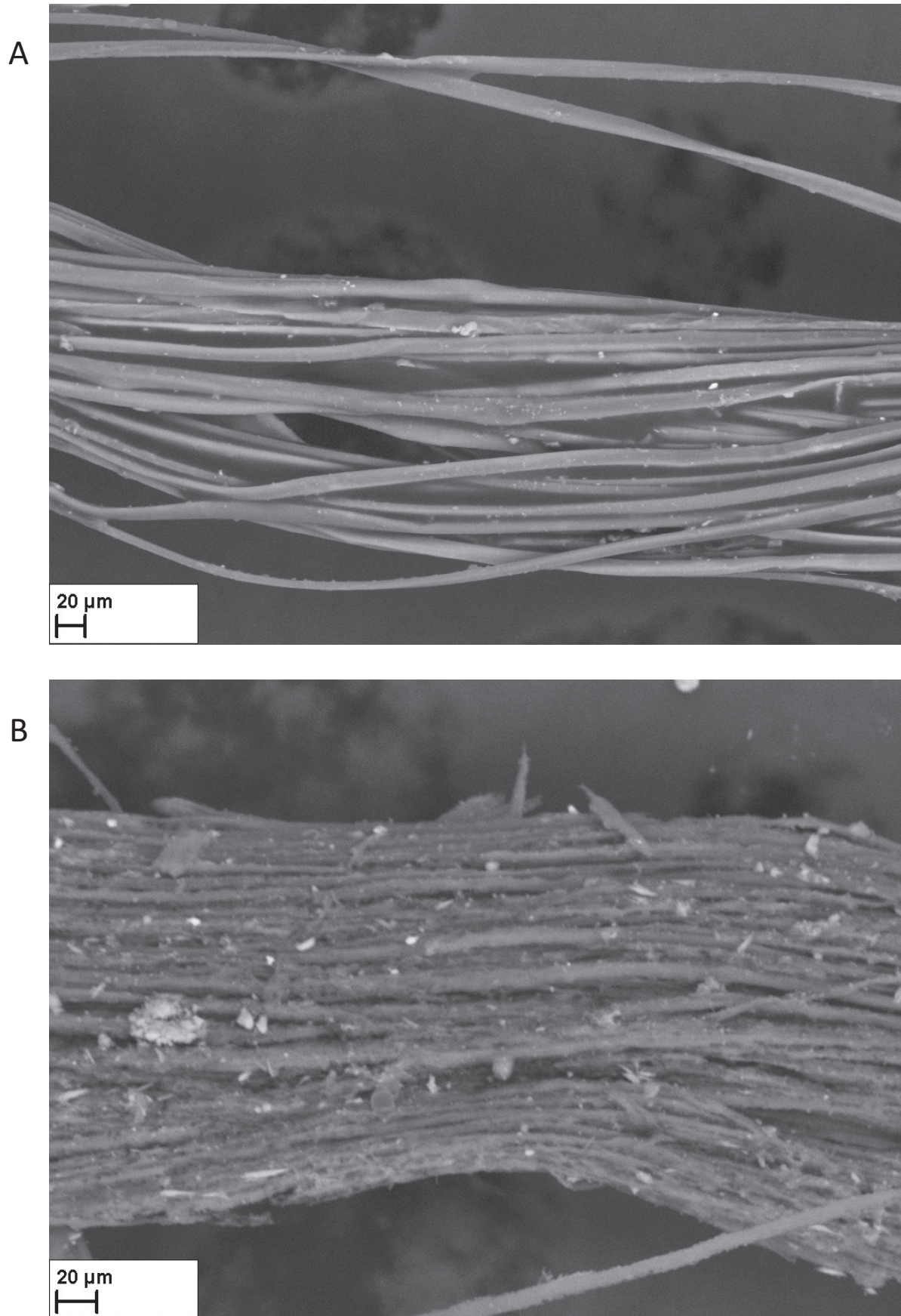


Fig. 9. Gniew, St Nicolas church, northern crypt, State of band yarn preservation: A – from the textile background, B – from zoomorphic ornament (photo G. Szczepańska, J. W. Łukaszewicz).

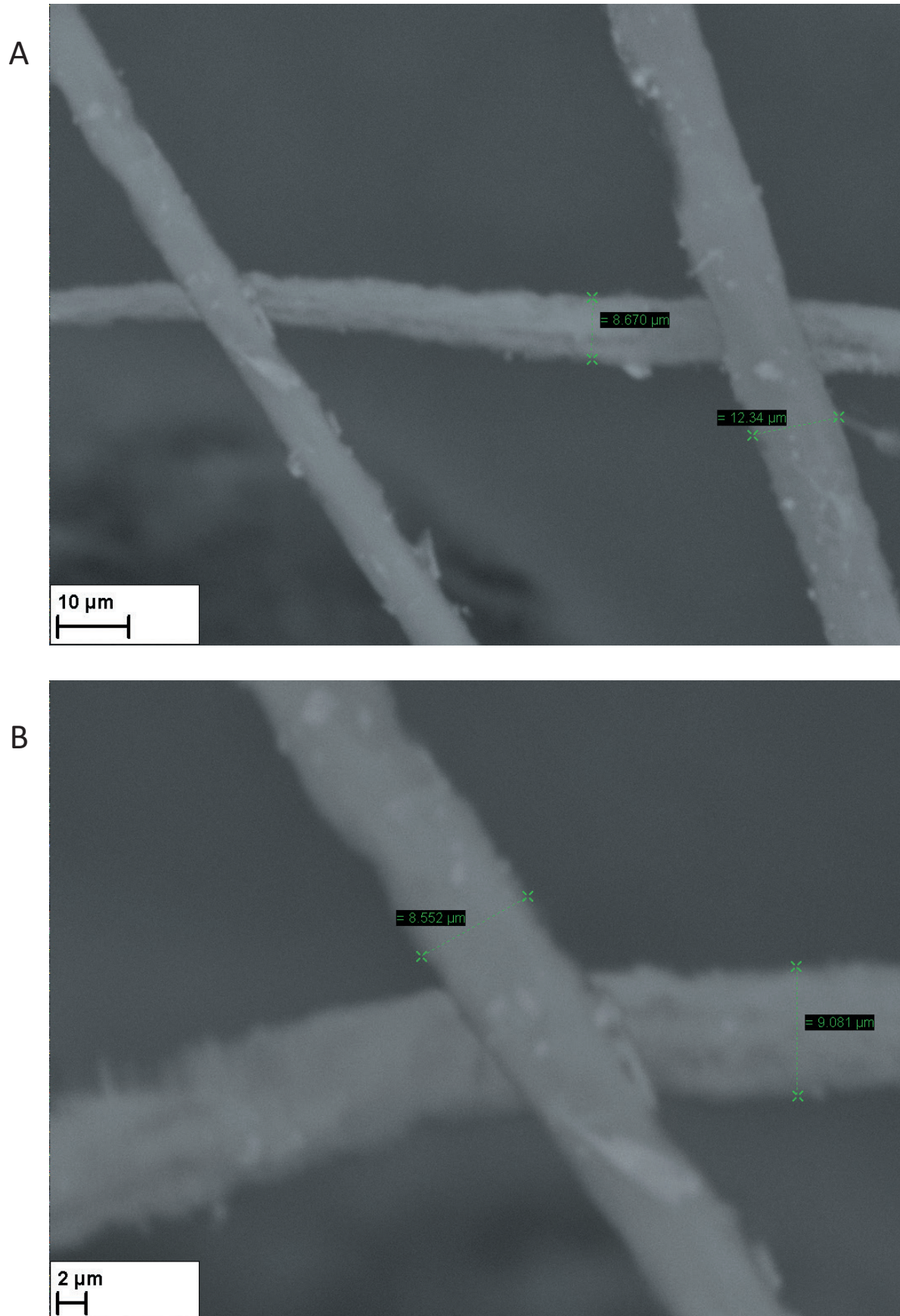


Fig. 10. Gniew, St Nicolas church, northern crypt, State of preservation of single silk fibres from the background:
A – smaller magnification, B – larger magnification (photo D. Grupa, G. Szczepańska, J. W. Łukaszewicz).

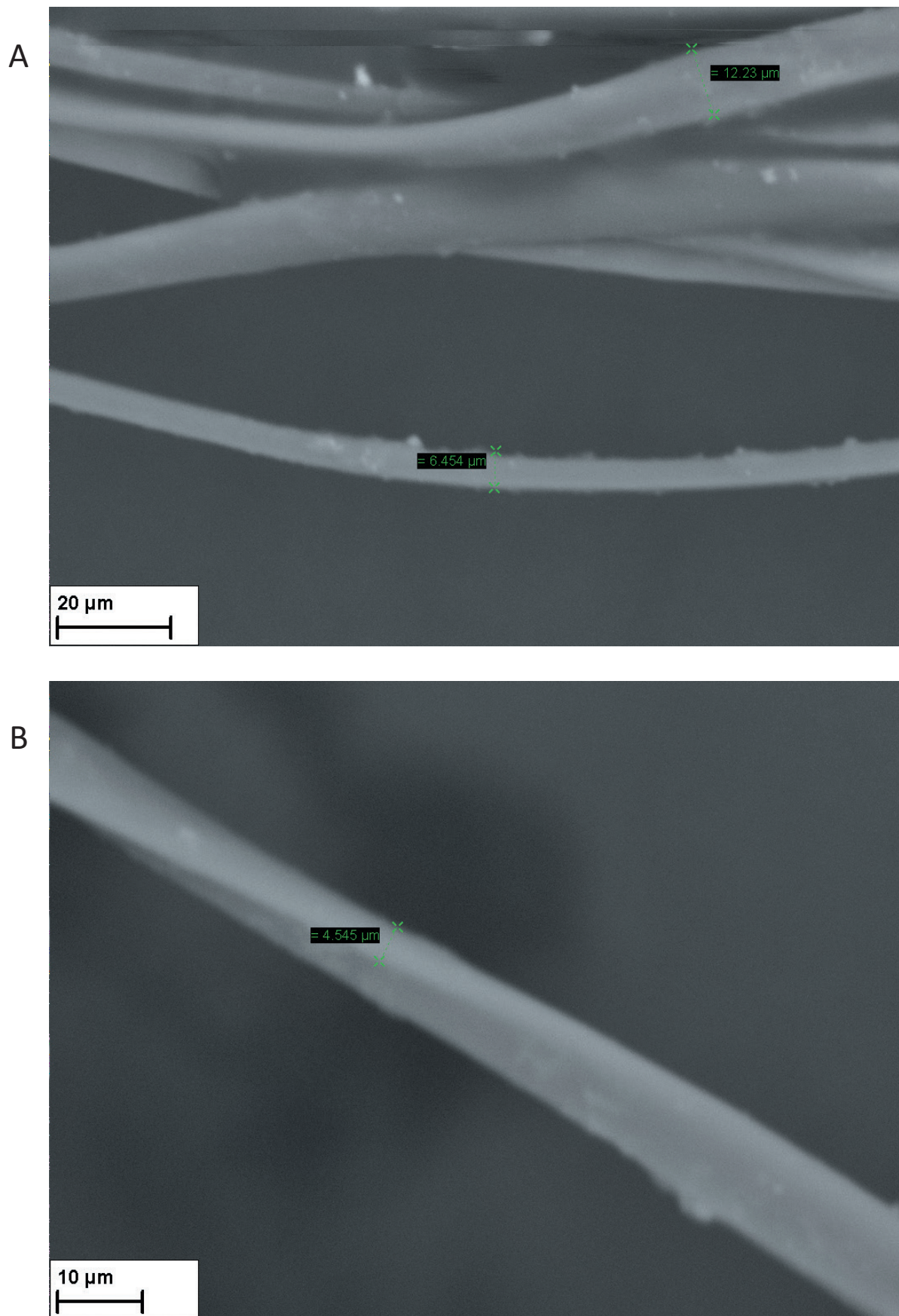


Fig. 11. Gniew, St Nicolas church, northern crypt, State of preservation of single silk fibres from the ornament at different magnifications: A – smaller, B – larger (photo G. Szczepańska, J. W. Łukaszewicz).

Metal decorations

Bunches of leaves fastened to the band are made of a thin metal strip wound round with yarn. Analogies can be found in decorative textiles with various uses, e.g. similar elements were reported in textiles exhibited in the palace of Mafra (Portu-

gal) (Fig. 12), or on fabrics in Lublin (Fig. 13), Gniew and Piaseczno (Grupa 2018, 36–37; Grupa *et al.* 2014, 162–182; Miazga 2018, 162–165; Miazga *et al.* 2018, 68–76).

Observation of the condition and corrosion products on the decorations suggest copper plate, which was evidenced in SEM-EDS tests (Fig. 14).



Fig. 12. Portugal, Palace of Mafra (palace-monastery complex) a detail with ornament in form of leaves bunch – chasuble from the 18th century (photo J. W. Łukaszewicz).

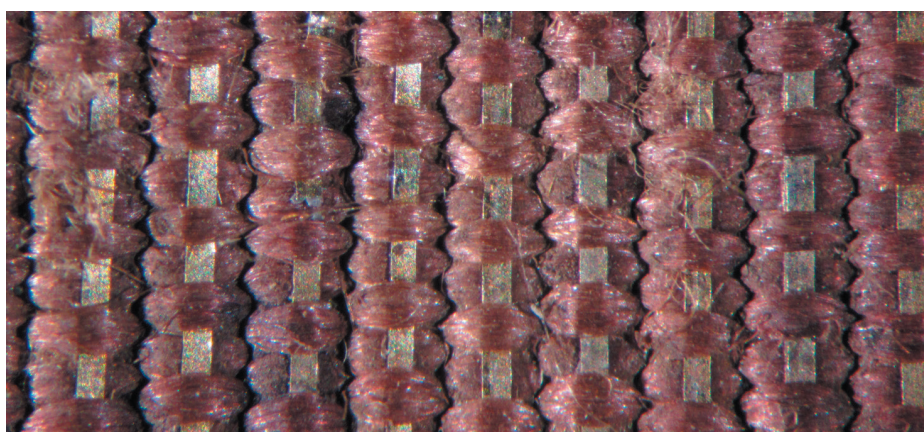
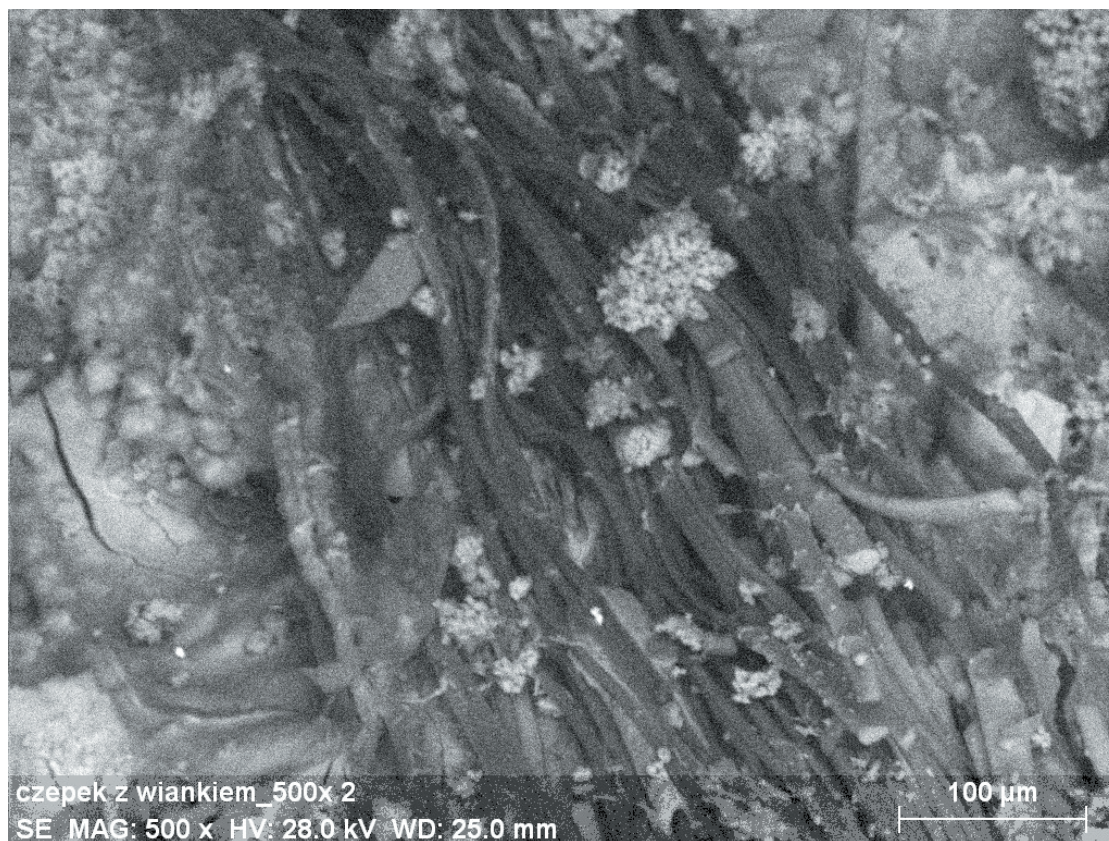


Fig. 13. Poland, Lublin, St. John church, Silk textile with extra gold weft in form of a band of a coffin upholstery (photo D. Grupa).

A



B

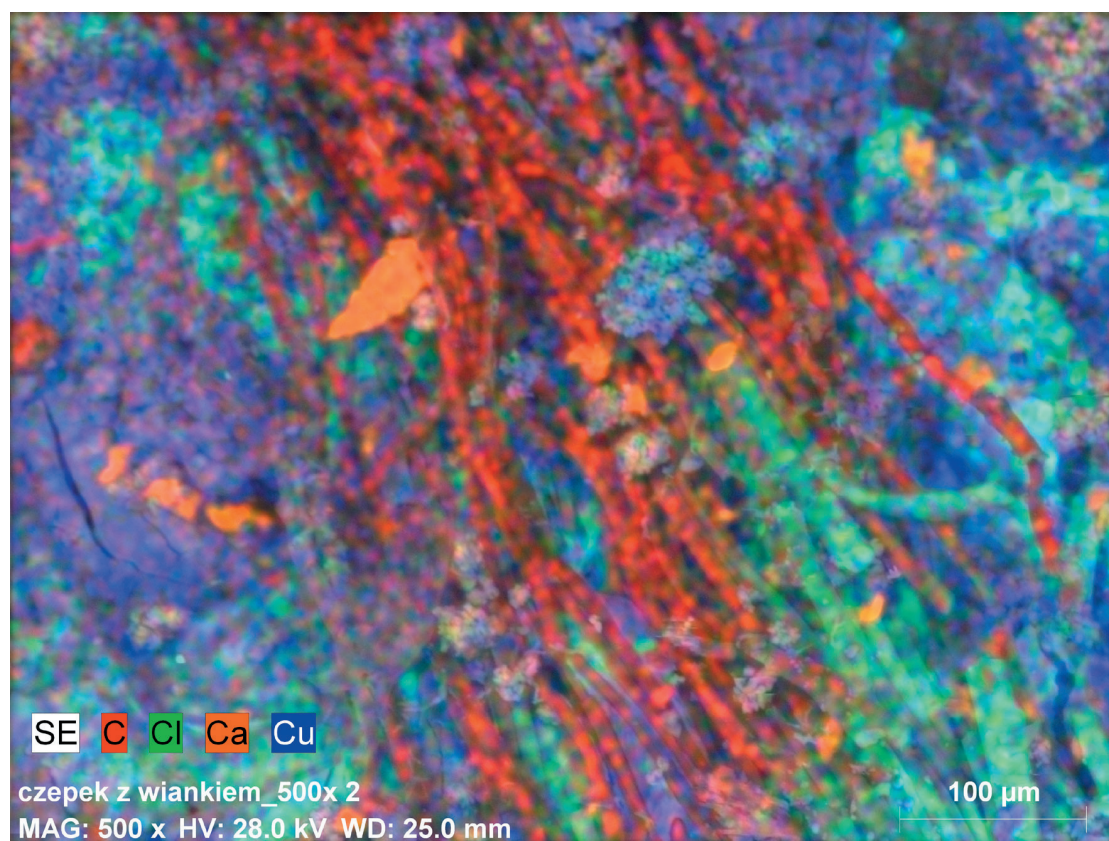


Fig. 14. Gniew, St Nicolas church, northern crypt, appliqué from a child bonnet, A – SEM image of the sample (BSE detector), B – quantitative analysis of metal decoration from the band places of presence of copper plate, copper chloride, calcium phosphates and silk fibres (photo G. Szczepańska, J. W. Łukaszewicz).

Qualitative and quantitative analyses (SEM-EDS) in the micro space of the metal decoration confirmed that the plate was made of copper, producing mainly copper chloride as a result of corrosion, and the braid fibres are an organic compound (presence of C, O and small quantity of nitrogen), i.e. silk. Within the analysed samples, the presence of calcium and phosphorus were reported and places of their occurrence overlap, leading to the conclusion that calcium appears in the form of phosphates coming from the decomposition of the bone tissue of the dead child. In the studied material, these phosphates appear as tiny grains (Fig. 14), but also as crystallized ones and these are the white coatings observed on a band fragment presented earlier (Fig. 8). The residual quantity of silver reported in the test of the metal decorations was a surprising and slightly unusual result (Fig. 15).

The presence of silver led to expanded tests which helped to recreate the technology of metal ornament's production and a more complete definition of the corrosion product. The analysis was made on prepared fragments of metal plates with yarn braiding (Fig. 16).

The tests showed that the decorative elements were made of thin copper plate silvered on both sides and braided with silk yarn. In the crypt conditions, the

copper corroded and this is confirmed by the number of copper compounds on the surface of the leaves and the band. The corrosion product caused the breakdown and delamination of the silver layers, hence it was difficult to identify the presence of silver at the initial testing stage. Chlorides were identified in places where copper compounds and silver occurred and thus it can be concluded that chlorides were created on the surface of both the copper and the silver.

Conclusions

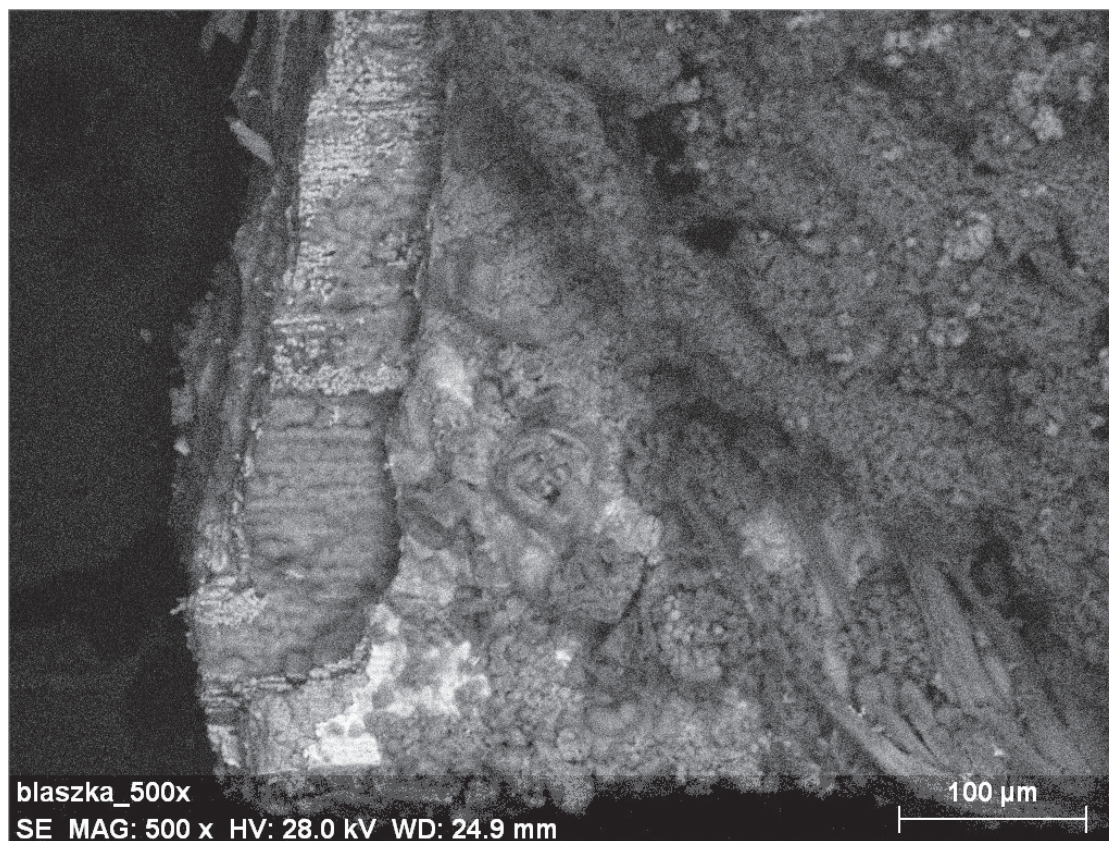
Due to the significant destruction of the crypt and the crushing of its contents, it is difficult to precisely recreate the forms of the excavated metal decorations, although it is certain that they are bunches of metal leaves tied around with silk thread (Fig. 6).

Archaeological analyses of wreaths, artificial flowers and textiles with metal thread are usually limited to formal descriptions and technological textile analyses (Drażkowska 2006; Grupa 2015a; 2015b). Physical and chemical tests using studies based on various methods considerably expand this knowledge base, defining the material for the production of wreaths, flowers, tex-



Fig. 15. Gniew, St Nicolas church, northern crypt, appliques from a child bonnet, SEM image of the sample (BSE detector) (photo G. Szczepańska, J. W. Łukaszewicz).

A



B

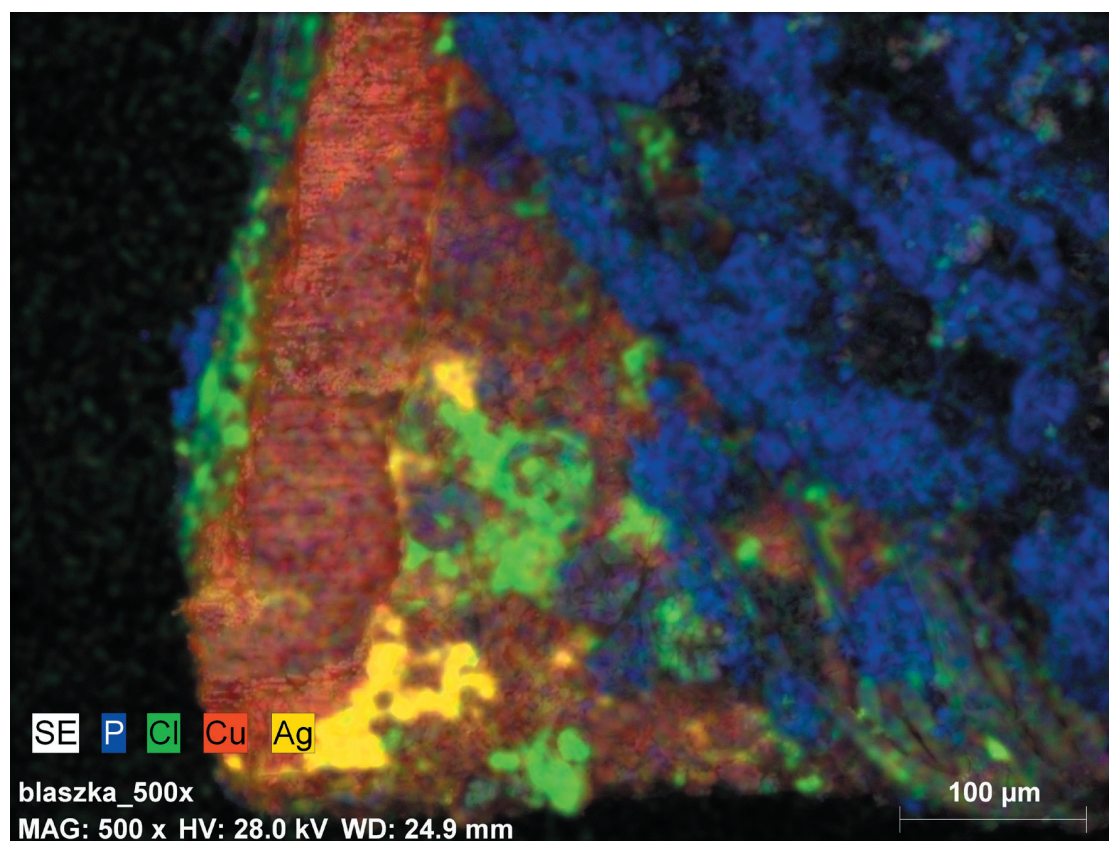


Fig. 16. Gniew, St Nicolas, northern crypt, appliqué from a child bonnet, A – SEM image of the sample (BSE detector), B – quantitative analysis of metal decoration from the band, residual presence of silver detected (photo G. Szczepańska, J. W. Łukaszewicz).

tiles and galloons (Miazga 2018, 161–167; Miazga *et al.* 2018, 68–76). and creating the opportunity for different interpretations of the data to be presented regarding the abilities of the craftsmen who made them.

The study defined the condition of the elements of the clothes of the buried child:

1. Differences and similarities of silk fibres in the band and its ornament were defined.
2. Technique of making metal ornaments fixed to the band was elaborated.
3. Composition of corrosion products present on the band and metal decoration was defined.
4. SEM-EDS methods were applied to obtain the results above.

Wreaths made of artificial or natural flowers were one of the most interesting elements of the grave goods of young girls, bachelors and children in the Baroque period, as they were symbols of virginity, purity, innocence and virtues (Drażkowska 2006, 209–217; Grupa 2015, 41–47). A significant quantity of these objects were excavated in southern crypt of Gniew temple and in graves under the church floor. The construction of each of them was a small work of art (Grupa *et al.* 2015, 117–122; Grupa and Nowak 2017, 159–172). However, the appliqué from the bonnet explored from northern crypt differs much from the construction of the wreaths. First of all, the bunches of leaves were arranged in a similar manner to a wreath. Their morphological analysis showed that they were made in a completely different way to the elements of wreaths known earlier, because a copper plate was covered with a silver coating from both sides and tied around with silk thread, possibly in a natural silk colour, although the green corrosion products on it do not permit us to define it properly. This construction could have been made for an individual order to make it stand out from the others. At present, it is difficult to find another such rich and varied decoration of a child's grave clothes from the Baroque period in Poland.

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