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A R T I C L E S

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The diversity of ceramic raw materials used in the production of Neolithic vessels in the upper Vistula basin near Krakow

Abstract

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Specialist analysis of ceramics helps to identify the raw material used for their production and to determine whether the material was chosen deliberately for its specific parameters. The present study of Neolithic vessels and of sampled raw materials has shown that Linear Pottery population tended to use plastic Miocene clay, but silty alluvial loam was equally popular. A comparison between the types of vessels and ceramic bodies has proven that thin-walled vessels were more often made of material with a high content of grains of silty fraction, while thick-walled vessels were usually shaped from heavy clay. This suggests that there were certain rules to be observed when preparing the paste, despite the local diversity of raw materials.

Key words: early Neolithic, raw materials, ceramics, petrography, Małopolska

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Introduction

Besides flint and stone tools, ceramic raw materials rank among the most numerous artefacts recovered from archaeological excavations. This provide evidence that the farming populations used resources available to them and that knowledge of these resources resulted from familiarity with the local environment, while the choice of the raw material depended on the level of expertise in vessel production.

Specialist analysis of ceramics helps to identify the raw material used for their production and to determine whether the material was chosen deliberately for its specific parameters. Studies of this kind have become a standard archaeological procedure. This text presents the results of mineralogical and petrographic analyses of raw materials and ceramic fragments related to early Neolithic cultures in the upper Vistula basin near Krakow. Diversity in the use of clay is illustrated here with several examples taken mostly from the sites from which complete set of data have been obtained, i.e. Site 5 in Modlnica, Site 62 in Mogiła (north of the Vistula River) and Site 17 in Brzezie (south of the Vistula River). Some of the results have already been published in descriptions of the individual sites (Rauba-Bukowska 2014; Rauba-Bukowska 2011) and in a report on a research grant (Czekaj-Zastawny and Rauba-Bukowska 2013). The publications are complemented by the analysis of clay materials sampled in the vicinity of Site 5 in Modlnica, Site 2 in Modlniczka and Site 62 in Mogiła, presented here for the first time.

Geology and geomorphology of the research area

The analysed sites lie within the Carpathian Foredeep. Their geological structure consists of Palaeozoic and Mesozoic deposits forming the substratum of the foredeep, Miocene deposits filling the basin, and a Quaternary cover which has developed since the Pleistocene.

The Miocene sediments are situated discordantly on the Upper Cretaceous planation surface. They are known from drilling and isolated surface exposures e.g. in the brickyard in Zesławice near Nowa Huta, or from isolated outcrops in the vicinity of the site in Brzezie. They are sediments of marine origin: clays and marly claystones interbedded with sand with interlayers of sandstones and locally with characteristic levels of tuffites. The outcrops of the Miocene sediments are located in places where the Quaternary cover has been cut through by erosion.

The Quaternary deposits consist mainly of alluvial sediments, including fluvioglacial sands and gravels filling the glacial valley of Vistula, loesses covering the high terrace of the Vistula and elevations, as well as Holocene muds, sands and gravels deposited within the flood plain of the Vistula and in the valleys of its tributaries.

The archaeological sites north of the Vistula lie within deposits of the high terrace (6–25 m high) built of sands, calcareous gravels and sandy loams covered with a loess layer 10–15 m deep.

The sites south of the Vistula (Brzezie) are located on loess. Site 17 in Brzezie lies in the seepage spring area of the Tusznica, a left-bank tributary of the Raba, on flat terrain between a steep scarped slope to the west and a gentle slope descending towards the bottom of the river valley to the east. Loesses are the immediate substratum of the soil.

When the Neolithic cultures evolved, the Vistula was an aggrading river in the low-lying areas (the Grobla Forest near Niepołomice being one of the vestiges). The aggradation, related to high humidity at the beginning of the Atlantic period (Kalicki and Starkel 1989), has left its traces in the avulsion of the channel in the Vistula valley. At the beginning of the Subboreal (ca. 3300 BC) the river started to cut into the rocks of the substratum. This probably resulted from climatic changes and anthropogenic transformations of the Vistula catchment area, which grew stronger with the developing settlement in the Carpathians at the turn of the Bronze Age (Valde-Nowak 1988).

Materials and methods

Specialist analysis, including microscopic examination of ceramics, is widely used in archaeology, and the material for comparison is steadily growing. Analysed ceramic fragments from the Krakow region mostly represent the Linear Pottery culture (abbreviated as LBK from German: Linearbandkeramik): approx. 400 thin plate sections (e.g. Rauba-Bukowska *et al.* 2007; Rauba-Bukowska 2014; Rauba-Bukowska 2016). The study has also covered vessels produced by the Malice culture (MC): 45 thin sections (Rauba-Bukowska *et al.* 2007; Rauba-Bukowska 2011), the Funnel Beaker culture (FBC): 20 thin sections (Rauba-Bukowska 2011), and the Corded Ware culture (CWC): 7 thin sections (Rauba-Bukowska 2011). Moreover, samples of local clay raw materials have been collected as reference material (Fig. 1).

Thin sections of the pottery sherds and the clay samples were examined under a polarizing microscope in transmitted light. The quantitative petrographic method (point counting) was used to identify the percentage of individual components, such as clay minerals, quartz, potassium feldspars, plagioclases, muscovite, biotite, carbonates, heavy minerals, and grains of sedimentary, metamorphic or igneous rocks. The analysis also involved the schematic description of each thin section, as well as photographic documentation of the results. Moreover, micrometric measurement of the grain size was taken under a microscope. Thermally induced changes in the clay matrix and temperature-sensitive minerals (e.g. glauconite, biotite) helped to establish the approximate temperature at which the vessels had been fired. Small bricks, 5 × 7 cm, were formed from the sampled raw material, dried at 100°C for 24 hours and then fired at 700°C in an electric kiln for 12 hours. The resulting product was well fired and hard, and thin sections were made for microscopic examination.

Results

Characteristics of raw materials sampled in the vicinity of the sites

Five samples were taken in the vicinity of Site 5 in Modlnica. After macroscopic overview, three of them were selected for further analysis: sample Sur14, taken from the depth of approx. 60 cm in a flat terrace of the Wedonka River in a boggy area near an old brickyard (Fig. 2:a); sample Sur15, a piece of a brick from the brickyard (Fig. 2:b); and sample Sur16, coming directly from the Wedonka river bed (Fig. 2:c). The analysis has shown that all three samples are loess-like sediments with a significant amount (>50%) of medium-rounded grains of silty fraction. Main components of the sampled materials are: clay minerals (approx. 30–40%), grains of quartz (40–60%), feldspars (approx. 1–3%), mica flakes (approx. 1%) and heavy minerals (approx. 0.1%). The clay mass is saturated with iron compounds, which makes the samples intensely orange after firing. Most grains are 0.02–0.05 mm in diameter. In this

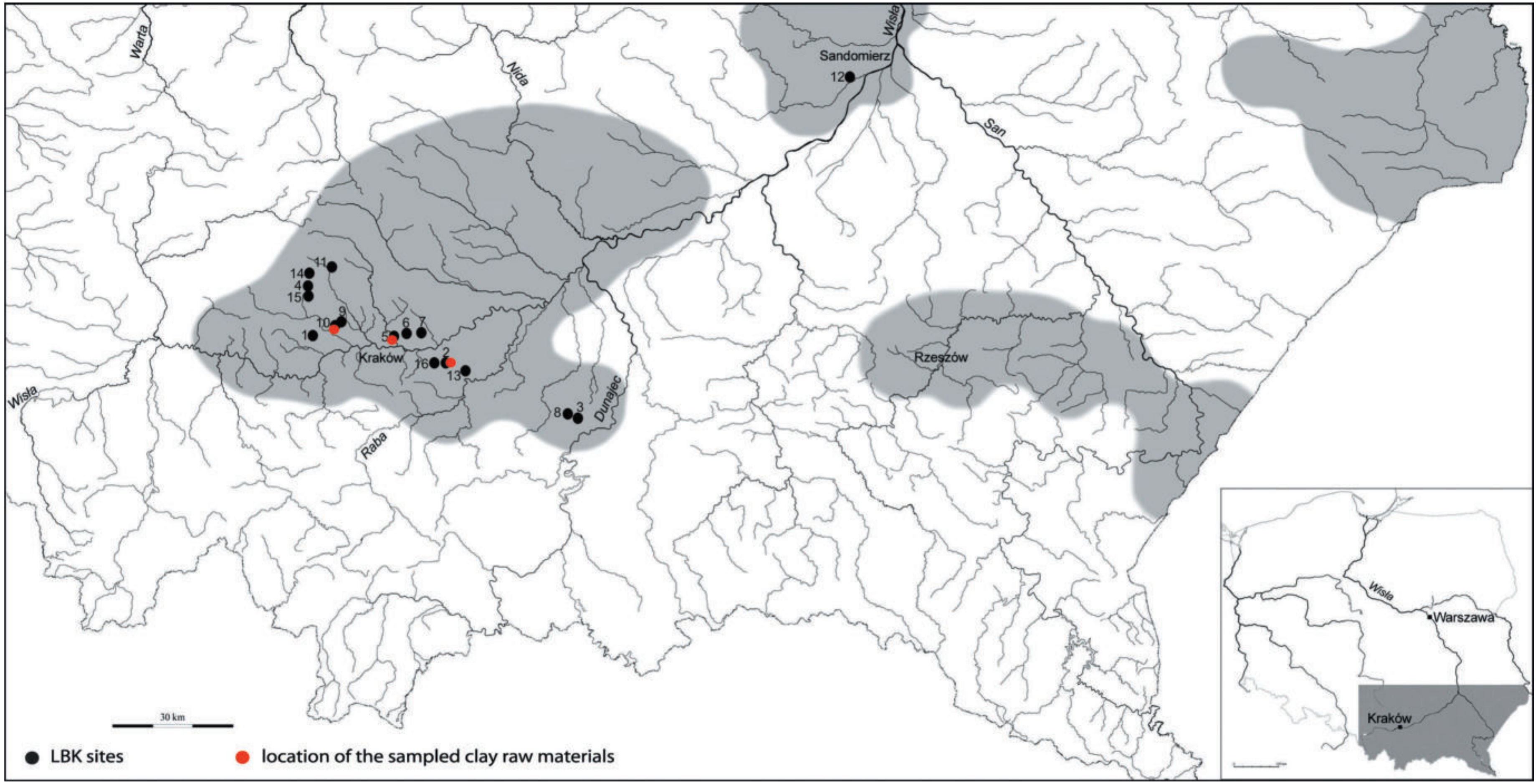

Fig. 1. A map of the Linear Pottery culture in south-eastern Poland with the sites which have provided ceramics and samples of raw material for analysis. 1 – Aleksandrowice 2, Zabierzów commune; 2 – Brzezie 17, Kłaj commune; 3 – Gwoździec 2, Zakliczyn commune; 4 – Kobylany 1 (Pod Słupami Cave), Zabierzów commune; 5 – Krakow-Nowa Huta-Mogiła, Site 62; 6 – Krakow-Nowa Huta-Pleszów, Site 17–20; 7 – Krakow-Nowa Huta-Wyciąże, Site 5; 8 – Łoniowa 18, Dębno commune; 9 – Modlnica 5, Krakow commune; 10 – Modlniczka 2, Krakow commune; 11 – Ojców 3 (Okopy Wielka Dolna Cave), Skała commune; 12 – Samborzec 1, Samborzec commune; 13 – Targowisko 11, Kłaj commune; 14 – Wierzchowie (Wierzchowska Górna Cave), Wielka Wieś commune; 15 – Więckowice 4, Zabierzów commune; 16 – Zagórze 2, Niepołomice commune.

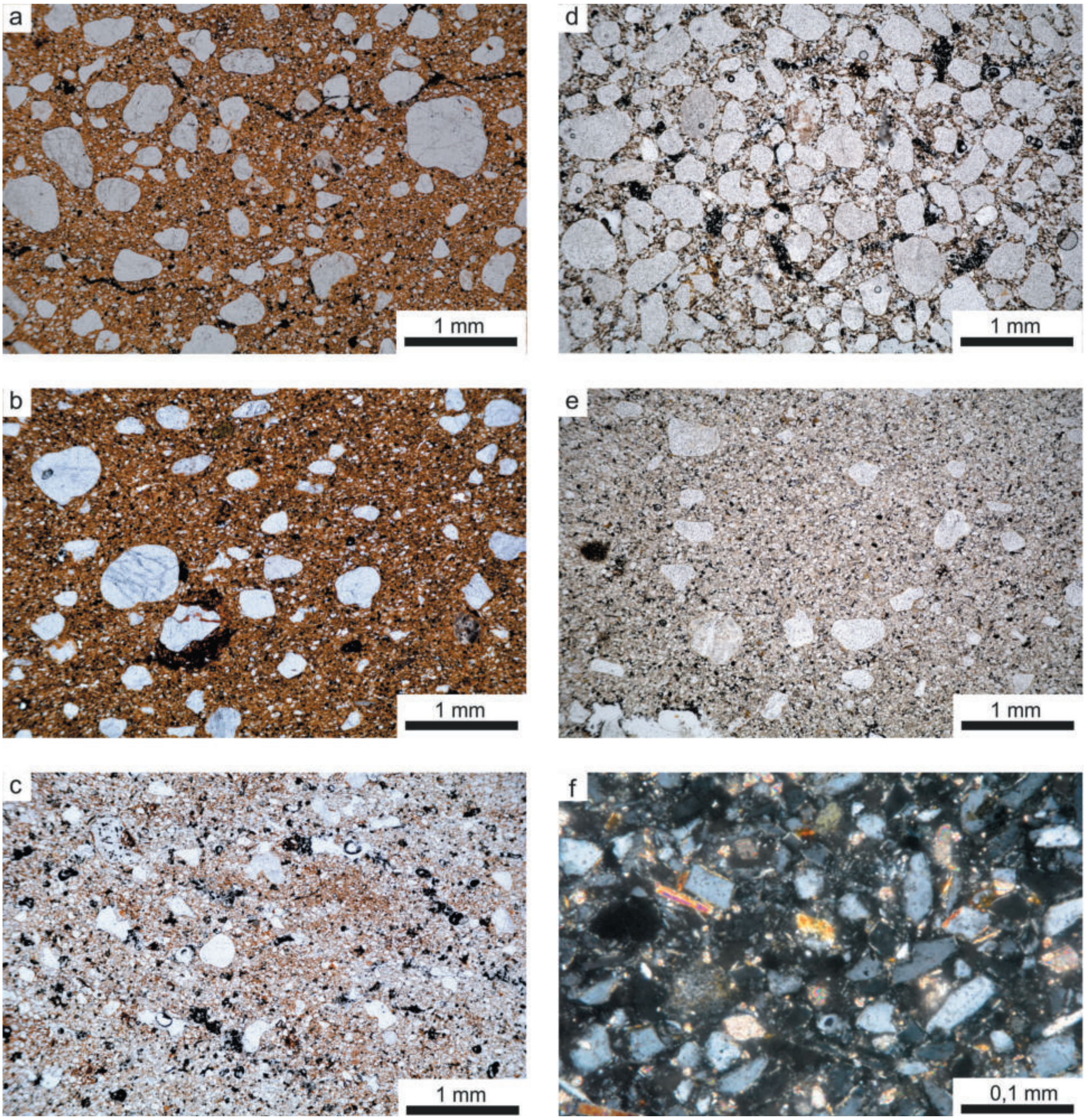

Fig. 2. Microscopic photographs of sampled raw materials: a – sample Sur14: numerous rounded grains of quartz in a fine-grained matrix, 1N; b – sample Sur15: numerous rounded grains of quartz in a fine-grained matrix, 1N; c – sample Sur16: fine-grained matrix coloured with iron compounds in some places, small content of clay minerals, 1N; d – sample Sur6: sandy clay with a significant amount of well-rounded grains of sandy fraction of quartz and feldspars, 1N; e – sample Sur9: loess consisting mainly of grains of silty fraction, a small amount of clay minerals, and rounded grains of sandy fraction, 1N; f – sample Sur9: carbonate components (micrite and fine grains of calcite) visible in voids, NX.

fraction, rounded grains of monocrystalline or (more rarely) polycrystalline quartz, usually with a diameter of 0.2–1 mm, make up approx. 5–10%. The smallest amount of grains of silty fraction has been identified in the sample taken from the brick in the old brickyard (Fig. 2: b).

During the excavation carried out at Site 62 in Mogiła in 2010–2011, which uncovered artefacts of the LBK, samples of sediments: sandy clay (Sur6; Fig. 2: d) and loess (Sur9; Fig. 2: c) were taken directly from the site. The analysis has shown that apart from grains of silty fraction, the loess sample contains medium- and well-rounded grains of quartz (approx. 0.15–0.3 mm), as well as clay and carbonate clay in voids (Fig. 2: f). The sample of sandy clay consists of grains of silty fraction and a significant amount (>50%) of grains of sandy fraction, mainly 0.2–0.5 mm, with clay substance without carbonates as the matrix.

During field survey at Site 17 in Brzezie, six samples were taken from the immediate vicinity of the site: loess, river sediments, soil and three samples of Miocene clay (Rauba-Bukowska 2007, 2014). The samples of loess, alluvial sediments and soil include over 50% of quartz, approx. 40% of clay minerals, as well as feldspars, grains of sedimentary, igneous or metamorphic rocks, mica (Fig. 3: a, b), and a small amount of heavy minerals. The grains are poorly rounded (Rauba-Bukowska 2014). Measurement of the grain size confirmed granulometry typical of loess deposits (e.g. Książkiewicz 1979: 238–241). The samples of Miocene deposits consist of clay minerals (60–70%), quartz (20–30%) and such non-plastic inclusions (5–15%) as feldspars, rock fragments, muscovite and biotite flakes and grains of glauconite (Fig. 3: c, d). As the analysis has shown, two clay samples taken from the depth of 10 and 20 cm are more contaminated, e.g. with organic matter and sedimentary rock fragments. Sample BVI collected at the depth of over 30 cm is the most plastic and with no contamination (Rauba-Bukowska 2014). The samples from the top part of the substratum have definitely coarser grains than the clay from the depth of 30 cm. The degree of the roundness of silty grains is again low.

In 2006, deep test pits near Site 17 in Brzezie revealed a continuous level of clays at 267 m a.s.l. The deposits had formed in a Miocene sea over the vast area between Krakow and Tarnów ca. 13–13.5 million years ago (the Upper Badenian). In their facies, they turn locally into the Bogucice sands, identified e.g. in the vicinity of Wieliczka (Porębski, Oszczypko 1999). The continuous level of those clays was documented several dozen metres from Site 17 in Brzezie.

The sample of clay with the least contamination (sample BVI) has additionally been examined under a scanning electron microscope. Moreover, the porosity and density of the material have been analysed, and the phosphorus content has been determined by absorption spectrophotometry and X-ray fluorescence spectrometry (XRF).

The examination of sample BVI under the scanning electron microscope has shown that the fired

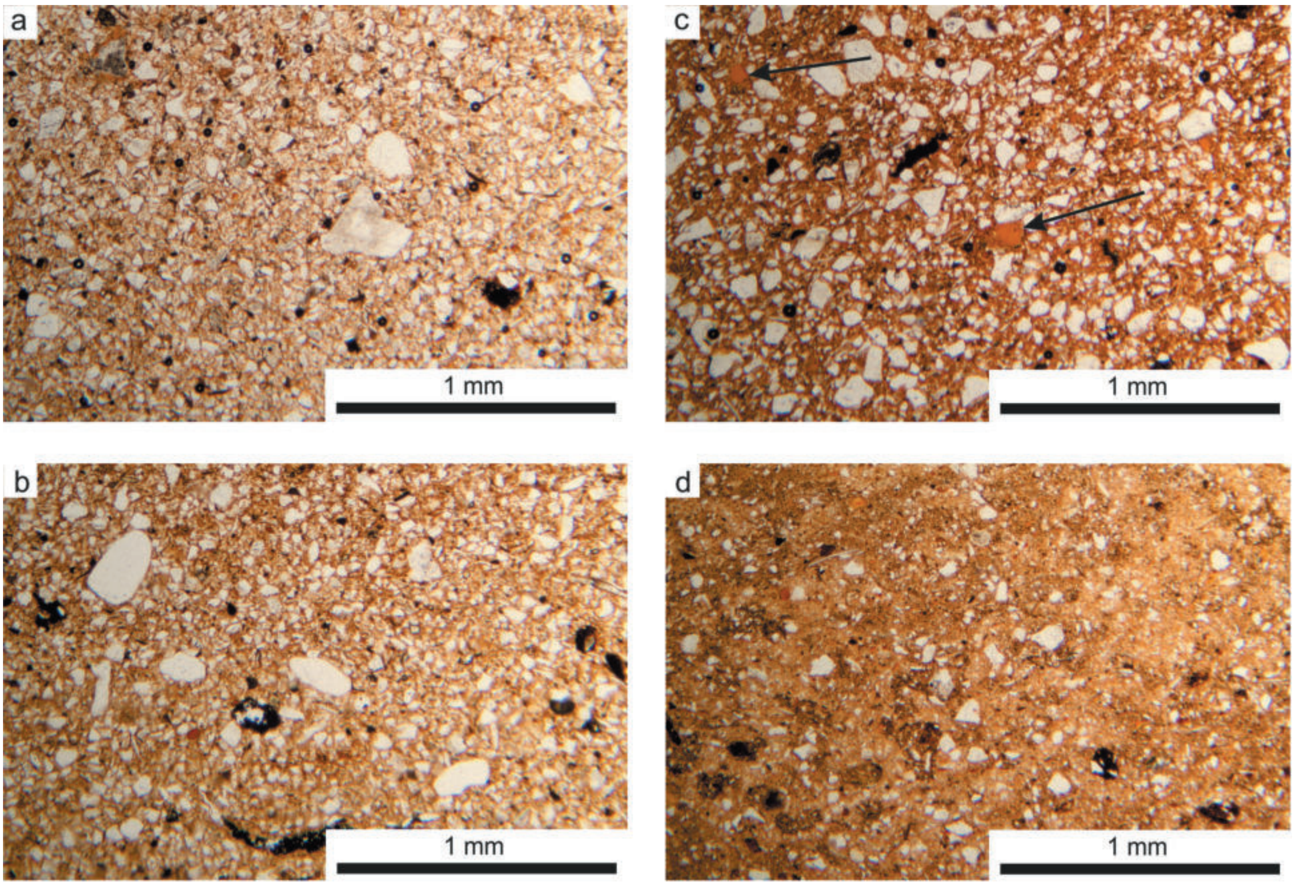

Fig. 3. Microscopic photographs of sampled raw materials: a – sample BI: loess with grains of silty fraction, 1N; b – sample BII: alluvial clay with grains of silty fraction and some organic remains, 1N; c – sample BIV: Miocene clay (10 cm) with grains of thermally altered glauconite (arrows) visible in sorted coarser clastic material, 1N; d – sample BVI: Miocene clay (30 cm), heavy clay with a small admixture of clastic material, 1N.

sherd is compact and fine-grained with no organic matter. Energy dispersive spectroscopy and chemical analysis have not detected a phosphorus content in the clay matrix. The content of P_2O_5 is 0.024% – over a hundred times lower than in the ceramic bodies of vessels (Rauba-Bukowska *et al.* 2007: 85). As the analysis of the physical properties of the sample has shown, the actual density of the material resembles that of earthenware and the porosity is low (Rauba-Bukowska 2014).

In order to determine the usefulness of the material for the production of ceramics, an attempt was made to form vessels from the sampled loess and alluvial sediment. The former material turned out to be unsuitable for the task, whereas the latter was successfully used to make a vessel, which was later polished with a piece of bone to obtain a smooth and slightly glossy surface (Rauba-Bukowska 2014).

The results show that heavy clay is a very good material in pottery. Its technological properties may be improved, however, by mixing loam with an appropriate amount (ca. 20–30%) of fine-grained sand (e.g. Kordek 1986; Bolewski, Budkiewicz and Wyszomirski 1991).

Characteristics of Neolithic ceramics in terms of raw materials used

Analysis of samples of pottery fragments recovered from Site 5 in Modlnica has shown that vessels of the LBK, the MC, the FBC, a Modlnica type assemblage with furchenstich and the CWC were made of two kinds of raw material at least (Rauba-Bukowska 2011: 311–383). One of the kinds, commonly used, was heavy clay with remains of marine microfauna, e.g. siliceous frustules of diatoms, and with sherds of volcanic glass (Fig. 4: a, b). This suggests that the material was Miocene age clay deposited in that area under of the Quaternary cover. Volcanic glass typical of those deposits reflects increased volcanic activity in the Carpathians during the Miocene time. The other popular raw material was fine-grained alluvium clay with fine mica flakes and fragments of rocks (e.g. flint) (Fig. 4: c). Sherds of the CWC, which have also been examined, do not contain any elements characteristic of Miocene clay, such as marine microfauna or volcanic glass. The ceramic bodies of those vessels include fragments of calcareous rock and grains of flint. Their raw material seems to have been alluvial sediment of rivers which carried clastic matter from the Krakow–Częstochowa Upland.

As microscopic examination has shown, ceramics of the LBK at Site 62 in Mogiła are made of diverse raw materials (Czekaj-Zastawny A. and Rauba Bukowska A. 2013), Miocene clay and alluvium being the most common (Fig. 4: d). Two kinds of remains of marine plankton have been identified within the Miocene clay: some samples contain skeletons built of calcium carbonate (*Foraminifera*), while other samples contain skeletons built of silica (*Diatoms* or *Radiolaria*). The alluvium usually includes grains of flint, chalcedony and the rocks of the Carpathian flysch (Fig. 4: c).

Several vessels were made most probably of material unavailable locally, with a significant amount of well-sorted medium-rounded grains of fine sand fraction. The samples also contain many thermally altered grains of glauconite (Fig. 4: f). The properties are reminiscent of Cretaceous deposits in the Miechów Basin (Panow 1934; Tarkowski, Liszka 1982).

Analysis of Linear Pottery ceramics from Site 17 in Brzezie has helped to identify several types of raw material which differ in their mineral composition, especially in the percentage of clastic material in the ceramic body. The first type: heavy clay with a small natural admixture of grains of silty fraction, contains small amount of mica flakes and heavy minerals, e.g. zircon, as well as bigger rounded grains of sedimentary rock, e.g. ferruginous slate, mudstone or, more rarely, sandstone (Fig. 5: a). The second type has a small amount of grains of silty fraction, too, but it contains a larger amount of clastic material, which consists mainly of grains of quartz, feldspars, fine mica flakes and heavy minerals. It also shows sporadic fragments of igneous rock. The grains are poorly or medium-rounded (Fig. 5: b). The third type has a significant amount of grains of silty fraction, of very fine or fine sand (ca. 15–30%), which are mostly grains of quartz or, more rarely, feldspars. There are small (approx. 0.05 mm) inclusions of yellowish isotropic clay substance and some thermally changed glauconite. The material contains more mica flakes (muscovite and biotite) than the preceding types. Heavy minerals, such as zircon, and clasts of sedimentary rock, mainly mudstone, are present as well (Fig. 5: c). The fourth type consists of clay mass (approx. 50–70%) and almost exclusively of grains of fine silt (<0.02 mm) and fine mica flakes, though heavy minerals have also been identified (Fig. 5: d). The analysed samples do not include relics of marine plankton or grains of volcanic glass, which are characteristic of Miocene clay on the left bank of the Vistula.

Conclusions

The Neolithic settlements were situated near genetically diversified ceramic raw materials including alluvial clay, loess-like material, Miocene clay and older marly deposits, mainly from the Cretaceous period.

Ceramics from the sites on the left bank of the Vistula include vessels made of Miocene clay which con-

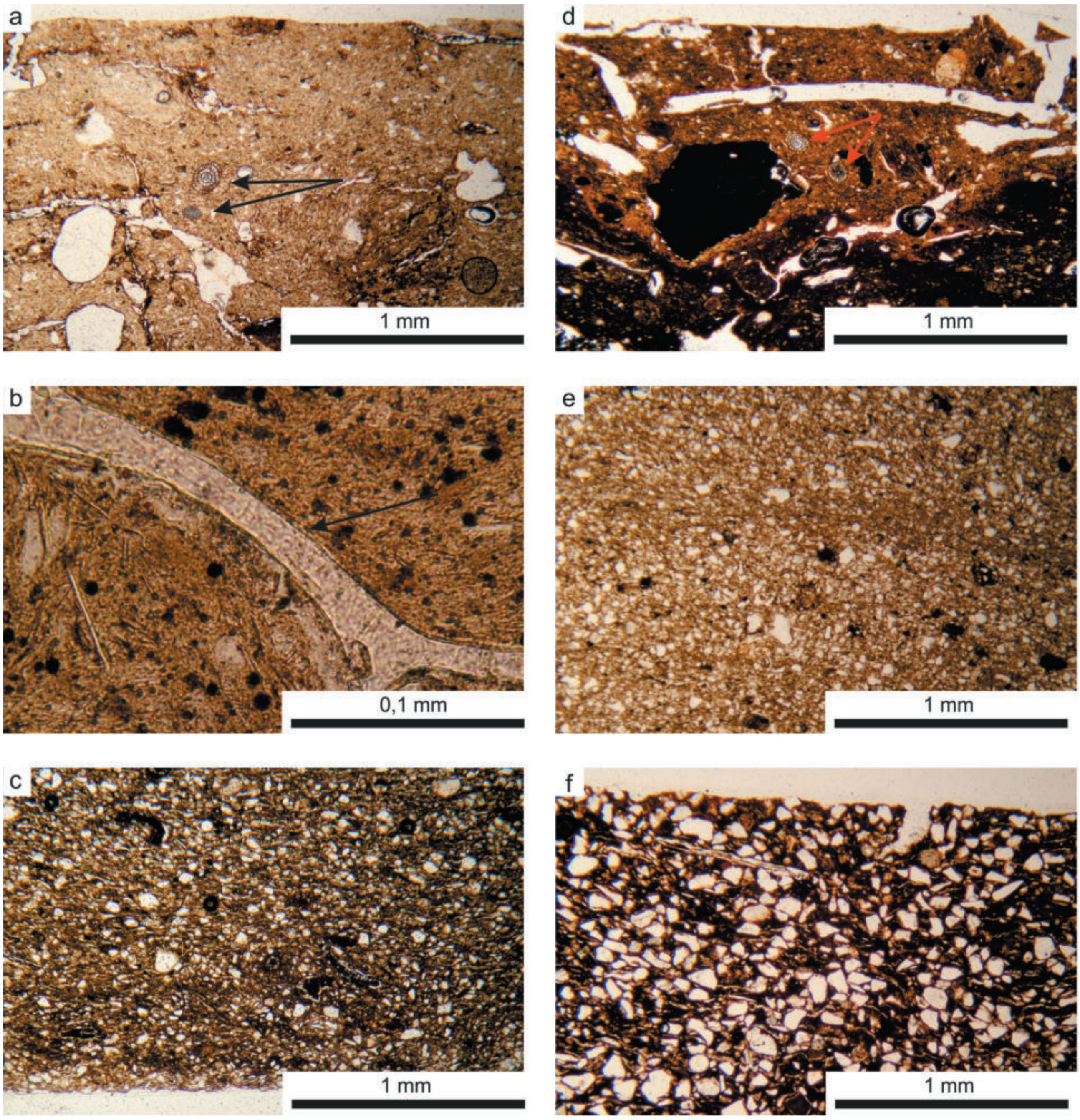

Fig. 4. Microscopic photographs of the ceramic bodies of Neolithic vessels: a – sample Modl69: ceramic body with relics of siliceous skeletons of plankton (arrows), 1N; b – sample Modl64: fragment of volcanic glass (arrow), 1N; c – sample Mod152: fine-grained matrix with some plant remains, 1N; d – sample Mog23: ceramic body with clasts of ferruginous rock (the dark clast in the centre) and relics of siliceous skeletons of plankton (arrows), 1N; e – sample Mog41: homogenous fine-grained ceramic body, 1N; f – sample Mog26: ceramic body with well-sorted grains of sandy fraction and thermally altered grains of glauconite (dark brown), 1N.

tains siliceous skeletons of *Diatoms* or *Radiolaria*. At Site 62 in Mogiła, calcium carbonate shells of *Foraminifera* have been recorded as well. Site 5 in Modlnica has yielded pottery with grains of volcanic glass. All these traits indicate the local diversity of deposits of a similar origin. The presence of volcanic glass and well-preserved relics of marine plankton in the ceramic bodies show clearly that the clay was formed in the Miocene.

Ceramics from the right bank of the Vistula are also made of older clay and loess-like material. Identification of raw materials has proven more difficult there than in the case of vessels from the left bank, because the examined thin sections do not have such characteristic components such as microfauna, volcanic glass or clasts of limestone. The clay sampled near Site 17 in Brzezie is more contaminated with clastic material, mostly quartz

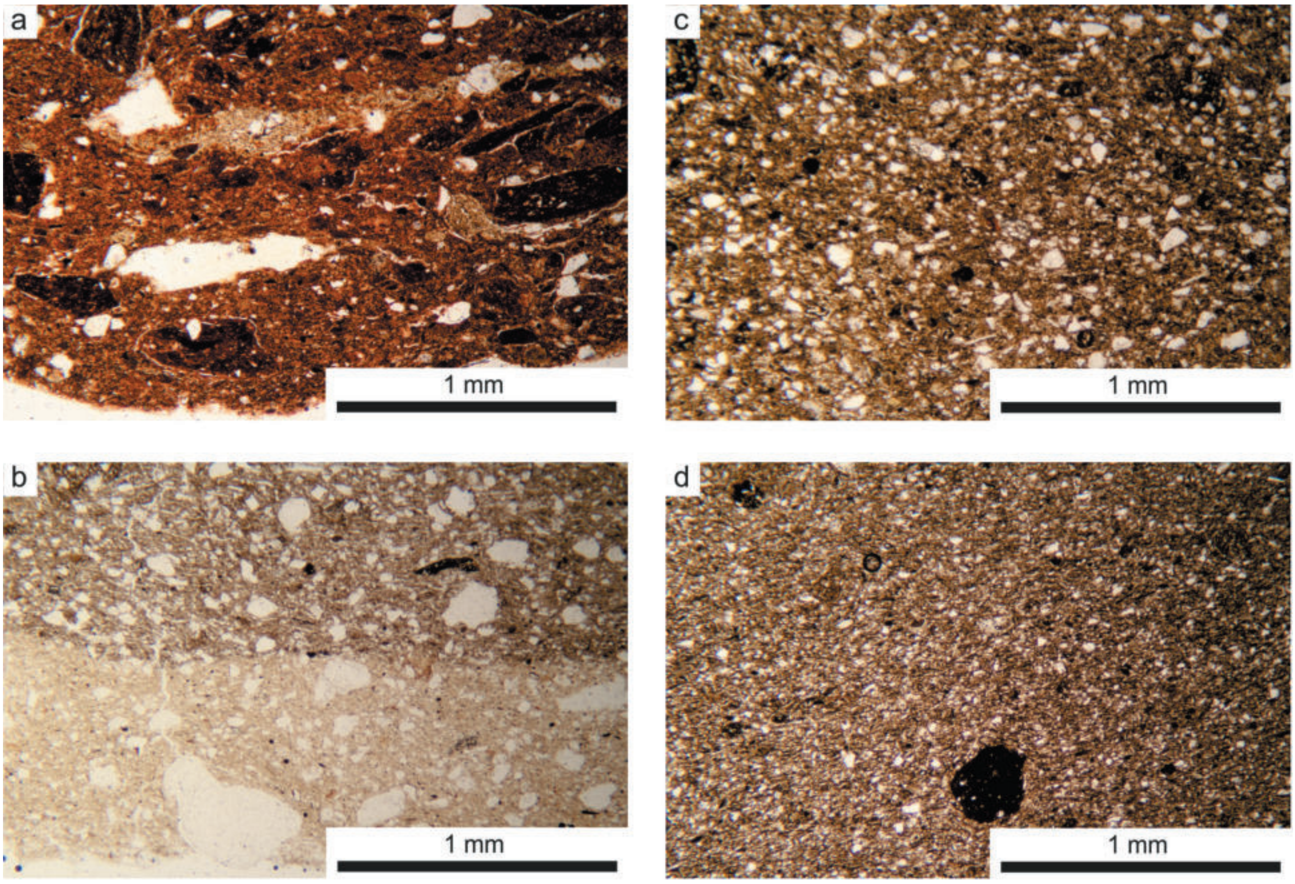

Fig. 5. Microscopic photographs of the ceramic bodies of Neolithic vessels: a – sample Br2: ceramic body with numerous clasts of ferruginous sedimentary rock (slate), 1N; b – sample Br1: coarser clastic material visible in a fine-grained ceramic body, 1N; c – sample Br3: homogenous fine-grained ceramic body, 1N; d – sample Br9: very fine-grained ceramic body containing almost exclusively grains of fine silt ($0.002<d<0.02$ mm), 1N.

and feldspars. There are also grains of eroded flint and clasts of sandstone. The percentage of mica is low. Both the Neolithic ceramics and the samples of Miocene clay contain thermally changed grains of glauconite, a mineral with the structure of mica, common in various marine deposits which abound in fine clastic material. In terrestrial formations, it is found only on secondary deposits (Borkowska, Smulikowski 1973: 352 ff.). A pit dug in the vicinity of Site 17 in Brzezie in 2006 revealed a locally exposed deposit of Miocene clay (Rutkowski 1989). This finding and the similarities in the mineral and petrographic composition suggest that the Linear Pottery communities in Brzezie used older (marine) clay for the production of their ceramics.

Fine-grained alluvium was commonly used, while pure loess was not suitable for vessel production, because it contained too little clay matrix and was not viscous enough, as the experiments have shown (Rauba-Bukowska 2007, 2014). Loess may also have served as an admixture to heavy clay, as suggested by some ceramic bodies with poorly mixed areas and silty spots visible under a microscope.

The SEM-EDS analysis of the pottery samples from the left-bank and right-bank sites has shown diversity in their content of calcium (Kozłowski *et al.* 2014: 63). This has recently been confirmed by examination under a polarising microscope which has recorded carbonate elements: micrite and fine grains of calcite, in loess deposits near Site 62 in Mogiła, while loess and loess-like deposits sampled near Site 17 in Brzezie do not have such components (Rauba-Bukowska 2014).

The identified characteristic traits of various raw materials, e.g. the presence of relics of marine plankton, volcanic glass and carbonates, suggest “migration” of some ceramic products.

During the field survey, it was not always possible to collect samples which matched the material of the recovered ceramics. This probably resulted from deforestation and intensive farming which had led to gradual accumulation of loess-like sediment in river valleys (Rutkowski 1984: 80–81; Rutkowski 1993: 25–26). In this way, natural exposures of Miocene deposits in the Wedonka valley had been covered with the accumulated material. The borehole (no. 28) in the vicinity of Site 5 in Modlnica revealed Miocene series at approx. 262 m above sea level, i.e. at the depth of approx. 6–10 m below Quaternary deposits (Rutkowski 1989; Rauba-Bukowska and Zastawny 2011(2013): 199). There are no outcrops of Miocene deposits in that area at present, as proven by raw material exploration.

Similarities in the ceramic bodies used by the archaeological cultures at the site indicate that access to raw materials changed to a relatively small degree in the period between the LBK and the FBC (over a thousand years). The outcrops of Miocene clay presumably still existed in the Wedonka valley at that time. By contrast, ceramics of the CWC at Site 5 in Modlnica do not contain Miocene clay. This can be accounted for in two ways: either the CWC vessels were produced far from that site or Miocene clay was no longer available to this communities (Rauba-Bukowska, Zastawny 2011).

The analysis of the ceramics has also shown that the various morphological types of vessels were made of different raw materials. In the LBK, thick-walled vessels were more often formed from heavy clay, whereas thin-walled vessels, especially those from the Želiezovce phase, were shaped from fine-grained loess-like material (Czekaj-Zastawny *et al.* 2017). This suggests that the potters observed certain rules for making the ceramic paste, despite the local diversity of raw material.

The materials sampled in the vicinity of Site 2 in Modlniczka have a bimodal distribution of the grain size, which can sometimes be considered as evidence of an admixture of sand added deliberately to the ceramic body. The data presented here indicate that interpretation of such results should be based on careful analysis both of the recovered ceramics and of the local raw material.

The specialist analysis of the Neolithic ceramics from the upper Vistula basin has shown that the vessels were shaped from clay with various origins. The field survey has also revealed that the raw materials were obtained locally in the vicinity of the settlements. The differences resulted both from the location of the sites and from the chronology of the vessels (Kozłowski *et al.* 2014; Czekaj-Zastawny *et al.* 2017). The chemical composition is not the same in the raw materials on the left and the right banks of the Vistula near Krakow. The ceramic bodies from the sites on the left bank have a higher content of calcium oxides (Kozłowski *et al.* 2014: 63), which is related to calcareous rocks, e.g. marl and limestone, situated near the surface and to alluvia of the Prądnik River. The tendency to use local material has also been confirmed at sites located in caves north of Krakow (the Pod Słupami Cave in Kobylany, the Okopy Wielka Dolna Cave in Ojców), where some LBK ceramics were made of carbonate clay available there (Czekaj-Zastawny, Rauba-Bukowska 2013).

Raw material analysis gives a lot of new information. Consequently, a database of clay raw materials is compiled to serve as reference material.

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The Gumelnița culture settlements in the Prut-Dniester Rivers area, in light of old and new research from Taraclia I (Republic of Moldova)

Abstract

Mistreanu E., Przybyła M. 2019. The Gumelnița culture settlements in the Prut-Dniester Rivers area, in light of old and new research from Taraclia I (Republic of Moldova). *Analecta Archaeologica Ressoviensia* 14, 17–39

The discovery of the first Gumelnița Culture settlements in the region between the Prut and the Dniester Rivers dates back to the 1960s and 1970s. Currently, thirty three settlements of this culture are known in the territory of Ukraine and Moldova. One of them, representing the Stoicani-Aldeni of Gumelnița Culture variant, is located in Taraclia (Taraclia district, Republic of Moldova). It has been excavated since 1979. In the spring of 2018, magnetic research was carried out on the site. They revealed the presence of a fortification system surrounding an area of approximately 1.7 hectares. It consisted of two parallel ditches forming a quadrangular arrangement. Similar fortifications have been discovered on sites belonging to the Gumelnița-Kodjadermen-Karanovo VI cultural complex, located in the South-Eastern European region.

Key words: Eneolithic, Gumelnița-Kodjadermen-Karanovo VI cultural complex, Gumelnița culture, enclosure, fortified settlement

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Short history of the research on the Gumelnița settlements from the Bugeac steppe

The Eneolithic in the region between the Prut and the Dniester Rivers has long been associated only with the Precucuteni-Cucuteni-Trypillia cultural complex. The first eponymous settlement found, the one near Bolgrad, was originally interpreted as Trypillian. It was discovered in 1960 by I.T. Chernyakov, while in 1962 the first results of the investigations were published. The author classified the ceramic fragments discovered into two categories. The first category mistakenly indicates analogies to the Luka Vrublevetskaya ceramic material, which could be chronologically framed within the early stage of the first Trypillian culture. With regard to the second category, the author stated that the discovered ceramics could be considered as belonging to the Gumelnița culture (Chernyakov 1962, 141).

Right about the time of these great discoveries, the Moldavian archaeological expedition of the Institute of Archaeology of the Academy of Sciences of the USSR, led by T. S. Passek, learnt about the existence of this site from the author of this discovery himself, I.T. Chernyakov. This expedition, which aimed at identifying the Trypillian sites in the steppe zone and, most importantly, at establishing their southern boundary, undertook the first surface studies on this archaeological site in 1961 (Passek and Chernysh 1965, 6).

The discovery of the first Gumelnița settlements in the area under scrutiny dates back to the 1960s and 1970s. T. S. Passek and E. K. Chernysh noticed a similarity between these sites and the settlements of the early Gumelnița culture in north-eastern Romania (Aldeni

II cultural aspect). Both researchers considered all the Gumelnița settlements found in Romania, Bulgaria and south-western USSR to be a unique cultural complex, highlighting several variants and local aspects (Passek and Chernysh 1965; Passek 1965, 8–9; Passek and Titov 1966, 75–77). The newly discovered sites have been included in the Aldeni II cultural unit (Comșa 1963, 8–9).

S. N. Bibikov, upon analysing the stratigraphy of the Bolgrad settlement, recorded two cultural layers that differed in terms of material culture and an existence of two types of dwellings, pit-houses and overground dwellings. He also proposed a chronology of the sites: Bolgrad I and Bolgrad II, including the sites in a separate archaeological culture, and later insisting on the idea of a regional variant of the Gumelnița culture (Bibikov 1971, 210–213; Bibikov and Subbotin 1986, 263–268). L. Subbotin argues that the Gumelnița sites in southern Bessarabia are a part of a particular local cultural unit (Bolgrad), which is individualised (Subbotin 1978, 36).

V.S. Bejlekchi was a coordinator of archaeological excavations at the sites Vulcănești II and Lopățică. The first monograph dedicated exclusively to the Eneolithic sites from the mouths of the Danube and the Prut Rivers enclosed the sites identified as Aldeni II, a local variant of the Gumelnița culture (Beylekchi 1978, 16).

In the same period, academic works that addressed a narrower but more specific aspect of the Gumelnița culture, namely overground dwellings, (Chernysh 1965) or tools (Chernysh 1969) were published. Scientific papers were also released on the geological origins of raw materials that were used for tool production (Petrun 1967), as well as articles on fauna remains discovered at the settlements (Tsalkin 1967). An important and well-researched aspect of the Gumelnița culture from the northern region of the Lower Danube River is represented by anthropomorphic figurines (Besfamil'naya 1966; Passek and Gerasimov 1967, 38–42).

H. Todorova insisted that the settlements in this area should be counted into the Bolgrad variant of the Varna culture (Todorova 1979, 70). This concept was proposed and supported by Bulgarian researchers for the most part.

In the 1980s, new Gumelnița sites were discovered. The excavations were continued in the Nagornoe II site by N. N. Skakun (Skakun 1985, 354–355; Skakun 1987, 413; Skakun 1994, 58–68; Skakun, Steganceva1994, 23–26). Also, a settlement in Taraclia was discovered and excavated, delivering new findings that were presented to the public (Mishina and Chirkov 1986, 385).

V. G. Zbenovich argued that the Bolgrad-Aldeni group represented an early manifestation of the Gumelnița complex (Zbenovich 1976, 79–92). E. K. Chernysh considered the Bolgrad-Aldeni to be a cultural unit associated with the Gumelnița complex, highlighting the Bolgrad and Aldeni variants (Chernysh 1982, 253).

L. V. Subbotin concluded that this new group of archaeological monuments can be regarded as a local Bolgrad variant of the Gumelnița culture (Subbotin 1983, 136), related to the Stoicani-Aldeni or Aldeni II (Subbotin 2013, 110). He proposed a chronological framework of the sites in the studied area, within which he distinguished successive colonisation stages of the area under scrutiny, identifying the earliest and the latest settlements established by new populations on the right bank of the Prut and the Danube Rivers (Subbotin 1983, 120).

I. T. Dragomir classified the Bolgrad group into the cultural variant of the Stoicani-Aldeni II (Dragomir 1983, 10–17). The theory according to which the group of Bolgrad settlements was supposed to belong to the Varna culture was abandoned (Şimon 1983, 305–319). The settlements in the area in question were analysed in the context of the Bulgarian Neolithic and Eneolithic cultures (Mikov 1985, 47–55).

V. I. Sorokin performed an analysis of the bibliographic sources and archaeological materials, following the idea of the Bolgrad-Aldeni culture (Sorokin 1989, 12–14; Sorokin 1994, 72; Sorokin 2001, 81–90), but pointed out that the problem of determining the taxonomic status of this phenomenon had not yet been fully elucidated. This is one of the issues addressed in the genesis of the Bolgrad-Aldeni culture. V. I. Sorokin referred to M. Şimon's viewpoints, who placed the Stoicani-Aldeni cultural unit in the middle of the Gumelnița A1 stage. He also challenged the opinion of E. Comșa, who believed that the formation of the Aldeni II variant was a contribution of the communities of the transition phase from the Boian into the Gumelnița culture, as well as those from the beginnings of the Cucuteni culture, an idea that was thrown into question by the Precucuteni imports in the Gumelnița environment. Taking into account these nuances, V. I. Sorokin did not exclude the possibility that the earliest settlements of the Bolgrad-Aldeni culture were contemporary with the Precucuteni settlements such as Larga Jijia-Floreşti I-Bernashovka or slightly younger. He admitted, at least hypothetically, that the beginnings of the Bolgrad-Aldeni culture was synchronous with the Precucuteni II or, possibly, the beginnings of the Precucuteni III phase (Sorokin 1994, 72–73).

Studies were also published on Gumelnița art (Beylekchi 1989; Rindyuk and Skakun 1996; Skakun and Rindyuk 1994; Rindyuk and Skakun 1999).

At the beginning of the 21st century, systematic archaeological excavations were conducted at the site of Kartal (Bruyako *et al.* 2003, 56–61; Bruyako *et al.*

2005, 13–33; Govedarica and Manzura 2015, 437–456). In 2010, a new Gumelnița settlement was studied by I. V. Manzura and therefore, the problem of the colonisation of the steppe (Bugeac) area in the Prut-Dniester interfluve by the Balkan-Danubian populations became a pressing one (Govedarica *et al.* 2012; Govedarica and Manzura 2016; Bruyako 2016, 121–131). A new settlement was discovered, Chioselia Mare I, which is currently the northernmost settlement point in the Prut-Dniester area (Mistreanu 2013, 145–156), and one which is mentioned not only in publications dedicated to the Gumelnița culture (Bolgrad-Aldeni). The first magnetometric studies were undertaken at the settlements of Cealîc and Chioselia Mare I (Manzura and Govedarica 2018). Different aspects related to the funeral and anthropological issues of the Gumelnița communities were investigated (Dambricourt *et al.* 2008). Some important information on the lithic industry encountered at the Gumelnița settlements were published as well (Kiosak and Subbotin 2016, 93–106). The role of the Bolgrad-Aldeni communities in the Balkan-Carpathian-Pontic Eneolithic cultural complex was discussed and presented as a distinctive cultural entity made of several territorial groups (Stoicani, Aldeni II, Bolgrad) (Burdo 2018, 5–14).

From this brief presentation of the history of research, some general conclusions could be drawn. The exact taxonomic status of the newly identified settlements has not been established, as different names are used to describe it, such as: *culture, cultural unit, cultural group, cultural type, cultural facies, local group*. These groups have been given different names in various works: *Gumelnița; Gumelnița-Ariușd; Bolgrad; Aldeni II; Stoicani-Aldeni; Bolgrad-Aldeni*. As the reader can notice, we use the term "Gumelnița", until more convincing evidence occurs which would permit one of the above terms to be used. What remain unclear are the period and the causes of development and disappearance of these settlements. Except for the last dates from the Kartal site, (Govedarica and Manzura 2015, 439–440, 442), there is a lack of absolute dating. The authors would like to stress that the general idea behind all of the research is that these settlements were inhabited by populations of Danubian farmers or those closely related to them, namely early Gumelnița communities that appeared in this area in the middle of the 5th millennium BC. They lived both in dwellings built on the ground surface and dug into the ground (pit-houses). The economy of these human groups was based on plant cultivation and animal husbandry. Anthropomorphic and zoomorphic art, as well as models of tables and amulets, were found at all of the studied settlements. A common element that provides some answers to the origins of the populations and trade relationships amongst them are artefacts made of *Balkan flint*. The production of stone tools was equally well developed, also using imported material. The ceramics was the most abundant category of materials discovered. It was divided into two large categories based on the paste and decoration technique – coarse and fine ceramics, with a great variability of types and forms (Subbotin 1983, 60, 71). Another classification system divides them into three categories: ceramics for common use, good ceramics and fine ceramics (Dragomir 1983, 53). There is also a roughly similar division (Govedarica and Manzura 2015, 444–445), distinguishing coarse (kitchen), fine and semi-fine pottery. All of these facts evidence how rich and evolved the material culture of these populations was.

Gumelnița settlements from the Prut and Dniester interfluve

The group of settlements between the Prut and the Dniester Rivers were found in the south-western part of this area, and site mapping allowed us to confirm that they had been occupied the north-eastern area of the early Eneolithic farming communities extent that migrated there from the south and the west in the middle of the 5th millennium BC. We believe that these were the same communities that formed the Stoicani-Aldeni cultural variant of the Gumelnița culture.

The sites were located on low river banks near watercourses, in valleys near to springs, and on the terraces of Bessarabian lakes. Due to a rather short period of occupation, the new communities in this area did not leave *tell*-type habitations, types of settlements like in north-eastern Wallachia and southern Moldova in Romania. At the Gumelnița settlements discovered in the area of our interest, no consecutive chronological stratigraphy typical of archaeological cultures was found, except for the Kartal site (Bruyako *et al.* 2003, 56–61).

Today, 33 settlements have been unambiguously identified as belonging to the Gumelnița culture – 12 in the territory of the Republic of Moldova and 21 in Ukraine (Fig. 1). Since the beginning of the discovery of the Gumelnița culture in our area of study until this day, 13 settlements have been subject to archaeological excavations: Bolgrad (1962–1963, 1970, 1984, 1999), Cealîc (2010–2012), Cucoara I (1972), Lopățica I (1965–1966, 1968), Nagirne II (1964, 1966, 1969, 1971, 1981, 1983–1991), Nova Nekrasivka II (2003), Novosil's'ke I (1984, 1988–1989), Ozerne (1963–1965), Taraclia I (1982–1985), Vulcănești II (1962–1963, 1965, 1969–1970). In the 1980s, surveys were conducted at the Matros'ka and

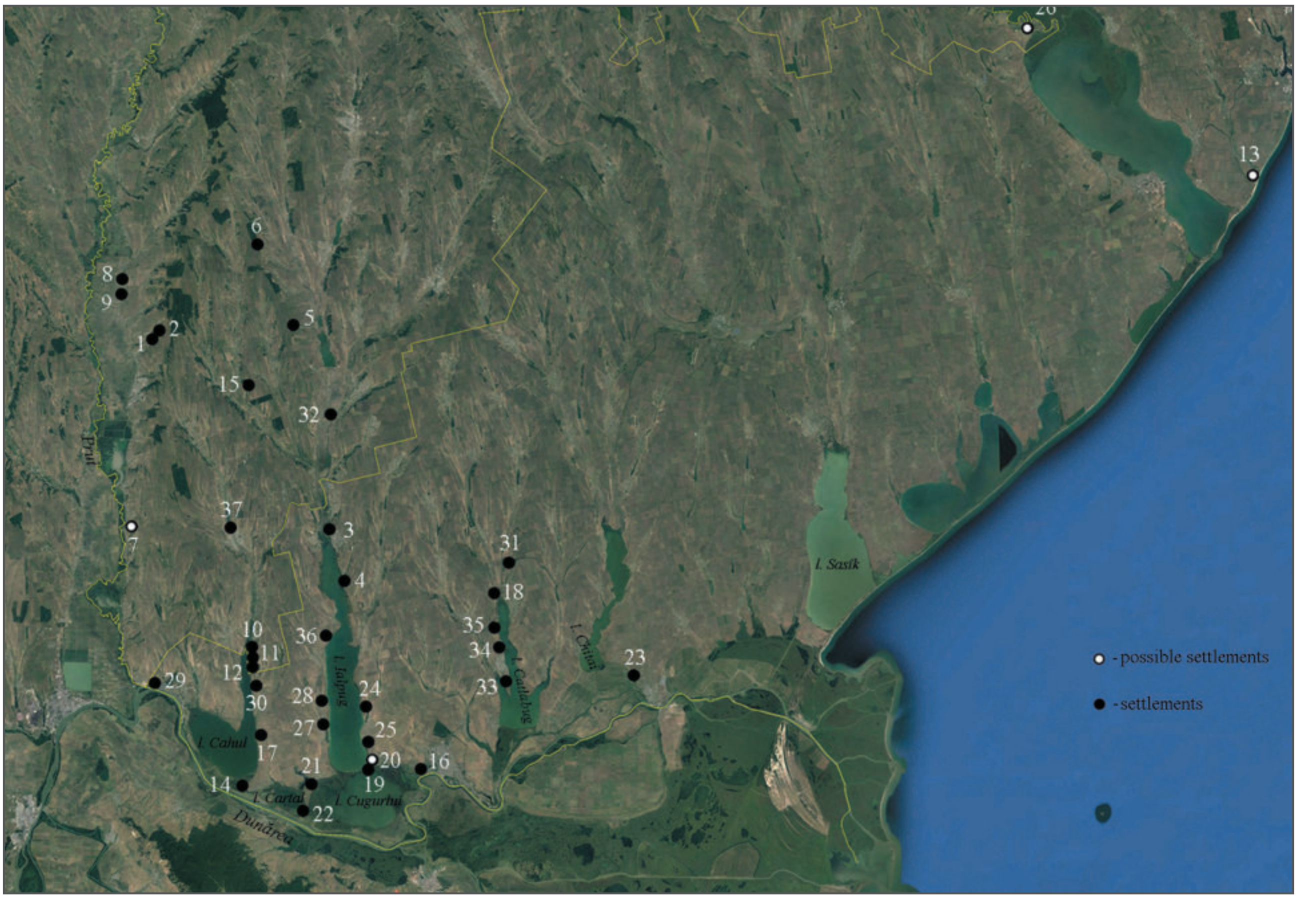


Fig. 1. The settlements of the Gumelnița culture in the Prut-Dniester region.1 – Andrușul de Sus I, 2 – Andrușul de Sus II, 3 – Bolgrad, 4 – Bolgrad II, 5 – Cealîc, 6 – Chioselia Mare I, 7 – Colibaș I, 8 – Cucoara I, 9 – Cucoara II, 10 – Etulia II, 11 – Etulia V, 12 – Etulia VI, 13 – Gribivka IV, 14 – Kartal (Orlovka I, Orlovka II), 15 – Lopățica I, 16 – Matros'ka, 17 – Nagirne II, 18 – Novokam'yanka IV, 19 – Nova Nekrasivka I, 20 – Nova Nekrasivka II, 21 – Novosil's'ke I, 22 – Novosil's'ke II, 23 – Omarbija, 24 – Ozerne, 25 – Ozerne II, 26 – Palanca, 27 – Plavni I, 28 – Plavni IV, 29 – Reni, 30 – Reniiskii II, 31 – Suvorove VI, 32 – Taraclia I, 33 – Utkonosivka, 34 – Utkonosivka I, 35 – Utkonosivka II, 36 – Vladicèn 'VIII, 37 – Vulcănești II.

Reni sites. Since 2000, systematic excavations at Kartal have been carried out, where the (Bolgrad-Aldeni) level has been confirmed at the Orlovka I site (Mistreanu 2019). In general, settlements sizes varied between 0.5 and 1 ha, but they also reached an area of 2 ha (Ozerne, Bolgrad), and more (Vladicen'VIII, Nova Nekrasivka I, Taraclia I, Utkonosivka), up to 10 ha (Vulcănești II, Reni) (Subbotin 2013, 89). Of course, it is hard to believe these statements, as long as no entire settlement has been investigated. We understand that this data is mostly based on the results of surface research.

History of the research in the Taraclia I settlement

The site was discovered in 1979 by T. A. Shcherbakova and S. Agulnikov, located near the town of Taraclia (Taraclia district, Republic of Moldova). The site is situated 1.5 km to the south-west of the town of Taraclia, in the valley of the Ialpug River, on a small promontory between the Ialpug and the Lunga Rivers (Fig. 2).

Fragments of burnt smear clay, ceramic fragments and bones were found on the site surface, and in some areas these findings were more abundant. Based on the material concentrations, the existence of four dwellings was assumed: two of them being located in the eastern part of the settlement, one in the south and another in the north (Shcherbakova *et al.* 1984). The settlement was identified as having been established by the Gumelnița communities, namely of the Stoicani-Aldeni type. Also, a mound/tumulus was found on the perimeter of the settlement, which was partially excavated in the following years. However, there is no graphic information or general plan of the site available that would document this research.

Between 1982 and 1985, archaeological rescue investigations were conducted at the site by: I.V. Man-

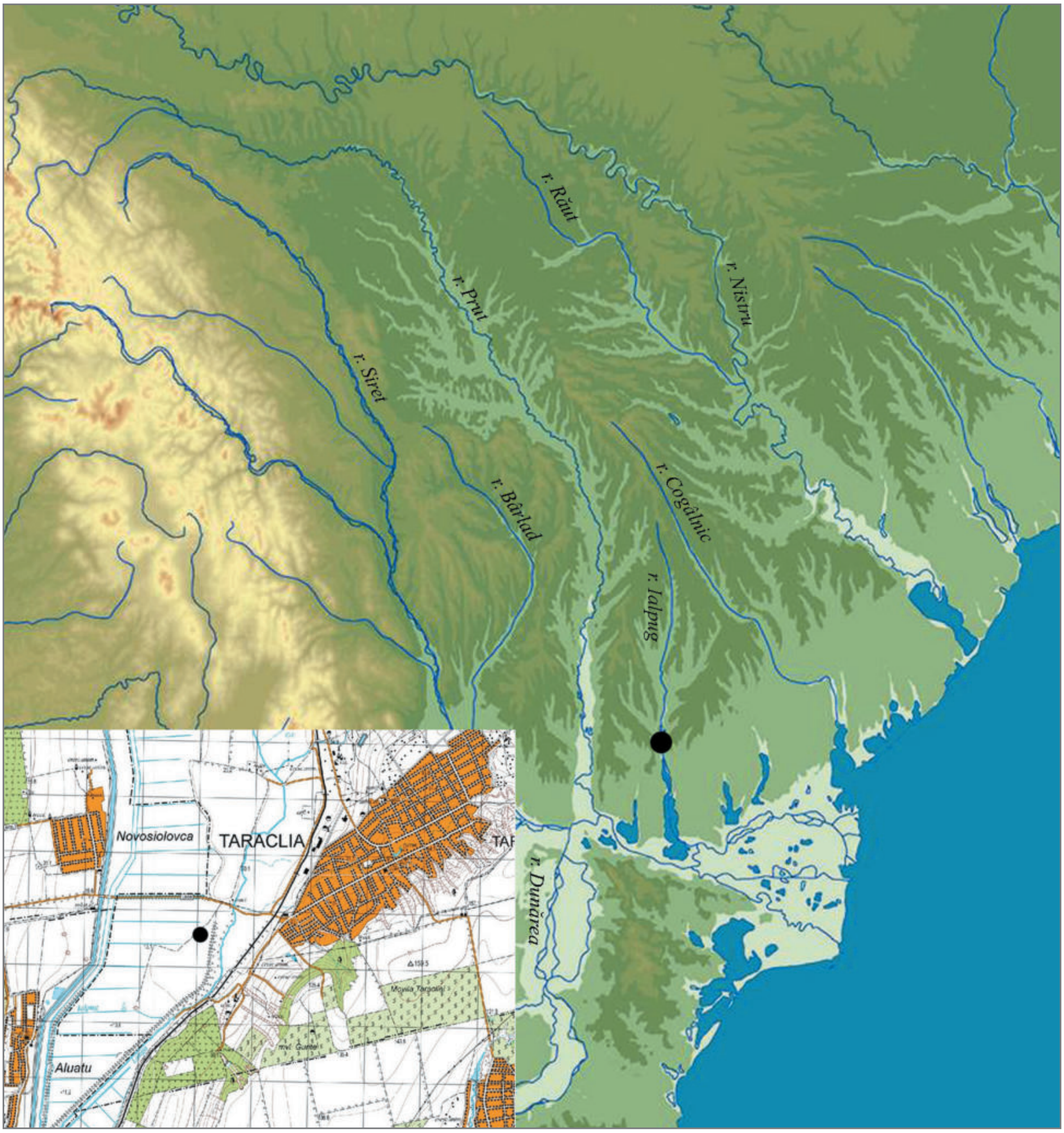


Fig. 2. Taraclia I. Location of the site.

zura (Manzura and Sorokin 1990) in 1982, V.I. Sorokin (Sorokin 1984) in 1983, I.V. Manzura (Mishina and Chirkov 1986, 385; Savva *et al.* 1984) in 1984, and V.S. Bejlekchi (Beylekchi *et al.* 1986) in 1985, all being a part of the "Bugeac" archaeological rescue campaign conducted by T. A. Shcherbakova. Very few of the materials discovered from these research campaigns were valorised, mostly with the publication of the article *Гумельницкое поселение упгт. Тараклия* (The Gumelnița settlement near the town of Taraclia) (Manzura and Sorokin 1990), dedicated to the excavations from 1982. A small summary of the excavations of the other three seasons was published later (Mishina and Chirkov, 1986; Beylekchi, 1987). The discovered anthropomorphic material was partially published in a study by V. S. Beylekchi (1989, 36–47). Several general publications referred to some individual objects discovered at this site (Dergaciov 2010, 242–248). Today, the information on the excavations from Taraclia I is enclosed in the excavation reports preserved in the

Archaeological Archive of NMHM, while the materials found there are stored in the collections of the NMHM. With the excavation reports available, we were able to draw the site plans for all four excavation campaigns, presenting the discovered complexes: dwellings, pits and ditches from the Eneolithic layer.

However, our investigation was hampered since the original documentation (plans, profiles, workbook and drawings) was only available for the 1985 campaign. The graphic quality of the plans in the archaeological reports is also very poor.

The excavation section from 1982 covered the southern edge of the site, namely the area of a possible surface dwelling occurrence, a place where a large concentration of ceramic fragments and burnt smear clay was found. The total dimensions of the site were 32×30 m (640 m²). After the excavations had been completed, two new sections, 32 m long and 3 m wide, south-north oriented, were opened at 2 m to the west from the previous section. Thus, in 1982, an area of 838 m² was uncovered, delivering the discovery of a dwelling (Fig. 3), three household pits, a clay hearth from a furnace belonging

1

2

Fig. 3. Taraclia I. Dwelling discovered in 1982. 1 – View from the north-west.
2 – General view from the north-east (after Shherbakova *et al.* 1984, photo 4, 5).

to the Gumelnița culture, and three inhumation burials dated to the Bronze Age (Shcherbakova *et al.* 1984).

The excavation section from 1983 was located to the east of the section investigated in 1982. The total area covered by the research was 850 m². In 1983, three dwellings, three pits of the Gumelnița culture and two graves from the Bronze Age were discovered (Sorokin 1984).

The section from 1984 was established on the south-eastern edge of the settlement, 15 m to the east of the section excavated in 1983. The total area subject to exploration was 432 m². In 1984, there were discovered three pits belonging to the Gumelnița culture, three deep complexes, six pits, and a trench-like construction identified as being the remains of the late nomad period (12–13 century), as well as three graves dated to the Bronze Age (Sava *et. al.* 1984).

The research in 1985 was carried out in the central part of the promontory, to the north of the section explored in 1984. The total area excavated was 1308 m². In 1985, two overground dwellings (Fig. 4), one pit-house (Fig. 5), four household pits, and a defence ditch were

1

2

Fig. 4. Taraclia I. Dwellings discovered in 1985. 1 – View of the dwelling no. 1 from the north-east. 2 – View of the dwelling no. 2 from the north (after Beylekchi and Chirkov 1986, fig. 22, 24).

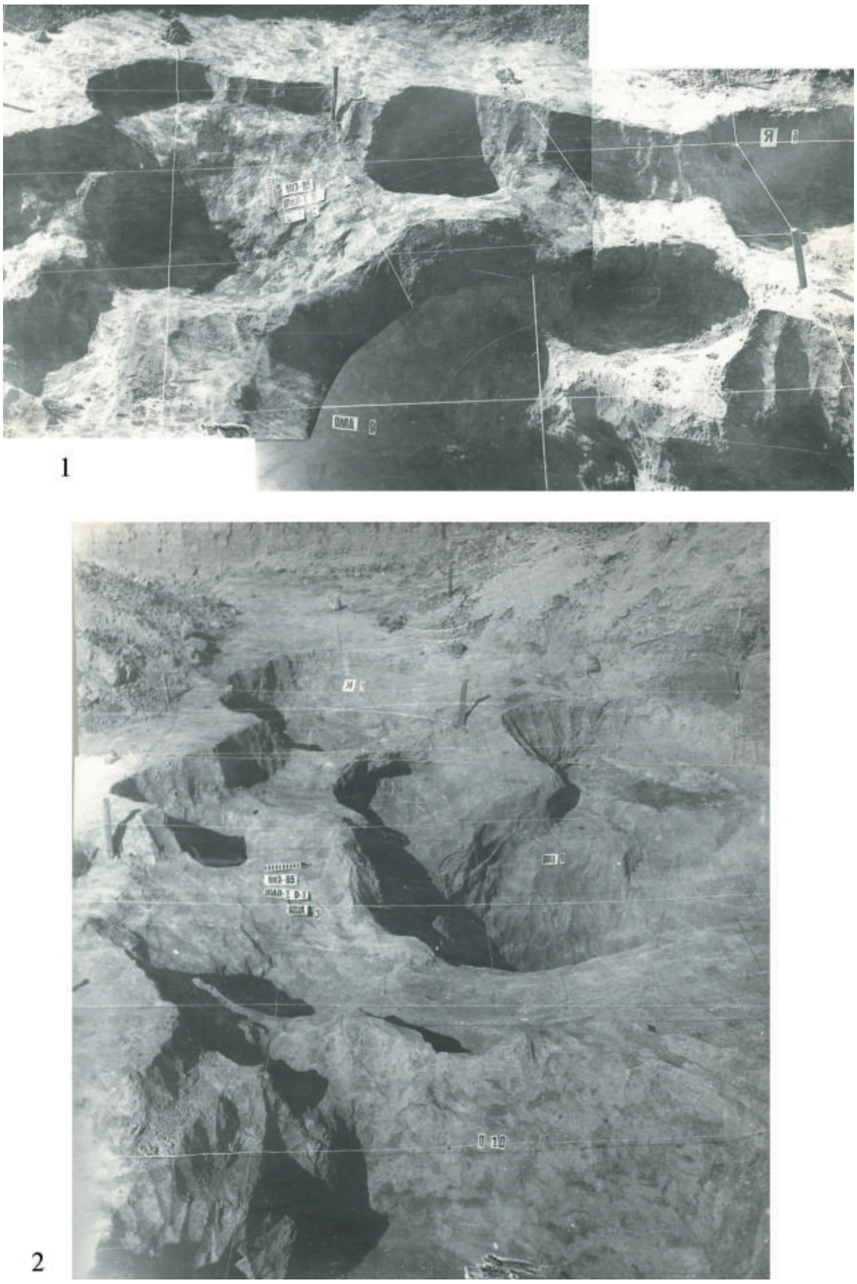


Fig. 5. Taraclia I. Dwelling no. 3, pit-house (?). 1 – View from the north. 2 – View from the east (after Beylekchi and Chirkov 1986, fig. 34, 35).

discovered (Fig. 6) belonging to the Gumelnița culture. Also, two constructions, two draining pits and four pits were assigned to the Golden Horde period; a pit was dated to the late Moldavian Middle Ages. The report also mentioned a pit without chronological and cultural identification, alongside with four tombs conventionally attributed to the Bronze Age (Beylekchi *et al.* 1986). The discovered tombs were most likely related to the mound nearby. The layer of the late nomad period and the Moldavian Middle Age are not substantial.

The Taraclia I site is one of the few archaeological settlements established by the Gumelnița communities to have been thoroughly excavated during four successive archaeological campaigns, and over such a large area. A total area of 3420 m^2 was investigated (Fig. 7.1). Our analysis will focus on the planimetry and the structure of the settlement, while avoiding the presentation of ceramic material and artefacts.

Upon studying the available reports, we identified 277 individual pieces discovered during the four excavation campaigns, where stone and flint pieces prevailed (Fig. 7.2). Most of them were discovered outside the dwellings, especially in the east, south and the north, with fewer in the western part. This fact confirms a hy-

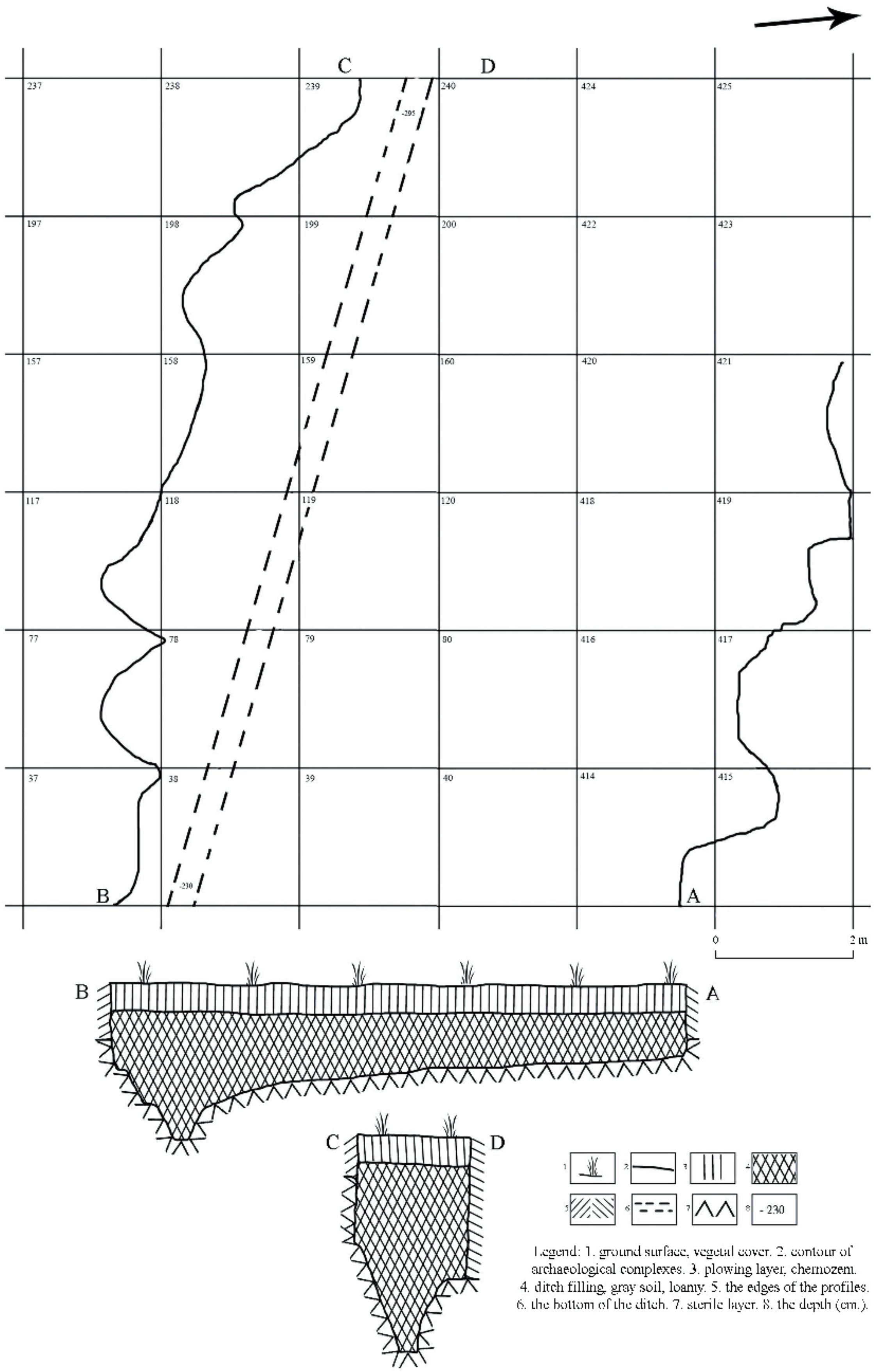


Fig. 6. Taraclia I. Defensive system discovered in 1985. Plan and profiles. (after Beylekchi and Chirkov 1986, fig. 72).

1

year of research	investigated surface (m²)	pit houses	dwellings	household pits	clay ovens	ditch
1982	838		1	3	1	
1983	850	2	1	3		
1984	432			3		
1985	1308	1	2	4		1
Total	3428	3	4	13	1	1

2

year of research	artifacts from silex	stone artifacts	artifacts from bone and horn	clay artifacts (fusaiole. amulets)	anthropomorphic and zoomorphic plastic	dishes from clay, spoons	stone grinders	Total
1982	10	10	4		6		2	32
1983	22	19	2	6	11	5		65
1984	9	16	7	2	5		2	41
1985	28	56	7	12	16	10	10	139
Total	69	101	20	20	38	15	14	277

Fig. 7. Taraclia I. 1 – Statistics of investigated areas and discovered complexes. 2 – Statistics of individual discoveries (after: Shherbakova *et al.* 1984; Sorokin 1984; Savva *et al.* 1984; Beylekchi *et al.* 1986).

pothesis that the artefacts once used were thrown away into the immediate vicinity of the settlement. Sometimes they were found spread in groups, often in household pits. This distribution of the assemblage also indicates the entry points into the dwelling. The number of individual pieces found inside the dwellings is rather small. Inside the dwellings there were found large vessels, and not whole individual pieces, which suggest that the dwellings were abandoned before the fire.

Having analysed the general plan of the excavations, we made some observations (Fig. 8). Eight houses were discovered, four overground dwellings and four pit-houses, one of them was just recorded, not researched. Dwellings were found at the depth of 0.2–0.6 m, pit-houses were identified at a depth of 0.6–0.8 m. Their dimensions ranged from 4 × 5 m to 22 × 2–8 m, having an approximately rectangular shape. Under the dwellings discovered in 1985, after burnt clay had been removed, five household pits were discovered in both dwellings. 13 features of the Gumelnița culture were indentified, most of them being household pits.

Three overground dwellings had annexes located to the west or south of the dwelling. They were oriented along the longitudinal axis in the direction SSW-NNE, with their facade to the east. A similar situation was observed in the overground dwellings from Vulcănești II (Passek and Chernysh 1965), Bolgrad, Ozerne, Nagirne II (Subbotin 1983, 14–29), and some dwellings built on the ground discovered within the Stoicani-Aldeni cultural unit at Drăgușeni-Tecuci, Lișcoteanca I, Suceveni-*Stoborăni* (Dragomir 1983, 24–26, 33–34). The minimum distance between them was 14–18 m, which is similar to the distance between the two big pit-houses (?) which were excavated entirely. The fragments of clay with traces of rods and beams were mostly oriented from east to west. Based on the material remains, we can assume that the dwelling no. 2, investigated in 1985, had two rooms.

The pit-houses discovered at Taraclia I reveal a picture similar to that of Bolgrad, Ozerne, Nagirne II (Subbotin 1983, 15–27), where smaller pit-houses and several bigger pit-houses were also discovered, in which many individuals could live together. This picture can help us to understand the social structures of these ancient communities. The plan of pit-houses present an irregular geometric form, consisting of several pits, with a fireplace and ash ground. The pit-house discovered in 1983, has a "L-letter" shape, while the depth of the pits varies between 2.3 and 3.1 m. The other pit-house also consisted of several pits, forming a unique trapezoidal contour.

The identification of the above-mentioned two types of housing indicates an existence of two levels of habitation, separated chronologically: a younger layer characterised by pit-houses, and an older layer represented by dwellings built on the ground. These chronological layers were termed the upper and the lower levels by V. S. Beylekchi (1978, 18–19).

An important element discovered was a protection structure, namely a defence ditch, being the first exca-

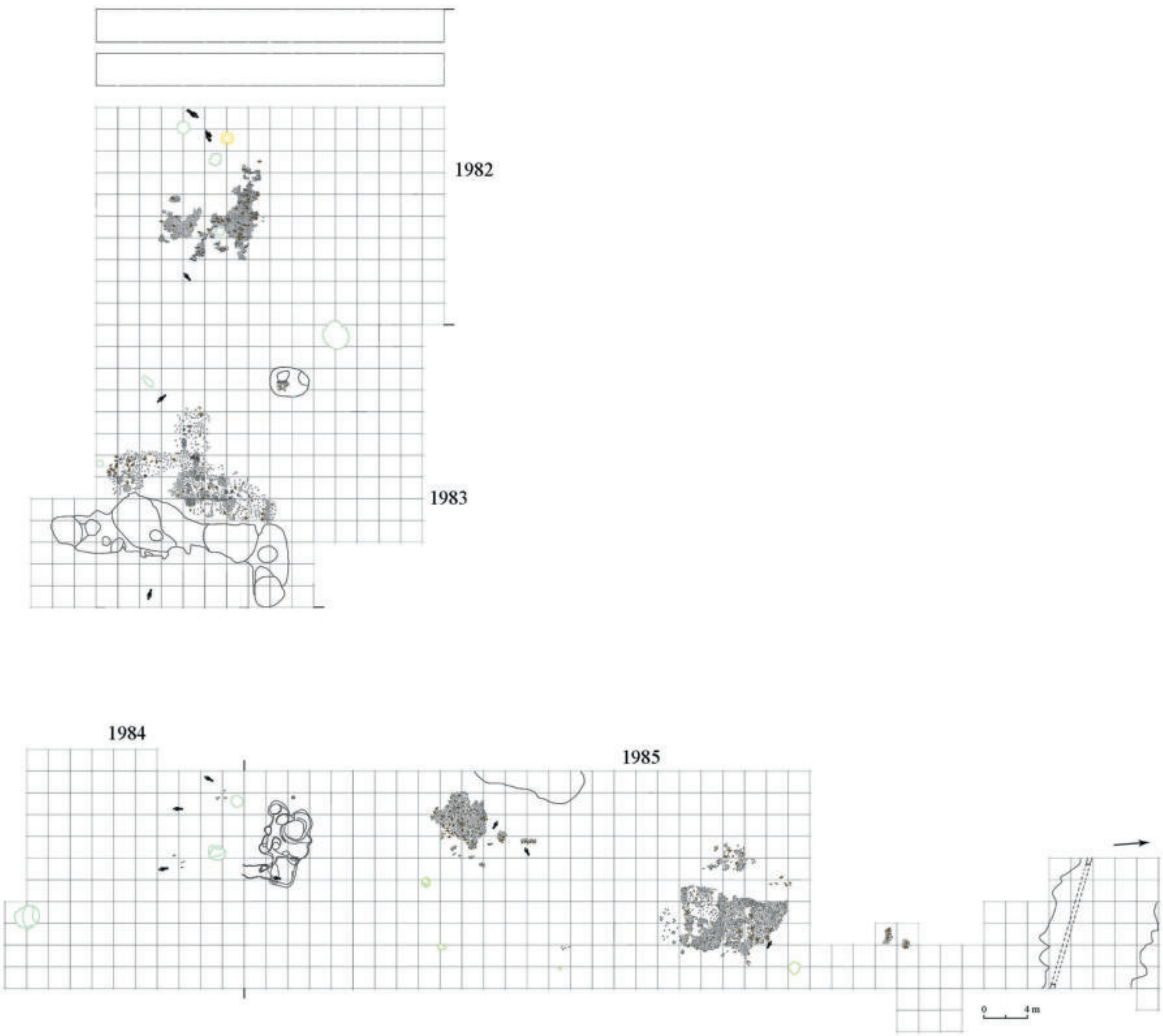


Fig. 8. Taraclia I. General plan of the entire area excavated in 1982–1985.

vated structure of this type within the Gumelnița culture context in this area. It was established that its maximum depth was 2.35–2.95 m, where 1.5–1.9 m were contained within the undisturbed soil. The authors of the research provided a picture of this complex, with a width of 10 m, that we think is unusual, and as we will see below, this was the space between defensive structures, they did not detect the exterior ditch.

By making a parallel to the geomagnetic maps of the Cealîc and Chioselia Mare I (Govedarica *et al.* 2012; Govedarica 2016, Manzura and Govedarica 2018), settlements that are located to the north of Taraclia I site, we found that the distance between them is about 15–16 km (Fig. 9). Compared to them, we can assume the presence of 3–5 dwellings along the SW-NE line arranged in a few row sat, the settlement from Taraclia I as well, up to the defensive ditch, forming a circular or a four-cornered layout living area. As far as we are aware, this is the first defensive system discovered and researched within the Gumelnița settlements in the Prut-Dniester region, while this model of artificial fortifications is widely found at the Stoicani-Aldeni settlements in Romania (Dragomir 1983, 18, 19).

Non-invasive investigation in Taraclia

Starting from the above-mentioned information, in the spring of 2019 (6–8 April), a team of archaeologists from Poland and Republic of Moldova, headed by E. Mistreanu and M. Przybyła, conducted geomagnetic research at the Taraclia I site. Employing the magnetic method enabled the fastest and the fullest coverage of large ares, additionally, it was suitable for discovering linear anomalies like ditches, trenches and moats (David *et al.* 2008, 16–21). Magnetic measurements were performed using a fluxgate magnetometer (gradientmeter, Misiewicz 2006, 74–98) FoersterFerrex 4.032 DLG, equipped with two probes with a resolution of 0.2 nT. Measuring lines were spaced at intervals of 1 m. The number of measurements per 1 square meter was 10. The data was collected in the bidirectional mode. The obtained results were presented on magnetic maps developed in the Terra Surveyor 3.0.29.3 software.

The investigations encompassed an area of 3.87 hectares. The visibility of detected anomalies related to archaeological features was limited due to the occurrence of a dirt road running through the entire research area. The waysides of this road appeared to contain concentrations of very numerous contemporary iron objects. These objects were also scattered, although in smaller numbers, over the entire area under study. Such specimens are the source of typical dipole anomalies. In the southern part of the investigated area, a linear anomaly was recorded which is associated with the occurrence of an underground installation (a pipeline). Despite this, the measurements performed allowed the authors to draw a magnetic map of the entire extent of the Gumelnița culture. Moreover, a certain number of anomalies related to archaeological features from recent chronological periods were detected (Fig. 10–13). Clearly legible were the positive linear anomalies connected with ditches surrounding the stronghold (Fig. 15: 1, 2). They formed an alignment which was square in shape, with an external diameter amounting to 130 m, and an internal diameter of 115 m. The distance between these two ditches was ca. 10 m. Additionally, there was another short ditch in the northern corner of the stronghold, between ditches 1 and 2 (Fig. 15: 3). The connection of the latter with the Gumelnița culture is, however, unambiguous.

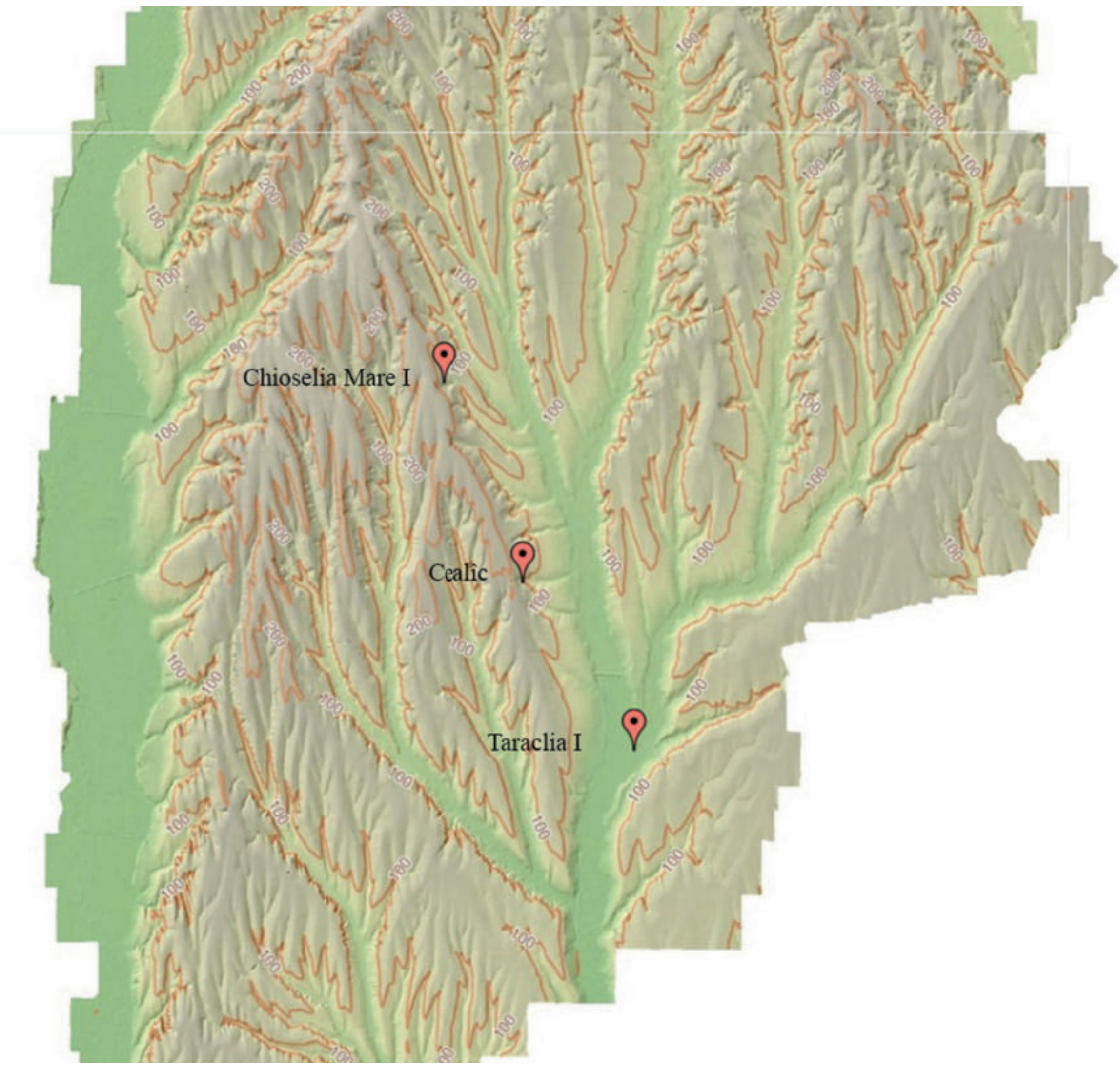


Fig. 9. Relief map with the location of the three sites investigated using the magnetometry method (www.geoportal.md).

Fig. 10. Taraclia I. Location of the magnetic prospection field.

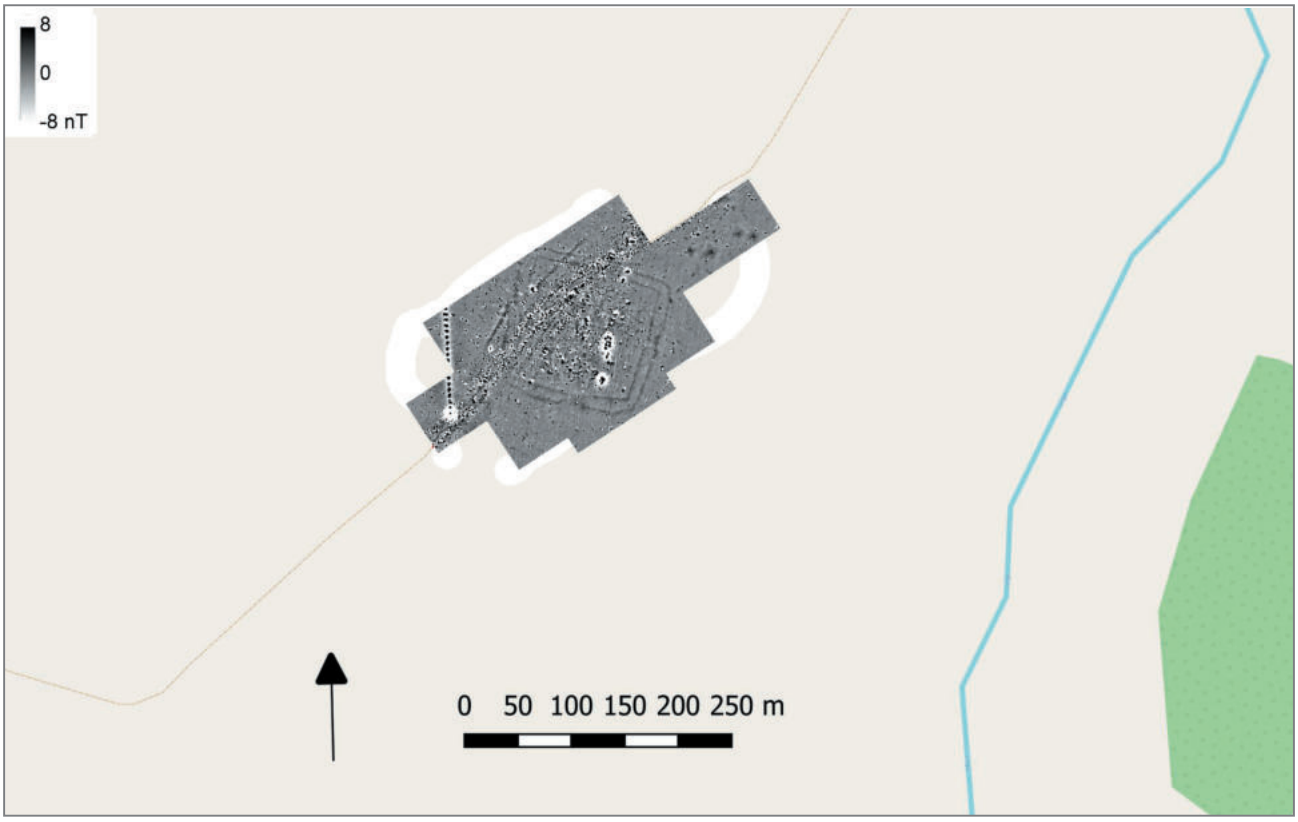


Fig. 11. Taraclia I. Magnetic map in greyscale, in range –8/8 nT, superimposed on the topographic map.

Fig. 12. Taraclia I. Magnetic map in greyscale, in range –5/5 nT, superimposed on the ortophotographic map.

Fig. 13. Taraclia I. Magnetic map in greyscale with selected extreme values, in range –7/7 nT, superimposed on the ortophotographic map.

Within the lines of the ditches there were readable gates established in the middle of each side of the stronghold. The eastern, southern and western gates were well visible on magnetic maps (Fig. 5: A, B, C). One can expect that there would also have been a northern gate. Unfortunately, in the place of its alleged location there is a present-day road which is a source of strong magnetic interference. It seems that each of these gates had a slightly different construction. The southern gate was the widest, with a passage width amounting to ca. 15 m. The terminal fragments of both ditches headed towards each other, which indicates that originally they might have been conjoined. The eastern and western gates were significantly narrower (ca. 5 m wide). With regard to the eastern gate, the ditches running on its southern side had been most likely conjoined with a transverse shoulder whereas the terminal fragments of the ditches flanking its northern wings split, forming Y-shaped alignments. The construction of the western gate is less obvious. In the south it was flanked by as many as three ditches. Unfortunately, interference from a contemporary source was recorded in its surroundings, hindering its better recognition.

The nature of the stronghold's spatial arrangement is impossible to be described in detail due to the above-mentioned occurrence of a dirt road and very numerous dipole anomalies caused by iron litter. Noteworthy is the fact that during the excavations carried out at the site (Fig. 14), the authors established that the houses which had been built using clay material had been burnt down. Magnetic anomalies induced by burnt clay are of similar dipole nature as those caused by an occurrence of iron objects. Moreover, the relics of buildings discovered during the excavations had irregular shapes, difficult to identify. Due to this determining a particular building is even more complicated. Despite this, the authors managed to indicate a regular zone of dipole anomalies concentrations, which most likely overpassed with the zone of compact housing of the stronghold. This zone was rectangular in shape and had approximate dimensions of 85×75 m (Fig. 15: 4). In the south, west and the north, the residential zone was separated from the internal ditches by an empty space which was a few meters wide. In the east this empty space was significantly wider, amounting to ca. 25 m. Taking into account all of these facts, the authors made an attempt to reconstruct the general spatial arrangement of the stronghold. The settlement consisted of a compact, rectangular block of buildings, surrounded by a double row with four entrances which were symmetrically arranged. In the eastern part of the stronghold, an empty space adjoined the inner ditch. The

Fig. 14. Taraclia I. Excavated area plan superimposed on the magnetic map.

Fig. 15. Taraclia I. Magnetic map with anomalies outlined in the text. Red colour – contemporary interference. Green colour – anomalies associated with the settlement of the Gumelnița culture. Blue colour – anomalies associated with younger chronological periods. Yellow colour – excavated area. Dark blue colour – excavated features of the Gumelnița culture.

quadrangular alignment of multiplied lines of fortifications, surrounding the central, regular residential zone, is known from other sites dated to the Copper Age, belonging to the Gumelnița-Kodjadermen-Karanovo VI cultural complex, discovered in the region under study in South-Eastern Europe (Fig. 16–19). This is exemplified, among others, by the sites of Poljanica and Radingrad in Bulgaria (Todorova 1982), Cealîc (Govedarica *et al.* 2012, fig. 4, 5; Govedarica 2014, photo 6) and Chioselia Mare I, in Moldova, as we saw in the presentation (Manzura and Govedarica 2018) or a settlement in Suceveni-*Stoborăni* in Romania (Adamescu 2011). Systems of fortifications with quadrangular ditches are known from the Cucuteni A sites, and the most recent example was recorded at Scânteia – *Dealul Bodești* (Mischka *et al.* 2016, 335, fig. 4, 5). Quite similar planimetry was reported for the Războieni – *Dealul Mare/DealulBoghiu* (Asăndulesei 2017) site, differing in terms of their sizes when compared with the Gumelnița sites.

In the central part of the site there was a Yamnaya culture mound (Fig. 15: 5), partially researched in the 1980s. Unfortunately, it was located within the zone where there is considerable contemporary interference and, therefore, it is impossible to identify any magnetic anomalies associated directly with its construction or the graves inside the mound. In the western part of the site there was another well legible positive linear anomaly connected with a feature of a ditch type (Fig. 15: 8). It cut through the Eneolithic ditches 1 and 2. This structure is believed to have been associated with settlement phases younger than the Gumelnița culture. A few other linear anomalies, with low values and varying in shape of their trajectories, were detected in the southern part of the investigated area (Fig. 15: 6). They were most likely induced by natural (geological) structures. In the northern part of the research area, however, a fragment of an undated settlement was recognised. It consisted of four, more or less quadrangular positive anomalies related to features of a pit-house type, as well as a dozen or so small positive point anomalies, the source of which were features of a pit type (Fig. 15: 7).

Conclusions

Summarising, we managed to capture three settlements belonging to the Gumelnița culture, namely the Stoicani-Aldeni cultural variant, located in the Ialpug River basin. The distance between them was

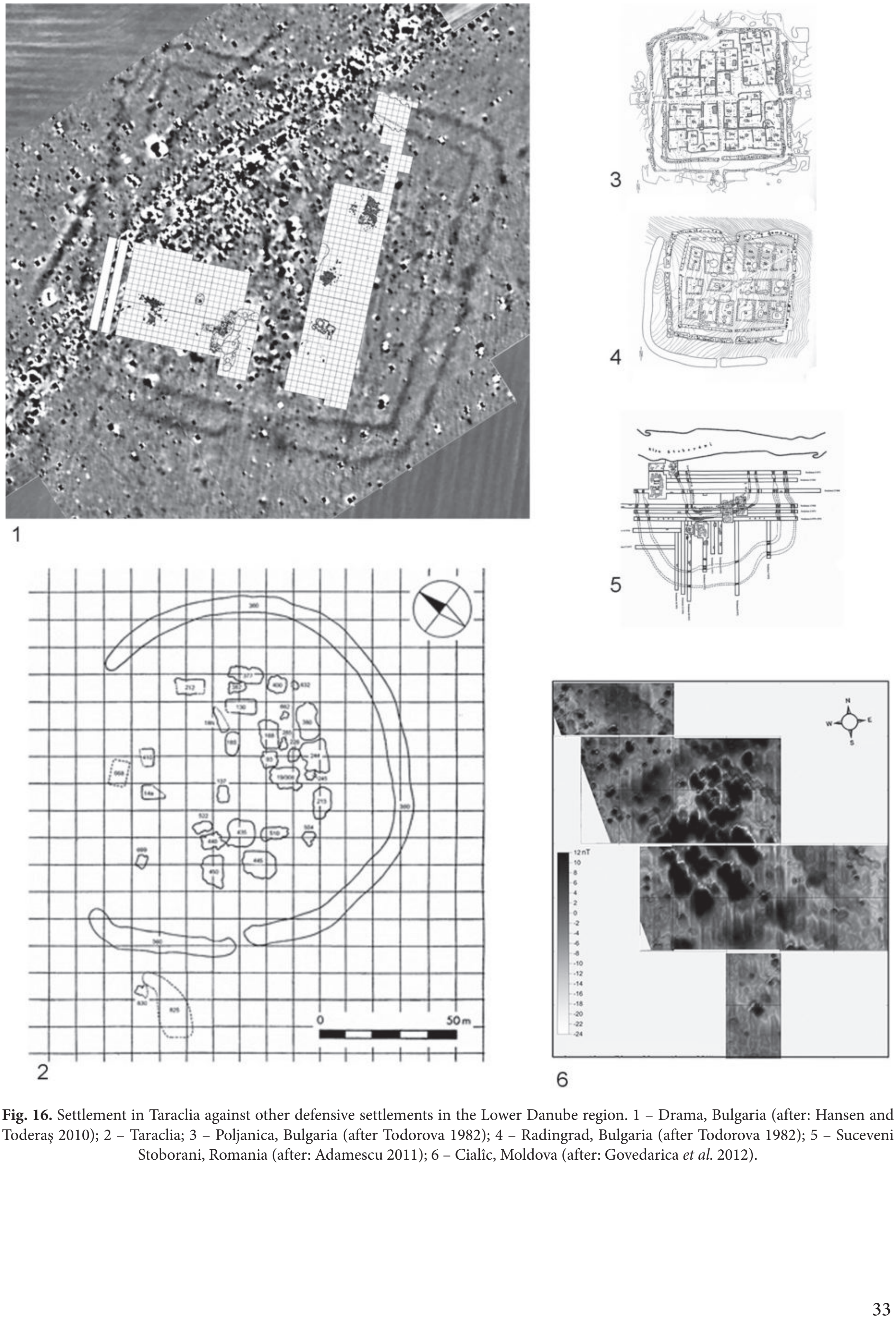


Fig. 16. Settlement in Taraclia against other defensive settlements in the Lower Danube region. 1 – Drama, Bulgaria (after: Hansen and Toderaş 2010); 2 – Taraclia; 3 – Poljanica, Bulgaria (after Todorova 1982); 4 – Radingrad, Bulgaria (after Todorova 1982); 5 – Suceveni Stoborani, Romania (after: Adamescu 2011); 6 – Cialîc, Moldova (after: Govedarica *et al.* 2012).

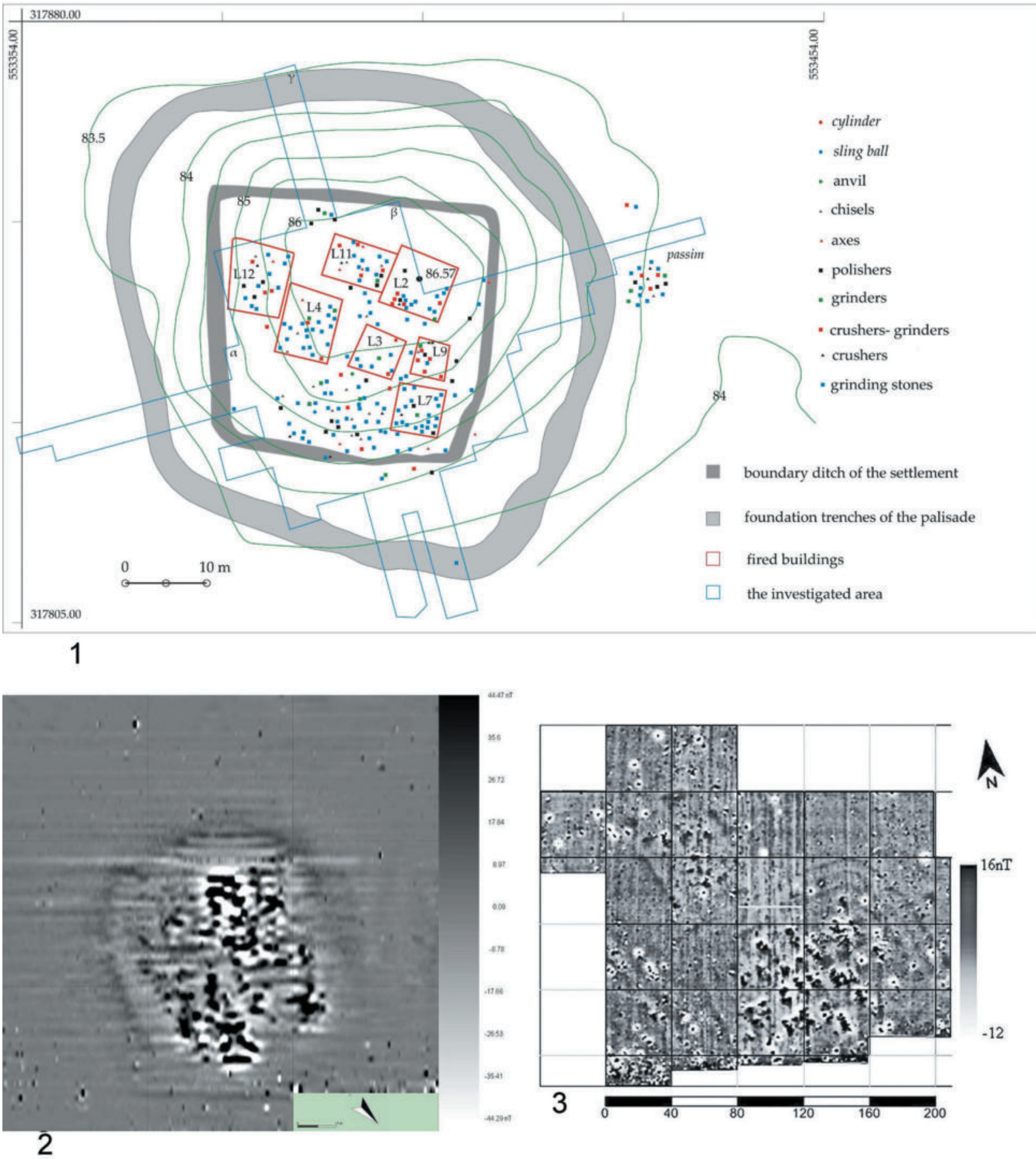


Fig. 17. Defensive settlements of Copper Age in the Lower Danube region. 1 – Bucşani-*Pod*. General plan (after: Bem and Haită 2016); 2 – Geangoeşti-*Hulă*. Magnetometric results (after: Micle and Stavilă 2014); 3 – Chioselia Mare I. Magnetometric results (after: Govedarica 2014).

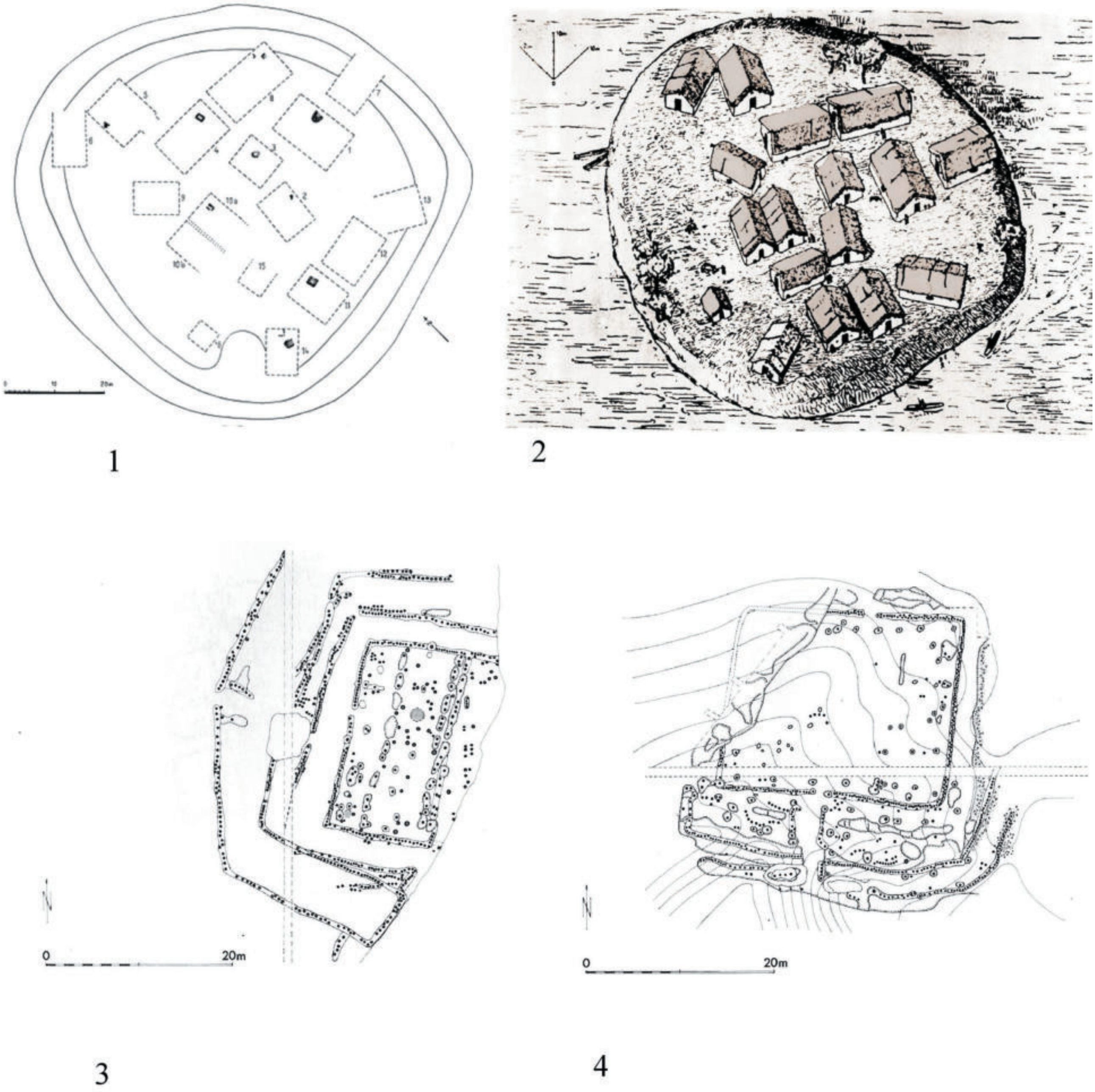
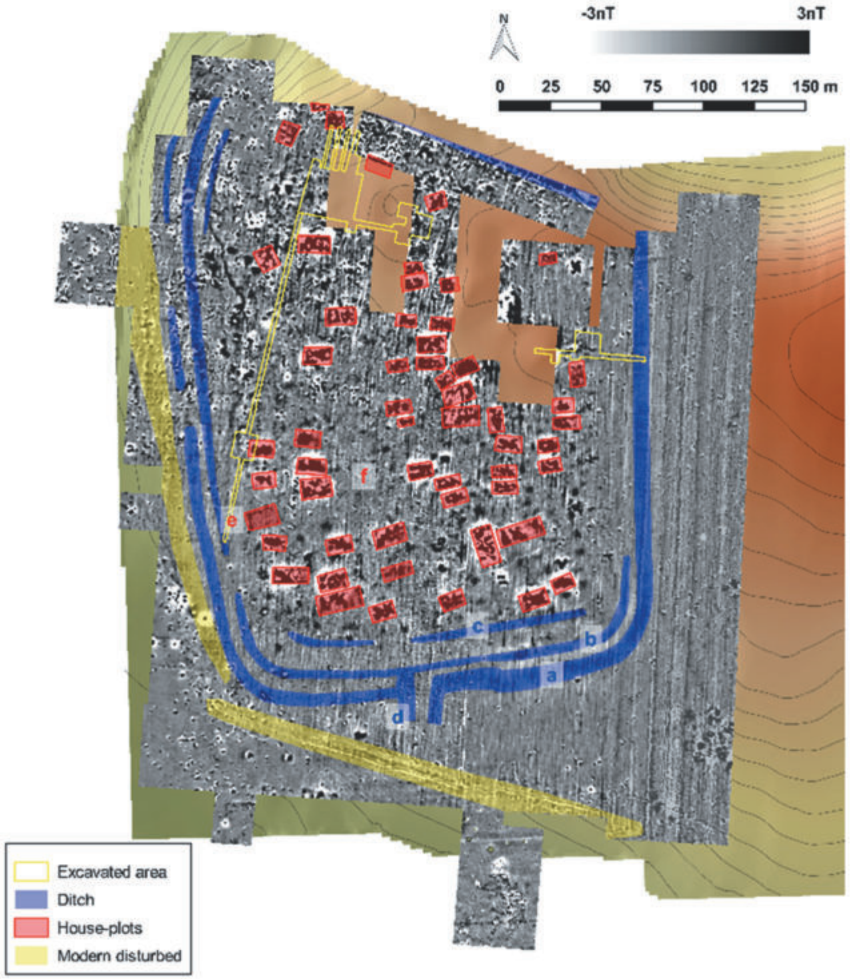


Fig. 18. Defensive settlements of the Copper Age in the Lower Danube region. 1 – Căscioarele, Gumelnița level, arrangement of buildings (Dumitrescu 1965, 37); 2 – Căscioarele reconstruction, after V. Dumitrescu (after: Lazarovici and Lazarovici 2007, 109, fig. Vc.41); 3 – Goljamo Delčevo, general plan (Todorova 1982, fig. 114, 183); 4 – Ovčarovo, general plan (Todorova 1982, fig. 134, 193).



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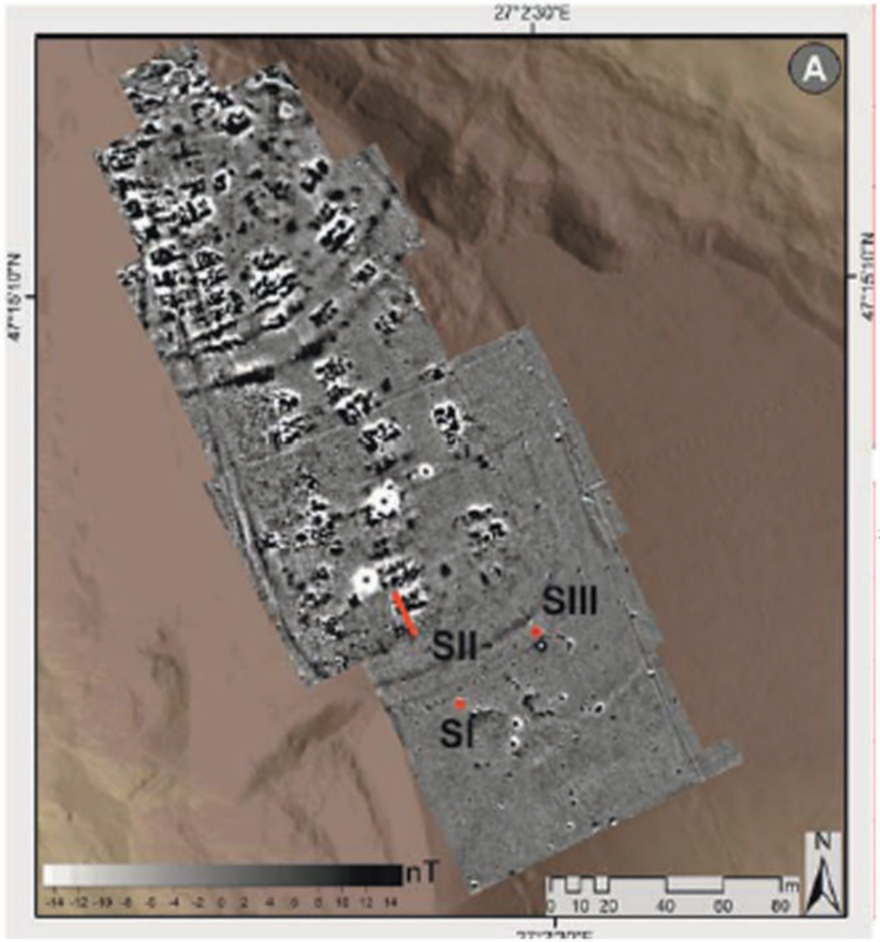

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Fig. 19. Defensive settlements of the Copper Age in the Lower Danube region. 1 – Scânteia – Dealul Bodești, magnetogram (Mischka *et al.* 2016, 335, fig. 5); 2 – Războieni – Dealul Mare/Dealul Boghiu, magnetogram (Vornicu *et al.* 2018, 383, pl. II, A.

approximately equal, and all had defensive systems. With this new information, we can state that one of the arguments for distinguishing the settlements from the Bugeac steppe, namely the lack of defence systems (Subbotin 1978, 34; Subbotin 1983, 124–125; Subbotin 2013, 112) is no longer valid.

The archaeological collections of Taraclia I represent an abundant and important source for studying the Gumelnița Eneolithic in the steppe area of the Prut and the Dniester interfluve. The ceramic assemblage recovered during the four excavation campaigns is quite impressive and will be valorised in the future. Supported by the new data concerning the planimetry, type of settlements, and the manner of the construction of the houses, we hope to obtain answers to the question of how this region was colonised in the early Eneolithic.

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Remarks on using tools with truncated edges in the Lublin-Volhynian culture on the example of materials from site no. 7 in Las Stocki, Puławy County

Abstract

Mączyński P. 2019. Remarks on using tools with truncated edges in the Lublin-Volhynian culture on the example of materials from site no. 7 in Las Stocki, Puławy County. *Analecta Archaeologica Ressoviensia* 14, 41–56

This article tackles the issue of the use of truncations by the population of the Lublin-Volhynian culture. The corpus of sources for their analyses is a group of 27 tools discovered during the research of the Las Stocki settlement, site 7. Microscopic observation made it possible to separate a considerable group of artefacts bearing use-wear traces on their surfaces. The most numerous were items used for processing plant material and wood. Other activities, like processing stone/pottery, hide, and other unspecified materials were recorded sporadically. Another research problem was the attempt to reconstruct the biographies of the stone tools. The analyses indicated that the materials were only partly useful in the research. This was caused by the poor preservation state of the artefacts and of the recorded use-wear traces. Tackling this issue gave the best results in the case of items used for cutting siliceous plants, which undoubtedly resulted from the distinct character of such use-wear patterns.

Keywords: Lublin-Volhynian culture, use-wear analysis, truncations, chocolate flint

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Introduction

Attempts to recognise the functions of flint tools linked with the Lublin-Volhynian culture (hereinafter referred to as L-WC) have been made for several decades. First, the main interest of scholars was focused on the analysis of materials representing grave inventories. The forerunner of research concerning this problem was Natalia Skakun, who, in the year 2003, analysed 16 microliths from grave 4 in Książnice 2, Busko County (Zakościelna 2010, 139, footnote 9; Wilk 2004, 237; Kufel-Diakowska and Wilk 2018, 247, 248). This trend was later continued by other scholars. One of them was the author of this article, who analysed sepulchral materials from such sites as: Złota, Sandomierz County, site "Grodzisko II"; Strzyżów, Hrubieszów County, sites 1A and 2A; Krasne Kolonia, Chełm County, site 16 (Mączyński and Zakościelna 2017a, 340–346; 2017b, 113–116). Simultaneously, further examination of the materials from Książnice was conducted (Wilk and Kufel-Diakowska 2016, 157–163; Kufel-Diakowska and Wilk 2018, 260–264).

Inventories from settlements have been studied much less frequently. Already in 2015, a modest sample of materials from site 7 in Las Stocki, Puławy County, was analysed. The results of the examination were presented during workshops organised by the SKAM Flintreaders Society (Stowarzyszenie Krzemieniarskie SKAM) (Mączyński 2015, 17, 18). Only inventories from the fortified settlement in Sandomierz – Wzgórze Zawichojskie (Zawichost Hill), Sandomierz County, were presented in an extensive publication. Its author, Małgorzata Winiarska-Kabacińska, analysed 150 flint artefacts, qualified as tools, blades, flakes, and production debris, regarding their functional aspects (Winiarska-Kabacińska 2017, cf. Table 1).

In this list, publications presenting 2 collections of macrolithic blades made of chocolate flint, discovered in Krowia Góra, Sandomierz County, and in Pełczyska, Pińczów County, should be mentioned (Skakun *et al.* 2008, 430–433; Mączyński and Polit in press).

Although the discussed research represents a relatively numerous group of analyses, not many artefacts qualified as truncations were examined. The only materials containing this category of tools come from Złota "Grodzisko II". On this site, in symbolic grave no. 122 located in the settlement, a rich inventory containing the mentioned truncation was discovered and which included a numerous group of clay vessels and a collection of flint tools (Mączyński and Zakościelna 2017b, 115). The next 4 tool specimens come from the settlement in Sandomierz, Wzgórze Zawichojskie (Zawichost Hill). The researcher Winiarska-Kabacińska demonstrated that these artefacts had been used for performing various activities connected with cutting cereals, piercing stones, and scraping hide (Winiarska-Kabacińska 2017, 255, 258). This article presents the results of the analysis of 27 similar tools discovered on the L-VC settlement site in Las Stocki (Table 1).

Table 1. Las Stocki, Puławy County, site 7. List of the results of the use-wear traces analysis. Legend: Ch. – chocolate flint; Ś. – Świeciechów flint; V. – Volhynian flint.

No.	Location	Morphology	Functional designation	Raw material
1	2	3	4	5
1	surface of the site	oblique truncation	– no use-wear traces were recorded	burnt
2	surface of the site	oblique truncation	– no use-wear traces were recorded	ch.
3	surface of the site	trapezoidal double truncation (Fig. 3: 2)	– whittling wood (Fig. 3: 1) – edge probably used	ch.
4	surface of the site /ploughed field	oblique truncation/retouched blade – damaged (Fig. 3: 4)	On the ridges between the negative scars and on protruding points, there is polishing, having a coarse texture, which abraded the natural microrelief of the flint. In some places, scars/linear fissures appear. These traces probably result from keeping the retouched blade in a sheath, presumably made of leather (Fig. 3: 5). – visible linear traces indicating that the tool was used for cutting or that it was kept in a sheath (Fig. 3: 6) – scraping (hide?) – scraping material of unspecified type – hide? (Fig. 3: 7) – filing material of unspecified type – soft stone? (Fig. 3: 7) – strike-a-light (Fig. 3: 3)	v.
5	ploughed field	end scraper/ truncation (Fig. 4: 1)	– edge probably used – scraping material of unspecified type?	ch.
6	ploughed field	trapezoidal double truncation (Fig. 4: 2)	– cutting siliceous plants (herbaceous plants/reed?)/whittling soft wood? (Fig. 4: 4)	ch.
7	ploughed field	oblique truncation – damaged (Fig. 4: 3)	– processing siliceous plants/soft wood (young shoots/branches?) – most possibly cutting (Fig. 4: 5) – cutting soft material – most possibly hide (Fig. 4: 5)	ch.
8	ploughed field	oblique truncation	– no use-wear traces were recorded	ch.
9	ploughed field	oblique truncation (Fig. 4: 6)	– scraping wood/soft bone	ch.
10	ploughed field	straight truncation	– no use-wear traces were recorded	ch.
11	ploughed field	straight truncation	– scraping soft stone – cutting soft material	ch
12	pit 5	oblique truncation (Fig. 4: 7)	– cutting siliceous plants	ch.
13	pit 5	trapezoidal double truncation? – damaged (Fig. 4: 8)	– cutting siliceous plants (Fig. 4: 9)	ch.
14	pit 19	oblique truncation (Fig. 5: 1)	– cutting siliceous plants	ch.

1	2	3	4	5
15	pit 19	oblique truncation (Fig. 5: 2)	– cutting siliceous plants	ch.
16	pit 19	trapezoidal double truncation? – damaged (Fig. 5: 3)	– scraping soft material – skin? (Fig. 5: 4) – working edge fragmentarily preserved – scraping hide?	ch.
17	pit 24	oblique truncation (Fig. 5: 5)	– edge probably used? – unspecified activity (Fig. 5: 6)	ch.
18	pit 26	straight truncation – damaged (Fig. 5: 7)	– cutting siliceous plants	ch.
19	pit 26	trapezoidal double truncation – damaged (Fig. 6: 1)	– cutting siliceous plants (Fig. 6: 2)	ch.
20	pit 26	trapezoidal double truncation (Fig. 6: 3)	– cutting siliceous plants (Fig. 6: 4) – unspecified activity – traces indicating that the tool was used for cutting and scraping/whittling plants/wood/soft bone?	ch.
21	pit 26	oblique truncation	– no use-wear traces were recorded	ch.
22	pit 28	oblique truncation – damaged (Fig. 7: 1)	– cutting siliceous plants – edge probably used – short-lived activity of cutting siliceous plants?	ch.
23	pit 28	straight truncation (Fig. 7: 2)	– scraping soft stone/clay/pottery? (Fig. 7: 4)	ś.
24	pit 39	oblique truncation/ retouched blade – damaged (Fig. 7: 5)	– scraping stone/traces of grinding (Fig. 7: 3)	ch.
25	pit 44	oblique truncation (Fig. 6: 5)	– cutting siliceous plants (Fig. 6: 6)	ch.
26	pit 44	oblique truncation – damaged? (Fig. 8: 3)	– cutting siliceous plants/soft wood? (Fig. 8: 5) – scraping material of unspecified type (Fig. 8: 1, 2) – cutting (Fig. 8: 4) and scraping (Fig. 8: 5) material of unspecified type	ch.
27	pit 54	straight truncation – damaged (Fig. 7: 6)	– scraping stone?	ch.

When performing the use-wear analysis, several basic research problems were focused on. The identification and interpretation of the use-wear traces observed on the surfaces of the tools and the reconstruction of the methods of their utilisation can be indicated as the most important question. This task consisted in determining the types of activities performed with the flint tools and establishing the types of processed materials. The question of identifying traces resulting from using hafts or from keeping the artefacts in sheaths is directly connected with this issue. Both categories of traces occur on the same surfaces, which frequently causes the blurring of earlier changes.

During the research, an attempt to present the tools' biographies, that is the sequences of the utilisation of particular items, was made. Tackling this research problem consisted in identifying the utilisation zones and establishing the chronologies of their creation in relation to each other, as well as to other changes occurring on the surfaces of the tools (like retouch or fractures). Annelou van Gijn, when considering this question, indicated that one might encounter several different situations: 1. The tool was hafted; 2 The tool was used for more than one activity; 3 The different used zones were the results of a single but complex activity; 4. The tool had been subjected to 'special treatment' after its use (van Gijn 2010, 33). We should bear in mind that the moments of creating different utilisation zones might have been separated by long time intervals and they might have been linked with different phases of using particular edges. This is why the analysis had to include changes in the morphologies of the tools.

Materials

The analysed collection of artefacts was yielded by archaeological excavations in the Lublin-Volhynian culture settlement in Las Stocki, Puławy County, site 7 (Fig. 1). Site 7 in Las Stocki is located on the terraced foreland of a vast hummock of a latitudinal orientation. The hummock is composed of Cretaceous rocks covered with boulder clay and a loess layer. The thickness of the loess on the flat areas of the hummock is smaller and it averages 1 metre, but grows significantly thicker on the slopes due to strong erosion. It is the loess cover that made it possible to intersect the slopes

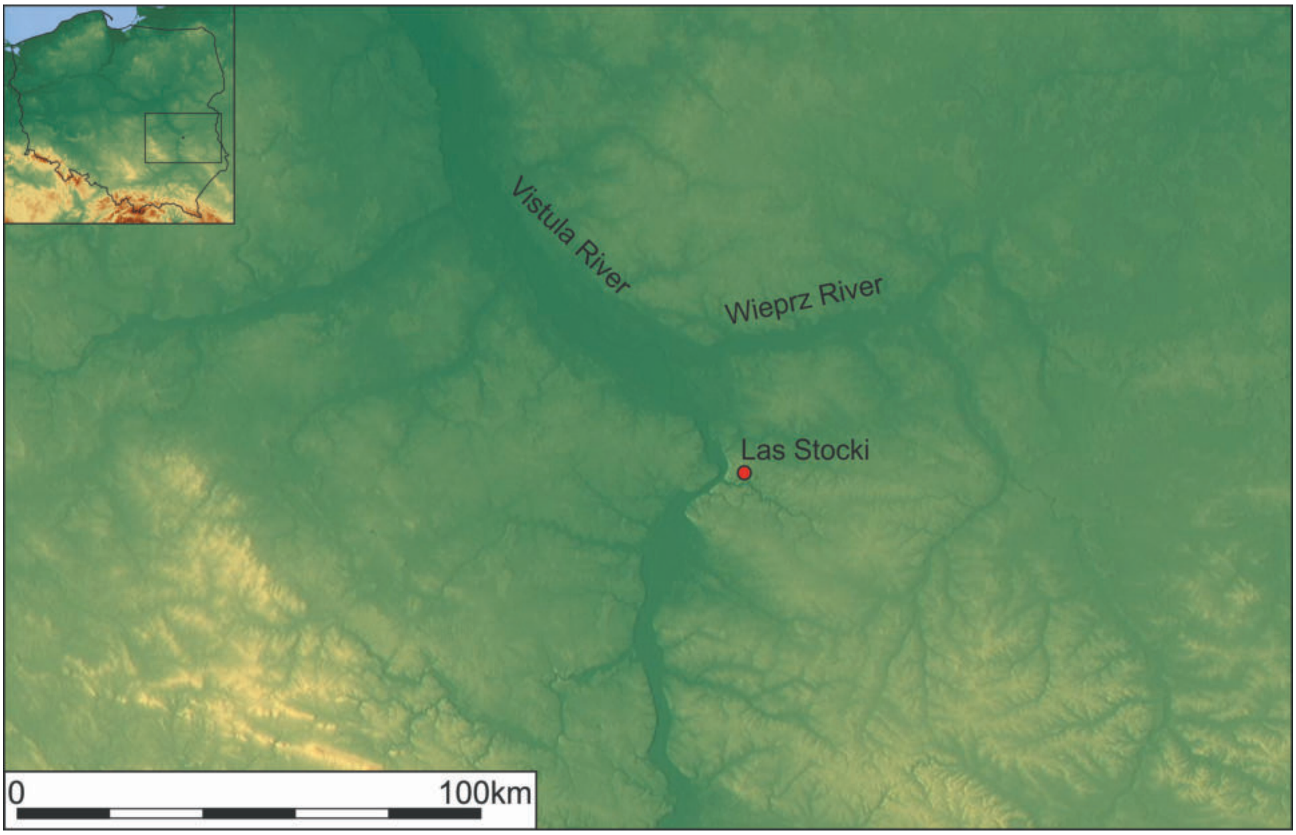

Fig. 1. Las Stocki, Puławy County, site 7. Location of the site. Drawings: P. Mączyński (https://maps-for-free.com).

of the foreland by numerous ravines of various sizes. From the north, the site is separated by a vast ravine, probably a valley of orientation close to latitudinal. From the south, the steep slope limiting the site is interspersed with smaller ravines which flow directly into the Bystra River. The southern and south-eastern slopes are very steep. Their altitude above the bottom of the valley reaches 40–45 metres. The research on this site, conducted in the years 1982–1985, was directed by Anna Zakościelna. During the 4 seasons of the research, the area of 1.700 square metres was explored and 2.207 flint artefacts were found (Fig. 2). This group included nearly 300 tools (see: Zakościelna 1996, 160). Chocolate flint was used in the production of most of the items while the others were made of erratic material. Świeciechów and Volhynian flint represent a minor addition (see: Zakościelna 1996, 132, 160). 27 tools from among the mentioned set were selected for the functional analysis.

Most of them (15 specimens) were discovered during the exploration of features and storage pits, in which they co-occurred with other flint artefacts and pottery. Due to the fact that the site yielded only several artefacts coming from other times, it was decided to also analyse materials from the upper surface of the settlement, as well as those found in the topsoil (Zakościelna 1996, 13). The collection encompasses 24 truncations and also contains several combined tools. The morphology of these artefacts deviates significantly from the previously described group, although, due to the fact that their truncated edges are fairly distinct, they were included in the set. Moreover, because of the presence of macroscopically observable use-wear patterns, taking them into consideration will undoubtedly affect the character of the obtained information. One of them is an end scraper + truncation, two others are fragments of retouched blades (Figs. 3: 4; 4: 1; 7: 3), which were included into the group due to their tips corrected with oblique retouch.

The great majority of the artefacts were made on fragments of blades struck from single platform cores. Only one of the items was formed on a slender flake (Fig. 4: 6). Most of them are tools bearing negative on their dorsal sides. Nevertheless, a group of artefacts with visible cortical surfaces, arranged longitudinally to the axes of the tools or located on distal part, was also recorded. Only one specimen was entirely covered with cortex.

The group of the items selected for the microscopic observation is very diversified. Tools with slanting truncated edges, typical for the L-VC, are predominant (Figs. 3: 1, 4; 4: 2, 3, 6–8; 5: 1–3, 5; 6: 1, 3, 5; 7: 1, 3). They are accompanied by a small number of artefacts with transverse edges (Figs. 5: 7; 7: 2, 6; 8: 3). Most of the tools are items with a single truncated edge. Only 5 artefacts have double truncated edges (Figs. 3: 1; 4: 2; 5: 3; 6: 1, 3). Sometimes, they are accompanied by segmented flat or semi-steep retouch of one of the sides (Figs. 3: 1, 4; 4: 7, 8; 5: 2; 6: 1, 3, 5; 7: 1, 2, 3; 8: 3). Several items represent the "Las Stocki" type (Figs. 5: 2, 5), characterised by having truncated edges shaped with flat pressure retouch (cf. Zakościelna 1996, 59–61). Among the single truncations, items retouched from the apex are predominant. The set is practically homogeneous in respect of the used raw material. Chocolate flint was used for the production of the vast majority of the tools (25 items). The others two were made of Volhynian (Fig. 3: 4) and Świeciechów flint (Fig. 7: 2).

Research analysis methodology

The performance of the analysis was divided into several phases, using two types of microscopes that made it possible to obtain various magnifications. In the first place, the artefacts were examined with the naked eye. The main purpose of this inspection was the selection of the materials due to their usefulness in performing the use-wear analysis. It consisted in excluding from the analysis forms with surfaces whose state made it impossible to make observations (considerably burnt surfaces or surfaces covered with strong patina). At this stage, attention was also paid to the presence of residues that might have resulted from different types of operations performed with the use of the tools or from setting them in frames. If necessary, the artefacts were additionally observed with a stereoscopic or metallographic microscope.

The next phase of the identification of the use-wear patterns consisted in the observation of the surfaces with the microscopes. At this stage, prior to the analysis, the observed artefacts were rubbed with acetone or ethanol in order to remove fingerprints. First, the stereoscopic equipment, giving small magnification between 8× and 80×, was required. For that purpose, Carl Zeiss Discovery V 8 microscope was used. During this phase, the artefacts were held in the hand and the surfaces of the flints were observed with the microscope, with light falling from various angles. The aim of this preliminary analysis was to detect edges that had been presumably used or edges bearing use-wear patterns (cf. Vaughan 1985, 56; van Gijn 1989, 16). At this stage, the observation of such elements as the features of use-wear patterns and the presence of rounded edges was considered as the most important. In the case of certain activities, it was also possible to observe linear traces and some features of the polished areas, especially their extents.

The second phase of the prospection consisted in the observation of the flint artefacts with Meiji Techno MC-50T microscope, giving the actual magnification of 50×/100×/200×. Due to the considerable magnification of the image, the observation of the scars was impossible. The researchers focused on the interpretation of characteristic features of the polished areas (topog-

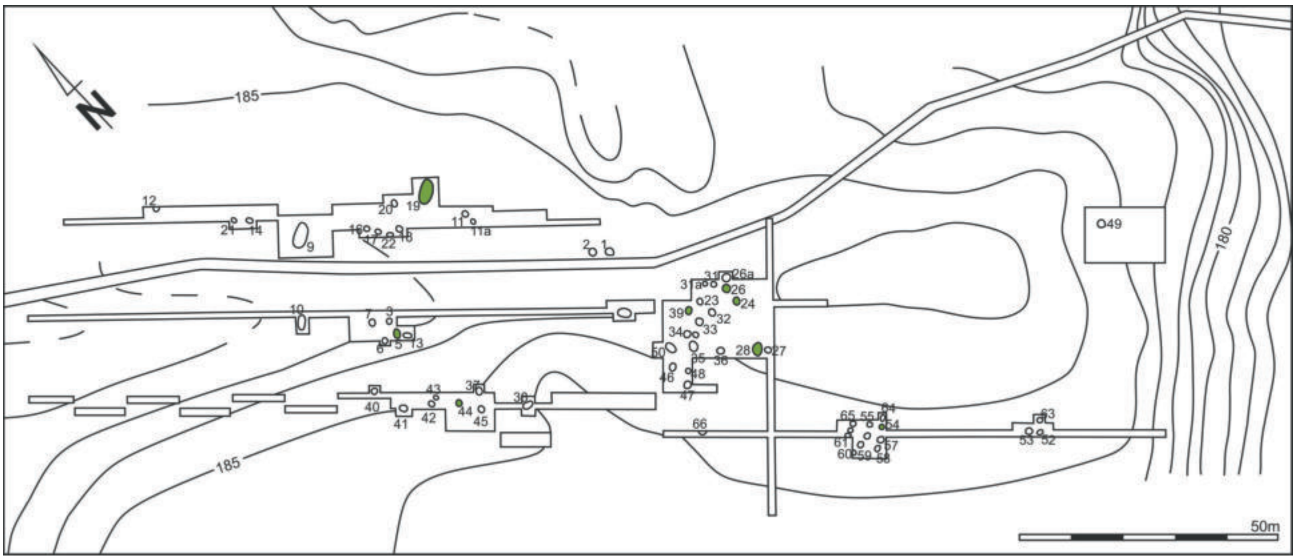

Fig. 2. Las Stocki, Puławy County, site 7. Plan of the site (A. Zakościelna 1986, fig. 1, witch author changes).
Legend: – location of pits containing the analysed material.

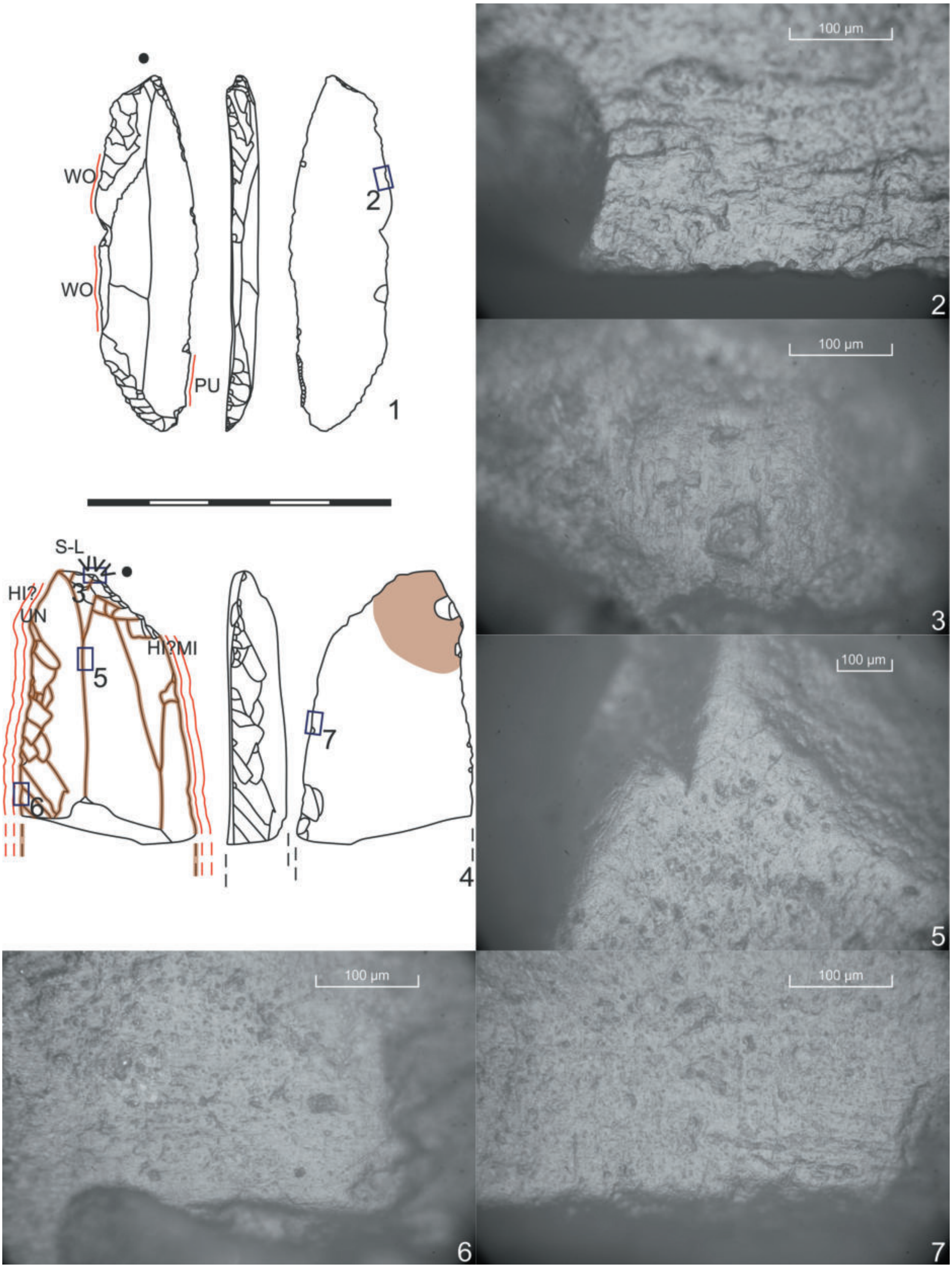

Fig. 3. Las Stocki, Puławy County, site 7. 1 – truncation, 2, 3, 5–7 – photographs of use-wear traces; 4 – fragment of a blade-dagger. Drawings/photographs: P. Mączyński. (2, 3, 6, 7 – 200× magnification, 20× objective lens; 5 – 100× magnification, 10× objective lens).
Legend: HI – hide; PL – plants; WO – wood; BO – bone; MI – mineral; S-L – strike-a-light; PU – probably used; UN – unspecified material; ▭ – place where the photograph was taken; ⟍ – scope of the working edge; ■ – extent of polishing caused by processing siliceous material; V – strike-a-light; ⟍ – scope of hafting; ⟍ – edge fragmentarily preserved (broken off).

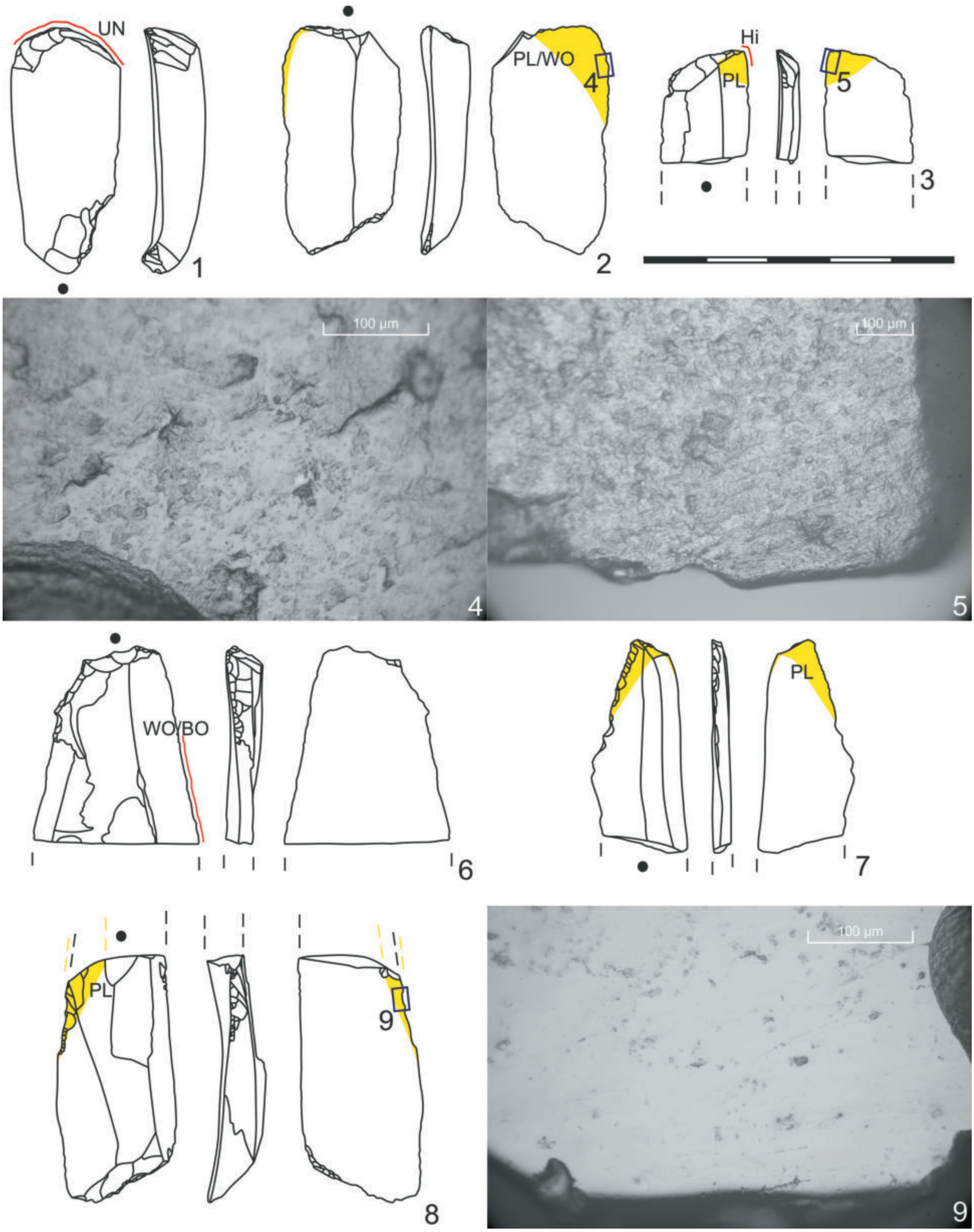

Fig. 4. Las Stocki, Puławy County, site 7. 1 – end scraper/truncation; 2, 3, 6, 7, 8 – truncations; 4, 5, 9 – photographs of use-wear traces; Drawings/photographs: P. Mączyński. (4, 9 – 200× magnification, 20× objective lens; 5 – 100× magnification, 10× objective lens).

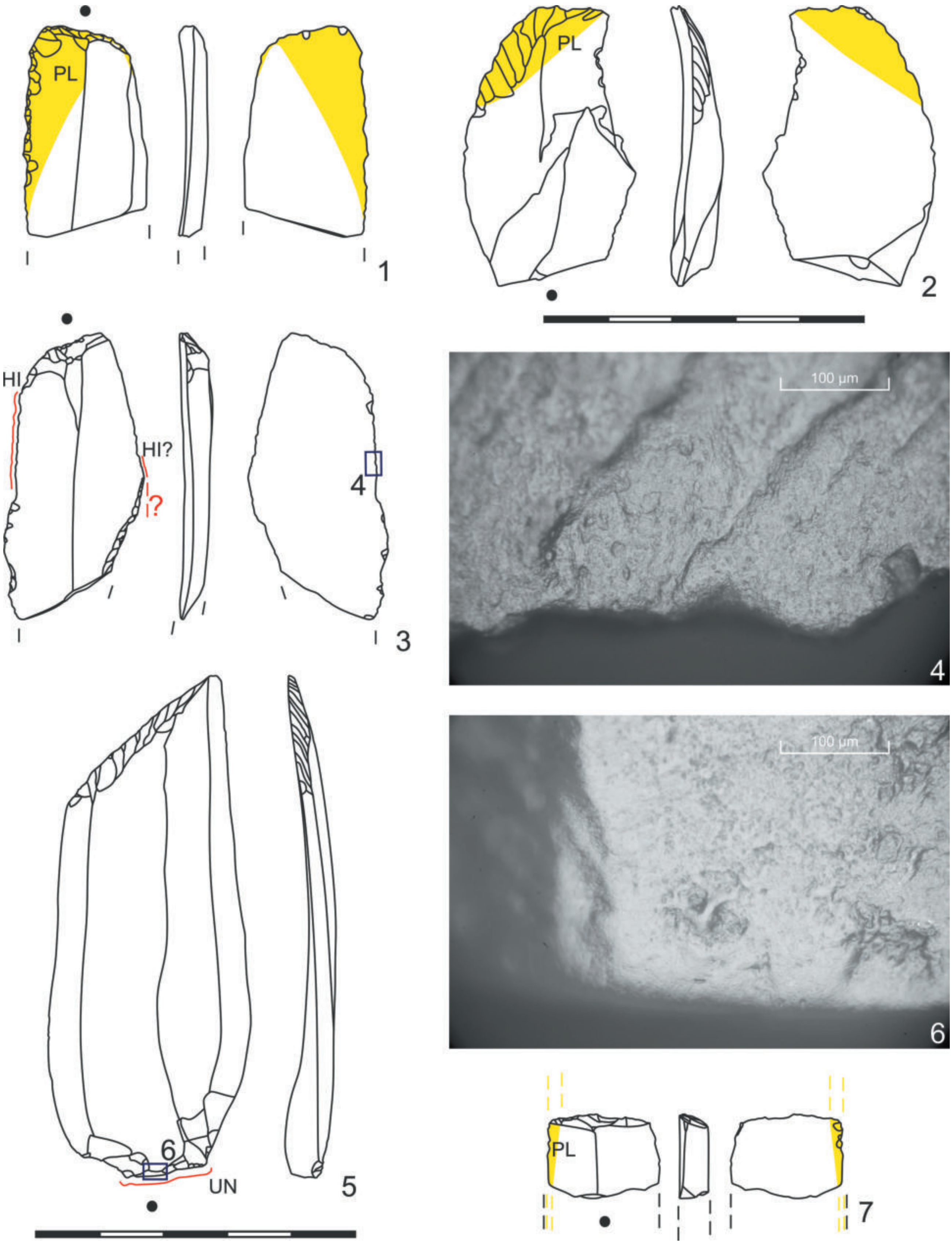

Fig. 5. Las Stocki, Puławy County, site 7. 1–3, 5, 7 – truncations; 4, 6 – photographs of use-wear traces. Drawings/photographs: P. Mączyński. (4, 6 – 200× magnification, 20× objective lens).

raphy, texture, extent) and of the linear traces. In the view of the obtained data, the types of the processed raw materials and the directions of the utilisation of the tools were established.

Before carrying out the study, it was necessary to clean the surface of the tools. It is worth pointing out that using any cleaning techniques may damage residues of mineral or organic origin preserved on tool surfaces (!). This is why their implementation, from the earliest procedures concerning the stocktake of the source material to the later stages of the analysis, should be preceded by thoughtful deliberation.

The source material used in this article was yielded by excavations conducted in the 1980s (Zakościelna 1996, 130). Due to earlier research, they were previously cleaned with warm water and detergent. This is the reason why at the present stage of the examination the items were only rubbed with acetone, just before the analysis, in order to remove fingerprints.

Functional analysis

The great majority of the analysed items (22 artefacts) either had use-wear patterns on their surfaces or were qualified as tools that had been probably used. The best known group are artefacts used for processing herbaceous plants or wood. This type of work was linked with 14 items (Figs. 3: 1; 4: 2, 3, 7; 8; 5: 1, 2, 7; 6: 1, 3, 5; 7: 1; 8: 3). The patterns observed on their surfaces indicate that not all of them were used for the same purpose. What is more, some of them also had other functions.

In this group, the most numerous are items used for processing siliceous plants. On the lateral edges of 9 tools, bright polished areas of invasive nature were observed (Figs. 4: 7, 8; 5: 1, 2, 7; 6: 1, 3, 5; 7: 1). Their shapes were close to triangular and they were accompanied by one-step or two-step chipping. The microscopic observation revealed that the topographies of the polished areas are flat, but they become increasingly vaulted in the areas located far from the edge. The texture is smooth. These marks are sometimes accompanied by linear traces (Figs. 4: 9; 6: 4, 6). Such patterns should be linked with using tools as sickle inserts for reaping siliceous plants, like wild grass and cereals (cf. Keeley 1980, 60; Vaughan 1985, 36; van Gijn 1989, 40; Juel Jensen 1994, 33). Only in one case was the surface of the polished area covered with numerous black or embedded scars (Fig. 6: 2), which indicates that the tool had been used for cutting plants of more abrasive character (?).

When discussing the question of the artefacts belonging to this group, it should be noted that the surfaces of most of the tools bear marks indicating that they were used for only this one type of activity. It is worth pointing out that there was retouch on several artefacts, which suggests that their working edges had been "sharpened". Nevertheless, due to the fact that the use-wear patterns occurring on this retouch covered it to a small degree, and because of the character of the retouch, it is impossible to answer the above question without any doubt (Figs. 6: 1, 3, 5; 8: 1).

On two other items, there were use-wear traces indicating that these artefacts had been also used for other purposes. Apart from the marks suggesting that siliceous plants had been cut with the tools, on the opposite edges of the artefacts, marks caused by contact with another type of raw material were observed (Figs. 6: 3; 7: 1). Unfortunately, due to the modest character of the use-wear pattern, it was impossible to determine the type of the processed material. At the same time, the linear traces visible on their edges (black or embedded scars) allow us to establish the direction of the performed work, which was linked with scraping or cutting presumably soft material.

Traces observed on the other 3 tools and associated with processing plants are different from the above discussed sickle inserts. They also indicate that they were used for other activities. A double truncation discovered in humus was used for processing a somewhat different type of raw material (Fig. 4: 2). As with the case of the previously mentioned artefacts used for cutting siliceous plants, a bright polished area of triangular shape, but of more limited extent, was registered on its surface. Its topography is flat or wavy and with a smooth texture. On its edge, there are single negative scars (Fig. 4: 4). This activity was not clearly interpreted, but maybe the pattern should be associated with processing plants of unspecified type. On the other hand, the fact that the polished area on one of the opposite edges is larger than the other may indicate that the traces are the result of whittling plant stalks or very soft wood (cf. Osipowicz 2010, 53–67; Vaughan 1985, 33–34).

In the second case, the truncation (Fig. 4: 3) was probably used for cutting plants or soft wood (young shoots/branches?). What is interesting, the same edge was next utilised for cutting soft material, presumably hide. This is attested to by the visible rounding of the edge's tip, on which a polished area of crater-like topography occurred. What is more, numerous linear fissures, which indicate the direction of the performed work, were visible on its surface. These modifications blurred the bright polished area, whose emergence had resulted from the contact of the tool with plants (Fig. 4: 5).

The next tool (Fig. 8: 3) had a similar function. On one of its sides, there was a polished area, stretching in the form of a band on both sides of the edge and

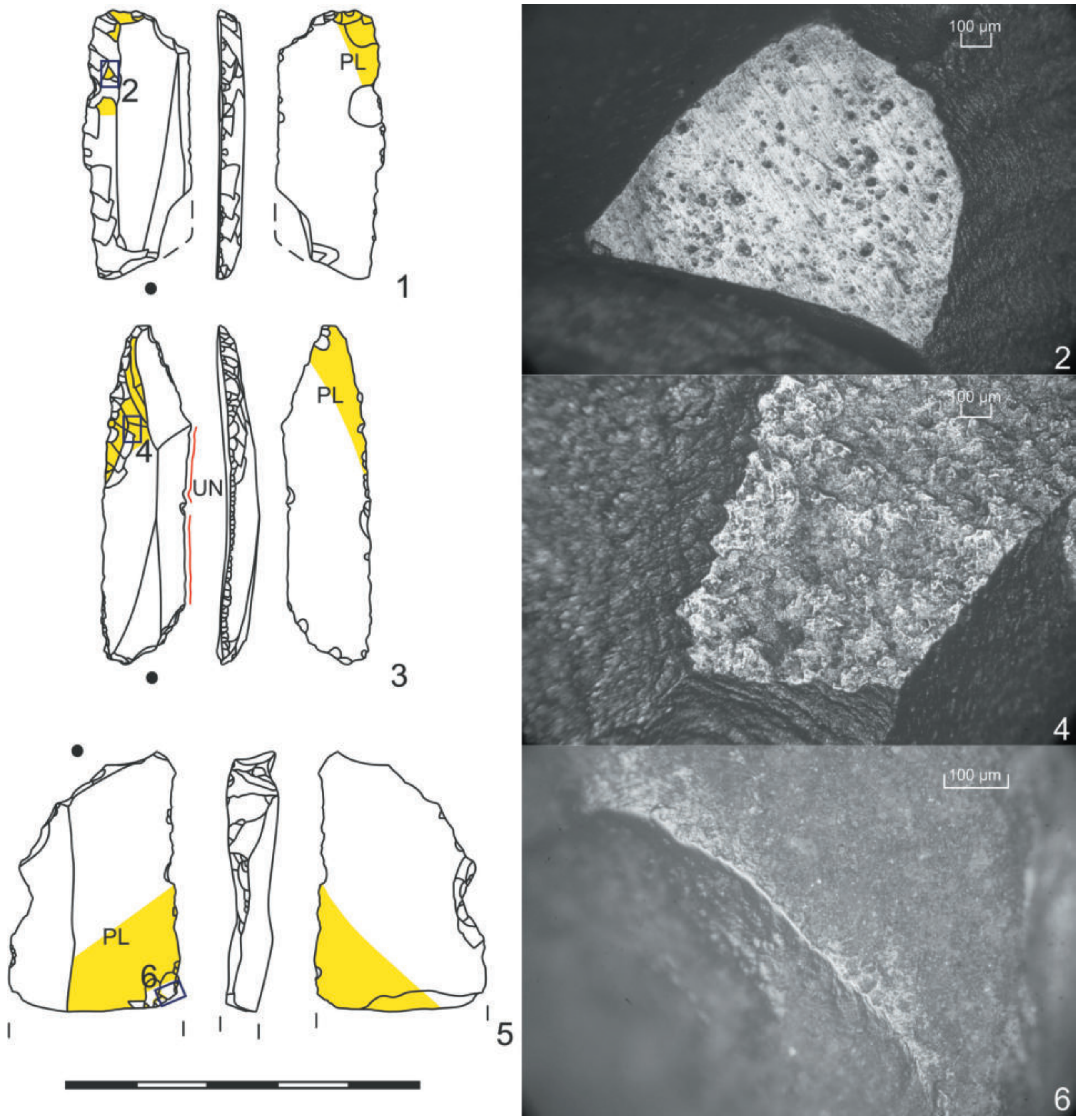

Fig. 6. Las Stocki, Puławy County, site 7. 1, 3, 5 – truncations; 2, 4, 6 – photographs of use-wear traces. Drawings/photographs: P. Mączyński. (2, 4 – 50× magnification, 5× objective lens; 6 – 100× magnification, 10× objective lens).

having a dome-like topography, as well as a soft texture (Fig. 8: 5). The pattern should probably be associated with cutting plants or soft wood (?). This was presumably one of the first functions of this edge, but we should note that it was not its only role. On the same side, there was multi-step, continuous retouch covered with a dome-like/crater-like polished area, which had damaged the previously mentioned traces. The modifications are accompanied by linear traces in the form of black scars or linear furrows which are parallel or perpendicular to the edge, which indicates that they were caused by both cutting and scraping (Fig. 8: 4, 6). These traces were associated with processing material of an unspecified type.

On the opposite edge, there is retouch having a similar morphology. It is accompanied by a polished area: its topography is flat/concave and the texture is coarse. This pattern completely blurred the natural micro-relief of the flint and significantly rounded the edge. On the surfaces of these traces, black scars, indi-

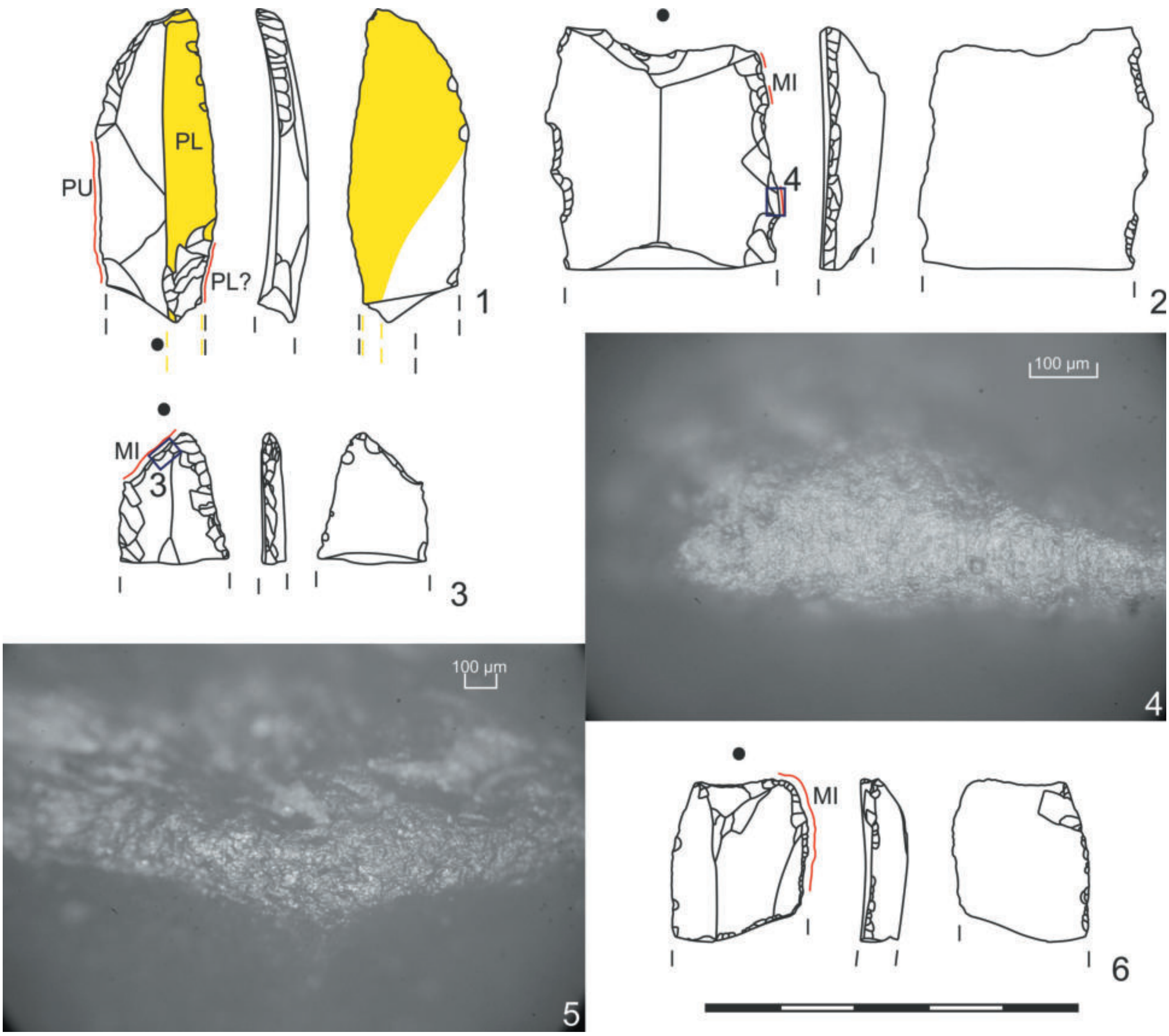

Fig. 7. Las Stocki, Puławy County, site 7. 1, 2, 6 – truncations; 3 – fragment of a retouched blade; 4, 5 – photographs of use-wear traces. Drawings/photographs: P. Mączyński. (4 – 100× magnification, 10× objective lens; 5 – 50× magnification, 5× objective lens).

cating that the tools was used for scraping, are visible (Fig. 8: 1, 2). Just like in the case of the opposite edge, this side was utilised for performing long-lasting work that consisted in scraping hard material.

It is very probable that the side edges of one truncations was used for processing wood (Fig. 3: 1). On their surfaces, traces in the form of bright polished areas, of invasive extent and dome-like or dome-like and crater-like topographies, were recorded (Fig. 3: 2). These patterns are accompanied by indistinct, embedded scars arranged perpendicular or slightly obliquely to the edge (cf. Osipowicz 2017, 60; Pyżewicz 2013, 45; Korobkowa 1999, 50).

An interesting group of artefacts is represented by tools bearing traces resulting from contact with or processing mineral material (Fig. 7: 3, 6). In the case of three items, such marks were recorded on the truncated edges, on which multi-step retouch, crushed edges, and abrasion, which indicate that the artefacts had come in contact with mineral raw material, were recorded. In one case (Fig. 7: 3), the marks are so distinct that the abrasion/smoothing can be seen with the naked eye (Fig. 7: 5). Unfortunately, the character of the marks makes it impossible to state whether they result from using the tools or from the blunting of one of the tool's sides. Similar traces were recorded on a truncation made of Świeciechów flint (Fig. 7: 2). Its edge had been secondarily retouched, but in some places, abraded/rounded fragments of the blade were preserved. On its surface, a polished area of a distinctly crater-like topography was observed. It was accompanied by indistinct, vast linear fissures indicating that the tool had been

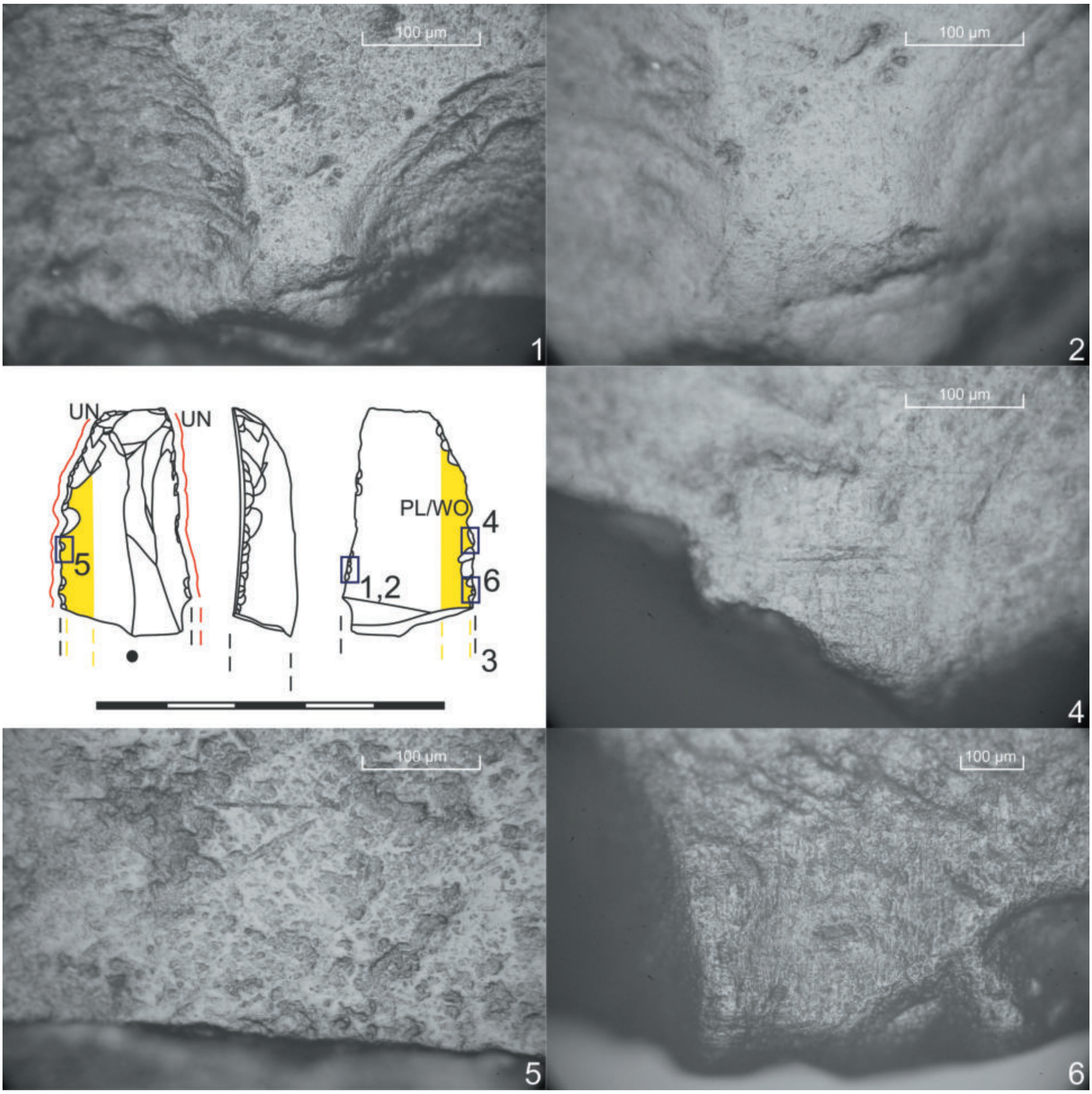

Fig. 8. Las Stocki, Puławy County, site 7. 3 – truncation; 1, 2, 4–6, – photographs of use-wear traces. Drawings/photographs: P. Mączyński. (1, 6 – 100× magnification, 10× objective lens; 2, 4, 5 – 200× magnification, 20× objective lens).

used as a scraper for processing soft material of mineral origin or clay/pottery (Fig. 7: 4).

The next noteworthy artefact is a massive Las Stocki type truncation (Fig. 5: 5). There are no typical use-wear traces on the tool, but a bright polished area of a flat topography and slightly coarse texture was recorded on the butt (Fig. 5: 6). The origin of these traces is not certain. Nevertheless, it appears that their location on the butt of the tool is not accidental.

A fragment of a blade-dagger formed on a massive Volhynian flint blade stands out from the rest of the collection (Fig. 3: 4). Such tools are relatively rare in settlement materials. Most of the known and well-preserved items come from grave inventories. Because of their unusual size and the technique of their production, they are interpreted as prestige tools (Zakościelna 2008, 586). Materials of this type have been analysed several times for the identification of the use-wear patterns. Marks indicating that the items were kept in sheaths or set in frames are typical of such artefacts. From among the activities performed with their edges, cutting soft material, as well as processing plants and hide deserve our attention. On the other hand, the areas adjacent to the butts bear traces indicating that the items were used for striking fire (Wilk and Kufel-Diakowska 2016, 157–163; Mączyński and Zakościelna 2017a, 344; 2017b, 114).

The above-mentioned fragment from Las Stocki is also covered with patterns indicating that it was utilised for long time. On the ridges between the negative scars, as well as on the lateral edges and protruding points, polished areas of crater-like topographies and coarse textures were recorded. Micro-relief had been completely blurred in many parts of the tools. The above presented marks are accompanied by a small number of linear traces in the form of black scars (Fig. 3: 5). Such abrasions can be probably linked with keeping tools in sheaths made of hide (cf. Wilk and Kufel-Diakowska 2016, 157, 106; 162; Mączyński and Zakościelna 2017b, 114). The above described traces were not recorded on the truncated edge, present on the apical part of the tool, which indicates that it had been formed in the later stage of using the artefact. In addition to the mentioned patterns associated with storing, many traces of use-wear character were recorded. On the retouched side, there was a distinct polished area of a crater-like topography and coarse texture, which had blurred the natural micro-relief of the flint. These marks were accompanied by numerous linear traces arranged parallel to the edge. The recorded patterns should be linked with cutting soft material (Fig. 3: 6). On the surface of the discussed section, linear traces were observed. They were arranged perpendicular to the edge, and their nature indicated that they had been used for scraping hide or other type of soft material. On the opposite side of the tool, strong abrasion of the edge was observed. It was accompanied by linear traces in the form of fissures arranged parallel to the edge. Because of the fact that the use-wear traces were distinct, it was suggested that they might have resulted from cutting such materials as soft minerals/pottery. Moreover, as in the case of the previously discussed edge, these marks were accompanied by traces in the form of scars indicating the activity of scraping (Fig. 3: 7). However, due to the fact that patterns associated with several types of work overlapped each other, establishing the type of the processed material was impossible. It appears that the last stage of using this artefact was the utilisation of the truncated edge as a strike-a-light. This assumption results from the established chronology of the modifications, described above, which is indicated by the fact that the edge bears no patters left be keeping the tool in a sheath. On the surface of the truncated edge, characteristic abrasion/rounding, discernible with the naked eye, was recorded. At the same time, bright polishing was observed under the microscope. Within its area, embedded scars were recorded (Fig. 3: 3). These types of traces represents typical marks indicating that the flint came in contact with pyrite or marcasite (Pyżewicz and Rozbiegalski 2012, 263; Sorensen *et al.* 2014, 481–483).

Remarks on the chronologies of the modifications

One of the aims of this work was to reconstruct the biographies of the flint tools (van Gijn 2010, 33). Performing this task consisted in establishing the relative chronologies of the modifications observed on the artefacts. Such patterns were divided into three types: retouch forming the truncated edge, retouch of the lateral edges, and transverse fractures.

The analysis of the first category of the modifications, truncated edges, in most cases did not reveal the presence of use-wear patterns on their surfaces. They were visible only on four analysed artefacts (Figs. 3: 4; 7: 3, 6). In 7 cases of tools used for processing plants, polishing caused by harvesting also entered the surface of the retouch, but the recorded extent of the intrusion indicated that it did not result from using these edges, but from the invasive character of the siliceous polishing (Figs. 4: 2, 3, 7; 5: 1, 2; 6: 1; 7: 1). The observed relations make it possible to state that the function of shaping the truncated edge was to make the tool shorter and probably to change its geometry. It should be also noted that in many cases no direct correlation between the working edge and the truncated edge was detected (Figs. 3: 1; 4: 1, 6, 8; 5: 3, 5; 6: 3, 5; 7: 2; 8: 3). Due to this fact, it cannot be ruled out that both categories of modifications were separated by a certain time interval and that there is no correlation between them. However, they are currently interpreted by archaeologist as a whole. This state of affairs can be represented by a tool on which retouch forming the truncated edge damaged harvest polishing, which indicates that is was created after reaping plants (Fig. 5: 7). Unfortunately, because the tool is incompletely preserved, the reasons for retouching the edge of the tool by its users are not clear.

In the case of most of such tools, the edge located opposite to the truncated edge is limited by a traverse fracture. None of these fractures bore on their surfaces use-wear patterns. The great majority of these artefacts had fractures whose observation did not indicate that they had damaged or shortened the working edges. Such situations, indicating that the tools had been damaged were recorded only in the case of several specimens (Figs. 3: 4; 4: 8; 5: 3, 7; 7: 1; 8: 3). It appears that the observed damages were the direct cause of the abandonment of the tools. It is however worth pointing out that this number may be actually higher, since the observation of the stratigraphies of the fractures was extremely difficult.

The last category of the morphological modifications encompasses retouches of lateral edges, which appeared on 12 tools. Use-wear patterns were recorded on the edges of 10 items (Figs. 3: 1, 4; 4: 7, 8; 5: 2; 6: 3, 5; 7: 1, 2; 8: 3). In several cases, a retouched edge damaged earlier use-wear patterns. This concerns 6 tools: a truncation serving as a scraping tool (Fig. 7: 2) and 5 tools used for processing siliceous plants (Figs. 6: 1, 3, 5; 7: 1; 8: 3). Unfortunately, in most cases, the reason for the formation of retouch was not determined.

Final remarks

The main goal of this article was to specify the functions of the truncations and to establish the chronologies of their modifications. The first task has been accomplished to a considerable degree. In many cases, it was even possible to establish the types of performed activities. It is also worth pointing out that the majority of the tools was used for processing siliceous plants. The other identified functions were recorded much less frequently. It should be noted, however, that tools used for cutting siliceous plants are very often identified, since they are easily recognised. The role of knives for cutting siliceous plants was usually played by oblique truncations. In several cases, items used for processing this material were transformed in later stages of utilization, which hinders determining precisely their forms. Tools used for cutting siliceous plants (herbaceous plants, grass) could have played different roles and been linked with harvesting, as well as with obtaining food for animals or materials for roofing houses or clothing production. Other, rarely registered activities associated, among others, with processing hide, wood, and mineral substances, should be assuredly linked with producing goods. Unfortunately, due to the small number of the tools, it is difficult to link particular activities with specific artefacts.

Truncations present in the L-VC materials represent rarely analysed artefacts. Previously, only several items of this type were subjected to such an examination. One of the specimens, discovered in Złota ("Grodzisko II" site), in grave 122, had been earlier examined by the author. In the section adjacent to the butt of this artefact, there is considerable rounding of the edge, discernible with the naked eye, accompanied by vast crushing. A bright polished area of a dome-like topography is visible under the microscope. The presence of a macroscopically discernible rounding is often considered as an indication that a tool was used for striking fire (Mączyński and Zakościelna 2017b, 115).

The next 4 tool specimens were discovered in features nos. 5A, 7, 8, and 32, in the Wzgórze Zawichojskie settlement (Sandomierz). Two of them had been used as sickle inserts. In the case of another item, the apex of the transverse edge had been used to drill soft stone and the last specimen was used for scraping hide (Winiarska-Kabacińska 2017, 255, 258, Fig. 3: 11; 8: a, c).

The comparison of this set with the result of the observation of the materials from Las Stocki makes it possible to remark certain analogies in the methods of their utilization. This concerns mainly using the tools as sickle inserts. In the case of the rest of the items, it is also possible to see minor similarities associated with performing similar activities and processing raw materials. Single tools, used as strike-a-lights or linked with processing stone and hide, were found in Las Stocki. Nevertheless, the way of their utilization (how they were held during performing the work) was different, which is attested by the location of the patterns in different parts of the tools.

The fragment of a blade dagger, with the truncated edge in the butt region, stands out from the collection. This item, apart from patterns indicating that it was kept in a sheath, bears numerous use-wear traces indicating that it was used as a strike-a-light, as well as for processing hide and mineral material. Flint daggers have been analyzed by the author (Złota, site "Grodzisko II"; Strzyżów, sites 1A and 2A), as well as by B. Kufel-Diakowska (Książnice, site 2). Usually, patterns present on such tools suggest that the items were used for a long time. The typical traces recorded on their surfaces are those that indicate keeping them in sheaths or frames. At the same time, the performed activities include processing meat/hide/plants and using the edges as strike-a-lights (Mączyński and Zakościelna 2017a, 344, 345; 2017b, 113, 114; Wilk and Kufel-Diakowska 2016, 157, 106; 162, 157–163). The fragment of the dagger with preserved truncated edge (from Las Stocki) was used in a similar way. The similarities concern keeping the tool in a sheath, scraping hide, and using it as a strike-a-light, but the patterns present on the items from Złota and Książnice were observed in the butt regions, whereas the working edge of the artefact from Las Stocki was the truncated edge.

The next aim was attempting to recreate the biographies of the tools. The results of the conducted observations indicate that tackling this question is a difficult and complicated task. In many cases, establishing chronologies of the modifications did not give expected results. On this point, most information was obtained from the analysis of tools used for processing siliceous plants. Working with these raw materials results in forming use-wear patterns of very invasive extents and bright polishing, clearly distinct from the natural surfaces of flints. In the case of tools used for activities that resulted in forming use-wear traces of insignificant extent of intrusion, establishing the stratifications in regard to fractures and retouch was immensely difficult. In certain cases, the observation made it possible to establish a relative chronology between the working edges and the truncated edges, as well as to record changes resulting from sharpening the working edges. In some cases, it was observed that certain transverse fractures had damaged the working edges This was undoubtedly the direct cause of the tools being abandoned. It is interesting that in the case of a few items, the formation of the truncated edge or retouching of the lateral edge was chronologically the final recorded modification of the tool. The reasons for such activities have not been interpreted. It cannot be ruled out that these artefacts were used for a short time, which did not result in the creation of clearly visible use-wear patterns.

The fact that in many cases it was impossible to detect close correlations between the working edges and the truncated edges is immensely interesting. It cannot be ruled out that both types of modifications could have been separated by certain time intervals and they were not related to each other. However, currently observed use modifications are associated with the preserved morphologies of the tools. Of course, the mentioned correlation is not a mandatory requirement. It is possible that using such tools did not require the truncated edge to come in contact with the processed material. Nevertheless, such doubts raise questions concerning the credibility of the results of such analyses and the methods of interpreting the functions of flint tools.

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Identification of a fragment of an Early Bronze bone recovered from the Borownia striped flint mine in the Ostrowiec district (on the centenary of Polish research on prehistoric flint mining)

Abstract

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The site was discovered in 1921 and identified as a prehistoric striped flint mine in 1922. It is notable for its excellently preserved prehistoric industrial landscape, particularly discernible in the valley of the Kamienna river. It was excavated for the first time in 2017. In 2018, the site was nominated for inscription on the World Heritage List together with the Krzemionki Opatowskie mine. Flint artefacts and radiocarbon dates set its chronology as the Late Neolithic and the Early Bronze Age. No bones have been preserved from that period apart from a fragment of a long bone in two parts. Microscopic analysis of thin sections has identified the fragment as a bone of a red deer (*Cervus elaphus*). The article concludes with remarks about the 2019 centenary of research on prehistoric flint mining in Poland.

Keywords: striped flint mining, thin section microscopic analysis of bone, Late Neolithic, Early Bronze Age, Borownia, Krzemionki Opatowskie.

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Introduction

The Historical and Archaeological Museum in Ostrowiec Świętokrzyski (HAM) and the Institute of Archaeology at the Cardinal Wyszyński University in Warsaw (IA CWU), in co-operation with the Autonomous Workshop for Prehistoric Flint Mining at the Institute of Archaeology and Ethnology, Polish Academy of Sciences in Warsaw (AWPFM IAE PAS), excavated the Borownia prehistoric striped flint mine, which was entered into conservation documents as Ruda Kościelna 18 (AZP 84-72/10) in the Ćmielów commune, Świętokrzyskie province, from 3 July to 26 August 2017.

An outline of research on the Borownia mine

The site was discovered by Stefan Krukowski (1890–1982) and Jan Samsonowicz (1888–1959) during their survey of the valley and the surroundings of the Kamienna between the mouth of the river and Ćmielów, where they hoped to find "flint sites". The survey lasted from 16 September to 9 October 1921 (Krukowski 1921: 157–158; Samsonowicz 1923: 16).

Krukowski considered Borownia to be the most interesting of the archaeological sites identified on the Kamienna river. Returning there soon afterwards to investigate it further, he collected 340 kg of "tools and spalls" from the surface. The researchers failed at first to recognise the place as a prehistoric flint mine; Krukowski interpreted it as "a Campignien workshop" (Krukowski 1921: 163; cf. Budziszewski 1999; Budziszewski and Michniak 1983: 152–153).

The alleged Campignien site in Borownia was identified correctly only after Samsonowicz discovered a flint mine in Krzemionki, south-west of the village of Magonie on 19 July 1922 (Samsonowicz 1923: 22–23). These two flint mines are situated at a distance of 7 km from each other, from the tourist route over the exploitation field in the Krzemionki Opatowskie Reserve to the best preserved north-western segment A of the Borownia exploitation field directly above the Kamienna valley (Fig. 1).

Borownia stands out among the prehistoric flint mines investigated in Poland to date because of its excellently preserved exploitation field with many visible shaft depressions surrounded by spoil heaps. The site ranks among the few European flint mines whose post-mining landscapes have survived until now in very good condition. In Borownia, this applies particularly to the north-western part of the site, where the bone fragment discussed here was found (Segment A; cf. Adamczak *et al.* 2011: 7, Fig. 1 and 2).

Because of attempts made from ca. 1931 to level an edge of the Borownia exploitation field so as to extend the adjacent farmland, an archaeological reserve encompassing the best preserved parts of the prehistoric mine was formed in 1934. The project had the support of Countess M. Broel-Platerowa, the owner of the land (Budziszewski 1999: 597; Budziszewski and Michniak 1983: 154).

Since its discovery, the site aroused considerable archaeological interest, first of all at the State Archaeological Museum in Warsaw and, in the second half of the 20th century, the Institute of Archaeology and Ethnology at the Polish Academy of Sciences in Warsaw and the Institute of Archaeology at the University of Warsaw, and recently, at the Institute of Archaeology at the Cardinal Wyszyński University in Warsaw (Sawicki 1948: 129; Krzak 1961: 29–44; Lech 1975: 140–141, 144–146; 1987: 114 and 125–126; Budziszewski and Michniak 1983: 152, 154–155, 164–167, 183–186; Borkowski 1992: 229; Budziszewski 1996: 87–89; Zalewski and Borkowski 1996; Adamczak *et al.* 2011; Radziszewska 2014: 168–174, 176–183). Until July

Fig. 1. The Borownia flint mine, Ostrowiec district. Segment A. Excavation 2017. A view of the eastern cut with the depression of the explored shaft A1. Photo by J. Lech.

2017, the Borownia mine was explored with non-invasive methods, mainly through surface surveys, but also geophysical and geotechnical investigation, which included airborne laser scanning, used by K. Radziszewska (2014).

The excavation, which began in July 2017, resulted primarily from the decision to nominate the Borownia mine, together with the Krzemionki Opatowskie and the Korycizna striped flint mines, as Polish heritage properties to be inscribed on the World Heritage List (*Borownia* 2018). At first, the plan was to nominate solely the Krzemionki mine. According to international experts on the World Heritage, however, there was a risk that such a nomination would be rejected in view of inscribing the Neolithic flint mine in Spiennes (Belgium) on the list on 30 November 2000 (Collet *et al.* 2008: 41). Experts both in Poland and abroad agreed that Krzemionki would stand a much better chance if the site were presented as a prehistoric region of striped flint mining together with the Borownia and the Korycizna mines and with the related settlement of the Funnel Beaker culture on the Gawroniec hill in Ćmielów in the Ostrowiec district. The decision was made at the end of March 2017 after consulting the National Heritage Board of Poland. The nomination for inscribing the Krzemionki Prehistoric Striped Flint Mining Region on the World Heritage List was submitted in Paris on 31 January 2018.

The excavation of the mine in 2017

The aim of the excavation of the Borownia mine was first of all to provide charcoal, which is usually found in sufficient quantities in exploration of prehistoric exploitation fields, for radiocarbon dating of the examined sections of the site. The project was supervised by Prof. Jacek Lech from the Institute of Archaeology of the CWU in Warsaw and the Archaeological Museum and Reserve "Krzemionki", a branch of the HAM, in co-operation with Artur Jedynak from the Museum in Krzemionki and Dr Dagmara H. Werra from the AWPFM IAE PAS. The excavation was carried out with the assistance of students from the Institute of Archaeology of the CWU, who had their student internship in Borownia or were employed there by the HAM.

The project involved two fragments of the exploitation field in segments A and D, several hundred metres apart, which had earlier been levelled and partly destroyed by various activities, some of them illegal. In segment A, which interests us here, a cross-shaped excavation unit was made, with its arms described as the northern, southern, eastern (Fig. 1) and western cuts. The arms were 10 m long except the southern one, which was only 6.5 m long, because of the extended root system of a clump of hazel, cut down at the beginning of the excavation (from the north, at the junction of cut S and the E-W trunk route descending westwards with the slope towards the Kamienna valley), and an old tree to the south, i.e. the centre of the exploitation field. The cuts were 2 m wide. The team uncovered and documented several prehistoric features no longer discernible at the surface, mostly shafts surrounded by limestone spoil (Fig. 2). Big angular limestone blocks from a prehistoric spoil heap in the eastern cut of segment A showed that the Borownia mineshafts, a few metres deep, had been sunk into solid limestone rock from which striped flint had subsequently been extracted. The team collected more than six thousand spalls and several interesting tools and blanks as well as hammers made of rocks other than flint, of different sizes and weights. The basic flint products at the site were initial forms or blanks of cutting edges with a lenticular cross section and adzes; other types of tools were only represented by isolated items.

Samples of charcoal and one fragment of bone were collected from organic matter. The bone was found at the eastern wall of shaft A1 [sections a, m.b 5(-80)] in a layer of loose fine limestone spoil bordering on a sand layer in the fill of the shaft at the depth of 190–210 cm on 14 August 2017, when the co-author of this article sampled the material for screening. The fragment survived in two parts in a thin layer of bluish loam which had flown down the eastern boundary of shaft A1 in the eastern cut of segment A (Fig. 2). The layer contained many flint chips and charcoal pieces, which were radiocarbon dated to Poz-95494, 3525 +/- 35 BP (i.e. 1575 +/- 35 bc) at the Poznan Radiocarbon Laboratory. After calibration, made with the OXCal software, the bone was dated to 1943–1751 BC. Several other flint mines exploited in the same period in the upper Vistula basin have been excavated by archaeologists and radiocarbon dated: Ożarów "Za Garncarzami", Wierzbica "Zele", Polany Kolonie II and Polany II (Herbich and Lech 1995: 502–504; Lech 1995: 469; Schild 1995: 484; Budziszewski 1997: 51–54; Lech and Leligdowicz 2003: 293, Table 1).

The bone fragment was situated in the first layer which had flown into shift A1 with heavy rain soon after the item had been discarded or after the first spring thaw in the following year. The material was carried to fine limestone spoil which had fallen from the spoil heap of shaft A1 or had been thrown in during the work on the adjacent shaft. The sample, which included charcoal, was contemporaneous with one of the phases of the exploitation of the striped flint mine in Borownia.

Fig. 2. The Borownia flint mine, Ostrowiec district. A view of the northern profile section of the eastern cut. On the left, the depression of the explored shaft A1; on the right, a profile section of the spoil heap of another shaft; at the bottom of the cut in the centre, the flown-in layer in which the bone fragment was found. Photo by J. Lech.

The radiocarbon dating of the sampled charcoal, the most important result of the excavation, helped to determine the chronology of the uncovered features as the Final Neolithic and the Early Bronze Age. Prof. Maria Lityńska-Zając's species analysis of the charcoal should make it possible to reconstruct the natural environment in the immediate vicinity of the shafts during the use of the Borownia mine.

Archaeological material collected from fields in the immediate vicinity of the mine during a surface survey carried out by the AWPFM IAE PAS (Adamczak *et al.* 2011) suggested that striped flint had been exploited in Borownia from the classic phase of the Funnel Beaker culture to the Early Bronze Age, as posited earlier by M. Zalewski and W. Borkowski (1996: 36–46, 49–50). The excavation in 2017 did not confirm that view, although the dating still cannot be ruled out because of the limited range of the investigation. Analysis of the recovered flint material has shown that the exploitation ought to be dated to the period from the Final Neolithic to the close of the second millennium BC in calibrated absolute chronology; the radiocarbon dating has determined the chronology as 2300–1500 BC, with intensive use of the mine between 2000 and 1700/1600 BC and the sporadic activity of prehistoric communities thereafter. The Borownia striped flint mine was partly contemporaneous with other flint mines in that part of Europe: the chocolate flint mines Polany II (Lech and Leligdowicz 1980: 151; Chmielewska 1988: 170–171; Herbich and Lech 1995: 502, 504), Polany Kolonie II (Schild 1995: 484) and Wierzbica "Zele" (Lech 1995: 469, 472–479; 1997: 102–103), the Ożarów flint mine at Za Garncarzami Site in Ożarów (Budziszewski 1997: 51), the mine complexes in *Krumlovský* Les in Moravia (Oliva 2010: 266) and Bečov in the north-western Czech Republic (Lech and Mateiciucová 1995: 277), as well as the Krasnaselsky and the Karpautsy mines in western Belarus (Gurina 1976: 127).

The significance of the Borownia mine in prehistoric flint mining in Europe was first pointed out at the international conference in Faro (Portugal) in 2016 (Lech and Werra 2016). A summary of the excavation in Borownia in 2017 was presented at the Second Archaeological Seminar in Krzemionki: Spring 2018, which took place at the Archaeological Museum and Reserve "Krzemionki" on 23 and 24 March 2018, and at the 18th World Congress of the International Union of the Prehistoric and Protohistoric Sciences (UISPP) in Paris, during the session organised by the UISPP Commission on Flint Mining in Pre- and Protohistoric Times on 6 June 2018.

The uncovered bone fragment proved unsuitable for precise anatomical and species identification. Macroscopically, it could merely be described as a fragment of a long or flat bone of a specimen similar in size to certain species (Fig. 3). Consequently, it was subjected to microscopic examination.

The method of identification

Microscopic identification consists of examining the microscopic structure of bone: a thin section of the material is analysed under a polarising microscope in transmitted light. A fragment of the shaft of the long bone, several millimetres thick, is cut out across the long axis to obtain a section of compact bone containing osteons with Haversian canals in their centres (Lasota-Moskalewska 2008: 112–113). In this case, the thin section has been analysed by the method described in the publications of A. Lasota-Moskalewska (1979; 2005: 35; 2008: 112–117) and A. Lasota-Moskalewska and S. Moskalewski (1980). The method helps to determine whether the bone belonged to a domesticated animal or a wild animal and, to some extent, to identify the species.

This approach involves the description of the arrangement, density and shape of osteons, the index of their surface area which is a quotient of the total surface area of osteons on the total intersystemic (interosteonic, extraosteonic) surface area in the same field, and measurement of the shorter diameters of Haversian canals. The index of the surface area of osteons can be reliably used to distinguish domesticated and wild animals, as it has different values for these two groups: 0.40–1.58 for wild animals and 0.07–0.35 for domesticated animals (Lasota-Moskalewska 1979; 2008: 113, 116; Lasota-Moskalewska and Moskalewski 1980).

Results of the measurement of the shorter diameters of Haversian canals are different for individual animal species (Harsányi 1993: 87; Horocholyn 2013: 40–41, 107, 109, 111–112; Lasota-Moskalewska 2008: 116; Urbanová and Novotný 2005: 80). Human bones are the largest in diameter. It may be assumed that the shorter diameter of Haversian canals equalling 50 µm is the threshold between humans and animals (Urbanová and Novotný 2005: 83).

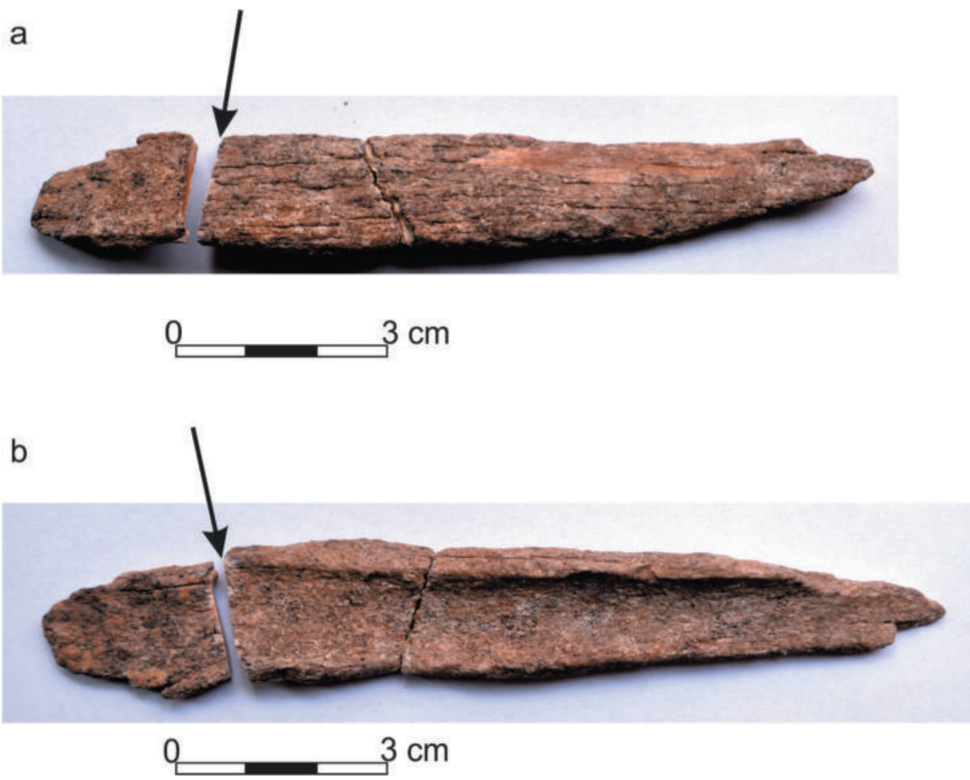

Fig. 3. The Borownia flint mine, Ostrowiec district. The bone fragment from the flown-in layer in shaft A1: a – view from the outside; b – view from the inside; the arrow indicates the direction of the cutting. Photo by A. Rauba-Bukowska.

The microscopic analysis was performed under a Nikon Eclipse LV100N POL polarising light microscope in the Institute of Archaeology and Ethnology at the Polish Academy of Sciences.

Results

The analysis of the bone fragment had two main stages: macroscopic and microscopic identification.

Macroscopic analysis

Macroscopic examination solely showed that the analysed material was a fragment of the shaft of a long bone (broken in two) which may have belonged to one of four species: human (*Homo sapiens*), horse (*Equus caballus*), cattle (*Bos taurus*) or red deer (*Cervus elaphus*). More precise identification was impossible.

Microscopic analysis

A thin section of the analysed bone fragment was examined under a polarising light microscope (Fig. 4). The analysis centred on two segments of the thin section, 0.77 × 1.16 mm (i.e. approx. 0.89 mm^2) each, containing osteons with Haversian canals. The osteons, round or slightly oval in shape, were densely packed and chaotically arranged (Fig. 5). In each segment, the shorter and longer diameters of the osteons were measured and their surface areas were calculated in the visual

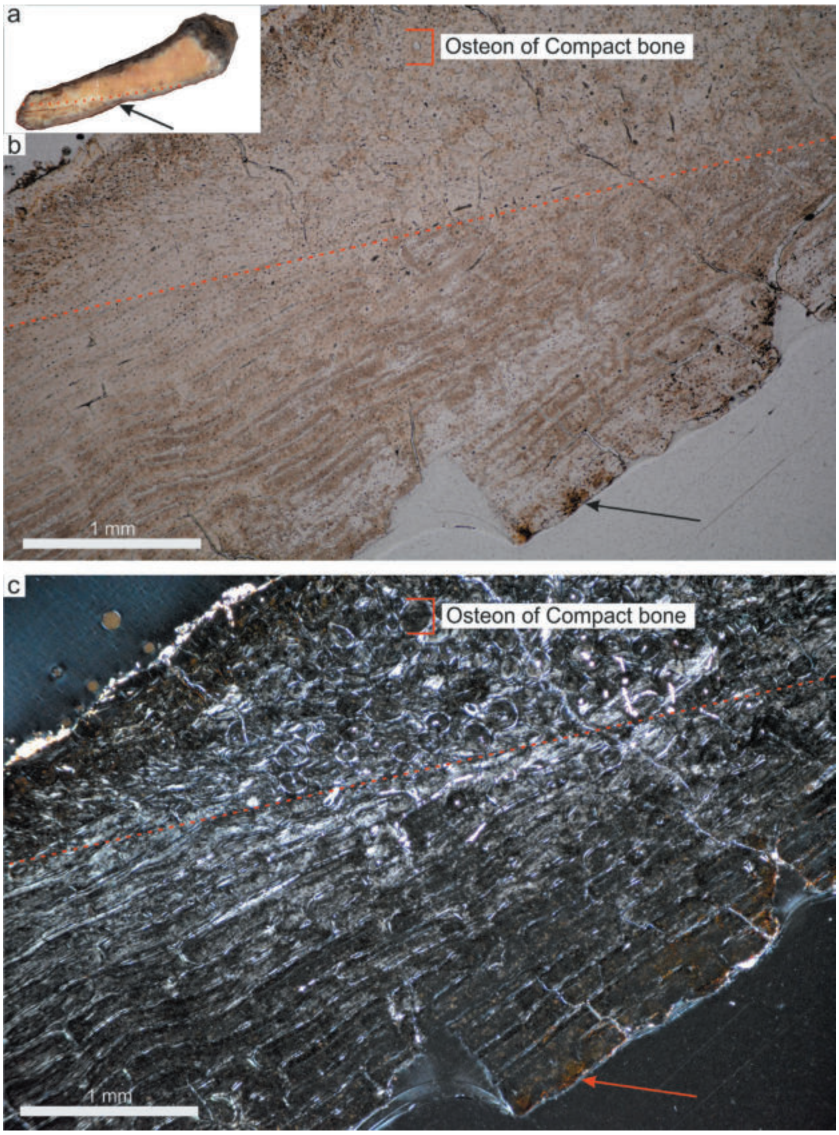

Fig. 4. The Borownia flint mine, Ostrowiec district. Cross section of the bone fragment under a microscope: a – cross section of the bone; b (1N), c (NX) – thin section. Above the dotted line, a segment with visible osteons and Haversian canals. The arrows indicate the outer surface of the bone. Photo by A. Rauba-Bukowska.

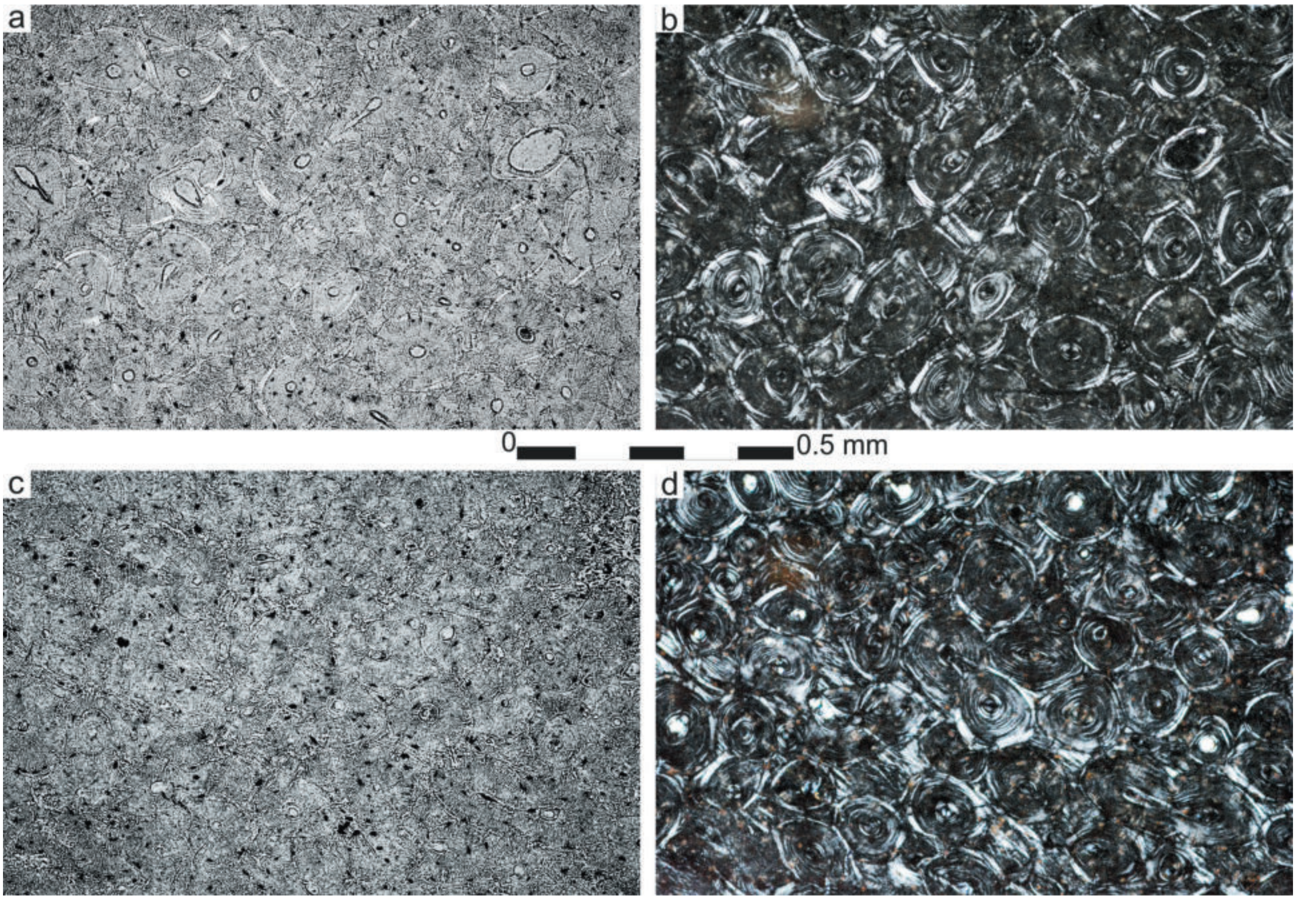

Fig. 5. The Borownia flint mine, Ostrowiec district. The bone segments examined under a microscope: a (1N), b (NX) – segment 1; c (1N), d (NX) – segment 2. Densely distributed round osteons visible in both segments. Photo by A. Rauba-Bukowska.

field covering 893 791,9 μm^2 (approx. 0.89 mm^2; Table 1, Fig. 6). The calculated surface areas were added up and the sum was subtracted from the total surface area under examination to obtain the intersystemic surface area. The total surface area of all osteons visible in the examined segments was divided by the intersystemic surface area, giving the index of the surface area of osteons in each segment, 1.69 and 1.58 respectively (Table 1). Such indexes and the descriptive information presented above are characteristic of wild animals (Lasota-Moskalewska 2005: 35; 2008: 113–116).

Measurement of the shorter diameters of Haversian canals helped to identify the species. In the first analysed segment, the mean shorter diameter was 14.8 μm; in the second segment, it was 16.0 μm (Table 2). The results match the values 14.9–16.8 μm (Horocholyn 2013: 107) obtained for the white-tailed deer (*Odoceileus virginianus*), common in North America, and they are similar to values typical of the deer family, including the European red deer (*Cervus elaphus*; Urbanová and Novotný 2005: 80; Horocholyn 2013: 40).

Table 1. The Borownia flint mine, Ostrowiec district. The calculation of osteon area index in the examined segments of compact bone.

Examined areas (segments)	Examined area (μm^2)	Total area of osteons (μm^2)	Intersystemic area (μm^2)	Osteon area index	Number of osteons (n)
1	893791,9	561851,1	331940,8	1,69	57
2	893791,9	547763,8	346028,1	1,58	63

Table 2. The Borownia flint mine, Ostrowiec district. The diameters of Haversian canals in the examined segments of compact bone; S.D. – standard deviation.

Examined areas (segments)	Minimum diameter of Haversian canals (μm)		Number of Haversian canals (n)
	Mean	S.D.	
1	14,8	5,9	20
2	16,0	3,9	43

Table 3. The Borownia flint mine, Ostrowiec district. The surface area of osteons and their diameters in the examined segments of compact bone; S.D. – standard deviation

Examined areas (segments)	Area of osteons (μm²)		Minimum diameter of osteons (μm)		Maximum diameter of osteons (μm)		Number of osteons (n)
	Mean	S.D.	Mean	S.D.	Mean	S.D.	
1	12817,4	6289,0	109,0	26,4	141,4	41,5	29
2	11376,3	4303,1	103,6	22,3	136,5	28,4	41

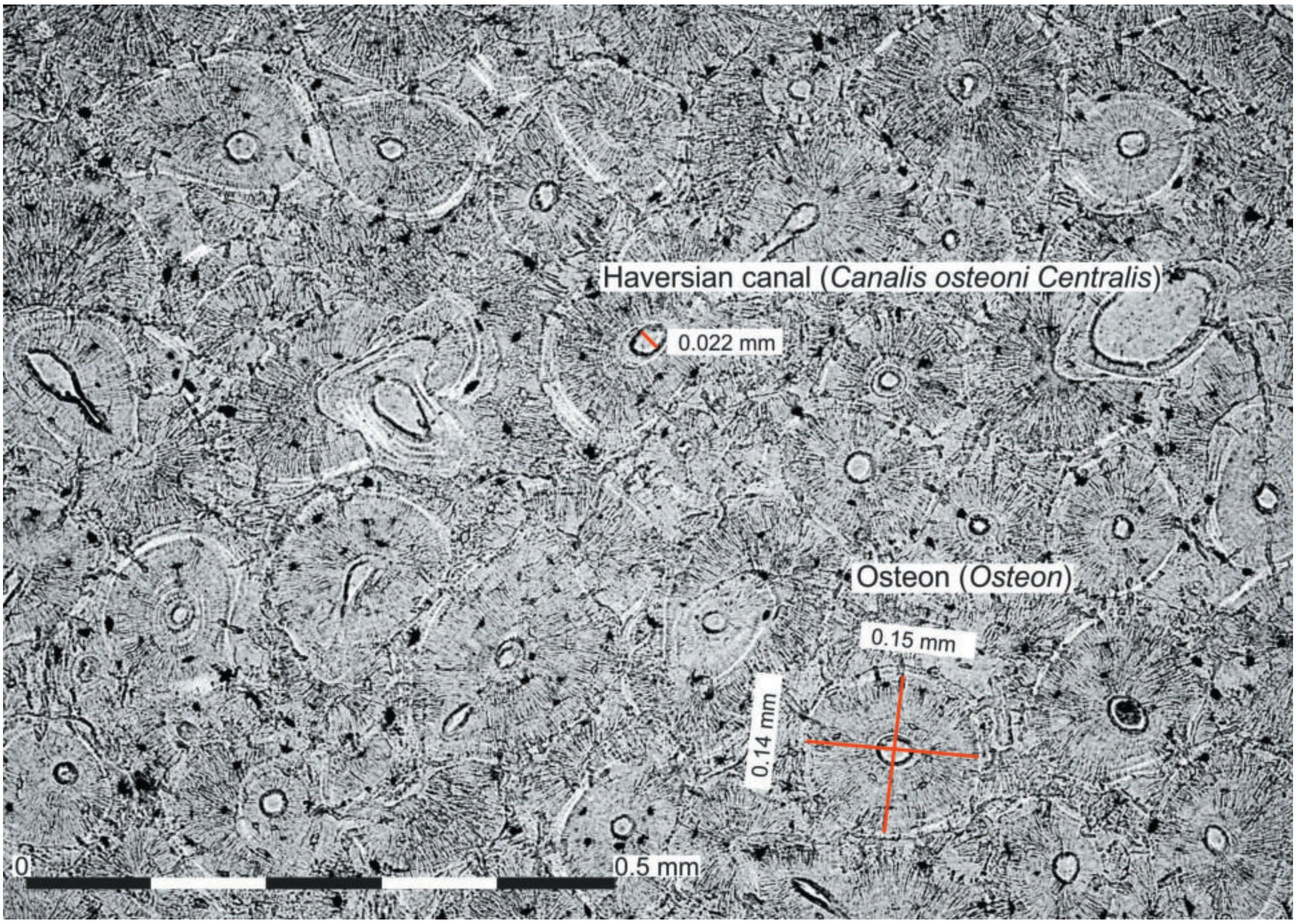

Fig. 6. The Borownia flint mine, Ostrowiec district. Segment 2 under a microscope. Examples of measurement of an osteon and a Haversian canal. Photo by A. Rauba-Bukowska.

Consequently, the analysed bone fragment may be assumed to be a part of the skeleton of a deer.

Summary and conclusion

The study concerned a two-part fragment of a bone recovered from the Borownia striped flint mine, contemporaneous with the exploitation of the local striped flint deposit. Morphological analysis of discrete flint finds as well as radiocarbon dating suggested that the item was related to flint mining of a Mierzanowice culture community. Macroscopic examination showed that it was a fragment of a long bone which may have belonged to one of four species: human (*Homo sapiens*), horse (*Equus caballus*), cattle (*Bos taurus*) or red deer (*Cervus elaphus*).

Microscopic analysis of a thin section of the bone, which involved measuring the diameters and the surface areas of osteons and the shorter diameters of Haversian canals, provided the index of the surface area of osteons in two examined segments, 1.69 and 1.58, respectively. These values, together with the recorded arrangement, density and shape of osteons, show that the bone fragment belonged to a wild animal. The measurement of the shorter diameters of Haversian canals, equalling 14.8 μm and 16.0 μm respectively, suggests that the bone came from the red deer (*Cervus elaphus*), common in Poland (Fig. 7). It is worth noting, however, that the diameters of Haversian canals are not stable for a given species due to interindividual and ontogenetic variability; moreover, their size depends on the type of bone and the area within the cortex (Lasota-Moskalewska 2008: 113).

In Małopolska, bones of the red deer have so far been identified at only two Early Bronze sites: the Babia Góra Site in Iwanowice and Site 9 in Szarbia (Makowicz-Poliszot 1997: 488, Table 1). The bones were found in materials related to the Mierzanowice culture (Kadrow 1991).

Archaeologically, the fragment of a long bone of the red deer from the Borownia flint mine may be a part of a mining or knapping tool. Alternatively, it may be a scrap left from a miners' or knappers' meal in the exploitation field; the workers may have bagged the animal themselves or acquired it in one of nearby Mierzanowice settlements. The fertile area of the Sandomierz Upland in the vicinity of the Krzemionki Opatowskie, Borownia and Korycizna mines (on the elevation above the Gierczanka river) was settled densely by communities interested in striped flint. This has long been emphasised in scholarship, but the relevant research has so far been disproportionate to the significance of the mines for the knowledge of the Middle and Late Neolithic and the Bronze Age in the Vistula basin (Balcer 1963; Machnik 1977, 71–74; 1978, 40–44, 54; Wiślański 1979, 278–280; Kruk 1980, 56–58, 104; Bąbel 1979; 1985, 56–64; 2013a, 101–103, 108, 111, 119, 226–227; 2013b, 11–199; Lech 1987, 124–128; Kadrow 1995, 21–24, 30–32, 45–46, 77; 2001, 146–150; Budziszewski 1996, 104).

Fig. 7. The red deer (*Cervus elaphus* L.) from: Z. Grodziński (ed.) 1967: 476.

What is necessary is a long-term programme of systematic research on the large unexcavated segments of the Krzemionki Opatowskie mine and at least one shaft in the Borownia mine and the Korycizna mine, as well as the excavation and radiocarbon dating of these mines and the settlement linked to them. This preliminary archaeological investigation, recording and radiocarbon dating of the remarkable finds related to prehistoric striped flint mining, have long been sorely needed in Poland, which has fallen behind in this respect as compared to Western Europe and to the Czech Republic in the last twenty years (cf. Collet *et al.* 2008; Oliva 2010; Healy *et al.* 2014; Lech and Longworth 2014: 283; Bąbel 2015: 124–126). The excavation of the Borownia mine in 2017 is an example of such research.

We may only deplore the fact that excavation of the Korycizna mine, planned and prepared on a similar scale for 2018, had to be cancelled due to the lack of funding and it cannot be carried out in 2019 either. Polish archaeology of prehistoric striped flint mining has been grappling for years with insufficient survey of the mines and with severe underfunding of the Archaeological Museum and Reserve "Krzemionki Opatowskie". It is a sad paradox that when the nomination for inscription on the World Heritage List was being prepared, the Borownia mine which was nominated for the inscription, was disturbed to a considerable extent by construction work on a local road broadened and asphalted without notifying the Provincial National Heritage Protection Office and without prior archaeological investigation, and rescue excavation *post factum* proved impossible. The Korycizna mine, nominated for the inscription as well, has never been excavated or radiocarbon dated, though it is threatened with serious damage.

The year 2019 is the centenary year of Polish research on the prehistoric exploitation, processing and distribution of siliceous rocks. Despite numerous achievements in this field, it is by no means a happy centenary (cf. Bąbel 1975; 2015: 19–27; Lech 1975; 1992: 139–143; 1999: 78–80; Borkowski 1999; Borkowski and Migal 1999: 89–90; Florek 2014; Piotrowska 2014: 30–34; Potocka and Zdeb 2014: 374–377; Radziszewska 2014).

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Dating of the Mierzanowice culture settlement in Jarosław, site 158, Podkarpackie province, based on the results of radiocarbon analyses

Abstract

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For the Mierzanowice culture from western Lesser Poland, the settlement in Iwanowice, Babia Góra site, is a chronological benchmark. A large number of datings obtained for objects from Jarosław, site 158, Podkarpackie province, provides grounds for treating that settlement as a model one in the eastern range of the Mierzanowice culture. The radiocarbon dating and ceramic design features allow them to be placed in a wide chronological frame of 2200–2000 BC.

Keywords: radiocarbon dating, Mierzanowice culture, Rzeszów Foothills

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Introduction

Only a few years ago, based on the published information, it could be assumed that the communities of the Mierzanowice culture did not intensively inhabit the Rzeszów–Przemyśl loess areas, especially during its earlier stages (Kadrow and Machnik 1997). The remains of a settlement in Chłopice, Jarosław district, connected by J. Machnik (1960; 2011) with the proto- and early phase of the Mierzanowice culture, were considered an exceptional discovery. In addition, there was a very small pool of radiocarbon dating related to the materials of the Mierzanowice culture at that time (Madej 1998; Calderoni *et al.* 2000). The results of analyses presented by S. Kadrow (1991) for Iwanowice, Babia Góra site were the benchmark for the description of changes in the style of ceramics of the Mierzanowice culture from the Rzeszów–Przemyśl loess areas.

In recent years, however, the situation has changed significantly due to extensive research conducted along the A4 motorway in 2008–2012 by the Institute of Archaeology in Rzeszów. As a result, a number of settlements (Kadrow and Poradyło 2016) were recognized, as well as the Mierzanowice culture cemeteries of diversified size and chronology (Machnik 2011; Rybicka *et al.* 2017). The following may be mentioned here as examples: the site in Skołoszów, site no. 7, Podkarpackie province (Rybicka *et al.* 2017) and the settlement in Jarosław, site 158, Podkarpackie province (Pelisiak and Rybicka 2013).

These discoveries showed that the communities of the Mierzanowice culture intensively inhabited Rzeszów Foothills throughout the entire duration of this culture (Madej 1998; Rybicka *et al.* 2017). To place the functioning of the Mierzanowice communities in the Rzeszów–Przemyśl loess areas in time, a number of radiocarbon datings were made for both sediment features from Jarosław, site 158 (Pelisiak and Rybicka 2013), as well as graves discovered in, among others, Skołoszów, site 7, Podkarpackie province (Rybicka *et al.* 2017).

The entirely excavated and investigated site 158 in Jarosław, Podkarpackie province, is particularly significant for the assessment of the beginning of the Mierzanowice culture communities' settlement in the region, as well as for determining the size and duration of their settlements (Pelisiak and Rybicka 2013). The Mierzanowice culture materials from this site and the results of radiocarbon analysis obtained for

Fig. 1. Jarosław, Site 158, Podkarpackie province. Location of the site in the context of other sites excavated on the route of prospective motorway A4 in the Podkarpackie province.

them have already been published. In the context of a number of new datings obtained for tombs from Rzeszów–Przemyśl loess areas, it is worth taking a closer look at them again. It is particularly important to assess whether, in light of the results of radiocarbon dating and analysis of the style of ceramics, the remains of the settlement of the Mierzanowice culture from Jarosław, site 158, represent different phases of the culture settlement in this place.

Location and arrangement of trapeze-shaped features in Jarosław, site 158, Podkarpackie province

Site 158 in Jarosław was located on the flattened loess spur of the upper terrace of the San River (Fig. 1). The relative heights between the bottom of the valley and the surface occupied by settlement are several meters. The settlement covered an area of over 2 ha (Fig. 2). In Jarosław, site 158, 45 trapeze-shaped pits representing the Mierzanowice culture (Fig. 2), most of them with layered fillings (Rybicka 2013, Figs. 16–20) and several hollow-shaped pits were found. They formed clusters consisting of several closely spaced features (e.g. 529–531; Fig. 2). These concentrations were relatively regularly distributed on the outer part of an oval area, while the centre of the settlement was characterized by a lower number of features.

If we assume after Sławomir Kadrow (1991) that the trapeze-shaped pit marks the place where a farmstead was situated, then the presence of such small clusters of them may suggest that individual features included in their composition were created at different times. As in many trapeze-shaped pits there were neither ceramics nor distinctive ceramic elements (e.g. features number 131, 231B, 248, 261, 264, 321, 326, 437, 437, 470 480, 482, 528, 531, 1255), it was difficult to assess the time of their creation. Therefore, an attempt was made to perform radiocarbon dating for features representing individual clusters located in different zones of the settlement (Fig. 2). Radiocarbon dating of all the identified clusters of features in Jarosław, site 158, was impossible due to a lack of the appropriate materials necessary for such analyses.

Ceramics

In the published study on the Mierzanowice culture ceramics from Jarosław, site 158, it was stated that it seems to be a rather typologically and stylistically homogeneous collection and that it generally fits entirely within the two stages of the early phase of the Mierzanowice culture (Rybicka 2013, figs. 29–56) distinguished by

Kadrow (1991) and also that it has numerous counterparts in similarly dated sites practically throughout the culture's entire range (Kadrow and Machnik 1997).

In the collection of fragments of vessels from Jarosław, site 158, however, one can distinguish some deviations from the early-Mierzanowice culture canon, presented by Kadrow (1991). In several features numbered 13, 243, 250, 290, 336, 397, 455, 529 (Fig. 2), more or less explicit references to both the proto- and early Mierzanowice phase (Rybicka 2013, 110–111) or / and the classic Mierzanowice phase (Rybicka 2013, 112) were noted. Ceramics from some of them, with stylistics reminiscent of proto-Mierzanowice, were found in the secondary deposit, sometimes with vessels with early Mierzanowice features and a style predicting the classic Mierzanowice (e.g. feature 336; Rybicka 2013, fig. 35). The full set of ceramic characteristics corresponding, in the view of S. Kadrow and J. Machnik (1997), to the proto- and classic Mierzanowice phases was not registered in Jarosław, site 158, there were only some characteristics signalling the last aforementioned stage of the Mierzanowice culture stylistics development (Rybicka 2013, 110–113). The results of stylistic assessments, as well as the cluster distribution of features, may suggest the non-homogeneity of the remains of the settlement from Jarosław, site 158.

According to Kadrow and Jan Machnik (1997, 31) "There are still no clear phase indicators. Therefore, it is the set of features that should constitute the assignment of a given artefact to a given phase." Thus, the observed deviations from the early Mierzanowice canon do not necessarily indicate the multiphase nature of the described settlement.

Radiocarbon dating of Mierzanowice culture features in the context of ceramic style

For materials and trapeze-shaped features of the Mierzanowice culture, 15 radiocarbon datings were obtained with the AMS method at the Poznań Radiocarbon Laboratory (Rybicka 2013, 114). What is more, two samples from backfill hollows of hollow-shaped pits were dated (Table 1; Rybicka 2013, 121).

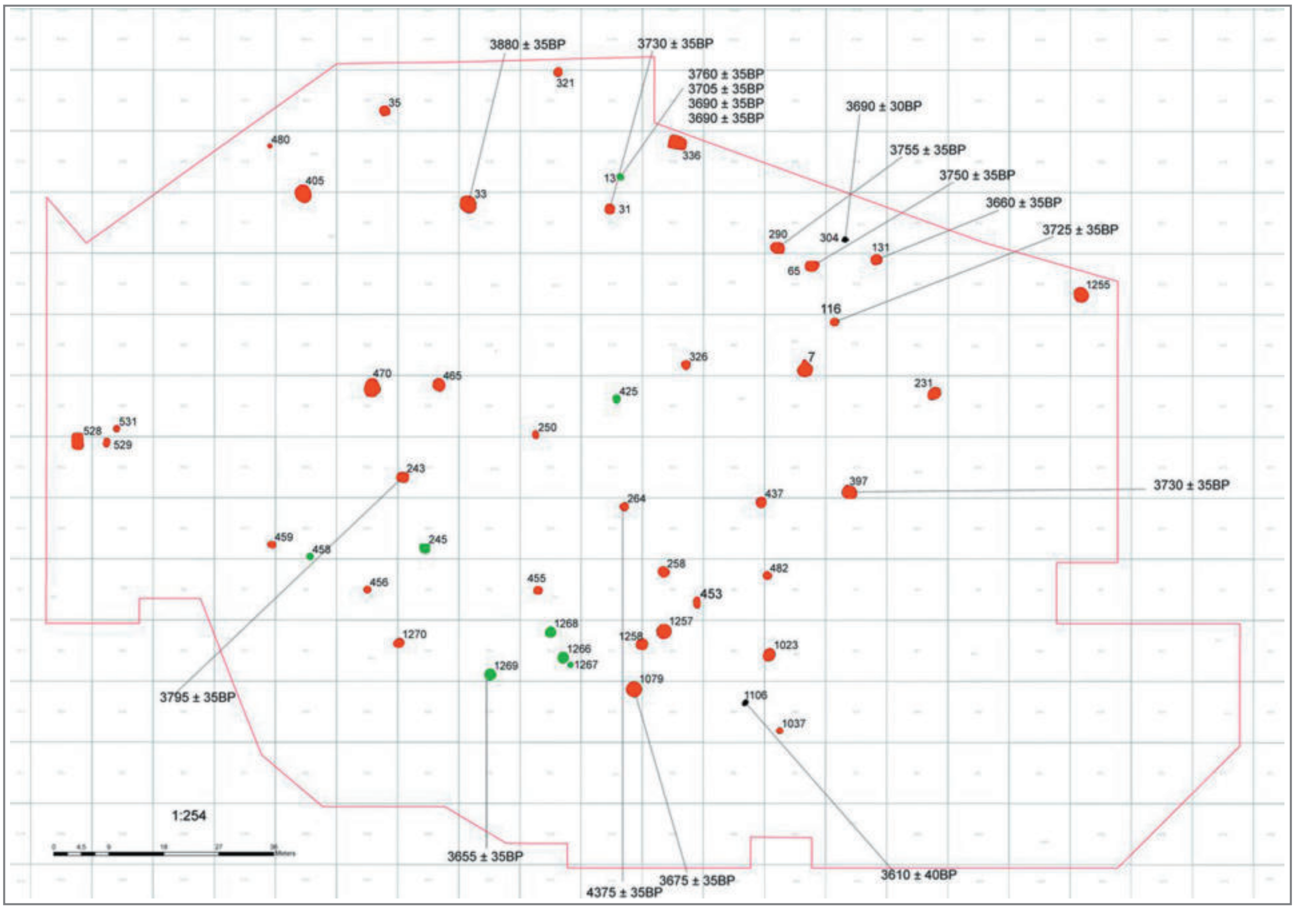

Fig. 2. Jarosław, Site 158, Podkarpackie province. Distribution of stratified and non-stratified trapeze-shaped features and hollow-shaped pits with 14C dates. 1 – non-stratified trapeze-shaped features; 2 – stratified trapeze-shaped features; 3 – hollow-shaped pits.

In five features there were no distinctive artefacts (e.g. trapeze-shaped features: 1079, 1269, 131; hollow-shaped features: 304, 1106; Fig. 2). In addition, one of the datings received is neither related to the Mierzanowice culture, nor to the earlier, short-term stage of the use of this place by the Malice culture communities (Pelisiak and Rybicka 2013), because the result obtained for the trapeze-shaped pit base 264 is Poz-31745: 4375 ± 35 BP. It is probably the effect of redeposited charcoal dating.

Very young datings, which are the result of the analysis of samples from backfill hollows of hollow-shaped pits nos. 304 (Poz-31736: 3690 ± 35 BP) and 1106 (Poz-31750: 3610 ± 35 BP), in which movable artefacts were not discovered, suggest their relationship with the Mierzanowice culture.

Three groups were distinguished in the series of other datings. The first of them includes the questionable dating obtained for feature 33, which is Poz-31696: 3880 ± 35 years BP (Table 1), and corresponds to the proto-Mierzanowice stage. In the said pit there were no ceramics with such features but only a few fragments with stylistics referring to the early Mierzanowice phase (Rybicka 2013).

Table 1. Jarosław, Site 158, Podkarpackie province. List of radiocarbon datings for the Mierzanowice culture features.

No.	Sample location	Dated material	Sample number	BP	BC(68,2%) Oxcal	BC(95,4%) Oxcal
1.	Jarosław, site 158, feat. 33, depth 80–100 cm	charcoal	Poz-31696	3880±35	2456 BC (20.7%) 2416 BC 2410 BC (38.7%) 2334 BC 2324 BC (8.8%) 2306 BC	2469 BC (91.0%) 2279 BC 2250 BC (3.4%) 2230 BC 2220 BC (1.0%) 2212 BC
2	Jarosław, site 158, feat. 243, depth 100–120 cm	charcoal	Poz-31697	3795±35	2286 BC (59.1%) 2198 BC 2166 BC (9.1%) 2150 BC	2397 BC (0.7%) 2385 BC 2346 BC (93.4%) 2133 BC 2080 BC (1.3%) 2061 BC
3	Jarosław, site 158, feat. 13, depth 100–120 cm	organic material from a vessel	Poz-31751	3760±35	2274 BC (8.9%) 2256 BC 2209 BC (54.7%) 2134 BC 2076 BC (4.6%) 2064 BC	2288 BC (80.4%) 2120 BC 2094 BC (15.0%) 2041 BC
4	Jarosław, site 158, feat. 290, depth 120–140 cm	charcoal	Poz-31704	3755±35	2271 BC (5.1%) 2259 BC 2206 BC (54.1%) 2133 BC 2081 BC (8.9%) 2060 BC	2286 BC (76.7%) 2116 BC 2098 BC (18.7%) 2038 BC
5	Jarosław, site 158, feat. 65, depth 120–140 cm	charcoal	Poz-31695	3750±35	2266 BC (1.8%) 2261 BC 2206 BC (51.9%) 2131 BC 2085 BC (14.5%) 2052 BC	2284 BC (9.7%) 2247 BC 2234 BC (62.7%) 2111 BC 2104 BC (23.1%) 2036 BC
6	Jarosław, site 158, feat. 397, depth 100–120 cm	charcoal	Poz-31742	3730±35	2198 BC (22.7%) 2162 BC 2152 BC (16.3%) 2126 BC 2090 BC (29.2%) 2044 BC	2276 BC (2.9%) 2254 BC 2210 BC (92.5%) 2028 BC
7	Jarosław, site 158, feat. 31, depth 120–140 cm	charcoal	Poz-31743	3730±35	2198 BC (22.7%) 2162 BC 2152 BC (16.3%) 2126 BC 2090 BC (29.2%) 2044 BC	2276 BC (2.9%) 2254 BC 2210 BC (92.5%) 2028 BC
8	Jarosław, site 158, feat. 116, depth 140 cm – base	charcoal	Poz-31739	3725±35	2197 BC (17.7%) 2168 BC 2149 BC (16.8%) 2121 BC 2094 BC (33.6%) 2042 BC	2274 BC (2.0%) 2256 BC 2209 BC (93.4%) 2024 BC
9	Jarosław, site 158, feat. 13, depth 100–120 cm	organic material from a vessel	Poz-31752	3705±35	2140 BC (68.2%) 2036 BC	2201 BC (92.9%) 2016 BC 1996 BC (2.5%) 1980 BC
10	Jarosław, site 158, feat. 13, depth 80–100 cm	organic material from a vessel	Poz-31753	3690±35	2136 BC (68.2%) 2031 BC	2198 BC (6.6%) 2166 BC 2150 BC (88.8%) 1966 BC
11	Jarosław, site 158, feat. 13, depth 100–120 cm	charcoal	Poz-31741	3690±35	2136 BC (68.2%) 2031 BC	2198 BC (6.6%) 2166 BC 2150 BC (88.8%) 1966 BC
12	Jarosław, site 158, feat. 304	charcoal	Poz-31736	3690±30	2134 BC (45.3%) 2070 BC 2064 BC (22.9%) 2032 BC	2196 BC (4.6%) 2170 BC 2146 BC (85.6%) 2010 BC 2001 BC (5.1%) 1977 BC
13	Jarosław, site 158, feat. 1079, depth 90–110 cm	charcoal	Poz-31734	3675±35	2134 BC (36.2%) 2078 BC 2063 BC (26.3%) 2019 BC 1994 BC (5.6%) 1982 BC	2192 BC (1.7%) 2180 BC 2142 BC (93.7%) 1952 BC
14	Jarosław, site 158, feat. 131, depth 80–100 cm	charcoal	Poz-31698	3660±35	2130 BC (24.4%) 2087 BC 2049 BC (43.8%) 1972 BC	2140 BC (95.4%) 1939 BC
15	Jarosław, site 158, feat. 1269, depth 150–170 cm	charcoal	Poz-31735	3655±35	2124 BC (19.3%) 2091 BC 2043 BC (48.9%) 1964 BC	2138 BC (95.4%) 1938 BC
16	Jarosław, site 158, feat. 1106, depth 50–70 cm	charcoal	Poz-31750	3610±40	2025 BC (68.2%) 1921 BC	2131 BC (6.7%) 2086 BC 2050 BC (88.7%) 1881 BC

The second group includes 6 datings made for charcoal from the base parts of features numbered: 243 (Poz-31697: 3795 ± 35 BP; depth 100–120 cm), 290 (Poz-31704: 3755 ± BP; depth120–140 cm), 65 (Poz-31695: 3750 ± 35 BP; depth 120–140 cm), 31 (Poz-31743: 3730 ± 35 BP; depth 120–140 cm), 397 (Poz-31742: 3730 ± 35 BP; depth 100–120 cm), 116 (Poz-31739: 3725 ± 35 BP; depth below 140 cm). These features are located in various zones of the Mierzanowice culture settlement (Table 1; Fig. 2).

The radiocarbon dating obtained for the sample from feature no. 243 (3795 ± 35 BP; Table 1) requires discussion, after calibration for 95.4% probability the result is 2397–2061 BC. In the dated layer (Fig. 3), a vessel was discovered – probably in situ – with technological features referring (Rybicka 2013, 111), in Kadrow's view (1991), to those distinguishing the classic phase of the Mierzanowice culture, in the literature dated to 2050 BC – 1850 BC (Kadrow, Machnik 1997), i.e., generally speaking, with younger chronology than the 14C result obtained for the sample from pit 243. It can be assumed that the mentioned vessel is connected with the period of functioning of this feature. A vessel (Fig. 4) made with a technology close to the features of the classic phase of the Mierzanowice culture (Kadrow 1991) was discovered in the base of feature no. 397. The dating obtained for this pit is, after calibration for 95.4% probability, 2276–2028 BC, i.e. it is similar to the result from feature no. 243 (Table 1). In this context, the dating obtained for the charcoal from pit base no. 290 (Table 1) is also interesting. It is 3755 ± 35 BP, which is after calibration for a 95.4% probability, 2286–2038 BC. In the dated layer of object no. 290 there were vessels with features that, according to Kadrow (1991), generally correspond to the early phase of the Mierzanowice culture as well as with features characterising the classical phase (Rybicka, 2013, 116; cf. Fig. 5; 6: 1, 3). As for feature no. 31, in the radiocarbon-dated layer (3730 ± 35 BP; after calibration for 95.4%: 2276–2030 BC) vessels with features of the early Mierzanowice phase were distinguished (Rybicka, 2013, fig. 42: 9). The obtained result goes well with the archaeological artefacts found there, as in the case of features no. 65 and 116 (Table 1; Rybicka, 2013, 120). Summing up, all the results presented allow the described features to be placed in a time interval of about 2280–2020 BC. They are also connected in terms of the features of ornamentation and ceramic technology that distinguish

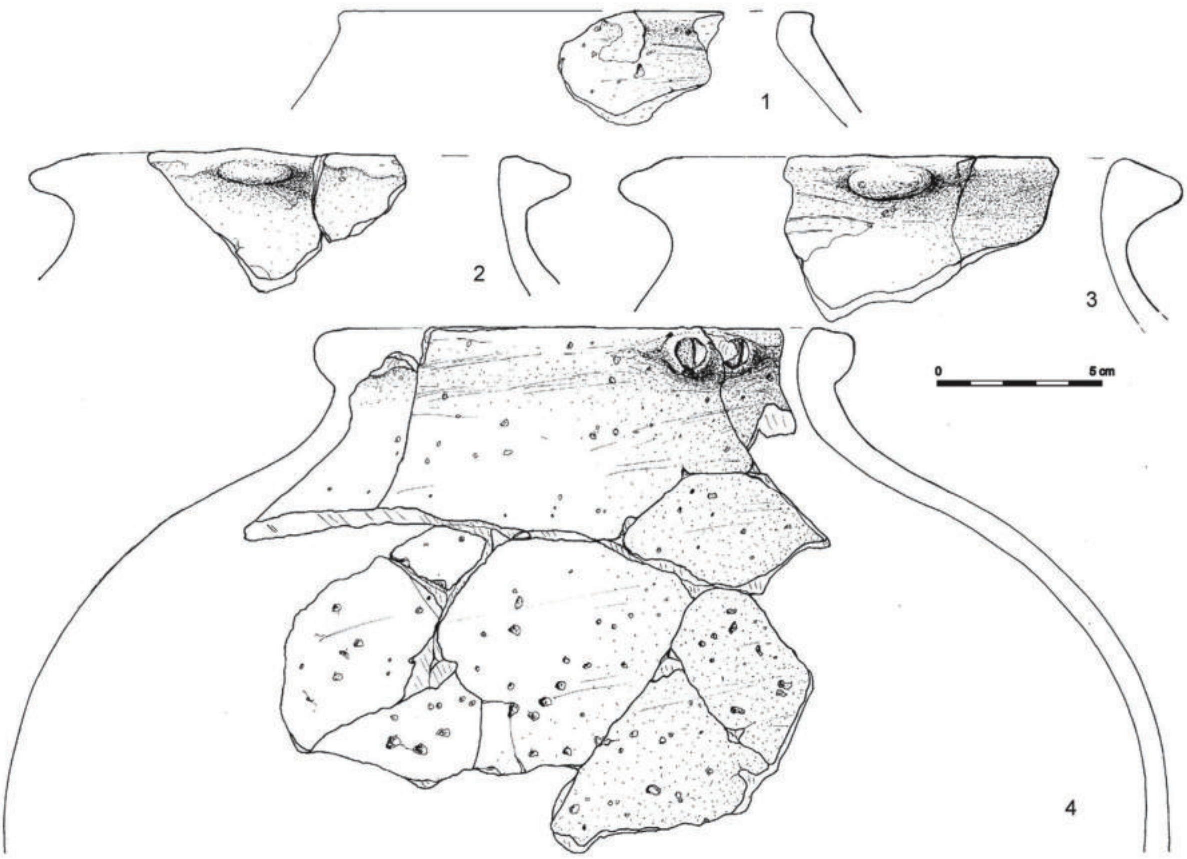

Fig. 3. Jarosław, Site 158, Podkarpackie province. Pottery of Mierzanowice culture from pit 243. 1–4: depth 100–120 cm.

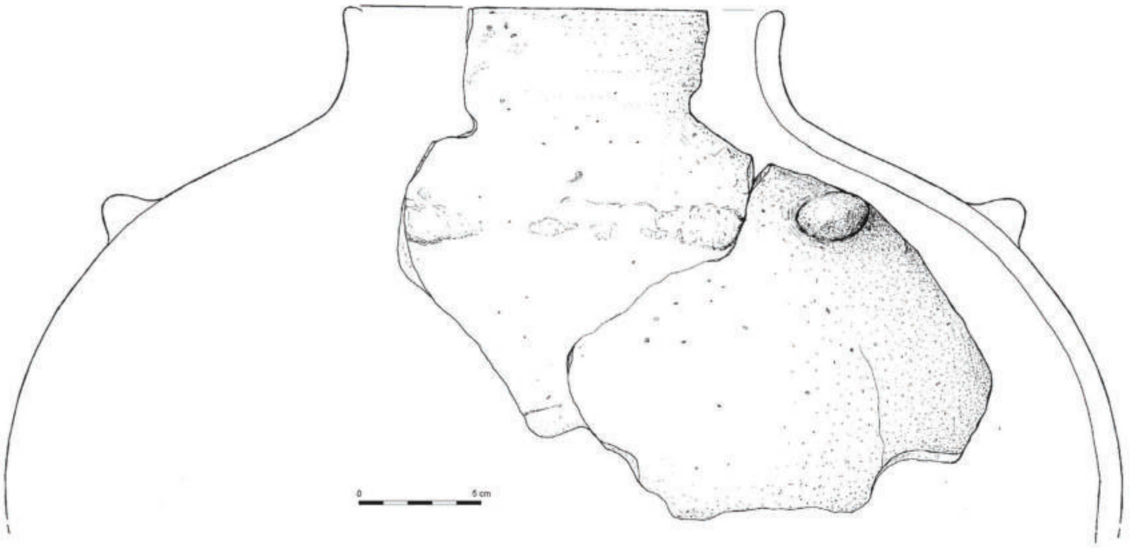

Fig. 4. Jarosław, Site 158, Podkarpackie province. Pottery of Mierzanowice culture from pit 397 (depth 80–100 cm).

the early Mierzanowice phase and signal the new quality of the classic Mierzanowice phase (see Rybicka, 2013, 110–121).

Four radiocarbon datings were obtained for charcoal and organic material deposited on the inner part of the vessel from feature no. 13. They are Poz-31751: 3760 ± 35, Poz-31752: 3705 ± 35, Poz-31753: 3690 ± 35 and Poz-31741: 3690 ± 35 BP (Table 1). The results are slightly different (Fig. 7; table 1). According to Adam Walanus and Tomasz Goslar (2004, 80) "...two measurement results of the same object will practically always be different, this is due to the inevitable random factor in the measurement...". The probability range for the dating made for the charcoal is 2298–1966 BC, while for the organic matter it is 2201–1980 BC, 2198–1966 BC and 2288–2041 BC. Generally, they fall within the younger stages of the early phase of the Mierzanowice culture and / or the beginnings of the classical phase.

In the context of the published time frames for the early Mierzanowice phases, that is 2200–2050 BC, and for the classic Mierzanowice phase, 2050–1900 BC (Kadrow and Machnik 1997), the dating obtained for features 243, 397 and 290, in which, among others, the culture's 3rd stage technology characteristics were found, could be considered too early. This could result from, as Kadrow (1991) explained in the case of radiocarbon datings from Iwanowice, Babia Góra site, which referred to the proto-Mierzanowice phase, dating redeposited coal. The results of radiocarbon dating obtained for the base of feature no. 13 (Fig. 7) and organic material registered on ceramics from this pit are partly similar to the dates obtained for ceramic assemblage from features 243, 290 and 397 (Table 1). Taking into account the earlier time intervals for the latter and the later time intervals for the previously described features, one can connect the trapeze-shaped features from Jaroslaw, site 158 with the younger stages of the early phase of the Mierzanowice culture (Fig. 8). Accepting the described 14C dating, it can be assumed that some characteristics related to the classic phase of the Mierzanowice culture might have appeared earlier than assumed by Kadrow and Machnik (1997).

The results obtained for the samples from the bases of trapeze-shaped pits numbered 1079 (Poz-31734: 3675 ± 35 BP; depth 90–110 cm) and 1269 (Poz-31735: 3655 ± 35 years BP; depth 150–170 cm) and located along the southern border of the settlement, in which few, non-distinctive fragments of ceramics were discovered, are difficult to assess in the context of the previously described pool of datings. As for the dating obtained for the backfill hollow of feature 131, which is Poz-31698: 3660 ± 35 years BP (Table 1), the situation is different. It can be assumed that the dating does not refer to the time of its functioning and creation, but it determines the time of the backfilling process within the feature.

As the presented data shows, trapeze-shaped features generally representing the early Mierzanowice phase can be directly connected with the time of the functioning of the Mierzanowice culture settlement. A few later dates, obtained for samples from the backfill hollows of trapeze-shaped and hollow-shaped features, are not related to the time of the Mierzanowice communities settlement in the place (features: 131, 304, and 1106).

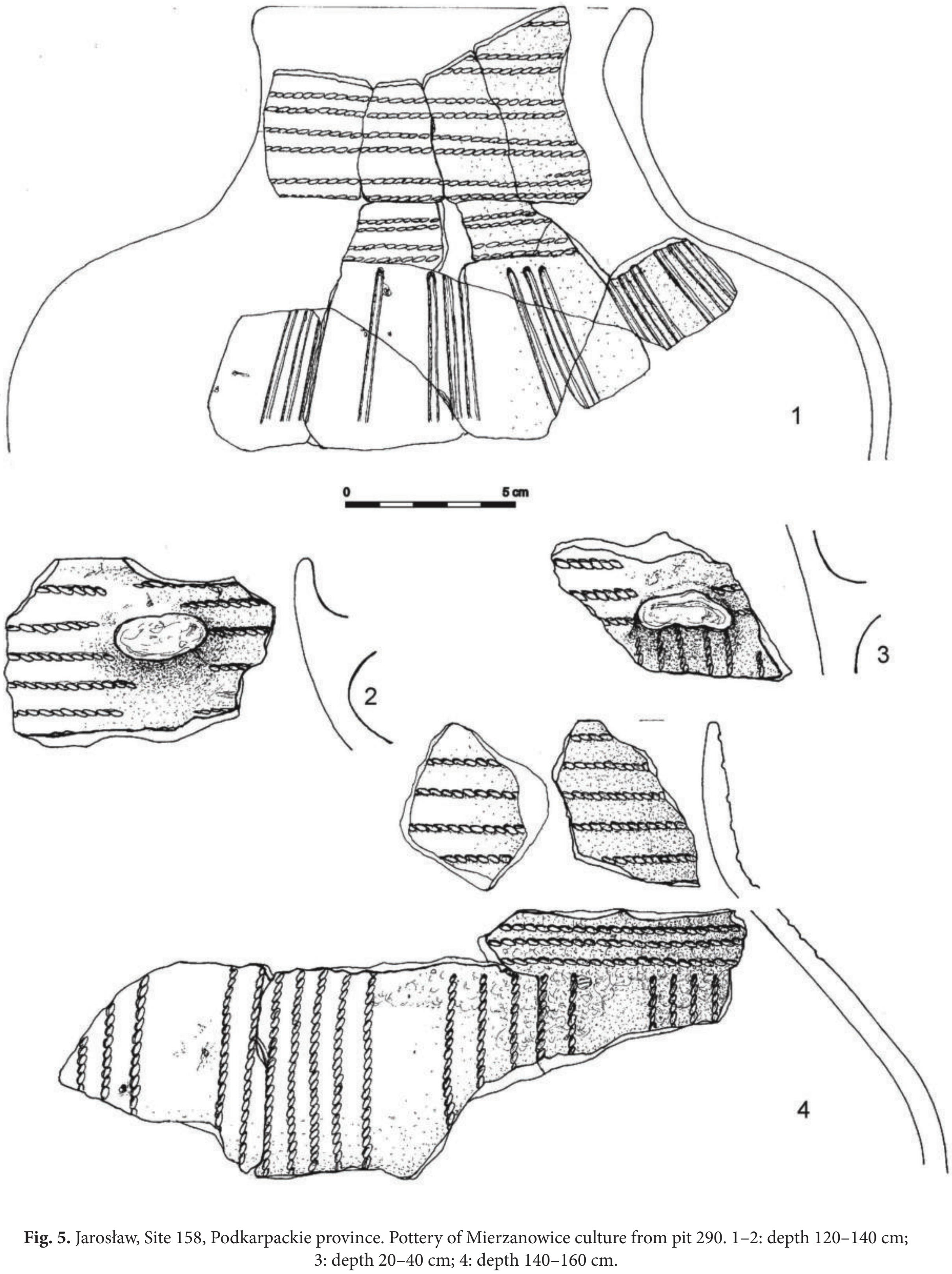

Fig. 5. Jarosław, Site 158, Podkarpackie province. Pottery of Mierzanowice culture from pit 290. 1–2: depth 120–140 cm; 3: depth 20–40 cm; 4: depth 140–160 cm.

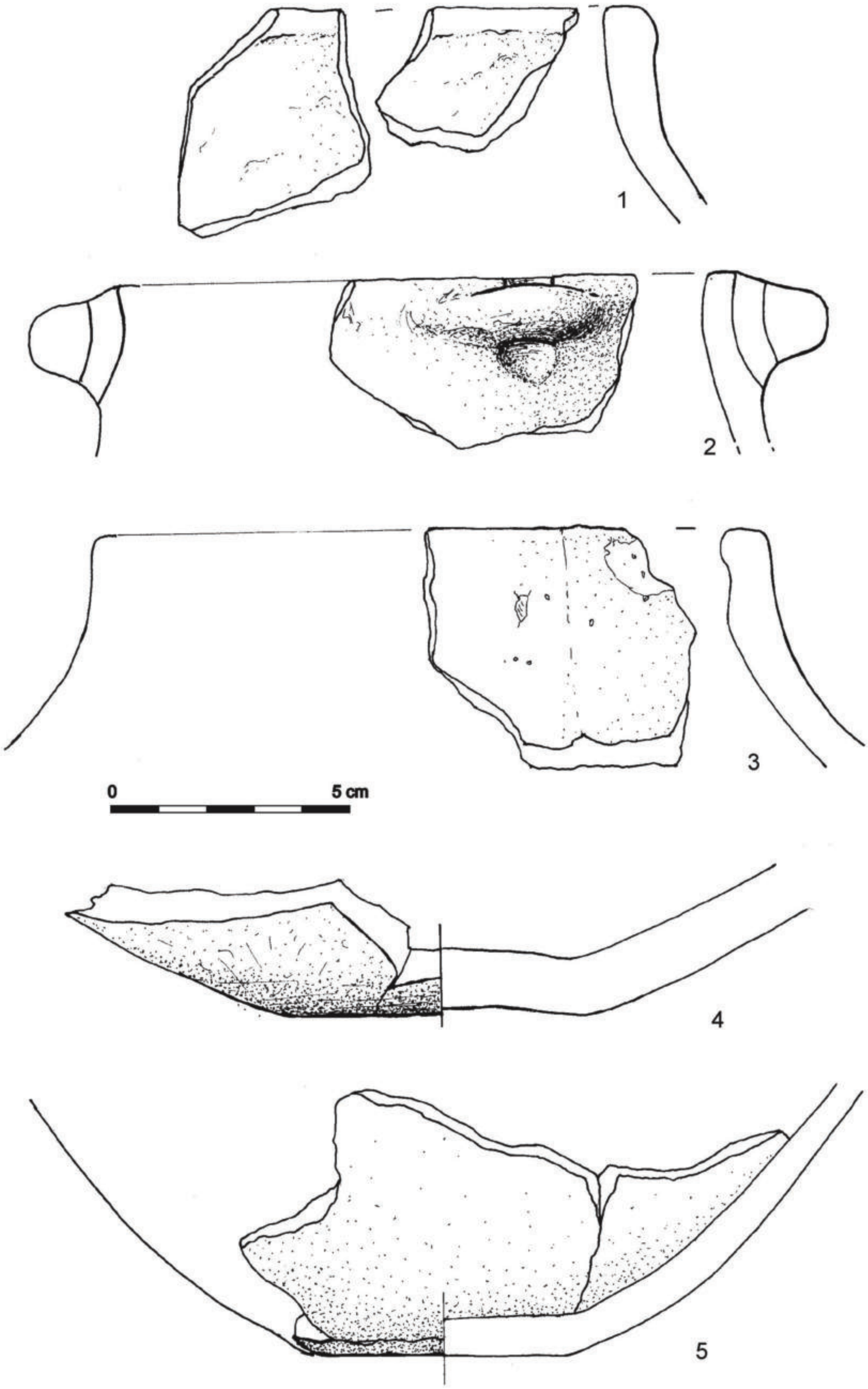

Fig. 6. Jarosław, Site 158, Podkarpackie province. Pottery of Mierzanowice culture from pit 290.
1: depth 120–140 cm; 2–5: 140–160 cm.

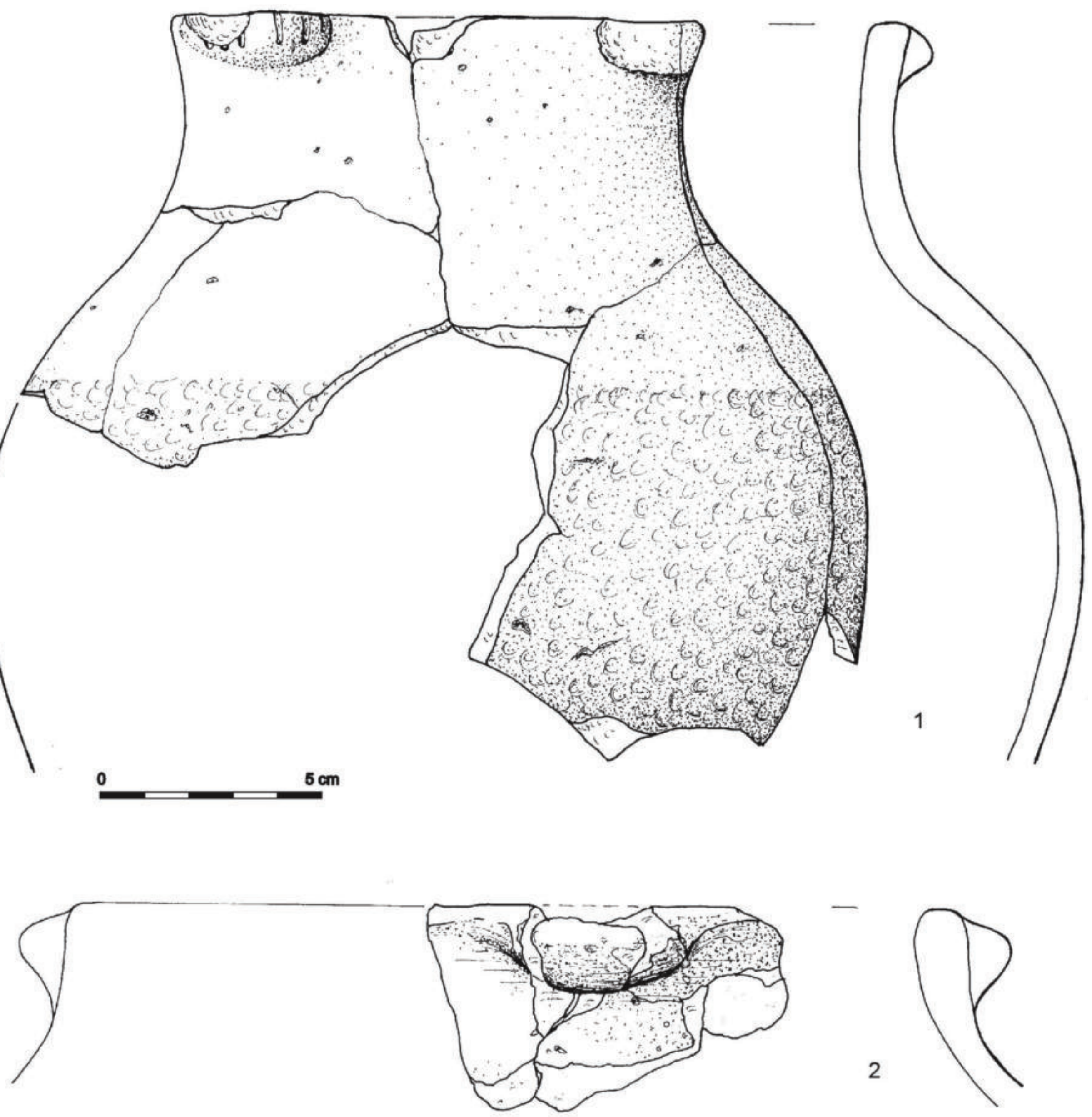

Fig. 7. Jarosław, Site 158, Podkarpackie province. Pottery of Mierzanowice culture from pit 13.
1: depth 80–100 I 100–120 cm; 2: depth 100–120 cm.

Is it possible to conclude, based on the assessments of the style of ceramics and radiocarbon dating, that the features of the Mierzanowice culture represent different stages of the settlement in this place?

Treating the received radiocarbon dating referring to the trapeze-shaped features of the Mierzanowice culture located in different zones of the settlement in Jarosław literally, site 158 can be connected with a relatively wide period of time, from about 2300 to 1900 BC (Fig. 8). Ceramics from many of the features generally correspond to the early Mierzanowice phase with elements signalling the classic stage of this culture (Rybicka 2013, 110–116). At the same time, in several 'early Mierzanowice' features, for one of which (object 290) 14C dating in the range of 2300–2050 BC (Table 1) was obtained, fragments of ceramics with proto-Mierzanowice features, which probably came from a secondary context, were distinguished (Rybicka 2013). The published study suggested that the beginning of the Mierzanowice culture settlement in Jarosław, site 158, might indicate the breakthrough in the transition from the proto- to early Mierzanowice phases and that this stage may be represented by trapeze-shaped pits with little material or no material at all (Rybicka 2013). Such assumption may also be supported by the result obtained for pit 33 (Table 1). Features with such characteristics are included in some clusters (e.g. 528, 531; 131; 231; 482, 437; 480; 470). However, there are no clear arguments supporting this conclusion.

In the case of the north-eastern cluster of features, which includes pits 290, 65, 116, the datings obtained for them are similar, and they are, respectively, 3755 ± 35 BP (95.4% probability: 2286–2038 BC), 3750 ± 35 BP (95.4% probability: 2284–2036 BC) and 3725 ± 35 BP (95.4% probability: 2274–2024 BC). The distances between neighbouring features in this cluster are about 10 m. Kadrow (1991) assumed that trapeze-shaped pits mark the places where farmsteads functioned. It cannot be determined, however, whether only one trapeze-shaped pit could function around the farmstead within one period of time, or if there were more, and whether the duration of such features corresponded to the period of the functioning of the hut, as well as how large the area used by the inhabitants of the hut was. Therefore, it cannot be unequivocally determined whether the features included in the clusters are remains of, according to Kadrow (1991), various construction phases within one settlement phase of a given place, or whether they are the effect of a gradual use of the economic environment around the farmstead. The style of ceramics from the above-mentioned features indicates their functioning within, in Kadrow's (1991) view, one settlement phase with the dominant features of the early Mierzanowice, similarly to most of the trapeze-shaped pits of the Mierzanowice culture from this site (Pelisiak and Rybicka 2013). One can only suggest that the chronological frame in which they were used was not wide and refers to the period between 2200 and 2000 BC (Fig. 8).

Summary

In recent years, a number of radiocarbon datings for the Corded Ware culture from the Rzeszów Foothills, representing the second half of 3rd millennium BC, have been obtained (Hozer *et al.* 2017, 108; Rybicka *et al.* 2017, 128). On this basis, it can be suggested that in the period of about 2500–2200 BC communities of this culture functioned in this area. Probably, at that time the aforementioned region was not intensively inhabited by communities of the Mierzanowice culture. The dating made for the settlement in Jarosław, site 158, with the result of 2200–2000 BC, coincides with the dating obtained for some of the Mierzanowice graves from Skołoszów, site 7 (Rybicka *et al.* 2017).

The Iwanowice, Babia Góra site, can now be treated as a chronological benchmark for the Mierzanowice culture from western Lesser Poland. Jarosław, site 158, currently plays a similar role for the early stages of this culture from Rzeszów Foothills. This is supported by a large pool of datings verifying ceramics style assessments. This led to considering the Mierzanowice settlement in Jarosław, site 158, as a place settled for a relatively short period of time. Studies on the spatial development of the Funnel Beaker culture habitats show that settlements inhabited for a short period of time provide the best basis for determining the settlement

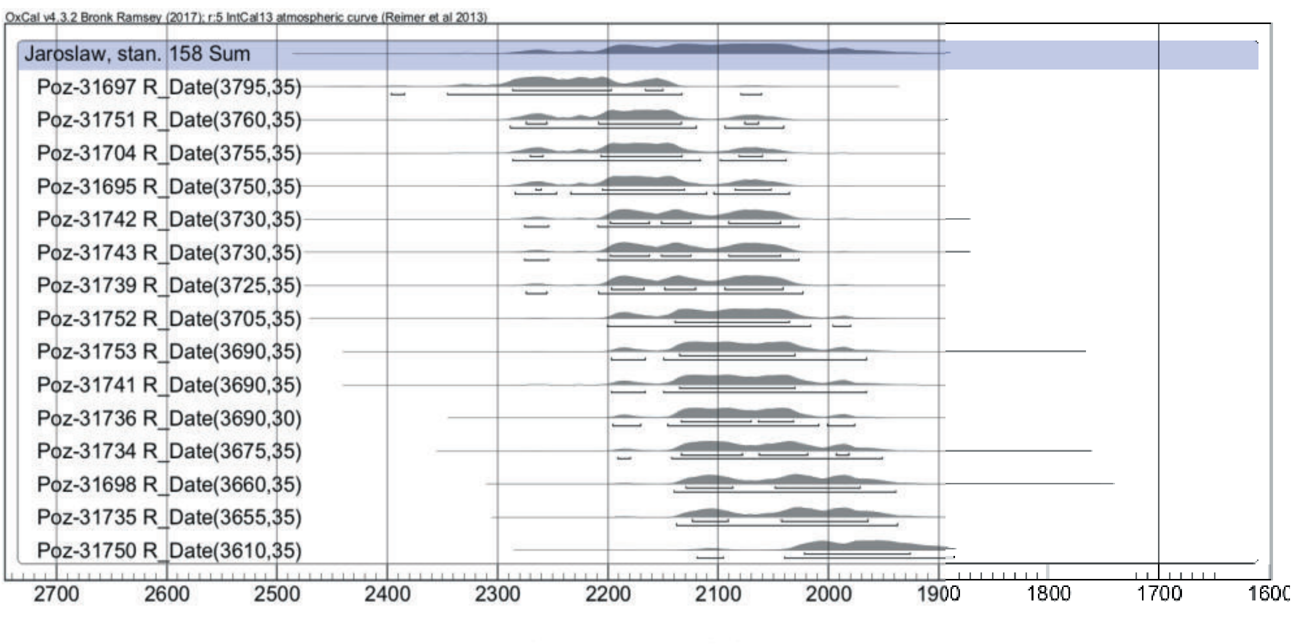

Fig. 8. Jarosław, Site 158, Podkarpackie province. Radiocarbon dates obtained for Mierzanowice culture features.

layout patterns functioning at a given time (Pelisiak 2003; Kulczycka-Leciejewiczowa 2002; Rybicka 2004; Rzepecki 2014). In this context, Jaroslaw, site 158, Podkarpackie province has a special place in research on the ways of occupation of space by the Mierzanowice culture communities.

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The archaeometric, formal and stylistic analysis of a black-glazed fish-plate from the National Museum in Poznań

Abstract

Głuszek I., Krueger M. 2019. The archaeometric, formal and stylistic analysis of a black-glazed fish-plate from the National Museum in Poznań. *Analecta Archaeologica Ressoviensia* 14, 81–90

This paper presents the results of the XRF, formal and stylistic analyses of a black-glaze fish-plate from the National Museum in Poznań. A non-invasive portable X-ray fluorescence spectrometer (pXRF) has been used to determine the chemical composition of the plate. Analysis of the shape and decoration provided data on the chronology, typology and provenance of the vessel. The obtained results were used to determine the possible region of the fish-plate's production. The form of the fish-plate represents features characteristic for the early stage of Italian black-glaze production, which is combination of Athenian traditions with new solutions in terms of proportion and shape. The analysis of X-ray fluorescence spectrometry data and comparative studies with already known results of the Italian black glaze pottery chemical analyses allowed the fish-plate to be identified as an example of the Campania A group from ancient Naples workshops, dated to the second half of the 4th century BC.

Key words: black-glaze pottery, X-ray fluorescence spectroscopy, provenience, multivariate analyses, museum collections

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History of the artefact

The history of some of the museum artefacts have their origins in the collections of the Kaiser Friedrich Museum in Posen, which was established in 1902 as a result of the transformation of the Prussian Provinzial Museum which had been founded earlier in 1894. Artefacts forming antique collections were brought to the Prussian museum from several collections in Berlin (1899, 1902, 1903). In addition, private collectors also contributed their gifts to the collection of Emperor Frederick's museum: in 1900, a gift from Kurt Schottmüller, in 1903 and 1904 a gift from Alfons Hugger, also in 1904 a gift from James Simon and in 1909, Józef Kantorowicz. Documentation regarding the above-mentioned collections is not always complete and detailed, hence it is difficult to indicate from which set the vessels described in the article originated. The vessels that became parts of the collection in the last decades of the 20th century came from purchases from private individuals (Szymkiewicz 2004, 103–107; Głuszek 2018, 7). In recent years, fish-plates from the National Museum in Poznań have also been the subject of studies by junior researcher (Kajzderski 2014).

Characteristics of the morphological features of fish-plates

The term fish-plate is related both to its function, as it was used to serve fish, and to the iconography of this kind of red-figure pottery, where fish were a common theme in the images decorating dishes of this shape (Sparkes, Talcott 1970, 147–148; McPhee, Trendall 1987, passim). The production of vessels of this shape began in Athens. These vessels were relatively popular in production in the red-figured technique in Attica, and were also widespread in Italian workshops, in both the decorated version and a simpler one with black glaze only. The characteristic features of the shape of this type of vessel, irrespective of the method of decoration, is a wide disc of the plate descending to a centrally placed round dip, the lip of the vessel is turned outwards and downwards, while the foot has the shape of a fairly high, massive ring. According to the abovementioned scholars, vessels decorated with the black-glazed technique appeared relatively late in Athens, with their production developing around 400 BC (Sparkes, Talcott 1970, 147; McPhee, Trendall 1987, 18). However, in light of later studies, this chronology can be moved back to the last decades of the 5th century BC (Rotroff 1997, 147) but the popularity of this type of pottery certainly increased in the Hellenistic period. In the series of Attic fish-plates in the black-glazed technique, the foot of the vessels changed significantly from the form with a profiled outer wall to one with a straight outer wall and a concave inner wall. A characteristic feature of the forms dated to the second half of the 4th century BC is the modelling of the resting surface of the foot provided with a circumferential groove running near the inner edge of the foot. On the external side of the plate, grooves appear around the edge of the central depression and near the lip of the vessel. The surface of the disc is covered with glaze both on the outer and inner sides. In the case of early forms of Attic fish-plates, the underside was covered with glaze witha reserved ring near the base of the foot. At the next stage, decoration appeared in the form of a reserved surface covered with a sequence of concentric rings of various widths made with black glaze with a dot marking the centre of the vessel. In vessels thus decorated, the inner wall of the foot was also covered with glaze, with the resting surface left in the colour of clay. Such a solution can be observed on the vessel from the collection of the National Museum in Poznań. Subsequent, later Attic ceramics have the underside of the vessel completely covered with glaze. The forms decorated with concentric circles and entirely covered with glaze functioned together for some time around the middle of the 4th century BC, while vessels from the Hellenistic period are in most cases entirely covered with glaze (Rotroff 1997, 147).

According to archaeological sources, it appears that the first fish-plates started to be produced in Magna Graecia in Sicily or southern Calabria. In these areas, numerous whole vessels, and above all, vessel fragments have been found: Locri, Amantea, Gela. The stylistic similarities between some of the plates from Sicily and others found in the area of Paestum or Cumae suggest that, like other red-figure pottery, the fish-plates from Campania and Paestum were also produced under a strong Sicilian influence. It can be assumed that some of the Campanian vessels, including fish-plates, were made by expatriates from Greece itself. These vessels can, like other examples of red-figure pottery from these workshops, be assigned to various (already existing) painters, groups, and stylistic workshops. The South Italian fish-plates can be divided into four main group: Sicilian, Campanian, Paestan, and Apulian (McPhee, Trendall 1987, 54). The first fish-plates appeared in in Sicily or southern Calabria in the first quarter of the 4th century BC, with the production of these types being expanded in the middle of the century in Campania, Paestum and Apulia, with the peak in production being assigned to the third quarter of the 4th century BC (McPhee, Trendall 1987, 58). It seems that production of the black-glaze examples developed in a slightly different manner to those with red-figured decoration.

At the end of the 5th century BC, workshops in southern Italy began to imitate and export black-glazed pottery, while the first products from Etruria date to the end of the 4th century BC. The production of fish-plates was most extensive from the late 4th to the early 2nd century BC. It should be noted that the first phase of the development of black-glazed ceramics production is characterised by strong connections to the forms, decoration techniques and technological solutions represented by the products of Attic workshops. Local products with a different character of vessel morphology and individual production features appeared only during the subsequent stages of production, essentially being characteristic of vessels from the mid-4th century BC (Hayes 1984, 21; McPhee, Trendall 1987, 58).

Regarding the shape of the fish-plates, the differences between the dishes from Attica and southern Italy can be observed in the area of the foot of the plates. Among the Attic plates, starting from the second quarter of the 4th century BC, the outer edge takes the shape of a convex arc, while in the case of the South Italian plates it is modelled (strongly rounded – convex in the shape of a roll), and sometimes the ring foot consists of two modelled levels. In the South Italian plates, the foot is usually low except for a few late Apulian examples, where its height reaches up to 5 cm. The curvature of the former plates is greater but the transition between the disc and the downwards-turned lip is not as sharply defined as in the case of Attic vessels. The widths of the downwards-turned lips are different, sometimes to the extent that they almost cover the whole profile of the vessel (McPhee, Trendall 1987, 54–56).

A black-glazed fish-plate from the collection of the National Museum in Poznań – formal analysis

The fish-plate (MNP A 844) has a height of 8 cm while the diameter of the vessel is 29.8 cm, and the diameter of the foot is 12.5 cm. The clay from which the plate was made is light orange 5YR 6/3–7.5YR 6/3. The colour of the retouch applied to the groove around the depression the plate is bright red 10R 5/6–4/6, while the glaze is black with a hint of dark brown. The glaze is a little dilute and semi-matte. The vessel is preserved in its entirety, with a few traces of damage on the external surface. The vessel surface covered with glaze has a slightly gritty texture. The plate from the museum has a thickened edge extending downwards and a flat top. There is a shallow groove around the central depression for sauce, a similar groove runs along the outer edge of the dish. The foot is high, rectangular in section, with a flat resting surface. In the case of the vessel studied, its most prominent features are the shape and proportions of the disc and the centrally located depression. In the place where the disc of the plate passes into the depression and where the base of the foot is affixed, the wall of the vessel is considerably thickened, which contrasts with the thinner wall of the central part of the vessel (Fig. 1). The fish-plate from the National Museum in Poznan is an example of a South Italian vessel.

A similar shape and proportions can be observed in the 1075 plate from the Athenian Agora (Sparkes, Talcott 1970, fig. 10. 1075). However, the Attic vessel has a flat surface for its sauce container and the bottom of the plate has a pointed shape, with a characteristic omphalos in the centre. The foot of the vessel from Poznań is high and simple, which suggests the later production from the first quarter of the 3rd century BC, but the vessel is relatively shallow, which could indicate the early phase of the production of plates (referring to the Athenian vessels), related essentially to the 4th century BC. Similarly, the sharp angle of the bend of the plate edge and the downward-facing edge, and the concentric circles on the bottom of the vessel point to late classical production. In case of the vessel from Poznań, the characteristic distinct angular bend

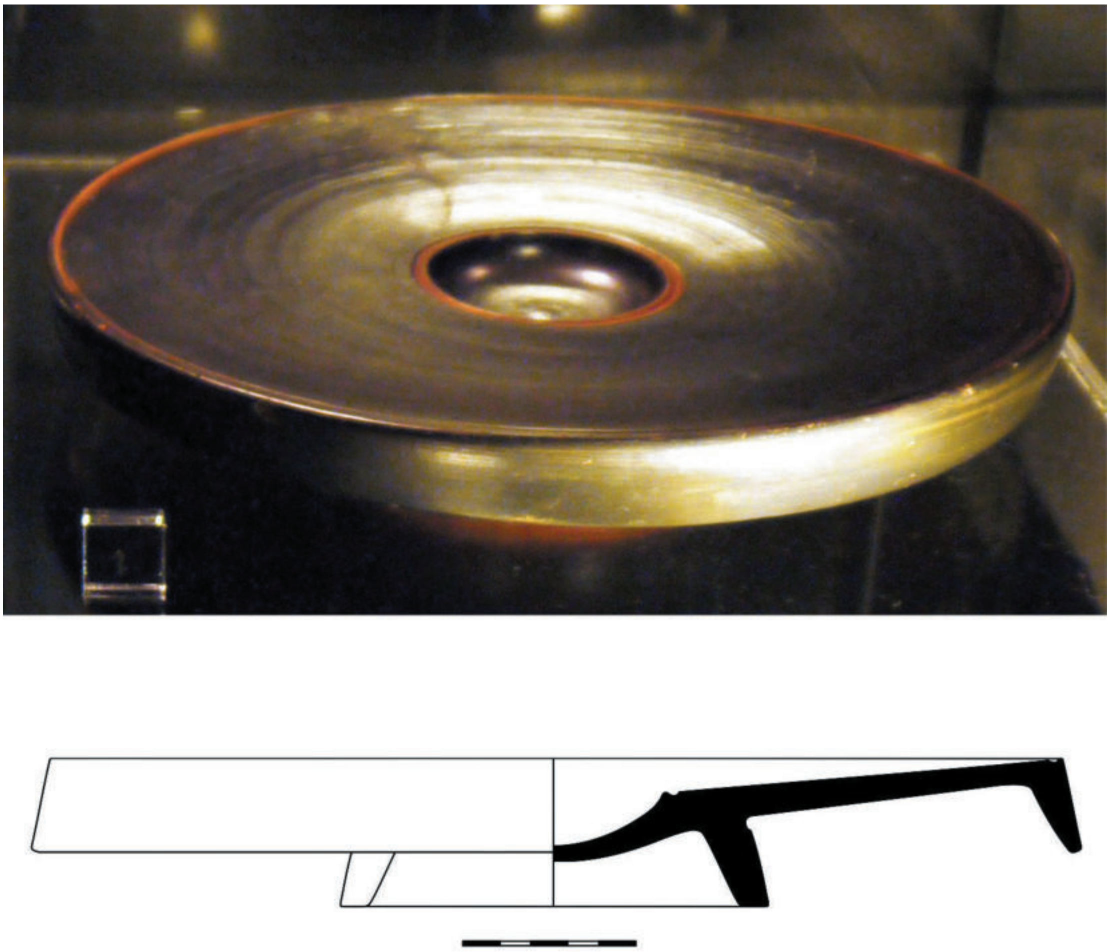

Fig. 1. A drawing of the MNP A 844 fish-plate, drawing I. Głuszek, phot. M. Krueger.

of the edge of the disk of the vessel passing into the vertical lip, the large diameter of the vessel and the use of two circumferential grooves on the disk indicates the imitation of the Athenian prototypes. In contrast, the characteristic ring-shaped foot, high, with straight walls and a flat base, a model repeating the solutions known from plates and bowls of the early Hellenistic period, indicates the later chronology of the vessel (Pedroni 1990, 28, 43–44, no 868, 909; Morel 1965, pl. 18, 271).

The fabric of clay and features of glaze suggests Italian provenance and are characteristic of Campania ware. Plates of a similar shape come from the museum collections of the Czech Republic (Bažant *et al.* 1997, pl. 69. 8). The vessel from the Charles University collection is compared to the form classified by J. P. Morel as 1121d1, described as an imitation of Athenian types dated to the second half of 4th century BC. Another example is from the Michigan University collection (Ingen 1993, pl. 18. 13) representing a vessel of presumably of Pozzuoli or Cumae provenance dated to the 4th–3rd century BC. The features of the shape of the vessel and the characteristics of the glaze indicate that the vessel was produced in Italy, while the visible features indicate the imitation of Attic vessels and supplemented with new solutions deviating from Attic standards. This allows the artefact to be dated to the second half of the 4th century BC (Głuszek 2018, 19).

Chemical analysis of the fish-plate using an X-ray fluorescence handheld spectrometer

Many specialists were involved in the study of various ceramic complexes from Italy in order to develop basic of typological distinctions (for those of greatest importance and diffusion, see Lamboglia 1952, 1958, 1960, 1961; Morel 1969, 1981, 1987, 1990). The distinctions of archaeological sources were made on the basis of the observed morphology and style of finds. Artefacts from the pottery production sites were examined, as well as the vessel distribution process; however, the identification of a single production site is sometimes ambiguous or uncertain. The combination of factors such as the heterogeneity of finds in terms of morphology, widespread production and distribution, and the presence of countless imitations of local forms coming from other production centres, significantly complicates the study of this class of pottery. These ambiguous sources hinder research into the provenance of the artefacts and technologies of their production. Such studies are even more difficult due to the poor recognition and identification of only a few production centres.

Answers to such numerous questions can be sought through long-term research using archaeological methods and techniques. Nevertheless, many examples of pottery produced in workshops have been described and analysed in the context of provenance studies. Numerous studies have already been done on black ceramic ceramics from the areas of southern Italy (Prag *et al.* 1974; Prag 1984; Maggetti *et al.* 1986, 1998; Picon 1988; Morel and Picon 1994; Mirti *et al.* 1995; Pasquinucci *et al.* 1998; Preacco Ancona 1998), southern Etruria and Lazio (Morel, Picon 1994; Olcese 1998; Picon 1988, central and northern Etruria (Lasfargues, Picon 1982; Harari, Oddone 1984; Maggetti *et al.* 1986, 1998; Schneider 1992; Frontini *et al.* 1995; Pasquinucci *et al.* 1998; Mazzeo Saracino *et al.* 2000), eastern and northern Italy (Maggetti *et al.* 1986, 1998; Frontini *et al.* 1995, 1998; Oddone 1998; Bonini, Mello 2000; Mazzeo Saracino *et al.* 2000; Schneider 2000).

The reference groups established in the course of these studies have provided new research directions to a certain extent, supplying fresh data that facilitates the study of the provenance of artefacts. However, differences in sample preparation and the analytical techniques adopted (optical microscopy, scanning electron microscopy, X-ray diffraction, X-ray fluorescence, inductively coupled plasma optical emission spectroscopy and neutron activation analysis) can provide such divergent and uncorrelatable results that further comparative testing becomes impossible to conduct. These problems are well known in archaeometry (Galetti 1994).

The analysis of the chemical composition of the surface of the fish-plate was performed using a Bruker Tracer III SD handheld X-ray fluorescence spectrometer. One of the basic advantages of conducting tests with a spectrometer is its non-invasive nature, rapidity and the relatively low cost of analysis. It is a method that, due to the small size of the apparatus, allows tests to be conducted outside the laboratory, for example in museum exhibition halls. The disadvantages include a lower degree of precision, the ability to analyse only the surface of the examined artefacts and the semi-quantitative nature of the data.

The methodology of the identification of chemical elements in archaeological ceramics involved multiple analyses of various parts of the same artefact. The focus was on the analysis of the black-glazed surface, but measurements were also made of parts that were not covered with the glaze.

During the measurements the „Major Mud Rock" analytical mode was used, whose analytical parameters are as follows: a voltage of 15kV, an intensity of approx. 25 μA. The time of a single analysis was 15 seconds.

These settings enable the identification of the following elements: Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Co, Cu, Zn, Ba.

In total, ten measurements of the plate were made: six measurements (824–829) of the external surface (Fig. 2) and four measurements (830–833) of the inner surface (Fig. 3). Two measurements of unglazed places were made: the edge of the foot (824) and the middle part of the inside of the foot (825). The most representative measurements for black glaze are from 826 to 833 (Tab. 1). The analysed areas covered with black glaze have the highest content of silicon (28.7–29.9%), aluminium (24.1–26%), and magnesium (9.5–14.3%). A distinctive feature is the very high content of potassium (5.4–7.1%), iron (5.7–6.9%) and also aluminium (24,1–25,8%). Differences in the chemical composition between the black-glazed surface and the places that are not covered with glaze are evident. The black-glazed surface has a lower content of calcium (1,3–3,7%), manganese (0,031–0,040%) and barium (0,219–

Table 1. Elemental composition of the analysed plate, values are in percentages, M. Krueger.

File #	Mg	Al	Si	P	S	K	Ca	Ti	V	Cr	Mn	Fe	Co	Cu	Zn	Ba
824	6.994	11.763	30.272	0.361	0.828	3.631	6.554	0.353	0	0.003	0.044	3.521	0.001	0.011	0.013	0.412
825	14.025	15.686	27.712	0.424	3.221	3.794	8.924	0.358	0	0.006	0.057	4.567	0.002	0.008	0.009	0.452
826	9.518	24.126	29.160	0.171	0.380	5.404	3.203	0.333	0.001	0.012	0.040	5.915	0.003	0.012	0.018	0.343
827	7.069	24.923	28.886	0.166	0.398	6.824	3.314	0.320	0.002	0.011	0.033	6.050	0.002	0.011	0.017	0.230
828	12.698	25.137	28.798	0.183	0.469	7.130	3.560	0.339	0.010	0.010	0.037	6.000	0.002	0.013	0.015	0.219
829	14.315	25.837	28.448	0.142	0.177	6.458	3.759	0.354	0.003	0.010	0.039	5.786	0.002	0.011	0.015	0.311
830	13.890	25.025	29.961	0.131	0.117	6.488	1.317	0.323	0.010	0.014	0.031	6.973	0.003	0.015	0.024	0.224
831	13.360	25.703	29.555	0.113	0.112	5.776	1.539	0.334	0.014	0.016	0.039	6.920	0.003	0.012	0.024	0.257
832	13.685	25.424	29.266	0.110	0.152	5.874	2.499	0.313	0.004	0.014	0.036	6.680	0.003	0.012	0.023	0.312
833	14.218	26.095	29.332	0.155	0.289	7.008	1.774	0.330	0.014	0.015	0.033	6.722	0.003	0.012	0.023	0.246

Fig. 2. Measurements of the external surface. Fish-plate from the National Museum in Poznań, MNP A 844, phot. S. Obst.

Fig. 3. Measurements of the inner surface. Fish-plate from the National Museum in Poznań, MNP A 844, phot. S. Obst.

0,343%) than the ceramic body and higher content of phosphorus (0,36–0,42% versus 0,11–0,18%) and sulfur (0,82–3,22% versus 0,11–0,18%). Differences between unglazed and glazed surfaces are visible also in case of trace elements: vanadium (not detected in unglazed areas), chromium (0,003–0,006% versus 0,010–0,016%), cobalt (0,001–0,002% versus 0,002–0,003%) and zinc (0,009–0,013% versus 0,015–0,024%).

It is commonly known that vitrified clayey coatings as black-glaze were worked from selected and refined clays such as illitic clay (Mirti, Casoli, Calzetti 1996, 103–104). This is the reason for the higher amount of aluminium in the slip than in the ceramic body. At the same time, the black-glazed surface is very low in calcium (compare with Chaviara, Aloupi-Siotis 2016, 515) commonly rich in unglazed ceramic materials. This may be a consequence of the refinement of black slip from impurities (Scarpelli *et al.* 2017, 7). It should be highlighted that the unusual enrichment of aluminium (Fig. 4), potassium (Fig. 5), and to some extent also iron (Fig. 6), and the parallel deficiency of calcium (Fig. 7) is the fingerprint of the black-glaze pottery in question. This outcome is in good agreement with the results obtained by R. Scarpelli, R. J. H. Clark,A. M. De Francesco (2014, 63 and 66) who studied the black-coated pottery from Pompeii dated back to the 4th and the 1st centuries BC. Together with typological features as the homogeneity of forms and decoration, these are also considered to be characteristic for Campania A ware, a group of pottery currently associated with the production workshops of ancient Naples (Bonis De *et al.* 2016, 437 and 457 with references).

The presented results of spectrometric analyses may be useful as basic data. At this stage of research, there is no coherent database that has collected the results of the chemical analyses of black-glazed ceramics in Polish collections and this study should be treated as the first step in this direction. Only after obtaining research results of other black-glazed vessels it will be possible to carry out statistical analyses that may show differences in the composition of chemical artefacts originating from different production centres.

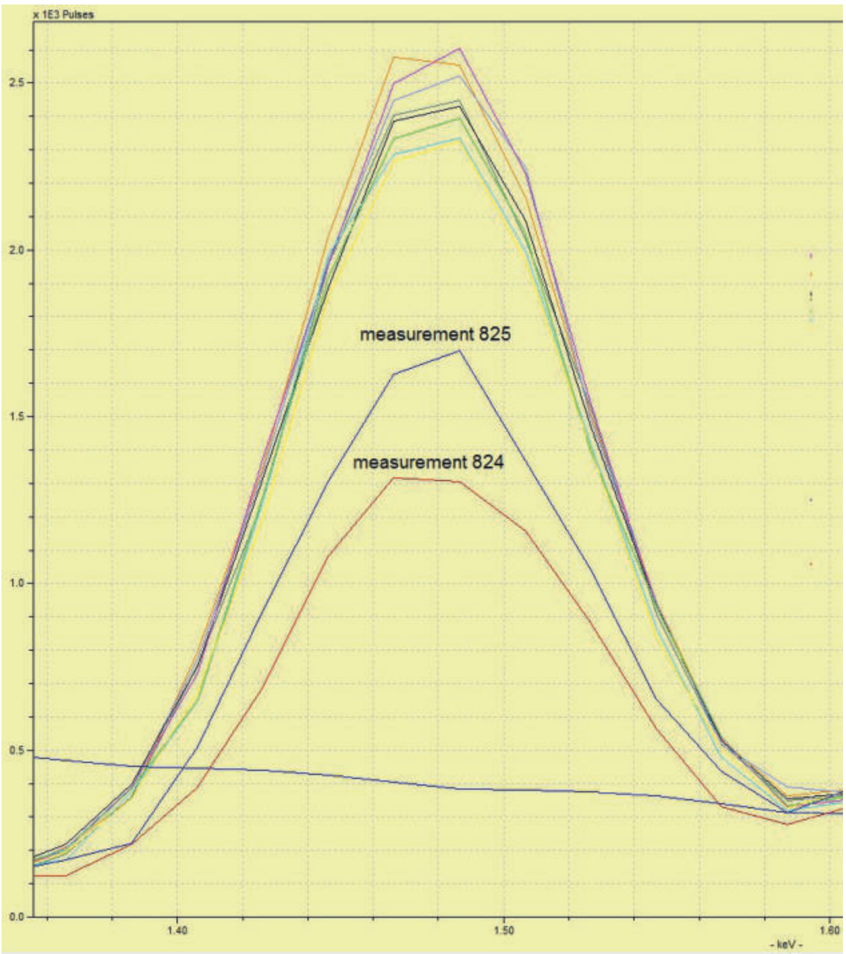

Fig. 4. Comparison between X-ray fluorescence spectra of aluminium by unglazed areas (measurement 824 and 825) and black-glazed surface (remaining spectra).

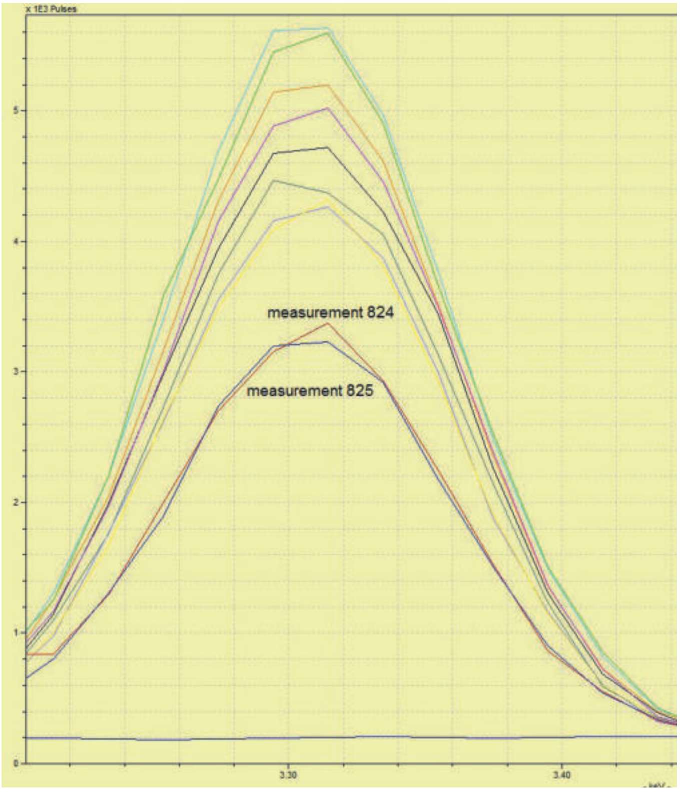

Fig. 5. Comparison between X-ray fluorescence spectra of potassium by unglazed areas (measurement 824 and 825) and black-glazed surface (remaining spectra).

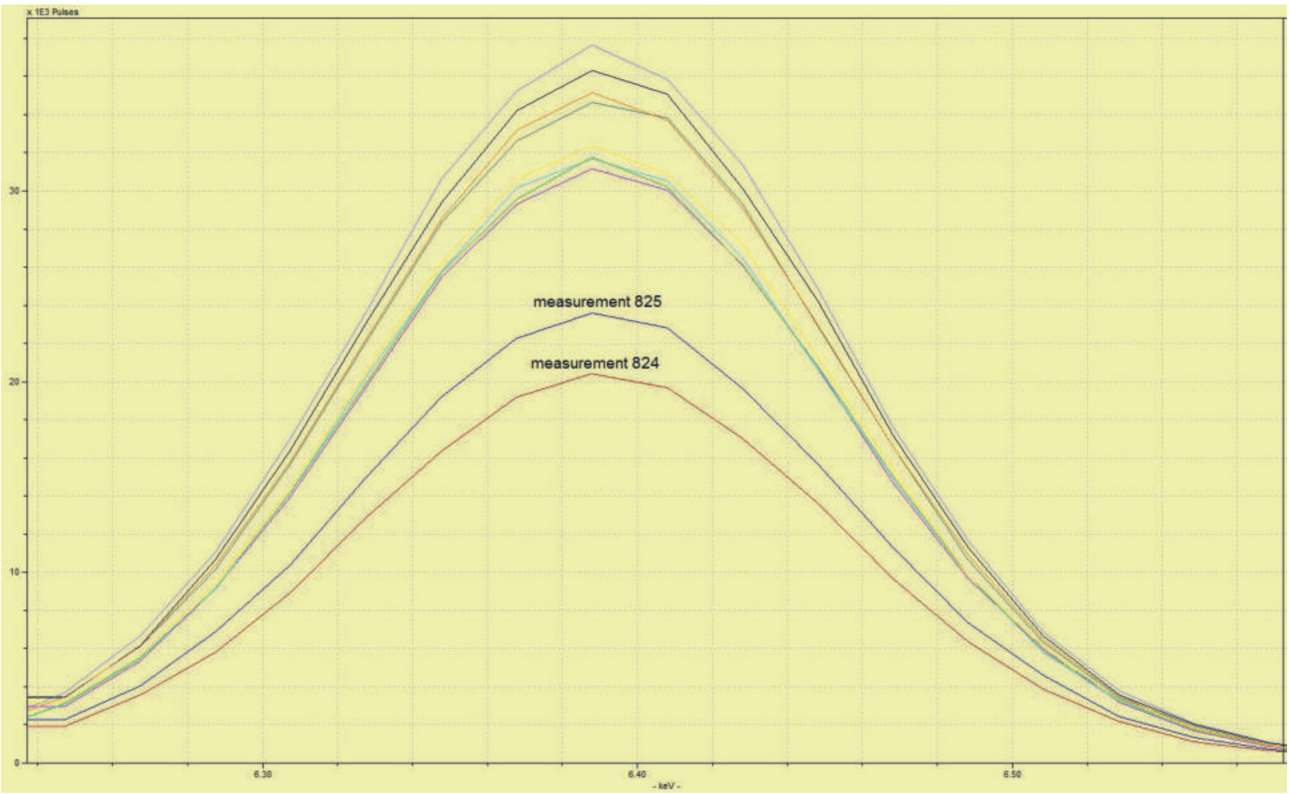

Fig. 6. Comparison between X-ray fluorescence spectra of calcium by unglazed areas (measurement 824 and 825) and black-glazed surface (remaining spectra).

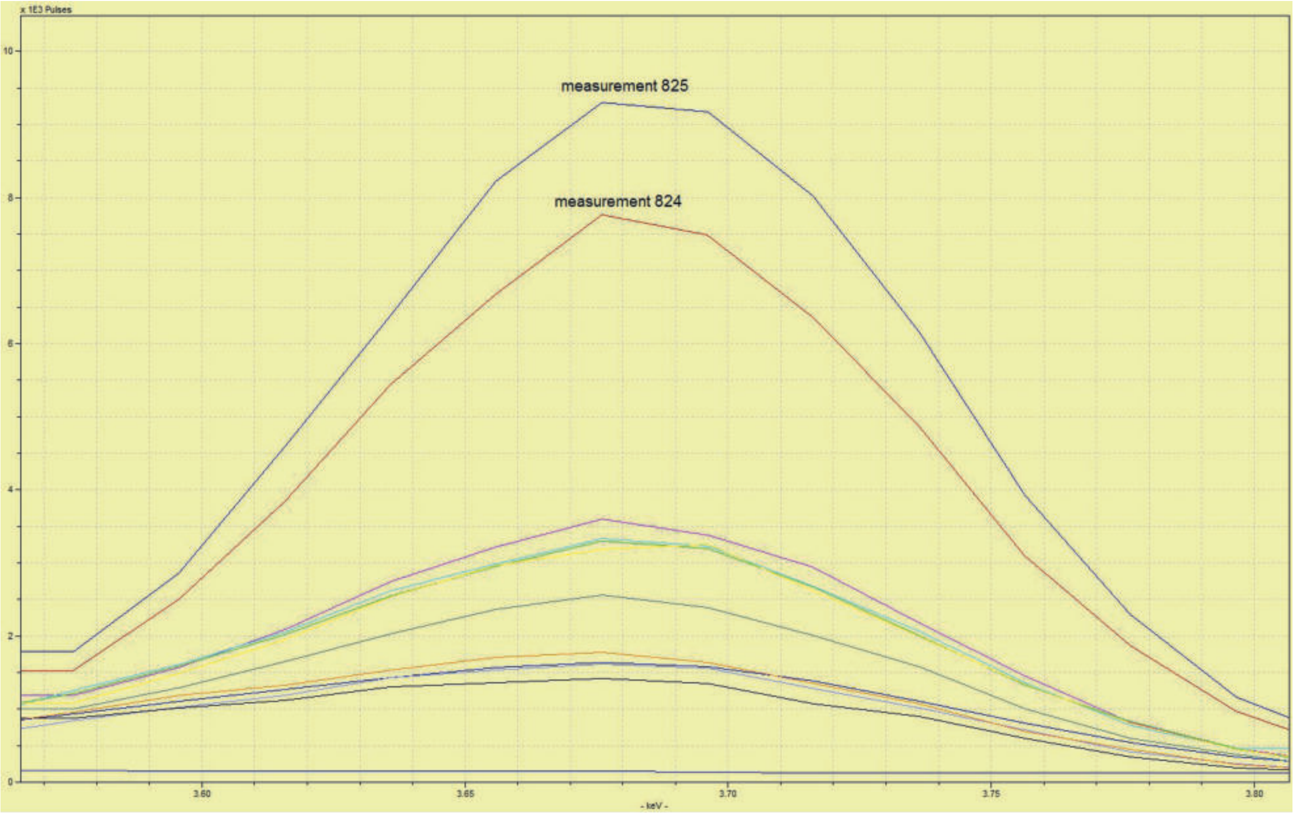

Fig. 7. Comparison between X-ray fluorescence spectra of iron by unglazed areas (measurement 824 and 825) and black-glazed surface (remaining spectra).

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Examining a scallop shell-shaped plate from the Late Roman Period discovered in Osie (site no.: Osie 28, AZP 27-41/26), northern Poland

Abstract

Sosnowski M., Noryśkiewicz A.M., Czerniec J. 2019. Examining a scallop shell-shaped plate from the Late Roman Period discovered in Osie (site no.: Osie 28, AZP 27-41/26), northern Poland. *Analecta Archaeologica Ressoviensia* 14, 91–98

Research conducted using Airborne Laser Scanning methods in northern Poland allowed traces of a settlement from almost 2,000 years ago to be registered. The most valuable item found is a copper-alloy scallop shell-shaped plate which is still an unknown object in the cultural realities of the Roman Period in northern Poland. The results of pollen analysis of the material obtained during the cleaning of the found scallop shell-shaped plate indicate the dominance of herbaceous plants over the representation of trees in the vicinity of the archaeological site discussed. The advantage of synanthropic plants among herbaceous plants informs us about the open habitat communities formed as a result of human activity (fields, meadows, roads or ruderal areas).

Key words: Scallop shell-shaped plate, Roman Empire, Late Roman Period, Late Iron Age, pollen analysis

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Introduction

In recent years in Polish archaeology there has been significant progress in the application of measurement methods based on the Airborne Laser Scanning (ALS) method (Pawleta, Zapłata 2015, 9–29). They allow the separation of micro-structures that have survived from former human settlements and arable fields. Research using this method is particularly useful for areas that are currently covered with forest, which on the one hand is a natural preservative of such objects, and on the other hand hinders traditional surface prospecting. Research conducted using ALS methods in the Tuchola Forest, in one of the largest forest complexes in northern Poland, allowed traces of a settlement in such a wooded area from almost 2,000 years ago to be registered (Fig. 1).

In the course of archaeological surface and survey excavations conducted in 2017–2018, numerous artefacts chronologically associated with the Late Roman Period were discovered in the aforementioned area. One of the most valuable items retrieved is a copper-alloy scallop shell-shaped plate (Fig. 2 and Fig. 3). It is a significant find that introduces a new category of objects into the cultural space of the Late Roman Period for northern Poland, one which points to its connections with the Roman Empire. In order to obtain the natural background of the presented relic, pollen analysis was made for the material obtained from the surface of the plate during its conservation process.

The archaeological site is located in the eastern part of the Tuchola Forest complex, about 5 km north of the village of Osie, site no.: Osie 28 AZP 27-41/26 (geographical coordinates of the centre of the site: N 53°38'52"; E 18°22'07"). Nowadays, it is an area

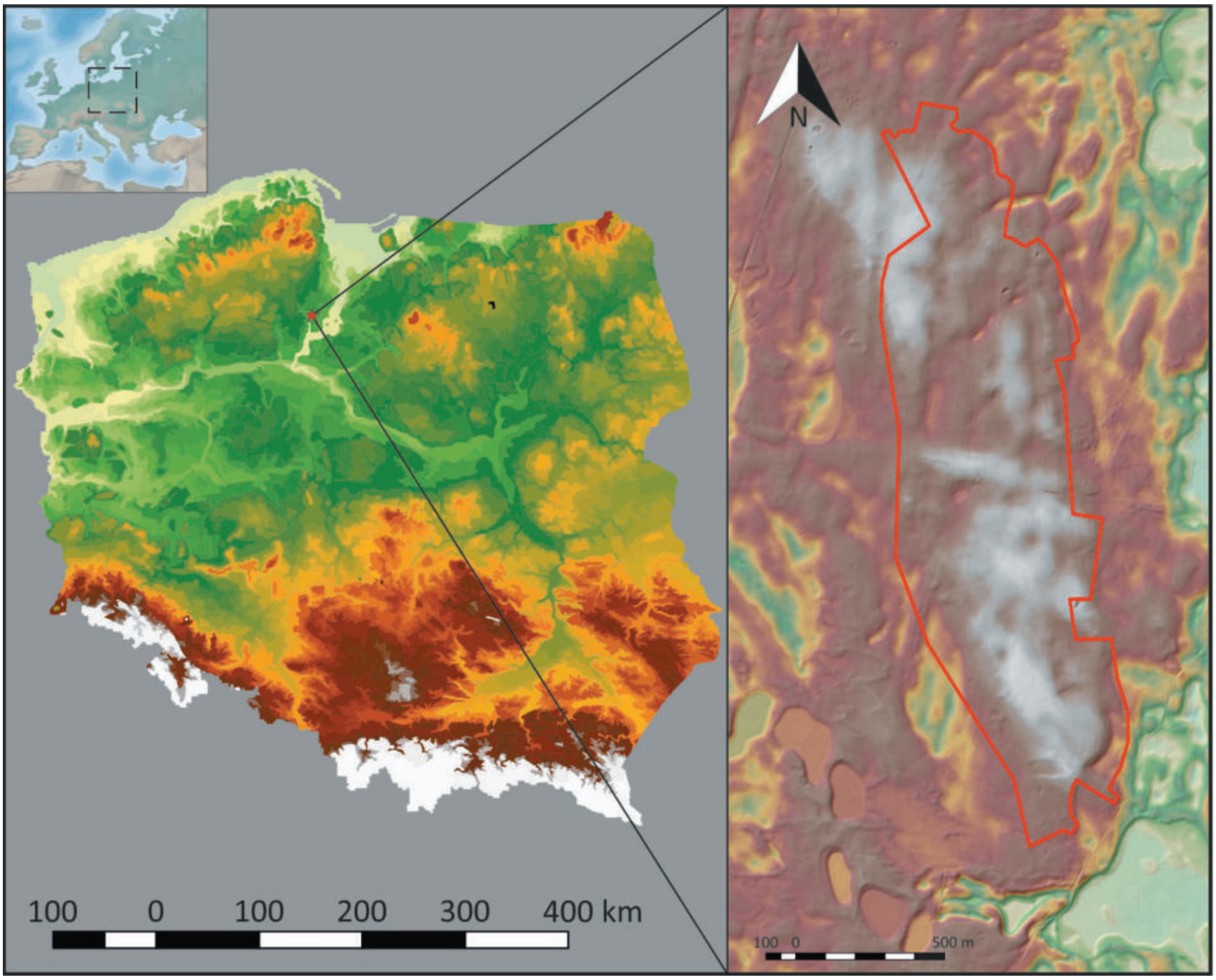

Fig. 1. Location of the site (map by M. Sosnowski & J. Czerniec).

Fig. 2. Photography of the scallop shell-shaped plate (photograph by W. Ochotny).

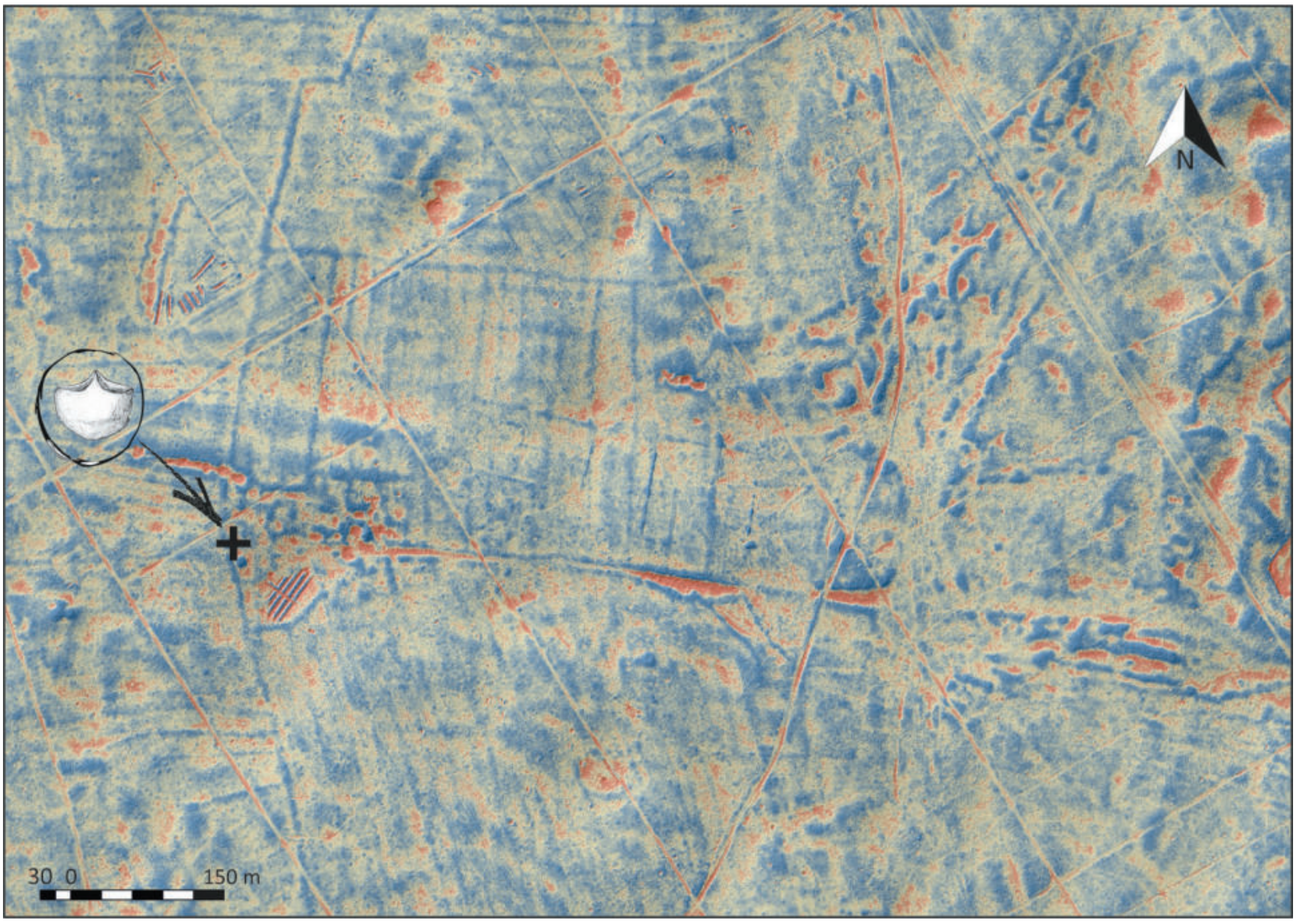

Fig. 3. Local Relief Model view of the discovered site with the place where the plate was found marked (map by J. Czerniec).

covered with pine and mixed forest, and in the northern part with oak-hornbeam forest with a service tree (*Sorbus torminalis*) present. Thanks to the application of the spatial analyses, an area of 170 hectares was delineated on which objects of anthropogenic origin were registered. Digital Terrain Model (DTM) analysis permitted us to observe objects, the structure of which could indicate the area in which the agricultural economy was likely to have been conducted (arable fields), as well as indicating the location of the probable human settlement (living space). In addition, the preserved communication system related to the functioning of this housing estate (road relics) has been shown. With the use of high resolution models, observations were made at 1:300 scale, which allowed the assessment of the state of preservation of field relics (Fig. 4). The boundaries of blocks of fields are visible in the depictions, including the division into nivas. The size of individual blocks varies from 12 to 20 ares. The width of the balk separating the blocks is 5-10 m. Such a spatial arrangement did not seem to be representative of the late medieval or modern human settlements that dominate in the immediate vicinity of the studied area. The observed arrangement of fields rather seemed to match the spatial arrangements of fields registered in northern Europe in the area of the Jutland, the British Isles and the Netherlands and interpreted as so-called "Celtic Fields", dated from the Early Bronze Age (c. 1800 BC) until the early medieval period – a term coined by O.G.S. Crawford (Crawford 1923, 350).

Material and methods

The function and chronology of a similar type of plate found in the area of the Roman Empire was very specific. Such objects in that cultural space occurred in a narrow time range, from mid 3rd century AD to the mid 4th century AD (Gschwind 1998, 115), and they functioned as a decorative part of a horse harness (Horvat, Trkaman 2016, 103). It gives the opportunity to pre-position the site from Tuchola Forest in a specific period before the absolute dating of the site is done. Based on the chronology of the item found, we can state that the settlement could have functioned from the middle of the 3rd century AD. Using the chronological clues regard-

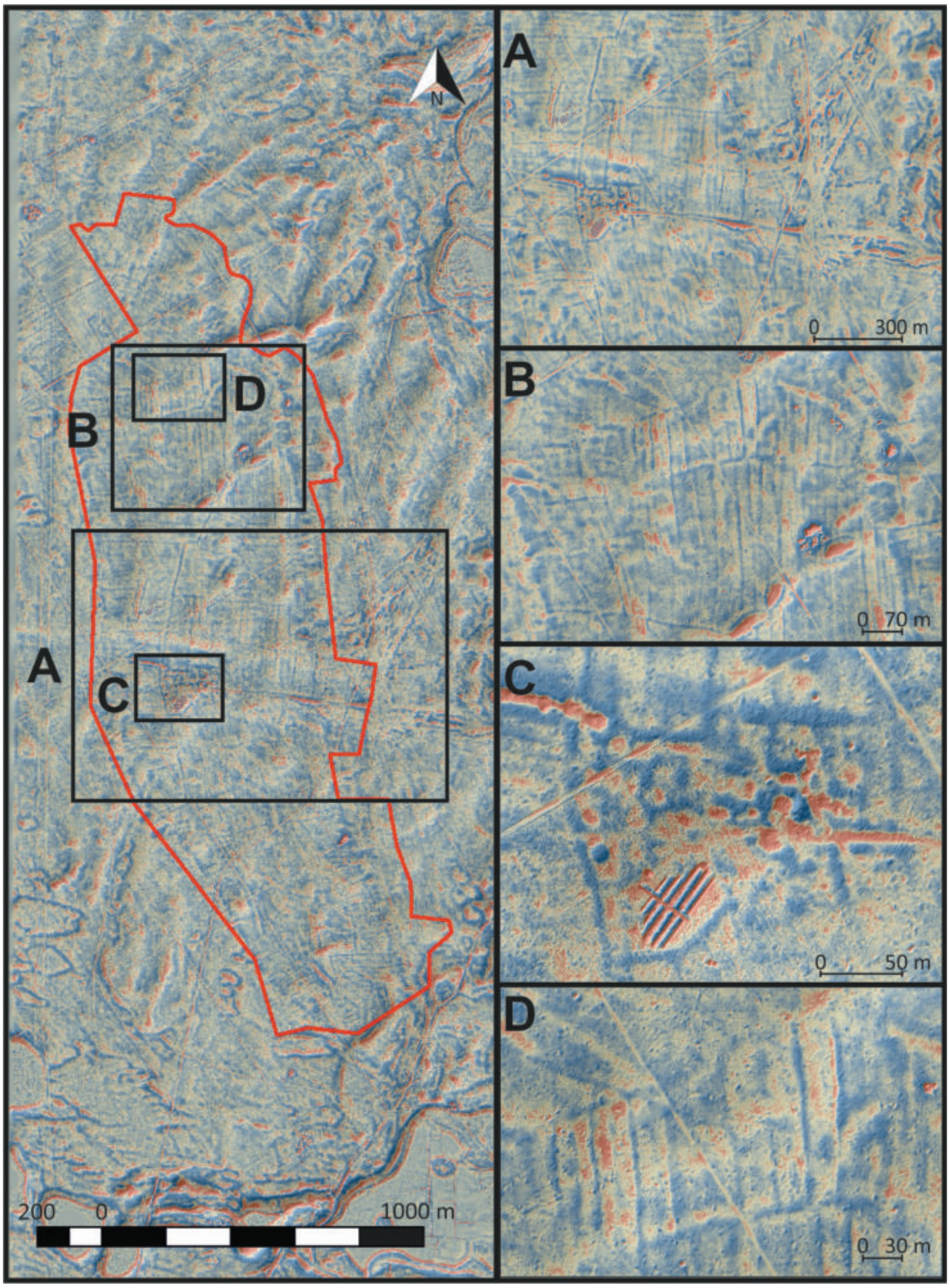

Fig. 4. Local Relief model of the site: A - spatial layout of the settlement; B – spatial layout of the field system; C – close look on the settlement (living space); D – close look on the single block of the field (map by J. Czerniec & M. Sosnowski).

ing the interval in which such artefacts occurred and using a historical source, we can link the chronology of this object to specific historical events and indicate one of the probable ways in which this item was imported into the area in which it was found. The Roman historian Zosimus gives information in his work "New History" about the conflict between Emperor Probus and the barbarian tribes that took place in the second half of the third century (Zosimus I:68). Zosimus mentions the Burgundian and Vandal tribes who allegedly went on a war expedition against the Empire. On the basis of archaeological knowledge and written sources from the Roman Empire, those Germanic tribes can be associated with the area of central Poland (Kokowski 2004, 25-86), which neighbours the cultural space where the site from Tuchola Forest was located.

The conducted pollen analysis concerned the examination of material originating from the cleaning of the plate's surface during preservation. Due to the nature of sediment fossilization, the most important task was to check if micro-plant remains were preserved on it. They could indicate the function of the object or the nature of the cultural landscape during its deposit. For the whole material obtained, a preparation typical for pollen analysis was used (Berglund, Ralska-Jasiewiczowa 1986, 455–484). At the stage of treating the material with 10% HCl, the sample turned blue, which clearly evidenced the presence of copper oxide and provided valuable information about the material the plate was made of. Pollen and spore identification followed Beug (2004), and The Northwest European Pollen Flora I–VIII (Punt *et al.*, 1976–2003).

Results

In the context of analogous objects from the areas of the Roman Empire, the plate found in the Tuchola Forest, in terms of shape and measurements, perfectly matches objects of this type found in Western Europe and the Balkans (Gschwind 1998, 116; Horvat, Trkaman 2016, 102). It should be noted that from the areas of the Roman Empire we know plates of this type appeared in two sizes, those smaller, size 19×19 mm and larger, with dimensions exactly like the item from northern Poland (45×50 mm) presented in the article.

Palynological analysis at archaeological sites encounters certain limitations. Most often, we have available materials of anthropogenic origin or formed in the conditions of direct settlement, instead of natural organic sedimentation. Pollen preserved on the tag was in a relatively good condition and attendance. 431 grains of the sum of AP (*arboreal pollen*) + NAP (*non arboreal pollen*) on two slides were counted. At the stage of treating the material with 10% HCl, the sample turned blue, which clearly evidenced the presence of copper oxide and provided valuable information about the material the plate was made of. Only a small percentage of pollen was included in the indeterminate group due to the blurring of diagnostic features (Fig. 5).

The results of the pollen analysis were presented in a cyclogram containing the percentage of pollen (Fig. 6). Herbaceous plants (*NAP*) dominate in the sample (69.4%). The share of trees and shrubs (*AP*) is small and reaches 30.6%. Pine (*Pinus* 15.5%) predominates, but there are also: birch (*Betula* 2.3%), alder (*Alnus* 1.2%), hornbeam (*Carpinus* 0.7%), oak (*Qurecus* 0.5%), elm (*Ulmus* 0.2%), spruce (*Picea* 0.2%) and hazel (*Corylus* 0.5%).

Discussion

This kind of artefact is well known and widely developed in the scientific discourse on the territory of the Roman Empire, but it is still an unknown object in the cultural realities of the Roman Period in the area of present-day northern Poland, where probably one of the ways of its import into this area can be presented in the text hypothesis that objects of this type could have come here as war loot.

Pollen analysis shows a very good preservation of pollen. The low share of trees (less than 30%) indicates the open space of the landscape. The presence of the alder should be associated with the occurrence of wetland or marshy communities. The general palynological record reveals the presence of a cultural landscape characterized by the appearance of synanthropic plants which find conditions favourable for development present in the area influenced by human groups. The indicator for arable fields is cereals (Cerealia type, Fig. 5D and rye *Secale cereale*, Fig. 5E) and for meadows and pastures are, for example, ribwort plantain (*Plantago lanceolata*, Fig. 5A), grass (Poaceae 30.4%, Fig. 5C) and plants from the astroids subfamily (Asteroideae) The numerous occurrence of mugworts (*Artemisia*, Fig. 5B) and grass (Poaceae) pollen is evidence of the presence of ruderal habitats characteristic of communication routes or human residences.

Until now, as a result of the author's own experience of analysing material obtained from cleaning bronze tools (Noryśkiewicz 2016), a blue colour was not obtained during maceration. The colour change proves the presence of copper oxide which raises a question of what material was used to produce the item. Was it bronze of better quality with a higher copper content or perhaps even pure copper? The chemical analysis may help to determine this fact but it might also be the reason for the good preservation of pollen.

Conclusions

By juxtaposing knowledge from archaeological research, both from the area of the Roman Empire (findings of shell-shaped plates) and those from contemporary Poland (Fig. 7) (linking archaeological cultures with Germanic tribes and the described plate), with information from historical sources (information about the location of Germanic tribes and the record of the war expedition from the 3rd century) we can hypothesize that one of the possible reasons for the appearance

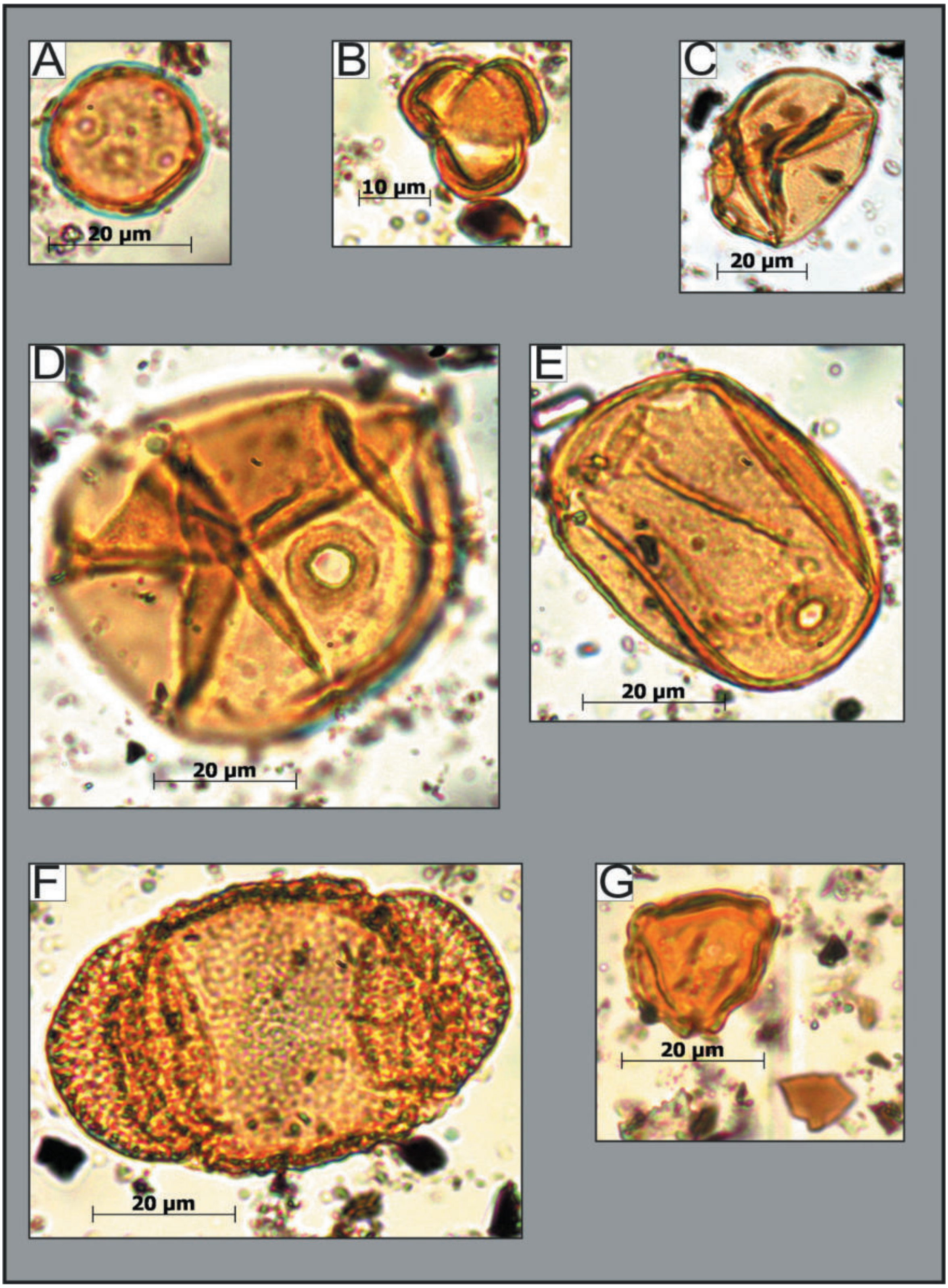

Fig. 5. Pollen grains of selected taxa: A – *Plantago lanceolata*, **B –** *Artemisia*, C – Poaceae, D – Cerealia type, E – *Secale cereale*, **F –** *Pinus sylvestris*, G – *Betula* (photograph by A. M. Noryśkiewicz).

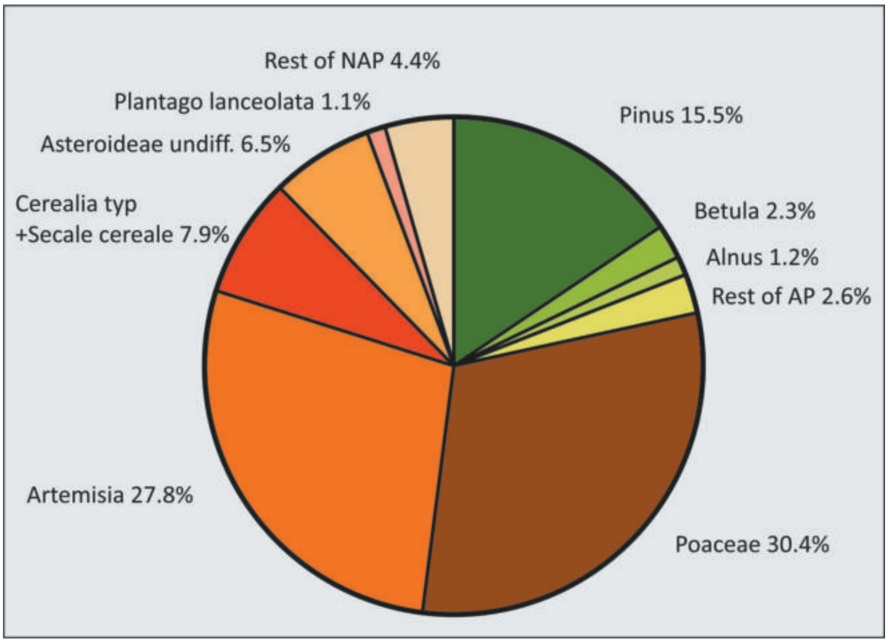

Fig. 6. Pollen percentage cyclogram (made by A. M. Noryśkiewicz).

of this object in the cultural space of Tuchola Forest in the late Roman period was as war loot.

The palynological record of the test sample undoubtedly reveals the presence of the cultural landscape during the deposit of the object. It should be noted, however, that in the mineral material part of the pollen became corrosive due to the conditions of fossilization and was therefore indeterminable and not included in the calculation sum AP+NAP. Thus, the percentages are not completely accurate but this does not change the interpretation. The presence of fields, meadows, pastures and ruderal areas is certain, even if the estimation of their size requires further research.

As we know from the similar findings in the area of the Roman Empire, this scallop shell-shaped plate might have functioned as a decorative part of a horse harness (Fig. 8). Finding this item in Tuchola Forest is a valuable discovery not only on a local scale. It is an important component of the interregional contacts of communities living in areas far from the borders of the Roman Empire. This is another element showing us the dynamics of processes (contacts between regions), which took place at the beginning of our era in this part of Europe, which only seemingly seems to be a peripheral area in relation to areas lying over the borders of the Roman Empire or the Empire itself.

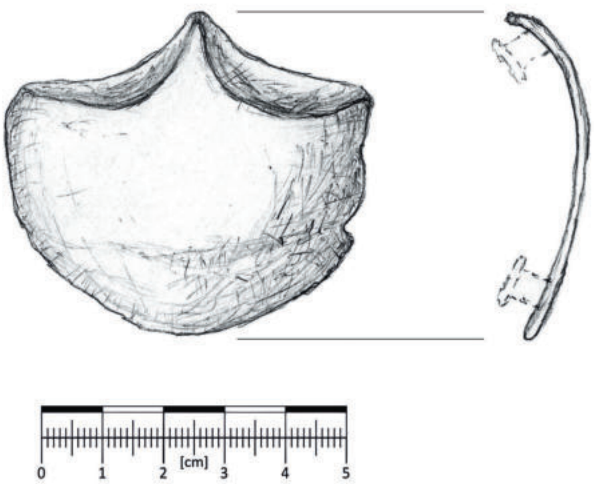

Fig. 7. Drawing of the scallop shell-shaped plate found in the Tuchola Forest (drawing by W. Sosnowski).

Fig. 8. Placement reconstruction of the plate on the horse harness (drawing by O. Rutkiewicz).

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A Medieval Ships Crew and their Weapon: from Archaeological Material to Interpretations

Abstract

Valentyrova K. 2019. A Medieval Ships Crew and their Weapon: from Archaeological Material to Interpretations. *Analecta Archaeologica Ressoviensia* 14, 99–107

Comprehensive research of artefacts has become the norm for modern archaeology. Archaeologist must pay attention to all aspects of the investigating problem and analyze material by means of methods from different branches of science. The Center for Underwater Archaeology of Taras Shevchenko National University of Kyiv have been researching finds from a medieval Italian shipwreck since 1999, with a very interesting group of artefacts consisting of baselard type daggers. At the stage of interpretation, we decided to use methods which are characteristic of historical science, with a reconstruction of medieval people's` perceptions of baselards forming the basis for it. The combination of data about the material object itself and its image (the concept of it) turned out to be useful for ensuring a clear interpretation of archaeological finds and even for the verification of some social reconstructions.

Keyword: baselard, medieval trade galley, personal belongings, perception, comprehensive research

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Introduction

The study of archaeological material helps researchers to reconstruct the past.

When an archaeologist researches an excavated material culture, by and large he/she reconstructs its creators` life. At the same time, it is very important to understand the worldview of these people to ensure the correct interpretation of material traces of their activity. Ideas, motivations, and imagination were and are the basis of the human material world. There are a lot of different methods and approaches for analyzing archaeological material today. Comprehensive and interdisciplinary research of finds and its context (Hodder and Huston, 2003, 156–173) has become a necessary norm for modern archaeology. Gradually, the artefact is becoming something that unites the methodologies of different branches of science. It also makes it possible to extract a lot more information than we had been possible before (Viduka 2015, 8–15). Thus an archaeologist must pay attention to all possible aspects of the problem he is investigating and involve a wide range of specialists to help solve it.

This article is an attempt to use the phenomenon of perception for the interpretation of archaeological material and for further social reconstruction. In psychology, perception is the organization, identification, and interpretation of sensory information in order to represent and understand the presented information, or the environment. It is not only the reception of elements of the surrounding reality, but also some analysis of it. When a person is aware of something, they use the knowledge and experience he/she possesses to make a representation of it in their minds. In this context we are talking about perception as the basis of the idea or image of things which are found in historical sources. Generally, this kind of research include the analysis of an artefact and its image (how their creators and users perceived it). Studying by means of perception help us to understand what the artefact meant for the people who interacted with it. Therefore, the *main goal* of the article is to combine the analysis of archaeological material, its perceptional image and use it for the interpretation and verification of some social reconstruction.

The site

In our research we used archaeological materials from a medieval shipwreck. The site is located in Sudak Bay near the modern settlement of Novy Svet (Ukraine, Crimean peninsula) (Fig. 1). Researchers think that it was a Pisan trade galley. Written sources have provided the opportunity to say that it sank on 14 August, 1277 as a result of faight with a Genoese ship (Zelenko 2008, 143). The site had been investigated by the Center for Underwater Archaeology of Taras Shevchenko National University of Kyiv (CUA) headed by Dr. Sergiy Zelenko since 1999 (Morozova 2008, 330). The site is not easy for investigation since the ship has not been preserved and archaeologists have only found some small, separate parts of it. As a result, archaeologists have estimated the location of the ship's sinking based on the archaeological material available. The depth of the excavation area is 11–14 m and not only archaeologists but professional divers took part in the expeditions.

In the Middle Ages (from the 12th to the 15th century) the Northern Black Sea was a region of interest to Italian maritime traders. There were some trade colonies and settlements controlled by the Italians, and the modern settlement Novy Svet is situated near to one of them – the medieval fortress of Soldaia (now – Sudak). The Northern Black Sea region has object of interest to southern traders from Antiquity. At the end of the 12th century, the Italians began to settle in this area since an unstable political situation forced Italian traders to find new maritime routs and markets. The thorough and systematic invasion of the area began in the second part of the 13th century after restoration of the Byzantine Empire. Generally, it was Venice and Genoa who competed in the region, with the Byzantine emperor Michael the Palaeologist awarding rights to free sailing

Fig. 1. Location of the Novy Svet shipwreck (Ukraine, Crimea peninsula); https://www.google.com.br/maps.

in the Black Sea to Genoa in 1261 and late, in 1265, to Venice. Occasionally, armed conflicts between the Italians broke out, with a good example being the war of 1294–1299. At the beginning of the 15th century, the Ottomans begun to crowd out the Italians and gradually the Italian economic interest in the region fell (Karpov 1990). Thus the historical context and written sources explain the shipwreck's location. The site is very informative and unique for Ukrainian territory.

Material

The excavations in Novy Svet provided a lot of material, with different types of ceramic, metal, glass and even wooden things. These have Mediterranean, Middle Eastern and European origins and provides the basis for many directions of scientific research. Ceramics are the largest group of material. Whilst some things were used by the crew, most of the pottery on the ship was cargo. The decoration, graffiti and dipinti on it can be used not only for historical and archaeological purposes, but also for art analysis. Glass (fragments of glassware) and wooden (spoon, combs, etc) findings are not as numerous, but are unique and very interesting. The assortment of metal things is diverse. The group is presented by vessels, coins, buckles, decor elements, lead cases, buttons, rings, sinkers, undefined items.

One of the main groups of metal artefacts are weapons and are represented by diggers, knives (which could be multifunctional), fragments of scabbards and one sword pommel (Valentyrova 2014, 65–72). In our research we have focused on daggers, of which there are six (Fig. 2). All of them are broken, with three having all pieces, two fragments of daggers in scabbards and one instance represented by three separate fragments. The daggers are all massive, with the length of the complete ones being 53, 56 and 60 cm respectively. The cross-guards are straight and grips are I-shaped. The blade cross-sections are double-fuller or lenticular.

The environment of the Black Sea is very aggressive to black metals and thus the daggers are badly preserved (Conservation of underwater archaeological finds 2011, 47–48). In fact, they are now oxidized artefacts, with the blades` shapes being fixed by organic layers. The thickness of these may sometimes reach up to 3 cm. The daggers need extensive research by chemical and physical methods and it may be interesting to analyze both the metal and organic layers. X-ray analysis of the daggers provided a lot of important information, above all it allowed us to see the specific morphology of the daggers. Also, X-ray analysis showed spots on the handles of two daggers and a unique ball-shaped ending of one scabbard (Fig. 3).

The daggers have specific morphology that allowed us to identify them as baselards ("baselard" from Basel, the German medieval town which was a famous center for the production of these weapons (Peterson 2001, 18). It is type of a medieval long dagger or short sword widely used in Western Europe from the 13th to the beginning of the 16th century. There were a lot of different variations of this type (Boccia, 1996, 37–38) and some experts think that it is incorrect to attributed ones that were used in the 15th–16th centuries to the baselard type. Generally, this type of weapon had some distinctive features. The baselards handle was the narrowing of a metal blade with holes for rivets. It had organic or, less often, metal brackets. The cross-bar was a monolithic construction with a grip that could be straight or curved. The blade was triangular-shaped with two or three fullers stretched to ½ or 2/3 of it. In the Middle Ages, baselards were made of different qualities of iron (still) or bronze. They also varied in size, with the smallest specimens reaching 30 cm and the biggest 100 cm. Baselards rarely had some incrustation or decoration. It was normal to wear a baselard on a belt but scabbards were sometimes used. There are a lot of baselards in European museums. The earliest one was found in the Thames (London) and dated to the first part of the 13th century (Laking 1920, 9–11).

The baselards from Novy Svet were dated by the second part of the 13th century (based on the archaeological context). Baselards were very popular in Italy in this period (Kiseleva 2002, 47).

Perception of baselards: textual and visual sources

We cannot analyse how medieval people perceived the baselard as a phenomenon by using only archaeological sources (Aleksic 2007, 13). For a reconstruction of the image of a baselard we forced to use textual and visual sources dating from the 13th to the 15th century. As a result, this reconstruction will have general character.

There are numerous mentions of baselards in medieval texts. Textual sources typically formed two groups:

– poems and narratives
– legal documents

There are overviews of them in "Costume in England: a history of dress to the end of eighteenth century" by Frederic William Fairholt (Fairholt 1896, 30–31) and in the "A record of European armour and arms through seven centuries" by Guy Francis Laking (Laking 1920, 9–11). "Costume in English" is glossary by its

Fig. 2. Baselards from Novy Svet (Ukraine, Crimea peninsula); photo by Kateryna Valentyrova.

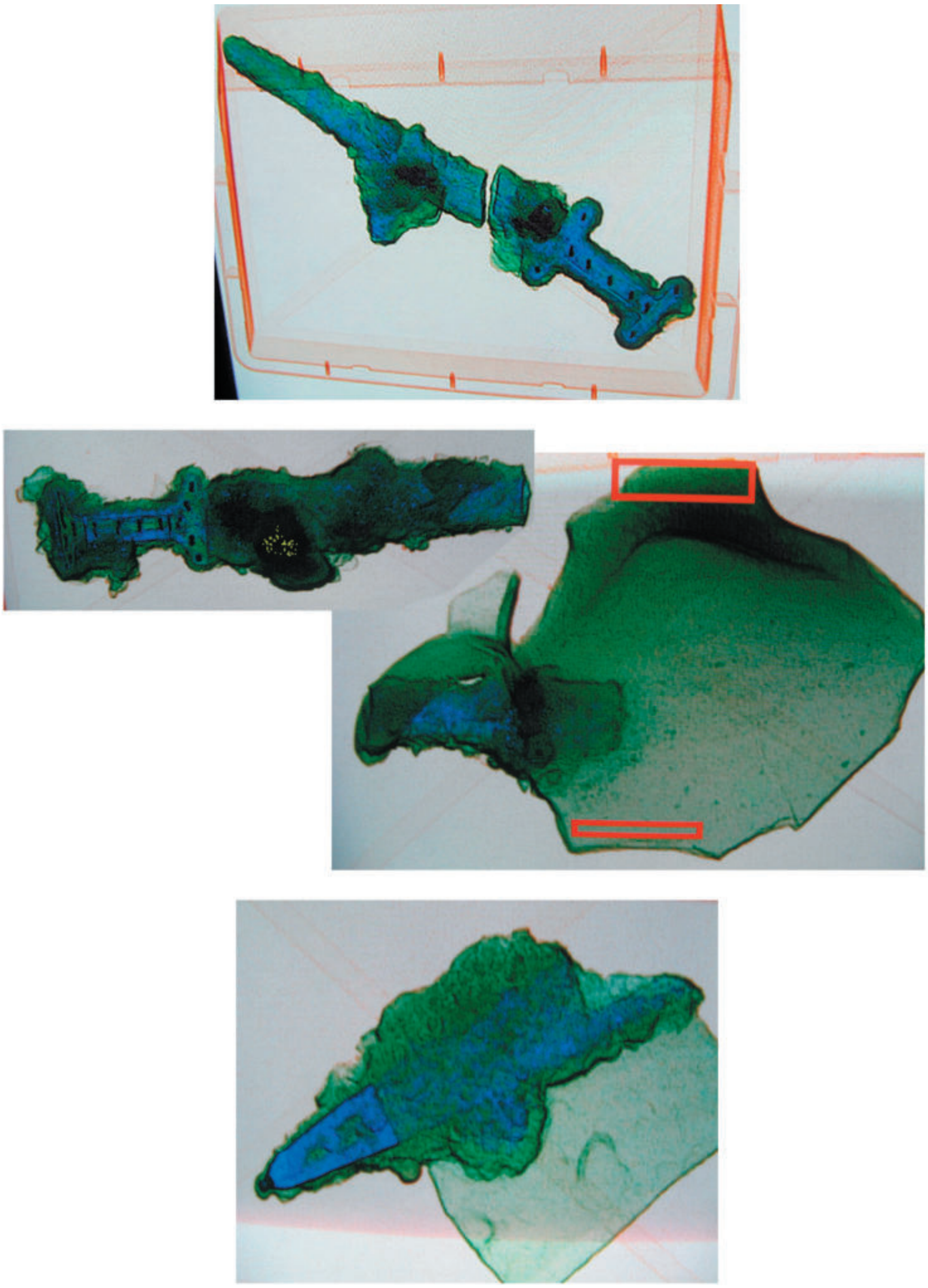

Fig. 3. X-ray photo of baselards from Novy Svet (Ukraine, Crimea peninsula); photo by Serhiy Zelenko.

content whilst Laking's work is more of an encyclopedia of weapons. The style of these books is characteristic for the end of the 19th and beginning of the 20th century. A lot of material and sources were analyzed and the authors used textual sources not only for the correct description of baselards but tried to show it in the historical context. For example, Fairholt writes about a passage from the "Vision of Piers the Plowman", in which priests were condemned by the author because they had baselards and other inappropriate things.

But if many preest beere, for hir baselardes and hir broches,
A peire of bedes in hir hand and a book under hir arme.
Sire Johan and Sire Geffrey hath a girdel of silver,
A baselard or a ballok-knyf with botons overgilte.

(Lengland 1978, *15.118–15.127*)

Fairfolt noted that baselards "were strictly forbidden to be worn by priests". He reinforces it with other links (Fairholt 1896, 31). But Fairfolt did not analyse all of the mentions from the poem. English poet William Langland wrote the allegorical poem “Vision of Piers the Plowman” in the second part of 14th century (Ruud, 2006, 388). Generally, he used term “baselard” three times in two episodes and Fairholt wrote about the second of these. In the first, a baselard is mentioned in the list of weapons which people had to reforge into “peacefull” tools in an imaginary future:

Alle that beren baselard, brood swerd or launce,
Ax outher hachet or any wepene ellis,
Shal be demed to the deeth but if he do it smythye
into sikel or to sithe, to shaar or to kultour

(Lengland 1978, *3.305-30*)

It is very important that there is a world “baselard” in the text. Author used not generalizing, but a specific term. He highlighted it by this way. Definitely, this is a significant fact.

A medieval satirical song dated from the beginning of the 15th century is a known source in which the term “baselard” is mentioned. The text is as follows:

Listen, lordings, I you besek:
There is no man worth a leke,
Be he sturdy, be he meke
But he bere a baselard.
My baselard hath a sheath of read,
And a clean locket of lead;
Me thinketh I my bere up my head,
For I bear my baselard.

Fairholt and Laking used this song to show that people from different social groups wore baselards. This song is very interesting because it touches on the problem of inequality and its vision in the first decade of the 15th century. A baselard appears here as a symbol of the power that exists without nobility and dignity. Baselards were also used by knights (together with a long sword). In the second part of the 13th century, it was used by Italian infantrymen but it was primarily popular with non-aristocratic men and those not connected with the army. Obviously, this circumstance became decisive in composing the image of the baselard.

The second group of textual sources is represented by legal documents. There are a lot of medieval legal documents about the use of a baselard in the committing of crimes, in particular in attacks on people for the purpose of robbery being frequent. Laking said that they were banned in some European countries in different periods of the 14th century as a result (Laking 1920, 10).

Visual sources point to the fact that the baselard was popular and used by people from all estates. Guy

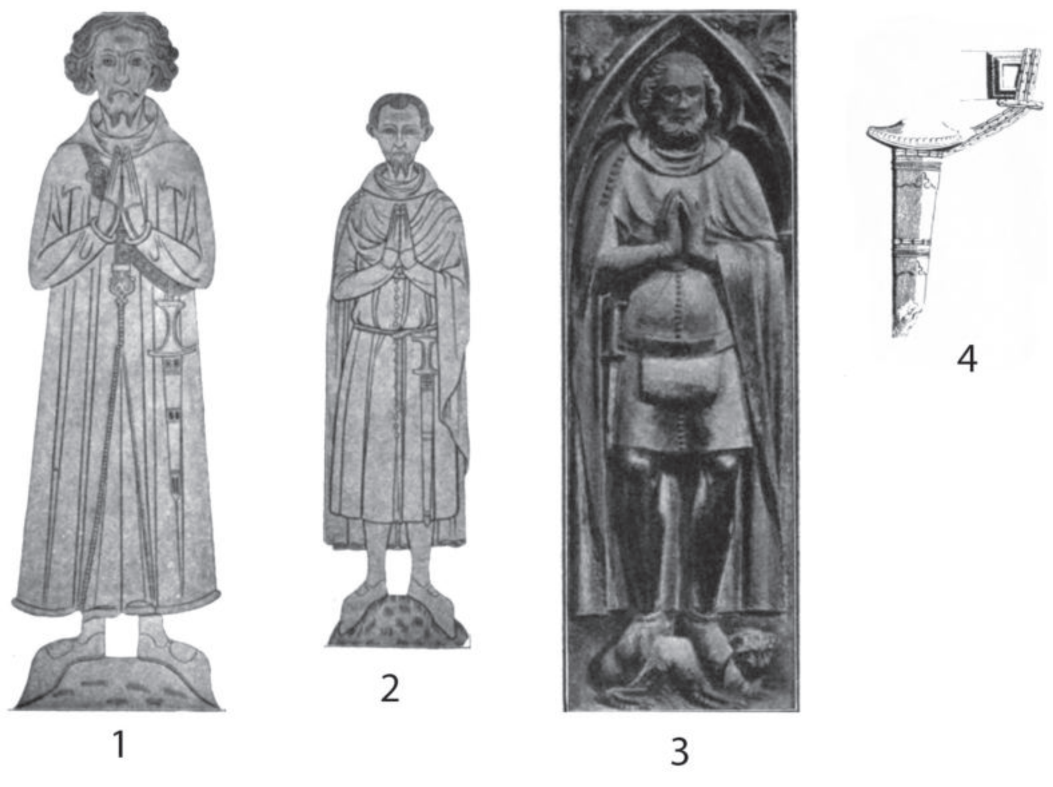

Fig. 4. From “A Record of European Armour and Arms through seven centuries” by Guy Francis Laking: 1. From the brass of John Corp. Stoke Fleming Church, Devonshire, 1391 (vol. 3, p. 10); 2. From a brass of a franklin. Shottesbrook Church, Berkshire, 1370 (vol. 3, p. 9); 3. Effigy of Johann von Holzausen, Frankfurt-am-Main (tombstone of the patrician Johann von Holzhausen (+1393) and his wife Gudela (+1371) (vol. 3, p. 10); 4. From the effigy of Sir Hugh Caveley. Bunbury Church, Cheshire, About 1390 (vol. 3, p. 9).

Fig. 5. Heidelberg University Library, "Codex Manesse", miniature "Herr Heinrich Hetzbold von Weißensee" p. 451 – CC-BY-SA 3.0.

Fig. 6. Heidelberg University Library, "Codex Manesse", miniature "König Wenzel von Böhmen", p. 15 – CC-BY-SA 3.0.

Francis Laking supplies an example of three pictures from the end of the 14th century (Fig. 4). Two of them are pictures of franklins with baselards while on the third picture there is a knight`s baselard (the author takes it from the effigy of Sir Hugh Caveley). It is necessary to pay attention to the fact that the freeholders` property status is not the same. This is indicated by their clothing and hairstyle. In particular, one of them wore baselard on the belt. More wealthy men have a baldric passing around the neck. The author also highlights the effigy of the patrician Johann von Holzausen (a tombstone of the patrician Johann von Holzhausen (+1393) and his wife Gudela (+1371), Frankfurt-am-Main). There are pictures of the baselard in "Codex Mannese". "Codex Mannese" or Große Heidelberger Liederhandschrift is the medieval illuminated manuscript, which is a corpus of minisinger`s poetry (was written in 1305–1340). The pictures are typical episodes from medieval life and we can see both servants and noblemen (Fig. 5, 6) with baselards. One more example is represented by the picture from the manuscript "The Regia Carmina". The Regia Carmina is a poem of praise for Robert of Anjou, King of Naples (1278–1343) from the town of Prato in Tuscany. It was written in 1335–1340. Contained in it is a picture of an infantryman with a short baselard and a long sword (Fig. 7).

– Some conclusions can be drawn based on the information provided:
– Medieval people distinguished the baselard from among different types of daggers and bladed weapons. This term is found in sources in the 14th century.
– The baselard was not an aristocratic type of bladed weapon. Everyone who was a free man had the right to wear one.
– It was an available and effective weapon.
– The baselard was quite popular and this has been confirmed by the material sources. The finds are very different in terms of quality and cost and this was in line with the owner's financial capabilities and desires.

In our opinion, the medieval perception of the baselard had a set of relatively stable features:

– «Knightly» features were not inherent to a baselard (in contradistinction to the sword)

Fig. 7. British Library Board, miniature from "Regia Carmina", p. 53 – Royal Ms. 6 E IX.

– Sometimes the baselard was associated with criminal and marginal elements of society
– The baselard was perceived as a weapon that was between "worthy" and "unworthy"
– The baselard was not tied to one social group but was generally associated with third estate.
– The baselard was an armament, but to wear it one did not require a particualr status, virtues or special physical training. That is why there is an image of a baselard as a "fashion accessory".

It can be argued that the formation of the baselard`s image was influenced by the medieval image of the dagger – as an insidious, unaristocratic weapon. In addition, associations of accessibility, extracurricular, "non-prestige" were very important. Nevertheless, the baselard was primarily perceived as an effective weapon. Also, the baselard's image reflects the changes in the social hierarchy which occurred during the Late Medieval period in Europe. To some extent it can be seen as a symbol of the degradation of the "old" aristocracy and the strengthening of the third estate. These thoughts are very general but are evidence of the idea of the baselard which began to form in the 13th century.

From archaeolycal material and perseption` analyses to social reconstruction

Now we have the opportunity to compare data about archaeological finds and their reconstructed perceptional image. The baselards from Novy Svet are massive but not very long and so they are perfect for use on a warship. In addition, both sailors and merchants could wear baselards, regardless of their social status, and therefore we can venture the hypothesis that the items from Novy Svet represented the personal weapons of the ship's crew.

In 13th century sailing, the maritime trade was especially associated with high risks. On the one hand, the sea was a terrible environment. Jacques Le Goff describes what the sea meant for medieval people. Like the desert, it was a mysterious, hard to understand place which might represent trials, suffering and temptation (Le Goff 1988, 27). It aroused superstitious but also quite realistic fears, since piracy had been prevalent in the Black Sea since ancient times. In particular, this phenomenon was fixed by the ancient textual sources. The trade routes attracted pirates in large numbers and, in the 12th–15th centuries, piracy was a large-scale and multi-layered phenomenon in the region (Sniukov 1995, 42–48). was not only a socio-economic, but also a political phenomenon. During the Middle Ages piracy did not differ significantly from "legal" military activity. Secondly, there were Turkish, Slavic, Italian and other European pirate groups. Textual sources (Italian, Greek and Byzantine) retain many references to the activities of pirates. Thus, maritime trade was not safe in the 13th century and a ship's crew always had to be ready to fight.

We think that the baselards from the Novy Svet shipwreck were the personal belongings of the crew members (Morozova 2009). This type of weapon was handy and available for sailors. Data about the perception of baselards in the Middle Ages gives an idea of the social structure of the crew since this type of dagger could have belonged to both a wealthy merchant or a free sailor. We know that crew numbers depended on the type and size of the ship (Kleinherz 2004, 1029–1030). The crew consisted of both free and dependent people who had different work and roles to perform. Since the ship sank not far from the coast, perhaps members of the crew and other persons who had been on board managed to escape. As a result, we do not have a lot of information about these people but, by conducting comprehensive research on the personal belongings which remain, we are able to form more complicated impression about them.

Conclusions

The aim of this article was to use analysis of archaeological material and its perceptional image for the interpretation and verification of its social reconstruction. The reconstruction of the medieval perception of a baselard created the opportunity to:

– confirm the dating of the artefacts (the last decade of the 13th century);
– find out why there were baselards but no other type of bladed weapon on the ship;
– verified a modern vision of the social structure of a medieval ship's crew;
– better understand the phenomenon of a baselard.

Therefore, we can state that research of perception is very helpful for ensuring the correct interpretation of archaeological material and securing an understanding of the past.

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Modern Semi-Majolica and Glazed Ceramics from Rzeszów – Research on the Findings from the Archaeological Sites on 3 Maja Street

Abstract

Trąbska J., Kocańda P., Trybalska B. 2019. Modern Semi-Majolica and Glazed Ceramics from Rzeszów – Research on the Findings from the Archaeological Sites on 3 Maja Street. *Analecta Archaeologica Ressoviensia* 14, 109–136

Steadily growing collection of modern ceramics of the present Podkarpackie Voivodeship, has not yet been fully documented. Historical research demonstrates that Rzeszów, located on the communication route with Russia, occupied a very important position in trade relations with the East and West. The archaeometric study was performed on two fragments of semi-majolica plates and six fragments of glazed jugs, pots and tripod vessels. Vessels were made of fine-grained paste of smectite/illite, kaolinite/illite and kaolinite/illite/smectite clay. The richness of colours and shades is surprising. In the case of semi-majolica, the underglaze paintings were made with the use of frit pigments, while the overglaze ornament was made with the use of Pb-P-Ca-Si paste. 'Slip-painting' technique was also used. Glazes were coloured with iron, copper and cobalt compounds of various combinations and concentrations which provided different shades. In the case of semi-maiolica quartz-argillaceous primer with a potassium-bearing substance was applied, surfaces under glazes were covered with flux-bearing substances.

Key words: Podkarpackie, Rzeszów, semi-maiolica, glazed pottery, SEM/EDS

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1. Introduction

The steadily growing collection of modern ceramics, discovered during numerous archaeological research conducted in the area of the present Podkarpackie Voivodeship, has not yet been fully documented. The reason for such a state of affairs was the limited interest of archaeologists in this subject. This is evidenced by a modest database of literature, most of which is limited to reports and studies from excavations, which describe the ceramic findings from the 16th to the 19th centuries. This problem concerns not only the Podkarpackie voivodeship, but also other parts of our country (see Gajewska 1991, 159–169), although in recent years the situation seems to be improving. The number of publications is also increasing. However, we will limit ourselves to mentioning only some of them (see: Buko 1997; Gajewska and Kruppé 2017, 109–141; Gardawski and Kruppé 1955, 123–141; Glinkowska and Orawiec 2016, 205–229; Kruppé and Milewska 2015; Olszacki and Różański 2018; Lelek 2004; Lubelczyk 2017; Morysiński 2000, 129–158; Rodak 2017, 149–167; Starski 2015; Supryn 2008; Trzeciecki 2016; Wojenka 2016, 231–240). The potter's settlement from Przemyśl in Zasanie region remains relatively best described; however, its horizon dates back to a much earlier period (the second half of the 13th and 14th centuries; Auch 2007, 131–175; 2009, 141–162; Kunysz 1965, 336–345; 1967, 137–141; 1968, 176–183). The same can be said about the materials obtained during the research of the old town center in Rzeszów (Czopek and Lubelczyk 1993). Several individual texts have been published on the collections from Lesko (Zielińska-Durda 1988, 267–278), Będziemyśl (Lubelczyk 1994, 73–94), Łańcut (Lubelczyk 1999, 359–370), Strzyżow (Lubelczyk 2002, 227–251), Przemyśl (Poradyło 2007, 73–84) and Krasiczyn (Poradyło 2007, 73–84). Quite a few works have been devoted to a particular type of vessel produced at that time, the so-called semi-majolica from workshops in Miechocin (Szarek-Waszkowska 1968, 256–263; Szetela-Zauchowa 1994, 45–72), Rzeszów (Kotula 1953, 303–318) and Jarosław (Supryn 1975, 239–264). In this connection, we should also mention the unpublished study by M. Bober (2005), in which the author attempts to synthesize the knowledge on modern ceramics from the Podkarpackie Voivodeship.

Therefore, the comprehensive study of the collection of modern ceramics obtained during the 2017 archaeological excavations on 3 Maja Street in Rzeszów is keenly anticipated, as it can provide a wealth of valuable information. During the research works, a total of over 5,400 fragments were collected, which typologically and chronologically correspond to the classification system developed by Sylwestr Czopek and Antoni Lubelczyk (1993). In accordance with the above-mentioned categorization, the majority of the discovered artefacts belong to group B, which consists of ceramics formed by dint of a high-speed wheel and then fired in an oxidizing atmosphere. The foregoing group can be further divided into two smaller sub-categories based on to the type of raw material used, namely BI, which includes traditional, brick-like items made of ferruginous clay and BII, which includes products made of white kaolinitic clay, in many cases covered with olive, green, brown, orange and grey colored glazes.

There is currently no study in the literature concerning Rzeszów's past that would cover the issues of pottery production. Some scattered information on this subject can be found in written sources and articles on economic issues. Certainly, craftsmen involved in the production of ceramics were working in the settlements around the later location of the town. Then, after the year 1354, they became a part of the Rzeszów community, which was settled under the Magdeburg rights. However, the first source materials about potters in Rzeszów date back to the end of the 16th century. During that time, together with blacksmiths, gunsmiths, swordsmen, carpenters, saddlers and locksmiths, potters created a common guild of craftsmen which was governed by the guildmaster and a potter, Łukasz Szczygieł, held this office in the years 1593–1634. Józef Pęckowski (1913, 221) assumed otherwise, as he claims that the potters co-created the guild of coopers created under the privilege of Hieronymus Augustyn Lubomierski issued on December 30, 1699. Among the signatories of the act was the potter and guildmaster, Wojciech Szafrański. At that time, there were also 6 other potters in Rzeszów – the city records reveal the names of some of them, including Mikołaj (mentioned in 1611), Krzysztof (1612–1613), Kasper (1619) and Szymon Szczygieł (1634; Przyboś 1957, XIV; 1958, 72; Motylewicz 1994a, 267). Back then, Rzeszów was a significant center of pottery production, one which was probably not inferior to other big cities. It was recognized not only for the production of the traditional pottery, but also the semi-majolica dishes modelled after Italian maiolica, which began to arrive in Poland in the 16th century (Fryś-Pietraszkowa 1970, 76; Meyza 1991, 118).

H.G. Stephan (1987) has recently addressed the issue of the genesis and dissemination of the ornamented glazed vessels in modern Europe. The term *majolica* (from the word *Majolica* – Majorca, or faience) will be understood as a kind of dish-like ceramics with tin or tin-lead enamel, produced in Italy between the 15th and 18th century, whose production developed under the influence of similar objects from Arab countries in the Middle East and Spain. The most important centers of majolica production in Italy were: Florence, Orvieto, Siena, Castel Durante, Gubbio and Derucio. Initially, in the second half of the 15th century, the most common patterns were those based on eastern motifs, decorated with green or purple colors. Between 1475 and 1530, the goods were decorated with floral designs, as well as the images of peacock feathers or various figures. The color palette was also systematized, as it embraced white, purple, yellow, orange and green colors. In the 16th century, ornamentation lost its decorative sense, as it was supplanted by figural scenes. The manufactured items were white, with yellow and blue colors put on top. In the next century, decorating majolica with figural scenes and monochromatic cobalt became very popular (Kubalska-Sulkiewicz 2015, 245).

A more complex problem concerns the definition of semi-majolica vessels (also known as mezzamajolica, faience). The researchers from Warsaw (Meyza 1991, 118–121; Mierosławski 1979, 139–140) believe that this term is inappropriate since it refers to products with specific technological properties. For this reason, they propose to use the term pseudomajolica, which shall include dishes covered with transparent enamel and underglaze paints (as in the case of majolica), but with tin glaze used as the undercoat in lieu of the white engobe. Such a technique produces items with a heavily baked, thick layer of coating (Mierosławski 1979, pp. 139–140). The following definition was recently updated by K. Meyza (1991, p. 119), who claims that the term in question is a conventional name for a group of several, technically different types of ceramics, related by the presence of an ornament painted under a transparent lead enamel, that shall cover the period from the 16th c. to the beginning of the 18th c.. *Słownik terminologiczny sztuk pięknych* (i.e. *The terminological dictionary of fine arts*) (Kubalska-Sulkiewicz 2015, 108) describes semi-majolica as vessels made of regular clay, fired at oxidising temperature. They are brick-colored and covered with a white coating on which colored decorations can be applied. During the final stages, such items were coated with clear glaze. The term *mezzamajolica* is also commonly used in Czech literature (Vydrová 1973). The above-mentioned general definition was adopted by several researchers, including M. Supryn (1975, 239), who deals with artefacts from Jarosław, as well as Franciszek Kotula (1953, 303), Czopek and Lubelczyk (1993, 25), who focus on findings from Rzeszów. The same view is shared by Maciej Trzeciecki (2016, 173–174), the author of the study of ceramics from Płock. Teresa Szetela-Zauchowa, who examines semi-majolica from Miechocin, states that these products should be referred to as engobe ceramics – according to the researcher, this name is more correct and accurate. Szetela-Zauchowa defines semi-majolica as ceramic products painted with both white and colorful clays, which were later covered with transparent lead enamel. The already-mentioned engobe was used mainly as a backdrop for colorful patterns. At the same time, it imitated tin or tin-lead coating, commonly used in Italian maiolica. The semi-majolica from Miechocin typically involved two varieties of engobe, namely the white one and the brown one (Szetela-Zauchowa 1994, 46–48); the latter one is prevalent on the vessels discovered during the research of 3 Maja Street in Rzeszów.

The significance of Italian influences on the pottery workshops in Rzeszów, Miechocin, Jarosław and Łańcut is emphasized by E. Fryś-Pietraszkowa (1970, 76), Maria Supryn (1975, 241–263) as well as Czopek and Lubelczyk (1993, 25). The latter assume that, apart from the Italian impact, potters in Rzeszów were also inspired by oriental elements; however, they do not mention the source of such a claim. The above-mentioned artefacts are frequently described as the so-called Rzeszów majolica, which dates from the third quarter of the 16th century to the beginnings of the 18th century (Czopek and Lubelczyk 1993, 25–27; Kotula 1953, 303–318; 1956, 24). The ability to manufacture this variety of dishes is a sign of the extraordinary craftsmanship of the potters, who were seen as serious competitors for other pottery centres, such as Jarosław and Miechocin, which were famous for their mezzamajolica products. For this reason, conflicts between these cities and guilds could occur, as evidenced by the situation in Sokołów Małopolski, where the local pottery guild severely restricted the influx of *glass or painted pots* brought by merchants from across the Vistula (Reinfuss 1955, 16–17.).

Historical research demonstrates that Rzeszów, which was located on the communication route with Russia, occupied a very important position in trade relations with the East and West. The route became especially important in the late Middle Ages and the early modern period (see Kurtyka 1994, 105–117; Leśniak 1994, 205–206; Motylewicz 1994a, 229–230; 1994b, 354–356; Wyrozumska 1977, 51–57). The city also played an important role in the merchandise trade, presumably ceramics included. This is evidenced by a specially separated square, designed exclusively for potters, on which ceramics were sold even during the postwar period. To this day, the spot is referred to as “pottery square” (Kotula 1985, 105).

Major changes took place at the end of the first half of the 17th century, when potters, saddlers, masons and woodworking craftsmen left the locksmith’s guild to form a joint saddlery guild (Motylewicz 1994a, 243). Certainly, this guild was somewhat connected to the prerogative issued by Jerzy Ignacy and Aleksander Lubomirscy on 8 October 1718, which states that *potters cannot do without masons* (Pęckowski 1913, 225–226). Starting from the middle of the 17th century up to the beginnings of the 18th century, only four craftsmen involved in pottery were recorded, whereas in the years 1701–1750 documents mention only one (Motylewicz 1994b, 349). The reasons for such a situation should be sought primarily in the economic and political crisis in Rzeszów (Motylewicz 1994b, 343–347), as well as in the gradual downfall of guild pottery. Both imported and locally produced dishes made of glass, porcelain, faience or metal became increasingly popular in kitchens and on tables (Reinfuss 1955, 16–19). The production of dishes was then directed towards the needs of small-town and rural communities. Rural potters also experienced a period of renaissance, as they produced ceramics that were cheaper but not inferior to those produced in the city workshops (Kotula 1956, 28–29). Within the timeframe mentioned above, various pottery centers, such as Medynia Głogowska and Zalesie developed – here, the potters specialized in folk ceramics modeled after semi-majolica, as well as miscellaneous flower pots and simple dishes. These items were then sold at trade fairs, including those held in Rzeszów (Ruszel 1994, 331–337).

The surfaces of archaeological and modern ceramics were subjected to various decorative procedures, many of which were also of a utilitarian nature. The enamel layer provided resistance to the potential penetration of fluids and damage caused by the stored and thermally processed substances. Furthermore, it also provided aesthetic value thanks to the use of multi-coloued glazes of varying degrees of transparency, applied to different elements of vessels. Owing to the invention of underglaze and overglaze ornamentation, the existing palette of colous and patterns was significantly expanded. The invention of glazing of ceramic surfaces dates back to the Bronze Age and developed first in the areas known as the cradles of glass–making, i.e. in Mesopotamia and Egypt. It is conceivable that the ability to manufacture glass objects stems from experimenting with it in the form of glazes (Płoński 1972). The close contact between modern Europe and the East was established, especially with Ottoman Turkey and, by extension, with Persia (Supryn 1975; Balcer 2018). The designs and technologies could have come from either the West or the East, along different routes. Extensive technological research needs to be conducted to identify the above relationships and such an investigation on the Podkarpackie ceramics has not been carried out so far. This paper serves as an introduction to a more elaborate project, one which is aimed at pinpointing the features associated with particular modern workshops in the Podkarpacie voivodeship, by comparing them and determining the sources of the applied technological concept.

2. Research material and methods

The study was performed on eight samples of artefacts - two fragments of semi-majolica plates and six fragments of jugs, pots and tripod vessels. Macroscopic photographs of the samples and their descriptions are provided in Table 1. For ease of reference, the pottery that cannot be categorized as semi-majolic will be referred to as "glazed pottery" or "unpainted pottery" throughout the article.

The majority of the fragments were retrieved from the excavation marked with number 6, that is located at the western façade of the former Piarist Convention building (now the Regional Museum). These are samples 5C (90–100 cm level), 7C (70–90 cm level), 7D (150–170 cm level), 11B-1, 11B-2 (40–60 cm level), 11B-3 (20–40 cm level) and 12-1 (120–140 cm level). In the excavation, we managed to find sundry structures which were then assessed on the basis of portable materials, written sources and radiocarbon tests and dated from the early Middle Ages to modern times. However, for the most part, these were mainly the remnants of the Piarist monastery that has been functioning there since the middle of the 17th century (Kocańda *et al.* 2018, 157). All the above-mentioned levels were characterized by a significant degree of the mixing of soil layers, which consisted of dark brown and light brown soil, pieces of bricks, crushed mortar and stones. These strata can be interpreted as utilitarian layers, or putting it another way, construction and demolition levels related to the monastery buildings that exist in the area. The only sample (i.e. a fragment of a vessel marked as sample 5F) obtained from the excavation number 2, which was located near the tenement house No. 10, was sent for analysis. The said excavation revealed a multi-level surface made of timbers. Based on the results of dendrochronological dating, the surface has its origin in the 17th and the second half of the 18th century (Kocańda *et al.* 2018, 153–155). The vessel in question, on the other hand, comes from the third layer, in which at a depth of 130–150 cm a fourth level of wood was exposed. This layer was light grey in color and consisted of sticky clay mixed with black soil.

The methods adopted for the purpose of the following project include polarized light microscopy in transmitted light, performed by means of an Olympus BX51 and scanning electron microscopy with X-ray microanalyzer on the NanoNova FEI with EDAX microanalyzer. Micromorphology observations were made on thin sections sprayed with graphite in the BSE mode. The concentrations of elements show the results of semi-quantitative analysis; moreover, they are always expressed by dint of weight percent. Concentration of oxygen was not taken into account, so that the bulk of analyses may not equal 100 wt %.

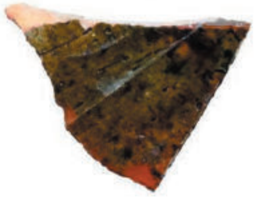
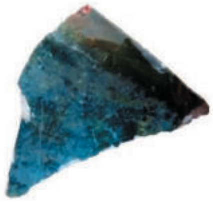
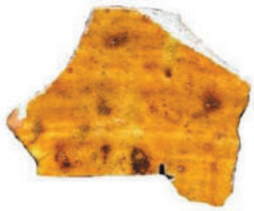
3. Research results – semi-majolica

Sample 5C

The ceramic mass is fine-grained and homogeneous, composed of aluminum, potassium, magnesium, calcium and iron aluminosilicates. It is a mixture of kaolinite (its presence is indicated by the low proportion of Si/Al, cf. Fig. 3), illite and smectite. Cryptocrystalline compounds of titanium are also present. The raw material contains about 2 wt. % Fe, which required firing in an atmosphere with limited access to oxygen, since after being exposed to oxidizing conditions, the clay would be pink. The concentration of calcium is the highest in the whole set of the analyzed ceramics (ca. 2.5 wt. % Ca), but marl was not used, as it typically contains much more Ca (Ryka and Maliszewska 1991, 208). Thus, calcium can be a natural component of the used clays. There were no concentrations of this element other than aluminosilicates with different cations.

The slip is a layer about 100 micrometers thick, composed of oval quartz grains of similar size, im-

Table 1. Macroscopic pictures of the fragments of the examined semi-majolica and glazed ceramics.

Code of sample	Macroscopic description	Image
5C	Semi-maiolica, a fragment of plate. A navy-blue and dark-red ornaments. Convex floral design, bluish glaze. Light-grey section. Disadvantages: uneven glaze cover, craquelures, thick and blistering navy-blue paint, detachment of dark red paint, stains of blue glaze. Numerous small black stains.	
11B-3	Semi-maiolica, a fragment of plate. Brown background covered by glaze, creamy linear overglazed ornament. Brick-red section. Disadvantages: loss of glaze, craquelures, loss of glaze transparency, blistering of creamy ornament.	
5F	Fragment of a pot or jug spout. Two-sided brown glaze, internal surface covered with a black, opaque crust. Brick-red-grey section. Disadvantages: dark brown stains, hairy smudges.	
7C	Fragment of a pot. Two-sided glaze, navy- blue with greenish shade on external surface, dark green on the internal one. Brick-red-grey section. Disadvantages: stainy, uneven coloration, cracks.	 
7D	Fragment of a middle part of a pot. Two-sided glaze, brown on external surface, executed in a 'fish-scale' ornament (dated in the Rzeszów region for the 17th and 18th centuries, Czopek, Lubelczyk 1993, 36). Light green glaze on internal surface. Light-brick-red section. Disadvantages: dark stains, craquelures.	 
11B-1	Fragment of a middle part of a pot. Two-sided glaze, on external surface two-coloured, creamy, matt, opaque and brown, on internal: yellow, transparent. Grey section. Disadvantages: uneven glaze thickness, stains, craquelures.	 
11B-2	Fragment of a pot spout. Two-sided green glaze, on external surface partially covered with a black, opaque crust. Brick-red-grey section. Disadvantages: blistering, craquelures, stains, detachments.	
12-1	Fragment of a tripod. Light-green glaze. White section. Disadvantages: craquelures, uneven thickness of glaze.	

mersed in argillaceous minerals. These include iron, calcium and magnesium aluminosilicates that are visibly enriched in potassium (7,61 *vs.* 1,79 wt. % K), when compared with the ceramic mass. It is possible, although not verifiable at this stage of research, that a mixture of illite and/or plant ashes or other potassium carrier substances may have been used.

Other elements of the stratigraphic cross-section are the coppery-red and blue paints, as well as glaze in non-ornamented areas. Under the red paint and above the slip there is a layer of clay similar to the one found in the ceramic mass. It was probably applied in order to obtain the convex effect of the strip ornament; unfortunately, this did not contribute to the permanent bonding of the paint to the base surface. The components of red paint are opaque, very fine (a few micrometers), granular, partially fused. The average thickness of the coppery-red layer is approximately 20 micrometers. The picture of blue paint is different: here, the layer is thicker (about 200 micrometers) and while large grains blend in, they retain their individual shape. The blue pigment is a cobalt-iron, lead-free glass composed, among others, of a large amount of potassium (12 wt. % K) and 3.6 and 2.8 wt. % of cobalt and iron, respectively.

Any contact between the paint layers and the base, as well as the glaze, is beneficial. At the edge of the pigment-free glaze that remains in contact with the base, one can notice secondary crystals, whose composition indicates the reaction between the components of the base and the enamel. The area of such occurrence is narrow (about 10 micrometers).

The clear glaze is not homogeneous, as it contains un-melted grains of the lead-silica frit and quartz. The glaze was therefore applied in the form of a suspension containing, among others, these components. Upon close inspection, one can spot transverse cracks and open bubbles in the glaze. These defects have a negative effect on the transparency of the enamel. The glaze has a thickness of about 50 μm. It is composed of Pb:Si in a ratio of about 4:1 to about 2,5:1; it was not, therefore, homogenized during the smelting process, which is a disadvantage. The iron and cobalt content is 1.3 and 1.1 wt. %, respectively, which translates into the bluish hue. A very thin area (about 3 micrometers) is found on the surface of the glaze, where the Pb:Si ratio is close to 1. The high content of silica ensures the hardness of this surface. The said area was formed (as with the other cases described below) by the evaporation of lead in the final stage of the smelting of the dish. The image created via scanning electron microscopy depicts the discussed section as a grey stripe on the brighter proper glaze.

The corrosive area is very thin, opaque, or bluish and semi-transparent. It is multilayered, stratified and contains numerous needle-shaped crystals, consisting mainly of lead, which is accompanied by silicon, calcium and phosphorus in the amount of approximately 10 wt. %, of each oxide. There is also calcium, which occurs separately, probably in the form of a carbonate, as well as lead and silica in the ratio of (in an outward direction) 7.7 – 6 – 3.2 (in the glaze: 4.4) - the components of the enamel. The total thickness of these areas is negligible (ca. 5 micrometers), which indicates that the advancement of the degradation processes is slow (Table 2–6).

Sample 11-B3

The following sample is a fragment of a dish with a fairly loosened layer of decoration. The color of the fracture is brick-red. The ceramic mass can be described as fine-grained and homogeneous. It is composed of calcium and potassium aluminosilicates (1.8 and 1.2 wt. % Ca and K), and while it has no visible pores, its texture is varied and chaotic. Also, the iron content is high, i.e. 5,72 wt. % Fe.

The brown shade on the surface of the dish is achieved by dint of a layer of granular pigments, characterized by having equal diameter. While most of them are opaque with a coppery tint, some are somewhat transparent and of pale blue hue or completely transparent and colorless. One may also encounter individual, large grains of quartz. The pigments have been applied in the form of a fairly thick layer (up to approx. 0.3 mm) on the surface of the dish; a fair share of them is embedded into the ceramic mass. The pigment layer is porous - in all probability it was too moist, thus the firing or drying of the dish caused the release of gases. The grains of fine pigments are either quartz or frit with extremely high silica content (only 1 wt. % Pb), as well as frit Al-Pb-Si with iron and frit Si-Al-Pb with iron and copper.

There is a layer of glaze on the pigments. On the decorative side it is even (approx. 0.2 mm thick) and adheres well to the base. A small number of cracks that are perpendicular to the surface of the dish is noticeable, together with few closed bubbles. On the non-ornamented side, the image is completely different: the enamel is thinner and uneven. The glaze consists of lead and silicon at a ratio of 5:1. Here, we can also find 2 wt. %. Cu, which is responsible for the subtle shade of green that is visible only under the petrographic microscope. The most external part of the glaze is an area of about 3 micrometers wide, in which the Pb:Si ratio is only 2.5. As in other cases, regardless of the manner in which it was created (i.e. intentional or not), it certainly protects the surface of the very soft proper glaze.

There is a creamy ornament on the surface of the glaze. It is made of paste, which is not homogeneous enamel, but a sinter made of phosphorus, calcium, lead, iron and copper. The sinter can be divided into two parts - the upper layer is low in lead, but enriched in iron, probably due to the evaporation of lead. Both parts are well-bound. Within the sinter one can spot only a few small grains of lead-silica frit. Therefore, we are dealing with a paint that was made intentionally, or in other words, a sinter made of calcium phosphate and lead (Table 2–6).

4. Research results – glazed, unpainted ceramics

Sample 5F

The ceramic mass of this sample can be described as being of greyish-brick color. It is fine-grained, but the grains are uneven; the grain size reaches 0.3 mm. The chemical composition of the ceramic mass was not determined for this sample. The surface under the glaze is uneven and the glaze is "soaked into it".

The point of contact between the glaze and the ceramic mass is covered with dendritic short-columnar crystals, formed as a result of the reaction between the hot enamel and the components of the ceramic mass. These are lead aluminosilicates with complex compositions. The thickness of the area of contact is about 20 micrometers; furthermore, it is discontinuous. In all likelihood, the vessel was inaptly fired and cooled.

Dark brown glaze is very thin (about 20 micrometers). Its thickness is uneven; moreover, in some places it is loosened from the base. The glaze has a Pb:Si ratio of 5, but in the very thin area on its surface, this proportion is only 0.6. The only chromophore here is iron (1.85 wt. %. Fe).

The opaque, matt layer on the outer side of the potsherd is reminiscent of carbon deposit, but upon closer inspection, it turns out to be a glaze that is thicker than its outer counterpart. The glaze was also applied on a negligently smoothened base, thereby "soaking" into it. The image created by petrographic microscope reveals that the glaze is of greenish color. Curiously, it has a different proportion of Pb:Si than its equivalent on the external side.

In the glaze of the inner part of the vessel, needle-shaped crystals were formed. They pierced the entire volume of the layer. Their Pb:Si ratio equals 8, while the concentrations of other elements are negligible. The investigated variety of a crystal is, in terms of its composition, most similar to a natural counterpart, the yellowish-green ferrisurite $(Pb, Ca)_{2,4}Fe^{3+}{}_2(Si_4O_{10})(CO_3)_{1,7}(OH)_3{\cdot}nH_2O$ (www.mindat.org/min-1501). The above-mentioned mineral is formed under hydrothermal conditions either in lead deposits (e.g. Le Rivet deposit, Occitania, France) or other metallic deposits, in which lead is a natural admixture (e.g. Monte Avazza near Udine, Italy). The habit of ferrisurite is also needle-shaped. Undoubtedly, the presence of this phase should be treated as a flaw in the enamel, as the said mineral was formed due to the presence of too much moisture in the enamel mass combined with a relatively low kiln temperature.

The black incrustation on the outer wall of the fragment of the vessel is composed of pure lead or lead oxide, as well as phosphorus and calcium at a ratio of approximately 1:1, mixed with a small amount of iron and aluminum. The foregoing combination is sinter, which may have developed during the production of the vessel. Both the presence of the above-mentioned crystals and sinter are indicative of the defectiveness of the glaze (Table 2–6).

Sample 7C

Here, the greyish-cream ceramic mass is fine-grained and homogeneous. It is composed of potassium, iron, calcium and magnesium aluminosilicates. The concentration of potassium and iron is very high, as it amounts to 6,76 and 5,91 wt. %. K and Fe. In the base of glaze, the concentration of almost all elements is slightly lower, as a result of their diffusion into the enamel; however, the concentration of sodium is almost doubled. Due to the lack of sodium feldspars build-ups, its source must be different; thus, sodium compounds were probably added intentionally.

Within the ceramic mass there are occasional, large (approx. 0.5 mm) areas of glaze that are partially dissolved in the enamel. The thickness of the area in which dendritic crystals occur on both sides of the vessel is approx. 50 micrometers. On the other hand, the thickness of the area in which the ceramic mass changes is approx. 150 micrometers.

The navy-blue glaze is cracked, and the fractures are mostly parallel to the surface of the vessel, which indicates high viscosity of the glaze during melting process. Within the glaze, there are large, closed or almost closed bubbles, filled with numerous copper-colored flaky clusters. The contamination of the bubbles indicates poor cleanliness of the kiln atmosphere. The ceramic mass or enamel mixture was rich in gases, which then sought an outlet during the firing process, yet the glaze was too sticky and it closed them in. The presence of these bubbles and the fact that they were filled with iron compounds produced undesirable visual effects on the glaze, i.e. the emergence of dark spots. The navy-blue glaze is about 3 times thicker than the dark green one. The Pb:Si ratio is approx. 5. Additionally, the investigated glaze contains high copper concentration (4 wt. %) and certain amount of iron (2.2 wt. %.). Finally, the outer surface of the enamel includes an area that spans several micrometers, in which lead evaporated – here, the Pb:Si ratio is 0.9.

The homogeneous enamel is covered with incrustation approx. 30 micrometers thick, in which phosphorus and calcium can be found. What is more, individual grains of potassium feldspar are melted into it. Importantly, this is a sinter, not a dirt residue. The foregoing imperfection, which adversely influences the aesthetics aspects of the glaze was probably created during smelting process. The exact source of contamination, as well as the reason behind its presence, are unknown.

The dark green enamel is much thinner than the navy-blue one. It is composed of lead and silicon in a ratio of 3, as well as aluminum and iron (3,94 and 3,12 wt. % Al and Fe). The dendritic clusters formed at the point of contact between the dark green enamel and the base cover a large portion of the cross-section of the layer. It should be noted that the only chromophore here is iron. The near-surface area of the dark green enamel is heavily cracked, but it has no incrustation as with the navy-blue enamel. The inner, dark green glaze is harder than the dark blue one – in other words, these are two different types of enamel (Table 2–6).

Sample 7D

In the following sample, the ceramic mass is varied in granularity and the size of angular grains is up to 0.3 mm. The argillaceous components here are iron, potassium and calcium aluminosilicate(s) in the form of smectite/illite. There is also titanium in the form of cryptocrystalline clusters.

The base under the glaze is decorated with "fish scale". When we compared it to the ceramic mass, it appears to be enriched with potassium and titanium. The base under the green glaze, on the other hand is rich barium, phosphorus, sodium, iron and titanium. Barium occurs in the ashes of some plants (Kabata-Pendias and Pendias 1999, 134–139). The lack of calcium indicates that the phosphorus in the base comes from plant ashes rather than from animal source. The point of contact between enamel and the base reveals areas which are 10 micrometers thick and which are covered with dendritic crystals, formed through the reaction of enamel and ceramic mass. In certain places, this connection is disrupted, as evidenced by the visible "soaking" of the glaze into the base. This, in turn, indicates that the glaze was applied on an unfired surface.

The brown and green glazes are similar in thickness. Both glazes are basically homogeneous, although in the brown one there are few compact clusters of fine- and evenly-grained substance. The chromophores in both glazes are iron and copper and while there is more iron in the brown glaze, the green glaze is dominated by copper. The ratio of lead and silicon in the brown glaze oscillates between 4.7 and 7.3, while in the green glaze between 4.5 and 6. Both glazes contain aluminum, equivalent to 2 and 3 wt. %. Al. Both glazes have a specific composition due to the presence of cadmium and – in the case of the brown glaze – also zinc.

All things considered, the analyzed piece of ceramics presumably comes from an extensively exploited vessel, as evidenced by the mechanical cracks in the glaze, which occur mainly on its outermost surfaces.

Sample 11B-1

The grayish-white ceramic mass is fine-grained and unevenly-grained. On both surfaces, i.e. the external and internal, additional clay is used, possibly as a "patch". The said cover is clearly more coarsely-grained than the ceramic mass. It contains pores of irregular shapes; this indicates the excessive moisture of the layer. The patch is made up of aluminosilicate with a ratio similar to that of kaolinite (Fig. 3), but containing almost 3 wt. % K and 2,6 wt. % Fe.

The transparent glazes, both brown and yellow, are similar in thickness, homogeneity and width of the contact area. In the yellow glaze the Pb:Si ratio is 4 and the chromophores are copper and iron (1,42 and 1,61 wt. % Cu and Fe). There are very few open bubbles here; however, they contain coppery flakes of iron compounds. The presence of such pollution is undeniable, but we are unable to determine at what stage it occurred, i.e. vessel production or post-depositional production.

Cream-colored, opaque, rough enamel is characterized by having a different morphology. It is a narrow and uneven layer, in which the roughness effect was achieved due to the granularity and unevenness of the base and the presence of short-column crystals (lead, potassium, iron and copper aluminosilicates) within the whole enamel.

The Pb:Si ratio in the discussed glaze is very high, when compared to other glazes, as it equals 2.2. The chromophores here are iron and copper (1,91 and 1,45 wt. % Fe and Cu). The surfaces of the glazes are cracked due to the exploitation of the vessel (Table 2–6).

Sample 11B-2

The moderately isotropized greyish-brick-red ceramic mass is fine- and even-grained, with few larger grains of quartz and feldspars. A relatively low proportion of silicon to aluminum indicates the presence of kaolinite (Fig. 3), and the concentrations of iron and potassium, which are up to a few percent (3.34 wt. % K, 2.75 wt. % Fe) suggest the presence of illite or illite-smectite.

The glaze on the external surface is thin and homogeneous; furthermore, it covers a moderately even base. The glaze on the internal surface is slightly thicker and significantly fractured - the cracks are perpendicular to the surface of the vessel.

The glaze on the internal part is composed of lead and silicon in the proportion of 3.5; it is, therefore, quite hard. Additionally, the glaze contains copper (1.8 wt. % Cu) and iron (1.7 wt. % Fe) acting as chromophores. The narrow contact area is made of dendritic crystals, i.e. lead, iron, copper potassium and calcium aluminosilicates.

Black incrustation is found on both the external and internal surfaces, but it appears to be more developed on the former, up to point of decreasing visibility of the glaze. The incrustation is multi-layered. Within the glaze there have been a number of processes aimed towards the formation of colomorphic areas, enhanced with phosphorus and calcium. On the glaze, however, there is fine-grained sinter with a large amount of phosphorus and calcium, as well as lead and iron with copper. In view of the above, it can be speculated that the incrustation was formed during the production stage of the vessel. This, in turn, may indicate that the vessel was a reject (Table 2–6).

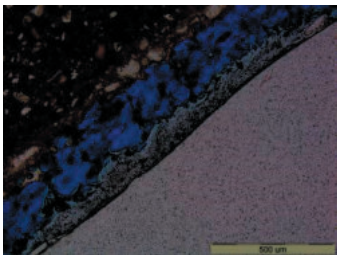
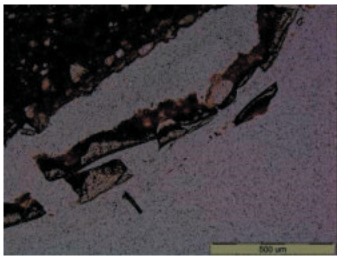
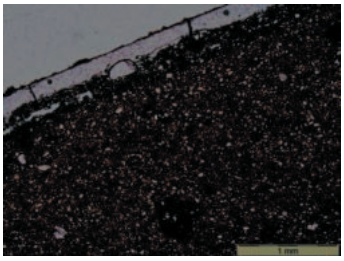
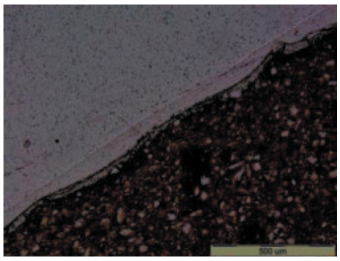
Sample 12-1

The white ceramic mass is fine-grained and homogeneous. Its chemical composition corresponds to that of kaolinitic clay (Fig. 3) with low calcium content (1,06 wt. % Ca), which in all probability is a natural component of the used clay; however, such a claim will have to be confirmed via raw material analysis.

The glaze was applied to a moderately even base, which appears to be enriched with potassium and titanium, when compared to the ceramic mass. Moreover, is seems to be homogeneous. The fractures perpendicular to the surface of the vessel can be categorized as craquelure cracking. The glaze is composed of lead and silicon in a proportion of about 5. It also contains copper (approx. 1.5 wt. % Cu) and iron (approx. 1 wt. % Fe).

The contact area within the ceramic mass includes numerous elongated pores, which are parallel to the surface of the item. At the border of the glaze and base, dendritic crystals were formed, covering the area that is approx. 10 micrometers thick (Table 2–6).

Table 2. Micromorphology of the studied ceramic fragments in the image of polarized light microscopy in transmitted light. All microphotographs were taken with parallel polarizers. The photograph in the left column is marked as "L", the photograph in the right column is marked as "R".

Sample code	Description	L	R
1	2	3	4
5C	(L) cross section through navy-blue ornament. From left: dark brown paste, narrow engobe zone with quartz grains, cobalt pigment layer, blue glaze layer. (R) section through the red strip. The glaze together with the underglaze pigments (opaque strip) and the „patch" of paste-like underneath breaks away from the lighter engobe.		
11B-3	(L) cross-section through the red plane. Under the transparent glaze, a thick layer of glaze pigments different in appearance, a large quartz grain, and pores within the pigment layer are visible. They were applied to a carefully leveled surface. (R) A very thin layer of glaze on the unpainted part of the dish.		

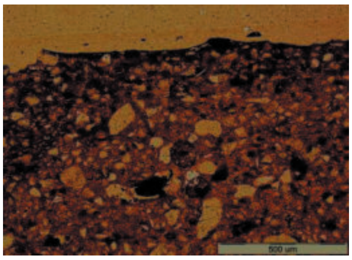
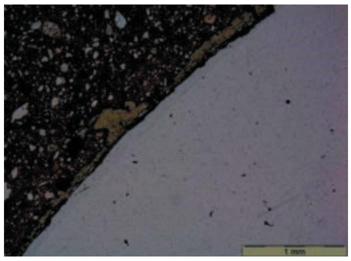
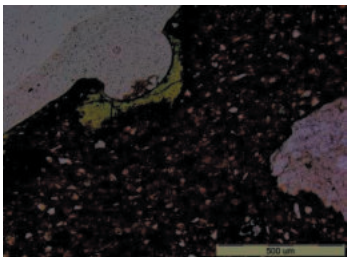
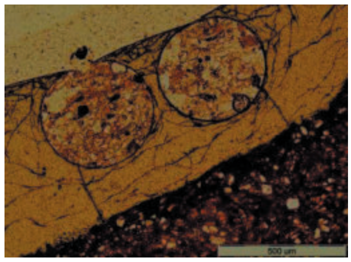
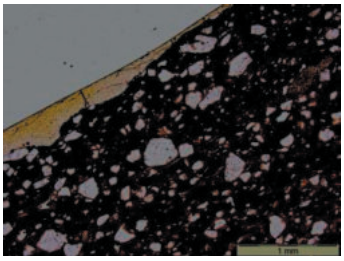
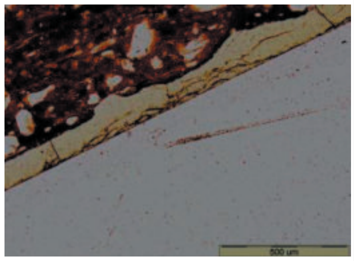
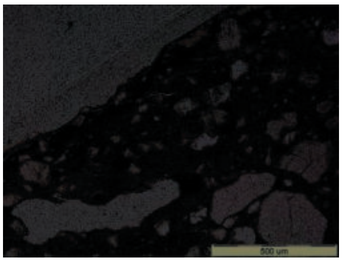
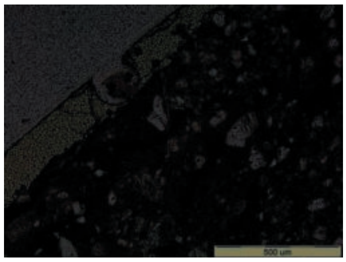
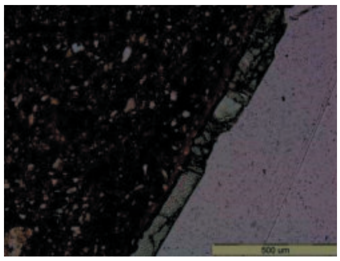
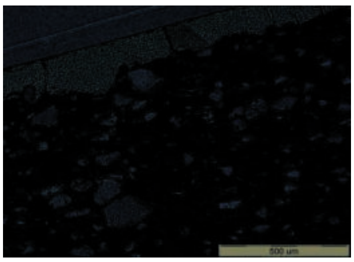
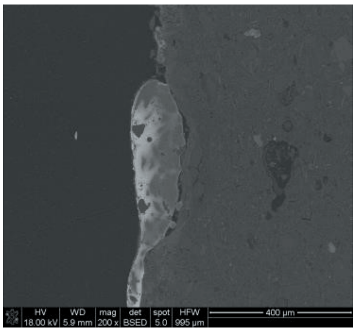
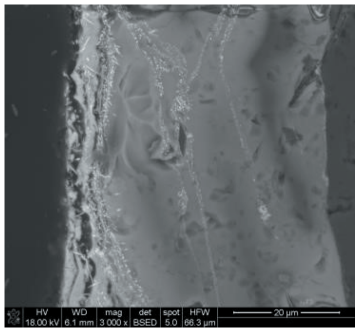
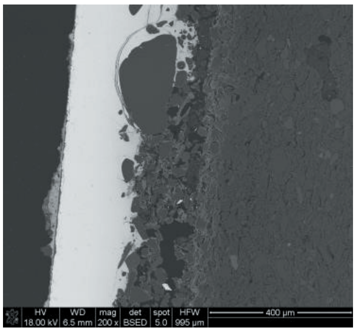
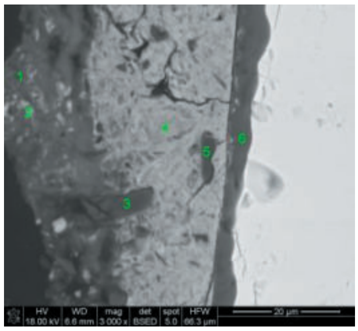
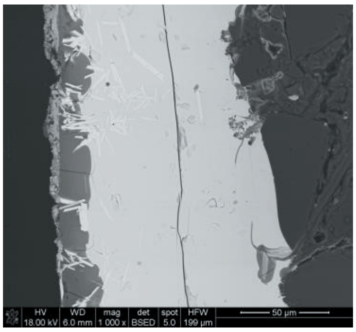
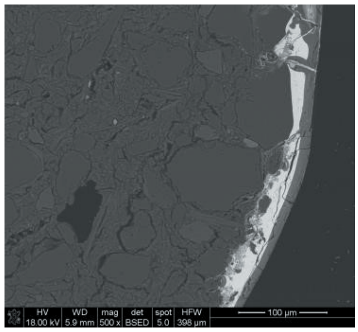
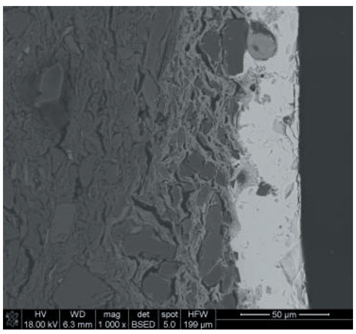
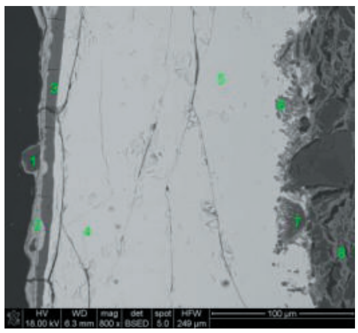
1	2	3	4
5F	(L) cross-section through the outer surface of the dark brown glaze. It is very thin, detaching from the ground, locally with opaque stains. (R) cross-section through the black surface: it is a green glaze soaking into the ground, covered with a narrow opaque crust.		
7C	(L) cross-section through dark green surface. Glaze soaks into the unevenness of the ground. (R) cross section through navy blue surface. Closed blisters within the glaze, filled with iron flakes, numerous cracks visible.		
7D	(L) cross-section through the outer surface, brown, executed as a "fish scale" pattern. The glaze is homogeneous. (R) cross-section through the inner surface, light green. Visible density of cracks in the outermost part of the surface.		
11B-1	(L) cross-section through the outer, creamy, rough surface. The glaze is narrow, partly peeled, applied to an uneven substrate. (R) cross-section through the inner surface. Yellow glaze with an open bubble. Under both layers a zone of paste different from the ground is visible ("patches").		
11B-2	(L) cross section through the outer surface with black crust. Below the crust a true glaze occurs. (R) cross-section through the inner surface: the glaze is thicker but heavily cracked.		
12-1	Section through the light green glaze. Just below it, a strong sintering zone is visible.		

Table 3. Microphotographs of semi-maiolica and glazed ceramics from scanning electron microscope. The description of the microphotograph in the left column is marked as "L" and the description of the microphotograph in the right column is marked as "R". In the marked points, EDS chemical analyses were performed, which are distinguished in Table 4.

Sample code	Description	L	R
1	2	3	4
5C	(L) cross section through the blue spot (decoration defect). From the left: glaze spot, engobe zone, paste. Dark areas inside the spot: cobalt frit grains. (R) section through the external part of the colorless glaze. Multilayer corrosion zone visible, glaze underneath. From the left: peeled off layers with varying proportions of Pb, P, Ca, Si.		
11B-3	(L) section through a transparent glaze with a red substrate. From the left: thin, bulging crust - creamy ornament (enlarged in photo R), glaze (light strip), underglaze zone with numerous pores, contact zone, paste. (R) cross-section through a cream ornament. From the left: the upper part of the sinter (1, 2), the lower with frit pigment grains (3–5), glaze enriched in silica (6, gray strip), light proper glaze.		
5F	(L) cross section through the black outer surface. Proper glaze – a bright area, a layer enriched with silica on its surface – a gray area. Both glazes are penetrated by lead aluminosilicate. Grit sintered crust on the surface. In the contact zone – poorly developed dendritic crystals. (R) section through the brown inner glaze. Visible unhomogeneity of glaze: silica enriched layer (gray) and proper glaze (light). The contact zone is disturbed, irregularly formed dendritic crystals are present in it.		
7C	(L) cross-section through dark green glaze. From the left: paste, contact zone, glaze (light strip). (R) section through dark blue glaze. From the right – a substrate with a dendritic crystal zone (p. 8, 7, 6), light glaze (p. 4, 5), dark zone enriched in silica (p. 3), crust - sintered quartz grain (p. 1, 2).		

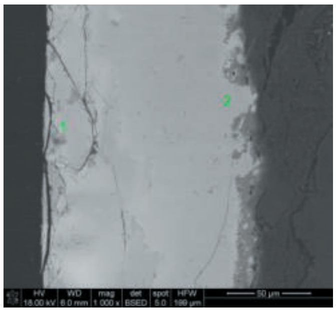
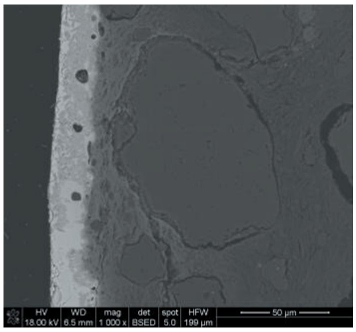
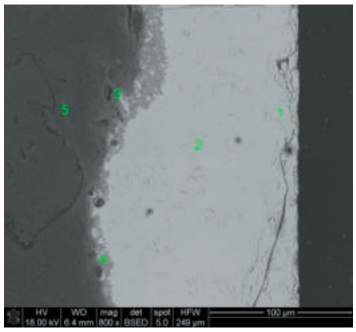
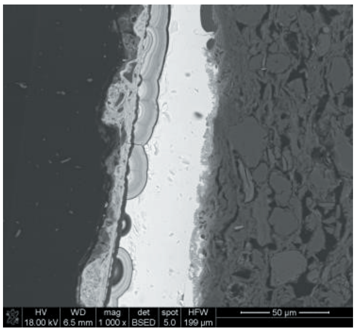
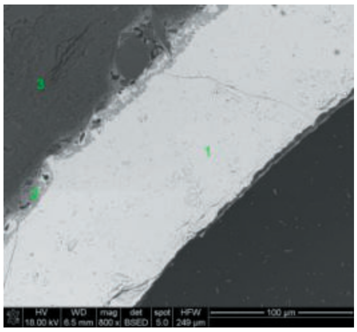
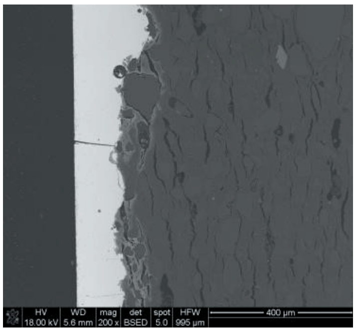
1	2	3
7D	Cross-section through the glaze on the 'fish scale' ornament. From the left: glaze with numerous surface cracks (1), contact zone with dendritic crystals (2).	
11B-1	(L) cross section through matt, creamy glaze. From the left: glaze with numerous bar crystals and unmelted quartz grains, contact zone, substrate with large quartz grain. (R) section through the yellow, transparent glaze. From the left: ceramic mass (5), contact zone with dendritic crystals (3, 4), glaze - cracked at the surface (1,2).	 
11B-2	(L) section through the glaze with black crust. From the left: sintered crust, colomorphic zone, glaze (light band), continuous contact zone (dendritic crystals), paste. (R) section through the green glaze. From the left: substrate / paste, contact zone, glaze (light strip), gray narrow zone enriched in silica.	 
12-1	Cross section of light green glaze. From the left: glaze (light strip), contact zone (dendritic crystals and paste impregnated with glaze, paste.	

Table 4. The results of semi-quantitative EDS chemical analyses [wt. %] of glazes. “<LD” denotes the absence of an element or concentration below the detection limit.

Code of the sample	The analysed area	P	Mg	Ba	Ca	Na	K	Si	Al	Pb	Cd	Zn	Fe	Co	Cu	Ti	Pb/Si
5C	Bluish glaze - covering the decorated surface	<LD	1,07	<LD	0,94	<LD	4,89	21,14	0,84	51,24	<LD	<LD	**1,48**	**1,57**	**<LD**	<LD	2,4
	The glaze on the undecorated surface	<LD	<LD	<LD	0,82	<LD	<LD	15,31	1,26	65,89	<LD	<LD	**1,35**	**1,14**	**<LD**	0,70	4,3
11B-3	Transparent glaze covering red background	<LD	<LD	<LD	<LD	<LD	<LD	13,79	0,79	71,38	<LD	<LD	**<LD**	**<LD**	**2,04**	<LD	5,2
5F	Brown glaze	<LD	<LD	<LD	0,80	<LD	0,80	13,60	2,00	70,02	<LD	<LD	**1,85**	**<LD**	**<LD**	<LD	5,2
	Brown glaze with black residue	<LD	<LD	<LD	0,81	<LD	<LD	10,69	2,32	74,64	<LD	<LD	**1,17**	**<LD**	**<LD**	<TI	6,8
7C	Dark-green glaze (bottle-green)	<LD	0,77	<LD	<LD	<LD	<LD	18,41	3,94	56,20	<LD	<LD	**3,12**	**<LD**	**<LD**	<LD	3,1
	Navy-blue glaze	<LD	<LD	<LD	1,18	<LD	0,4	13,45	2,30	63,20	<LD	<LD	**2,05**	**<LD**	**3,95**	<LD	4,7
7D	Brown glaze	<LD	<LD	<LD	<LD	<LD	<LD	10,54	2,32	74,44	1,37	<LD	**1,11**	**<LD**	**1,77**	<LD	7,1
	Brown glaze	<LD	<LD	<LD	<LD	<LD	<LD	11,68	3,11	72,61	0,87	<LD	**0,82**	**<LD**	**1,48**	<LD	6,2
	Brown glaze	<LD	<LD	<LD	<LD	<LD	<LD	10,18	2,41	74,33	0,89	1,49	**1,20**	**<LD**	**1,53**	<LD	7,3
	Light green glaze	<LD	<LD	<LD	<LD	<LD	<LD	11,71	2,95	71,63	1,35	<LD	**2,80**	**<LD**	**1,53**	0,79	6,1
	Light-green glaze	<LD	<LD	<LD	<LD	<LD	<LD	15,55	3,16	69,45	<LD	<LD	**1,41**	**<LD**	**<LD**	<LD	4,5
11B-1	Yellow glaze	<LD	<LD	<LD	0,67	<LD	<LD	15,25	4,06	60,92	<LD	<LD	**1,42**	**<LD**	**1,61**	0,64	4,0
	Creamy glaze	<LD	<LD	<LD	0,72	<LD	<LD	22,04	4,60	48,06	<LD	<LD	**1,91**	**<LD**	**1,45**	1,07	2,2
11B-2	Malachite-green glaze	0,71	<LD	<LD	1,55	<LD	0,70	15,1	2,91	59,93	<LD	<LD	**1,83**	**<LD**	**2,18**	<LD	4,0
12-1	Light-green glaze	<LD	0,73	<LD	<LD	<LD	<LD	15,09	3,95	61,27	<LD	<LD	**1,15**	**<LD**	**4,05**	<LD	4,1

Table 5. The results of semi-quantitative EDS chemical analyses [wt. %] of pigments and coloured pastes. "<LD" denotes the absence of an element or concentration below the detection limit. Chromophores are underlined.

Code of the sample	The analysed area	P	Mg	Ba	Ca	Na	K	Si	Al	Pb	Cd	Zn	Fe	Co	Cu	Ti
5C	Navy-blue frit	<LD	1,70	<LD	0,94	<LD	12,03	43,56	0,87	0,64	<LD	<LD	**2,80**	**3,63**	**<LD**	<LD
11B-3	Grained pigment	<LD	1,48	<LD	1,34	0,97	4,43	24,40	13,09	16,66	<LD	<LD	**6,93**	**<LD**	**1,04**	0,60
	Grained pigment entrenched in the base	<LD	<LD	<LD	1,79	0,60	1,92	10,19	31,82	21,13	<LD	<LD	**7,51**	**<LD**	**<LD**	0,83
	Grained pigment	<LD	<LD	<LD	<LD	<LD	1,06	56,78	0,60	1,06	<LD	<LD	**0,60**	**<LD**	**0,67**	<LD
	Grained pigment	<LD	1,37	<LD	1,79	0,59	1,92	31,82	10,19	21,13	<LD	<LD	**7,51**	**<LD**	**1,10**	0,83
	Creamy ornament	12,15	<LD	<LD	19,78	<LD	<LD	1,67	0,64	42,64	<LD	<LD	**1,31**	**<LD**	**2,20**	<LD

Table 6. The results of semi-quantitative EDS chemical analyses [wt. %] of the ceramic masses and the contact areas between semi-majolica and glazed ceramics. "<LD" denotes the absence of an element or concentration below the detection limit, "n.o." states for "not observed".

Code of sample	Localisation in the sample	P	Mg	Ca	Ba	Na	K	Si	Al	Pb	Fe	Co	Cu	Cd	Zn	Ti	Si/Al
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
5C	Ceramic mass	<LD	0,70	2,76	<LD	<LD	1,79	33,18	19,57	1,07	2,25	1,13	<LD	<LD	<LD	2,57	1,7
	Engobe (slip)	<LD	0,84	2,37	<LD	0,68	7,61	33,76	15,93	2,19	2,31	<LD	<LD	<LD	<LD	<LD	2,1
11B-3	Ceramic mass	1,36	1,64	1,87	<LD	<LD	2,05	35,67	13,54	1,15	5,72	<LD	<LD	<LD	<LD	0,93	2,6
5F	n.o.																
7C	Ceramic mass	<LD	1,29	1,90	<LD	0,82	6,76	39,98	13,19	1,05	5,91	<LD	<LD	<LD	<LD	<LD	3,0
	Engobe (?) (slip)	<LD	1,42	1,34	<LD	1,42	4,49	26,40	12,89	20,26	4,30	<LD	<LD	<LD	<LD	<LD	2,0
	Engobe (?) (slip)	<LD	1,62	1,43	<LD	1,15	3,79	27,95	10,46	15,98	4,73	<LD	1,15	<LD	<LD	<LD	2,7

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
7D	Ceramic mass	<LD	0,89	2,04	<LD	<LD	2,88	46,65	17,94	<LD	3,05	<LD	<LD	<LD	<LD	1,72	2,6
	Engobe (?) (slip) “fish scale”	<LD	0,71	1,18	<LD	<LD	4,58	34,12	17,77	<LD	2,20	<LD	0,89	0,89	0,56	2,53	1,9
	Engobe (?) (slip) light-green	<LD	0,69	<LD	2,66	0,85	4,55	27,74	16,26	16,06	2,56	<LD	0,66	0,88	<LD	5,54	1,7
	Engobe (?) (slip) light-green	0,73	0,92	<LD	4,04	<LD	3,55	36,37	21,52	<LD	3,69	<LD	0,75	1,11	<LD	4,64	1,7
	Grain in engobe (?)	0,61	<LD	<LD	1,09	<LD	<LD	60,85	1,47	<LD	1,28	<LD	0,96	1,20	<LD	8,88	–
11B-1	Ceramic mass (“the patch”)	<LD	1,12	0,90	<LD	<LD	2,89	32,04	20,49	3,45	2,56	<LD	<LD	<LD	<LD	1,17	1,6
	Engobe (?) creamy surface	<LD	0,9	0,72	<LD	<LD	3,38	27,17	18,21	12,01	2,18	<LD	0,81	<LD	<LD	3,01	1,5
11B-2	Engobe (?) under the black external glaze	<LD	1,00	1,5	<LD	0,96	3,34	36,63	16,25	2,36	2,75	<LD	<LD	<LD	<LD	<LD	2,3
	Engobe (?) under the green glaze	1,37	<LD	2,49	<LD	<LD	1,05	33,65	17,32	<LD	3,33	<LD	<LD	<LD	<LD	<LD	1,9
12-1	Ceramic mass	<LD	0,60	1,06	<LD	<LD	<LD	31,37	21,77	<LD	<LD	<LD	<LD	<LD	<LD	<LD	1,4
	Engobe (?)	<LD	0,59	0,72	<LD	<LD	1,25	23,30	16,90	15,79	1,97	<LD	0,99	<LD	<LD	5,24	1,4
	Engobe (?) the lower part	1,08	0,7	1,19	<LD	<LD	0,94	29,15	20,91	3,96	1,59	<LD	0,66	<LD	<LD	1,13	1,3

5. Discussion

5.1. The characteristics of glazes in semi-majolica and glazed unpainted ceramics

All of the tested glazes are lead-silicate ones. The advantages of using such enamels have been known for a long time. They are easy to prepare and apply and the visual effects they provide (i.e. gloss and shine) are unparalleled; however, the final effects depend on many factors. These include: the type of raw material (in the strict sense, so different substances used to introduce a given element have to be distinguished), the degree of granularity, chemical purity (in all kinds of glasses even minimal admixtures can change the properties of the product), the proportion of the ingredients, the diligence in applying paints and glazes (e.g. preventing the intrusion of air), the quality of the untreated vessel (e.g. lack of porosity), the method of firing and cooling and the cleanliness of the kiln. In practice, the adjustment of these numerous parameters has always been carried out by trial and error method (Shaw 1971).

Lead-silicate glazes first appeared in the Western world at the turn of the eras. They contained from 45 to 60 wt. % PbO, to approximately 2 wt. % alkali and between 2 and 7 wt. % aluminum oxide. Glazes of this composition were common in Byzantium and in the Islamic world (Iraq, Iran, Egypt, Mauritania), as well as in medieval Europe. At the same time, the invention of tin glazes developed in the Islamic world and although they are not discussed here, they played a significant role in modern European ceramics (Tite *et al.* 2008).

The concentration of lead in semi-majolica glazes varies between 51,24 and 71,38 wt. % and in non-semi-majolica glazed ceramics between 48,06 and 74,33 wt. %. The lowest Pb value was recorded in the opaque glaze (sample 11B-1). The Pb:Si ratio varies between 2.4 and 5.2 in semi-majolica glazes and between 3.1 and 7.3 in other glazes. The only exception is, again, the opaque cream glaze of sample 11B-1, where Pb:Si is 2.2. Consequently, it is evident that glazes with a high amount of Pb, i.e. soft and not very viscous, were clearly preferred. In some cases there is a difference between external and internal glazes of the same vessel – they differ not only in color, but also in the Pb:Si ratio. These were simply different glazes (Fig. 1). The one exception in the set is the glaze in 7D sample, which contains cadmium and zinc.

The composition of the studied glazes is very similar to the composition of the glazes from medieval workshops in Przemyśl (Auch 2016), while at the same time it clearly differs from the composition of Iznik glazes that were popular in modern Europe (Paynter *et al.* 2004). Furthermore, the above-presented composition varies, although to a lesser degree, from the composition of Mauritanian glazes from medieval Spain (Molera *et al.* 2001).

On the surface of some glazes, there is a very thin, several micrometers long, uninterrupted layer deficient in PbO. Higher concentration of silica enhances glaze firmness and its resistance to external factors: abrasion and the influence of acidic or alkaline substances. Since this layer is very thin, probably due to lead evaporation

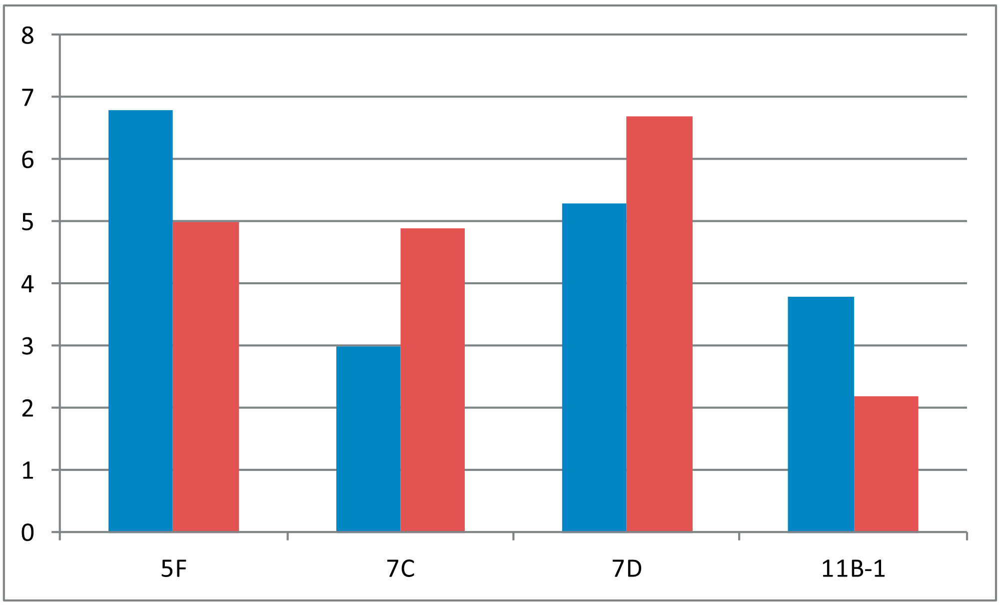


Fig. 1. The graph showing Pb:Si differences in glazes applied on internal (left post) and external (right) surfaces of the examined vessels.

in the last stage of the firing process (Tite *et al.* 1998), it is difficult to say whether the above-mentioned procedure was intentional. Such layers are present in three samples (Table 3, 7).

Among the components of glazes, one can distinguish intentionally added aluminosilicates, in the form of suspension composed of kaolinite, smectite or other argillaceous minerals. The aim of such a procedure was to improve the rheological properties of the glaze, its adhesive capacity and ensure clogging of the on the surface of the vessel. The amount of added clay depended on the firing conditions and was regulated experimentally by the glazer (Rada 1993; Shaw 1971). Proving the use of such a suspension is not an easy task. The elements of the added argil and those present in the ceramic mass can be, and usually are, identical. Experimental studies (Molera *et al.* 2001) show that the use of argil in glazing sets results in a narrower area of contact than otherwise, but in order to perform a valid interpretation, it is necessary to have a point of reference, and this may be difficult in the case of archaeological material.

We can, however, look at the amount of aluminum in the glazes and ceramic masses. The amount of aluminum in the studied glazes varies between 0.79 and 1.26 wt. % in semi-majolica and between 2.00 and 4.60 wt. % in glazed ceramics moreover, it is the highest in the atypical opaque glaze (sample 11B-1). The comparison of aluminum concentration in enamels and ceramic masses reveals clear differences between the two ceramic groups (Fig. 2A). In semi-majolica, there is a lot of aluminum in ceramic masses in relation to enamel, whereas in unpainted ceramics there is much less aluminum. The conclusion drawn from this situation can be twofold. First of all, semi-majolica was produced on biscuit (hence the slight diffusion of aluminum into the enamel), while the enamel of the remaining ceramics was applied to the unstable, unfired base. Second of all, a certain amount of argil was added to the enamel masses of the unpainted ceramics.

The comparison of Si/Al proportions of glazes and ceramic masses also reveals a clear difference between semi-majolica and unpainted glazed vessels (Fig. 2B). The Si/Al ratio in ceramic masses is an estimated (i.e. with the exclusion of cations) characteristic of the argillaceous minerals found in it. The Si/Al ratio in glazes may reflect the presence of these elements resulting only from their diffusion into the enamel, but also the presence of additional aluminosilicates in the suspension or the glazing frit, as well as the application of the enamel to the unfired base (greater diffusion of Al, Si). The high Si/Al value in all glazes is due to the presence of silicon with sand or frit. However, significantly higher concentration of silicon in glazes of semi-majolica than in their ceramic masses, when both are compared with other ceramics, does not result from the use of exceptionally large amounts of silica (Table 4), but from the lack of (or weak) diffusion of silicon into the enamel. Regarding the similar concentrations of Al in the glazes of semi-majolica and other ceramics, as well as such a distinct diversification of the factors discussed above, the differentiation is due to the fact of firing (or lack thereof) the vessels, rather than the potential admixture of argil into the glazing suspension. Importantly, the argil was incorporated into the glazing suspension only in one case, namely the matt, creamy glaze of sample 11B-2.

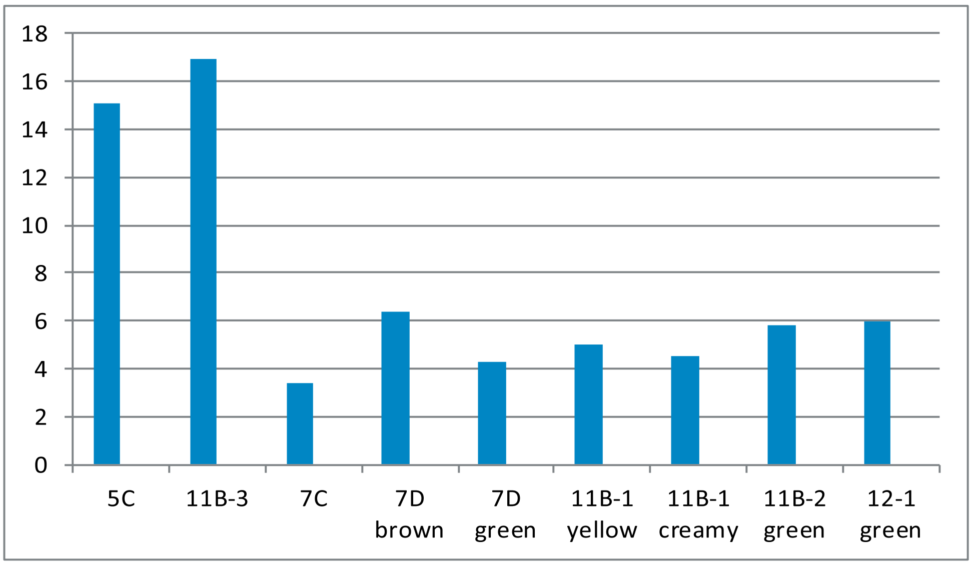


Fig. 2. The graph depicting Al paste *vs*. Al glaze ratio in tested samples.
5C and 11B-3 represent semi-maiolica.

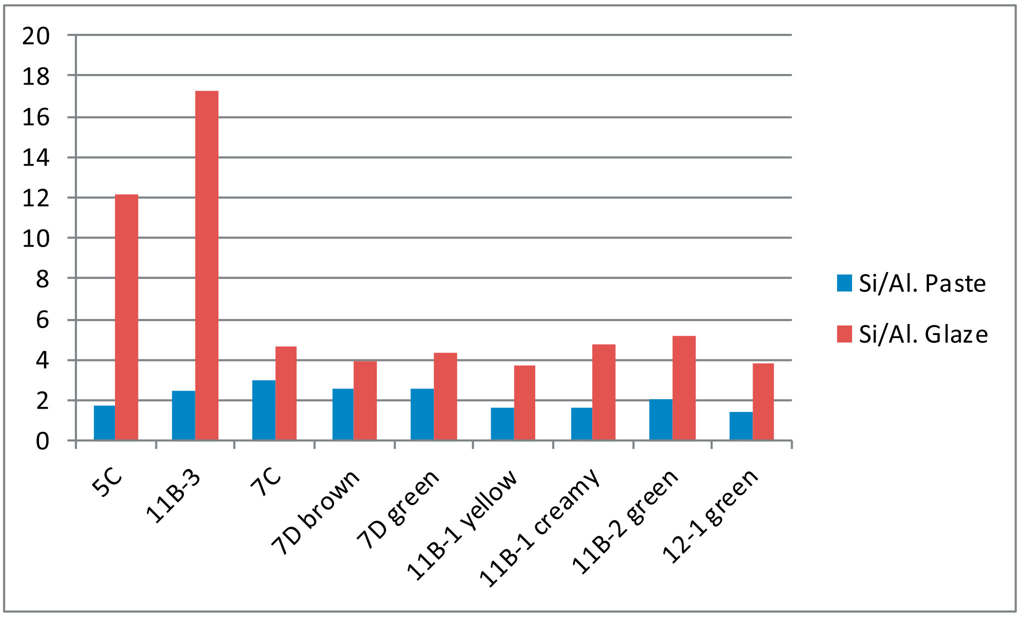


Fig. 3. The graph depicting Si/Al glaze *vs*. Si/Al paste ratio in tested samples.
5C and 11B-3 represent semi-maiolica.

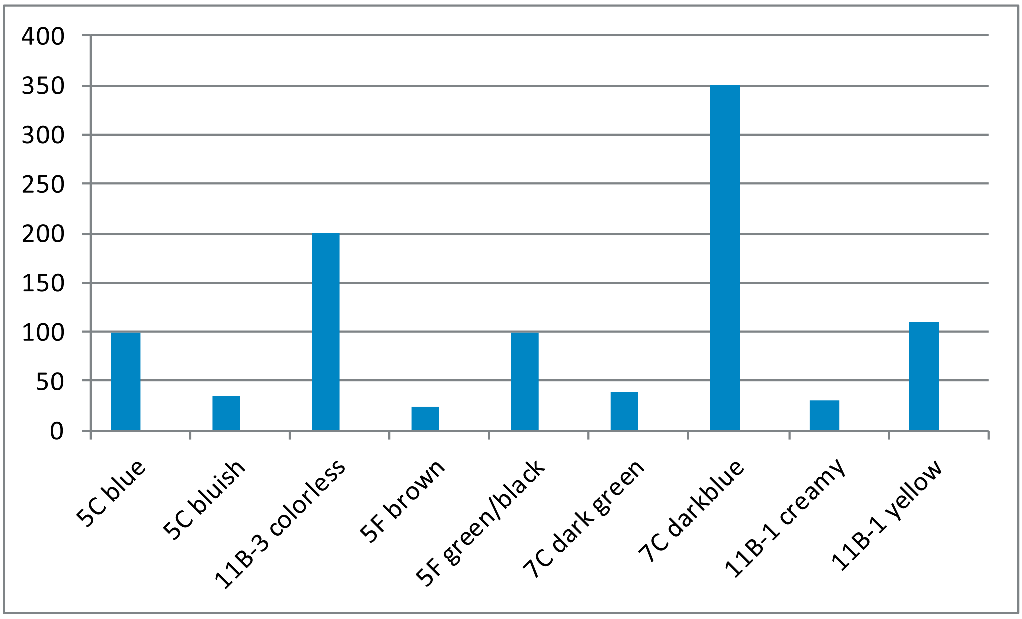


Fig. 4. Diversification of glaze thickness expressed in micrometers (vertical axis).

The thicknesses of the glazes vary, also within the outer and inner sides of the same vessel (Fig. 4). According to the authors, this may be an individual trait of a workshop or a glazer.

Lead for glazing could also be used in the form of lead-silicate frit or as a powder of lead oxides: red lead, lithargite, massicot or basic lead carbonate, white lead. These substances were not only by-products of silver purification in the cupellation process, but also deliberately produced semi-raw materials included in the trade turnover (Rozmus 2014). In all probability, the raw material was extracted from intensively exploited Silesian-Cracow deposits, but other locations should also be taken into account, namely the areas of present-day Ukraine, specifically, the region of Truskawiec (Dobis 1938) and the Świętokrzyskie Mountains, where galena was exploited from the 14th century (Rubinowski 1971). This issue can be solved through lead isotope testing and archival research. The analysis of the latter could help to determine the type of raw material purchased:

whether it was red lead, massicot, lithargite, white lead, or galena, or the unpurified or poorly purified product of galena and sphalerite weathering. Only in one case (sample 7D) it can be stated that the latter situation actually took place. This is indicated by the presence of cadmium and zinc. The most probable source of these elements is cadmium-bearing calamine, which should not be present in lead compounds (oxides and carbonates) purified in metallurgical processes. In the weathering area near Olkusz, where lead and silver, and since the 18th century also zinc minerals were exploited from the surface, cadmium has been present in the amount of approx. 1000 ppm, as an admixture in ore minerals (Mayer *et al.* 2001).

Glass sands are usually found near Tarnobrzeg and Roztocze (Kozłowski 1986, 367). It is a valuable and rare resource. Nevertheless, it was also possible to use more accessible, inferior (i.e. containing a small percentage of iron compounds) sands from the numerous dunes in the Sandomierz Basin (Kociszewska-Musiał 1988, 64). The exact source of sands can be precisely identified only by means of trace element analysis.

In one case (semi-majolica, sample 5C), lead-silica frit is detected in the glaze. Therefore, the frit was treated as a semi raw material for glazes. Its production site is obscure, but it could have been manufactured on site. Further research, especially concerning the potential discovery of crucibles with frit remnants, could possibly resolve this issue.

It should be stressed that the concentrations of lead and silica in the glaze are by no means a simple reflection of the concentration of these elements in the raw material. Molera *et al.* (2001) have demonstrated that, generally speaking, the amount of silica in glazing increases and the amount of lead decreases in relation to the raw material, but depending on the initial proportion, the final ratios might be variable. Thus, it is impossible to strictly determine the amount of raw material used solely on the basis of the information concerning the chemical composition of the glaze.

5.2. The characteristics of the glaze-base interaction in semi-majolica and unpainted ceramics

The preparation of the base in the process of decorating the vessel was of various nature. It consisted in levelling the surface by smoothing, repairing defects with "patches" of clay (which can be observed in one of the tested samples) or applying slips of different compositions. Furthermore, the relevant literature mentions the application of suspensions made of plant ashes, greasy argil or flour and water (Walton and Tite 2010; Herakliusz see Auch 2016). All these measures were aimed at increasing the adhesiveness of the base to the applied layer and obtaining optimal aesthetic results.

A typical slip (engobe) was used in the semi-majolica with a light grey cross-section (sample 5C). It is a thin layer composed of fine-grained quartz grains that are homogeneous in terms of size that have been mixed with clay minerals. High potassium content, in relation to the ceramic mass base, suggests that raw plant ash, potash or cream of tartar (potassium hydrogen tartrate, obtained during wine production) could have been used. The use of a specially selected argillaceous mineral, rich in potassium (white illite clay), is also likely, albeit such claims transcend the results obtained by this study, since we did not observe the presence of potassium feldspar grains. Potassium, which was used as a flux, increased the adhesion of the slip to the ceramic mass. Often described as 'slip-painting', they are viewed as predecessors of polychromatic under-glaze decoration. After the year 1200 A.D., the use of under-glaze paints without quartz began in Iran (Mason and Tite 2007).The "slip-painting" priming was also applied in the semi-majolica with a dark-red background (sample 11B-3). Here, the base of the glaze, which is responsible for its distinct color, is made of a layer of various, evenly-grained frit pigments (this will be discussed later on), mixed with a handful of quartz grains.

Sophisticated surface treatments for glazing are also observable in the case of glazed ceramics. Here, the base is made of ceramic mass enriched with certain elements (K, Na, Ba, P, Fe, Ti) or an argil "patch", whose structure is different from the structure of the base (i.e. the proper ceramic mass). In all of the above cases, plant ash suspension could have been used, but other substances, such as cream of tartar should also be considered. Furthermore, a very thin layer of potassium or sodium-bearing argil (i.e. white illite, smectite or a mixture of both of them with kaolinite) may also have been used. The inclusion of particular clay is indicated by the presence of titanium. All of the above-mentioned elements, with the exception of titanium, act as a flux and facilitate the binding of the enamel with the base. Iron compounds found under the green glaze of the sample 7D also rectified the color effect of the glaze.

The contact areas between the ceramic mass and the glaze are crucial, when it comes to the physicochemical properties of the vessels. They are responsible for the appearance of the glaze and its adhesion to the surface, and therefore, for its stability. The contact area includes the near-surface section of the ceramic mass, whose chemical composition and morphology differs from the proper ceramic mass, as well as the dendritic-crystals section, which is located within the glaze (Shaw 1971). Currently, attempts are being made to interpret the conditions of vessel production on the basis of the width of contact areas, but due to the multiplicity of factors influencing the process, conclusions must be drawn very carefully (Tite *et al.* 1998) and this should be heavily emphasized.

The breadth and continuity of the secondary-crystals area, as well as their chemical composition stem from the following factors: the reaction between the aluminosilicates in the base (ceramic mass with a specific, not accidental mineral composition) and the glaze which has a specific, not accidental chemical composition, the temperature of firing, the firing and cooling time (Shaw 1971), the application of the glaze to the unfired base or to the biscuit and the use of argil in the glazing suspension (or lack thereof) (Molera *et al.* 2001). In accordance with a well known phenomenon in both natural and technological processes, the higher the firing temperature and the longer the firing and cooling time, the thicker the reaction area becomes and the bigger the crystals get. It has been experimentally proven that under the same firing conditions, the thinnest area will be the one created on the kaolinite base. When extremely high-lead glazes (Pb:Si = 9) are used, the crystal area fills in the entire volume of the glaze. Crystals formed on the base of non-calcareous raw material are lead aluminosilicates, but their composition is highly diversified within the glaze itself (Molera *et al.* 2001).

Glazed ceramics from the investigated set are similar in terms of the width of the contact areas, regardless of the type of base used, glaze thickness and Pb:Si ratio. The width of the contact area within the ceramic mass oscillates between 30–50 micrometers, however, in two cases (the external glaze of sample 11B-2 and the glaze of sample 12-1) it can be up to 100 micrometers. The area covered with dendritic crystals is up to 10 micrometers, except for the opaque glaze of sample 11B-1, where crystals fill in the entire volume of the glaze. Despite having identical thickness throughout, the contact area is characterized by varying continuity, which points to disruptions in the technological process. It cannot be asserted that the firing conditions were identical, but it can be assumed that the process was carried out in such a way as to achieve a specific result for ceramics and glazes of different composition. The results have always been obtained through practical tests, which still take place in small workshops (Shaw 1971). The number of firing sessions is still to be determined. In the case of unpainted glazed ceramics, the unevenness of the base (Table 2) indicates the application of the glaze to an unfired vessel and single firing. This is further confirmed by the difference in proportions of aluminum in ceramic masses and glazes of semi-majolica as well as ordinary glazed ceramics and the variation in Si/Al proportions (Fig. 2).

The firing temperature would have to be about 850 –900°C, as evidenced by the properties of the ceramic mass (i.e. isotropization, but not vitrification). This seems plausible. In the case of semi-majolica, where the surface treatment was fairly sophisticated, the firing was at least double. The light grey semi-majolica vessel (5C) was fired in conditions with restricted access to oxygen or reduced oxygen, then decorations were applied and the vessel was fired once again. The red vessel (11B-3) was treated in a similar way. The melting of some pigments from the 'slip-painting' area into the ceramic mass base was probably due to the high concentration of flux, i.e. iron. For this vessel, one more firing was performed, in order to consolidate the creamy strip of the glaze ornament.

5.3. Characteristics of the colored elements: ornaments and glazes

The color palette of the examined fragments is rich. The coloring effects were obtained by means of pigments and glazes, the shade of the ceramic mass and the color of the slip. In semi-majolica, both under-glaze ("frit pigments") and over-glaze ("cream sinter ornament") decorations were used.

As regards the light grey semi-majolica vessel (5C), here, the slip described elsewhere was used. The grains of quartz amplified the transparency effect by extending the path of light rays, while the argillaceous components, which turned yellowish after firing, optically warmed the background. On top of all this, there was the effect of bluish glaze achieved with the use of cobalt and iron. It should be mentioned that glazed ceramics with a bluish background were a popular product of Ottoman workshops in Iznik in the 16th century (Denny 2004, 129). The deep red of the semi-majolica 11B-3 is created not only because of the color of the ceramic mass, but also due to the layer of frit pigments (which are described below). In the case of glazed ceramics, the base enriched with iron (7D) also modified the green shade of the glaze.

The color effect of the glazes depends on several factors: the chemical composition of chromophores, the concentration of chromophores and the chemical composition of the environment in which they are immersed, the color of the base and the degree of transparency of the glaze. We have access to the information concerning these parameters; in most cases, however, we do not know exactly which raw materials were used, and this is also an important factor affecting the final color effect (Shaw 1971).

Table 5 summarizes the chemical composition of the colored parts, highlighting the elements responsible for the coloring. Cobalt, iron and copper, in various configurations, act as chromophores – iron is the stand-alone chromophore in four cases, while copper assumes such a form in one case. In the remaining cases, iron and copper always co-exist and so do iron and cobalt. Hence, the question arises, whether such a composition of coloring substances is a consequence of not purifying the raw material from iron (which in turn, indicates their cheapness or the use of impure sand in local workshops) or whether it was a conscious purchase, motivated by aesthetic reasons. It is evident that the application of different proportions of chromophores (e.g. iron and copper) yields decidedly different color effects (e.g. malachite green *vs.* apple green), thus it can be assumed that pure pigments mixed in the desired proportions were used in some cases.

In the set of the examined samples, we observe as many as three distinctly different shades of green: dark bottle-green (7C), apple green (7D and 12-1) and malachite-green (11B-2). The bottle-green glaze is the only one that contains exclusively iron, while the remaining glazes contain iron accompanied by copper. More specifically, the malachite-green glaze has a Cu:Fe ratio of 2,18:1,83 wt. %, while the apple-green glaze has ratio of 4,05 to 1,15 wt. %. Also, the malachite glaze contains calcium and sodium – they might be used as modifiers of the green shade, together with iron and copper (Table 4).

The cream, opaque glaze on the surface of the vessel 11B-1 was created owing to the presence of numerous crystals of lead, potassium, iron and calcium aluminosilicates. These crystals were formed through the reaction of the base components (ceramic mass) and the glaze, including the argil that was added to the glaze. Based on the rather elegant appearance of this surface, it can be assumed that this effect was achieved intentionally, by long firing and cooling of the vessel. Perhaps it was an attempt to imitate tin-lead glazes used in Italian majolica, and other derivative products.

The next question concerns the form in which the coloring agents were added. The morphology and composition of the granular substances indicate that the coloring agents in both examples of semi-majolica were certainly added in the form of frit pigments. The grains of cobalt frit (sample 5C), the outline of which is still visible despite its strong tendency to melt away, are very large in comparison with the grains of frit used in sample 11B-3. Cobalt frit (smalt) is a silicate potassium glass, with a high concentration of iron, used in addition to cobalt. The correlation between the grain size of pigments (including cobalt pigments) and the intensity of a given color is well-known, as it was described by Johannes Kunckel (Estaugh *et al.* 2005), an 18th century glazier and alchemist. To illustrate, large grains of cobalt glass are known to produce a navy-blue color, which is observable in one of the analyzed examples.

In view of the fact that Podkarpacie region has no cobalt deposits, such pigments were undoubtedly imported. While the discussed pigments were known since antiquity, the 16th century brought a breakthrough in their production. More to the point, in 1520 various cobalt oxides (zaffre) were created, whereat the year 1540 brought the invention of cobalt glass, i.e. smalt. Cobalt pigments were certainly produced in Saxony and the Bohemia from the raw materials in the Ore Mountains. Cobalt was mined in Saxony from 1470, and the first mill for the grinding pigments was built there in 1635. The production and trade of cobalt pigment turned out to be so profitable that the Saxon elector taxed it, at the same time issuing a strict ban on any private activity concerning the above-mentioned substance. By 1654, 34 mines were already in operation (Hammer 2004). The prices of smelt remained at an average level (Harley 1982).

Another large cobalt deposit, Qamsar, was located in central Iran (Zucchiati *et al.* 2006). It supplied the eastern market, including the entire Muslim world. Due to the wide use of cobalt pigments in Eastern ceramics (including Ottoman ceramics), cobalt frit producers in this part of the world must have been plentiful. Certainly, the cobalt pigments from this deposit were also sold on European markets (Matin and Pollard 2015). Cobalt from Levant, in the form of cobalt oxides (zaffre), was marketed in Europe *via* Venice (Saliba 2004). Smaller deposits of cobalt are relatively numerous, both in Europe and in the Middle East. Among the former, one can mention the Lower Silesian Przecznica (Łodziński *et al.* 2009), and Saxony, which imported cobalt ores from Italy and Hungary in the 19th c. (Hammer 2004). After initial processing, all the mining output was transferred to pigment manufacturers and traders. A number of issues, including establishing the exact locations and numbers of European pigment trade centers, as well as pinpointing the differences between their products (such as cobalt pigments) has yet to be resolved, as it is insufficiently researched.

The dark red background of the second majolica vessel (sample 11B-3) was created by the application of a mixture of frit pigments. All of them were made on the basis of lead-silicate enamel mixed with aluminum and potassium. They are therefore fundamentally different from cobalt frits, as they are dominated by dark red pigments that are high in iron. Apart from the red pigments, there are also blue pigments with copper and colorless pigments with a very small amount of chromophores. The observed diversity is either the result of using a mixture of pigments in order to achieve the expected effect or it was caused by brush contamination. The grains were evenly distributed on the base, and then the glaze was applied. The form in which the grains were applied remains unknown. Despite very high lead content, the glaze was not viscous enough to penetrate the pigment area and blend well with the base, which led to the emergence of defects that can be observed macroscopically. In all probability, the firing temperature was too low. Ceramics with underglaze decorations, that contain pigments used without a medium that would have been preserved until now, appeared for the first time in Islamic Syria (Mason *et al.* 2001).

The pigments identified in the "slip-painting" layer in the dark red half-majolica are different from the smalt described above. They are very fine, evenly-grained, angular or slightly rounded. Their Pb:Si ratio is different than in the glazes, in favor of the amount of silicon. The high amount of aluminum, which hardens the frits enamel, is also noticeable. Unfortunately, no data on this type of pigment can be found in the literature. Consequently, the place of their production remains a mystery.

As attested by the monk Teofil (1998), frit pigments have been widely used by glaziers since at least the Middle Ages. Notwithstanding, raw mineral pigments were also exploited, such as chromite found in Islamic ceramics (Tite 2011). Copper pigments could have been produced on site from patina or slag that was left over from metal smelting; they could also be imported (not necessarily from a distant region – e.g. from the Świętokrzyskie region, Rubinowski 1971) as mineral coloring agents. Furthermore, they could be a result of fritting in workshops. The same applies to iron and iron-manganese pigments. In each case, the pigments had to have a certain, unified grain size. Attaining this result required a lot of experience.

The composition of the creamy ornament on the semi-majolica with a dark red background (sample 11B-3) is interesting. It consists of calcium phosphate, lead and silicon, as well as iron and cobalt. The structure of this paint is not homogeneous ‑ it is not enamel, but a sinter. The surface of the ornament is blurred, sometimes clearly blistered, in short – defective.

Using phosphorus as an opacifier of glasses and enamel and for the production of white glasses and enamel is an old technological custom, known from tesserae in ancient mosaics (Silvestri *et al.* 2016), the Byzantine glass-making traditions (Maltoni and Silvestri 2019), as well as Venetian and Islamic workshops (Wypyski 2006). Experimental studies have shown that obtaining impeccable results requires pre-calcination of bone meal at 700°C (Maltoni and Silvestri 2019). In the semi-majolica from Rzeszów, the achieved effect is unsatisfactory; hence it should be seen as an unsuccessful attempt to make ornaments in this way. Defining the conditions for the production of this ornamentation requires further research by means of Raman spectroscopy, which will enable the phase identification of the components and thus the reconstruction of the conditions under which the product was manufactured.

We should also mention the red stripe ornament on the bluish semi-majolica (5C). Here, the convexity effect was achieved by putting a narrow layer of argil on the base. It was only then that the frit pigments were applied. Unfortunately, this treatment did not contribute to the durability of the ornament.

5.4. Ceramic masses

The first features of ceramic masses that can be seen in macroscopic view are their fineness and color. In the case of semi-majolica, the vessel with grey cross-section (5C) was made of clay characterized by kaolin-illite-smectite composition. A small amount of Ca is probably a natural component of the clays. In the second fragment of semi-majolica (11B-3), illite and smectite (or illite-smectite) clay(s) was/were used, with double amount of iron and lower calcium content, when compared to sample 5C.

In the set of glazed unpainted ceramics there are at least four fragments in which the ceramic mass is, or was intended to be, white-fired. In all cases, the ceramic mass is made of kaolinite-illite clay, as evidenced by the high concentration of aluminum and the low value of Si/Al ratio, the presence of which results from the chemical composition of kaolinite (cf. Fig. 2B). The whitest clay (sample 12-1) has iron concentration below the detection limit, while the grey ones (7D, 11B-1) have iron concentration of approx. 2–3 wt. %. This which translates into the grey effect during reduction firing or firing with limited oxygen access.

The ceramic base of glazes cannot be porous or vitrified. To eliminate the first problem, colloidal smectite was sometimes applied to the surface, as it clogged the pores. In order to remove moisture from the base, vessels were sometimes heated (Shaw 1971, 49). Different bases required different consistency (viscosity) of the glazes, and the consistency was determined by means of experiments. The composition of ceramic masses was marked near the decorated surfaces; hence it usually contains a small amount of lead, or alternatively, also chromophores (Table 4–6).

The surfaces for decorations were prepared with varying degrees of precision, from carefully smoothed (half-majolica, vessel 12-1), to vessels with uneven surfaces, even patched (11B-1). Other surface modifications have been discussed above. No frits were observed in the ceramic masses, except for the 7D sample, where the presence of irregular, randomly distributed enamel grains, was detected. On the one hand, the above-mentioned example is reminiscent of the 'fritware' technique, used in experiments with proto-porcelain in the East and West (Mason and Tite 2007), but on the other hand, the presence of the grains might have been an accident.

The potential raw materials used for the production of ceramic masses are abundant in the Podkarpacie region. These include mainly the tertiary (usunąć Baden) Cracovian loams, but also fluvisol and other quaternary raw materials. White-burnt clays, composed of kaolinite (approx. 60%), illite (approx. 25%) and quartz (approx. 15%), are found in the Świętokrzyskie region's jurassic deposits. The clays of similar composition were also known to exist in the vicinity of Cracow (Budkiewicz and Tokarski 1971). A detailed identification of the place of origin of the raw material (and perhaps also the mixing of its several types) will be possible after detailed analyses of the raw material are performed.

5.5. Defects of the glazes and corrosive phenomena

On and within the surfaces of many glazes there are unintentional defects resulting from production, use and post-depositional history. Open bubbles with micro-crystals composed of lead and iron, and probably also oxygen, occur in the glaze of the semi-majolica (5C) – these are the black spots visible in the macroscopic photograph. They were formed when the vessel was in the kiln or as a result of other burning-related actions, e.g. a fire.

Open and closed bubbles in the glaze are also present in samples 7C and 11B-1, in both cases within the thickly applied navy-blue and yellow glazes, respectively. The presence of these bubbles results from excessive moisture of the glazing paste, regardless of the form in which it was applied (i.e. powder or fine frit) and/or the high moisture of the base. The small flaky clusters of iron compounds that are closed within the bubbles suggest that the atmosphere of the kiln was not particularly clean. The presence of such bubbles is not the result of a fire, since in that case the glaze would drain off. The cracks in the glaze are caused by the differences in the thermal expansion of the ceramic mass and enamel. Such fractures are virtually inevitable; however, their quantity depends mainly on the adopted methods of firing and cooling (Shaw 1971, 26). The concentration of cracks near the surface of the vessels results from exploitation, but it can also stem from mechanical damage inflicted after depositing the object in the sediment.

Another variety of flaws, that is visible only under the scanning electron microscope, is the accumulation of substances partially resembling the composition of the glazing enamel. The substances are structurally connected with glazes or the ornament. As regards their morphological make-up, they assume the form of parallel, narrow, partially loosening areas. On the surfaces of two glazes, one can find black, thin areas consisting of lead, phosphorus, calcium and iron (5F) and lead, phosphorus and calcium (11B-2), respectively.

In other cases (5C, 7C, 11B-2), we have recorded corrosion areas within the external surface of the glaze, in the form of colomorphic or cryptocrystalline regions, that are either loosening from the base (5C) or are closely bound to it. When compared to the chemical composition of the glazes, they exhibit variable concentrations of lead and silicon, as well as the presence of calcium and phosphorus. The latter two are not independent residues, but together with the other mentioned elements, they create a sinter. Furthermore, they are also incorporated into needle-shaped crystals, which are composed with the addition of lead and silicon. Therefore, the presence of these elements is not an unambiguous result of their existence within the sediment. Notwithstanding, the genesis of such overlays is not clear. The composition of the creamy, opaque ornament on the surface of the glaze of the semi-majolica with the red background (11B-3) may be a hint. It is, as mentioned above, a sinter paint composed of lead, silicon, phosphorus and calcium. Such substances were widely used and could have possibly contaminated the atmosphere of the kiln. This issue can be clarified once the kiln is found and its remains are examined.

6. Conclusions

The analysis of the several fragments of vessels revealed a wealth of valuable information about the raw materials used and the production technology employed. However, due to the same circumstances, it is impossible to comment on the characteristics of the workshop(s). Such opinions can be expressed only after examining representative groups of semi-majolica and glazed ceramics from several documented sites. Similarly, only then will the comparative research on the resource base be meaningful.

Table 7. The stratigraphic diagram of the technological and corrosion layers of the examined samples („n.o." states for „not observed").

Semi-majolica		Glazed unpainted ceramics										
Sample 5C	**Sample 11B-3**	**Sample 5F External surface (brown)**	**Sample 5F Internal surface (black)**	**Sample7C External surface (navy-blue)**	**Sample 7C Internal surface (dark green)**	**Sample 7D External surface (fish scale, brown)**	**Sample 7D External surface (green)**	**Sample 11B-1 External surface (creamy)**	**Sample 11B-1 External surface (yellow)**	**Sam-ple11B-2 External surface (black)**	**Sample 11B-2 External surface (green)**	**Sample 12-1**
Thin layer of secondary changes	Thin layer of secondary changes	(–)	Black incru-station	Black incru-station	(–)	(-)	(–)	(–)	(–)	Thin layer of secondary changes	Thin layer of secondary changes	(–)
Glaze: area with increased silica content	Glaze: area with increased silica content	Glaze: area with increased silica content	Glaze: area with increased silica content	Glaze: area with increased silica content	(–)	(–)	(–)	(–)	(–)	(–)	Glaze: area with increased silica content	(–)
(–)	Overglaze ornament	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)
Glaze Pb:Si = 2,4 – 4,3	Glaze Pb:Si = 2	Glaze Pb:Si = 5,5 – 6,8	Glaze Pb:Si = 4,6	Glaze Pb:Si = 5,0	Glaze Pb:Si = 3,0	Glaze Pb:Si = 4,7 – 7,3	Glaze Pb:Si = 4,5 – 6	Glaze Pb:Si = 2,2	Glaze Pb:Si = 4,0	Glaze (n.o.)	Glaze Pb:Si = 4,0	Glaze Pb:Si = 4,1
Pigments	Pigments	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)
Slip: quartz, clay, enriched with K		(–)	(–)	Enriched with Na	Enriched with Na	Enriched with K, Ti	Enriched with P, Ba, Na, Fe, Ti	"Patch" of clay	"Patch" of clay	"Patch" of clay	"Patch" of clay	Enriched with K, Ti
Contact area	Not visible due to the pigment area	Contact area		Contact area		Contact area		Contact area		Contact area		Contact area
			The base – frit grains									
Light grey ceramic mass	Brick-red ceramic mass	Dark-brick-red ceramic mass		Greyish-cream ceramic mass		Ceramic mass with indi-vidual enamel particles		Greyish-cream ceramic mass		Greyish-cream ceramic mass		White ceramic mass

The investigated vessels were made of fine-grained ceramic mass, a part of which was evenly grained, while the other part was unevenly-grained. Its chemical composition indicates the use of smectite/illite clay, kaolinite/illite clay and kaolinite/illite/smectite clay. The basic vessels were made with care, although not without errors. The latter include the uneven surface, which required repairs ("patches") and the presence of small, fissured pores, that were occasionally irregular. The firing took place at a temperature of approx. 850–900°C, i.e. before vitrification, which hinders the adhesion of the glaze. The unpainted vessels required a single firing, whereas semi-majolica vessels were burnt twice and the vessel 11B-3 was burnt three times. Depending on the needs, the firing was carried out in oxidizing or reducing atmosphere. The latter ensured obtaining white or light grey fractures, provided that the ceramic mass incorporated iron.

The richness of the colors and shades is surprising. In the case of semi-majolica, the underglaze paintings were made with the use of frit pigments, while the overglaze ornament was made with the use of lead-phosphate-calcium-silicate paste. Apart from painting the ornaments, the "slip-painting" technique was also used. The glazes were colored with iron, copper and cobalt compounds in various compositions and concentrations, which provided different shades. In the light grey semi-majolica, quartz-argillaceous primer with a potassium-bearing substance was applied, while in the glazed unpainted vessels, the surface under the glaze was covered with plant ashes or other flux-bearing substances, which did not leave any micromorphological traces.

It should be noted that the chemical compositions of glazes and ceramic masses and the methods of conducting the firing process, are closely related. Therefore, relying solely on the results of chemical analyses of the glazes in order to differentiate the set, draw conclusions about the characteristics of the workshops and indicate the sources of raw material may lead to erroneous conclusions. Identifying the types of raw materials, in the strict sense (e.g. galena *vs.* red lead), on the basis of the studied chemical composition is risky - the fact of obtaining different effects from different raw materials carrying the same element is well-known. Good knowledge of recipes is based on the good knowledge of specific ingredients, not the chemical composition, as emphasized by glazing technologist (Shaw 1971, 52).

The technological traits of semi-majolica described above suggest that the sources of aesthetic and technical inspiration behind it might not necessarily be found in the West. In this respect, its similarity to Eastern items is clear, especially regarding the features of the ornamentation. Eastern ceramics were known in the Western European world (Denny 2015), including Hungary, where they appeared even before the Ottoman occupation (Gerelyes 2008). Needless to say, the influence of the Islamic ceramics on the Italian Renaissance majolica and the popularity of both throughout Europe are well-documented (Greenberg (ed.) 2004).

The research problems that arise during the examination of the Podkarpackie semi-majolica sets and glazed unpainted ceramics concern the basic technological features and their similarity to the ceramics from other significant western and eastern centers. Additional issues, such as the provenance of raw materials and the direction of trade routes are also pivotal and again, both should be taken into account. In this aspect, it seems crucial to combine the results achieved by dint of archaeometric research and archival studies.

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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

Grupa M., Łukaszewicz J.W. 2019. Silk band and metal appliqués of a child's bonnet from the northern crypt of the parish church in Gniew. *Analecta Archaeologica Ressoviensia* 14, 137–153

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

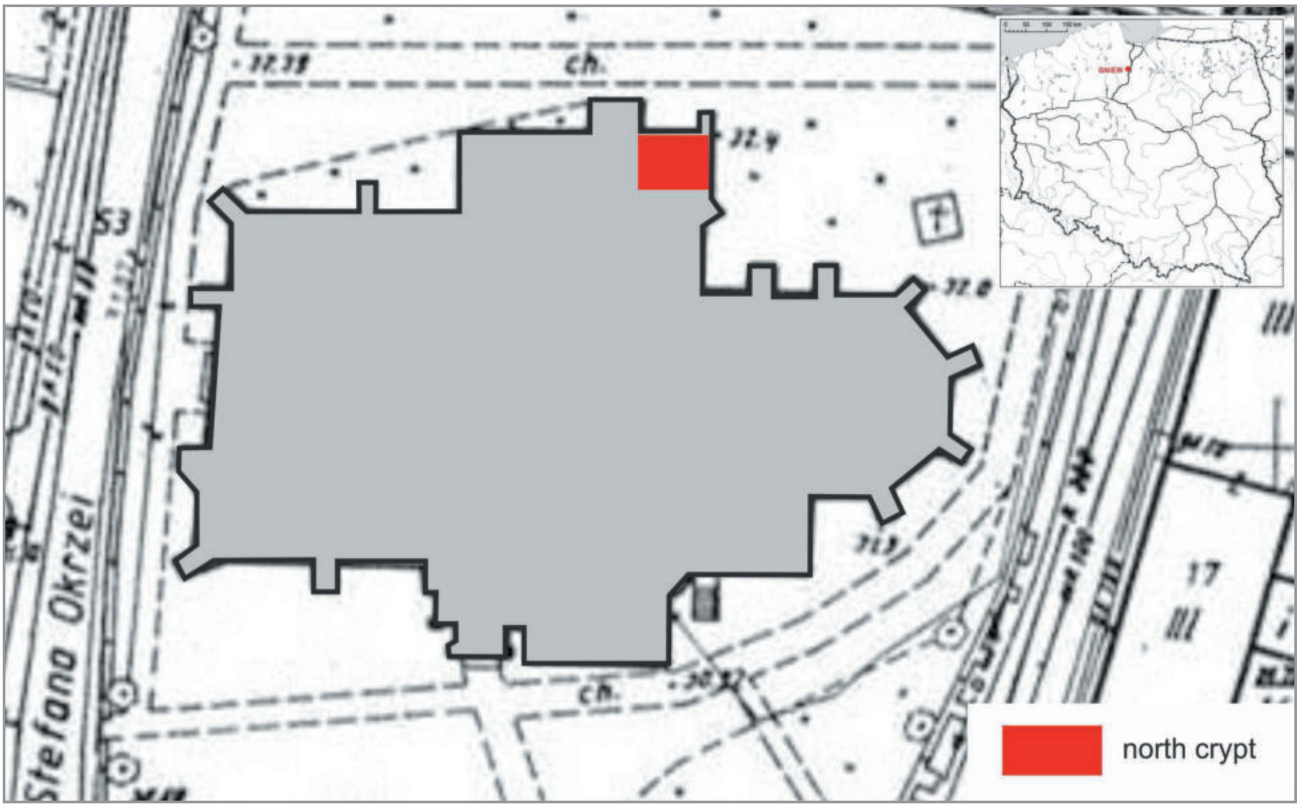


Fig. 1. Gniew, St Nicolas church, The crypt location inside the church. Gniew location on the map of Poland (dig. T. Dudziński).

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).

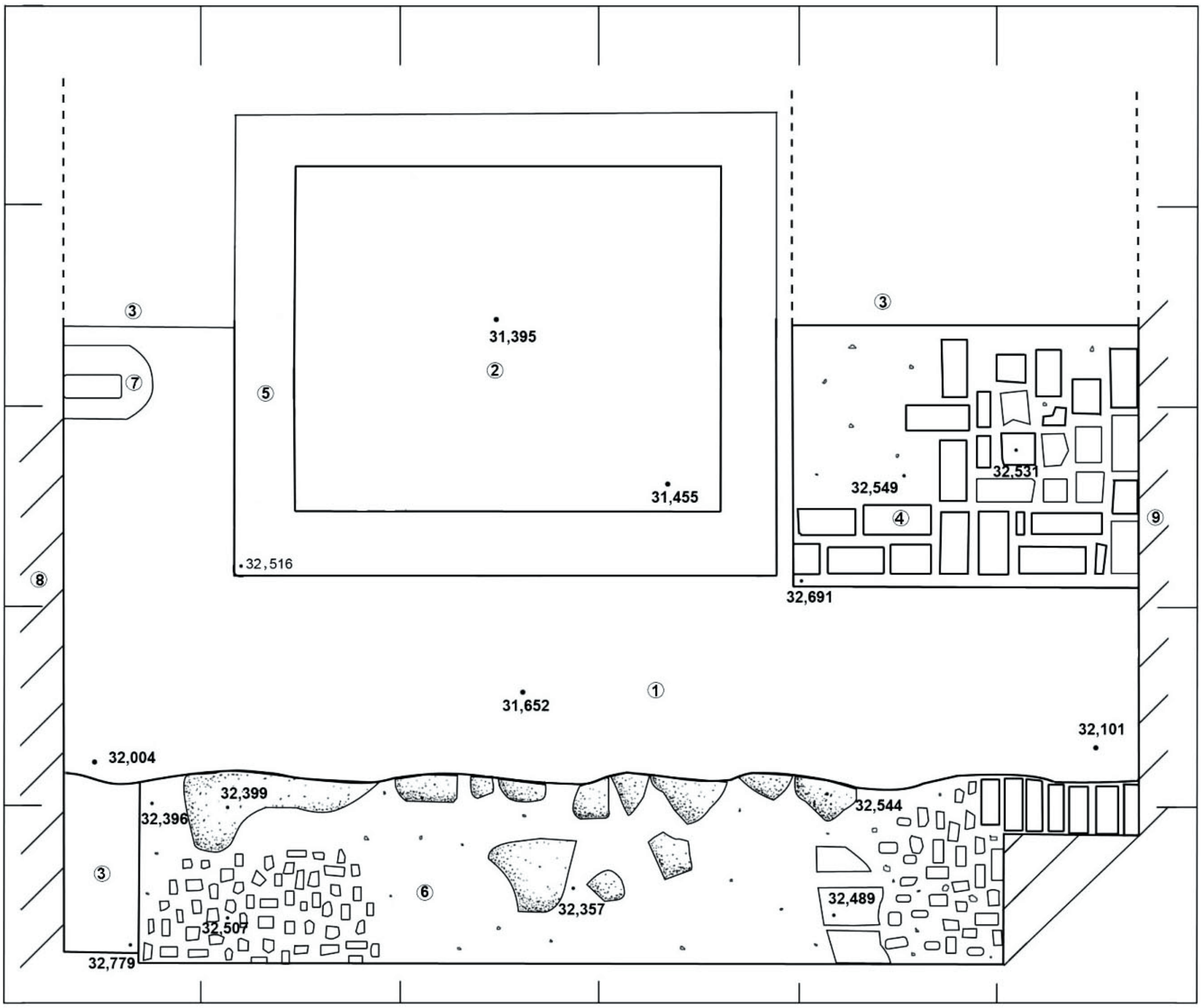


Fig. 2. Gniew, St Nicolas church, northern chapel, Projection of a trench bottom on the level (AMSL) in northern chapel after excavating architecture relics. Captions: 1. bright brown humus with sand, 2. mixed brownish humus with sand, crypt filling, 3. floor of northern chapel, 4. brick floor, 5. crypt 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).

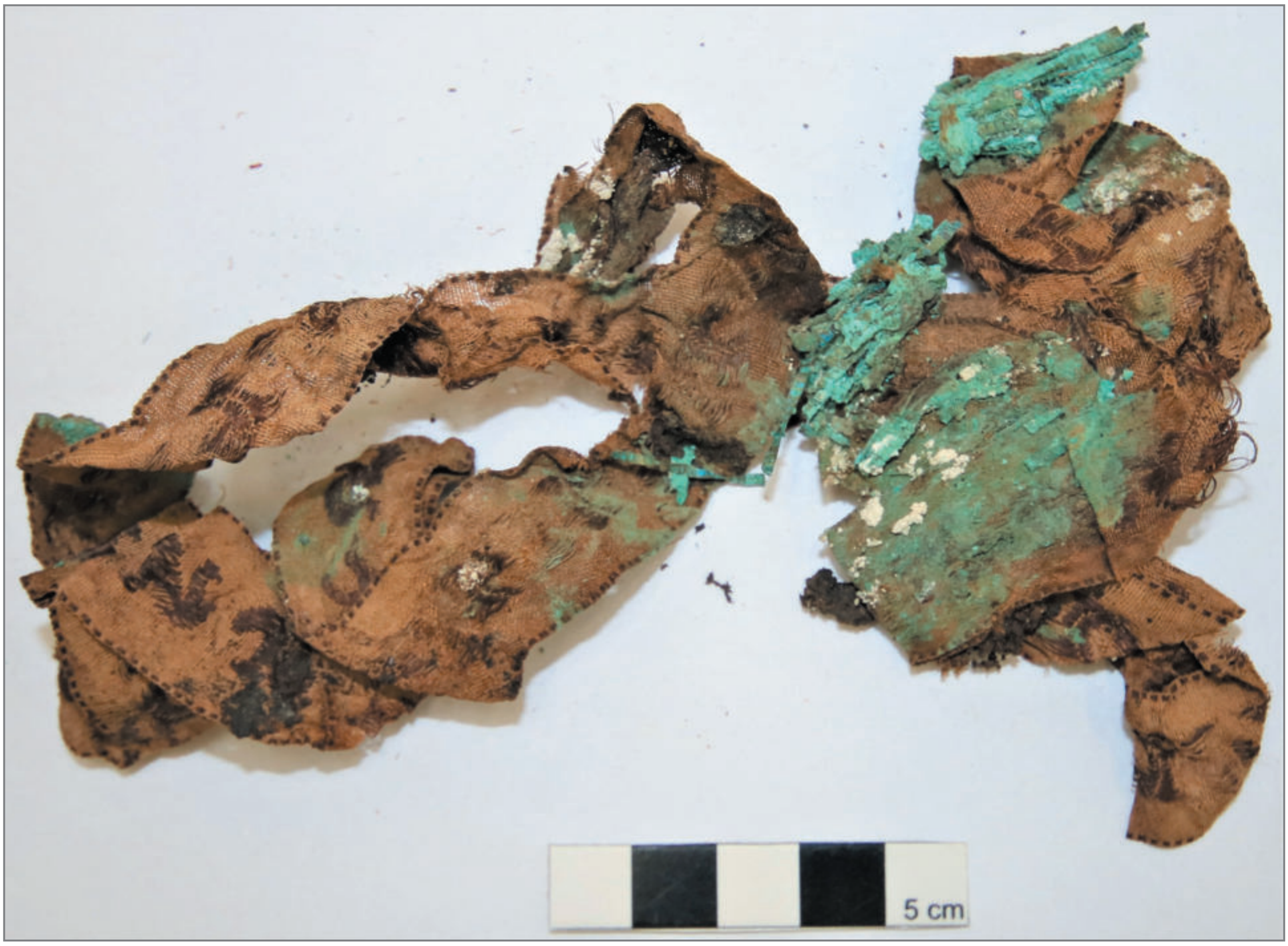


Fig. 5. Gniew, St Nicolas church, northern crypt, Band and metal appliqués from a child bonnet (photo D. Grupa).

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

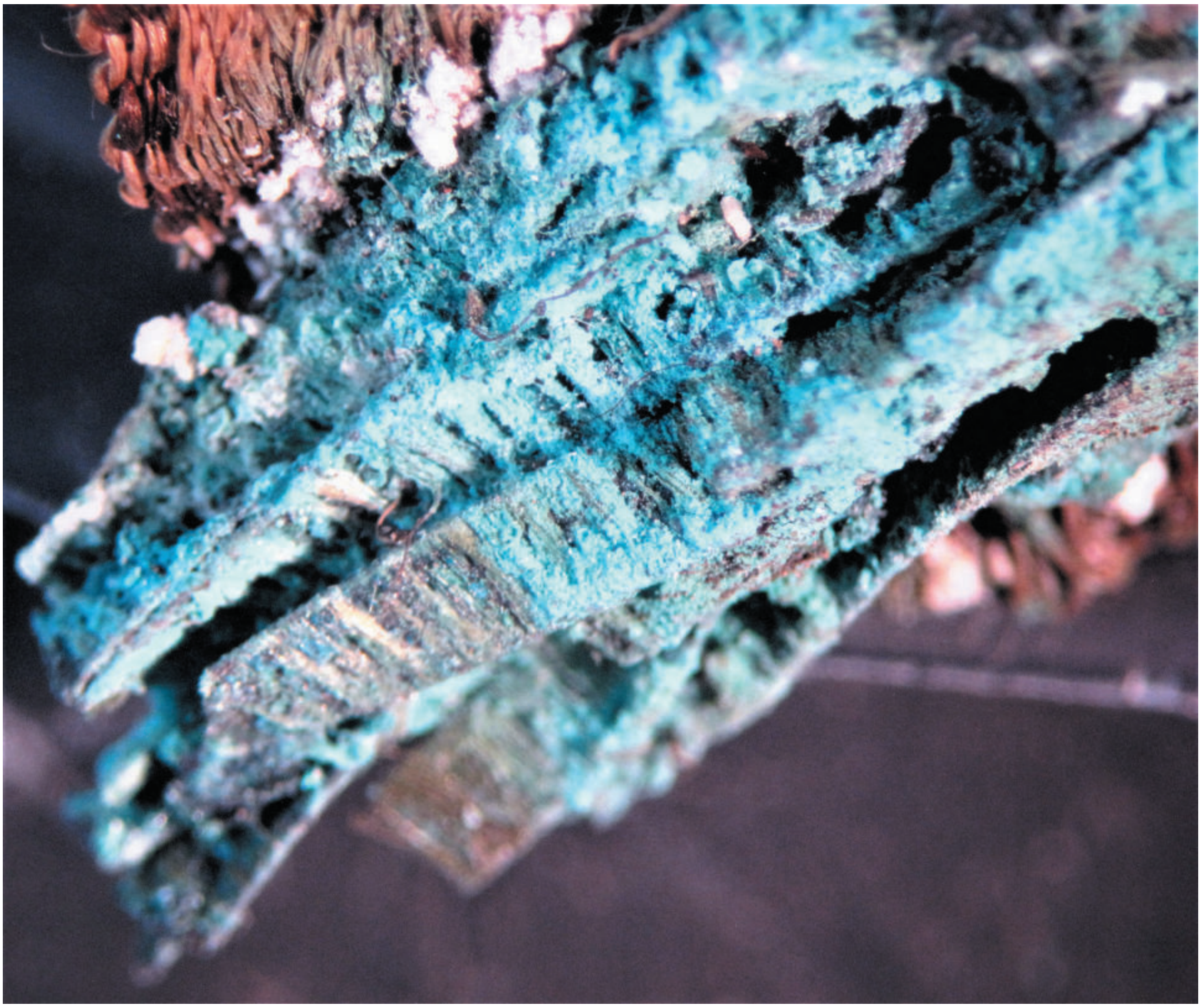


Fig. 6. Gniew, St Nicolas church, northern crypt, Metal appliqués wound round with thread from the bonnet band, magnification 10× (photo D. Grupa).

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 organic 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 fibrolin 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.

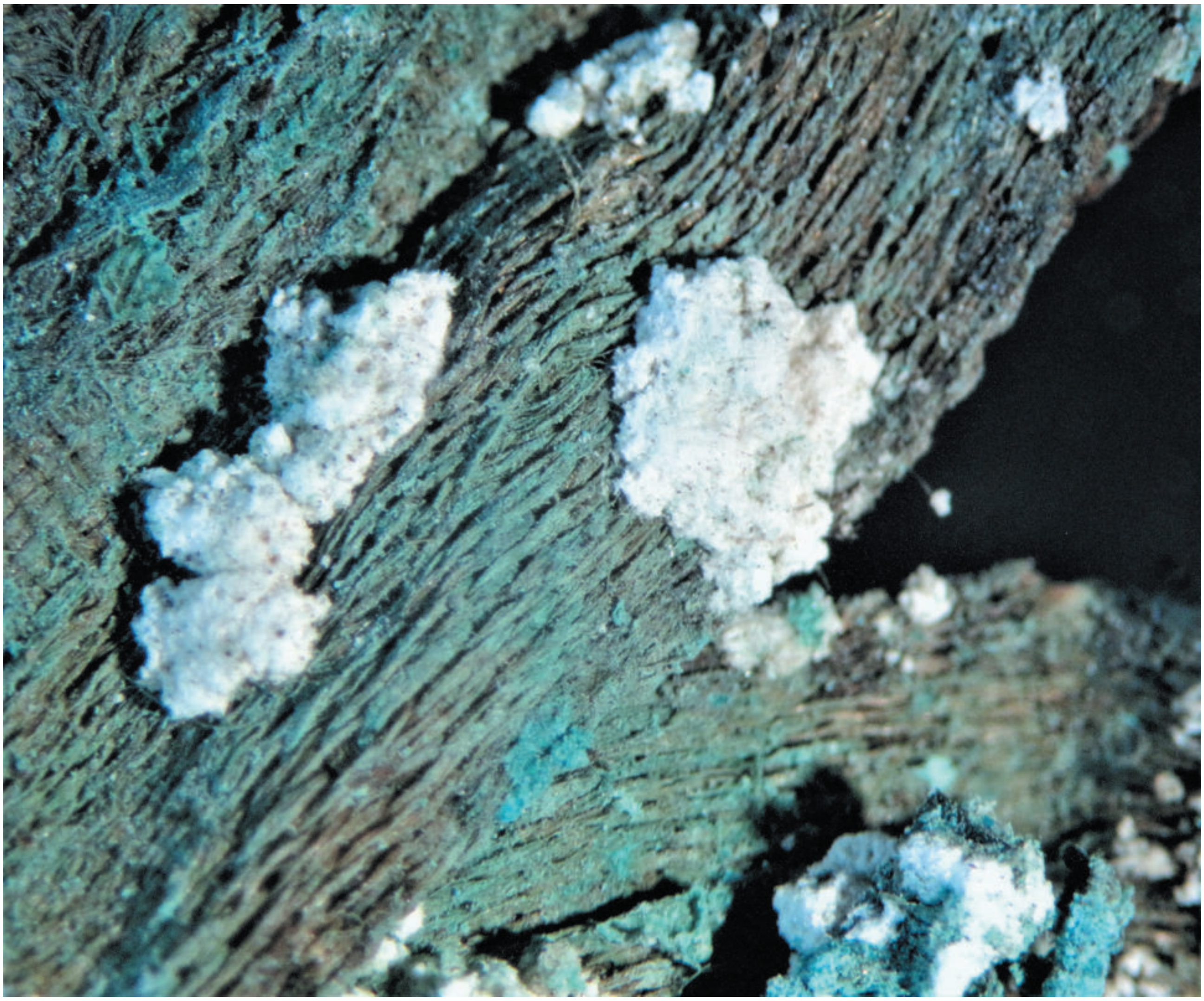


Fig. 8. Gniew, St Nicolas church, northern crypt, Coating of mineral substances on the band surface, magnification 10× (photo D. Grupa).

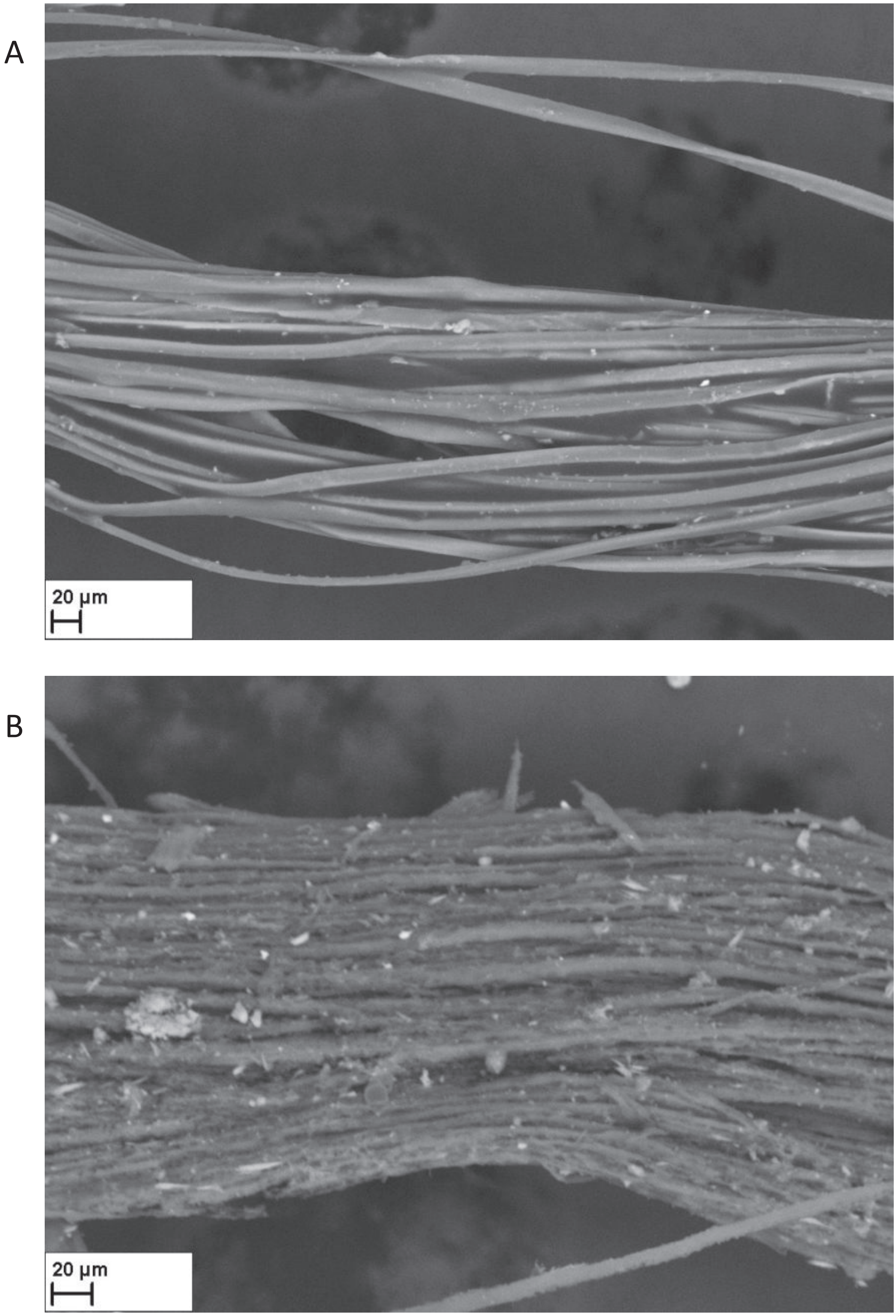


Fig. 9. Gniew, St Nicolas church, northern crypt, State of band yarn preservation: A – from the textile background, B – from zoomorphic ornament (photo G. Szczepańska, J. W. Łukaszewicz).

A

B

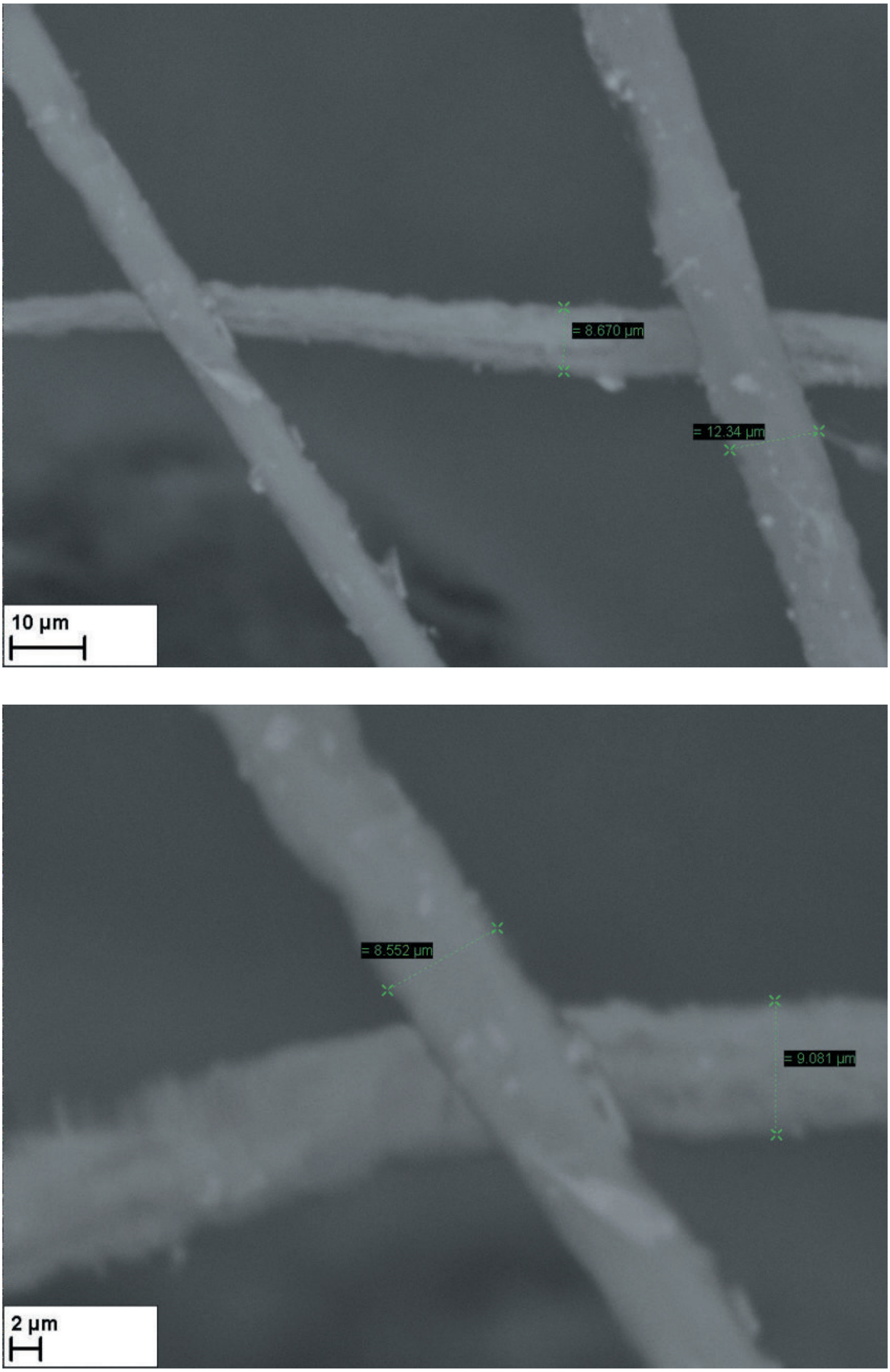


Fig. 10. Gniew, St Nicolas church, northern crypt, State of preservation of single silk fibres from the background: A – smaller magnification, B – larger magnification (photo D. Grupa, G. Szczepańska, J. W. Łukaszewicz).

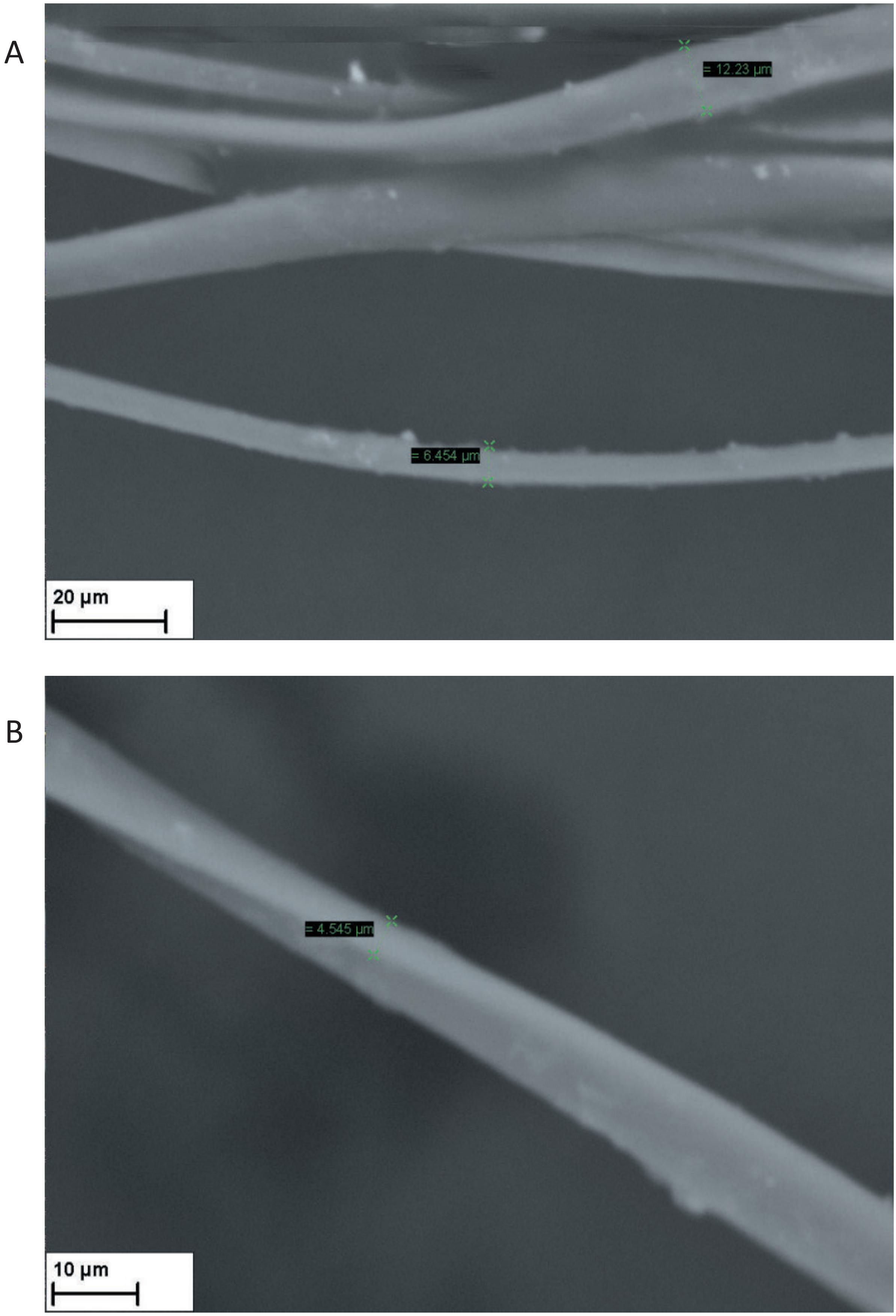


Fig. 11. Gniew, St Nicolas church, northern crypt, State of preservation of single silk fibres from the ornament at different magnifications: A – smaller, B – larger (photo G. Szczepańska, J. W. Łukaszewicz).

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 (Portugal) (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).

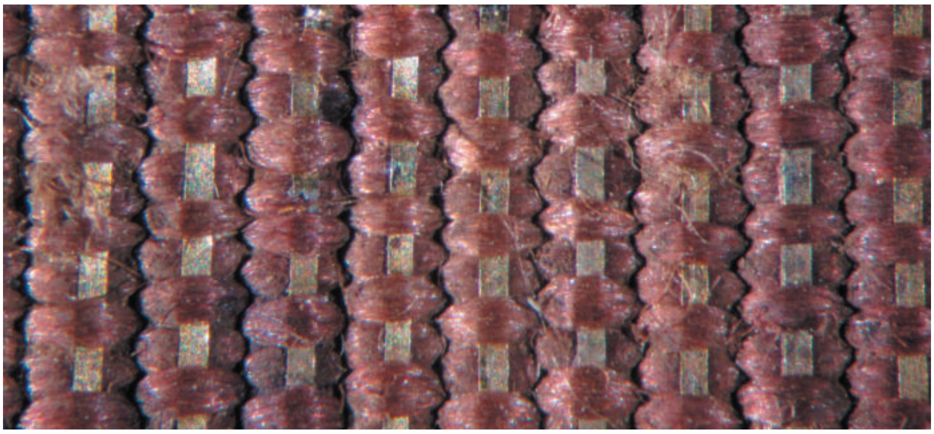


Fig. 13. Poland, Lublin, St. John church, Silk textile with extra gold weft in form of a band of a coffin upholstery (photo D. Grupa).

A

B

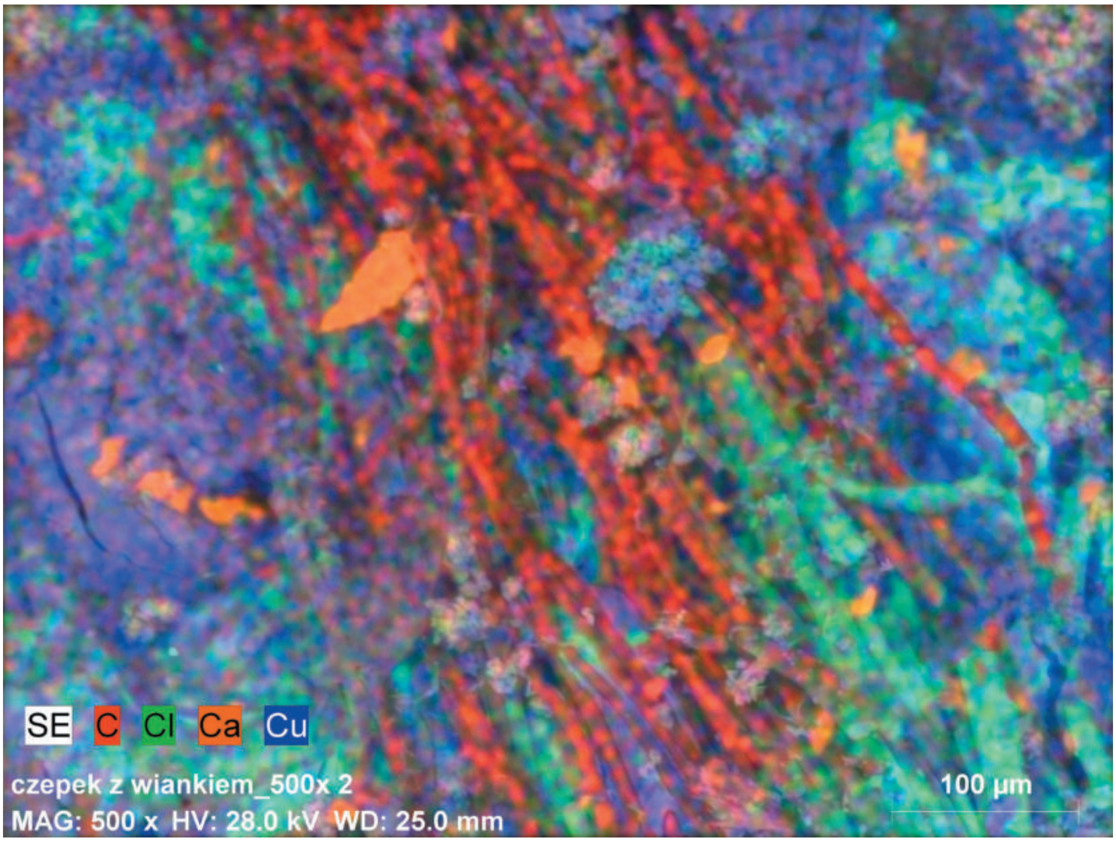


Fig. 14. Gniew, St Nicolas church, northern crypt, appliqués from a child bonnet, A – SEM image of the sample (BSE detector), B – quantitative analysis of metal decoration from the band places of presence of copper plate, copper chloride, calcium phosphates and silk fibres (photo G. Szczepańska, J. W.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

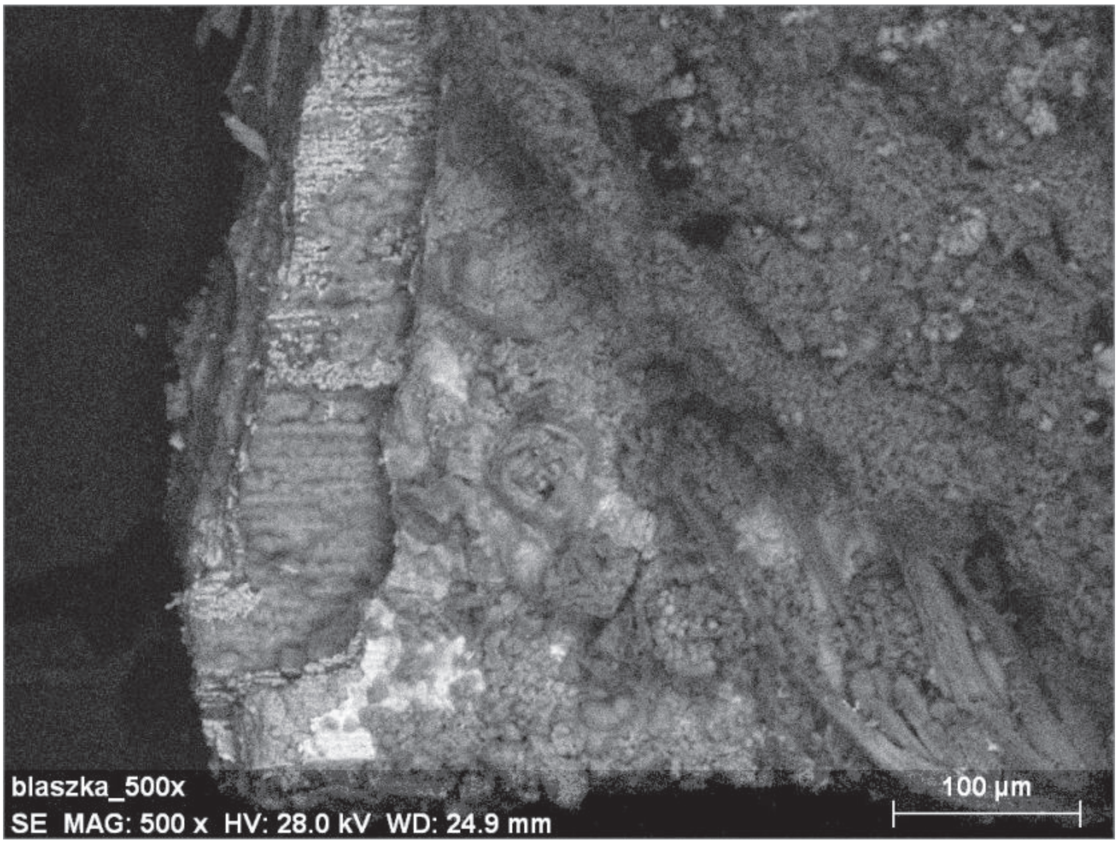
Conclusions

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 (Drążkowska 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, appliqués from a child bonnet, SEM image of the sample (BSE detector) (photo G. Szczepańska, J. W. Łukaszewicz).

A



B

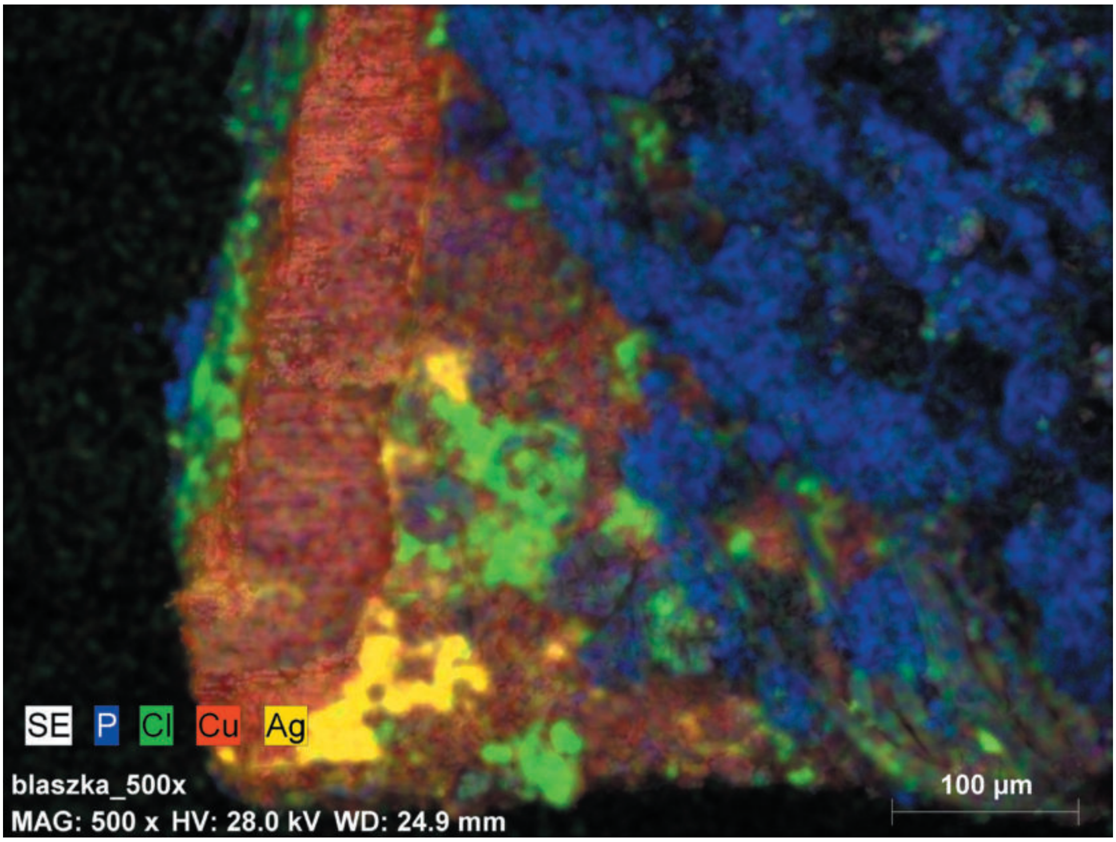


Fig. 16. Gniew, St Nicolas, northern crypt, appliqués from a child bonnet, A – SEM image of the sample (BSE detector), B – quantitative analysis of metal decoration from the band, residual presence of silver detected (photo G. Szczepańska, J. W. Łukaszewicz).

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 (Drążkowska 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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Women's shoes from the crypt of the church of the Name of the Holy Virgin Mary in Szczuczyn, Podlaskie Voivodship

Abstract

Kulesz A. 2019. Women's shoes from the crypt of the church of the Name of the Holy Virgin Mary in Szczuczyn, Podlaskie Voivodship. *Analecta Archaeologica Ressoviensia* 14, 155–168

During the inventory-arranging works inside the western and eastern crypts under the presbytery conducted in the church of The Name of the Holy Virgin Mary in Szczuczyn, two examples of women's eighteenth-century shoes were found. The first specimen represents a slip-on, leather shoe decorated with silk ribbons. The second one belongs to the class of footwear with a textile upper fastened with a buckle. Excellent conditions prevailing in the crypts ensured that the artefacts have been preserved in very good condition. This permitted detailed research on the raw materials used in constructing the footwear to be conducted. Textiles, leather and wood were subjected to microscopic analysis.

Key words: crypts, footwear, 18th century, silk, leather, shoemaking, Poland

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Introduction

During the inventory-arranging works inside the western and eastern crypts under the presbytery (Fig. 1) conducted in the church of The Name of the Holy Virgin Mary in Szczuczyn two examples of women's eighteenth-century shoes were found. They represent two different types. The first one was made entirely of leather, and only the additional, decorative elements, were made of textiles. The second is characterized by an upper made of high quality silk. Both are extremely valuable cognitive examples since artefacts made of organic materials typically quickly decompose. This is related to the soil pH and the putrefaction processes occurring in it (Drążkowska and Grupa 1998, 121–122). An important factor is also the quality of the raw materials used to make the deposited artefacts. Textiles made of cellulosic fibres react differently to those made from animal-based fibres. In the case of leather, the tanner's technique, species differentiation of leather and the area of the animal's body from which it was obtained are of primary importance. No less important is the history of its use, i.e. what damage and deformations occurred and, finally, what processes took place in its structure during bedding in the layer (silt, mulch) or in the crypt (Grupa 2011). However, the exceptional, permanent conditions prevailing in the crypts in Szczuczyn – low temperature and constant access of fresh air (Dudziński *et al.* 2013, 15–16, Grupa 2012, 109; Kozłowski and Krajewska 2013, 86) meant that the artefacts preserved the majority of their components and have not fundamentally changed colour. If the artefacts are in the soil or silt, the products of iron ions and tannins absorbed by the leather make it become black and less elastic (Grupa 2011, 31).

In the Polish literature on the subject, there have been a small number of publications on eighteenth-century footwear. Among them, these include analysis of shoes excavated in Warsaw (Blusiewicz 2009, 62–72; Blusiewicz 2013), the footwear from the General Carleton shipwreck (Jakimowicz and Rodzik 2008), the shoes from crypts in Sczuczyn (Dudziński *et al.* 2015, 65) and Piaseczno (Kulesz 2018), as well as the general characteristics developed on the basis of both excavated and museum objects (Drążkowska 2011, 235–275). Therefore, it was decided to make a detailed descrip-

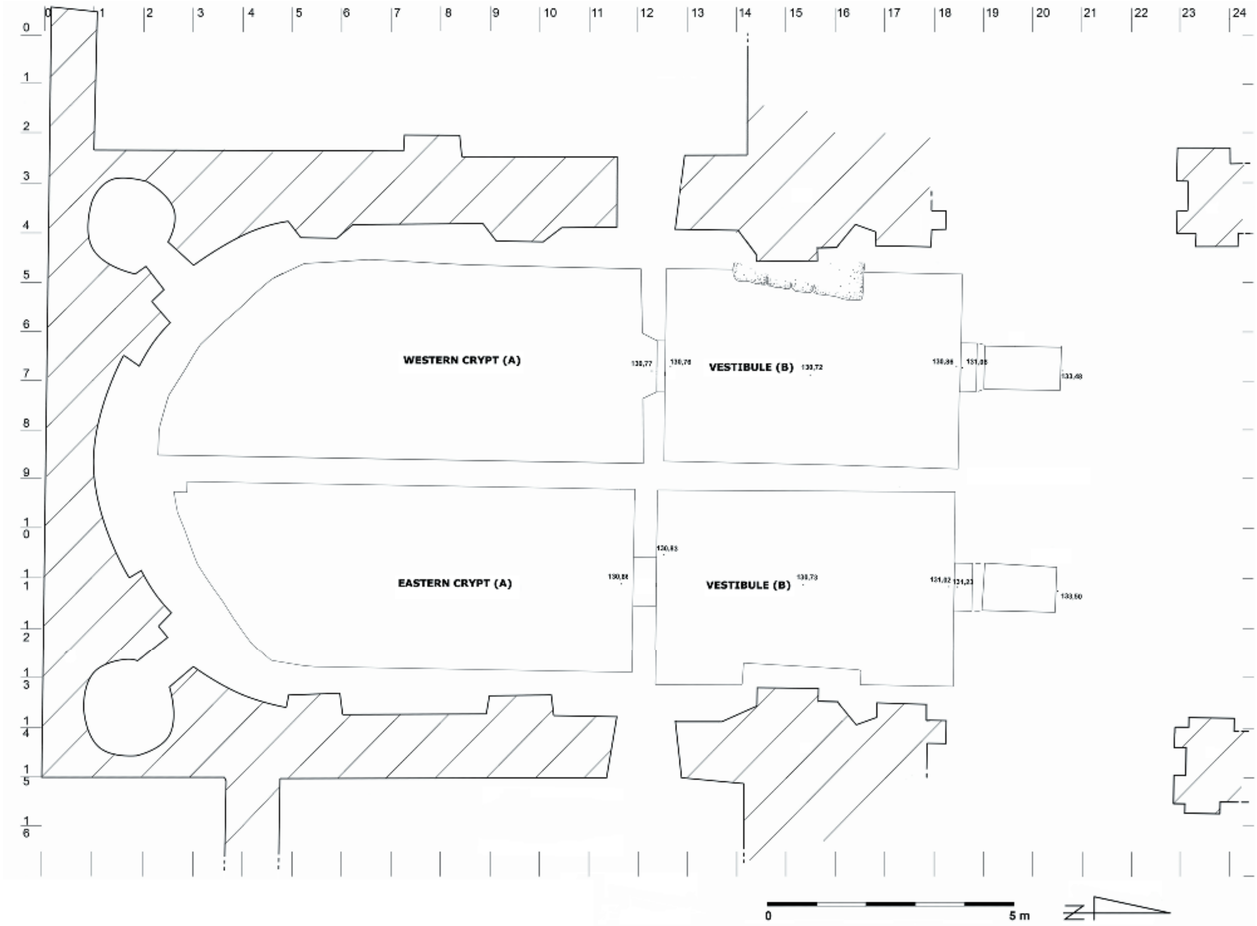

Fig. 1. The architectural plan of the crypts.

tion and carry out a series of material analyses. This permitted the identification of the raw materials and shoemaking techniques used.

Materials

The Leather Footwear

Footwear made of leather was found in the eastern crypt. One of the shoes lay on the floor (Fig. 2) and only the one worn on the right foot was found. Unfortunately, it cannot be attributed to a specific burial. However, due to its sole length (20 cm) and shape, it can be clearly stated that it is an example of women's footwear.

The bottom part of the shoe is partially preserved (Fig. 3. 1), with the insole and top lift of the heel missing. The shoe is heightened with a leather covered, three-and-a-half-centimetre heel. The top surface of the heel is concave. This shape ensured the comfortable positioning of the heel part of the foot. A strongly profiled sole lies underneath the wooden heel. The sole was sewn with a heel cover and vamp. Additionally, wooden pegs fastened it to the heel. The heel was secured with a top lift. Holes in the bottom part of the heel are evidence that it was attached by means of two wooden pegs.

The upper of the footwear is made of soft, well-tanned leather. It consists of the vamp and two quarters. It is additionally reinforced with a low heel stiffener. The top edge of the upper was covered with a textile piping. The bridge part of the vamp was decorated with a small pleats made of silk ribbon (Fig. 4). The decoration was fastened in two rows, arranged one above the other.

The microscopic analyses were carried out on the individual components of the footwear. It was established that the heel was made of birch – a soft wood which was easy to process. The leather used in footwear is categorized into two classes. The first one is soft, vegetable-tanned leather, 1 mm thick. It was made of calf skin (Fig. 5). It was used to make the upper elements and heel cover. The second one is harder, also vegetable-tanned, 1.5 mm thick. It was used to make the sole. The grain of the sole has been heavily worn during use, meaning that further analysis is impossible. However, it can be assumed that cowhide was used for this purpose. This kind of leather is characterized by adequate strength and was most often used for sole-making (Kowalska and Radek 2015, 234).

The ribbon used to make the piping has a width of about 1 cm. It is bicolour, white and dark beige. It was folded in half and the white part was attached to the inner edge of the footwear, while the dark part was visible from the outside. It is made in a linen weave 1/1, with an unresolved edge. The weave is very loose and the warp is made of white and dark silk. The warp on the bright side is in the S-spun and on the dark side on the Z-spun. The weft is non-spun.

The ribbon attached to the instep is made of a linen weave 1/1, with a width of 1.6 cm. There are 50 (2 ×) warp threads per 1 cm (,each thread consists of two strongly S-spun bands) and 16 non-spun weft threads. Such a number of thin threads of a warp into a thick threads of a weft gives the impression of a warp rip weave.

The twine connecting the individual leather elements is made of vegetable fibres (flax or hemp). Unfortunately, its condition does not allow to determine the spin type or amount of bands that make up a single thread.

The leather shoe was undoubtedly used during the deceased's life. A strongly worn sole and signs of wear on the upper (lateral parts of the vamp) testify to the results of intensive use. The thickness and delicacy of the leathers used may have significantly reduced the strength of shoes and led to their faster wearing. At the same time, the presence of the heel stiffener shows that the craftsman wanted to maximize the lifetime of the object.

The Footwear with a Textile Upper

The second analysed artefact was discovered in the western crypt and associated with the burial no. 8. The sole length (21,5 cm) and shape shows that it is a female shoe (Fig. 6).

The bottom of the footwear is constructed of two layers: a sole and insole (Fig. 3. 2). The sole grain was turned inward, with the bottom heightened with a wooden, five-centimetre heel, covered with a light cream leather. As in case of the leather shoe, the heel is concave. From the bottom, the heel is covered by a dark brown, contrasting sole. The top lift is an ad-

Fig. 2. The leather shoe *in situ.*

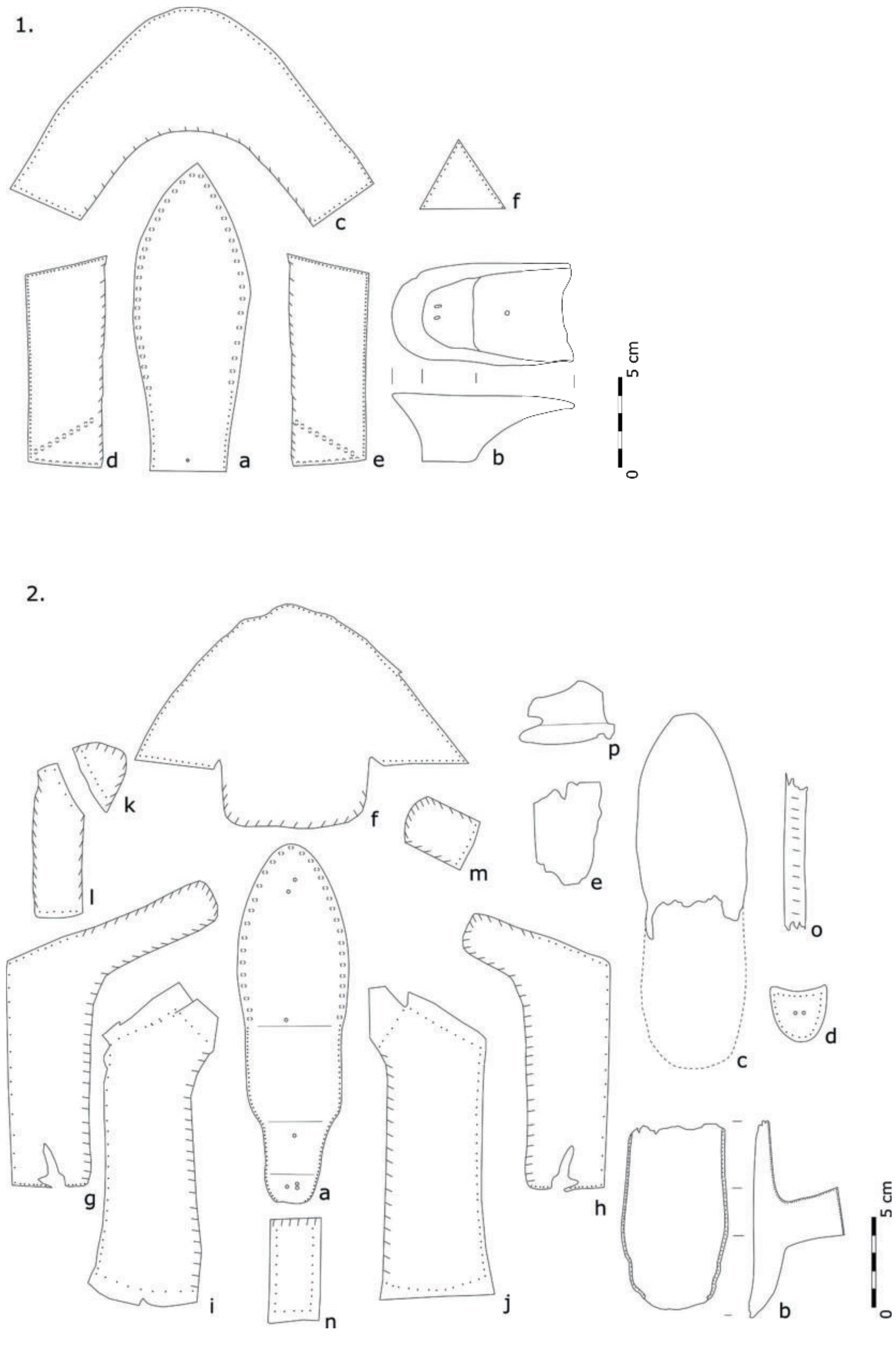

Fig. 3. 1. Leather shoe parts: a. sole, b. heel, c. vamp, d., e. quartiers, f. heel stiffener; 2. Textile shoe parts: a. sole, b. heel, c. insole, d. top lift, e. wooden sole reinforcement, f. vamp, g., h. leather quartiers reinforcement, i., j. quarters, k., l., m. parts of the latchets, n. back stitch cover, o. silk piping, p. satin lining

Fig. 4. The decoration of the leather shoe.

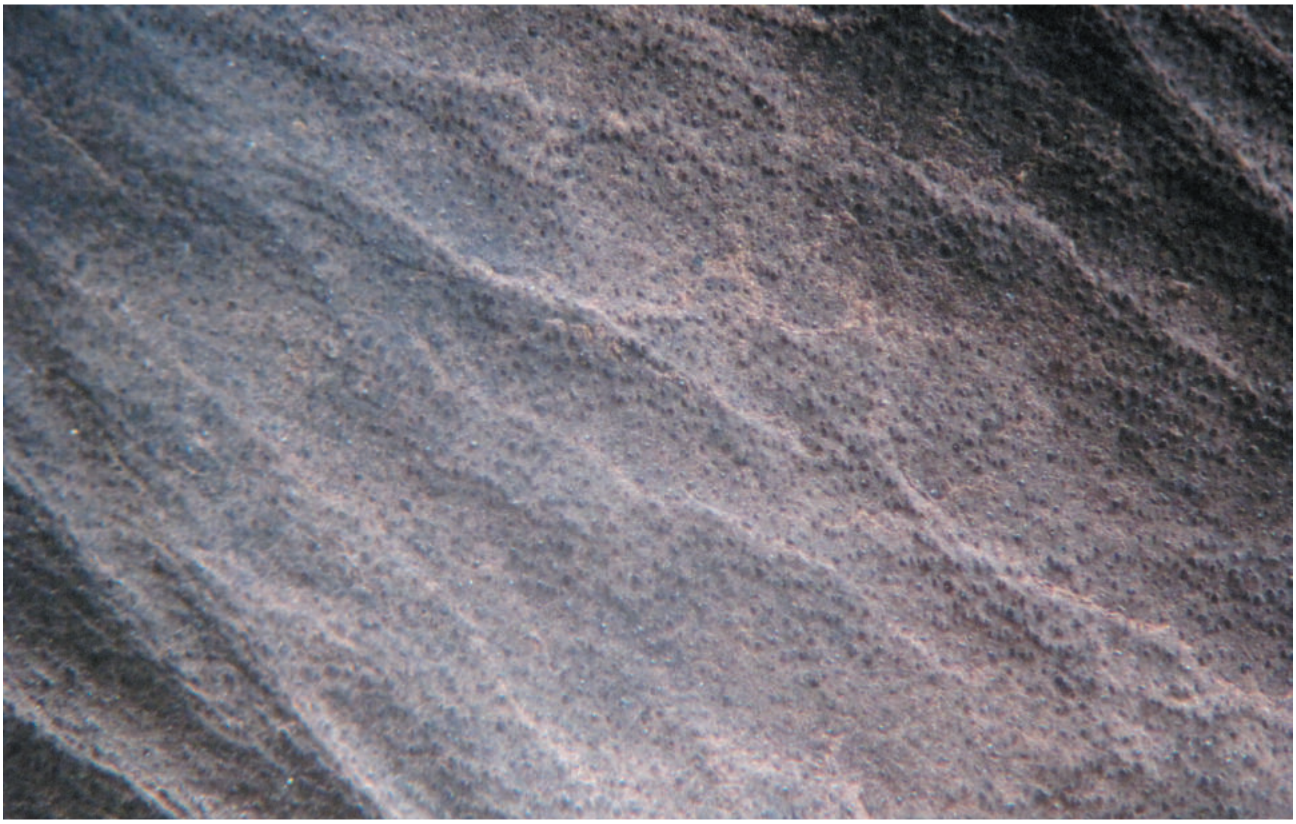

Fig. 5. The microscopic view of the vamp's grain.

Fig. 6. The shoe with a textile upper before conservation.

ditional means of reinforcement. It was fastened with a stitch hidden in an oblique cut made underneath the sole (protecting the twine against moisture) and two wooden pegs (Fig. 7). The heel was fastened with a stitch connecting the heel and the insole. In order to stiffen the tread and waist between the sole and the insole, a wooden stave was placed there and fastened with twine. The sole has an almond, strongly upcurved toe. A small piece of greenish fabric was found between the heel cover and the wooden core (Fig. 8). It can be presumed that this is the remnant of the footwear lining.

The upper of the footwear was made of silk fabric with a fine geometric pattern. The edges were sewn with silk ribbon. Unfortunately, as a result of its deposition in the crypt, the colours have changed the shades slightly. The upper of the shoe consists of quite a large number of components: a vamp with a low, square tongue; two quarters; three small elements – parts of latchets; piping and reinforcement of the back stitch. All the above-mentioned elements, except the trimming, were made of one type of red, silk fabric, with a geometric pattern (isosceles triangles). The silk is currently claret-coloured and the triangles are pink. The ribbon used to pimp the upper edge of the footwear was bicolour. The weft was in the natural colour of the silk, and the warp was made up of red threads. Currently, the colours have changed to beige-gold and dark red. The economy of the craftsman is worth noting. The latchets were cut from small fragments, probably made of larger cut-offs that remained after other work. The upper stiffness was given by the bottom layer made of soft, light leather. The shape of the leather elements corresponds to those of the quarters. The edges of both quarters and the reinforcement were sewn at the top with an overhand stitch.

Originally, the footwear was fastened with a buckle. However, it was deposited in the grave in a budget version, fastened with a pin made of copper or its alloy. This is indicated by the greenish colour of the corrosion products deposit on its surface (Grupa 2013, Grupa and Łukaszewicz 2019 – in this volume).

As in the case of the leather footwear, in order to determine the raw materials used more precisely, microscopic analyses were carried out. The heel was made of limewood/linden, another soft wood. This kind of wood allows a strongly profiled shape to be given to the heel. Due to the poor condition of the wooden reinforcement of the sole, it was impossible to obtain a preparation

Fig. 7. The top lift fitting.

from it and the use of a more invasive preparation method would probably lead to the destruction of this element of the artefact. However, it can be identified as a soft, flexible broad-leaved tree – e.g. hazel, birch, willow or limewood/linden. The size of wooden pegs was also a preventing factor, so they were not analysed.

The leather used in the shoe is of two types. The first type is calf leather – soft and thin, alum tanned (Fig. 9), it was both aesthetic and functional. Its thickness was only 1 mm and the use of such delicate leather was to stabilize the quarters but also enhance user comfort. On the other hand, the light leather covering of a heel provided an interesting visual effect by contrasting it with the dark sole. The second type of leather is harder, made from cowhide (Fig. 10) and tanned with vegetable tannins. It was used to make the sole and the top lift of the heel and has a thickness of only 1.5 mm.

The last raw material group are textiles. Three types of fabrics and two types of threads were tested. The first thread was used to connect the elements of the upper. This was a red silk thread, made of two strands. Each of the strands was in the gentle S-spun and consisted of six filaments. The second thread is a twine, made of vegetable fibre (hemp or flax), two-strand (Fig. 10). Each of the strand was in the S-spun, and then both were spun again in the same way. The twine was used to make joints between the leather elements of the bottom.

The fabric used to make the parts of the upper has a harmonious geometric ornament, emphasized by the colour of the threads used. The background was dark, cherry-red, and the ornamentation (isosceles triangles) was light red. The fabric background is the linen weave, 1/1. The centimetre of fabric consisted of 50 threads of non-spun warp and 40 threads of non-spun weft. A geometric pattern was made by introducing additional warp threads. The pattern was created by means of the differentiation of the interlacing. The smallest loose interlace included two weft threads and the longest, seven (Fig. 11).

The upper piping is made of silk ribbon, with a total width 1.15 cm. It is divided into parts – the central zone and the separated side edges. The edge is made up of five warp threads in a weave 2/1. A warp consists of two strands, each in a delicate S-spun. The main zone is in a linen weave 1/1. For each centimetre there are 20 non-spun, red warps and 32 wefts in a delicate S-spun. Each weft consists of four strands (Fig. 12).

Fig. 8. The lining fragment.

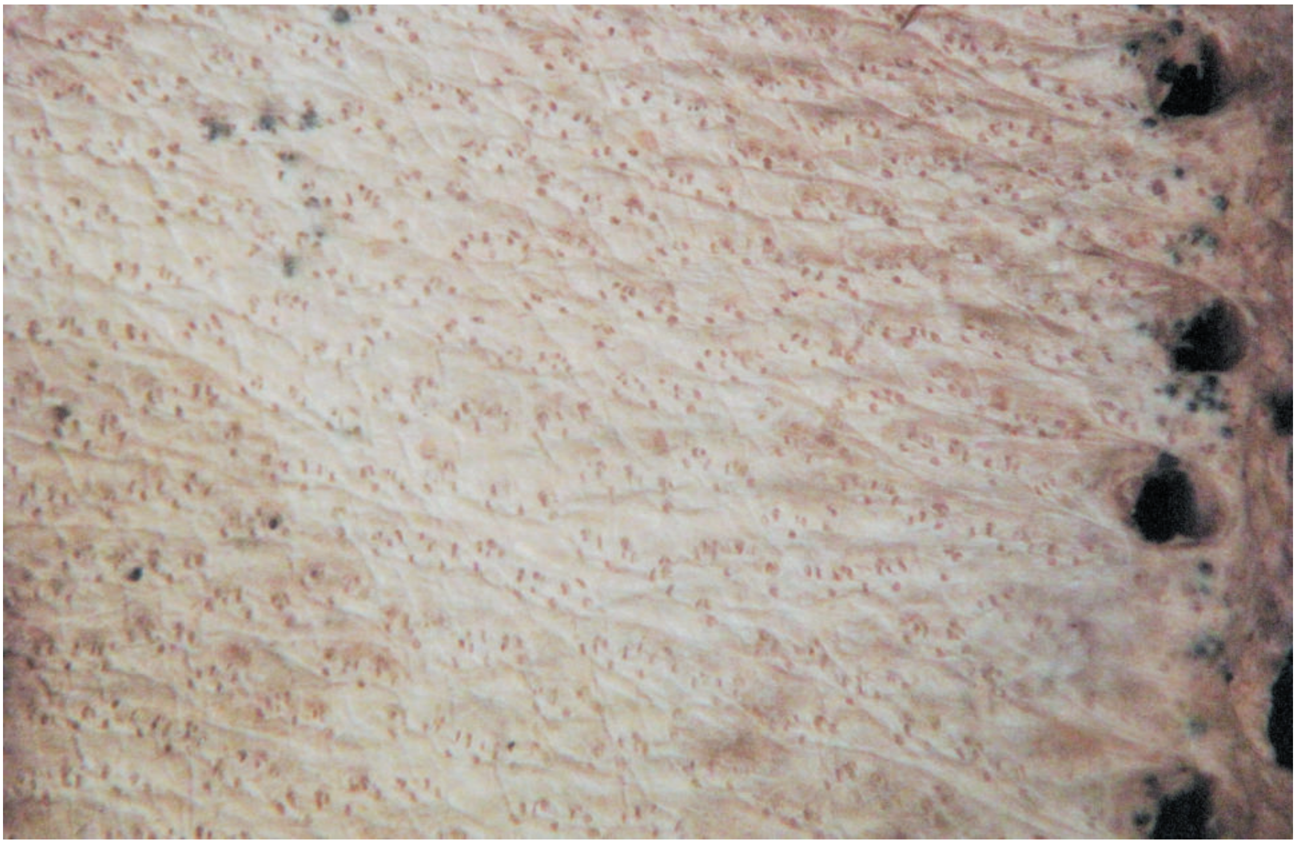

Fig. 9. The alum tanned leather.

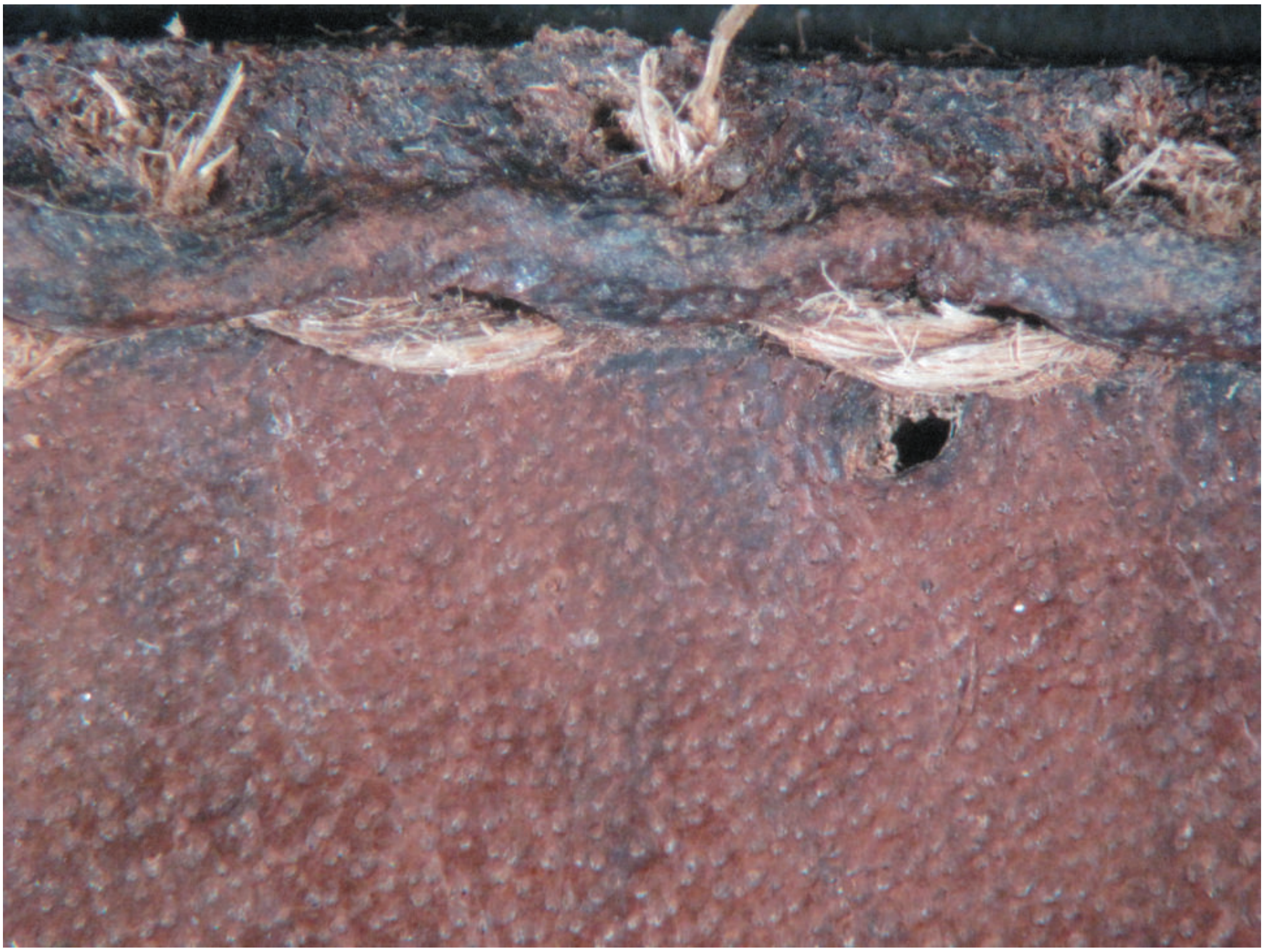

Fig. 10. The sole leather and the twine of the textile shoe.

The last analysed type of fabric is the lining. It was made in satin weave, 5/1. For each centimetre there are 96 warps in S-spun and 32 non-spun wefts.

The textile footwear was certainly not just made for the funeral ceremony. The extremely precise nature of the seams and a textile insert on the heel covering the seam, prove that it was worn during the deceased's lifetime.

Style and dating of the Szuczyn Shoes

The leather shoes can be described as low, and according to Goubitz's typology – based on the fastening methods – it should be included as type 90 – slipped footwear (Goubitz *et al.* 2011, 219–227). The footwear with a textile upper is also a low variety, reaching up to the ankle. In Goubitz's typology it represents type 135 – footwear fastened with a buckle on latchets (Goubitz *et al.* 2011, 289–295).

The footwear described above was made as an accessory to outfits made in the western European style (Fig. 13). Unfortunately, the garments worn with the leather shoes were probably destroyed. However, linking the textile footwear to a specific burial allowed us to analyse the dress of the deceased young woman to whom it belonged (burial No. 8 – western crypt). The dress and accessories distinguished in the entire set of grave dresses in Szczuczyn. The gown was made in the style à la *française* with a stomacher, an open robe and a petticoat. The outer dress and petticoat were made of the same fabric. Each of the pleats made along the vertical edges of the outer dress was adorned with two types of bobbin lace of different widths. On her legs, the woman had white, silk stockings that contrasted with the red shoes, although the viewers of the *Pompa Funebris* would not have seen them since noblewomen of the day did not reveal even their ankles (Grupa 2012, 238). Dresses of this type were worn from the first half of the eighteenth century (Boucher 2004, 264–266; Możdżyńska-Nawotka 2002, 156–157). The crypts in Szczuczyn began to function in 1711, one year after the death of the church's founder Stanisław Antoni

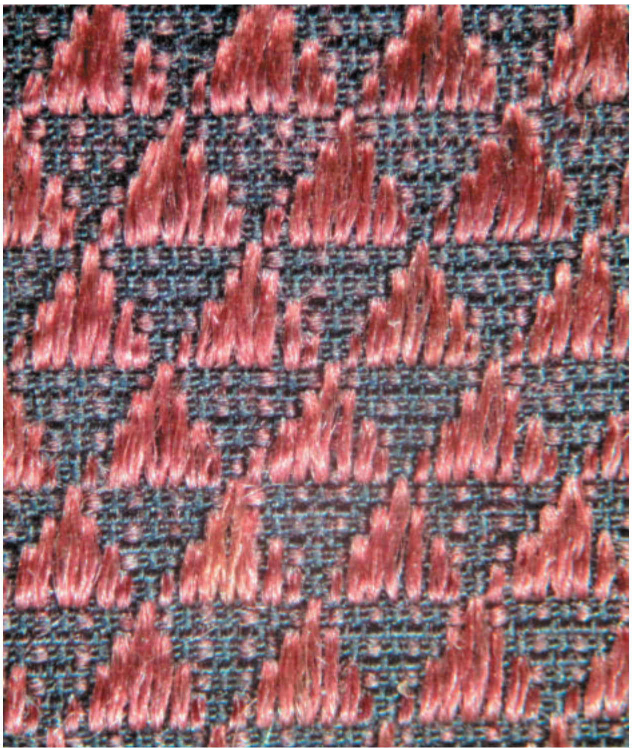

Fig. 11. The fabric with a geometric pattern.

Szczuka (Dudziński *et al.* 2013, 10, 12, 14–15). The dead woman could not have been laid to rest there any earlier. In Toruń, in the Church of the Assumption of the Blessed Virgin Mary, women buried in the Czapski crypt had grave dresses in the same type. The Czapski crypt was built after 1724, when the church returned to Catholic control (Grupa 2005, 24). Therefore, it should be assumed that dresses from Toruń and Szczuczyn were made in the eighteenth century.

Shoes connected with the Szczuczyn *robe à la française* had soles with almond, upcurved noses. This feature allows to narrow down the dating of the object. This shape of nose was the most popular in the first half of the eighteenth century (Swann 1982, 29). However, the use of a geometric fabric to make shoes in this style is surprising. At the beginning of the 18th century, baroque, richly embroidered or woven fabrics were still fashionable. According to June Swann, monochromatic fabrics with geometrical patterns became popular in the 70s and 80s (Swann 1982, 29). Museum objects, e.g. no. T.436-1913 from V&A Museum or no. SM43 in Bayerischen Nationalmuseum München (Durian-Ress 1991, 81), show that the first

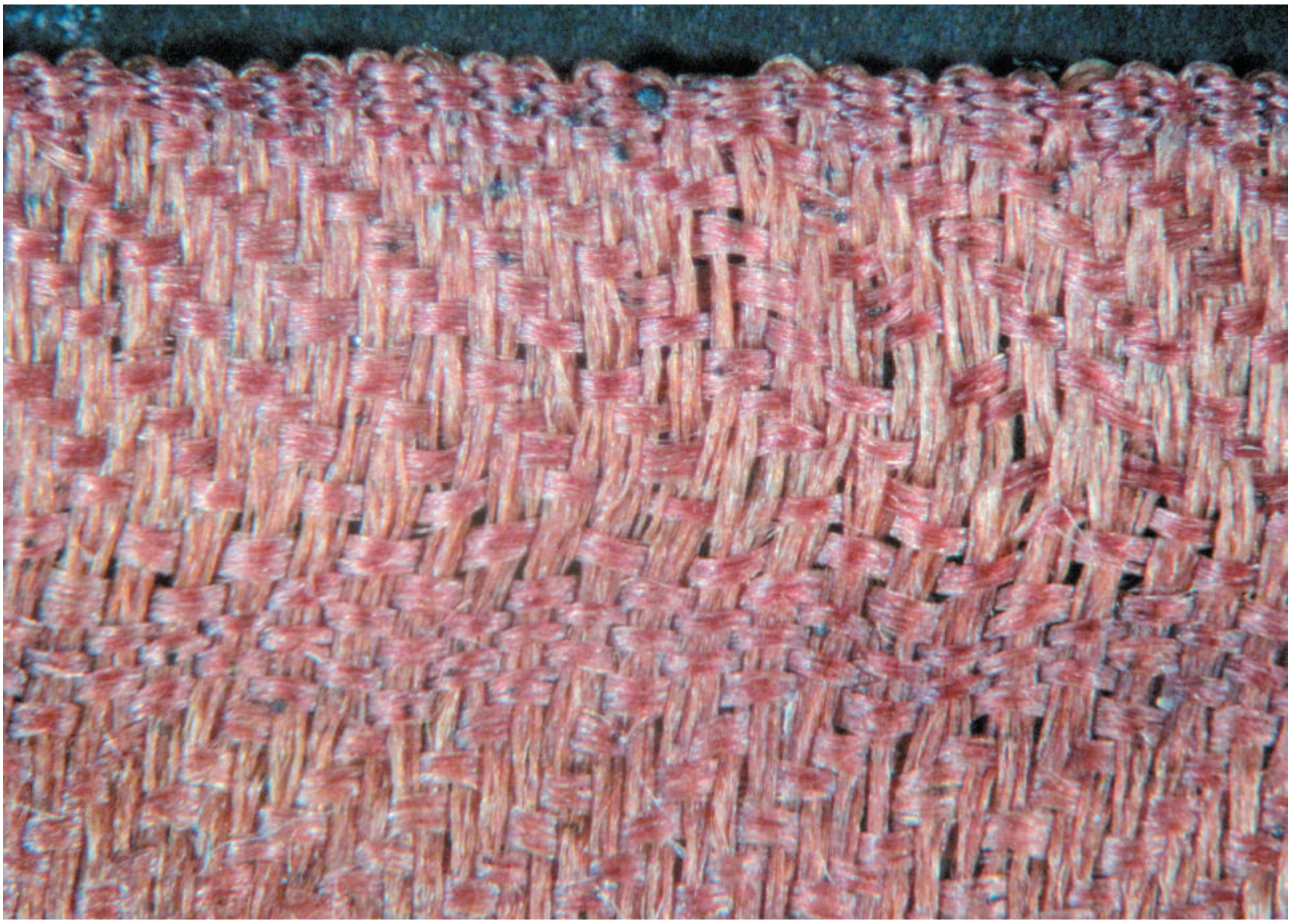

Fig. 12. The silk ribbon.

Fig. 13. Francois Boucher. Portrait of Jeanne Antoinette Poisson, Marquise de Pompadour. Alte Pinakothek, Munich. 1756. Public domain.

examples made from more subtle fabrics can be dated to the 1750s – 1760s. Therefore, if we consider all the elements: the use of a geometric fabric, a fairly low heel and an upcurved nose, we know that the entire toilette of the deceased was created about the middle of the century.

The shape of the leather footwear and the height of its heel indicate that it was made in the second half of the eighteenth century. Leather shoes of the type described above became popular in the 1780s (Turnau 1967, 278). The textile elements used in this footwear – ribbons, give no hints as to the dating. They were produced in the same way in the seventeenth and eighteenth centuries (Grupa and Grupa 2013, 44–51, Grupa *et al.* 2015, 49–52).

The style of the footwear confirms the trend observed so far. Polish noblewomen, unlike their fathers, husbands and sons, preferred fashion patterns from Western Europe (Fig. 14). Since the 17th century, especially since the reign of the queens, Marie Louise Gonzaga (known in Poland as Ludwika Maria Gonzaga de Neveres) (1646–1667) and Marie Casimire Louise de La Grange d'Arquien (1674–1696), women diligently tried to follow the latest trends (Janisz 2016, 52, 55). In one nobleman's house we have two coexisting worlds. Eastern (Polish, Sarmatian) chosen by men and western preferred by women (Grupa 2005, 98, 108). Research in Szczuczyn confirms these conclusions, with Polish style garments definitely prevailing in men's clothing and western dresses predominating in women's (Grupa 2012, 110–112, Grupa *et al.* 2013, 99–104).

Fig. 14. Louis de Silvestre. Portrait of Katarzyna Barbara Branicka from the Radziwiłł family. Muzeum Narodowe w Warszawie, Wilanów. c. 1730. Public domain.

Character of the Szczuczyn footwear

A number of solutions used in both pairs of footwear find analogies in examples known both from the lands of the former Polish-Lithuanian Commonwealth and elsewhere in Europe. Shoemakers had to know the techniques and trends used in the shoemaking of the day and among them we can mention:

The leather reinforcement of textile quarters. An, analogous solution was used in textile footwear stored in the National Museum in Warsaw, probably belonging to Teresa Kunegunda Sobieska (Drążkowska 2011, 249), or in footwear no. 2009.300.4744a, stored at the Metropolitan Museum of Arts in Boston.

Wooden reinforcement between the sole and the insole in textile footwear. Although it was not possible to determine the wood from which it was made, it can be suspected that, like the artefacts discovered in Jabłonowski Square in Warsaw, it was made of the tree's secondary phloem (Blusiewicz 2013, 208). The flexibility and quite high durability of phloem perfectly suits the needs of this type of reinforcement.

The light, alum-tanned leather (Turnau 1983, 49–52) contrasted with the dark, vegetable-tanned one gives a remarkable visual effect. Craftsmen in the eighteenth century clearly appreciated this technique. It is quite commonly found in former footwear, e.g. footwear from the Bayerischen Nationalmuseum München catalogued under number I 7-260 (Durian-Ress 1991, 76) or footwear with inventory no. 270 & A-1890 and No. T.64 & A-1935 from the Victoria & Albert Museum in London.

Heel stiffener used in leather footwear. Many modern shoes have various types of reinforcements, the purpose of which was to extend the life of the footwear. Although in modern times mainly toe and sides reinforcements have been used, the heel stiffeners were also applied by European shoemakers. Their presence is recorded even in the second half of the eighteenth century, e.g. in men's leather footwear from Groningen (Goubitz *et al.* 2011, 293; Fig. 10), or women's footwear stored at the MET Museum in Boston (no. C.I.50.8.22a, b).

Unfortunately, the character of the buckle worn with textile footwear cannot be described. The absence of this item in the burial is not surprising, especially since the buckles used in that period could be freely removed and replaced. This feature allowed the appearance of the footwear to be modified. A buckle dedicated to such a rich shoe could have been valuable, perhaps even incrusted or jewel-encrusted (Drążkowska 2011, 280–281). Therefore, this kind of accessory was a significant asset that could be passed down or sold to cover funeral expenses.

Analogously constructed footwear is stored in many world museums. Among them: Victoria and Albert Museum in London, e.g. no. T.436-1913; 230 & A-1908; T.444A-1913 or 270 & A-1890 (http://collections.vam.ac.uk/ – accessed on 20.06.2019), Kyoto Costume Institute no. AC4790 84-5-3AB (https://www.kci.or.jp/en/archives/digital_archives/1700s_1750s/KCI_004 – access: 20/06/2019), Metropolitan Museum of Art in Boston, e.g. no. 2001.345a, b; 2009.300.1482; 2009.300.4740a, b; 2009.300.4743a, b. (Https://www.metmuseum.org/art/collection/search/ – access: 20/06/2019), or Bayerischen Nationalmuseum München (Durian-Ress 1991, 74–82).

Conclusions

The footwear discovered in Szczuczyn confirms the thesis that western style fashions spread throughout the Polish-Lithuanian Commonwealth. Textile shoes represent a particularly popular type in the first half of the 18th century. The leather shoes from the second half of the century have a lower heel, and no longer feature an upcurving nose, which is typical of the fashion of that time (Turnau 1967, 279). The delicate character of the textile footwear and the exposed to the damage sole indicate that it was worn indoors. In the course of possible external use, it was probably covered with protective footwear. On the other hand, the leather shoes definitely played the role of everyday shoes worn outside (Pratt and Woolley 2008, 35). In both examples, the shoemaker's precision is noteworthy, with the shoes being perfectly stitched and cut. Their luxurious character is not only an effect of the wonderful craft, but also of the high-quality raw materials – silks and delicate leathers. The deceased women had high social status and were wealthy enough to be laid to rest in the crypt. The shoes which they wore were a confirmation of their position in society. The excellent conditions prevailing in Szczuczyn's crypts afforded the opportunity to carry out detailed analyses. This allowed us to take a closer look at the technology and raw materials used to make eighteenth-century women's shoes.

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Polychrome from the southern crypt of the church of the Holy Trinity in Byszewo in light of archaeological and conservation studies

Abstract

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Polychrome on the vaults or walls of grave crypts are a rare category of finds and they are often accompanied by problems for specialist analyses or restoration. A composition of five images of religious and symbolic character was registered on a completely plastered barrel vault with lunettes in a crypt situated under the chapel of The Passion in postcistercian church of The Holy Trinity in Byszewo.

Archaeological exploration of the crypt resulted in the excavation of 92 coffins of lay representatives – both adults and children. Burial and grave goods analyses confirmed that the crypt could have been erected in the middle of 18th century and used until the beginning of 19th century.

Physicochemical tests and conservation analysis of the painting suggest that walls and the vault completing works could be continued in the time of intense use of the room as a burial place, and the present polychrome is probably the fourth layer of painting. The elements preserved until the present day might have been created between the 18th and 19th century.

Key words: Byszewo, archaeology, crypts, conservation, paintings, conservation studies

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The church of The Holy Trinity in Byszewo

Byszewo is a small village situated at the eastern border of Pojezierze Krajeńskie (Krajeńskie Lakeland), in a glacial trough of the Byszewskie lakes (Wyrwa 1999, 83; Grupa and Nowak 2019, 4), North-West from Bydgoszcz. Its documented history is related to the Cistercian Order, although as a result of the monastery relocation (Okoń *et al.* 2016, 9), sources and other written material do not give univocal information.

The beginnings of Byszewo Abbey foundation take us back to middle of 13th century, when in 1250, when the Treasurer of Kujawy-Łęczyca, Duke Mikołaj, donated eight villages situated in the location of the future monastery (Wyrwa 1999, 83). It can be assumed that the generous donation might have been part of the noble's last will, written just before his death. Duke Kazimierz Konradowic was a guarantor and the foundation chancellor (Karczewski 2000, 301–303).

The first monks arrived only six years later, possibly delayed by the war activities on the borderline of Kujawy–Wielkopolska–Pomorze (Kujavia–Great Poland–Pomerania) between 1255–1256, but their origin is not evident. The *Annales Cistercienses* only provides the information that monks arrived from the monastery in Lubiąż in 1256, although there is also a note on Cistercians from the abbey in Sulejowo or a convent in Szpetal, the abbey founded about 20 years earlier on the right bank of the Vistula River, opposite Włocławek (Wyrwa 1999, 83–84; Karczewski 2000, 304–306). The monks probably started by erecting a wooden church, or redecorating a temple which had functioned there earlier (Adrich 2016, 13). We can suppose that it was more likely to have been a new wooden temple when we consider other Cistercian monastery structures. For the first years or even decades following the founding of a monastery, the monks typically used temporary buildings and, after achieving some economic prosperity, they started more serious investments (Świechowski and Zachwatowicz 1964, 168).

In 1285, as a result of reforms in monasteries of Sulejowo, Byszewo and Szpetal, the Byszewo properties were expanded to include the lands of the Szpetal monastery and Dobrowolski estate. Silesian Lubiąż was probably the primaeval seat for the Byszewo monastery, supplying its future abbots (Wyrwa 1999, 48; Karczewski 2000, 307). The significant regional development and plans for investment can be confirmed by the attempt to found a town in Byszewo, a matter that was taken up by the monks in 1286. The duke of Inowrocław, Ziemomysł, granted founding privileges based on Środa Śląska rights, also giving his consent to establish a fair, an inn, a slaughterhouse and other facilities necessary for a town to function. However, undefined reasons meant that the idea failed and the monks turned their attention towards a hamlet located about 10 km away called *Smeysche* (Śmiewce), situated in an evidently more economically attractive location, on the bank of the Brda River (Kabaciński 1968, 22–23; Okoń *et al.* 2016, 10).

Based on the goods and tithes exchanged with the Włocławek bishop, Wisław, the Byszewo Cistercians became the owners of Śmiewce in 1288. Some months later they decided to relocate their seat to a new place, establishing the settlement of Nowe Byszewo, later called Byszewo (Kabaciński 1968, 23; Wyrwa 1999, 84; Okoń *et al.* 2016, 10). The relocation of the monastery is not an isolated case as sometimes there were economic or health reasons to do so (e.g. Samboria – Pelplin or Kacice – Mogiła), or safety precautions (e.g. Wieleń – Przemęt or Łekno – Wągrowiec) (Świechowski, Zachwatowicz 1964, 168). In turn, the fact that the same name was used for both settlements leads to some mistakes in the source information. Koronowo, as a seat of the relocated convent, is commonly used as late as the middle of the 15th century (Okoń *et al.* 2016, 10).

In 1368, Casimir the Great granted a privilege for the Abbot of Byszewo to locate a town based on Magdeburg rights in the place of the *Smaysche.* village. It can be estimated that by the year 1370 Byszewo Cistercian properties included forty seven villages and two hamlets (Okoń *et al.* 2016, 10).

Having moved the convent to a new location, the Cistercians handed care of the temple and believers to a diocesan priest from Włocławek. The church returned to the monastery, according to sources, in 1460. From that time until the secularization of the monastery in 1828, Byszewo parish priests came from Koronowo convent (Adrich 2016, 15).

The 15th century brought the church's modernization. Instead of a wooden temple, a brick, one nave church was erected, which unfortunately burned to the ground at the beginning of the 17th century. The next structure, was built in the mannerist style between 1651–1663. In the 18th century, thanks to the Byszewo provost Mikołaj Liszkiewicz and the care and financial support of the founders, the Elzanowski and Chrząstowski families, the church was redecorated and extended, adding a narthex and two side chapels to the main body and thus making a transept. The chapels had crypts underneath, probably designed as family burial places for the donors (Adrich 2016, 15). The church has preserved in nearly unchanged form to the present day. Modern historical sources have not yet been properly elaborated. It negatively affects the possibilities of interpretation and identification of burials discovered during archaeological research.

The need to explore the Byszewo crypts appeared together with a grant for the restoration of both burial places. Archaeological rescue operations revealed the need for both crypts to be disinfected, although conservation works in the southern crypt were disturbed by the irregular burials deposited all around the room. After consulting the problem with the Voivodeship Monument Conservation Office and the owner of the site, the decision to undertake complete archaeological research was made (Grupa and Nowak 2019, 5–7).

The southern crypt in archaeological terms

Research supervised by NCU prof. Małgorzata Grupa and Sebastian Nowak, M.A., from the Institute of Archaeology of NCU in Toruń was performed in the winter season of 2017/2018. Preliminary recognition estimated that the relatively small space of southern crypt might contain approximately 100 coffins belonging to both adults and children (Fig. 1). The large number of remains within one enclosed space excludes the notion that the room served as the burial place of only one noble family.

The lack of space required a special work method – particular burials were transported to the nave, where they were carefully examined. A series of documentation charts (Fig. 2) for selecting obtained information concerning each burial was prepared (Grupa, Nowak 2019, 6). A burial chart (Fig. 2.1) contained basic

Fig. 1. The state of the southern crypt after removing the protective wall which had closed the entrance. Irregular burial layers seen throughout the whole space. Photo by M. Majorek.

information on the human remains, their composition in a coffin, the coffins planigraphy within the crypt and their contents. A coffin chart (Fig. 2.2) collected data concerning a coffin chest, its cover, decoration, if any, and metrical data. The sample inventory (Fig. 2.3.) enabled the collection of the planigraphy of the material monuments and botanical and entomological samples to be taken for laboratory analysis from every burial. To summarize all the material, a simple graph with symbols and numbers was used.

The researchers were able to establish that there were 92 wooden coffins, including 25 coffins belonging to adult representatives and 67 child coffins, in the examined crypt (Grupa and Nowak 2019, 15). Some of them contained skeletons of more than one individual, which might suggest that other burials from the church area were intentionally collected only in the southern crypt, placing the remains from damaged coffins in those which were better preserved. Coffins are generally simple in construction, most being made of rough planks with visible signs of polishing or processing (Grupa and Nowak 2019, 16). Despite the predominant simple form, 40 coffins had signs of decorating in form of painting layers (26 coffins) or upholstery (16 coffins). 34 coffin lids were decorated with painted or nailed crosses and other religious symbols (Grupa and Nowak 2019, 15–16).

Grave goods were preserved in a relatively good condition. Most of these dead bodies were dressed in linen garments in the form of a long shirt-robe, sometimes folded under the body's legs, with some accessories made of bands, or silk textiles pinned to the clothes or tied around wrists, necks, forming decorative bows. This type of grave attire is known from numerous sites in the Polish Republic such as: Szczecin, Kostrzyn on Odra, Lublin, Toruń or Bytom Odrzański (Grupa *et al.* 2013, 104), although the flax clothes preserved in good condition are rare finds. This is a consequence of flax fibres' poor physicochemical resistance as a textile production material (Drążkowska and Grupa 1998, 121–123).

The entire collection includes only four garment elements made completely of silk. A long żupan made

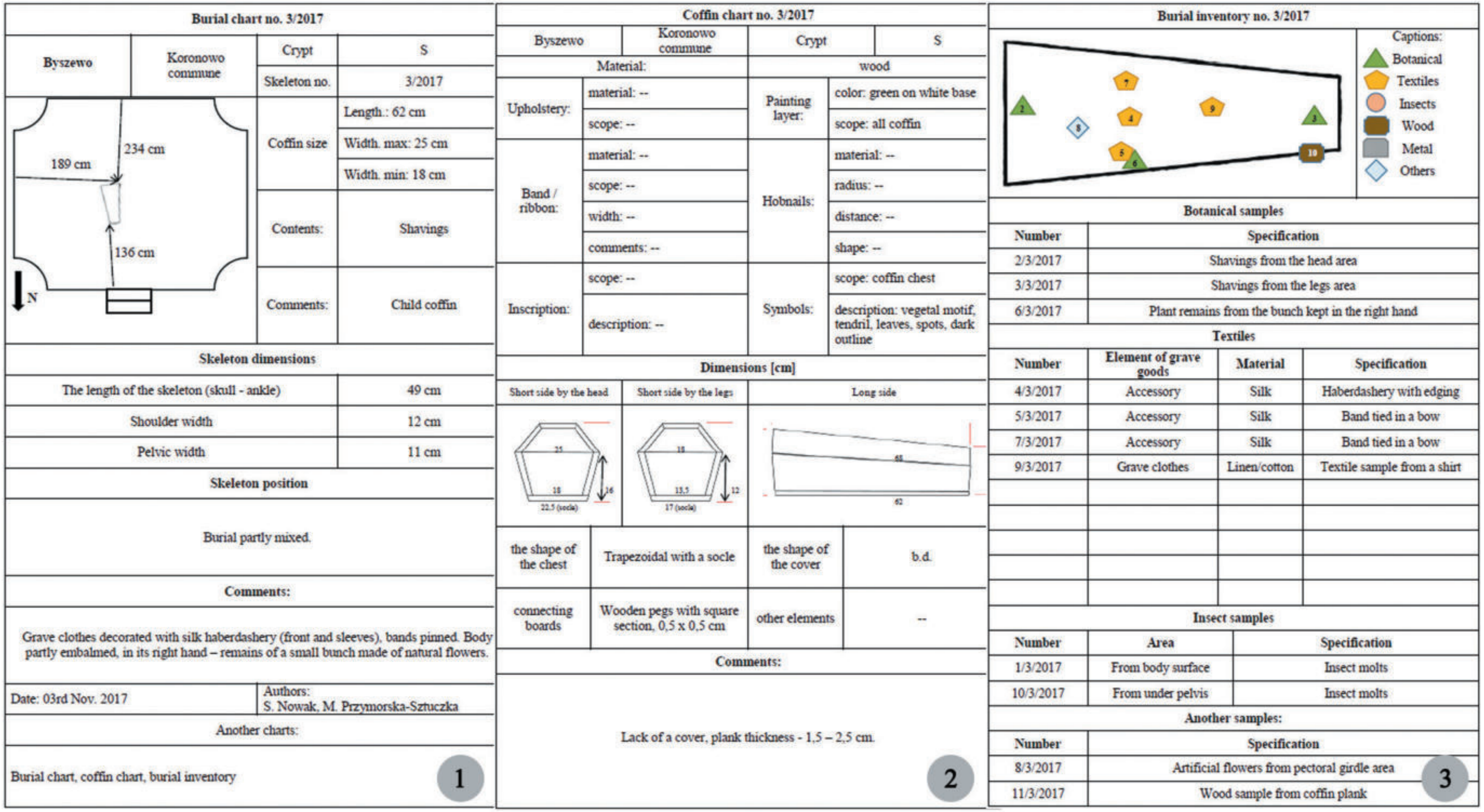


Fig. 2. Documentation chart system designed for the archaeological explorations of the crypt of the Holy Trinity church in Byszewo. Author: S. Nowak.

of silk satin from a male burial (nr 61/2018) is the only element of Polish national costume, characteristic as grave equipment of noble burials from the territory of the Polish Republic (Nowak 2016, 88–90). Similar żupans made of the same textile were also found in sites of Lubiń, Toruń, Gniew (Grupa 1998, 287; 2005, 46; Grupa *et al.* 2015, 97–98; Nowak 2016, 91). The other three elements of silk garments consist of child bonnets of sheared velvet, richly decorated with galloons. This type of a headwear is rather a frequent archeological find excavated in burial grounds, characterized by a variety of forms (Grupa *et al.* 2015, 104).

A female burial (no 81/2018) revealed a large fragment of silk gauze (Grupa and Nowak 2019, 17), which appears very rarely in archaeological finds. The textile name comes from the name of the city of Gaza in the Middle East, which was famous for its production. Thanks to its transparency and delicate construction, obtained by using special weaving techniques, it was an attractive element of a multi-layered dress, although the same properties are responsible for its limited mechanical resistance and it is easily destroyed in grave conditions (Grupa 2012, 182–184; Grupa *et al.* 2014, 65–66).

Coffin interiors were richly filled with plants and wooden shavings, sometimes covered with a piece of linen and making a kind of a mattress. Plant concentrations at the head sides suggests that they were also used as pillows covered with textiles which could have been made of vegetal fibers. Vegetal fibers deposited in soil in poor conditions can decompose within 5–10 years (Nowosad *et al.* 2018, 76). The researchers registered only two pillows whose cases were made of silk patterned damask (Grupa and Nowak 2019, 17–18).

The characteristics of the grave goods confirms the chronology of burials assumed for the second half of 18th century to the beginning of 19th century. It corresponds with chronology of the crypt itself, which is dated from the middle of the 18th century (Adrich 2016, 15). Despite this fact, we cannot exclude the possibility that the crypt also contains burials which are chronologically older, as suggested by the date of 1712 identified on a short coffin side of an adult person (Grupa and Nowak 2019, 15). We are not able to identify the buried persons univocally. Marks in the form of initial letters, party unreadable due to the dye oxidation of the paint layers, were registered on only six coffins (Grupa and Nowak 2019, 15). Further analysis of grave goods may help us to specify the interpretation of the burials in terms of the social groups registered in the collection.

Architectonic analysis of the crypt

The southern crypt was erected on a rectangular plan with sizes 430 * 460 cm, with a shift of south-eastern corner. Its walls are compatible with the foundations of the Passion chapel above. Wooden joists (Fig.3) were identified under the burial layers, which originally served to place the coffins on to protect them from direct contact with the pugging of the floor. The floor had places with identified layers of lime mortar, being signs of the plastering of the crypt vaults and walls (Grupa and Nowak 2019, 6, 12).

The northern wall has an entrance with a narrow neck equipped with 6 bricked stairs, made of gothic brick in a rolled composition. The opening was secondarily expanded with three irregular cuts in a brick frame, which might have been caused by the relocation of the coffins or the deposition of a coffin which was wider than the door.

The eastern (Fig. 3), southern and western walls were equipped with one light ventilation hole each, protected with grates. This probably contributed to the good state of preservation of the grave goods and human remains, which naturally mummified. The situation changed after the bricking up the holes, which caused a lack of air circulation and growing humidity, which finally led to gradual degradation of burials, walls (Fig. 3) and painted decorations in the crypt.

The crypt foundations were erected of stone, while the circumferential walls and the vault were all made of brick. The room was covered with a barrel vault with lunettes, covered with plaster. Lunettes concentrate in the middle on East-West axis, with a slight shift towards each other of about 45 cm (Grupa and Nowak 2019, 6).

Painting decoration – iconographical program

The southern crypt vault is decorated with painting, an interesting factor which is rarely encountered in the Polish context. Until now, only three crypts with painted decoration coming from 18th century have been identified: in the church of the Piarists of the Transfiguration of Jesus in Krakow, the church of the Holy Trinity in Radzyń Podlaski and the church of the Immaculate Conception of the Holy Virgin Mary in Wigry. In Radzyn Podlaski and Wigry there are images of the danse macabre, while in Krakow there is the Passion (https://dzieje.pl/dziedzictwo-kulturowe/xviii-w-polichromie-w-krypcie-kosciola-oo-pijarow-w-krakowie-mozliwe-do [online 05.06.2019];

Fig. 3. The crypt's eastern wall: with a ventilation-light opening, the wall's destruction and original wooden joists visible in the crypt pugging. Photo by S. Nowak.

https://wane.wigry.pro/krypty.html [online 05.06.2019]; authors' own study).

The walls and the vault were plastered using lime-sand mortar and next whitewashed, forming the base for painting (Fig. 3–4). On the northern side of the barrel (from the entrance side) there is a disc with a solar glory, inside which there is a cipher *Maria* (Fig. 5), on the southern side – there is similar disc with a cipher *IHS* with three nails below and a cross above it (Fig. 6). The lunettes from the East and West are equipped with the heads of winged angels – putti, looking to the south (Fig. 7–8). The central vault part is decorated with a simple four-petal flower (Fig. 9) with edgings (leaves) at their joints, being a closed composition and optical keystone.

To paint these simple and schematic images, only a few colors were used: curcuma yellow, red and green-blue. Sun discs with monograms are designed likewise – the central disc is painted red with a yellow monogram. The disc is surrounded by a broad, yellow border with a red outline. Sun rays appear in turn as closed triangles and with flaming tongues with two round edgings. Each ray is outlined in red and in some places matched additionally with a glazed line, giving a delicate spatial character. Some rays also have extra lines running along the entire form and enriching the drawing.

The monogram *Maria* (Fig. 5) consists of entangled decorated letters with serifs. The base of the composition is a capital letter "M" with decorative weaving edgings at the sides, and "A" and "I" composed in the middle, with the side arms marked by the letters "R" and "A" directed inside. The Christogram *IHS* is visible practically only in the picture made using UV light and after computer processing. This made a considerable contrast between the background and the drawing (Fig. 6). Letters with serifs were also used in this case. The horizontal line of the "H", breaks upward in the middle, making a triangle finished with a cross with serifs. Below the line, there are three crossed nails. The UV light photo shows two diagonal lines between the letters "I" and "H" (Fig. 4), which can be interpreted as the author having changed the composition of the letters while painting.

The putti are painted similarly, but the western one is preserved in a much poorer condition than the eastern one (Fig. 7–8). The figure composition was made here first of all using a red line. Their yellow faces are round and chubby. Only the large almond eyes and straight noses are schematically marked with red, and the lips were probably made in the same way (the least readable). The putti's yellow hair is short, with red painted weaves and locks. Under their heads there are single fragments of feathers and, at the sides, yellow-or-

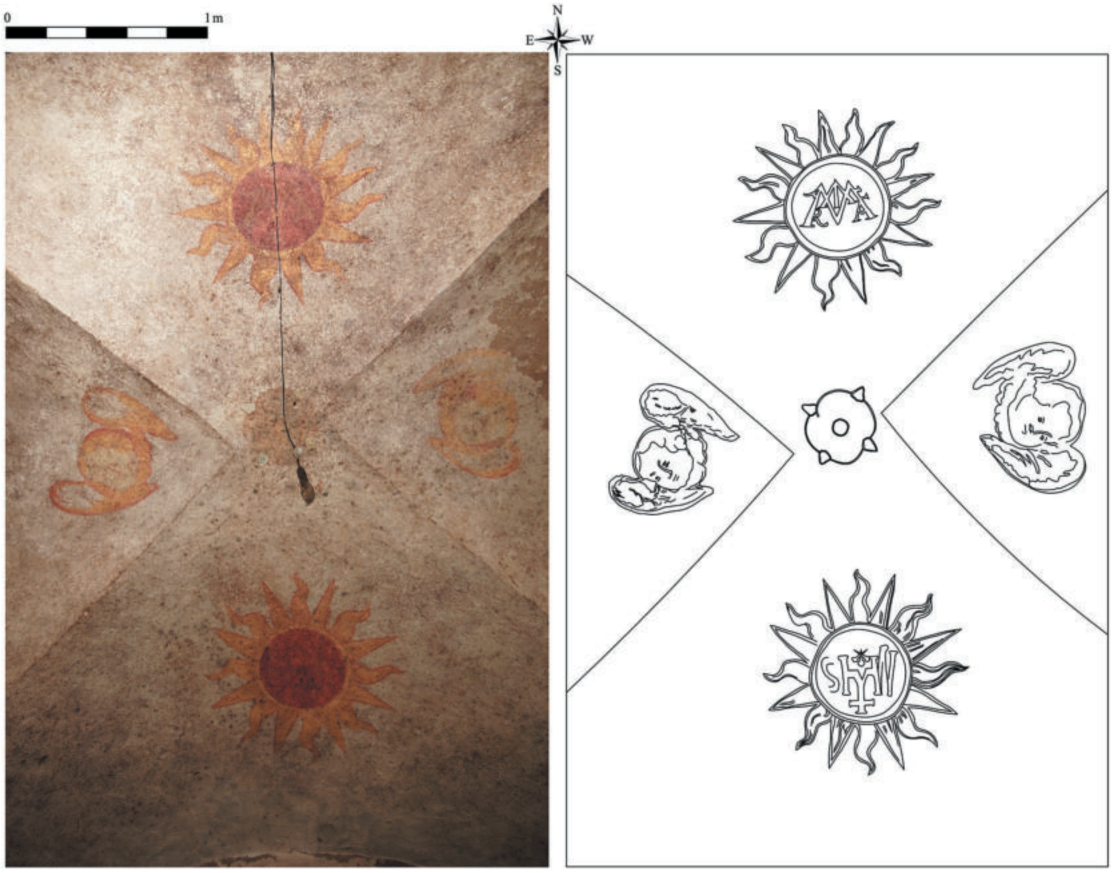


Fig. 4. Polychrome photo and graphic outline of the composition. Photo S. Nowak, graphic design A. Kaźmierczak.

Fig. 5. Solar disc with the cipher *Maria* in solar glory on the barrel vault from the northern side. Photo by A. Kaźmierczak.

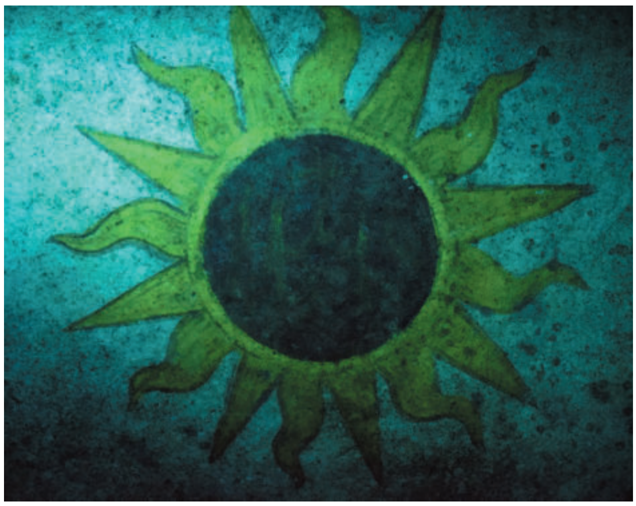


Fig. 6. Solar with the cipher *IHS*, a cross and nails in solar glory on the barrel vault from the southern side using UV light. When the iron red fluorescence is blanked, the monogram outline is better seen. Photo by A. Kaźmierczak.

Fig. 7. Putto in the eastern lunette. Photo by A. Kaźmierczak.

Fig. 8. Putto in the western lunette. Photo by A. Kaźmierczak.

Fig. 9. A flower in the central crypt vault section. Photo by A. Kaźmierczak.

ange wings lined around with red (barely discernible at present). Whitewash was used for lightening the faces and for the parts of the upper wings.

A primitive flower in the middle of a vault (Fig. 9) has four rounded bright orange petals with a small round yellow center lined in red. Straight malachite leaves are small and close triangles. All elements are lined in red.

The entire iconographical program of the ceiling's decoration is simplified and refers to traditional signs and images of the Catholic Church. Christological, Marian and angelical motifs often appeared on scapulars, coffins, funeral banners, epitaphs and tombs. The sun disc symbolizes Christ, Church and Paradise (Moisan and Szafraniec 1987, fig. 32, 61, 114, 136–137, 152, 164; Rządek *et al.* 1991, 50; Majorek and Grupa 2014, 76–79; Nowak and Przymorska-Sztuczka 2013, 59–65). The monogram *IHS* traditionally refers to an appeal: *Iesus Hominum Salvator* – Jesus Savior of Men, or *In Hoc Signo [Vinces]* – in this sign thou shalt [conquer] (Rządek *et al.* 1991, 22). The crucifix is the fundamental sign of faith and victory of life over death. Nails – the Instruments of the Passion – *arma Christi*, are to remind of the Crucifixion of Jesus Christ (Gibson 2010, 181). The monogram *Maria* refers to God's Mother, whose intercession is to help the soul of a dead man to be accepted by God in eternal paradise.

Winged angels as bright, good and beautiful spiritual creatures symbolize heavenly nature and function as emissaries of God (Gibson 2010, 195). The angel image was particularly popular in the context of death and Eschata from the end of 18th century and often became a motif of funeral art in the Romantic period (Pieniążek-Samek 2013, 61). Angels were also guards protecting the Gates of Paradise from sinners (Grzesik *et al.* 2016, 9). A flower in the vault center can symbolize hope, innocence, virtue, compassion, but also mourning and sadness (Grzesik *et al.* 2016, 167).

Physicochemical tests

To estimate the technical parameters and methods of the finishing of the crypt walls and vault, several samples of plaster, whitewash and polychrome were taken. The tests served for the examination of the physical and mechanical properties of the mortar, its structure, water absorption by weight, color, binder kind, but also the chemical analysis of insoluble elements was made to identify the binder and granulation analysis of the separated aggregate. Conservation analysis of mineral plaster mortar was made by Dr Aleksandra Gralińska-Grubecka.

The water absorption weight of mortar sample was calculated in reference to mass of dry material. To make the chemical analyses of the insoluble parts, first a small sample of mineral mortar with irregular shape was dried solid. A strictly defined quantity was then treated with a hydrochloric acid solution. The sample dissolved quickly and intensely, extracting gas ↑CO_2. After the proper time, the solution was filtered through a tissue. Rinsing was continued until a pH indifferent of the filtrate was obtained. The mineral filler was dried, weighed and adhesive to a filler weight ratio was calculated. The filler was sifted in a set of sieves with meshes: 1,1 mm; 0,5 mm; 0,315 mm; 0,2 mm; 0,071 mm to establish masses of particular fractions of aggregate and pelite fraction – below 0,071 mm. Next, the weight ratio of both the adhesive and the filler was calculated. The extracted filler was observed with a microscope to estimate the approximate qualitative composition. The weight proportions of particular aggregate fractions to the total sample mass was presented in the diagram (Fig. 10).

Mortar is grey-yellow and contains lime-silt binder and quartz aggregate in the main. It contains about 17% of binder and about 83% aggregate, i.e., 1 part by weight of binder and about 5 parts of aggregate. Participation of a silt fraction is high and amounts about 18,21% of tested sample.

Plaster is characterized by low mechanical resistance and high water absorption by weight – 11,97%, which is typical for plasters with a lime-silt binder. The aggregate demonstrates predomination of fraction with granulation 0,2–0,071 mm, which is as much as 33,43% of the sample mass. Fraction with granulation over 1,1 mm is 1,28%, 1,1–0,5 mm – 7,54%; 0,5–3,15 mm – 7,25%; 0,315–0,2 mm – 15,50%, and the finest fraction below 0,071 mm is 18,21% of the sample mass (Fig. 10).

The general filler component is a metrically varied granulation of colorless quartz – fine and medium grained, but also milky and yellow (medium and fine grained). There were also pink, white-pink and grey felspars, fragments of igneous rock and numerous black minerals.

Thermogravimetric analysis of mortar was also performed. Thermogravimetric tests were made by Dr Marta Chylińska in the Laboratory of Conservation of Architectonic Details and Elements of the Institute for the Study and Conservation of Cultural Monuments (IZiK), Fine Arts Department (WSP), NCU Toruń, using a Perkin Elmer TG/DSC – STA 6000 thermal analyzer with an autosampler. Analysis evidenced the existence of two crystalline forms of calcium carbonate: micrite and sparite. On the energy curve, polymorphic transformation of quartz was observed at a temperature of about 573°C.

In the range of temperature 200–600°C, a bias in the thermogravimetric curve was observed, perhaps evidence of the dehydroxylation processes of the clay minerals or the degradation of FeOOH.

Particular paint layers composing the polychrome were identified, recognizing pigments and binders by making basic microchemical tests. Pigment and binder micro chemical tests were made by the PKZLAB SC lab in Toruń: Dorota Sobkowiak and Elżbieta Orłowska. The authors would like to express their gratitude to Barbara Mrożkiewicz for releasing the test results.

Basic microchemical tests were performed, with reactions characteristic for pigment and adhesive identification present in the examined material. Ocher $Fe_2O_3 \times nH_2O$ was identified as follows: a test by dissolving a sample in hydrochloric acid HCl and nitric

Sample mass [g]	7,03					
Mass of insoluble parts in 2n HCl [g]	5,85					
Aggregate fraction [mm]	over 1,1	1,1 – 0,5	0,5 – 0,315	0,315 – 0,2	0,2 – 0,071	pelite below 0,071
Particular fraction aggregate mass [g]	0,09	0,53	0,51	1,09	2,35	1,28
Particular fraction aggregate mass [%] compared to sample mass	1,28	7,54	7,25	15,50	33,43	18,21

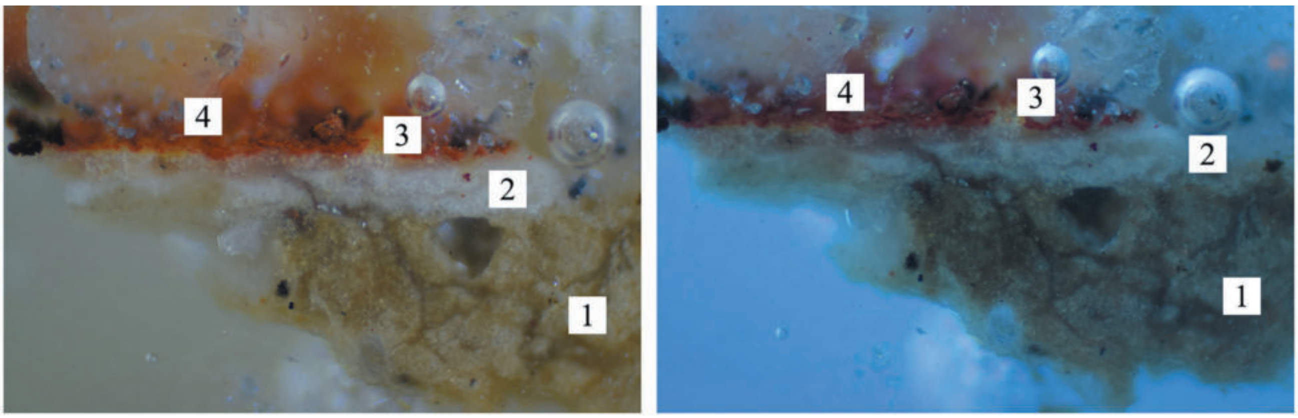
Fig. 10. Weight proportions of particular aggregate fractions from the lime-sand mortar compared to total sample mass. Compilation: A. Gralińska-Grubecka, A. Kaźmierczak.

acid HNO_3, which gave partial dissolving. In sodium hydroxide (base) the sample was untouched. In reaction with acetic acid 2n CH_3COOH and ammonium thiocyanate NH_4SCN, blood-red coloring was obtained, evidencing the presence of Fe (III). During calcination, the pigment particles changed color to a brown-red ferric oxide (III) Fe_2O_3. Having recognized the iron red Fe_2O_3, similar reactions to those with the ocher were made, but during dissolution in acids and base, the sample did not change.

Malachite $CuCO_3 \times Cu(OH)_2$, blackened during calcination as a result of the creation of cupric oxide (II) CuO. The process of dissolving the sample in acids extracted carbon dioxide $\uparrow CO_2$. During the reaction with ammonium, mercury thiocyanate $(NH_4)_2[Hg(SCN)_4]$ and presence of Cu^{2+} cation, we obtained yellow-green rosette-shaped crystals and single needles of cuprum thiocyanate (II) $Cu[Hg(SCN)_4]$. Dissolving a chalk sample $CaCO_3$ in acids, carbon dioxide $\uparrow CO_2$ was extracted. After dissolving the pigment in 3M HCl, adding sulfuric acid H_2SO_4 and heating it a little, characteristic needles and bonds of needles were crystalized $CaSO_4 \times 2H_2O$ (Rudniewski 1994, 32–33, 53–54, 69–70, 101–103).

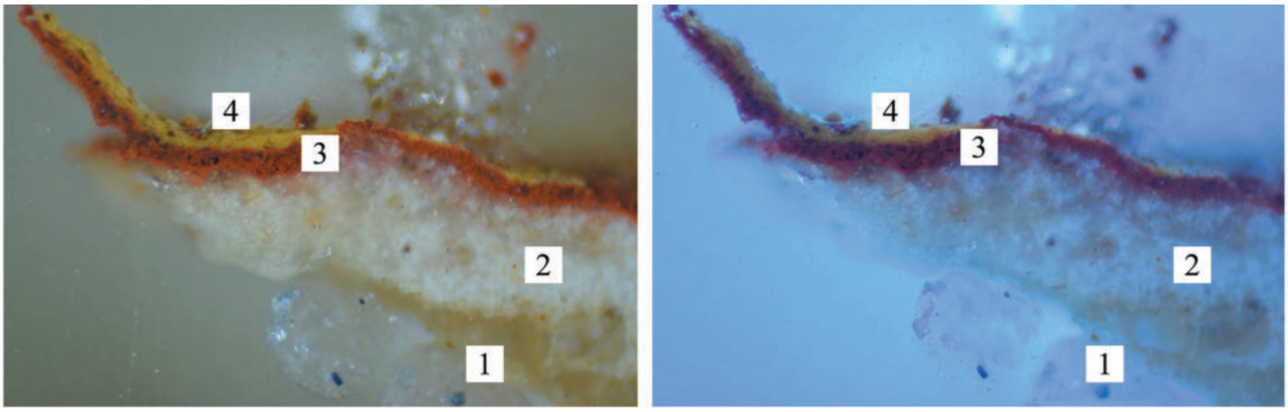
To identify protein adhesives, three basic reactions were made. The first was the biuret test, where 1% of copper sulphate (II) $CuSO_4$ and 40% of sodium hydroxide NaOH were added to the sample. In the presence of proteins, the solution was colored blue-violet. In the next reaction, the sample was completed by lead acetate (II) $Pb(CH_3COO)_2$ and 40% NaOH, and boiled in a water bath. With the presence of egg albumin, a dark coloring was obtained. In the hydroxyproline test, 6n of NaOH was added to the sample and heated in a water bath. Next, 0,01 m of copper sulphate (II) $CuSO_4$ and hydrogen peroxide H_2O_2 were added, the test tube was shaken until frothing occurred and then placed again in a water bath. 3n of sulphuric acid H_2SO_4 and Ehrlich's reagent were added, stirred and heated in the bath. The presence of a pink-red color indicated that glutin glue had been used.

A yellow layer (Fig. 11–12) contained ochre and a protein binder (probably tempera), while the green-blue (Fig. 13) had malachite and a chalk and protein



No	Color and layer type	Pigments, binder	Spectral analysis XRF	Layer specification
4	red painting layer	colcothar, binder - gluten	Ca, Fe, Mn, K, Pb, Ti	Glory ray outline. In UV light – red particles fluorescence blanked visible
3	yellow painting layer	ochre, protein binder	Ca, Fe, Mn, K, Ti	Thin ray painting
2	whitewash	lime	Ca, Fe, Mn, K	Whitewash in three layers. In UV light – blue-white fluorescence visible
1	grey-yellow mortar	lime-silt binder, quartz filling		Lime-sand plaster. Cracks visible

Fig. 11. Microscope pictures of the red cross-section from the southern 'glory' ray in VIS and UV lights, magnification 40×. The pictures show the layers of the composition of the vault's completion: 1 – lime-sand plaster, 2 – whitewash, 3 – yellow paint layer, 4 – red paint layer. The diagram contains the pigments and binding present, with the elements identified using spectral analysis XRF and the brief characteristics of a layer. Photo and compilation A. Kaźmierczak.



No	Color and layer type	Pigments, binder	Spectral analysis XRF	Layer specification
4	yellow painting layer	ochre, protein binder	Ca, Fe, Mn, K, Ti	Color of a cipher letters
3	red painting layer	iron red, binder – gluten	Ca, Fe, Mn, K, Pb, Ti	Color of solar disc with monogram. In UV light – red particles of iron red fluorescence blanked visible
2	whitewash	lime	Ca, Fe, Mn, K	Whitewash put in three layers. In UV light – blue-white fluorescence visible
1	grey-yellow mortar	lime-silt binder – quartz filling		Lime-sand plaster

Fig. 12. Microscope pictures of cross-section of yellow and red painting layers from a monogram of the southern solar disc using VIS and UV light, magnification 40×. The pictures show the composition of the layers of the vault's completion: 1 – lime-sand plaster, 2 – whitewash, 3 – red paint layer, 4 – yellow paint layer. The diagram contains the pigments and binding present, with the elements identified using spectral analysis XRF and the brief characteristics of a layer. Photo and compilation A. Kaźmierczak.

binder. The red (Fig. 11–12) represents a reddish-brown iron oxide, fixed using glue. It is difficult to establish why yellow and green were placed by using the distemper technique while only the red used glue. Both techniques are the most popular wall painting methods, apart from dry and wet frescos (Roznerska *et al.* 1995, 7).

Pigment composition analyses were made using fluorescence XRF. The tests were made by Adam Cupa at the Institute of Painting Technology and Techniques, IZiK, WSP, NCU Toruń, using a MiniPal PW 4025energy-dispersive Xray spectrometer.

Examining the whitewash (Fig. 14), the presence of Ca, Fe, Mn and K were identified. Manganese and iron may have come from lime contamination in lime pits. The yellow layer revealed Ca, Fe, Mn, K, Ti. The presence of iron was confirmed in the ochre pigment. The green-blue painting layer contained (Fig. 15): Ca, Cu, Fe, Mn, K, Si, where copper confirmed the presence of malachite green. When testing the red, we identified the presence of Ca, Fe, Mn, K, Pb, Ti, while the traces of confirmed iron red.

The pigment and whitewash tests were completed using spectroscopic infrared FTIR. Tests were made by Adam Kaźmierczak in the Institute as above in Toruń using a FT-IR Alpha-P spectometer with Quick Snap ATR, a Bruker device, and with a diamond crystal 2 ×2 mm. Spectra ATR FT-IR were registered within the range of 4000–400 cm^{-1}, at a resolution of 2 cm^{-1}, making 64 scans of every sample.

Spectrum analysis confirmed the presence of a protein binder in the ochre (Fig. 16) and malachite and bands coming from carbonates. The presence of lime was determined in every sample, disturbing practically every analysis. Undoubtedly, the test results of the XRF and FTIR were influenced by the disinfection of the whole crypt with 4-chloro-3-methylphenol (PCMC, Raszit) prior to exploration (Grupa and Nowak 2019, 6) and the taking of samples.

Microphotos of mortar, whitewash and painting material cross-sections in visible spectrum and UV (Fig. 11–13) enabled, among others, possible changes in painting to be defined which were not finally evidenced. This test suggested the kinds of pigments used, e.g. particles of iron red blank fluorescence of UV light. It also demonstrated the poor condition of the plaster with numerous cracks. We were also able to estimate the number of whitewash layers placed on the plaster: from two to three.

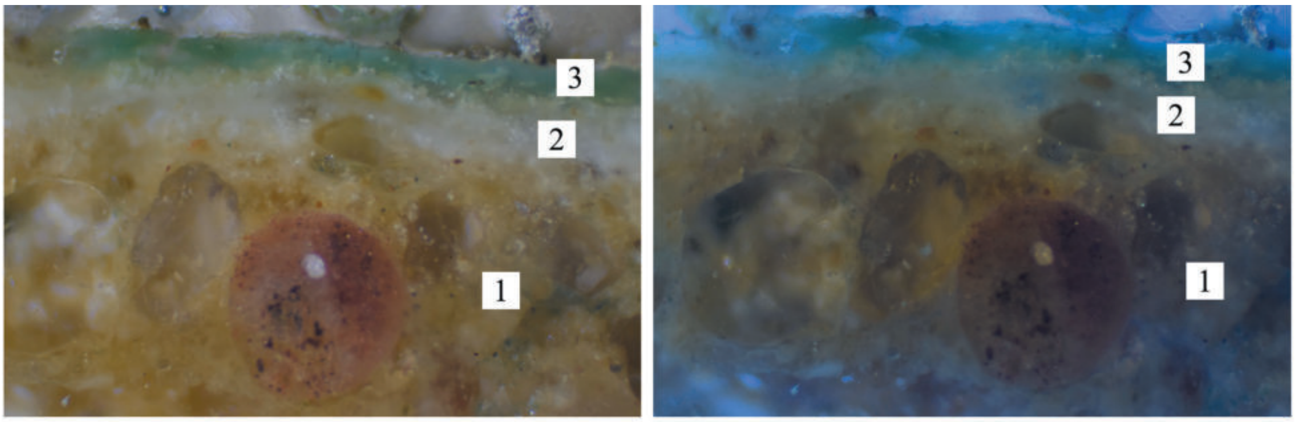
The state of the preservation of the polychrome

By blocking the crypt entrance and bricking up all of the ventilation holes, the conditions changed and led to very limited air circulation, high humidity and the capillary rise of water through the walls, resulting in destructive effects. The coffins had also been deposited in the room for decades. All these factors contributed to high levels of biological infection, with microorganism growth on practically all of the inside surfaces. Painting degradation was also generated by the binder used: protein and glue are not very resistant to humidity changes and thus this hastened the development of microorganisms. It resulted in substantial losses and the powdering of both the polychrome and whitewash. In particular, the protein binder used in the yellow and green tends to result in substantial shrinkage, microelement growth and thus the loosening of the paint (Roznerska *et al.* 1995, 13).

At present, it is impossible to decipher the whole decoration and its details. UV light helps to some extent, although the damp lime-sand mortar is strongly cracked, fragile, indicating weak adhesion to the brick base and the preserved whitewash has been subjected to carbonization.

Restoration analyses

In 2018, the southern crypt was redecorated and restored. Conservation work was supervised by Barbara Mrożkiewicz (Toruń) – a certificated art restorer of elements and architectonic details. During these works, earlier plaster, whitewash and painting layers were reported at the southern glyph of a light opening – three layers. The oldest one contained an ochre lime-sand plaster with a bright grey-yellow shade of whitewash. Mortar component tests and microchemical pigment analyses were made by the PKZLAB SC Laboratory in Toruń: Dorota Sobkowiak and Elżbieta Orłowska.



No	Color and layer type	Pigments, binder	Spectral analysis XRF	Layers specification
3	green-blue painting layer	malachite, chalk, protein binder	Ca, Cu, Fe, Mn, K, Si	In UV light – copper pigment fluorescence blanked visible
2	whitewash	lime	Ca, Fe, Mn, K	Whitewash put in three layers. In UV light – blue-white fluorescence visible
1	grey-yellow mortar	lime-silt binder, quartz filling		Lime-sand plaster. Quartz grains visible: reddish and grey

Fig. 13. Microscope pictures of the cross-section of the green from a flower petal in the vault center using VIS and UV light, magnification 100×. The pictures show the composition of the layers of the vault's completion: 1 – lime-sand plaster, 2 – whitewash, 3 – green-blue paint layer. The diagram contains the pigments and binding present, with the elements identified using spectral analysis XRF and the brief characteristics of a layer. Photo and compilation A. Kaźmierczak.

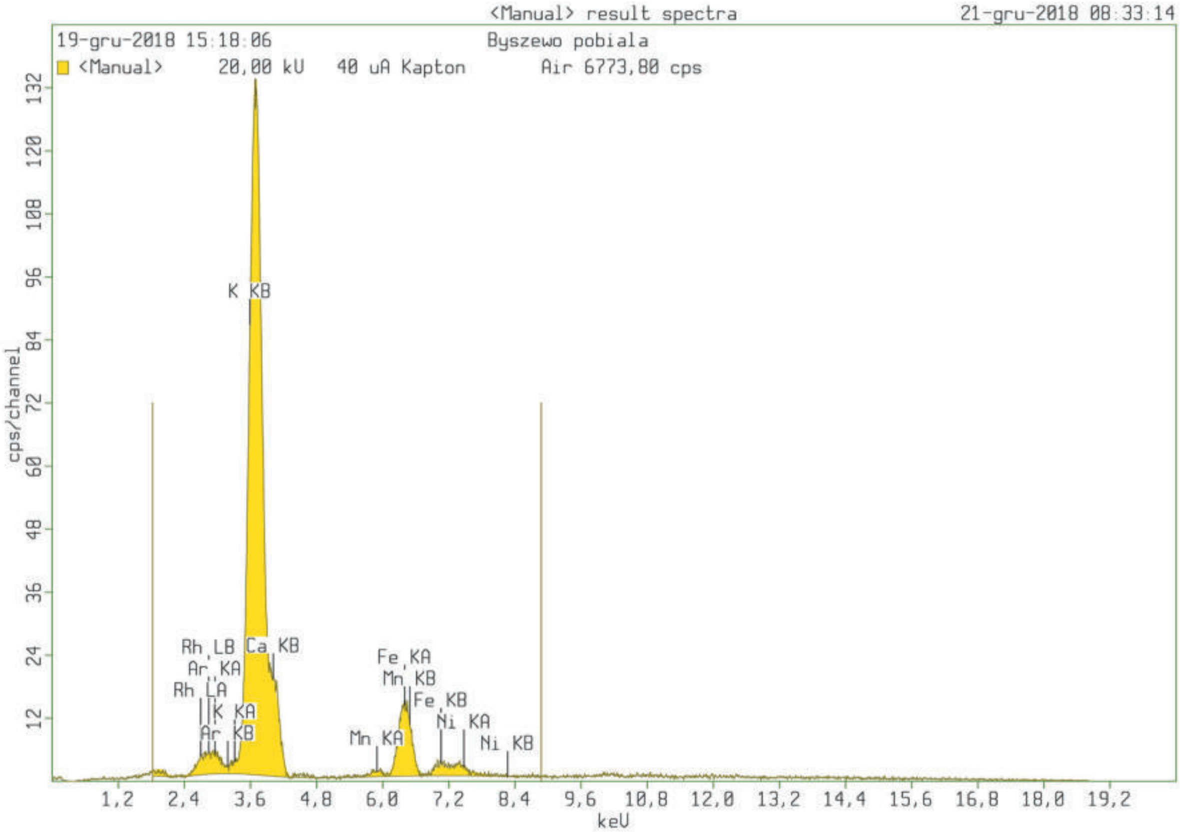


Fig. 14. X-ray fluorescence spectrum obtained from the whitewash sample, with the presence of Ca, Fe, Mn and K evidenced.

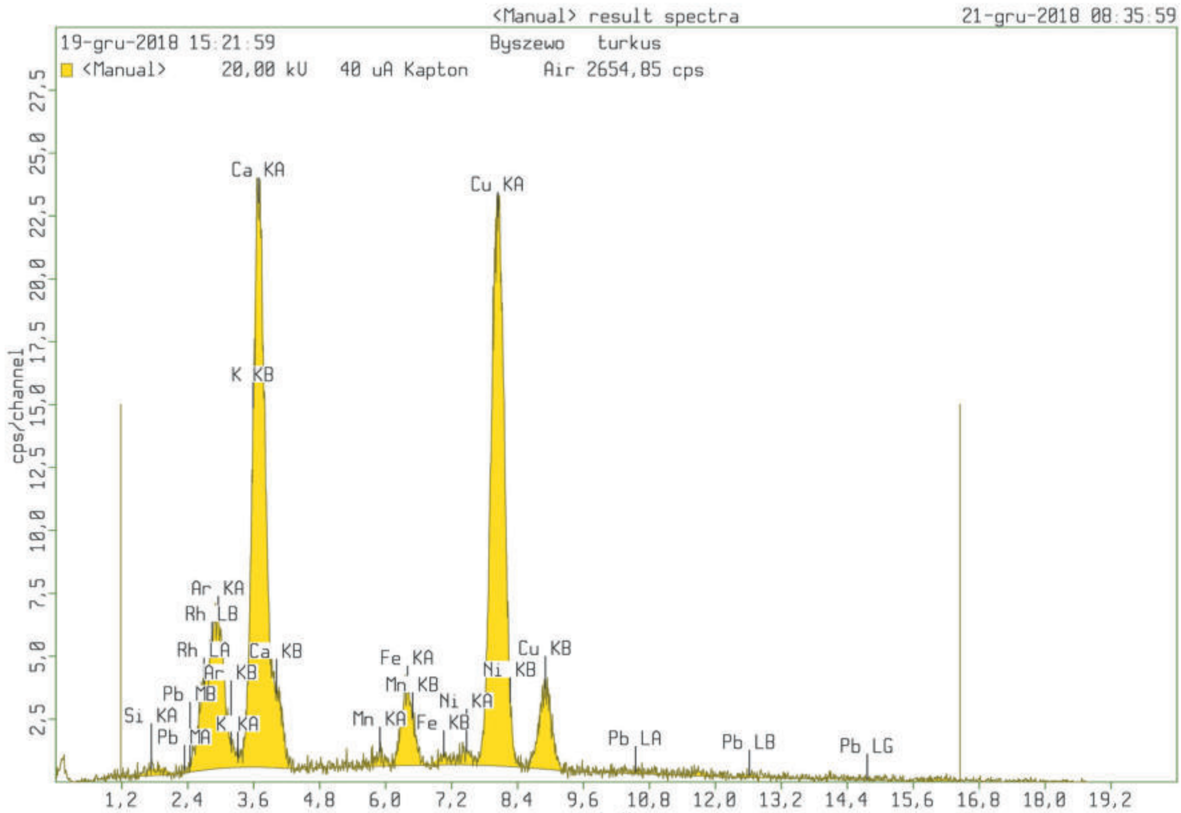


Fig. 15. X-ray fluorescence spectrum obtained from the green-blue paint layer on a leaf of the flower in the central vault section. The presence of Ca, Cu, Fe, Mn, K and Si are evidenced.

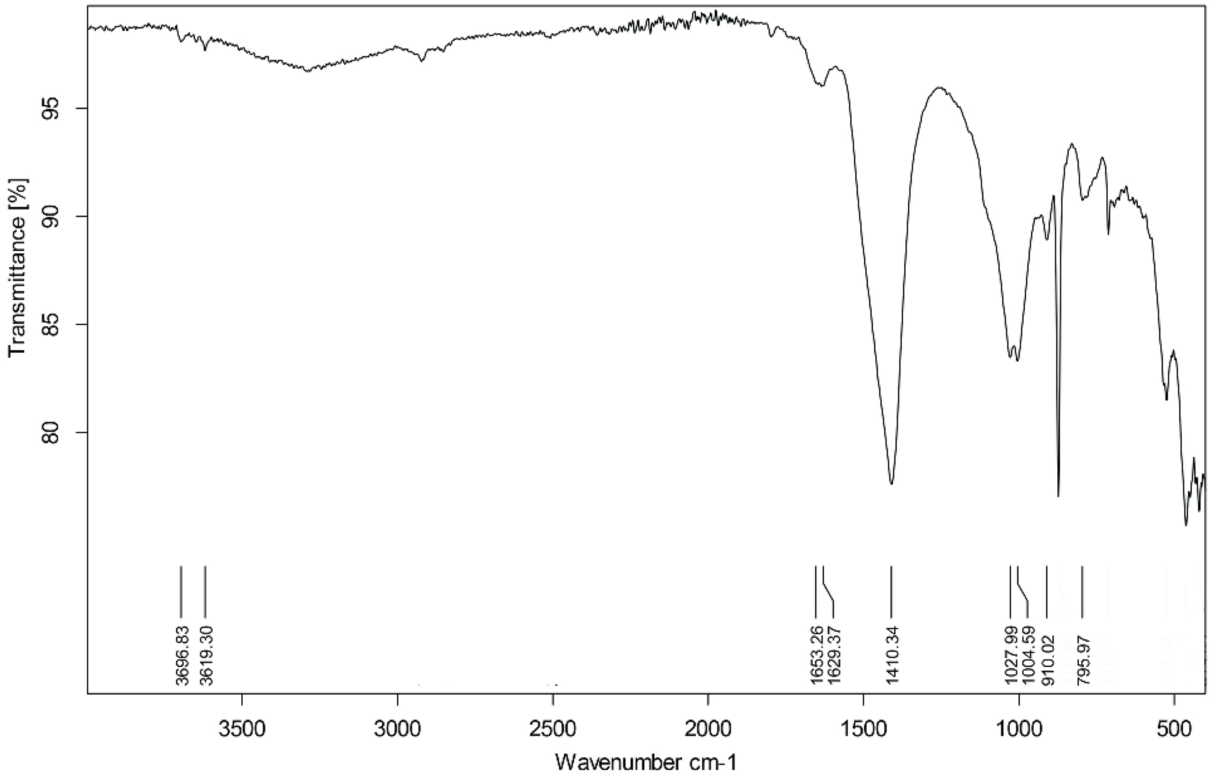


Fig. 16. Infrared spectrum of yellow from a sample in the southern glory. Amide bands identified at 1653.26 and 1629.37 cm^{-1}, confirming the presence of a protein binder. The strong band at 1410.34 cm^{-1}, can be attributed to the presence of whitewash carbonates. Bands at 3696.83, 3619.30, 1027.99, 1004.59, 910.02 and 795.97 cm^{-1} refer to an ochre spectrum pattern.

It contained lean lime and clay and filling of unselected sand aggregate (quartz with various granulation and various mineral contents, being erosion products of igneous rock). The lime binder proportion to aggregate in mass is about 1:4. The plaster has poor mechanical resistance and a high water absorption by weight – 16,5%. The whitewash also contains chalk, and an ochre admixture with a protein binder.

The next layer included lime-sand mortar and red painting, consisting of iron red with a casein binder. That layer was covered with another whitewash with bright grey-yellow paint.

The walls and vault finishing discussed here and preserved to some extent till today began by coating the surface with a number of layers of lime-sand plaster, using short trowels which left traces on the plaster: rough and wavy with a delicate fracture and shading. The lime whitewash was applied with a bristle brush in at least three coats, evidenced by the pictures of the microscopic cross-sections of the samples. The vault has signs of a hard brush having been used. (Fig. 8).

Before the particular images were painted, a composition sketch might have been made, for example on parchment at a 1:1 scale, and next placed on the vault using the pouncing technique from a pattern. It is a technique of transferring an image from cardboard or paper onto a surface of a wall or a ceiling. The contours of the pattern are created by means of the pricked marks and laid over a new surface with paint (Kubalska-Sulkiewicz *et al.* 2015, 336). Painting the sun disc first, the red dial and yellow rays were made followed by the yellow Mariogram and Christogram. The red dye, weakened with water, was used for the glaze outlines of the rays and, finally, a darker shade outlined all the composition.

With the painting of the putti, first the yellow outlines of the basic shapes were made and a weakened red paint was used for the rest and the details of the figures. The flower – the central vault decoration – was started by painting bright orange petals, with a yellow center, green leaves and red outlining all of the drawing.

There is a problem with dating the polychrome. The pigments used in this object have been known since antiquity and thus cannot be used to aid the dating in this respect. Taking into account other historical aspects, including the possible period of its erection and the fact that the crypt had been redecorated at least three times, we can suppose that the present form of the walls and polychrome could have been made between the 18th and 19th centuries.

Conclusions

Polychrome appears only rarely in grave crypts and, due to their fragile character and susceptibility to climate changes, constitute a challenge for art restorers. The capillary rise of ground water is a direct reason for the damage here. The particular grave crypt environment and the numerous microorganisms living there (Drążkowska and Grupa 1998, 122; Walczak *et al*. 2015, 327–329, 342) also affect a polychrome's condition. Destructive human activities also contribute to base and painting disintegration, e.g. intentional closing the ventilation system, not to mention the kinds of pigments used in compositions. The malachite applied in Byszewo is poorly resistant to the alkaline character of the walls and often discolors in wall paintings (Roznerska *et al*. 1995, 13).

The wall painting identified in the southern crypt of the Byszewo church of the Holy Trinity refers to images commonly used in Catholic symbols, in funeral culture, coffin decorations, epitaphs or by scapular brotherhoods (Saar-Kozłowska 2015, 50). The plaster layers on the walls and vault can be a sign of four independent redecoration works, e.g. to prepare the room for subsequent burials of eminent persons. When organizing sumptuous burial ceremonies, great sums of money were also set aside for preparing the event and places of eternal rest (Saar-Kozłowska 2015, 46–47). It is difficult to estimate how long the painting decorations lasted under grave conditions and when a crypt required redecoration. For example, the crypt under the presbytery of a church in Piaseczno, e.g. (Pomorskie voivodeship) was redecorated and reroofed from the foundation of John III Sobieski only 15 years after its erection (Nowosad 2018, 30).

The pigments and techniques used in the Byszewo crypt are defined as popular for wall painting, appearing in a wide chronological range. Due to the lack of additional source information, it is impossible to estimate precisely the time of the creation of the polychrome. It can be stated, based on archaeological evaluations concerning the burials, that it was around the turn of the 18th century.

Conservation and physicochemical analyses of plaster and paint layers from the crypt deliver important information on the techniques used in decorating sepulchral locations, indicating the local workshops' mastery of aesthetics. The interdisciplinary character of the research conducted at this site confirms the significance of the cooperation of various specialists in discovering and preserving cultural heritage components.

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Plant Identification and Significance in Funeral Traditions Exemplified by Pillow Filling from a Child Crypt Burial in Byszewo (18th/19th centuries)

Abstract

Jarosińska M., Nowak S., Noryśkiewicz A.M., Badura M. 2019. Plant Identification and Significance in Funeral Traditions Exemplified by Pillow Filling from a Child Crypt Burial in Byszewo (18th/19th centuries). *Analecta Archaeologica Ressoviensia* 14, 187–197

Plants have always played an important role in funeral customs. To understand their true meaning, close cooperation between the archaeologist and the archaeobotanist is needed, not only during the final interpretation, but from the very beginning, at the stage of collecting materials. In the article, plants' identification, using both pollen and macroremains analysis, was described, based on one of the children's burial from the Holy Trinity Church in Byszewo (18th/19th centuries). The filling of the coffin pillow consisted of numerous hop (*Humulus lupulus*) macroremains, the representation of which was very low in pollen sample. This is due to the fact that only female specimens of hop were inserted into the coffin. To determine the reason for using hops in funeral practices in Byszewo, ethnobotanical data was used. The following research indicates the need for the cooperation between two methods of plant identification. It will allow misinterpretations of botanical findings to be avoided.

Key words: archaeobotany, funeral plants, crypts, child burial, Byszewo, Northern Poland

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Introduction

Archaeological studies are the basis for research on the human socio-cultural past (Ławecka 2019; Bielińska-Majewska 2011). One of its elements is the funeral ritual, which consists of a group of practices and beliefs related to the burial of the dead. Funeral archaeology, based on preserved materials, attempts to reconstruct not only the customs themselves, but also the whole culture, with its rules and restrictions rarely found in written sources (Trawicka, Ceynowa 2010; Czopek 2012). The rituals associated with the burial included the tradition of placing objects into the coffins which accompanied people in their lives, so that they could use them after death, or coins to cover the fees on the way to the afterlife (Bohdanowicz 1999; Skóra, Kurasiński 2011). An important element of these practices were plants and herbal accessories. Botanical remains in burials are mainly preserved in the form of bouquets and wreaths, as well as mattress and pillow remnants (Rożek 1977; Pela 1997; Galera *et al.* 2013; Hryszko 2013; Noryśkiewicz, Sulkowska-Tuszyńska 2016). Apart from their aesthetic value, flowers and herbs were placed for religious reasons or as a superstition, like the belongings of the deceased, meant to provide food after death or facilitate 'the trip to the other side.' The type and number of plants that were placed in the coffin depended on the season and on the family's wealth. In spring and summer, when gardens, meadows, roadside ditches and fields were covered with colourful flowers, they were the main decorative element (Drążkowska 2006, 2007). Plants were also put into coffins for purely practical reasons; because of their aseptic properties which slowed down decay or due to their strong fragrance which screened the smell of the decomposing remains (Bohdanowicz 1999; Drążkowska 2005). Bearing in mind such an important role of plants in the ritual of the transition between death and eternal life, it is necessary to cooperate with an archaeologist in order to get a full picture of the ancient funerary rites in each historical period. So far, only a few publications and reports have been created, in which botanical data obtained from various types of burials are discussed in greater detail. This is true of both Poland (e.g. Pińska, Latałowa 2010; Galera *et al.* 2013; Kurasiński *et al.* 2018) and of other countries (e.g. Hansson, Bergström 2002; Korolyuk, Polosmak 2010; Nadel *et al.* 2013; Šálková 2015; Akeret 2016; Lempiäinen-Avci *et al.* 2017; Wu *et al.* 2017). The purpose of this paper is to present, on the basis of an analysis of the pillow filling from one of the burials in Byszewo, the methods used in archaeobotany and the possibilities of interpretation of botanical findings preserved in coffins.

Historical background and outline of archaeological research in the Holy Trinity Church in Byszewo

Byszewo is a small village situated between the regions of Pomerania and Greater Poland, in the county of Bydgoszcz (Główny Urząd Geodezji i Kartografii 2019). The first certain mention of the place is connected with the arrival of the Cistercian Order in Byszewo in the 13th century and the erection of a wooden church. At the turn of the 15th and 16th centuries, the building was modernised and a brick church stood in place of the wooden structure, which 150 years later was destroyed by a fire. In the middle of the 17th century, a third temple was built on the site – the Holy Trinity church. In the 18th century, the church was extended by means of two side chapels and a porch (Adrich 2016). The church is the Sanctuary of the Blessed Virgin of Byszewo, the Queen of Krajna.

Archaeological work was conducted from November 2017 to April 2018, with the research focus on the southern crypt. More than hundred coffins containing the remains of more than 115 men, women and children were discovered there. Most of the burials date back to the 18th and 19th centuries, although older burials, also from the beginning of the 18th century, cannot be excluded. Archaeological documentation involved a detailed description of the crypts, location and characteristics of coffins, and an inventory of their adornment, including clothing and movable memorials. It is worth noting that children's coffins were markedly simple, while those of adults were more elaborate both in their making and decoration (Grupa, Nowak 2019). After the research, the human remains, along with the destroyed coffin relics, will be reinterred in the parish cemetery.

Among the studied burials, child burial no. 37/2018 is an exceptional one. The wooden coffin consists of a coffin chest and a lid, both trapezoidal. Lid proportions and dimensions suggest a second chest was used for the purpose. Individual boards were processed with little diligence (visible traces of treatment with a plane) and joined with wooden dowels. Child burials are usually associated with bright colours highlighting the innocence of the deceased (Kizik 2001; Majorek, Grupa 2013; Grupa *et al.* 2014), but this coffin, however, had been painted black. This decoration of child burials is not uncommon at the sanctuary of Byszewo (Grupa, Nowak 2019).

Inside the coffin, the relatively well-preserved remains of the deceased child were found, most likely in the first year of life. The infant was equipped with a shirt or a funeral dress made of linen fabric in a plain weave 1/1, the length of which allowed the bottom edge of the clothing to be placed under his/her feet. The linen fabric underwent far-reaching destruction due to the physicochemical conditions prevailing in the crypt (Drążkowska, Grupa 1998). Decorated appliqués (around the chest, the legs and the cuffs), stitched to the garment with tailoring pins, remained in a decidedly better condition. They were made of silk rep ribbon in a 1/1 rep weave, keeping the insets at the edges. The infant's head was decorated with a funeral wreath made of green plants and fragments of silk bands, identical to those used as appliqués on the grave clothing.

The body of the deceased was laid on the layer of plants and wooden chips, which were probably covered with linen fabric forming the shape of the mattress (Drążkowska 2005; Grupa *et al.* 2014). Near the skull, there was an accumulation of plant parts and small scraps of linen fabric, which indicate the use of these plants as the filling of the coffin pillow. The use of pillows could have both practical and symbolic dimension. An additional element of the coffin adornment strengthened the impression of wealth. The pillow allowed the body to be arranged for the last farewell or presentation before the funeral, giving the impression that the dead person was asleep – one of the allegories of death (Drążkowska 2005). The use of mattresses and pillows with a herbal filling as an element of coffin lining was quite a common practice (Drążkowska 2005; Matuszewski 2007; Wojcieszak 2010; Grupa *et al.* 2014). They were often made of the same fabric as the mortuary clothing (Drążkowska 2005), which in the case of linen fabrics that are much less resistant to grave conditions than silk. This turns out to be quite troublesome for an archaeologist engaged in reconstructive research. In most cases, it is possible to determine the presence of pillows through the characteristic accumulation of botanical debris directly under the head of the deceased.

In the described burial, the plants were also registered in the form of a bouquet (not well preserved) arranged directly on the child's body (Figs. 1–2).

Archaeobotanical analysis

The archaeobotanical analysis was performed on a 24 g sample taken from the area of the head of the dead infant. It consisted of numerous, dried fragments of plants mixed with fragments of cocoons and insect moults. Firstly, part of the material was secured for palynological analysis (one subsample). About 1 cm^3 of the sample was treated with a 10% hydrochloric acid solution (HCl) to remove any carbonate compounds. In the next stage, to remove any humic acids, the matter was treated by hot 10% KOH and macerated by means of the Erdtman acetolysis method. Due to the high content of mineral substances after decantation, the sample was also treated with hot hydrofluoric acid (40% HF) to dissolve the clay fraction (Berglund, Ralska-Jasiewiczowa 1986). The samplings – after standard maceration – were examined under an Axioskop 2 microscope, and the photographic documentation was made with a Zeiss Axiocam ICC3 camera. Pollen and spore identification followed Beug (2004), and the Northwest European Pollen Flora I–VIII (Punt *et al.* 1976–2003). 205 sporomorphs were counted in the pollen sample.

Material for macroremains analysis was dry-sieved on 0.2 m and 0.5 mm sieves. Each fraction was sorted with the use of a stereoscopic microscope, while specialized atlases (Marek 1954; Kulpa 1974; Cappers *et al.* 2006; Cappers, Bekker 2013) were used for identification. The accuracy of the identification was compared with the collection of carpology collected in the Laboratory of Paleoecology and Archaeobotany

Fig. 1. Burial no. 37/2018 (phot. S. Nowak).

Fig. 2. Location of archaeobotanical sample with common hop (phot. S. Nowak).

of the Plant Ecology Department of the University of Gdańsk (CRefColl-UGDA) and herbal specimens from the Herbarium of Department of Plant Taxonomy and Nature Conservation of the University of Gdańsk (Herbarium Universitatis Gedanensis UGDA).

Results

The archaeobotanical list consisted of thirty-five taxa, which represent crops, segetal and ruderal weeds as well as forest and meadow plants (Table 1).

The analysis of the pollen sample has shown the presence of relatively well-preserved sporomorphs. Twenty-nine individual taxa have been determined – five belonging to a group of trees and shrubs, one to draft shrubs and twenty-three to herbaceous plants. The palynological sample is characterised by a relatively great taxonomic diversity. Mugwort pollen (*Artemisia*, 35%), mint-type pollen (*Mentha* type, 13.2%) and representatives of the celery family (Apiaceae undiff, 6.3%) were most frequently found. The predominance of these three taxa is an indication that the plants could have been put into the coffin on purpose. Less numerous is the pollen from three types of the Asteroideae subfamily (*Aster*, Asteroideae undiff and *Cirsium*/*Carduus* – 5.4% in total), unidentified grasses (Poaceae, 4.9%) and bedstraw family (Rubiaceae, 4%). Lower values have also been achieved by bellflower (*Campanula,* 2.9%), crucifers (2.9%) and hops (*Humulus lupulus,* 2.4%). The share of cereals is relatively high: rye (*Secale cereale*, 2.5%) and Cerealia type (2%). Other taxa have reached <2%. Occasional sporomorphs could have entered the coffin as a modern burial pollen or as random pollen grains that were previously deposited on plants.

The analysis of macroscopic remains has revealed numerous findings of plants representing nine taxa (Table 1). The most frequently recorded were the remains of hops (*Humulus lupulus*, Fig. 3 A-E), mainly preserved in the form of fragments of female inflorescences (cones). Among these, the most numerous are bracts (Fig. 3A). They are almost transparent, tracing paper-like leaves of various sizes and shapes. There are also a few strings (axes forming the cone) that look like reindeer antlers (Fig. 3B). Interesting finds were pistils as well as featherlike stigmas (Fig. 3C). In addition, single, spherical fruits (achenes) with a diameter of up to 2 mm have been noted (Fig. 3E). The specimens have a characteristic, cushion-shaped trailer with a distinc-

Table 1. Taxa found in the pillow filling

FAMILY	TAXA	PALYNOLOGICAL ANALYSIS	MACROREMAIN ANALYSIS
Apiaceae	*Pimpinella saxifraga* L.	–	2
	undiff.	6.3%	1
Asteraceae	*Anthemis cotula* L.	–	1
	Artemisia	35%	–
	Aster	0.5%	–
	Asteroideae undiff.	1.4%	–
	Cirsium/Carduus	3.5%	–
	Centaurea cyanus L.	0.5%	–
Betulaceae	*Betula*	1.9%	–
	Corylus avellana L.	1.5%	–
Boraginaceae	*Symphytum*	1.9%	–
Brassicaceae	undiff.	2.9%	–
Campanulaceae	*Campanula*	2.9%	–
Cannabaceae	*Humulus lupulus* L.	2.4%	>500
Chenopodiaceae	undiff.	1.5%	–
Ericaceae	*Calluna vulgaris* (L.) Hull	1%	–
Fabaceae	*Lathyrus*	0.5%	–
Lamiaceae	*Rosmarinus officinalis* L.	–	2
	Stachys type	3%	–
	Mentha type	13.2%	–
Linaceae	*Linum usitatissimum* L.	–	2
Malvaceae	undiff.	–	1
Pinaceae	*Pinus sylvestris* L.	3%	–
Poaceae	Cerealia	2%	–
	Secale cereale L.	2.5%	–
	undiff.	4.9%	3
Polygonaceae	*Polygonum*	–	1
	Polygonum persicaria type	0.5%	–
	Rumex acetosa/acetosella type	0.4%	–
Primulaceae	*Lysimachia*	0.9%	–
Ranunculaceae	*Ranunculus*	0.4%	–
Rubiaceae	undiff.	4%	–
Tiliaceae	*Tilia*	0.5%	–
Ulmaceae	*Ulmus*	0.5%	–
Urticaceae	*Urtica*	0.5%	–
others	fungal spores	–	7
	moss fragments	–	2
	leaf fragments	–	+

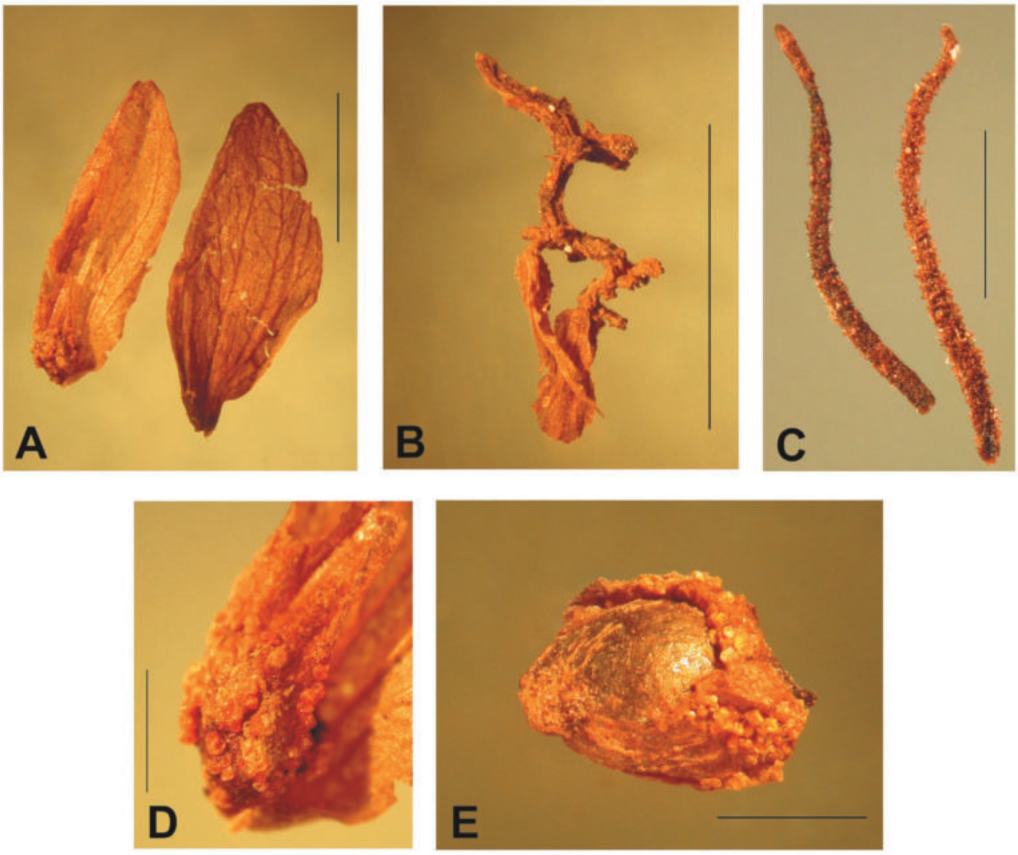

Fig. 3. Macroremains of the common hop. A – bracts, B – strig with remaining bracts, C – stigmas, D – lupulin on a bract, E – achene (phot. M. Badura, M. Jarosińska); scale bars equal 1 mm.

tive appendix. There were yellowish lupulin particles on the surface of the fruits and partially on the bracts (Fig. 3D). Lupulin is responsible for the bitter taste and strong aroma of hops, it also contains substances such as terpenes, tannins, resin compounds and flavonoids (Strzelecka, Kowalski 2000).

In addition to hops, single fruits of stinking chamomile (*Anthemis cotula*), burnet-saxifrage (*Pimpinella saxifraga*) and flax (*Linum usitatissimum*) have been recorded. In the absence of unambiguous diagnostic features, identification of some of the fruits is to the genus type (*Polygonum* sp.) or family (Apiaceae, Poaceae). The sample has also shown the presence of the perianth from the mallows family (Malvaceae), fragments of rosemary leaves (*Rosmarinus officinalis*), moss remains, fungal spores and indeterminate vegetative parts of herbaceous plants.

Humulus lupulus – common hop

The results of the analysis of the macroscopic remains may suggest the intentional use of hops as the basic component of the pillow filling. In the palynological spectrum, this species is represented by single pollen grains (2.4% of the total of all determined grains). Such a small share of hop pollen can be explained by the selective farming of female specimens or selective use of female specimens in funeral customs, thus the presence of a small amount of pollen.

Hops are a dioecious plant (female and male reproductive organs occur on various individuals), perennial, from the Cannabaceae family. Stalks – so called shoots – grow up to 10 m in natural conditions. It usually occurs in climbing form, but in the absence of support, it may take a creeping form. It always winds clockwise. Male inflorescences (containing only stamens) are paniculate and embedded singly on short petioles. Pistillate flowers (female, containing one or more pistils) are collected in more or less loose clusters – strobili – resembling cones, borne in the axils of bracts and bracteoles. The cone is an inflorescence, consisting of nodes and internodes; at each node there are four flowers. A single flower consists of a spherical ovary, a pistil completed with a double feathered stigmas and a stipule. At the base of the bract and bracteoles, there are numerous multicellular glands containing lupulin. Hop is an anemophilous plant and its fruit is a spherical nut with a diameter of up to 2 mm, orange to pale brown. It blooms from August to September and, under favourable conditions, fruits from the second half of August. In natural conditions, it occurs in moist habitats, in riparian and alder forests, and often forms tall herb fringe communities; in anthropogenically transformed forests it develops on forest edge communities, although it also eagerly takes up anthropogenic positions co-creating hedges (Herse 1980; Behre 1999; Hanelt *et al.* 2001). Hops are believed to be natives of Europe and America (Davis 1957 after: de Candolle 1885), although Majewski (1893) suggests a foreign origin. Currently, it is cultivated almost all over the world and in the wild it occurs in almost all of Europe, western and central Asia and North America (Davis 1957; Tutin *et al.* 1964; Szafer *et al.* 1986).

At archaeobotanical sites in Europe, hops are already recorded in the Neolithic period, however, until the Roman period only single ovules were found. A significant increase in the share of the remains of this plant is noticeable in the early Middle Ages, which may result from the development of brewing at the time (Behre 1999; Beck 2005). The knowledge of how to use hops was probably brought by monks or pagan Slavs, who brought the custom of hopping beer from their neighbours, Finns and Tartars (Majewski 1893 after: Doublet 1625; Brückner 1937; Hegi 1957; Nowiński 1980; Kujawska 2016). There are only female specimens in hop cultivation; males are eliminated from the plantation. This is to avoid fertilization, after which female inflorescences lose their quality as a brewer's raw material (Herse 1980). However, the appearance of hops in the material from the crypt would indicate the presence of male specimens among the crops or in the close surroundings from which the material for pillow filling came.

In folk medicine, the common hop is famous for its healing and aromatic properties. Many sources indicate the use of hops to relieve nervousness, headaches, insomnia and fever, as well as to support appetite, in urinary tract diseases, and externally as a treatment for scalp diseases (Kluk 1808; Davis 1957; Paluch 1984, 1989; Rejewski 1992; Schiller *et al.* 2006; Kujawska 2016). At present, the antibacterial, antifungal and antiviral, or even chemopreventive effects of compounds contained in hops have been found and are undergoing further research (Mielczarek *et al.* 2010).

Hops also played an important role in folk customs. At Easter, it was intertwined into palms, and on the Assumption Day (August 15th), it was used to arrange bouquets. The common hop also played a special role in wedding ceremonies: it was considered to be the ally of love and the 'marriage maker,' a symbol of courage and marriage, and during the wedding – the symbol of the groom. It was not only added to beer, honey and bread dough were also flavoured with it (Majewski 1893; Paluch 1984; Kujawska 2016). It is mentioned in the popular folk song of *Oj chmielu, chmielu* sung during some Polish wedding customs (Brückner, Estreicher 1939; Szcześniak 2013) and in works by various contemporary authors (Pawlikowska-Jasnorzewska 1937; Grechuta 1979; Bajor 1983–1993). In the past it was popular to plant the vines by the houses, in the area of porches – it was supposed to calm the farmers returning from the field; a hop climbing under the windows of the bedroom and stuffed into pillows made falling asleep easier (Davis 1957 after: Johnson 1867; Morgan 1952; Kujawska 2016).

Such a wide use of the common hop has been transferred to funeral rites. It is known from the literature that hops would be scattered in the doorway when the dead body was carried through (Szcześniak 2013). Based on Józef Rostafiński's surveys, it is known that in Poland, at the turn of the 19th and 20th centuries, coffin pillows were made from hops, which was included in the set of holy plants for the Assumption Day (Köhler 2017). Remains of hops were already found in the pillows of Mazovian dukes (Pela 1997), King Sigismund II Augustus, Anna Jagiellon and Stephen Báthory (Rożek 1977), as well as in the coffins of the Griffin Dukes of Słupsk (Rawa-Szubert *et al.* 1981), burial crypts under the floor of the Jasna Góra Monastery of the Blessed Virgin (Galera *et al.* 2013) and in the 18th/19th children's burials from Bytom Odrzański (Grupa 2011). The moment of death is known to have been compared to sleeping in various ways (Pokropek 1993). It can be assumed that the practice of putting hop cones in the coffin or pouring them in front of the deceased were supposed to 'calm down' his/her soul, and stuffed in a pillow to give the deceased a good night's sleep. However, their antimicrobial and antifungal properties could also be important.

Other plants

The botanical study has shown that the sample, apart from common hop, also included other plant species (Table 1). Considering their ecological requirements (Zarzycki *et al.* 2002; Matuszkiewicz 2018), they certainly did not grow together with hops, whether cultivated or in the wild. It is possible that the aesthetic values in the form of the splendid umbels of burnet-saxifrage and its rather intense smell speak for the purposeful composition of the plant in the coffin. Rosemary is also characterized by a strong aroma. Moreover, it is also a symbol of memory, in wedding ceremonies it was woven into wreaths along with myrtle and put under the pillow was to facilitate falling asleep (Szcześniak 2013). Perhaps, just like hops, rosemary leaves were placed in the coffin on purpose in order to soothe the soul of the deceased. However, it cannot be ruled out that these plants were part of bouquets placed around the head of the deceased child and as a result of fossilization mingled with the hop-filled pillows. The use of rosemary branches as an ornament on the head of the deceased child finds confirmation in the iconographic material (Drążkowska 2006).

The filling of the pillow may have been contaminated with plant material at the time of the sampling for archaeobotanical research. Pollen analysis revealed the significant share of *Artemisia* pollen, macroremains of which were not noted in the sample. Probably the source of wormwood spores was the bouquet that was also put into the coffin. The high proportion of pollen in *Mentha* type and plants from the Apiaceae family confirm the presence of plants characterized by an intense aroma. Interestingly, the presence of rye *Secale cereale* and weeds typical of its cultivation (cornflower *Centaurea cyanus*, common sorrel/ red sorrel type *Rumex acetosa*/*acetosella* type) has been determined in palynological samples, but not found among macroremains. It is possible that the pollen grains of these plants found their way into the coffin during the preparation of the burial. In view of the flowering time of both plants, this could have taken place in July or August. There is also a possibility of pollen mixing with the rest of macroremains when hops were being harvested. Cereals may have been grown in an adjacent field.

Summary

The advantage of archaeobotanical research is the ability to recognize and describe plants that were part of the funeral ceremony. As the example of the described burial demonstrates, the quality of results depends primarily on the condition in which the plants have been preserved. Also, the field work (method of collecting material during archaeological work, the choice of research methods), as well as the transport to the laboratory and storage are crucial. For this reason, the first stage of work may have a major impact on the quality of results.

Burial no. 37/2018 is a great example of the practical use of a plant with a high symbolic meaning at the same time. The choice of the common hop, the main ingredient of the pillow filling, was dictated by its fragrance – the characteristic aroma of lupulin could screen the smell of the corpses. Applying hop cones under the head of the deceased child was also imposed by the desire to provide comfort after death. The few reports about the presence of hops in burials indicate that this species was used regardless of the status of the deceased person. One can, therefore, be tempted to say that in funeral practices it was a 'universal' plant. The low percentage of hop pollen may, on the one hand, indicate the selective and purposeful use of hop cones in funeral rites, and on the other – the fact that only female specimens were selected for cultivation in the 18th and 19th centuries.

The presented results are only a fragment of archaeobotanical research conducted in the crypts of Byszewo. Collecting data from other burials will allow the more accurate identification of plants and the indication of their role in funeral practices used by the local community.

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ANALECTA
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REVIEWS

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(review) P. Jarosz, J. Machnik and A. Szczepanek (eds.), *Nekropolie ludności kultury ceramiki sznurowej z III tysiąclecia przed Chr. w Mirocinie na Wysoczyźnie Kańczuckiej* [*Cemeteries of Corded Ware culture from 3rd millennium BC at Mirocin on Kańczuga Heights*] (= *Via Archaeologica Ressoviensia* 15). Rzeszów: Instytut Archeologii Uniwersytetu Rzeszowskiego, 241 pages

"Nekropolie ludności kultury ceramiki sznurowej z III tysiąclecia przed Chr. w Mirocinie na Wysoczyźnie Kańczuckiej", edited by Paweł Jarosz, Jan Machnik and Anita Szczepanek, summarizes the results of archaeological and supportive analyses of materials documented during the excavations of two, final Neolithic cemeteries of the Corded Ware Culture (later CWC) in Mirocin, Przeworsk district. It represents an informal continuation of a previous work addressing similar issues, but in regard to the necropoles unearthed in the vicinity of Szczytna (Hozer *et al.* 2017). In fact, both burial grounds were discovered during the same rescue fieldworks associated with the construction of the A4 motorway. The archaeological record from the sites appears to be unique in many ways, as it vividly depicts the structure of a wide network of social and cultural interactions, which in the 3rd millennium BC spanned vast areas of south-eastern Poland and the adjacent regions of Eastern Europe. Therefore, a thorough publication of these materials is necessary for the elaboration of our current understanding of the social milieu of the Corded Ware traditions.

The reviewed work was originally planned to be published as a part of a monograph encompassing all CWC funerary sites documented during the previously mentioned excavations. However, due to some adverse circumstances briefly mentioned by the editors, it was impossible. Despite this, "Nekropolie ludności kultury ceramiki sznurowej z III tysiąclecia przed Chr. w Mirocinie na Wysoczyźnie Kańczuckiej", was eventually published in the same archaeological series entitled Via Archaeologica Resoviensia. The structure and layout of this publication relates to the work addressing previously mentioned necropoles in Szczytna and is additionally supplemented with papers presenting the results of more detailed analyses carried out by specialists from different branches. It consists of a brief editorial note, an elaborate archaeological overview of the material record and 7 supplementary papers. The former covers more than half of the volume and for that reason ought to be discussed in a more detailed manner.

The archaeological part is divided into 4 chapters (I–IV). The first one provides a necessary informational background for both sites in Mirocin, marked with the numbers 24 and 27. Fieldwork took place in the winter and spring of 2011, and was conducted as a part of rescue excavations associated with the construction of the A4 motorway, funded by the General Management of State Roads and Motorways and conducted by Mirosław Mazurek, and Mirosław Okoński representing the Foundation of Rzeszów Archaeological Centre. Professor Jan Machnik was appointed to the position of main consultant.

Sites 24 and 27 in Mirocin, Przeworsk district, covered the area of 160 and 308.3 ares, respectively. The total number of 198 archaeological objects, spanning the Neolithic to the Modern Age, were documented on the former site and 385 on the latter. Both necropoles were situated on the flattenings of the two neighbouring loess hills, located few hundred metres to the east and south-east of the locality of Mirocin, on both sites of the road nr 94 from Przeworsk to Jarosław. It lies within the northern part of the Kańczuga Heights, a microregion constituting the south-eastern border of the Sandomierz Basin, adjacent to the "edge" of Carpathian mountains. Its landscape is mostly rugged, covered with a thick layer of loess soil and most probably offered very favourable conditions for prehistoric economic activities based on agriculture and animal breeding. Probably around the middle of the 3rd millennium BC it became inhabited by people of the CWC. Their presence is indicated by the remains of 9 structures, one of which contained an animal burial.

Chapter I is rather short, but represents a plausible and well-formatted introduction to the subsequent parts of the book. Photos provided are of good quality and supply valuable insights into the conducted fieldwork. Spatial data are also well-managed. Locations of the discussed and other Corded Ware Culture sites from south-eastern Poland are displayed as a point layer on shaded relief with a mild-coloured hypsometric background, which gives a subtle, but informative hint about settlement preferences and its geographic distribution. As for the second figure (no. 2), a hillshade background with additional vector layers would have been more readable than the topographic map, which does not seem suitable enough for the presentation of such large scale data.

In chapter II, a catalogue of finds is presented. It is divided into two parts referring to sites 24 and 27 respectively and consists of a detailed description of excavated features, as well as their inventory. First, the technical characteristics of the grave features, such as the diameter of the entrance and burial pits, classification of its shape, length and width, orientation according to the cardinal directions, and depth, are given. After that the construction is discussed in detail. The last part of the description is focused on the buried individual(s), and discusses information regarding biological sex, age, body orientation according to cardinal directions, its exact location on the bottom of a burial pit, as well as position of trunk and arrangement of limbs. In the end, brief information about types and number of grave goods, along with their location in the burial pit and spatial relation to the skeleton, is presented. Furthermore, each description is followed by a detailed list of objects found in the grave, including their type, size, material used for production, and observations regarding their state of preservation – naturally with references to adequate figures and analytic papers from the second part of the discussed tome. The inventory always begins with ceramic vessels. The remainder of objects are also presented in a standardized order: bone tools directly after ceramic wares, after that large implements made of stone and siliceous rocks, with small flint artefacts, such as tools, arrowheads and flakes at the end. All objects are additionally divided into artefacts found *in situ* at the bottom of the burial pit and those extracted from its fill. This is particularly helpful as it simplifies the process of querying data and resolves the problem of time-consuming, and often fruitless examination of features' description. In general, the whole catalogue part has been prepared according to an established, high standard of the previous volume of the Via Archaeologica Resoviensia series. As stated before, the description is comprehensive and provides all necessary information. However, due to the small font-size and line intervals, it is sometimes difficult to "filter" specified information from the text column. Therefore, an additional table comprising the basic metric data of a feature, as well as sex, age, and body orientation of the deceased, could significantly facilitate the process of "extracting" basic information for other research and statistic purposes. Similar solution was included, i.a., in an excellent monograph of the Corded Ware cemetery in Żerniki Górne, site 1, by Andrzej Kempisty and Piotr Włodarczak (2000).

Chapter III begins with a brief overview of the Corded Ware Culture funerary ritual. It includes number, characteristics and location of particular grave features unearthed during the excavation of both necropoles in Mirocin, Przeworsk district. These were situated along the main axis of local summits, in their close vicinity or in the upper parts of their slopes. The authors suggest that graves no. 50, 53, 54 on site 24 could have been originally located at the south-eastern border of a barrow mound, which was most probably levelled. Niches of the catacomb graves show a resemblance to structures previously known from the Sokal Ridge, and are quite different from objects documented in the region of Małopolska Upland – their entrances were located far below the level of the corridor's floor. Apart from the description, which summarizes previously presented data, characteristic traits of all excavated features have been put into a table (table 1), which facilitates the search for particular attributes. It is worth noting that the authors incorporated A. Hausler's (1974) classification of lower and upper limbs' arrangement. Thanks to that, objects from Mirocin can be easily compared to other graves from different parts of south-eastern Poland. All uncommon traits of burials are thoroughly analysed and discussed, usually on the basis of their resemblance to other features from different regions of the CWC ecumene. As a result, the burial rituals of the communities occupying the Kańczuga Heigths are presented in a wider scope. One of the commonly shared burial customs was the deposition of grave goods in the deeper parts of the niche, closer to its inner wall. Unfortunately, the location of artefacts was not systematically examined, as was recently done by Bourgeois and Kroon (2017). Because of that, interregional comparative analysis of burial rituals, e.g. in relation to the CWC communities from its western part, requires additional data processing.

In the subsequent, second part of the chapter, the typology of artefacts (movable objects) is presented. Due to their spatial vicinity (1100 m), artefacts from both sites were analysed together. The whole assemblage of grave goods is divided into categories, such as clay vessels, including amphorae, beakers and other forms. Their features are discussed in a very detailed manner and a great emphasis is put on their resemblance to ceramic products from other regions, particularly the Małopolska Upland and the Sokal Ridge, but also the Middle Dnieper area. The latter direction seems to be treated with additional attention, as it constitutes a solid basis for the authors' assumption regarding close contacts between the Corded Ware communities from Kańczuga Heights and populations from the aforementioned Middle Dnieper zone, covering areas of today's Ukraine and Belarus. This hypothesis receives additional and, more importantly, convincing support in the subsequent part of the book (a paper regarding the origin of people from CWC cemeteries in Mirocin). Other classes of analysed objects include stone utensils (battle-axes and grindstones), flint artefacts (axes, tools, arrowheads and half-products), bone tools and objects with marginal or no traces of manufacturing (chisels, awls, boar tusks, beads) and copper adornments. At the end of the second part of chapter III, the authors make an interesting suggestion on the origins of two necklaces made from copper plates found in graves 54 from site 24 and 360 from site 27. According to the text, similar forms could be traced in the assemblages of the Fatyanovo culture, which shows many resemblances to the Corded Ware tradition. Unfortunately, this assumption is based solely on (probably) oral information and therefore appears to be insufficiently embedded in the recent literature. Nonetheless, the whole analytical part is very solid and constitutes an abundant source of valuable information. One of its visible flaws is the lack of analysis regarding patterns of deposition of particular categories of movable objects in different parts of the burial pit's bottom. An attempt to quantify this matter was previously made by Włodarczak (2006). Recently, Quentin Bourgeois and Eric Kroon (2017) published an article addressing the burial ritual of the Corded Ware communities from the western part of its ecumene, which included a functional scheme designed for the discussed purpose. Despite some differences, it could be easily adapted to the analysis of grave goods' location in the context of other parts of the Corded Ware settlement, such as south-eastern Poland. Furthermore, the presence or absence of specific types of grave goods is not discussed in relation to burial traits, be it biological or cultural. The adoption of a more quantitative approach to this issue could lead to the revelation of interesting patterns, such as the preference of placing different kinds of objects in the graves of people of particular sex and age. According to the recent state of knowledge, the association between the deceased and the objects placed in his or her grave offers an invaluable insight into socio-cultural milieu of prehistoric communities and, as such, should not be omitted (Skrzyniecki 2018). It was also noticed that authors sometimes use the term "wealth" in reference to the quantity and quality of artefacts deposited in graves. In general, their purpose is understandable and usually fits the main narration line, but their assumptions would have been more convincing if the wealth had been quantified. Such analysis constitutes a powerful tool for the reconstruction of previously mentioned social background, as it helps to indicate, apart from its limitations, the relative social rank of different groups.

The third part of chapter III deals with chronology. At the beginning, some preliminary assumptions regarding the relative time sequence of the necropoles' development are discussed in relation to the structure of grave features, objects found in their fill, as well as their location in the cemetery. The most important remark of this part of the text concerns the spatial distribution of graves. According to the text and Fig. 59, there is a possibility that features no. 110, 127, 54, 53 and 50 were originally dug into the soil at the southern border of an older barrow mound, which was most probably levelled due to the more recent, intensive agricultural activity. The presence of fragmented ceramic vessels with traits characteristic for the older developmental phases of the Corded Ware culture in the upper parts of burial pits' fills seems to support this hypothesis. In addition, the authors make reference to the similar spatial situation documented on one of the CWC cemeteries from the Sokal Ridge. In the conclusion, it is stated that the construction of the catacomb graves took place after the erection of an older mound, representing a characteristic feature of the Corded Ware burial customs from the first half of the 3rd millennium BC. In the subsequent part of the text, a functional categorisation of grave features, according to chronologically (in relative terms) distinctive traits of ceramic vessels, is presented. It encompasses eight classes of assemblages which, apart from differences in the quality and quantity of grave goods, also display some resemblances. This observation seems to indicate their socio-cultural, as well as chronological proximity. ^{14}C dates obtained for 6 out of 8 graves generally fall within the first two centuries of the second half of the 3rd millennium. On the basis of a combination of relative chronology and radiocarbon dating, the authors proposed a hypothetic chronological sequence of the construction of catacomb graves, which also takes into account the resemblance between the artefacts from the Mirocin and Szczytna cemeteries. Chapter III ends with the conclusion that a well-defined chronological scope provides the possibility to examine grave assemblages from the perspective of the intergenerational continuity of cultural traits, as well as the appearance of new features, thus inviting the reader to delve into the last chapter.

The final section of the first, archaeological part of the book starts with a direct statement that materials from Mirocin, due to their overall similarity and spatial proximity to assemblages from Szczytna, must be examined and interpreted in conjunction with the latter. The sparse distribution of grave features, as well as their relative low number, are interpreted in economic terms. The lack of archaeologically traceable settlement structures, along with the presence of animal burials, leads the authors to make the assumption that people using cemeteries in Szczytna and Mirocin were pastoralists, and their (most probably) rotational wanderings with herds could have encompassed also the vast grassland environs of adjacent territories, such as the Sokal Ridge, the eastern part of Roztocze, as well as loess uplands of San and Dniester interfluve. Contacts with other regions inhabited by populations sharing the Corded Ware tradition left discernible, material traces in archaeological record, such as the presence of Książnice Wielkie jugs, beakers characteristic for the Middle Dnieper culture, copper necklaces made of rectangular plates and quadrangular axes made of Świeciechów flint. These multiple directions of interaction are presented on a map, labelled Fig. 72, which is meritorically correct, but lacks visual polishing. The river network provides an important reference for spatial orientation, however an additional layer consisting of clearly defined borders of geographical regions, as well as polychromatic hypsometry could make the overall effect even more informative. Furthermore, the authors describe the Kańczuga Heights as particularly suitable for a pastoral economy, supporting their assumption with relevant maps depicting soil conditions and natural resources, along with geographical zones. They also mention the presence of salt springs as one of the factors facilitating the exploitation of the region by groups of pastoralists. However, the map with locations of these springs is not included. The hypothesis of a mobile way of life, although lacking solid evidence, is unceasingly popula among archaeologists dealing with Corded Ware culture settlement from south-eastern Poland. Nonetheless, it still poses an interpretational puzzle which the authors of the book seem to be aware of. One of the passages, in which they point at the incompatibility of the pastoral way of life and the use of ceramic vessels, expresses these doubts quite well. One of the proposed solutions to this problem is to accept the idea that the on-going use of ceramics through the ages did not have any economic reason but was in fact a relic of an old tradition, maintained only in the funerary sphere. Following that line of thought, particular types of ornamentation, as well as differences in vessels' shape might be interpreted as symbolic marks of group identity of the deceased. This perspective is refreshing, as it brings a breath of fresh, dare I say humanistic, air into the archaeological discourse recently dominated by models and numbers. It is regrettable that the authors did not elaborate more on this sociological perspective. For example, nothing is said about the social structure of those people and their potential social roles. Most of the researchers' attention is drawn by the ceramics, which is reasonable and justified. However, other categories of finds, such as weaponry, are equally important, especially in terms of the reconstruction of the previously mentioned prehistoric social milieu. It is worth noting that warrior's equipment also played a crucial role in establishing and maintaining one's identity, be it in life or death. The abundance of arrowheads, as well as different kinds of implements suited for close combat, testifies to this assumption. *Warriorhood*, defined as a collective identity related to the actual engagement in the physical activity of fighting and the sum of material and non-material culture that emerges around it, was probably one of the key factors in the development of inter- and intrasocial relations in the 3rd millennium BC (Schulting 2013; Vandkilde 2013). With access to the data regarding not only the quantity and quality of grave goods, but also biological (sex, age, potential signs of *trauma*, overall state of health, etc.) and cultural (body orientation, arrangement of limbs) characteristics of the burials, one can analyse the correlations between these traits and produce a robust, bio-archaeological basis for the reconstruction of identity. This, in turn, could be compared to different kinds of data, e.g. that derived from social anthropology, psychology, and so on. While human culture changed dynamically over centuries, basic psychological responses to some external factors, for example confrontation with an enemy, remained the same. Therefore, the description of modern soldiers' experiences on the battlefield and their reactions to the atrocities of war represents a potential source of knowledge for understanding the nature of conflict in prehistory. With an interregional database storing multidimensional data about Corded Ware culture burial rituals, one can come up with valuable remarks relating not only to *warriorhood*, given here merely as an example, but also other social roles or identities. The reviewed work represents a remarkable source for such analyses, as it focuses on the thorough and detailed presentation of data. Nevertheless, the interpretational part, whilst solid, could be elaborated more.

The second part of the reviewed book consists of seven additional papers in which the results of more specialised analyses are presented and discussed. The first one relates to petrographic analyses, conducted in order to identify mineral composition of ceramics and particular admixtures utilized during their production. According to the author's conclusions, ceramic vessels found in Mirocin and Szczytna, despite their spatial adjacency and many similarities in terms of morphology, were made of different ceramic fabrics.

The next article summarizes the results of the macroscopic analysis of flint artefacts documented on sites 24 and 27 in Mirocin. Materials are presented in a logical manner; their description is detailed and clear. However, the part related to social interpretation raises some doubts. These especially concern the suggestion that at least two arrowheads found in graves 50 and 110 could be interpreted as potential signs of *warfare*-related trauma. The first one was located near the heel of an individual. The second was unearthed during the exploration of the burial pit's fill and therefore does not represent an intentional deposit. Nonetheless, according to the author's opinion, the fact that it was made of radiolarite suggests that an alien, and apparently hostile group used it against the individual buried in Mirocin. Obviously both these interpretations are controversial. In the first case, there is no direct spatial relation between the arrowhead and the remains of the deceased. It was not embedded in the bone, nor did it bear any signs on its surface indicating that it had been stuck in soft tissue. The presence of a loose arrowhead in a burial pit is even less informative and therefore more difficult to associate with an act of interpersonal violence. The assessment of its intensity only on the basis" zamiast "of the presence or absence of prehistoric violence only on the basis of the occurrence of arrowheads in more or less ambiguous burial contexts is often misleading, as thoroughly explained by R. B. Ferguson in one of his papers on pre-state *warfare* (2013). What is more, at the end of his article the author claims that the 3rd millennium BC was a period of recurring conflicts. This is an interesting remark, however the issue should be discussed with more caution. For example, according to Rick Schulting, the number of violence-related signs on skeletons decreased significantly during the 3rd millennium in comparison to early and middle Neolithic (2013). This rather unexpected observation was interpreted in relation to R. Kelly's idea of *social substitutability* (Kelly 2000). In short, this means that with the emergence of a new social class of *warriors,* the intensity of violence decreased, as the actual activity of fighting had become limited to a group of particular individuals, and therefore ceased to affect the whole population. It is remarkable that a similar situation could be traced in materials associated with Corded Ware communities from Bohemia and Central Germany (Neubert *et al.* 2014). What is more, several *warfare*-related signs of trauma were also documented in a number of graves from the Małopolska Upland. These were almost exclusively associated with the burials of the "weapon-bearers" (Skrzyniecki 2018). One such trace was identified by Anita Szczepanek and discussed in her article, also included in the reviewed book. A male individual from grave 360, site 27, had a healed blunt depression on the left side of his skull. Almost identical injuries were recorded on skulls of males buried on the previously mentioned necropoles from Central Germany and Bohemia.

Other papers cover, *inter alia*, the analysis of faunal remains, archaeometallurgical studies of copper artefacts found in Mirocin, analysis of stable isotopes of carbon and nitrogen extracted from bone collagen of the deceased buried on both sites and, *last but not least*, an article presenting the latest results addressing the origin of individuals from Mirocin, identified on the basis of strontium isotope ratios. Without going into details, all of them provide a significant amount of invaluable information, which is an important step forward in the on-going struggle to better understand and reconstruct the ways of life of the Corded Ware people from both the local and pan-European perspective. This last, conclusive remark might be as well used to summarize the content of the whole book. On one hand, it represents a traditional, descriptive approach to analysis of archaeological record. On the other, it relies on the most up-to-date analytical methods. Whilst it is not revolutionary, it provides a solid basis for future research. To sum up, in this book tradition and modernity complement one another amazingly well, which is a goal that is often difficult to achieve. Therefore, the reviewed publication, despite some minor flaws, deserves recognition.

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(review) M. Grupa, T. Kozłowski, R. Jankauskas, D. Grupa, M. Krajewska, S. Krakowska, M. Majorek, J. Mosiejczyk, M. Nowak, S. Nowak, M. Przymorska-Sztuczka and A. Wojciechowska, *Tajemnice krypty w kaplicy św. Anny*. *Secrets of the crypt in St. Ann chapel*. Gniew (2015): Stowarzyszenie Centrum Aktywnych, pages 189

This publication on archaeological research in St. Ann chapel of St. Nicolas church in Gniew was edited in 2015. It was a result of explorations started in 2009 and continued for some seasons.

Four years have passed since then, and the publication has unfortunately not yet been reviewed. However, it will not be a typical review of an archaeologist, written for archaeologists, because its author is a historian, a researcher of archive records and sources, one who has participated for some years in archaeological projects as a consultant and a research team member, preparing historical base of the studied objects.

The publication consists of 13 parts, the first of which – *Słowo wstępne (Preface)* – is not in fact an integral part but more of a formal expression of praise of the town mayor by the researchers. The work starts with the chapter *Krypta południowa w kaplicy św. Anny (Southern crypt in St. Ann chapel),* which has two functions: a short introduction to the history of the St. Nicholas church in Gniew, and the general purpose – presenting information of the object situating, subsequent stages of its exploration and its contents. In this place – as a historian – I must refer to the first part of the chapter. I am fully aware that the town's history does not enjoy a very rich literature, including very poor written material on the history of the church itself. The latest studies were available for the publication's authors, but they turned out to be insufficient and influenced by information concerning the object's chronology, or rather its absence in fact. Thanks to the knowledge and experience of the researchers, the majority of the statements referring to the dating of the objects discussed in the text seems to be compatible with the Gniew temple's history.

I would now like to present some general remarks. Archaeologists conducting works and studies in modern times objects (as well as mediaeval and contemporary ones), cannot work without a historian's support, as it is obvious that one should use already existing historical written material – general and monographs of particular objects, comparing the knowledge collected therein. In many cases, it is insufficient for obtaining answers to questions which arise during archaeological field works. Therefore, it seems that historians of the epoch, being able to read the written sources, should be invited to work with research teams since they are especially helpful in deciphering and interpreting unstudied and unpublished material. Their work can be strictly directed and synchronized with archaeological works, and this cooperation would contribute to the more complete elaboration of the studied subjects. This is by no means an exaggerated requirement. Archaeologists have been cooperating with anthropologists and biologists for years. Working with historical objects whose presence is depicted in written sources, collaboration with historians is necessary because they can read sources, deliver new information and supply its proper interpretation.

The second part of chapter *Krypta południowa...* is a reliable report of the exploration works with detailed information on the crypt excavation, opening, construction and its contents, which is a real introduction to further activity.

The chapter *Dobra śmierć i uroczysty pochówek – pompa funebris na przestrzeni wieków (Good death and ceremonial burial – pompa funebris in the space of the centuries)* is an attempt to collect all of the information accessible in literature concerning burial ceremonies, starting with antiquity until modern times and, I must admit, it is a successful attempt. This part is not directly connected with works in St. Ann chapel crypt, but taking into account the publication's studied problem, it is fully justified, as it takes a reader across European funeral culture world, demonstrating the context for the objects described later.

The following chapter: *Trumny z krypty pod kaplicą św. Anny (Coffins from the crypt under St. Ann chapel)* directly introduces us to the world of the artefacts excavated during the archaeological exploration of the Gniew temple, where the evident lack of the participation of a historian is clear. The crypt housed six coffins which were dated on the base of external features from the turn of 18th century. One of them (coffin no 5) had a painted date 17th November 1801. Unfortunately, even the most precise examination, directly in situ or later in laboratories, cannot tell us anything more than the results of external analyses: shape, size, material, inscriptions, if any, or workshop characteristics, if there are any decorations. These are, of course significant details, and they are placed in the coffin descriptions. Thanks to them we can deduce if the buried person was an adult or a child, or what the material status of that person was, but they are still assumptions which can lead to wrong conclusions. In this study, the researchers did not go too far, limiting themselves only to the strict characteristics of the artefacts. By doing so they made rooms for other specialists who will be able to create a broader, more attractive and inspiring narration using this data and information taken from the records. The date 17th Nov. 1801 from one of the coffins is quoted here not accidentally. The Diocesan Archives in Pelplin preserves parish registers of Gniew church, including the death records from 1776, where we can see that on 17 Nov. 1801, the death from consumption was registered of 40 year old Zuzanna Wolff from Pastwa, a since abandoned hamlet between Gniew and Tymawa, and a notice that she was buried one week later on 23rd Nov. With some luck, we would be able to establish the names of the other individuals buried in the rest of coffins, but if not, this single case generates next very important question. How was it possible that a peasant woman from a nearby village was buried in the crypt which originally was reserved for eminent personalities from the local castle (from the mediaeval period it was a seat of Teutonic comtur's office, later a starost's seat), some brotherhoods (brotherhood of St. Ann existed in Gniew from 1685) or representatives of the local patriarchy? What kind of social changes took place between the 18th and 19th century to make this fact possible? These questions remain unanswered and await further studies.

The next chapter, *Prace konserwatorskie (Conservation Works),* refers to the subsequent stages of work taken to protect and preserve the excavated artefacts. As the authors remark, only silk textiles and metal objects have been preserved. Perhaps unsurprisingly, the majority of the examples of conservation treatments discussed were based on silk fabrics. This is a very detailed description, starting with a brief history of silk and its production, cleaning excavated objects, disinfection, consolidation, cataloguing, and finally reconstruction of selected garment items and relics. This chapter is a very important work part demonstrating archaeological workshop, unknown for exhibition visitors – time-consuming, monotonous process, much different from spectacular works in archaeological sites. However, I am not certain whether it is placed in the right book section, perhaps at the end of the publication, after reviewing all of the artefacts groups would have been better.

The next chapter: *Wyroby tekstylne, Wianki grobowe i sztuczne kwiaty, Szkaplerze, Obuwie (Textile products. Grave wreaths and artificial flowers, Scapulars, Footwear)* describes groups mentioned above. This is the biggest part of the publication – a total of 100 pages of a volume nearly 200 pages long. It is difficult to question or evaluate its contents, because it is very detailed, delivering specialist information on archaeology, materials science, production technology. It shows clearly that the authors know their field perfectly, skillfully moving around various disciplines. Technical data is wisely backed up by passages concerning the history of clothes or haberdashery production. This is not general knowledge, but well recognized in circles of researchers studying contemporary fashion, and the publications available are a sufficient basis for researchers working on the problem (provided – they find them). In this case, we can observe the authors' perfect knowledge of the subject literature, including the historical.

One piece of information is missing in this part – whether the discussed artefacts come from coffins or the area under them, from a concentration of bones and textile relics pressed into the floor. This information might appear elsewhere in the text, among other data, but it should be pointed out here. While coffins placed in the crypt were dated from between 18th–19th century, human relics situated underneath must have been at least a little older. Here again, we observe an absence of historical studies which could possibly answer these questions, trying to find out if the crypt had earlier been an ossuary and, if so, when it was created and which part of the church the relics could have come from. If the assumption was false, how long was the break in using the crypt that led to destruction of the coffins originally placed there, that relics situated there earlier could have been the ground for putting next coffins preserved till the time of opening the room by archaeologists. Solving these problems, in turn, could have led to the more precise dating of excavated relics.

The last 'essential' chapter is titled: *Badania antropologiczne (Anthropological studies)* and it is a result of the cooperation of archaeologists and anthropologists, financed within the frames of scientific project of MNiSW (Ministry of Higher Education). Bones excavated from coffins, scattered around the crypt and the ones placed in the crypt floor composition pressed by later burials were examined, giving evidence of at least six persons, matching the six coffins placed there. Two men and four women were recognized. Examining the ground bones, about one hundred individuals were distinguished. Preliminary tests showed that the bones in coffins were mixed – e.g. the remains of three persons were placed together in coffin no 1. Anthropologists statements concerning misplacing human remains within different coffins is stressed and consolidated by the case given in the beginning of the review, in reference to the only dated coffin no 5, with the body of 40-year old Zofia Wolff. The problem is that this very coffin contained the bones of a young woman, aged 20–30. It is evidence that body misplacing might concern all coffins, and the problem is when it happened, in the 19th century, or later during the events of WWII, or even after the war, when the crypt could have been robbed. Historical studies may help in solving that secret.

The same chapter contains very detailed bone analysis, trying to find pathological deformations caused by diseases or traumas. What is surprising is the fact that none of these bones had traces of the tuberculosis that Wolff died from, and particular attention is devoted to syphilis, recognized on only one of the deposited persons.

The publication ends with a *Podsumowanie (Summary)* and is completed with a *Spis rycin*, *Bibliografia (List of figures, Bibliography)* and short notes about the authors. Here, two remarks should be made about these parts. The illustration list contains 121 objects: both photos and drawings. It is a huge swathe of material, illustrating all chapters of the work and making the text more understandable and visually attractive. This provides the possibility of a wider context of reception, being clearly intended for non-professionals, local history lovers and amateurs. The publication has therefore a character which is not strictly scientific, but it is also popular-science literature, one which is usually neglected by professionals, without any harm to its scientific values. I tried to show this above, I hope. The opinion is supported by the extensive bibliography placed at the end, consisting of over 200 sources, unpublished papers and pieces from the subject literature.

Summing up, the publication *Tajemnice krypty w kaplicy św. Anny/Secrets of the crypt in St. Ann chapel*, despite not being completed with historical layer, is a book worthy of recommendation. I believe that it is a complete work and there is no reason to prepare another volume on the subject. However, I hope that the results of archaeological research conducted simultaneously in other locations of the church will be published soon, perhaps with the participation of a historian this time.

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