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Applying isotope analyses of cremated human bones in archaeological research – a review

Abstract

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Numerous experiments have recently been conducted on burnt bones in order to develop methods of isotope analysis which would be useful in archaeological research. Since the results of these studies are not yet widely known, this review presents their potential applications in investigations of human remains from cremation burials. Radiocarbon dating of burnt osteological materials is discussed, including problems related to the "old wood effect". Also considered is the analysis of light stable isotopes, i.e. $\delta^{13}C$, $\delta^{15}N$ and $\delta^{18}O$, which is unsuitable for palaeodietary determinations, but useful as a source of information about certain parameters of funeral pyres. Tracing geographical origins and human mobility is possible by means of the analysis of strontium isotope ratio $^{87}Sr/^{86}Sr$. Since an understanding of high-temperature-induced transformations of bone structure and chemical composition is important for these considerations, a detailed account of the processes is given as an introduction.

Key words: isotopes, cremated human bones, radiocarbon dating, funerary practices, migration

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1. Introduction

The application of isotope analyses in archaeological research is a landmark achievement of the cooperation between the humanities and the natural sciences. This remark is easily justified by pointing out the significance of $\delta^{14}C$ radiocarbon determinations, which have remained the first-choice method of absolute dating for over 70 years. Furthermore, the analyses of $\delta^{13}C$ and $\delta^{15}N$ isotopes are currently widely used in studies of dietary preferences of past populations. Another success was the development of protocols for measuring the ratio of strontium isotopes ^{87}Sr and ^{86}Sr, which allows the detection of geographical origins and for the possible migrations of selected individuals to be traced. The ability to provide answers to such basic questions as to when, who, what, wherefrom and where-to, was the primary drive which led to isotope analyses becoming a valued investigative tool in archaeology, and one which has also aroused interest among the Polish scientific community (e.g. Belka *et al.* 2018; Szczepanek *et al.* 2018; Wadyl (ed.) 2019; Linderholm *et al.* 2020).

The headway of isotope analyses of unburnt human skeletal remains attracted the attention of scholars concerned with those periods, when cremation was the common funerary rite. The first and foremost question was the following: are these analyses equally valuable in the study of osteological material from cremation burials? It is known that the process of burning causes fragmentation, warping and the shrinkage of bones, all of which reduces the pool of data about the deceased. However, it was noted that the high degree of fragmentation of burnt remains may not necessarily result from cremation itself, but instead be the effect of mortuary rituals, post-depositional processes and the exploration of urn vessels (Harvig *et al.* 2012; Harvig 2015, 44, fig. 3.1). In general, it was observed that cremated remains may provide more information than poorly-preserved skeletal material from inhumation graves (Williams 2015, 259–261; cf. Thompson 2015a, 1–3). Recent decades have also brought progress in research on possible burning-related alterations of the chemical composition of bones (Snoeck 2014, 11–26). As a result, burnt osteological material became a valuable source of physico-chemical knowledge to be used in archaeology and forensic science (Harbeck *et al.* 2011; Schmidt and Symes (eds.) 2015; Ubelaker 2009; 2015; Mamede 2018). The current state-of-the-art allows the above-mentioned question to be answered and this constitutes the main objective of this paper.

2. Heat-induced transformations of the chemical composition of bone tissue

To assess the possible applications of isotope analyses to burnt osteological material, it is important to understand the transformations of bone structure and chemical composition that result from exposure to high temperatures.

Bone is made up of three basic components: 1) water, 2) the organic phase, mainly collagen (ca 90%) as well as proteoglycans, non-collagen proteins, phosphoproteins and lipids, and 3) the inorganic matrix called bone apatite or bioapatite (LeGeros 1991; Lee and Einhorn 2001). Due to the destructive impact of the temperature of the funerary pyre, only the inorganic phase, which constitutes ca 60% of bone mass, is useful in most studies of burnt remains.

Bioapatite is a crystal form of calcium hydroxyphosphate, which strongly reassembles the naturally occurring mineral hydroxyapatite ($Ca_5(PO_4)_3(Cl/F/OH)_2$). However, in contrast to the latter, it is more susceptible to non-stoichiometric transformations of chemical compounds, which enables the incorporation of ions present in the blood into the structure of bioapatite (Figure 1). Essential in this respect are the carbonate ions (CO_3^{2-}), which substitute nearly all of the hydroxyl groups (OH^-) and part of the phosphates (PO_4^{3-}) – called A-type carbonates (exchangeable with OH^-) and B-type carbonates (exchangeable with PO_4^{3-}) respectively (LeGeros 1969; 1991; Astala *et al.* 2005; Wopenka and Pasteris 2005; Snoeck 2014, 12; Madupalli *et al.* 2017). This process of substitution is highly relevant to the structure of the inorganic matrix of bone. The ions (A- and B-type carbonates) are not of the same shape and size, leading to deformations of bioapatite crystallinity during the exchange. For this reason, bioapatite is built up of smaller crystals than hydroxyapatite (it is less crystallized), which in turn leads to its enhanced susceptibility to various chemical processes, including diagenetic ones (Wopenka and Pasteris 2005; Snoeck 2014, 12; Snoeck *et al.* 2014a; Mamede *et al.* 2018).

High temperatures strongly alter both bone structure and their chemical composition. At first, the chain of transformation involves dehydration and the destruction of the organic phase, including the disintegration of collagen fibres. At the same time, the inorganic matrix undergoes a progressive loss of

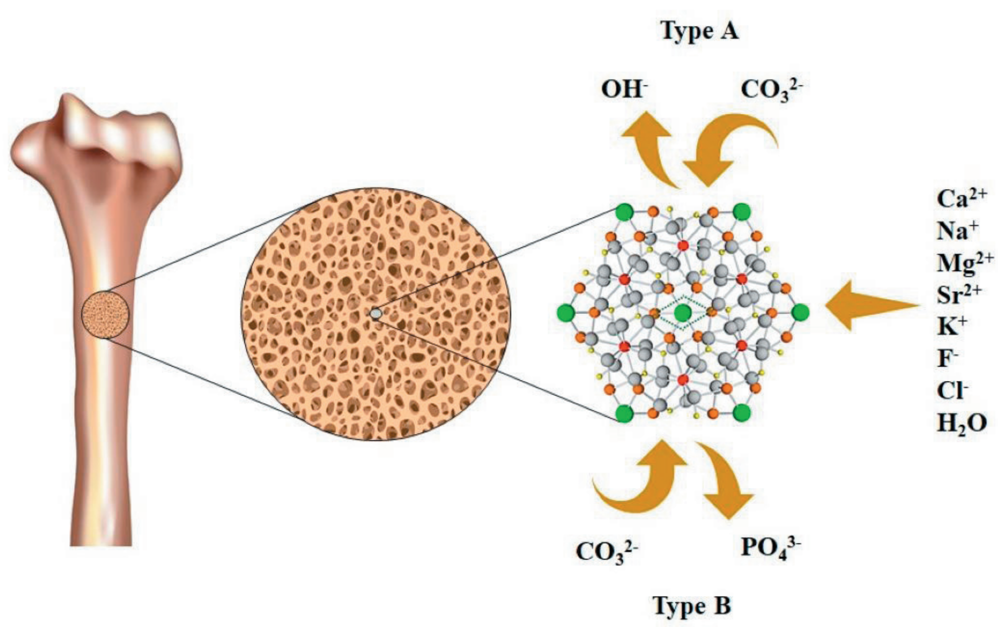

Fig. 1. The transformation of chemical compounds in bone apatite (after Mamede *et al.* 2017, modified by B. Wolska)

carbonates (CO_3^{2-}), a rise of hydroxyl groups (OH^-), and even the formation of new mineral forms, i.e. NaCaPO4, NaCl and KCl (Van Strydonck *et al.* 2005; Zazzo *et al.* 2009; Snoeck 2014, 39–94; Snoeck *et al.* 2014a; Mamede *et al.* 2018, Fig. 2). However, above all, these processes are accompanied by a gradual increase of bone apatite crystallinity, resulting in a high resilience to chemical weathering (Stiner *et al.* 1995; Lebon *et al.* 2010; Quarta *et al.* 2013; Thompson 2013; 2015; Snoeck 2014, 16, 89, 123; Snoeck *et al.* 2014a; Mamede *et al.* 2018). This property makes it similar to two-hydroxyapatite – the main component of the enamel of teeth which are considered the most robust elements of the human skeleton (LeGeros 1991; Hoppe *et al.* 2003; Chai *et al.* 2009; Muller *et al.* 2019). Consequently, burnt bone is highly resistant to post-depositional chemical transformations, which is significant from the perspective of physico-chemical and osteological analyses. It should be noted that this only pertains to fully calcined bones, that have been exposed to temperatures higher than 600°C (Snoeck *et al.* 2014a).

Isotopes (gr. "equal place") are variants of chemical elements that have the same atomic number but a different mass number (Jones and Atkins 2016, 11). Based on their stability, they are divided into stable, e.g. ^{13}C, ^{15}N, ^{18}O, ^{86}Sr, ^{87}Sr and radioactive, such as ^{14}C. In the life cycle of humans and animals, isotopes accumulate in the organic phase and inorganic matrix of bones. For instance, ^{14}C infiltrates organisms during the digestion of $^{14}CO_2$, which is an element of the food consumed (Jones and Atkins 2016, 1034). Similarly acquired are strontium isotopes ^{87}Sr and ^{86}Sr, present in ingested water and plant/animal tissues, in amounts dependant on the local geological background (Beard and Johnson 2000; Bentley 2006; Slovak and Paytan 2012; Snoeck *et al.* 2015).

The above-mentioned heat-induced alterations of bone tissue bear heavily on studies of its isotopic composition. Poor preservation of extractable collagen (with a nitrogen value lower than 0,8%; see Brock *et al.* 2010) precludes the possibility of analysing this particular fraction, as is usually done in the case of unburnt bones (e.g. skeletal burials). Bone apatite is subjected to significant deformations as a result of the gradual loss of carbonates and increased number of hydroxyl groups, what corresponds with the loss and increase (respectively) of certain chemical elements (isotopes). These undergo further transformations, such as exchange and/or incorporation/fractioning during the process of cremation or subsequent residence of the remains in the soil (see below). All in all, it seems justified to say that burning causes irreversible changes in the original isotopic composition of bone. Nevertheless, even in this form, it is still a source of data that is extremely valuable in archaeological research.

3. Isotope analyses in studies on burnt human bones

3.1. Radiocarbon dating

Radiocarbon dating of burnt osteological remains was first conducted at the end of the 20th century. During the procedure, comparable ^{14}C dates were obtained for burnt bone and charcoal derived from the same context, opening up the possibility to determine the age of archaeological materials in which no organic matter was present (Lanting and Brindley 1998). This revolutionary discovery spurred further research (Lanting and Brindley 2000; Lanting *et al.* 2001; Van Strydonck *et al.* 2005; Naysmith *et al.* 2007), yet this did not fully consider the potential differences between the age of bones and the fuel used for their cremation. As it transpired, this has major relevance for radiocarbon dating: the process leading to the "old wood effect" takes place when a bone is burnt in the presence of much older wood – the latter "conveying" a portion of its age, resulting in the artificial oldening of osteological material (Olsen *et al.* 2008; 2013; Hüls *et al.* 2010; Zazzo *et al.* 2012; Snoeck *et al.* 2014b). This phenomenon is best illustrated by the results of an experiment in which a contemporaneous pig trotter was burnt using ca 480-year-old wood, and its remains obtained a date of 326 ± 22 BP (Snoeck *et al.* 2014b). A similar but opposite effect was observed in a test where "old" archaeological bone and modern-day wood were subjected to burning (Zazzo *et al.* 2012). These studies have shown that ^{14}C dates do not necessarily indicate the actual age of burnt remains, but the age of the fuel used.

The above-mentioned findings reflect certain chemical processes that take place in bone during its exposure to high temperatures, e.g. of a fireplace or funeral pyre. Specifically, of crucial importance is the origin of the carbon isotopes present in the carbonate fraction of burnt bone apatite, since surely some of them are not part of the original composition (hence the "old wood effect"). Four mutually non-exclusive possibilities were proposed: 1) contamination of the carbonate fraction of bone apatite by atmospheric carbon, 2) exchange of carbon between the carbonate fraction of bone apatite and the gas released by the cremation fuel, 3) incorporation of organic carbon released during the combustion of organic matter, i.e. skin, muscle, fat, 4) incorporation of organic carbon released during the combustion of collagen as well as other proteins and lipids, and 5) heat-induced fractioning of the carbonate fraction of bone apatite (Figure 2) (Zazzo *et al.* 2009; Snoeck *et al.* 2014b).

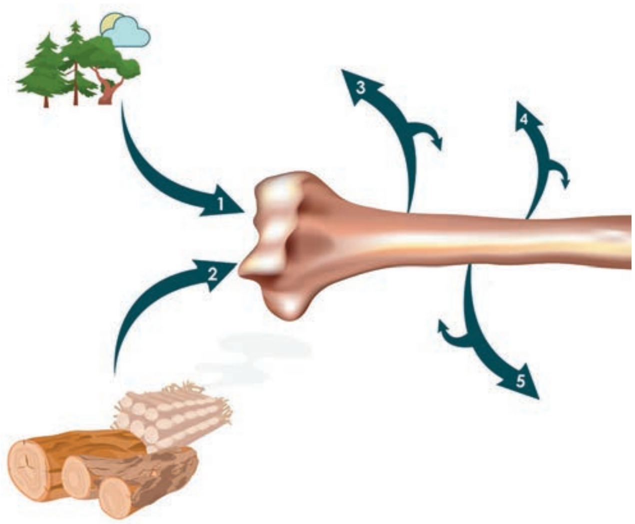

Fig. 2. Sources of CO_2 that probably affect the isotopic composition of the carbonate fraction of bone apatite during heating/burning: 1) the atmosphere, 2) the burnt fuel, 3) the burnt organic matter, i.e. skin, muscle, fat, marrow 4) the burnt collagen, 5) the burnt carbonate fraction of bone apatite. The arrows indicate the possible directions of carbonate and/or CO_2 flow, and the conditions in which the fractioning of carbon occurs (after Snoeck 2014, 97, fig. 5.1., modified by K. Kij)

In reality, only four possibilities are relevant (2–5), the first one being less feasible due to the low CO_2 content (0,04%) in the atmosphere. The third and fourth were confirmed only for the exchange of carbon between bone apatite and collagen. Soft tissues (skin, muscles, fat) undergo relatively rapid combustion (see Fairgrieve 2008, 44–45, tab. 3.3, 3.4.) and for this reason they do not have a substantial influence on the final chemical composition of the carbonate fraction of burnt bone apatite (Snoeck *et al.* 2014b). At the same time, since collagen is close to apatite and subjected to gradual degradation up to 600°C, it has more potential for mutual chemical interaction (Hüls *et al.* 2010; Van Strydonck *et al.* 2010; Zazzo *et al.* 2012; Snoeck *et al.* 2014b; 2016a). It is not responsible, however, for the incorrect radiocarbon dating of burnt bones, because both these fractions (collagen and apatite) share a similar (although not identical) ^{14}C age (Snoeck 2014, 121; Snoeck *et al.* 2014b). Experiments have also confirmed the fractioning of carbon isotopes, occurring between bone apatite and CO_2 released by burning organic matter and combustion gases (Zazzo *et al.* 2009; Hüls *et al.* 2010; Van Strydonck *et al.* 2010; Harbeck *et al.* 2011; Snoeck *et al.* 2014b; 2016a). Nevertheless, the isotopic composition of carbon in burnt bone is mostly influenced by the process of the exchange with the burning environment, i.e. an exchange with carbon emitted by the fuel (Table 1). It is precisely this phenomenon which is mainly responsible for the "old wood effect" (Olsen *et al.* 2008; 2013; Hüls *et al.* 2010; Zazzo *et al.* 2012; Snoeck *et al.* 2014b; 2016a).

Table 1. Research results indicating an increased exchange of carbon between the burnt fuel and the carbonate fraction of bone apatite, what is the main reason of the "old-wood" effect.

Authors	Research material	Carbon exchange with old fuel
Hüls *et al.* 2010	Modern bovine bone	36% – 86%
Zazzo *et al.* 2012	Archaeological human and animal bones	48% – 91%
Snoeck *et al.* 2014	Modern animal bones	39% – 95%

Summarizing, the carbon present in the carbonate fraction of burnt bone apatite has three possible sources: endogenic apatite carbon, endogenic carbon present in collagen, and fuel-derived carbon. In light of this knowledge, is it practical to date burnt remains using radiocarbon? Despite certain limitations, in most cases the method delivers relevant information. However, the following circumstances should be considered:

1) The remains of the deceased might have been cremated some-time after their death, using young wood as fuel. The result of the ^{14}C analysis will indicate the approximate date of the burning, not the actual moment of the individual's death.
2) The remains of the deceased might have been cremated using also old wood as fuel. The result of the ^{14}C analysis will indicate the approximated age of the wood, not the actual moment of the individual's death.

Both these conditions may be difficult to assess for cremated materials from archaeological contexts, with the consequence that the radiocarbon dating of singular samples will deliver unambiguous data. The interpretative field can be narrowed by obtaining a series of dates for several graves, or in the case of bi-ritual cemeteries, by additionally comparing values acquired for skeletal and cremation burials. Such radiocarbon research has recently been caried out on numerous (1428) samples from cremation and inhumation burials discovered at archaeological sites in Belgium. The results have shown cultural changes in funerary practices from the Mesolithic period to the Middle Ages (Capuzzo *et al.* 2020).

3.2. Light stable isotopes ^{13}C, ^{15}N and ^{18}O

Isotopes of light elements present both in the organic phase and inorganic matrix of bone, such as carbon, nitrogen and oxygen, have been used in bioarchaeological studies to reconstruct the dietary preferences of past communities. Their successful applications to unburnt skeletal remains led to an interest in using a similar analysis for cremated osteological material. Unfortunately, however, this was found to be unsuitable for such determinations (DeNiro *et al.* 1985). The advantages of investigating stable isotopes in burnt bone only became clear in the last decade, although they turned out to be unrelated to palaeodietary research (Snoeck *et al.* 2014b; 2016a).

Isotope signatures of $\delta^{13}C$, $\delta^{15}N$ and $\delta^{18}O$ preserve their original values only up to 200°C (DeNiro *et al.* 1985; Harbeck *et al.* 2011; Schurr *et al.* 2015). Changes occurring above this threshold were identified experimentally, with varying degrees of influence on the final isotopic composition. The most recent results indicate a rapid loss of light isotopes in collagen and apatite, except for structural carbon $\delta^{13}C$, the level of which decreases to 700–800°C but starts to increase with a further rise of temperature (Harbeck *et al.* 2011; Snoeck *et al.* 2016a). This general reduction is directly related to the heat-induced alteration of bone composition and structure, above all the combustion of the organic phase and loss of carbonates (CO_3^{2-}) from the inorganic matrix, accompanied by the processes of exchange, fractioning and incorporation of carbon from different sources (see 3.1., Fig. 2). The current state of research shows that palaeodietary analyses in burnt bone are not possible (DeNiro *et al.* 1985; Lanting *et al.* 2001; Van Strydonck *et al.* 2005; Olsen *et al.* 2008; 2013; Zazzo *et al.* 2009; 2013; Harbeck *et al.* 2011; Snoeck *et al.* 2014b; 2016a; cf. Schurr *et al.* 2015).

It has recently been pointed out that stable light isotopes may be used in studies oriented at reconstructing the cremation ritual, serving as proxies of the conditions in the funeral pyre during the burning of the deceased (Snoeck *et al.* 2016a).

This method was developed in the course of experiments concentrated on the isotopic variance of $\Delta^{13}C$ and $\Delta^{18}O$ ($\Delta = \delta$ of the sample – δ unburnt apatite), instead of their absolute values (Snoeck *et al.* 2016a). To confirm that the conditions of cremation have a meaningful bearing on this variance, a test was arranged that simulated possible different circumstances of the ritual – burning of a sample on firewood (with fuel), also with the addition of C_3 and C_4 plants (or their products, such as maize). Burning in laboratory conditions (without fuel) served as reference (Snoeck *et al.* 2016a). It was observed that bones cremated on firewood have less carbon $\delta^{13}C$ and oxygen $\delta^{18}O$, and that the values of oxygen $\delta^{18}O$ are lower when the exchange of carbon $\delta^{13}C$ between the bone and the fuel intensifies. Moreover, bones containing cyanamide – an organic compound identified by FTIR and expressed in relation to the amount of phosphorus in the sample (CN/P) – usually have higher values of carbon $\delta^{13}C$ with a slight difference in oxygen $\delta^{18}O$ presence. The addition of C_4 plants during the cremation also has an impact on the isotopic composition of samples, resulting in considerably enhanced levels of $\delta^{13}C$ and $\delta^{18}O$ (Snoeck *et al.* 2016a). All these observations are related to complex processes of exchange, fractioning and incorporation of the described elements, which to a varied extent (still unassessed) shape the final isotopic composition of burnt bone apatite. Tracing this composition in individual samples allows recognizing remains cremated under different conditions. Three possibilities were outlined:

1) identification of remains burnt in the presence of firewood and those cremated without its use (probably a rare occurrence in archaeological materials).
2) identification of remains burnt using C_3 firewood and C_4 plant fuel.
3) identification of remains burnt on larger or smaller funeral pyres, in different places (pyres located in landscape positions with higher or lower oxygen availability) and the positioning of the body during the cremation (on/in the pyre).

Considering these remarks, a comparison of the results of $\delta^{13}C$ and $\delta^{18}O$ isotope analysis of remains from a single cemetery allows the pinpointing of those individuals who were cremated in different circumstances than others (i.e. their isotopic values do not correlate with the cemetery "baseline"). Further investigations may address the possible reasons for such exceptional treatment, which can be a consequence of customs specific for a given community, or a sign suggesting that the deceased in question was cremated in a location different than the place of burial. In the latter case, an analysis of strontium isotope ^{87}Sr and ^{86}Sr ratio is a supplementary investigative method.

3.3. Strontium isotope ratio $^{87}Sr/^{86}Sr$

Geographical origins and the mobility of people have been intensely studied topics in archaeology. Informative in this matter is an analysis of strontium isotopes ratios $^{87}Sr/^{86}Sr$ – an element assimilated by the human organism during the ingestion of food and water, which becomes incorporated in the structure of bones in a manner similar to calcium. Among the isotopes discussed in this paper, strontium is the only one resistant to high temperatures, a fact known from the early 1990's (Grupe and Hummel 1991). In the last decade, the method was applied to remains from cremation graves, confirming its usefulness as a tool in research on ancient migrations (Snoeck 2014, 125–137; Harvig *et al.*, 2014; Snoeck *et al.*, 2015; 2016b; 2018; Graham *et al.* 2019).

As an element heavier than 50u, strontium is not subjected to the same chemical processes as the above-mentioned light isotopes during burning. Experiments have indicated that the $^{87}Sr/^{86}Sr$ value in samples does not change, even after heating in temperatures exceeding 1000°C (Grupe and Hummel 1991; Beard and Johnson, 2000; Harbeck *et al.* 2011; Snoeck *et al.* 2015). This is related to a relatively high melting point of strontium carbonate (ca 1500°C), i.e. considerably above the temperatures potentially reached in funeral pyres (McKinley 1994; Ubelaker 2015; Snoeck 2014, 126; Snoeck *et al.* 2015). Moreover, there is no noticeable process of fractionation between ^{87}Sr and ^{86}Sr during bone combustion (as was it observed in the case of carbon isotopes), because the difference between their atomic masses is low (Harbeck *et al.* 2011; Snoeck 2014, 126; Snoeck *et al.* 2015).

Of crucial importance in strontium isotope analysis is the type of material selected for the study. In the case of inhumation burials, the enamel of teeth is usually sampled due to its specific properties: 1) the lack of metabolic activity, which ensures a fixed isotopic composition during the whole human life, 2) a high resilience to post-depositional alteration (see 3.1.), and 3) temporal differences in the formation of individual tooth crowns, allowing the assessment of the individuals' place of residence in particular periods of their lives, between the early childhood and adolescence, depending on the type of tooth studied. Due to the rare occurrence of tooth enamel in cremated materials, a substitute needed to be found. This role was taken by the otic capsule located in the petrous part of the temporal bone which is composed of very dense bone tissue that is resilient to chemical processes (Jeffery and Spoor 2004; Jørkov *et al.* 2009; Harvig *et al.* 2014). Its morphology remains unchanged even under high temperatures and for this reason it is often discovered among burnt human remains. Experimental research confirmed the credibility of this material in studies on the geographical origins of cremated individuals (Harvig *et al.* 2014). However, it is important to note that analyses of the petrous portion of the temporal bone reveal information about the place of residence in very early childhood, as this bone forms at a prenatal age and does not change after the second year of life (Jeffery and Spoor 2004; Jørkov *et al.* 2009).

To ascertain the whereabouts of individuals in later stages of their lives, additional samples have to be taken from other parts of the human skeleton (e.g. the long bones or cranium), which had been rebuilt during the whole life due to progressing ossification. This process involves the embedding in bone of new bioapatite crystals, including strontium isotope values characteristic for the local geological background. However, ossification is a non-uniform process and proceeds differently in particular types and structures of bones. It is also determined by the metabolic level of the individual. For these reasons, the analysis of the strontium isotope composition in such samples is less straightforward as it cannot be related to a specific age of humans, (contrary to the case of the petrous part of the temporal bone or the enamel of teeth, whose period of formation in the human organism is well-researched), but only to a time interval of 10–20 years before their death (Jørkov *et al.* 2009; Szostek *et al.* 2015; Snoeck *et al.* 2015). Moreover, the possible intensive mobility of individuals or several year-long residence in new places have to be considered, which significantly influences the strontium isotope composition in the skeletal tissue, further complicating proper interpretation (Slovak and Paytan 2012, 748–749). Consequently, it is advised to conduct the analysis using samples taken from different elements of the cremated remains.

Another matter to be considered when studying strontium isotopes in the context of human mobility is the potential susceptibility of burnt bones to absorption/incorporation of exogenic strontium during their long residence in soil. This issue, important from the viewpoint of archaeology, was investigated in a series of experiments which have shown successive enrichment in Sr of a calcined cow tibia left for 12 months in a strontium-rich (^{87}Sr) solution (Snoeck *et al.* 2015). The subsequent application of acetic acid and an ultrasonic bath helped to remove the contamination, including the exogenic strontium isotopes; in effect, a sample with an original ^{87}Sr and ^{86}Sr composition was obtained (Snoeck *et al.* 2015). During the same research, an identical procedure (artificial enrichment in Sr and sample pre-treatment) was administered to the enamel of a horse tooth, which at the end of the experiment still exhibited a higher value of exogenic strontium compared to the burnt cow bone. Most likely, this results from the incorporation of the isotope into the crystallite structure of teeth, instead of its absorption onto the surface, as in the case of burnt cow bone. The experiment shows the high resilience of the latter to the diagenesis caused by the high crystallinity of the cremated bone (Snoeck *et al.* 2015). This points towards an equal (or even slightly higher) credibility of cremated osteological material in strontium isotope analysis, compared to teeth enamel.

In sum, the physico-chemical processes that occur during cremation do not affect the original composition of strontium isotopes in bone, and the possible alterations resulting from protracted burial in soil may be mitigated by diligent laboratory treatment. In this light, burnt osteological remains are reliable material in studies on geographical origins and mobility in communities that cremated their dead.

4. Conclusions

Cremation burials are thought to have been practiced in Polish lands as early as the Mesolithic (Gil-Drozd 2011). This funerary custom proliferated in later times and burnt human bones are frequently discovered during archaeological fieldwork as a result. The paper reviews the possibilities of conducting isotope analyses on such material and shows that the research perspectives that they entail are centred around several issues.

The first is the determination of the absolute chronology of sepulchral sites by means of the radiocarbon dating of burnt bones. It must be remembered, however, that the obtained $\delta^{14}C$ dates will not reflect the actual radiocarbon age of the remains, but of the wood used for the cremation. Consequently, the analysed samples may be oldened if they were burned in the presence of old wood (the "old wood effect"). Such circumstances may have been common in the past, as shown by anthracological studies of charcoal from cremation graves discovered in present-day Poland (Moskal-del Hoyo 2012).

The second is the interpretation of the funerary rite, albeit focused on the cremation procedure itself, instead of the manner in which the burnt remains were deposited in graves. By comparing the values of $\delta^{13}C$ and $\delta^{18}O$ it is possible to assess whether the corpse was burned in the presence of fuel (usually wood; probably a universal occurrence in archaeological materials) or without it. Also feasible are estimates regarding the size of the funeral pyre and its location in the landscape with higher or lower oxygen availability, as well as the positioning of the body in/on the pyre. Tracing the values of these isotopes in a series of samples from a single cemetery allows us to recognize those individuals who were cremated in different conditions. This opens further avenues of inference.

Another issue is the identification of the geographical origins of people interred in cremation graves by an analysis of the strontium $^{87}Sr/^{86}Sr$ ratio, which in certain circumstances is simultaneously linked with attempts to describe the migrations they made during their lifetime. These matters are raised in discussions regarding long-range trade, mobility of labourers/specialists or even of whole communities, and for this reason information about the birthplace of individuals seems to have significance in many areas of research on the past.

On the other hand, isotope analysis of cremated bone is not a suitable method in palaeodietary studies. This is caused by the lack of collagen and the high temperature-induced changes in bone apatite which result in an irreversible alteration of $\delta^{13}C$ and $\delta^{15}N$ values. Other procedures should be sought to investigate the issue of alimentation.

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Graphite in an archaeological context comparing to other black substances – research problems and prospects

Abstract

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In the archaeological context, substances with a black color have been extensively used in many ancient communities, in the form of items and layers, with the use of biogenic and mineral substances, and requiring a separate methodological approach. Each of them behaves differently in technological and postdepositional processes. The potential degree of the complexity of intentionally applied layers (e.g. paints or cosmetics) and the overlap of secondary substances and crusts, increases difficulties in obtaining unambiguous results and their interpretation. Graphite plays an important role among them. Several areas of the current use of graphite are, or at least could be, commonly shared in the present and in the past, and thus their analysis could be inspiring for archaeology and archaeometry. Graphite fingerprint and potential fingerprints are discussed in terms of their variability. The problem of graphitization as a potential source of misleading interpretation is discussed.

Key words: black substances, black layers, graphite, archaeology, fingerprints

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Introduction

Ancient and modern people alike have willingly used black substances for many purposes, for example applying them on various surfaces and manufacturing objects. The identification of these substances is the subject of archaeometric research and allows us to obtain information on technological processes and the exchange of raw materials. It is also a part of the analysis of the symbolic meaning of the color. A considerable body of work has been devoted to the study of black substances in the context of use and origin.

The aim of this article is to emphasize the diversity of black substances, including graphite-like ones, the problems that are hidden in their research, the potential for the appearance of secondary phases whose presence may be misleading in interpretations, and the complexity of the systems in which they occur, especially in paints. The attention will be focused on graphite, the types of its fingerprints and the numerous factors affecting the uncertainty of their interpretation.

Black substances known from the archaeological context

In the archaeological context, substances with a black color have been extensively used in many ancient communities. These can be items (e.g. the spectacular Caergwrle Bowl; Smith 2005, further literature there), medicines, cosmetics, binders (e.g. Trąbska *et al.* 2014), residues used on dishes (e.g. Craig *et al.* 2013), magic items (Baczyńska and Lityńska-Zając 2005), fuel (Klíma 1956; Smith 2005), ceramic inclusions (e.g. Kwiecińska *et al.* 1970; Druc 2001) and layers (Gediga *et al.* 2019), including those resulting from previous conservation activities (Wiłkojć 2018). The literature cited above serve as examples, and there are of course many more sources.

The blacks are biogenic and mineral substances. Depending on the method of use, they were produced or processed to obtain a fine fraction or a monolith. Biogenic substances include the ones obtained from solid and liquid caustobiolites: peat, brown coal (including jet and sapropelite considered by some researchers to be a variety of brown coal), hard coal, anthracite, shungite, asphalt, bituminous shale and other bitumens. All the mentioned rocks occur in many varieties (e.g. Bothe 2007; Gjostein Resi 2005; Smith 2005; Teichmüller 1992; Waleńczak 1987). The biogenic black group also includes soot resulting from incomplete combustion of plant debris: bark, branches, stones, fruit of trees, herbaceous plants and even fungi, e.g. birch, oak, beech, cherry, plum, date, almond, coconut, Italian nut, vine, yeast. Blacks were also obtained from the combustion of other biological substances: bone, ivory, bistre, gelatin, paper, and papyrus (Eastaugh *et al.* 2005). Also, wood tar and tar were used for sealing, impregnating, decorating, healing, and as magical substances. Fine biogenic black fractions were obtained in a variety of ways: by simple grinding and sieving, but also by depositing soot from the flame on a cool medium or in furnaces, these are called lamp blacks. Charring processes were also carried out in closed crucibles and with temperature control to avoid tar formation on the one hand, and destruction of the raw material on the other (Witruwiusz 2000; Winter and West FitzHugh 2007). It should be emphasized that different starting and variously prepared substances provided products of different shades as well as different microstructural features.

Black mineral substances identified as raw materials for making objects and layers are also numerous. Antimony and its compounds (Chaundri and Jain 2009), manganese and its compounds (Chalmin *et al.* 2007), manganese and iron compounds (Trąbska *et al.* 2003), black iron compounds (Kotowiecki 2004), chromite (Groot *et al.* 2006), black lead compounds (Chaundri and Jain 2009), and finally black rocks, e.g. black shales (Smith 2005).

Different forms of inorganic and carbonaceous matter vary in their specific characteristics, and therefore also in terms of their fingerprints. Each of them requires a separate analysis and methodology and each behaves differently in technological and post-depositional processes, a phenomenon that can be used in researching artefacts.

Black pigments and dyes currently available for sale illustrate the multitude of these substances and the variety of their shades. These include, for example, black from vines, ivory black, dried blister soot, sepia – dried cuttlefish dye, ground charcoal, and among inorganic substances, e.g. iron bluish black – intense or dark (original names of pigments and dyes from various companies have been preserved). This variety must have been known earlier as it was documented at least in historical paints (Winter and West FitzHugh 2007).

Graphite, a common substance used in the past, is an inorganic form of carbon. Nevertheless, there are numerous forms: semi-graphite (Kwiecińska and Petersen 2004), chaoite (hexagonal impact mineral), brown lonsdaleite, tetragonal fullerite (black, tetragonal mineral present in trace amounts in the Karelia shungites and in the basalt chimney in the Viloyati region, Tajikistan; www.mindat.org), cliffonite (pseudomorphosis of graphite after kamacite, also known from some iron meteorites) or chiemsite – impact carbon glass with microfossils (www.mindat.org, www.chiemgau-impact.com). Many of these rare substances were listed as pigments (Eastaugh *et al.* 2005), however, they certainly were mentioned as a casual admixture, clearly indicating geological provenance and even location.

Problems of black layers research

When considering painting layers (neglecting a variety of a substrate) we are dealing with complex systems, which include color-modifying substances or fluxes. For example, in black sintered or vitrified surfaces of Etruscan ceramics (bucchero nero) and Attic ceramics, the raw material was illite clay mixed with iron compounds and it was the type of the latter that determined the shade of black. The shine-modifying components were feldspar and quartz with the alkali and probably also boron fluxes (Gliozzo *et al.* 2004). Conclusively, a painting layer cannot be studied as composed of only pigments. Studies of layers demand a specific approach compared to "3D" objects, although many elements remain in common. The surfaces that are the result of human activities are intentionally covered for decorative purposes (paintings, intentional patina, black and similar decorations – black inlaids, inc. niello; in some cases also as cosmetics; Colombini and Modugno 2009; Demakapoulou *et al.* 1995; Tapsoba *et al.* 2010; Winter and WestFitzHugh 2007), informational purposes (characters and also the forms mentioned earlier), protective purposes (varnishes, intentional patina, impregnates, Aucouturier *et al.* 2010; Connan 1999; Harrel and Lewan 2002).

In the area of environmental sciences, research on layers and crusts is a dynamically developing branch of geochemistry (Schindley and Dorn 2017).

Phenomena of this kind are on the one hand burdensome, e.g. as unwanted patina on the surfaces of monuments and as places releasing pollution, but on the other hand they are collectors of information on environmental parameters in stratigraphic and temporal cross-sections. Microcomponents of cultural layers and speleothems, both plant and resin debris, as well as inorganic ashes, are important carriers of information about ancient and modern processes; it is difficult to omit them in these considerations.

Cross-sectional studies of speleothems from South Korean caves have revealed the presence of carbon from burned fuels. It had a spherulite and a spherulite-chain habit characteristic of high-temperature clusters of this element, (Jeong *et al.* 2003), in mineralogical terms it was poorly ordered graphite. Black lamines in the speleothems of the Kraków area caves (Prądnik Valley) are evidence of human habitation in the Neolithic, Bronze Age and later (Gradziński *et al.* 2003). Gray, sometimes reddish sediment surrounding the remains of the shaman at the Upper Paleolithic site of Dolní Věstonice I contained a large amount of black bone ash, used during a funeral ceremony (Trąbska *et al.* 2016). Charcoals, which are indicators of the use of fire, have been subjected to research aimed at identifying the manner and degree of its degradation at archaeological sites, which is important in identifying the oldest manifestations of fire use (Cohen-Ofri *et al.* 2006).

Layers formed unintentionally are traces of thermal influence, of a contact with an organic matter, crusts resulting from the precipitation of environmental components (e.g. manganese compounds, metal sulfides, also from ancient metal emissions; Caplete and Schindler 2018), urban and industrial crusts. They may resemble deliberate layers (Trąbska and Trybalska 2014). During the research of the decorated final-Paleolithic object from an antler from the Rusinowo site (NE Poland), it was necessary to solve the problem of the origin of black fillings and stains: were black paints applied in the grooves of the ornament? Were the stains the result of storing the item in an organic container or case? It turned out that all the colors are of natural origin, and they emerged due to framboid pyrite (Trąbska *et al.* 2017). A similar problem was encountered when examining black tiny points on a surface of a flint Magdalenian object from the Klementowice site (E Poland) where very few clusters of organic matter (resin glue) were masked by natural manganese compounds (Trąbska *et al.* 2014). Scanning microscopy (SEM / EDS), Raman spectroscopy and laser ablation – gas chromatography – mass spectrometry (LA-GC-MS) are the main (but not only) methods used for examining layers and crusts (Caplete and Schindler 2018); the use of other types of couplings in the case of the last of mentioned method is also possible.

Due to the possible degree of complexity of intentionally applied layers (including cosmetics, see Chaundri and Jain 2009) and the overlap of secondary substances, the following systems can be found in research work. Objects or layers may have been made of (i) original and simple raw material that has not undergone any changes, (ii) simple raw material that has undergone environmental or deliberately introduced transformations, (iii) intentionally complex material (e.g. paints or cosmetics) that were not influenced by the environmental factors, (iv) intentionally complex material that has undergone changes, (v) all of the above-mentioned materials obscured by the presence of secondary micro-sediments and crusts. Assemblies can be organic-organic, organic-inorganic and inorganic-inorganic. In addition, in all versions we may be dealing with deliberate treatments that could have led to the processing of the raw material, resulting in changes in the composition or specific characteristics of the ingredients (e.g. the size of crystallites). Natural clusters can be mistaken with intentional clusters. In addition, we may be dealing with imitation of raw material A by raw material B. The specific metallic gloss characteristic of graphite-coated ceramics could be obtained in the same way as the medieval Africans in Congo did it (see below). Demetrykiewicz describing the black surface of the urns from SE Poland reports that "they were blackened only by means of hot, thick smoke", having anointed the vessel with fat and smoothed it, and the effect was similar to graphite vessels (1897). The problem of distinguishing between "real" and "fake" graphitized surfaces is therefore not new, but in recent years research regarding that issue has moved forward thanks to the development of research methods and experiments (Abłamowicz and Karwowski 2009; Kreiter *et al.* 2014; Łaciak and Stoksik 2010; Łaciak *et al.* 2019).

It may be difficult to distinguish between deliberately used and secondary carbon in artefacts though the use of both was documented (e.g. Łaciak *et al.* 2019). There has been no research conducted to date regarding this issue. Amorphous carbon occurring with graphite in archaeological objects, esp. pottery, may not necessarily have been introduced deliberately. It can arise as a result of the Boudouard reaction of disproportionation of carbon monoxide originating from the thermal transformation of various carbonaceous substances ($CO = C + CO_2$) under conditions possible to attain in the systems typical for old technological processes, i.e. at a temperature of about 800°C and higher. Currently, this reaction is of interest due to the possibility of reducing the effects of greenhouse gas emissions (Lahijani *et al.* 2015).

Medieval Congo ceramics, decorated in a sophisticated way with vegetable pastes and palm oil applied on the hot surfaces of dishes by dipping in paints, is an example of the complexity of the composition of black surface colors. Charcoal dust was rubbed into grooves on dishes and the surface was often covered with waxes and resins, and to obtain the black mirror effect a mixture of earth pigments, metallic iron powder, bone black and charcoal were applied; the latter also acted as a plasticity modifier (Hexter and Hopwood 1992). Gedl and Malinowski wrote about painting the graphited surface with a non-graphitic black (soot is likely to be mentioned) (Łaciak 2010; Łaciak *et al.* 2017); thus, we also deal with a combination of several types of black substance. Black paints composed of inorganic (iron and manganese oxides) and organic components were identified in geometric ornaments in rock paintings in NW Argentina (Vázquez *et al*. 2008).

Graphite in an archaeological and modern context

Soft and easily abraded graphite items are characterized by their rather small dimensions, for example the Neolithic pendant from the Brzezie site (Małopolskie voivodship) (Trąbska and Wesełucha-Birczyńska 2014). They are not numerous, and more often graphite can be found as inclusions in graphite ceramics or on the surface of objects, e.g. graphite-coated pottery, produced in different places around the world, e.g. in South Africa (Pikirayi 2007), not only in the Hallstatt or Celtic communities (e.g. Abłamowicz and Karwowski 2009; Poleska 2006). While graphite objects are relatively easy to study in terms of raw material composition, ceramic surfaces and other paint or impregnation layers are not, for the reasons discussed above. Graphite-coated surfaces were developed by applying graphite powder, rubbing, and polishing the graphite surface before or after firing (Abłamowicz and Karwowski 2009; Kreiter *et al.* 2014; Łaciak *et al.* 2019). A review of prehistoric ceramics in which graphite was used to develop the surface and as a filler can be found in the same works.

Graphite as a filler in ceramics of various types plays an important functional role; it increases the thermal conductivity of vessels and resistance to chemicals (as evidenced by studies of alchemical crucibles from the workshop in Oberstockhall near Vienna, Martinón-Torres *et al.* 2003). The foundry crucible and casting molds made of clay with "high graphite content" were identified at Celtic sites of the Tyniec group near Kraków. Also, objects interpreted as whetstones (fragments of graphite vessels with strong surface smoothing) were identified there (Poleska 2006, further literature there). About 30% of the graphite admixture was identified in the mint form of Zakrzów (Lesser Poland Voivodeship) (http://naukawpolsce.pap.pl).

Graphite in cast iron is tested as an important element of its classification based on the morphology, quantity and distribution of the mineral (Cvikel *et al.* 2013). A discovery of artefacts originating in Greece (Messemvria site) allowed to make the supposition of early (i.e. 5th century BC) production of cast iron on the European continent (Kostoglou and Navasaitis 2006). The research problem 'with the participation' of graphite regarding the reconstruction of Hannibal's route across the Alps (218 BC) was interestingly formulated. The surfaces of hornblende shales were searched for signs of burning by fire, currently manifested in the presence of poorly ordered graphite (Mahaney *et al.* 2008). Finally, graphite was used as a writing and sketching substance, for example the 17th century Dutch pencil in a brass holder, found in Gdańsk (Trawicka and Ceynowa 2011). Fragments of graphite with smoothed surfaces identified at Zagórze 2 (Poland, Małopolska voivodeship; Dulęba *et al.* 2012) could be used as styli but also as a substance for the surface treatment of ceramics, though it was experimentally proved that this method of ornamenting is less efficient than rubbing with a powder (Abłamowicz and Karwowski 2009).

Graphite and other more or less common forms of carbon, including semi-graphite, graphene, fullerenes and carbonaceous matter with different levels of ordering and origin are treated in mineralogical aspects as indicators of interpretation of natural processes (Pasteris and Wopenka 1991; Touzain *et al.* 2010). The interpretation of the origin of substance C in one of the oldest rocks on Earth, the meta-sediments of West Greenland, is a good example (Ohtomo *et al.* 2013).

Much attention is paid to the current use of graphite and its similar phases (Mukhopadhyay and Gupta 2013). Several areas of use of graphite are or could be commonly used in the present and in the past. Some of them could be an inspiration for archaeology and archaeometry. Suggested areas of research are former glass production: graphite in glasses can be both a strong reducing agent enabling obtaining black products and a glass degassing aid. Graphite is now part of high temperature coatings due to its oxidation resistance of up to several hundred degrees Celsius. Carbon-based coatings are difficult to wet with metal or slag. The use of graphite as a surface protective coating also increases the abrasion resistance of the object. Graphite is an excellent lubricant in binders made of mineral oils, kerosene, alcohol and even water with various additives, which is due to its outstanding cleavage and flexibility. Exceptional thermal conductivity in a direction perpendicular to the crystallographic axis c allows removal of excess heat from an object covered with a graphite coating. These properties allowed it to be used in graphite glass vessels and in ceramic vessels with graphite filler in alchemical, chemical, and pharmaceutical laboratories of different periods (Tamashausky 2003).

We know that graphite mined in the late nineteenth and early twentieth century in Zakrzów near Niemcza (Poland, Dolnośląskie Voivodeship) was used as a lubricant and in the production of foundry molds (Lis and Sylwestrzak 1986). In modern metallurgy, graphite is used in welding, forging, casting, and the production of wires as well as in powder metallurgy. The potential to use graphite in the archaeological context in this area was suggested long ago (Kwiecińska *et al.* 1970). In combination with rubbers and resins, graphite gives the opportunity to create light, flexible and easy to mold – and above all heat-conducting forms. Modern sculptures can be a potential analogy – graphite powder casts (https://www.silesiakultura.pl). Conduction, of course, is possible when the graphite particles are in contact with each other, which occurs due to their fragmentation or the use of naturally fine dust. At this point it is worth noting that the particle size also regulates the viscosity of the system: 10% of particles of 5 microns size significantly increase this viscosity, while 10% of 100-micron particles have no effect on it. Graphite is used as a soft polishing powder (Tamashausky 2003). A few studies have revealed the antibacterial effects of graphite and graphene (Liu *et al.* 2011). Graphite is inert in an oxidizing atmosphere up to 450°C and up to over 3000°C in a reducing atmosphere, thus being one of the more refractory substances. This inertness means that graphite dust, even with a size of 3 microns, is not explosive, which has facilitated its transport and storage (Tamashausky 2003).

Instead of graphite, coal was found as a filler in the La Tène pottery from the Thunau am Kamp site (Lower Austria) (Pawlikowski and Karwowski 2017). Using black substances other than graphite in ceramic pastes, e.g. soot or brown coal, is an old research problem. Currently, the distinction of these components is possible due to relatively simple and fast Raman spectroscopy studies.

Criteria for distinguishing graphite of different origin (fingerprints)

Fingerprints are features or sets of features characteristic of a strictly defined type of raw material and the object made from it. They must be measurable in the raw material as well as in the artefact; they also must have a small variability, that allows the unequivocal assignment of a specific artefact to the type of deposit (genetic provenance) or a specific location. Fingerprints must be stable under conditions of technological processes and postdepositional conditions; if we intend to study artefacts of this nature (e.g. graphite in fired ceramics), their behavior should be well known.

Graphite occurs in deposits of various genesis, which means that it is diverse in many respects. However, this diversity is not unequivocal. The origin of substance C in graphite parent rocks is different, e.g. from igneous fluids, volatile phase from the Earth's mantle, liquids of basites and ultrabasites of the asthenosphere, lithosphere and gases derived therefrom, diamonds, biogenic carbon, and abiotic carbon. The temperature and pressure to which the carbonaceous substance was subjected varies, as well as various host rocks and associated minerals (e.g. Pasteris and Wopenka 1991; Smirnov 1986; Touzain *et al.* 2010). All these phenomena influence the specific parameters of a graphite, thus resulting in the ambiguity of the interpretation of provenance studies.

Graphite fingerprints are as follows: crystal morphology including grain shape and size, degree of crystallinity, presence of rhombohedral phase, presence of 3D intermediate phase (towards diamond formation), graphite isotope composition, C/H ratio, type and amount of trace elements, presence and type associated minerals and their specific characteristics, e.g. isomorphic substitutions and (very rarely) microfossils. The best result can be achieved by studying several features at the same time. The range of specific features of graphite may be extended.

Attempts to indicate the features that differentiate graphites have long been undertaken in the studies of the relationship of the conditions of the mineral formation and its specific characteristics. Kwiecińska and Szpunar (1970) studied graphite from the Male

Vrbno deposit (Czech Republic), regionally and contact-metamorphosed, and from the Pinerolo deposit in Piedmont (Italy), contact-metamorphosed. Clear differences can be seen in C/H values, in crystallite sizes and micromorphology. Natural carbon and graphite pigment in siliceous rocks formed at different times and in different conditions differs in the size of crystallites observed in the image of HRTEM (High Resolution Transmission Electron Microscopy), in the characteristics of Raman spectra and the C:H ratio measured by NMR (Nuclear Magnetic Resonance) spectroscopy (Delarue *et al*. 2016).

Morphology is the most commonly used parameter when describing graphite. Numerous studies indicate that the spectrum of the mineral form, even in one deposit, is much broader than the general descriptions would indicate. In the graphite of Sri Lanka (well-known deposits, from which graphites often used for comparative studies come from), derived from the fluid phase, different forms of the mineral are present (fibrous, flake, spherolite, semi-spherolite, fine crystalline and recrystallized fine graphite) (Touzain *et al*. 2010). Spherical aggregates, hollow channel structures, coatings on other minerals, whiskers, barrel forms, spheres, cones and triskelions have been observed among Khibiny alkaline pegmatite graphites (Kola Peninsula, Russia) (Jaszczak *et al*. 2007). Therefore, one should pay attention to the presence of many forms in one deposit, although usually (but not always) only one form prevails. The scaly form of graphite is attributed to early-magmatic alkaline rocks. Extremely high pure graphite, usually needle-like, usually comes from vein deposits (Luque *et al.* 1998; Smirnov 1986; Tamashausky 2003). It is known from experimental studies that the type of precursor also affects the form of graphite microstructures, e.g. flakes, microspheres and aggregates are obtained from anthracite heated in 2000 and 2500°C; their proportion depends on the initial amount of anthracite (Rodriguez *et al*. 2011). Information on this feature is obtained through microscopic observations; the scanning microscopy image provides the most comprehensive results, but polarized microscopy in reflected light can also be useful.

The degree of crystallinity reflects the size of an area with the same structure order (perfectly ordered crystals are extremely rare in nature). This area is known as a crystallite. The size of a crystallite depends on the conditions of mineral formation, i.e. the energy supplied and the ability to organize the structure of the starting substance. Crystallites are small areas and their characteristics can be researched with the use of HRTEM, XRD and Raman spectroscopy. Unlike crystallites, grains are visible under polarizing and scanning microscopes.

The graphite of the Silesia-Moravia zone (NE Czech Republic) is considered to have lower crystallinity than the graphite of the Moldanubikum zone (among others SW Czech Republic). Nevertheless, in the latter there is not only highly ordered graphite, but also so-called amorphous graphite (actually cryptocrystalline), and mixed graphite. A similarly ambiguous situation also applies to carbonaceous matter in the metasediments of the Eastern Alps (Teichmüller and Teichmüller 1982) and many other occurrences. In graphite from Borrowdale deposits (Cumbria, Great Britain) the co-occurrence of colomorphic and high-crystalline graphite was evidenced using Raman spectroscopy (Barrenechea *et al.* 2009). In summary, graphite from a given location may be characterized by different degrees of crystallinity, and organic matter may have different levels of graphitization. Despite many sources of uncertainty, this parameter allows, in general, to relate graphites to the type of deposit (Luque *et al.* 1998).

The study of the size of the crystallites of graphite in a pendant from the Neolithic site of Brzezie (Poland, Małopolska Voivodeship) allowed the mineral to be defined as moderately ordered. Unfortunately, it was impossible to assign it to a specific deposit due to the lack of a reference database (Trąbska and Wesełucha-Birczyńska 2014). Raman spectroscopy is commonly used to define this parameter in order to characterize even poorly ordered carbonaceous material and graphite based on the spectra bands, their presence, location, shape (half width) and mutual relationship (Beyssac *et al*. 2002; Pasteris and Wopenka 1991; Reich and Thomsen 2004; Rodriguez *et al.* 2013). Carefully collected, the shape and location of Raman bands can be used as a geothermometer, allowing the determination of the temperature of formation of the graphite or graphitized substance with an accuracy of up to 50°C (Beyssac *et al*. 2002). This feature was used to estimate the temperature of alleged fires on Hannibal's route across the Alps (Mahaney *et al.* 2008).

Unfortunately, the energy of the laser used affects the shape and location of these bands (Pimenta *et al.* 2007). When preparing the sample for testing, grinding and milling should be avoided – all such activities, again, affect the location of Raman bands (Rantitsch *et al*. 2016, more literature therein). For example, graphite with a sharp band of 1581 cm^{-1}, milled in a ball mill for 25–50 hours, was characterized by the appearance of an additional 1353 cm^{-1} band (Pasteris and Wopenka 1991). These generated structure disorders may adversely affect the conclusions of the study. This will not apply to "3D" objects that have hardly been subjected to such treatment. Structure disorders can, however, appear in graphites applied on surfaces of pottery, possibly also graphite in ceramic mass (see Kreiter *et al.* 2014).

Another method for defining the degree of crystallinity is HRTEM (High Resolution Transmission Electron Microscopy). It is less frequently used due to the labor-intensive process of sample preparation, but it nonetheless provides information on the extent of order structures, on the presence of ring structures and their polygonization, and the evolution of precursor micropores towards lamellar forms (Rantitsch *et al.* 2016).

The study of the size of graphite crystallites can also be carried out by X-ray diffraction analysis by identifying the ordering of structures relative to the crystallographic axes a and c, based on the analysis of full width at half maximum (002) and (110), respectively. It is also possible to measure the number of aromatic layers in a carbonaceous substance, whose presence makes the carbonaceous substance susceptible to graphitization (Laggoun-Defarge 1994; Rodriguez 2011, further literature there). The presence of quartz may obscure the interpretation of the relevant diffractogram.

Measurement of the C/H ratio in the tested black substance also helps to define the degree of crystallinity, because the amount of hydrogen decreases with the increasing maturity of the carbonaceous substance (Delarue *et al.* 2016; Kwiecińska and Szpunar 1970). Measurement by NMR spectroscopy supplements the results obtained by HRTEM and Raman spectroscopy methods.

Graphite crystallizes in a hexagonal system, but sometimes it has a rhombohedral component. In special geological conditions, its quantity may be relatively high, which could allow the use of this feature as a fingerprint. In graphites from Sri Lanka, it appears in the amount of 13 to 32%, in other graphites (e.g. from Bavaria) its amount was estimated at about 14% (Lipson, Stokes 1942). The presence of this phase is influenced by shear pressure and shear deformations (Touzain *et al.* 2010). In experimental studies, the rhombohedral phase appears after a few hours in hexagonal graphite under the influence of both hydrostatic and directional pressure, albeit in a very small amount. It undergoes transformation into a hexagonal phase after several hours of heating at a temperature above about 1300°C (Laves and Baskin 1956). Prolonged grinding or milling of hexagonal graphite significantly increases the amount of rhombohedral phase (Bacon 1952, Wilhelm *et al.* 2007). This phenomenon, in favorable research conditions, would reveal the fact of graphite processing (milling, grinding) and thus identify the semi-raw material. Most likely, however, it would not make sense to use this feature as a fingerprint for graphitized ceramics. This type of graphite has also been identified in 'kish' graphite formed in cast steel (Lipson and Stokes 1942).

The identification of rhombohedral phase is mainly achieved by the Raman spectroscopy method and X-ray diffraction analysis, as well as XPS (X-ray Photoelectron Spectroscopy) to a lesser extent. Mathematical processing of parameters obtained by means of these methods is useful in identifying the arrangement of rhombohedral elements in a hexagonal structure (which depends on the type of raw material and the conditions of its processing and as such, it can also be a component of fingerprints) (Parthasaradhy *et al.* 2006; Wilhelm *et al.* 2007). No information about rhombohedral phase identification was provided in the context of archaeological artefacts.

The 3D phase appears in the graphite that evolves towards diamond formation, and therefore in very high-pressure zones (Fayos 1999; Sekine and Sato 1993). Identification of this phase can be carried out by X-ray diffraction and electron microscopy. Undoubtedly, its presence in graphite from artefacts would be a "strong" fingerprint.

The isotope composition of graphite, in particular the $\delta^{13}C$ value, but also other isotopes, e.g. oxygen, hydrogen or nitrogen for a weakly graphitized substance, carries information about the primary carbon origin (Hahn-Weinheimer and Hirner 1981) which can be biotic or abiotic; it can come from various sources and undergo various transport and precipitation processes. Biogenic genesis of graphite found in Greenland's metasediments, which are about 3.7 billion years old, was evidenced thanks to isotope analyzes (Ohtomo *et al.* 2013). Isotope analyzes allowed the differentiation of graphite separated from Celtic vessels from different Transdanubia sites and to further determine its genetic provenance (Havancsák *et al.* 2011).

The type of trace elements in graphite also allows the determination of the origin of carbonaceous matter. Increased vanadium content is observed in the graphites of some metamorphogenic deposits, e.g. graphitic quartzites in Moravia (Czech Republic; Houzar and Šrein 2000). A comparison of rare earth elements (REE) of graphite and adjacent black shales allows the establishment of a genetic relationship between them (Schrauder *et al.* 1993). Investigations of trace elements have enabled the identification of different origins of graphite in ceramic pastes of graphitic pottery from the Bavarian (Kropfmühl deposits) and Czech La Tène sites (Gebhard *et al.* 2004). NAA (Neutron Activation Analysis) and Mössbauer spectroscopy were used here.

Accompanying minerals characterize a graphite parent rock, and they can be different. For example, graphite of vein origin, genetically associated with pegmatites and arising in hydrothermal processes, is accompanied by minerals typical for these occurrences. The most abundant mineral impurities occur with so-called amorphous graphite, which results from the conditions for the formation of such rocks. Residual graphite, similarly contaminated with minerals, is concentrated in the weathering zones of parent graphite-bearing rocks (Luque *et al.* 1998; Smirnov 1986). Graphite waste at the Olomouc-Neředín site in Latern was considered to have originated from South-Czech graphite-muscovite shale from the vicinity of Svinov-Mohelnice (Hlava 2008). So that it is possible to collect evidences of provenance on the ground of minerals accompanying graphite in filler grains in ceramics but it must be remembered that technological processes (e.g. firing) can lead to changes in the original minerals.

Information from accompanying minerals is obtained not only based on their type, but also on the basis of their specific characteristics, e.g. chemical composition. As an example, let us consider vanadium substitution in the muscovite crystal lattice accompanying graphite in the Moravian quartzites of Moldanubikum (Houzar and Šrein 2000). The methods by which these issues can be studied are the classic methods of mineralogical research, ranging from polarizing microscope to XRD, Raman, infrared spectroscopy and others, depending on the amount and type of material. Microfossils traces in graphite are very rare (Hamilton *et al.* 1970); it is undoubtedly a very "strong" fingerprint.

The problem of graphitization

Graphite can be present in artefacts from its application, but it may also appear because of the graphitization of a carbonaceous matter. This process occurs to varying degrees or not at all. The results of experimental studies on ceramic pastes into which hard coal crumbs were introduced, after which the whole mixture was fired at a temperature of 700°C in a reducing atmosphere, are an example of the latter situation. Coal has not been graphitized (Pawlikowski and Karwowski 2017). We know that tar begins to organize its structure after 10 minutes of exposure to 600°C at normal pressure but only to a very small extent (Trąbska *et al.* 2011). Graphitization was used in the aforementioned work on the reconstruction of Hannibal's route across the Alps. It was this phenomenon that allowed the effect of high temperature on hornblende shales to be traced (Mahaney *et al.* 2008).

The analogy flowing from the analysis of modern processes for the preparation of graphite, for example in the presence of quartz and oxides of some metals (Acheson reaction), indicates that organic substances may undergo rapid graphitization, i.e. lasting only hours or days, but technological processes taking place at 1700°C were rarely achievable for ancient communities. The formation of very small, several dozen-degree clusters of secondary graphite is then observed (Lee *et al.* 2015). Graphitization not only depends on the conditions of the process, but also to a large extent on the type of starting substances, the so-called precursors. These are substances with specific structure features, including the presence of planarly arranged aromatic rings, which can therefore easily be graphitized, e.g. anthracite. Depending on the precursor structure, the degree of the graphitization of the secondary graphite varies. Generally, it is very difficult to distinguish primary from secondary graphite (Rodriguez *et al.* 2013). The scope of the graphitization process in graphite, graphitic ceramics and in graphite objects that have been affected by temperature is poorly recognized. In the area of archaeometric research, no attempt has been made to identify primary graphite and to distinguish between primary and secondary graphite.

The graphitization of carbonaceous matter occurs in natural processes under the influence of temperature, depends on its duration, host-rock lithology, type of starting substance and shear stress, especially in low P-T conditions. Graphitization may begin already at 750°C, but the time factor plays a role here. At high pressure, it already starts at 500°C. It was noticed that some types of carbonaceous substances are reluctant to graphitize, which results in, among others, the presence of low crystallinity graphite in rocks subjected to a high degree of metamorphism. Graphite appears in natural conditions, not only as a result of graphitization of a carbonaceous matter, but also in the process of the direct precipitation from carbon-bearing fluids, i.e. containing CO, CO_2, CH_4 and other substances (Delarue *et al.* 2016; Luque *et al.* 1998; Tamashausky 2006).

According to some researchers, the transformation of graphite into less ordered phases is possible. A small amount of alkali (about 1%) is needed and a temperature of about 1100°C. Then, large alkali ions diffuse into the graphite network and destroy it. Coke was used in the experiments during which this phenomenon was observed (Bhattacharya *et al.* 2015). In postdepositional conditions at archaeological sites, the destruction of a graphite component within charcoal was observed. This is an important finding in research on the beginning of the use of fire which is based on an analysis of the composition of the ash (Cohen-Ofri *et al.* 2006). Other researchers believe that the effects of the graphitization processes are irreversible (e.g. Teichmüller and Teichmüller 1982), which makes it possible to use a graphitized carbonaceous substance and graphite as a source of information on the origin of the starting substance and conditions of the technological processes. It should be stressed that further investigations in this area are required. Results of interesting experiments of a half-year deterioration of graphite-coated pottery did not reveal any macroscopic changes but, unfortunately, they were not followed by instrumental analyses (Abłamowicz and Karwowski 2009). As can be seen, graphitization processes are less clear-cut than one might think and require careful observation.

Summary

The identification of the black components of items and layers allows the reconstruction of technological habits and methods of obtaining raw material. However, an interpretation of the research results is not a simple matter. Black substances that entirely or only partly make up objects found in the archaeological context can have an overly complex composition. Many processes of the formation and disappearance of components of black layers in artefacts are not yet known and require experimental research. On the other hand, graphite has attracted great interest in many branches of research and industry in recent years; new data are constantly appearing. A broad look at the presence of black components, including graphite in various ancient technological aspects, may attract the interest of scientists representing numerous other fields. The interdisciplinary exchange of experience is highly desirable in this area. Provenance studies based on the use of only one fingerprint may provide equivocal results, as well as neglecting their variability.

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The influence of redeposition on the anthracological records from the Moravian Karst caves (Czech Republic, Central Europe)

Abstract

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The study focuses on some methodological problems associated with the research of cave sites. A large amount of anthracological material came from the context of the layers with archaeological material from the Pod hradem Cave (Moravian Karst, Czech Republic). Some samples were determined as *Taxus*, which in this context would be among the first evidence of yew in the Middle Pleistocene. However, their dating showed significant secondary redepositions. Similar redepositions of material were repeatedly found in the dating of material from the Kůlna Cave (Moravian Karst, Czech Republic). Here, too, in certain parts of the cave, there was secondary redeposited archaeological material in seemingly intact sediments. Both caves were inhabited – Kůlna Cave from MIS 8 to MIS 2, Pod hradem Cave – from MIS 3e to MIS 2. At the same time, intensive post-sedimentation processes took place in both caves, accompanied by the activities of large carnivores inhabiting these caves alternately with humans. The last important factor influencing stratigraphy was the archaeological excavations at the end of the 19th and the beginning of the 20th century.

Keywords: Pod hradem Cave, Kůlna Cave, Anthracology, ^{14}C dating, Post- depositional processes

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1. Introduction

This study is a contribution to the issue of cave research methodology. It deals with the evaluation of two examples in which scientific samples were obtained from seemingly intact cave sediments by archaeological research. Research on the Pod hradem Cave, the first example, was conducted in the first half of the 1950s: (Valoch 1965). Species determination for the remaining charcoals was only performed in 2012. In several cases, the results were in conflict with the presumed (archaeological and geological) age of the strata from which the samples were taken. The second example is Kůlna Cave (Valoch 1988), from where properly contextually controlled samples of osteological material were taken for new absolute dating from 1961–1976 (Neruda and Nerudová 2014; Nerudová and Neruda 2014).

In this paper, we present the unpublished assessment of charcoals from the Pod hradem Cave, radiometric dating of selected samples and compare them with similar results obtained from the Kůlna Cave.

Study area

The caves of the Moravian Karst (Czech Republic, Central Europe) are world famous from an archaeological point of view (e.g. Neruda 2016; Valoch 2011). In the northern part of the Moravian Karst is Pod hradem Cave, situated in the Pustý žleb Dry Valley, approximately 4 km SSW of Kůlna Cave (Fig. 1B). Its entrance is situated on a north-facing slope 60 m

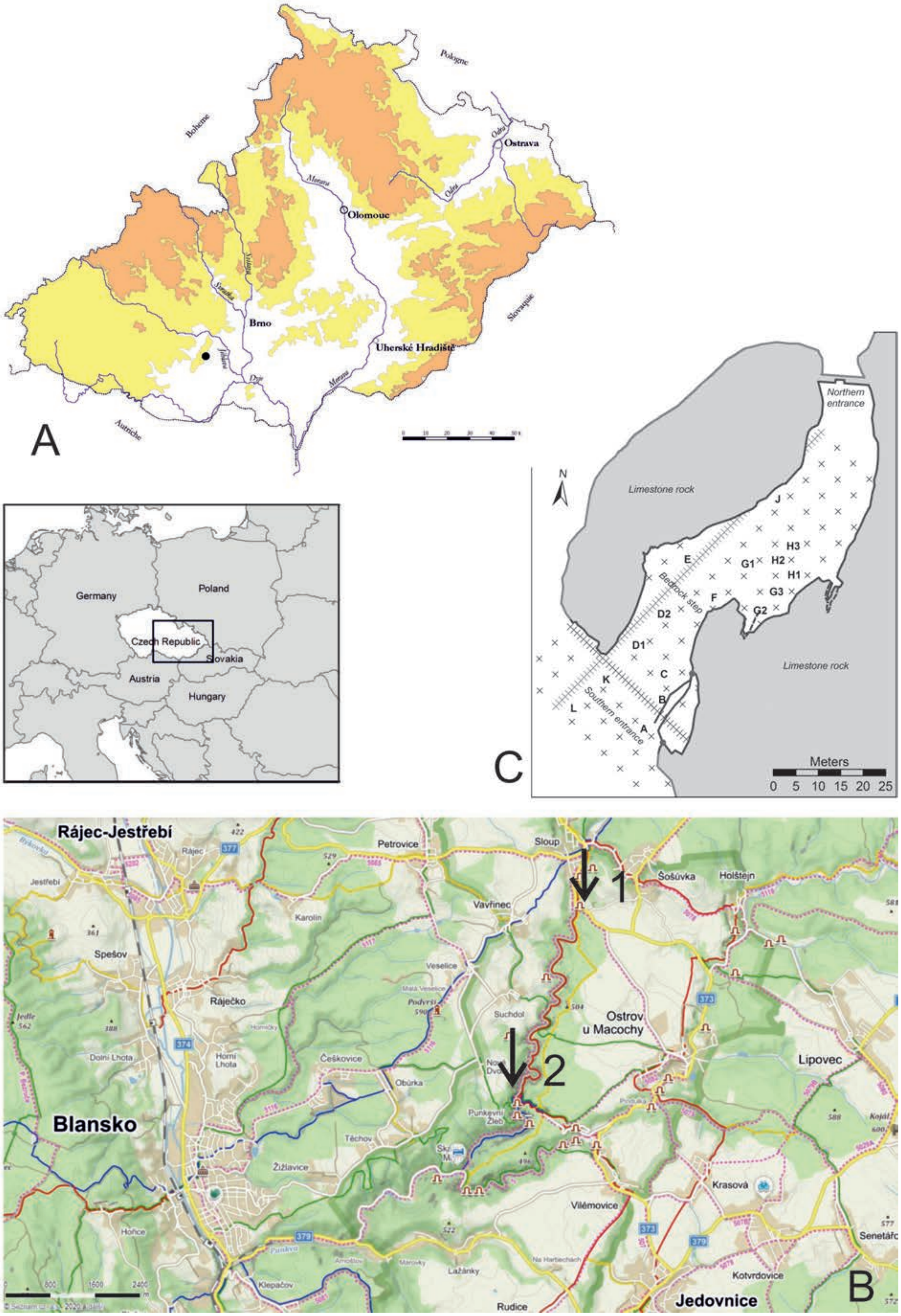

Fig. 1. Area under study. A – Position of the Czech Republic and detail of Moravia region; B – detail localisation of the Kůlna Cave (1) and Pod hradem Cave (2); C – ground plan of the Kůlna Cave.

above the valley floor. The narrow portal is 4 m wide and 2 m high. The cave was occasionally inhabited by humans during the MIS 3 period (Nejman *et al.* 2018; Nerudová *et al.* 2012). In addition, it was intensively used by predators (Musil 1965; Valoch 1965). Palaeontological research has been carried out here since the end of the 19th century. The first unique artifact – a leaf-point, which has since been lost – was obtained from here in the 1930s. Multidisciplinary archaeological research took place in the cave between the years 1956–1958 (Valoch 1965). One longitudinal probe was placed along the entire entrance part of the cave and two smaller probes in the rear part of the cave in the side corridor (Fig. 2A, B; Nerudová *et al.* 2012). Where the main probe was located, a profile 27 m long with a maximum depth of 5.5 m was documented (Fig. 2C). This provided the most complex stratigraphic sequence. In addition to a considerable amount of palaeontological material, particularly bear bones (*Ursus ingressus*), a large hearth and unique archaeological finds were discovered; these were associated with the cultures of the Upper Palaeolithic, namely the Szeletian, Aurignacian, and Gravettian (Valoch 1965, 96).

In the northern part of the Moravian Karst is Kůlna Cave (Fig. 1B, C). It is a long, S-shaped curved tunnel cave with two entrances. Palaeolithic settlement in the cave was concentrated in the area around the northern entrance to the central part of the cave. Intensive research carried out since the end of the 19th century has excavated mainly Holocene and Late Glacial sediments with evidence of Gravettian and Magdalenian settlements in several places and partially also older sediments (for more details see Valoch 1988; Neruda and Valoch 2011). In the years 1961–1976, interdisciplinary research was carried out here, which revealed most of the area in the entrance and the middle part of the cave up to the bedrock (Fig. 1C). Although research has found evidence of Palaeolithic settlement from the Taubachian to the Epi-Magdalenian, in contrast to the numerous chipped stone industry and osteological material, anthracological remains are not very numerous (cf. Opravil 1988).

2. Material and methods

As part of the research on the Pod hradem Cave (1956–1958), a total of 37 charcoal samples were taken, coming from different layers and places of the entire researched area (Tab. 1). They should, therefore, represent the time period from the beginning of the

Table 1. Pod Hradem Cave, analyzed samples. The square description is according to Musil 1965, depth is in cm. Interpretation (performed by ZN) is based on the column note and depth. The information was compared and re-measured to the published overall longitudinal profile, which was reproduced in detail in colour at scale 1:10 in Musil 1965 (see Fig. 2 here). Each sample in Table 1 represents the content of one glass test tube. For a comparison of sample positions see Fig. 2.

Sample	Square	Depth	Museum Label Note	Interpretation
1	2	3	4	5
1	33–35	70–90	1956, W2/3	Layer 5, closely over the Gravettian hearth (perhaps touching the hearth?)
2	29–30	60–70	W2/3	Layer 6a, perhaps touching the periphery of Gravettian hearth
3	31–32	140–150	W1/2	Layer 14 (significantly below the Gravettian hearth and significantly above the layer with leaf point)
4	10–12	100	New Age	Layer 4
5	10–12	150–160	grey, LBK culture	Layer 3
6	7–9	180–190	light grey-brown; below the LBK	Layer 5a
7	13–14	30–80		unclear; according the profile include basis of Layer 1, Layers 1a and 2
8	15–16	60–70	surface of dark	Layer 2
9	31–32	10–20	ligh yellow-brown	unclear; Layer 2 or 3; both were surface and outside of archaeological finds

1	2	3	4	5
10	23–24	160–170		Layer 13b
11	29–30	40–50		Layer 6a, perhaps touching the periphery of Gravettian hearth
12	19–20		white sediment, depth sonda	unclear
13	7–9	150–160		Layer 3a
14	13–14	30–80		unclear; according the profile include basis of Layer 1, Layers 1a and 2
15	31–32	40–50		Layer 5, outside of Gravettian hearth
16	10–12	160–170	light grey-yellow	probably transition of Layer 3 and Layer 3a
17	21–26	340–350		samples come from 6 sq m, but the indicated depth was achieved here
18	10–12	150–160	grey, LBK culture	Layer 3a
19	12	160–170	in the corner Middle Age	Layer 5a
20	13–14	120–130	grey, LBK culture	Layer 3
21	21–22	120–130	disorder	unclear; discorder reached deep 150 cm, then excavated only 90 cm depth
22	29–30	20–30	W3, light yellow-brown	Layer 5, above the Gravettian hearth
23	19–20		depth sonda, brown loess-like sediment	unclear
24	25–26	150–160	cf. cofee brown soil, second W1-2	basis of Layer 13b or Layer 13c
25	11–12	170–180	yellow-brown	Layer 5a
26	10–12	150–180		Layer 3a? Layer 5a? Uncleare.
27	13–14	110–120	grey, LBK culture	Layer 3
28	2–30	10–20	soil W3, light yellow-brown	unclear; it looks like charcoals from Layer 5 from the whole entrance of the cave
29	10–12	180–190	yellow-brown	Layre 5a, basis
30	11–12	160–170	light grey-brown	Layer 3
31	10	160–170	black	probably Layer 3a, according to the profile
32	13–14	100–110	grey-brown, cinereous	Layer 3 or Layer 5a
33	29–30	70–80	W2/3	transition of Layers 6a and 6, outside the Gravettian hearth
34	25–26	160–170		Layer 13b
35	33–35	150–160		Layer 14
36	29–30	80–90		bordeline between basis of Layer 6 and Layer 7
37	29–30	50–60		probably Layer 6a – upper level, probably touching the Gravettian hearth

Upper Palaeolithic to its upper phase, i.e., 40,000–20,000 uncal BP. Unfortunately, for the purposes of publication (Opravil 1965) only a selected part was determined (from layers Würm 1/2, Würm 2/3 and Holocene; see Opravil 1965, 149).

Similarly, not all of the samples from the Kůlna Cave were used. As we identified some decades later, not all available anthracological findings were included in the monograph, not even in the monographic interdisciplinary treatment of Kůlna Cave (Valoch 1988).

The material from Pod hradem Cave seemed to be a suitable reference (temporal) analogy. Therefore, an as yet unrealized anthracological analysis of samples from the Pod hradem Cave was performed. Practically simultaneously, the hitherto undetermined charcoals from the Kůlna Cave were also determined. The remaining part of the unspecified charcoals from the Kůlna and Pod hradem caves was handed over for assessment in 2011–2012. The determination was performed by J. Novák; subsequent radiocarbon dating took place in an Oxford laboratory.

2.1 The collection of samples

The collection of samples took place within the archaeological research of the sites in 1956–1958 (Pod hradem Cave) and 1961–1976 (Kůlna Cave). Archaeologists took samples of varying volumes: individual bigger charcoals (0.5–2 cm) macroscopically distinguishable in the course of preparation of the archaeological layer and target sediment samples of 2–4 cm^3 from places with dispersed pieces of charcoals. Unfortunately, the methodology of sampling is not known. Dry-sieving of the sediments was performed on both sites (Musil 1965, 13; Valoch 1988, 13–14). The charcoal samples taken from both studies were stored at the Anthropos MZM Institute in glass test tubes. Each sample contained location data (site, square, depth, note, see Tab. 1).

2.2 Laboratory preparations and analysis of fossil samples

Charcoal analysis was performed on fragments from the largest fraction (>1mm). The charcoals were identified using an episcopic interference microscope (Nikon Eclipse 80i) with

200–500 magnification and the reference collection. Additional standard identification keys were also used (Heiss 2000; Schweingruber 1990). Species abundance was expressed in the number of charcoal fragments (e.g. proposed by Delhon 2006) and charcoal anthracomass (e.g. Carcaillet and Thinon 1996). The individual taxa were weighted with an accuracy of 0.001 g. The sediment anthracomass (milligram of charcoal per kilogram of sediment; Talon *et al.* 1998) was derived from charcoals larger than 1 mm.

2.3 Radiocarbon dating

New radiocarbon dating was performed at a laboratory in Oxford using the accelerator mass spectrometry (AMS) method. Samples underwent standard laboratory procedure (Bronk Ramsey *et al.* 2004b). Before dating, the charcoals were determined.

According to laboratory standards, the dates are uncalibrated in radiocarbon years BP. Isotopic fractionation was corrected for using the measured $\delta^{13}C$ values measured on the AMS. The quoted $\delta^{13}C$ values were measured independently on a stable isotope mass spectrometer (to ±0.3 per mil relative to VPDB). Chemical pretreatment, target preparation and AMS measurement was done according to the standards (Bronk Ramsey *et al.* 2004a; Bronk Ramsey *et al.* 2004b; Bronk Ramsey *et al.* 2002). The calibration was measured using the 'INTCAL09' calibration curve (Reimer *et al.* 2009).

3. Results

3.1 Anthracological analysis

Our study analyzed 413 charcoal fragments from Pod hradem Cave and 105 charcoal fragments from Kůlna Cave (Tab. 2). The anthracological analysis from Pod hradem Cave revealed fifteen different charcoal taxa: *Abies, Acer, Carpinus, Corylus, Fagus, Fraxinus, Juniperus, Larix/Picea, Pinus, Pinus cf. cembra, Quercus, Salix/Populus, Taxus, Tilia,* and *Ulmus* (Tab. 2, Fig. 1, 2). Detailed diagrams are shown in Figures 3 and 4.

We obtained a higher density of charcoal samples at layers 13 and 14. Samples are characterised by the dominance of *Larix/Picea* charcoals and the common presence of *Pinus.* The abundant presence of *Taxus* charcoals was characteristic for layers 5–7 and 14. Other deciduous broad leaf trees (*Acer, Carpinus, Corylus, Fagus, Fraxinus, Quercus, Tilia, Ulmus*) were determined. In addition to the relatively common species, the presence of yew is particularly striking. Also found were maple, oak, hazel, elm, and beech, which are all unexpected species due to the context of the find.

From Kůlna Cave, charcoals from the Micoquian layer 7a were selected for determination. In addition to fragments of burnt bones, relatively large charcoals of oak and pine were determined (Tab. 3).

Table 2. Pod hradem Cave. In Table 2, the samples are sorted in ascending order by the layers as identified by us (see Table 1, Interpretation column). The individual layers represent different time periods of cave settlement and correspond to the layers that Nejman also identified by his revision research. 12 sedimentary layers were recognized in the excavated section (Nejman *et al.* 2017). Red – problematic sample, yellow – dated samples from clear controllable contexts.

Sample	Layer	Square	Depth (cm)	Abies	Acer	Carpinus	Corylus	Fagus	Fraxinus	Juniperus	Larix/Picea	Pinus	Pinus cf.cembra	Quercus	Salix/ Populus	Taxus	Tilia	Ulmus
1	5	33–35	70–90		1	0			0	0	4	0	0	0	0	0	0	0
2	6a	29–30	60–70		1						2					4		
3	14	31–32	140–150		3						4					14		
4	4	10–12	100	9	15													
5	3	10–12	150–160					3			8	1				9	10	
6	5a	7–9	180–190		1						1	1		2			2	
7	1,2	13–14	30–80													6		
8	2	15–16	60–70								2							
9	2,3	31–32	10–20	1	2		3	8	1							1	1	
10	13b	23–24	160–170		1			2			32	2					1	
11	6a	29–30	40–50								4				2		1	1
12	?	19–20	depth sonda					1										
13	3a	7–9	150–160				1				5				1	1		
14	1,2	13–14	30–80		1											4		
15	5	31–32	40–50				14		1		2			7		3	1	
16	3, 3a	10–12	160–170								5	2		1		1		
17	21	21–26	340–350							1	23	2	9					
18	3a	10–12	150–160		7			2		1	11						6	
19	5a	12	160–170		2											1	2	
20	3	13–14	120–130							1	4							
21	?	21–22	120–130								3	1						
22	5	29–30	20–30	1			1	1			1						2	
23	?	19–20	depth sonda								1					1		
24	13b	25–26	150–160								11				1			
25	5a	11–12	170–180				1				3	2		1		3		
26	3a	10–12	160–170		1		2				7					11		
27	3	13–14	110–120								3					2		
28	5	29–30	10–20	2		2	1	1	1		2					1	1	
29	5a	10–12	180–190				2	1								2		
30	3	11–12	160–170								4	2				1		
31	3a	10	160–170								1	5		1		1		
32	5a/3	13–14	100–110				1				6					1		
33	6a	29–30	70–80		3						3							
34	13b	26–26	160–170		2						5							
35	14	33–35	150–160								5							
36	7	29–30	80–90				2				2			1				1
37	6a	29–30	50–60												1			
Σ				13	40	2	28	19	3	3	164	18	9	13	5	67	27	2

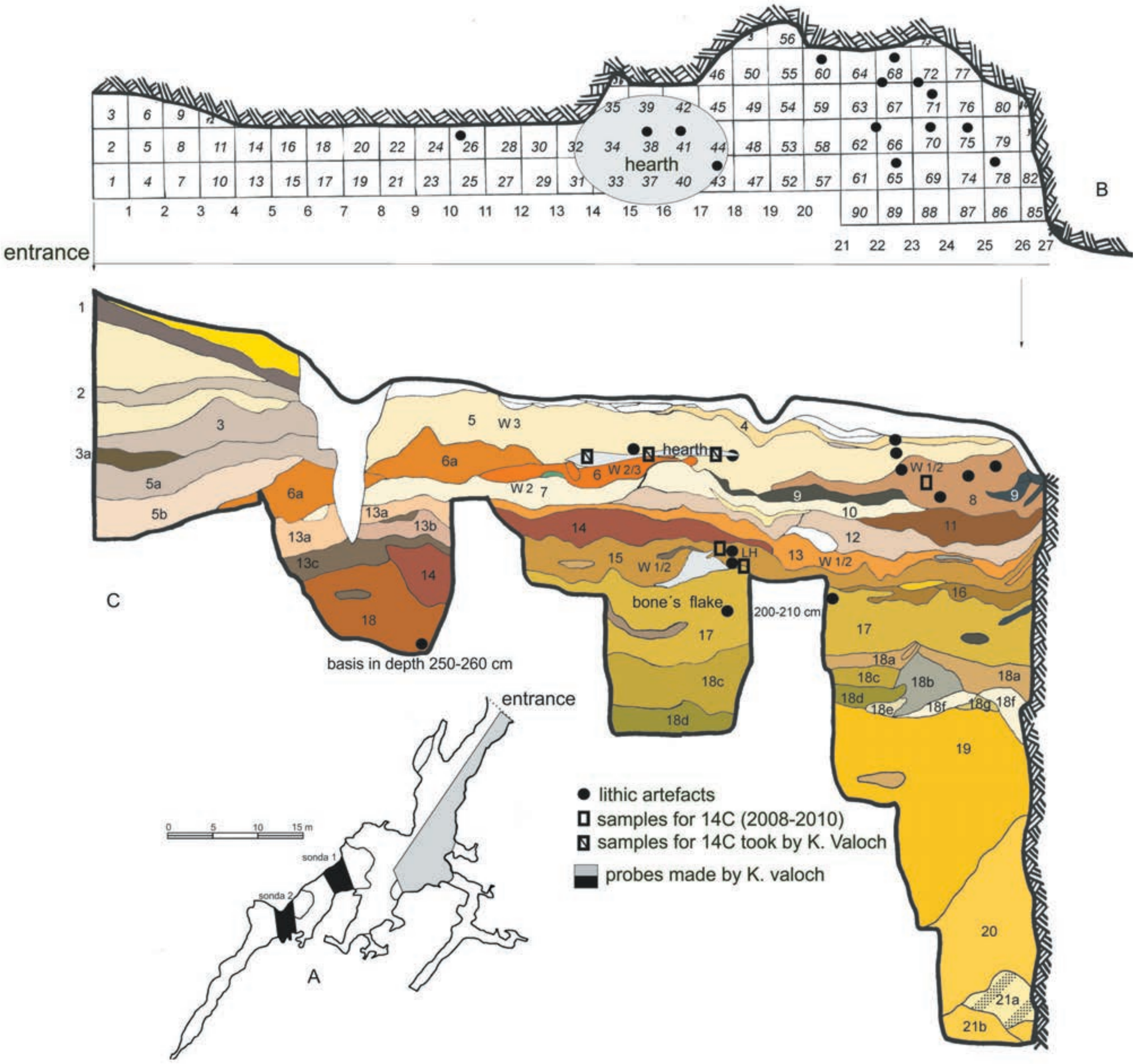

Fig. 2. The plan of Pod hradem Cave digitized and reconstructed according to Valoch (Nerudová *et al.* 2012) and subsequently modified. A – ground plan of the cave. By grey – K. Valoch's excavation, black – sound 1 and 2 made in the inner part of the cave by K. Valoch during his excavations; B – horizontal plan of the excavations with numbering of square metres, horizontal distribution of lithic artefacts (black dots) and probable extension of the hearth (grey oval); each square is 1 × 1 m; C – digitized stratigraphy with vertical position of lithic pieces (black dots), hearth (grey oval), samples for ^{14}C taken by Valoch (crossed out rectangles) and samples for dating taken between 2008–2010 from material stored in the Moravian Museum (rectangles). Probe 1 (sound 1) was probably situated in the place where Simon found a leaf point. In sound 2 at a depth of 190–200 cm the sediment was macroscopically identical to the sediment in Layer 15. Valoch took a sample for dating from this depth and sediment.

3.2 Results of radiocarbon dating

From Pod hradem Cave, three different samples of *Taxus* species (Tab. 2) were sent for dating. According to our analysis, all samples came from places unaffected by post-Palaeolithic settlements. In contrast to their presumed age due to the archaeological context, we obtained unexpectedly young data from them. The samples are placed from the 3rd century BC to 3rd millennium BC (Tab. 3).

Unexpectedly recent data was also obtained from Kůlna Cave. These did not correspond to the archaeological age of layer 7a at the cave. These data represent the period of the 2nd century BC to the 9th millennium BC (Tab. 3).

Table 3. Above: Kůlna Cave, Layer 7a. List of determined species the number of pieces. The samples taken for dating are marked with an asterisk. Below: The results of dating from the Kůlna (KUL) and Pod hradem (PH) caves.

Square	**Depth (cm)**	***Fraxinus***	***Pinus***	***Picea / Larix***	***Quercus***	**Burnt bone**
11/i	270		6*	2	49*	
g/34–37	190–220					3
2–5/bc	430–440	15*	13*			
11/i, 26 1/11	270		10		40	

OxA Sample	Material (species)	$\delta^{13}C$	uncal BP
OxA-26996	PH2012-1 charcoal (*Taxus baccata*)	–26.24	320 ± 24
OxA-26997	PH2012-1 charcoal (*Taxus baccata*)	–26.30	347 ± 24
OxA-26998	PH2012-2 charcoal (*Taxus*)	–23.30	2534 ± 27
OxA-25719	KUL2011-1 charcoal (*Fraxinus*)	–23.29	4001 ± 28
OxA-25720	KUL2011-2 charcoal (*Pinus*)	–25.02	149 ± 23
OxA-25721	KUL2011-4 charcoal (*Pinus*)	–24.72	8832 ± 37
OxA-25781	KUL2011-3 charcoal (*Quercus*)	–25.38	8940 ± 40

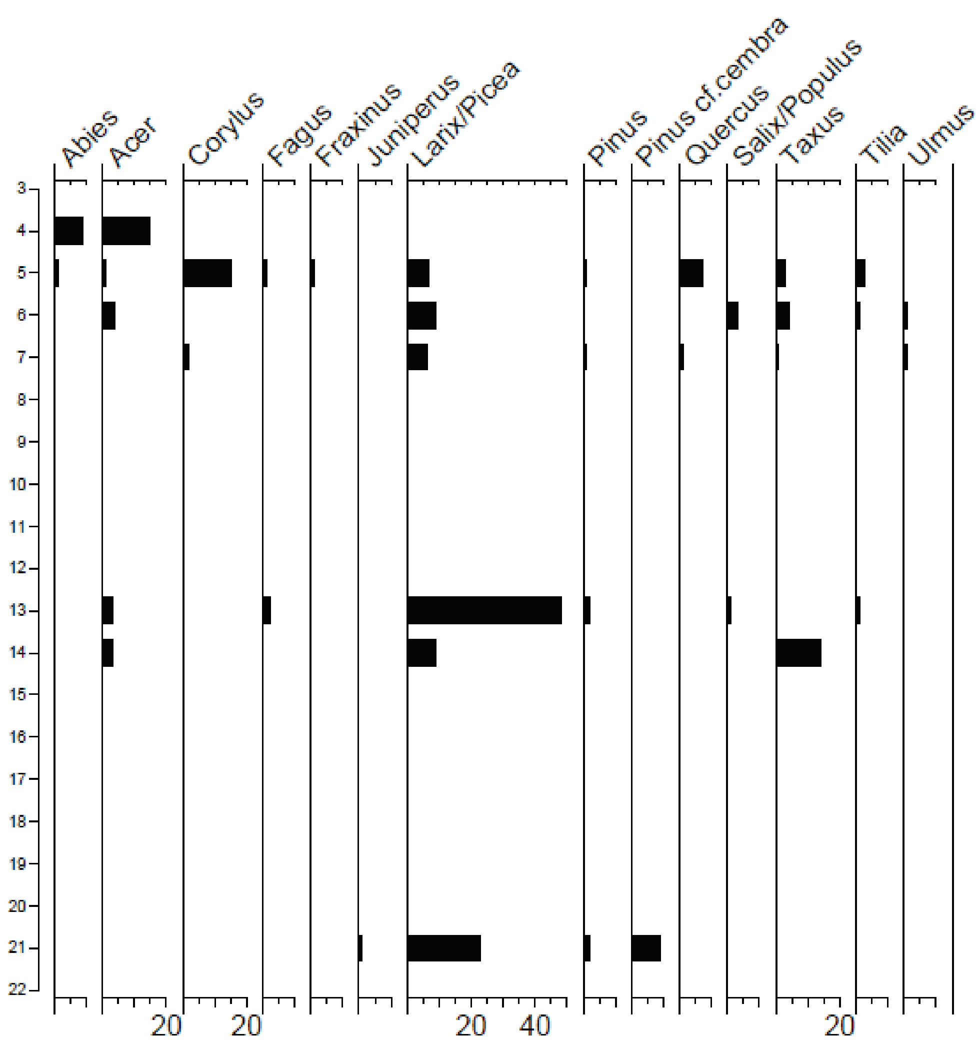

Fig. 3. Pod hradem Cave, all analyzed samples from layers 3–21 (Y-axis)

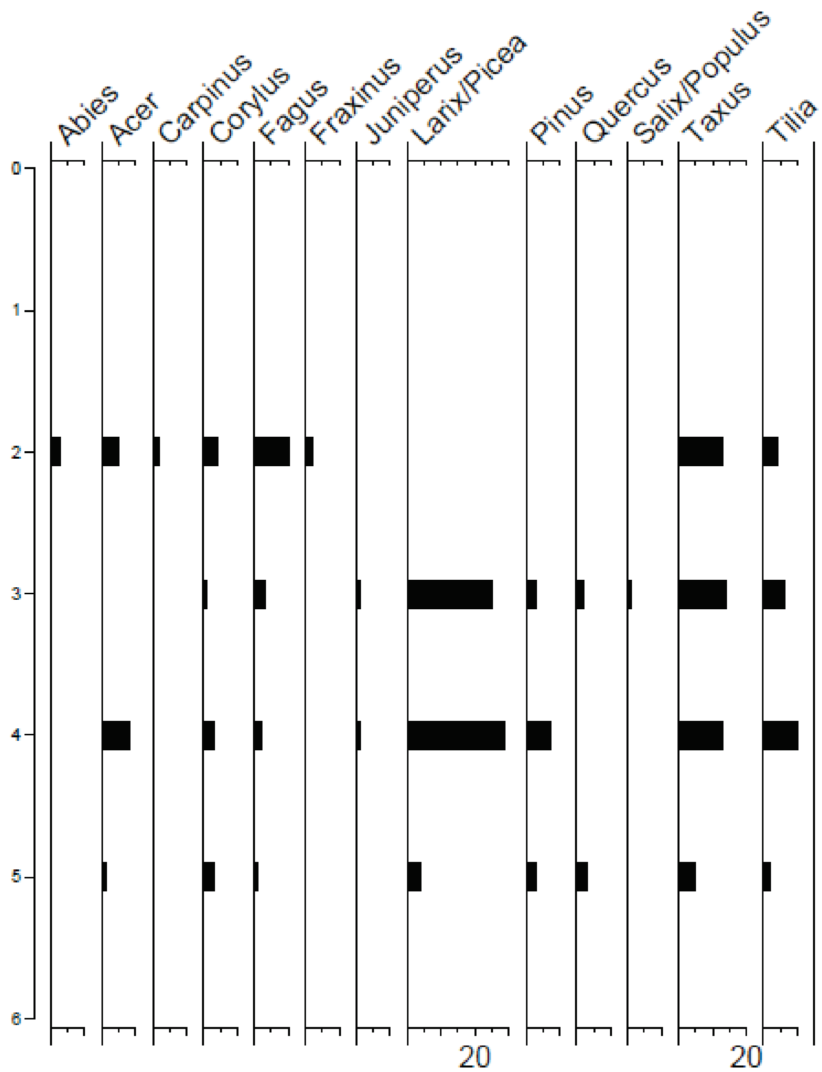

Fig. 4. Pod hradem Cave, the detail of samples from layers 1–5 (Y-axis).

4. Discussion

4.1 Anthracology

The genus *Taxus* is a tree, the wider occurrence of which is usually associated with the Holocene in Central Europe (Batchelor *et al.* 2019; Bevan-Jones 2016; Deforce, Bastiaens 2007; Uzquiano *et al.* 2015). Although this tree occurred and was used at least in the Middle Pleistocene (a find from Clacton-on-Sea), evidence of its occurrence is generally rather poor. In the Czech Republic, documentation in the late Pleistocene – Gravettian is registered, for example, in Dolní Věstonice (Mason *et al.* 1994). *Taxus* charcoals are more abundantly found in wells from the period of agricultural prehistory (Neolithic-Bronze Age) and in sandstone rock shelters in North Bohemia (e.g. Novák *et al.* 2015).

The amount of yew recorded in the intact Middle Palaeolithic layers of Pod hradem Cave (Tab. 2) is really unexpected. In addition, relatively large, burnt fragments of wood were present. Along with yew, a number of other deciduous trees such as maple, oak, hazel, elm, and beech, were found. The question was whether, on the basis of identified tree species, we could consider that the generally presented character of the vegetation of the natural environment could be much more varied in places than is generally assumed. Indications suggested that the yew from Pod hradem Cave could be one of the oldest evidences of this taxon in Central Europe (for an overview of the presence of yew during the Pleistocene see Deforce and Bastiaens, 2007). Charcoal-dated yew from Moravany (Slovakia) from 22,000 BP is mentioned in the literature along with hazel, oak, ash, alder and beech (Slavíková-Veselá 1950), but its refugium is generally assumed to be in regions with a mild, oceanic climate (Deforce, Bastiaens 2007). Revision of the archaeological research has provided some guidance.

Charcoal was recovered from layer 3 (3 samples) and layer 10 (574 charcoal samples in total) from new excavations conducted by L. Nejman between 2011–2012. In layer 10 the most common species was *Larix / Picea* (larch / spruce) followed by *Pinus* cf. *cembra*.

Two species of charcoal *Taxus baccata* and *Fagus sylvatica* were identified in the small number of fragments recovered from layer 3 (Nejman *et al.* 2017). Further analyzes also showed that *Picea / Larix* and *Pinus cembra* were not only numerous in layer 10 but also in upper layer 9 and the underlying layer 11 (cf. Nejman *et al.* 2018, Fig. 5). Less common species included *Populus / Salix* and *Juniperus.*

If we analyze the findings from the Pod hradem Cave (Tab. 2) and compare them with the reconstructed plan (Fig. 2), we can observe several tendencies. A large amount of carbon from yew and other unusual woody plants was identified mainly in layers 1–3 (Tab. 2). These are layers which, according to research by Valoch and also by Nejman, represented the youngest phase of the cave's settlement. Also, Nejman *et al.* (2018) refer to the information that "Layer 1 contained ceramic and metal artefacts, some of which are associated with early medieval occupation". Layer 2 chronostratigraphically corresponds to the Atlantic climatic optimum (with phases of Mesolithic, Lower and Middle Neolithic, and Upper Neolithic). Layers 3, 4, and the upper part of Layer 5 were AMS dated to approximately 36–28 cal kyr BP (Nejman *et al.* 2018). At the same time, based on analyzes (pollen, anthracology, and sedimentology), the authors do not rule out the possibility that layers 3 and 4 were contaminated with Holocene material (Nejman *et al.* 2018, 208). No Palaeolithic artifact comes from layers 3 and 4 of Nejman's research.

If we compare Nejman's stratigraphy with that of Valoch's, we find that they fully correspond with each other. Valoch does not indicate layer 1, his findings of linear ceramics (LBK) are in layer 3 (see Tab. 1), which corresponds to layer 2 in Nejman's research. In Table 1 we can see that Valoch presents modern finds at a depth of 100 cm; according to the profile we interpreted this should be layer 4. At the same time, LBK was located in these places (squares 10–12).

On the contrary, the places where yew was not identified were the areas of squares 23, 24, 25, 26, and 28, i.e., before that ash lens (hearth; although its spatial distribution was only reconstructed approximately). Theoretically, these could be "intact" places (see below). L. Nejman's probes were located rather in places opposite the hearth (cf. Nejman *et al.* 2017, fig. 2), because the aforementioned *Taxus* also comes from his research. We could label all the lower horizons in the Pod hradem Cave, i.e., layer 5 and deeper, as relatively "safe" layers.

Nevertheless, the findings of *Taxus* charcoals also come from layer 5 and deeper layers.

4.2 Dating

All obtained radiocarbon data from both the Kůlna and Pod hradem caves did not correspond to their presumed age. This repeated discrepancy can be influenced by several factors. The general problem is the limitations of the use of the old collections, here represented by samples from the Kůlna and Pod hradem caves. Similarly, the younger date mentioned in the Nietoperzowa Cave (Krajcarz *et al.* 2018), the Ciemna and Obłazova caves (Alex *et al.* 2017) are results of possible admixture of some material in sediments. Another explanation for the observed discrepancy between the expected and resulting dates is also discussed by other colleagues, recently with regard to Koziarnia Cave (Kot *et al.* 2020). The results of dating burnt materials (bones, charcoals) can be influenced by the temperature of burning, e.g., charcoals burned at relatively low temperatures. This may likely produce a shift to younger radiocarbon dates (Kot *et al.* 2020).

5. Interpretation

The reconstruction of the course of the layers in the Pod hradem Cave shows a rather complex, often area-limited sedimentation from several directions, so that the deposition of some layers took place only in a part of the cave. Although the research was conducted in intact sediments and the only significant defect was documented near the entrance to the cave, i.e., away from places with archaeological finds, there were significant post-deposition changes in the cave, caused mainly by large carnivores, as the cave served as a winter habitat for cave bears.

A planar and vertical reconstruction of the distribution of archaeological finds (*Nerudová et al.* 2012), carried out on the basis of known information (Valoch 1965), indicates the main problems of sedimentation and interpretation of archaeological horizons. Not all of the layers associated with archaeological cultures were in direct superposition. An extensive hearth or ash-deposit, which provided several indistinct stone artifacts and a date belonging to the Gravettian period, was located in an extended place in the middle part of the cave, at the level of length meters 15–18 (Fig. 2B). A lone leaf point was found in layer 15 one meter deeper and in approximately the same location. Another industry attributed to the Aurignacian (the so-called second cultural circuit) was then scattered in several layers between lengths of 21–25 (Fig. 2B,C). These findings are usually associated with absolute data from probe 2, which dated the so-called horizon W1/2 and which was related to the findings based on the similarity of sediments.

As indicated in the introduction, the Pod hradem Cave, although initially only providing palaeontological material, has been studied by archaeologists since the 19th century. The cave was primarily a bear cave, only occasionally inhabited by humans. The bear bones were occasionally scavenged by wolves and hyenas.

Not only the intensive activity of carnivores and sedimentation processes in the cave (better illustrated by the profile published by Valoch 1965; see also Nejman *et al*. 2018) but also later interventions in the cave caused tree charcoals to move out from their layered sediments and penetrate deeper. Two radiocarbon dates correspond to finds from the Middle Ages; the third date is later in the Late Bronze Age. At the same time, the data correspond to known knowledge about the spread of yew in our environment (Batchelor *et al*. 2019; Deforce, Bastiaens 2007).

Archaeological layer 7a in Kůlna Cave was considered to be unaffected by secondary post-deposition processes (Neruda and Valoch 2011), especially with regard to the results of dating the findings from the Micoquian 6a layer at the cave entrance (Neruda, Nerudová 2014). No recent contamination was evident in the set of osteological material, and radiocarbon data obtained from osteological material confirmed the archaeological age of the layer (Neruda and Nerudová 2014). However, the situation is different with the isolated charcoals. Their relocation into Middle Palaeolithic positions was most likely caused by digs conducted by amateur archaeologists in the 19th and 20th centuries. One sample almost precisely coincides with the time of excavations by Wankel (Neruda and Nerudová 2014).

The Mesolithic date confirms a small collection of lithic industry from layer 3 to the Mesolithic period. The last date from the Neolithic/Eneolithic transition undoubtedly pertains to numerous post-Palaeolithic occupations of the cave.

6. Conclusions

Radiocarbon dating of three charcoal samples, which were identified as *Taxus baccata* from the Pod hradem Cave, and dating of four charcoal samples from the Micoquian layer 7a of the Kůlna Cave showed a significantly younger age of dated material that did not correspond to the real age of the archaeological layers from which these samples were removed for dating. Similar results were found earlier, as part of a project focused on climate reconstruction and chronostratigraphy in the Kůlna Cave, when anthropically affected osteological material was dated. The occurrence of tree species which did not correspond to published global climate reconstructions, seemingly confirmed the specific climatic condition in Moravia in the Czech Republic and showed its exceptional tree diversity with several temperate deciduous tree taxa (for comparison see Jankovská and Pokorný 2008). Woody assemblages dated to between 35 and 30 ka cal BP are mentioned in the literature. These also include the oceanic *Taxus baccata* in Moravia (Feurdean *et al*. 2014). The results of radiocarbon dating illustrate extremely well why it is not worth dating isolated charcoals, unless we are interested in learning more about the period when the archaeological layer was contaminated.

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The Mesolithic settlement and economy in the Lake Gościąż area

Abstract

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Lake Gościąż is located in a Gostinińskie Lake District (Central Poland). It contains long and good preserved continuous sequence of the annually laminated lake sediments spanning from the end of the last glaciation to contemporary times. They offer unique opportunities for investigating changes in the environment and human activity in the vicinity of the lakes. This paper is focused on correlation of palynological indicators of activity of the Mesolithic people with the picture of settlement in the region. Another problem discussed there question of reliability of palynological data, and therefore their usefulness for studies on settlement and economy.

Key words: annually laminated lake sediments, palynology, Mesolithic, Gościąż lake, environmental changes,

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Introduction

Annually laminated lake sediments offer unique opportunities for investigating changes in the environment and human activity in the vicinity of lakes. The Gostynin Lake District stands out in this respect, with two lake complexes in its northern part having well-preserved annually laminated bottom sediments. The first complex is known as Na Jazach, with Lake Gościąż being the largest. Sediments at its bottom form a continuous laminated sequence spanning from the end of the last glaciation to contemporary times. It should be emphasized that the absolute chronology diagram was developed on the basis of ^{14}C dates made for over 250 samples. The calendar age has been obtained by a calibration based on dendrochronological analyses of pine and oak wood (Ralska-Jasiewiczowa *et al.* 1998, Table A.1).

The sediments and the environment around Lake Gościąż were investigated by a large international and interdisciplinary research team (Ralska-Jasiewiczowa and van Geel 1992; Ralska-Jasiewiczowa *et al.* 1998). The results provided inspiration for undertaking regular archaeological research in the vicinity of Gościąż (Pelisiak and Rybicka 1993; 1998a; 1998b; 1998c; 2005; 2006a; 2006b; 2008a; 2008b; Pelisiak *et al.* 1994; 2006; 2007; 2009). A second lake complex where annually laminated bottom sediments have survived comprises the Białe and Lucieńskie lakes. Here as well, bottom sediments were studied and archaeological research was carried out in the surroundings of the two lakes (Ralska-Jasiewiczowa 2012). The two complexes lie approx. 10 km from each other. The Na Jazach Lakes are surrounded by complexes of dunes and various sands, an environment that offered limited opportunities for early farming communities (Kruk 1980), while archaeological materials indicative of hunter-gatherer activity are relatively abundant there (Pelisiak *et al.* 2006; Pelisiak and Rybicka 2008b).

Archaeological data in the context of palynological data

Among the objectives of the archaeological research undertaken around Lake Gościąż was the correlation of palynological indicators of prehistoric human activity with the picture of settlement in the region (Pelisiak *et al.* 2006). One issue that always emerges in any discussion on human activity recorded in palynological diagrams is the question of the reliability of palynological data, and therefore their usefulness for studies on settlement and economy. These problems have long been present and addressed in studies concerned with various spheres of human activity, primarily in the context of distances over which pollens are transported in different floristic and landscape conditions (Iversen 1941; Tauber 1965; Kruk 1980; 1994; Jochimsen 1986; Valde-Nowak 1995).

They have also been comprehensively described in discussions of settlement and economy of Neolithic communities around both lake complexes (Pelsiak and Rybicka, in print), so we will not go into a more detailed presentation of these issues here. What is worth emphasising, however, is that the lay of the land around the lakes from which the palynological samples were collected, and the fact that the Mesolithic sites – and therefore the areas economically exploited by the hunter-gatherers – were situated close to the lakes (up to 5 km), provide grounds for concluding that the picture and processes captured in the pollen diagrams from sediments at the bottoms of these lakes are relevant to local (in the vicinity of Gościąż) changes in vegetation caused by these communities (Pelisiak and Rybicka 2008b). It should be noted that the presence of charcoal dust in layers containing pollens of plants regarded as indicators of human activity provides important supplementation to the palynological record of the life of Mesolithic people (Pelisiak *et al.* 2006). According to Latałowa (1994, 144–146), apart from when hunting and in camps, Mesolithic communities also gradually learned to use fire to actively manage forests by creating more open spaces favourable for animals feeding on grass or leaves and the shoots of young trees. This kind of activity left traces in the environment and can be identified in palynological diagrams. Plant indicators in the diagrams not only make it possible to confirm the presence of Mesolithic people, but also to determine the nature of their activity. It is worth noting that although examples of interference of Mesolithic people in the environment have been recorded in Poland on the southern Baltic coast (Latałowa 1994) and in Miłkowskie Lake (Wacnik 2005), those from Lake Gościąż are particularly well-dated. Summing up, the high-resolution pollen diagrams from Gościąż should be seen as a fully credible source of information on environmental transformations caused by prehistoric communities.

Gostynin Lake District. Palynological evidence

The earliest traces of human activity around Lake Gościąż were recorded in lamina dated to 7350–6400 BP (6100–5330 BC) and 6200–5770 BP (5145–4550 BC), described as phases 1 and 2 of the anthropogenic disturbances of the natural environment (Fig. 1; Ralska-Jasiewiczowa and van Geel 1998, 269–270; Pelisiak *et al.* 2006). Phase 1 manifests itself in pine forests by the increase in pollens of *Pteridium aquilinum*, *Calluna vulgaris*, and *Rumex acetosella*. In wet alder forests, the changes can be seen, among others, in the presence of *Humulus lupulus*, *Urtica dioica*, *Valeriana*, and *Filipendula*, and plants regarded as characteristic of wet meadows, like *Rumex acetosella*, *Lythrum*, and *Sanguisorba officinalis*. In addition, pollens of *Artemisia*, *Chenopodiaceae*, and *Sambucus nigra* were identified, which are ruderal plants. Maximum values of *Pteridium* pollens are indicative of regular forest fires, as this species grows best in ash-fertilised soils (Zarzycki *et al.* 2002).

Between phases 1 and 2, indicators of anthropological transformations become less evident or disappear. The beginning of phase 2 is marked by increases in the frequencies of pollens belonging to birch (*Betula*), aspen (*Populus tremula*), and alder (*Alnus*). In addition, pollens of several species marking human activity during phase 1 were also identified in phase 2. The diversity of bushes (*Taxus baccata, Cornus sanguinea*) increases, as do the shares of *Pteridium aquilinum* and *Urtica dioica*. Their presence, along with the presence of pollens of *Plantago media*, *Pulsatilla*, and *Anthericum*, points to openings in pine forests. The regularity of fires observed in that period testifies to their anthropogenic nature (Pelisiak *et al.* 2006, 15). The activity of hunter-gatherer populations is also responsible for the next phase of anthropogenic disturbances around Lake Gościąż, dated to 4460–4300 BC, which chronologically corresponds to the Brześć Kujawski group of the Lengyel culture (Czerniak 1994) from the Kuyavia region neighbouring the Gostynin Lake District to the west. Previously, that phase was correlated with Neolithic communities, but archaeological research has revealed no farming-herding communities of that age in the Gostynin Lake District (Pelisiak and Rybicka 1998b; Rybicka 2004). Changes in plant assemblages

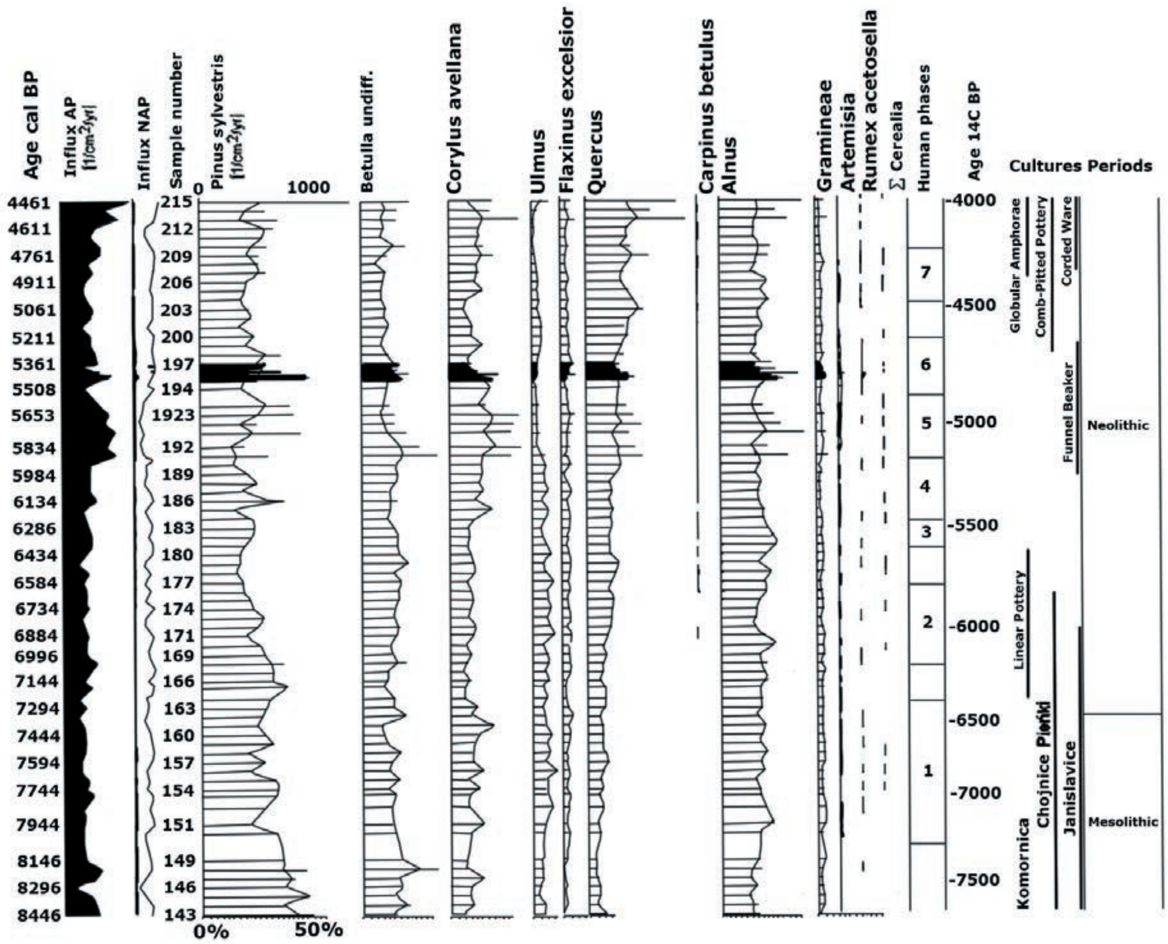

Fig. 1. Lake Gościąż, Kujawsko-Pomorskie voivodship. Pollen diagram referring to the period 7500–4000 BP (after Pelisiak *et al.* 2006, fig. 9)

are evidenced by pollens of *Pteridium aquilinum*, *Urtica dioica*, and the first appearance of *Plantago lanceolate*, indicative of more open forests.

With respect to Lake Białe (which also preserved laminated sediments) and the Gąsak peat-bog, the earliest traces of fires, manifesting themselves by the accumulation of charcoal dust, are not unambiguously parallel to those recorded in Gościąż (Pelisiak *et al.* 2006; Wacnik and Rybicka 2012). The first disturbances of plant assemblages in the diagram from Lake Białe can be dated to around 6059–4540 BC, while traces of fires appear around 6340 BC (Wacnik and Rybicka 2012, 172). During that phase, the proportion of *Quercus* increased in forests, with *Populus* and *Frangula alnus* also present. Around 5890/5790 drops in *Betula*, *Corylus*, and *Ulmus* were recorded, while *Pteridium*, *Artemisia*, and *Poaceae* appeared in deforested areas. *Pteridium* and *Calluna* develop well in recently burned sites (Wacnik and Rybicka 2012, 172). Between 4380 and 3930 BC, the disturbances became less marked, as reflected by the smaller concentrations of charcoal dust and an increase in the proportion of hazel, which filled open spaces within forests. In the diagram from fossil Lake Gąsak, the first phase of human activity falls to a period of 7270–7140 BC, when the proportions of charcoal dust, *Calluna*, and photophilic plants (*Artemisia*, *Rumex acetosa*, *Valeriana*) all noted increases. At the early stages of phase 2, dated to 6520–5630 BC, short-term drops are observed in *Ulmus*, *Corylus*, and *Alnus*, accompanied by fluctuation of *Betula* and a considerable share of *Pinus silvestris*. The share of herbaceous plants (*Chenopodiaceae*, *Urtica*, *Rumex acetosa*) increased in that period, as also did those of charcoal dust and *Pteridium*. This is interpreted as indicating the opening of forests as a result of the infiltration of the region by hunter-gatherers, causing short-term and small-size disturbances of the natural environment. The period of 5500–4740 BC saw the regeneration of forests, while in phase 3 (4600–4380 BC) the evidence for anthropogenic disturbances became more pronounced, including the indicators of fires (charcoal dust, *Pteridium*, *Calluna*, *Melampyrum*) and meadow plants (*Rumex acetosa*, *Plantago media*, *Chenopodiaceae*). Until 3850 BC, changes in forest cover were localised and short-term.

Archaeological evidence

The area around Lake Gościąż is covered with forest, which poses an obstacle to performing archaeological research. 14 sites linked with the Mesolithic period were discovered within a radius of 5 km (Fig. 2), many of them at the margin of the Na Jazach lake complex, like camps at Gościąż sites 8, 11–12 situated on the shore of Lake Gościąż. In the vicinity of Gościąż, of particular importance is a complex of camps at Wistka Szlachecka (Schild *et al.* 1975), representing two techno-typological inventories; one reflects exploitation of single-platform blade cores, and the other has less regular blades and is attributable to the Janisławice culture (Schild *et al.* 1975; Pelisiak and Rybicka 2008b, 26–28). Such characteristics were also recorded in assemblages retrieved from sites in the immediate vicinity of Lake Gościąż. Their chronology cannot be precisely determined, and they can only be placed within the broad chronological frameworks of cultural units they represent (Pelisiak and Rybicka 2008b, 26–28; Kozłowski and Nowak 2019, 261–262). This makes it impossible to identify the camps whose inhabitants were responsible for the particular disturbances in floral assemblages.

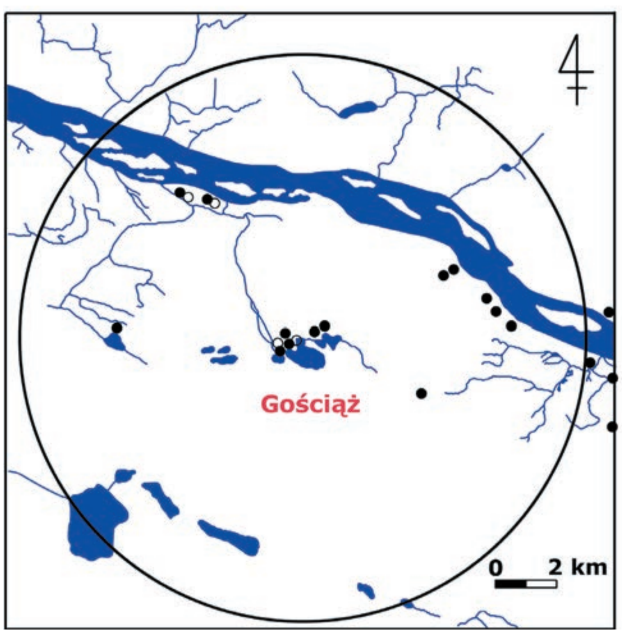

Fig. 2. Location of Mesolithic sites in the vicinity of Lake Gościąż (Pelisiak *et al.* 2006, fig. 5).

Numerous traces of Mesolithic occupation were identified around Lake Białe and fossil Lake Gąsak as well (Figs 3–4). At least 20 such traces were found in the vicinity of the palynological site of Białe (Rybicka 2012, 77), including at least nine camps. Materials from the excavated Neolithic settlements at Klusk Biały, site 7 and Lucień, site 12 (Gowin and Rybicka 2003), both within a radius of 1 km from the place where the profile was collected, included abundant collections of flint artefacts linkable with the Mesolithic. Eight traces of occupation of the same age were identified near fossil Lake Gąsak as well, including what were probably places of short-term economic activity at Krzywie (Rybicka 2012, 77). However, the chronology of Mesolithic camps uncovered in the vicinity of these palynological sites cannot be determined with more precision at the current stage of research.

Conclusions

The high resolution of the annually laminated lake sediments offers unique opportunities for the precise dating of environmental disturbances recorded in the palynological material and in the sediment itself (Pelisiak *et al.* 2006). The dating precision of the order of one or a few years allows for phasing and identification of short periods of increased human activity, of periods when this activity was less intense, and finally periods for which no indicators of human activity are present in the palynological material.

Communities of the LBK and the Brześć Kujawski group did not settle in the immediate vicinity of Lake Gościąż (Rybicka 2004; Pelisiak *et al.* 2006). The local environment was not suitable for the economic model, and therefore the occupation, of these communities (Kruk 1980). The closest Early Neolithic settlements are known from Kuyavia, at a distance of approx. 30 km in a straight line (Czerniak 1994). This fact is important for the proper identification of anthropogenic disturbances of the natural environment before the middle of the 5th millennium BC. They cannot be linked with the activity of Neolithic populations, and they can instead be unambiguously attributed to hunting-gathering populations who left numerous traces in the immediate surroundings of Gościąż, and sometimes even near the lake shore (Pelisiak and Rybicka 2008a; 2008b; Rybicka 2012).

Mesolithic activity reflected by changes in the natural environment discernible in pollen diagrams has been identified in earlier research as well. It is

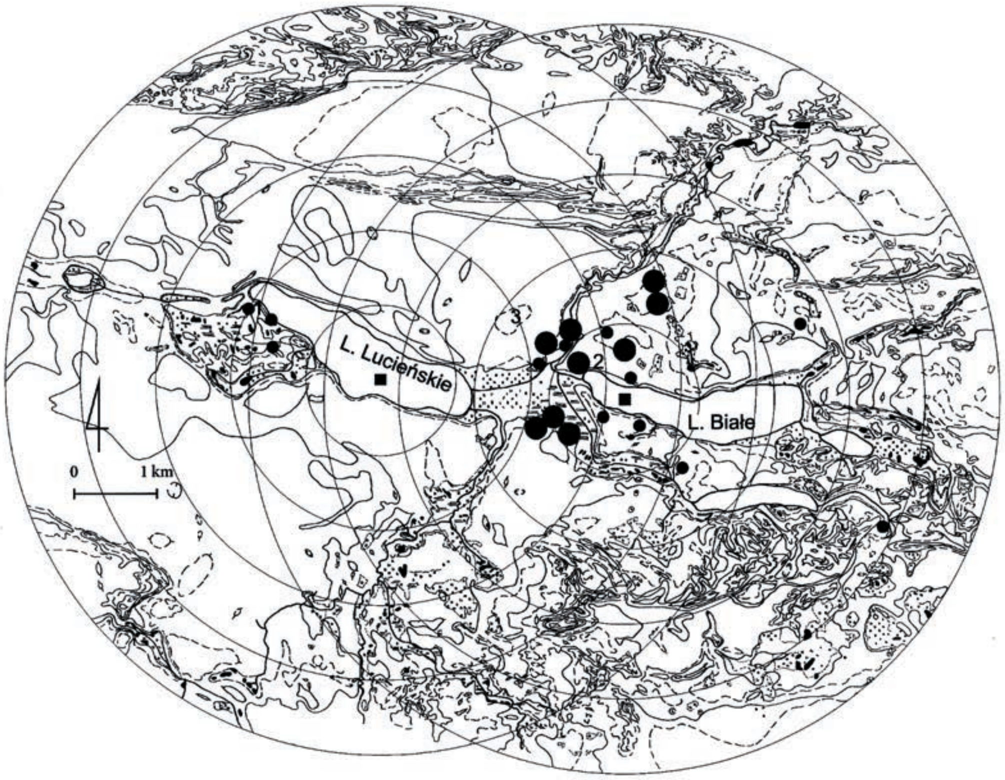

Fig 3. Location of Mesolithic sites in the vicinity of Lake Białe (after Rybicka 2012).

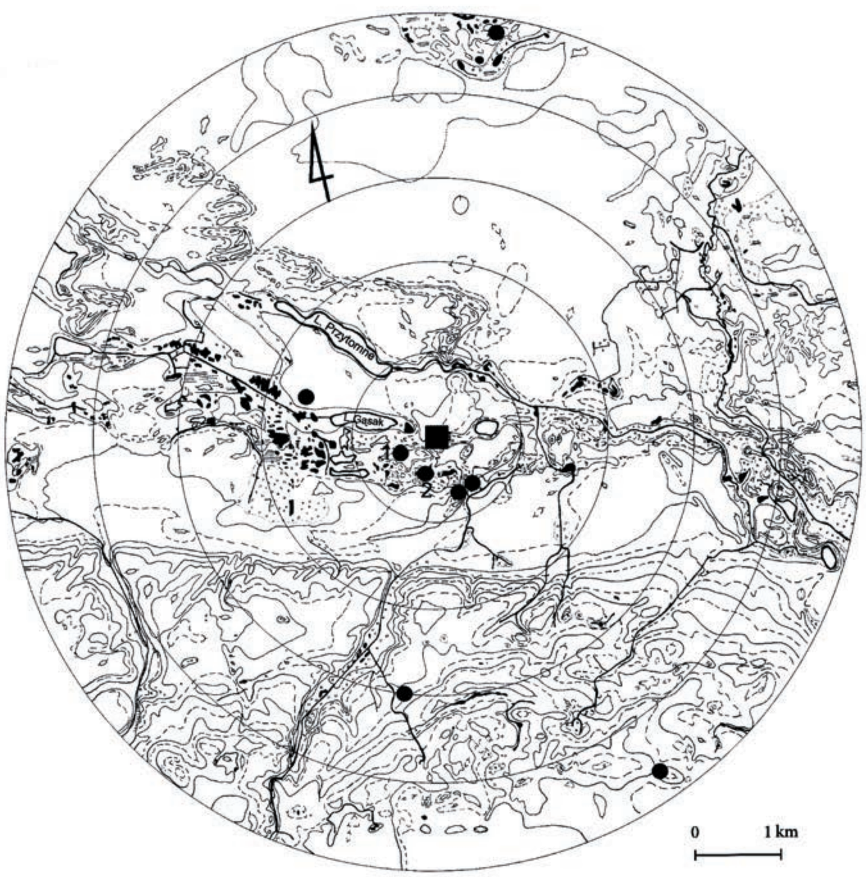

Fig 4. Location of Mesolithic sites in the vicinity of Lake Gąsak (after Rybicka 2012).

worth recalling important findings made in this respect in the British Isles (e.g. Hicks 1972; Innes and Simmonms 1988), Germany (e.g. Kloss 1987; 1990), and Poland (Latałowa 1992a; 1992b; 1994). It needs to be emphasised, however, that in the diagrams from Wolin (Latałowa 1992a; 1992b) the earliest phases of anthropogenic disturbances could be caused by Neolithic people whose settlements were located at distances ranging from a few up to a dozen or so kilometres from places where the palynological samples were collected. Such a potential blurring of the picture by Early Neolithic populations is very unlikely in the case of Gościąż. This allows us to regard Gościąż as a model example of a palynological record of the activity of hunting-gathering populations in the lowlands.

Analogical information concerning the activity of Mesolithic communities resulting in disturbances in plant assemblages were identified in the diagrams from Lake Białe and the Gąsak peat bog (Wacnik and Rybicka 2012). Camps used by Mesolithic groups were discovered in the vicinity of all these palynological sites, although the economic activity of their inhabitants cannot be precisely dated.

What the research presented here shows is that the described disturbances reflect the impact of Mesolithic groups inhabiting the close surroundings of the palynological sites, who often caused short-term disturbances in the natural environment without causing its permanent transformation.

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The first radiocarbon dates for the Globular Amphora culture cemetery in Sadowie in the Sandomierz Upland

Abstract

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The article presents new results of radiocarbon dating for the settlement of the Globular Amphora culture from the Sandomierz Upland area. These are three determinations obtained for animal graves (No. 4, 7 and 11) coming from the site 23 in Sadowie near Opatów, where traces of a vast cemetery were discovered. ^{14}C dating was established in the Poznań Radiocarbon Laboratory. The received values were verified by indicating diagnostic features in the composition of artefacts that are referenced in groups of other features of the Globular Amphora culture.

Keywords: Globular Amphora culture, Sandomierz Upland, radiocarbon dates

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Introduction

The chronology of the settlement of the Globular Amphora culture in the Sandomierz Upland has been the subject of scientific research since the 1960s. The issue related to periodization was discussed for the first time by Nosek in his monographic study of the discussed culture in the Lublin region, and then on the whole Polish lands (1954/55; 1967). Moreover, Wiślański also presented his remarks on the chronology presenting the studies on the Globular Amphora culture in north-western Poland (1966). At the beginning of the 1990s, Ścibior and Ścibior (1990; 1991) joined the discussion, while organizing information about the Globular Amphora culture in the Sandomierz Upland with reference to the studies of single funerary complexes. A little later, some determinations were obtained to establish the absolute chronology of the society of the Globular Amphora culture in the neighbouring areas (Kadrow and Szmyt 1996). At present, a serious barrier for the studies on the chronology of the Globular Amphora culture in the Sandomierz Upland is a small series of absolute dates, which would allow the presentation of a chronological framework and identification of the stages of development. There are also no undisturbed deposits that could be valuable in the analysis of relative chronology. To date, there is only one, clear ^{14}C designation which has been obtained for the site 78 in Sandomierz (Ścibior and Ścibior 1990, 192).

During recent research on the newly discovered cemetery in Sadowie near Opatów, a series of absolute determinations were obtained for the late Neolithic graves. Three of them relate to graves No. 4, 7 and 11 which contain the animal remains of the Globular Amphora culture. The aim of this article is to publish the obtained ^{14}C dates and verify them in terms of the relative chronology.

Characteristics of the site

The archaeological site 23 is located on a plateau of one of the prominences of the Sandomierz Upland (height, 280 m above sea level; height difference 30 m; Kondracki 2002, 277–278), strongly separated from the surroundings and topographically exposed in the area (Fig. 1). From the south, it passes into a series

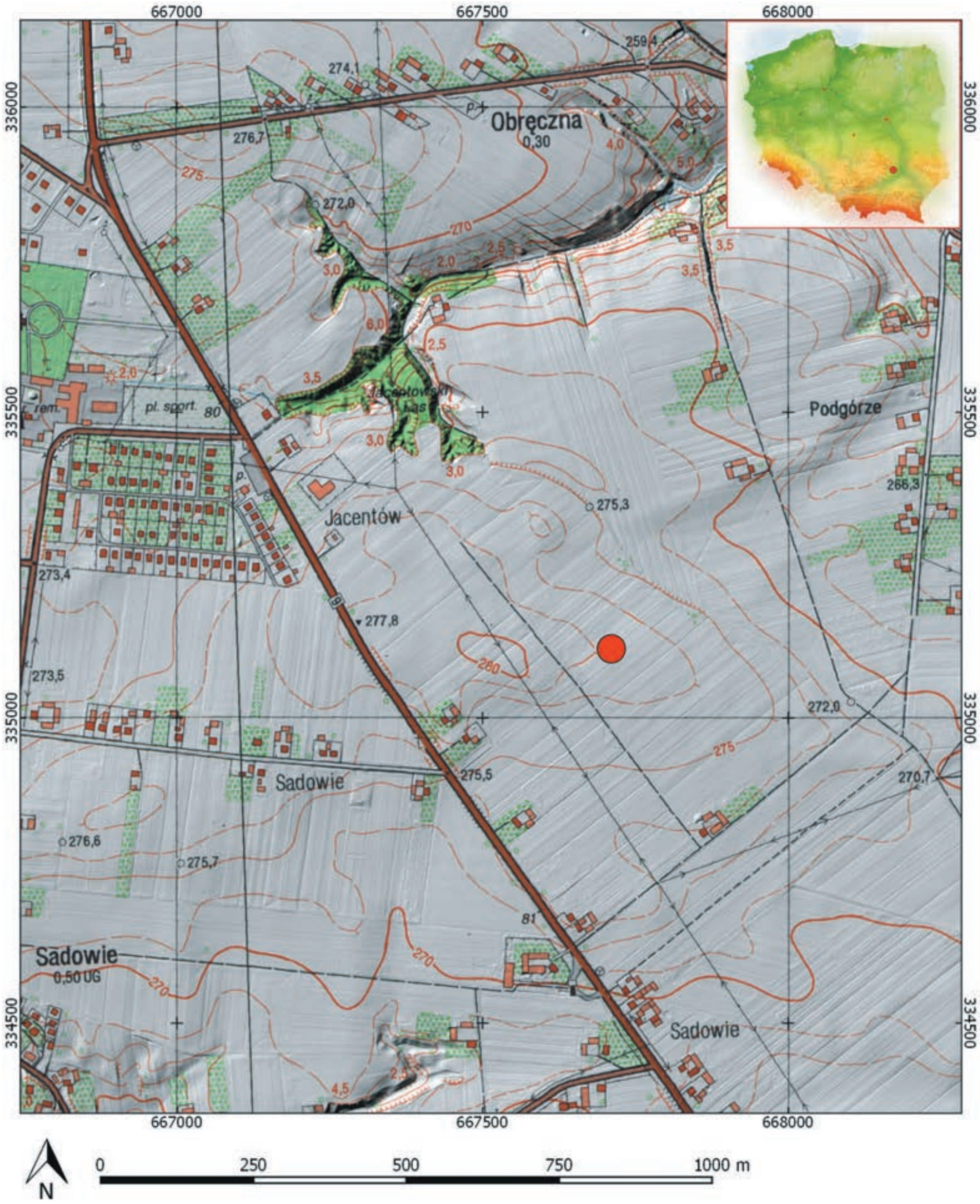

Fig. 1. Location of the site No. 23 in Sadowie, Opatów dist. (marked as a red point) on the background of the shaded terrain model and the 1: 10 000 map (prepared by M. Mackiewicz and B. Myślecki).

of flat and fragmented hills located at an altitude of about 250-220 m above sea level, drained by tributaries of the Przepaść stream (also known as Trębanówka or Obręczówka), located in the catchment of the Kamienna River. The part of the hill on the north-west side lowers with terraced slopes towards the Kamionka River. With reference to geomorphology, it is an area of a loess accumulation plain, developed during the Middle-Polish and North-Polish glaciations (Czarnecki 1996; Romanek 1994, 5-8). The surface of the area is heavily cut by deep gullies, often reaching below the hydro-glacial and glacial deposits, before the Quaternary (Dowgiałło 1974, 40). The hydrographic network is most developed in the north-eastern part of the area around the site in Sadowie. The main rivers in the discussed area are the Opatówka, Kamienna and Kamionka, which drain water from the Jeleniowski Range to the south-east.

The soils in the site and its hinterland are relatively slightly diversified. Chernozem or brown soils predominate in the plateau zone, while deluvial and alluvial soils are common in the valleys. Their bedrock is mainly loess from the Vistula glaciation period and late Pleistocene sands, loams and silts (Romanek 1991). At present, these areas are heavily eroded and this is related to the intensive, destructive slope processes as well as agricultural mechanization that mainly covers the plateau zones (see i.e. Mroczek 2018, 43-53; Pasieczna 2006). The soil profiles at the site are characterized by a high degree of disturbance by the leaching of calcium carbonate into the topsoil, subsoil and transitional levels up to the bedrock (up to a depth of almost 100 cm). Moreover, the area of cultivated fields is often subjected to chemical fertilization and plant protection products, which have a large impact on the state of preservation of the discovered material remains, mainly bone remains.

The cemetery is located within the archaeological site No. 23, discovered by M. Florek in 1996 and it has been known so far from the finds of ceramic materials typical of the Funnel Beaker culture. Since 2015, archaeological excavations have been carried there, during which two trenches with a total area of over 13 ares were established. It resulted in the discovery of a total of 25 Late Neolithic graves. Twenty-three of them belonged to the Globular Amphora culture, and the other two can be associated with the Złota culture (Fig. 2). The extent of the cemetery, with reference to the results of geomagnetic research, is about 20-25 ares and it covers a triangular-shaped space with a base length of about 70 m and a height of about 50 m (Mackiewicz *et al.* 2016). In addition to the Late Neolithic burials, two settlement pits, dated to the Early Bronze Age were discovered in the studied part of the site (most likely the Mierzanowice culture) as well as a communication trench from the Second World War. Apart from that, single culturally undefined features have also been uncovered.

The graves of the Globular Amphora culture that were discovered and examined in Sadowie included human and animal burials, both skeletal and cremation ones. They differed in shape, type of fill, type of stone structures and material remains. Human graves (total number 7) were burials in pits with additional construction elements, such as paving, stone cists or kerbs (Pasterkiewicz 2017, 283). Their interiors included collective human remains, as well as secondary deposited skeletons, often with missing bones or having been mixed up following ritual procedures. One of the unique discoveries has been made in the grave No. 10, which had the character of a "house for the dead" or might have been the remains of a funeral pyre. Animal burials (15 cases in total) were found most often in elongated pits with a rectangular outline. The arrangements of the skeletons were varied e.g., crouched position, antipodal, or only deposited fragments of animals. Burials included elements of stone structures in the form of paving or individual stone blocks around some pits. The equipment found in graves, both human and animal, consisted mainly of vessels, often incomplete, affiliated to the Globular Amphora culture, flint artefacts such as punches and axes, and amber ornaments. In addition, a significant number of flint preforms were found and individual, badly damaged bone items (wild boar or pig's tusks). The layout of the discovered graves in the cemetery in Sadowie is arranged in certain regularities. There were animal graves in the vicinity of the human graves, containing individuals of different ages and species, ranging from one to three individuals. As for the uncovered area of the cemetery there were six such groups, arranged along the east-west (graves No. 1-2, 3-5), north-west-south-east (graves No. 7, 8?; 9, 10; 22, 11-13; 20-21; 19, 18 A, B, C) and north-south lines (No. 14 and 15; Pasterkiewicz 2017, 285). According to observations and analysis performed in other cemeteries, it can be assumed that the graves included in such clusters were simultaneous (e.g. Złota, Sandomierz dist., site "Gajowizna"; Krzak 1977, 66-67; Koszyce, Proszowice dist., site 3; Włodarczak and Przybyła 2013, 223). Due to the location of the cemetery in Sadowie, it can be included in the Kielce group of the Globular Amphora culture according to Nosek (1967, 340-346) or the Małopolska group included in the Polish group according to Wislański's suggestions (1966, 88, 89). With reference to Włodarczak and Przybyła, this area is defined as the local Sandomierz-Opatów group (Włodarczak and Przybyła 2013, 233). Site No. 23 is also located within one of the largest clusters of settlement points of this culture, located in the loess of the Sandomierz Upland (Ścibior 1991, 57; Kowalewska-Marszałek 2019, 127–130).

In 2019, four samples from three animal burials - No. 4, 7 and 11 - were selected for research to perform in the Poznań Radiocarbon Laboratory. Establishing the radiocarbon dating was financed by the Institute of Archeology of the University of Rzeszów, for which I would like to express my sincere thanks to the Director at that time – dr hab. prof. UR A. Rozwałka. In the course of selecting them, some aspects were taken into account such as the burials containing well-preserved and complete bone remains as well as their location, i.e. their location in one of the grave clusters. They could help to trace the spatial development of the cemetery and to establish chronological relations between the various groups of graves. When qualifying, the presence of material remains with diagnostic features was also important, so that the results of dating could be confronted with stylistic analysis.

Fig. 2. Sadowie, Opatów dist., site 23. Plan of excavations, discovered features, their chronology and location of the graves determined by radiocarbon dating.

Description of the dated graves

Grave No. 4

At a depth of 30 cm from the ground level, the grave presented an oval-shaped outline with dimensions of 2.45 × 1.1 m, oriented with its longer axis in the north-west – south-east direction (Fig. 3: A). In its cross-section, it was rectangular in shape with a flat bottom, reaching up to 30 cm deep (Fig. 3: C). Its fill was homogeneous, consisting of layers of ordinary brown dust. Inside the burial pit there was a burial made up of at least three skeletons and possibly fragments of animals (Fig. 3: B). The bone material from the described graves was subjected to archaeozoological identification by Dr M. Zabilska-Kunek. The central part included the remains of large cattle (No. 1), which consisted of the pelvic bone, vertebrae, mandible, fragments of the scapula and long bones. A little further to the east, there was a poorly preserved skeleton of a pig, most likely deposited on its left side (No. 3). More towards the eastern corner, there were bones belonging to another, smaller individual of cattle (No. 2): fragments of the mandible, skull, single vertebrae and scapula, and a few long bones. The remains of the animal were covered by blocks of stone, probably deposited in order to press the animal material. The grave inventory (an amphora) was located in the eastern part, in the vicinity to the skull of cattle No. 2 and it was broken, with its fragments scattered inside the grave.

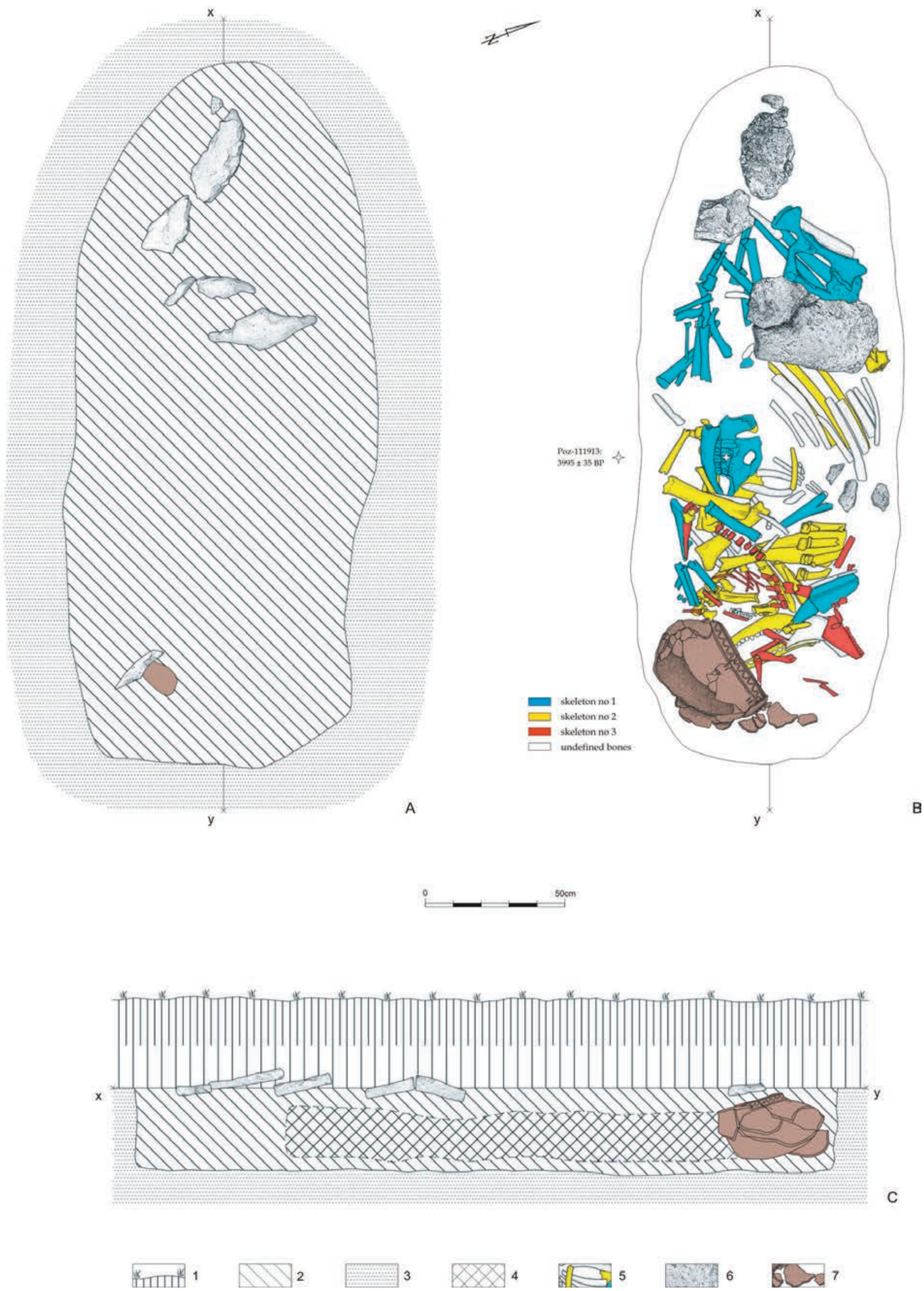

Fig. 3. Sadowie, Opatów dist., site 23. Documentation of the animal grave No. 4: A – plan view, profile of the burial pit, location of animal skeletons and inventory. The figure shows the ^{14}C date from the sample collected in the indicated place. Legend: 1 – surface layer; 2 – brown fills of feature; 3 – loess subsoil; 4, 5 – bone remains; 6 – stone; 7 – pottery vessel (drawn by A. Bardetsky)

Artefacts:

1) a pottery vessel – a large amphora (mass find No. 150/2019; Fig. 4) referring to the shape of the belly to some forms of vases and wide-mouth vessels type VII B1 according to the division of Wiślański (1966, 31, 32, data sheet V) and the so-called „barrel-shaped amphorae" according to Nosek (1967, 296, 297, tabl. VI). With reference to the typological classification of Szmyt, it is similar to the type VBII1-21-2a-ca (1996a, 31). The amphora has a low, straight neck with a narrow, slightly rounded rim, provided with six symmetrically arranged vertical handles in a cylindrical shape. Below the rim and partially in the upper part of the belly, there is a decoration made with the cord impressions in the form of a double wavy line underlined at the top and at the bottom by a similar impression in a horizontal, triple arrangement. The belly is strongly defined, descending conically towards a small base. The base is ill-defined, finished with a low foot. The clay paste has a high content of medium and large-grained grog admixture and a small amount of whitish stone grains. The surfaces of the vessel walls are carefully smoothed, have a uniform, brown colour, and only in the bottom part there are slightly darker spots. In addition, there are traces of brushing with grass or straw on the outer and inner surfaces. The firing of the vessel is good, uniform, the fracture is compact, and the surfaces are hard. Weight: 3578 g. Dimensions: height – about 36 cm; rim diameter – 25.5 cm and 28.5 cm; neck height – 4.5 cm; the largest belly diameter – 35 cm; base diameter – 12.5–13 cm; wall thickness: below the rim – 5 mm; in the middle part of the belly – 5.3–6.5 mm; above the base – 6–7 mm; base thickness – 10–13 mm.

The amphora from grave No. 4 does not have many analogies in the complexes of Globular Am-

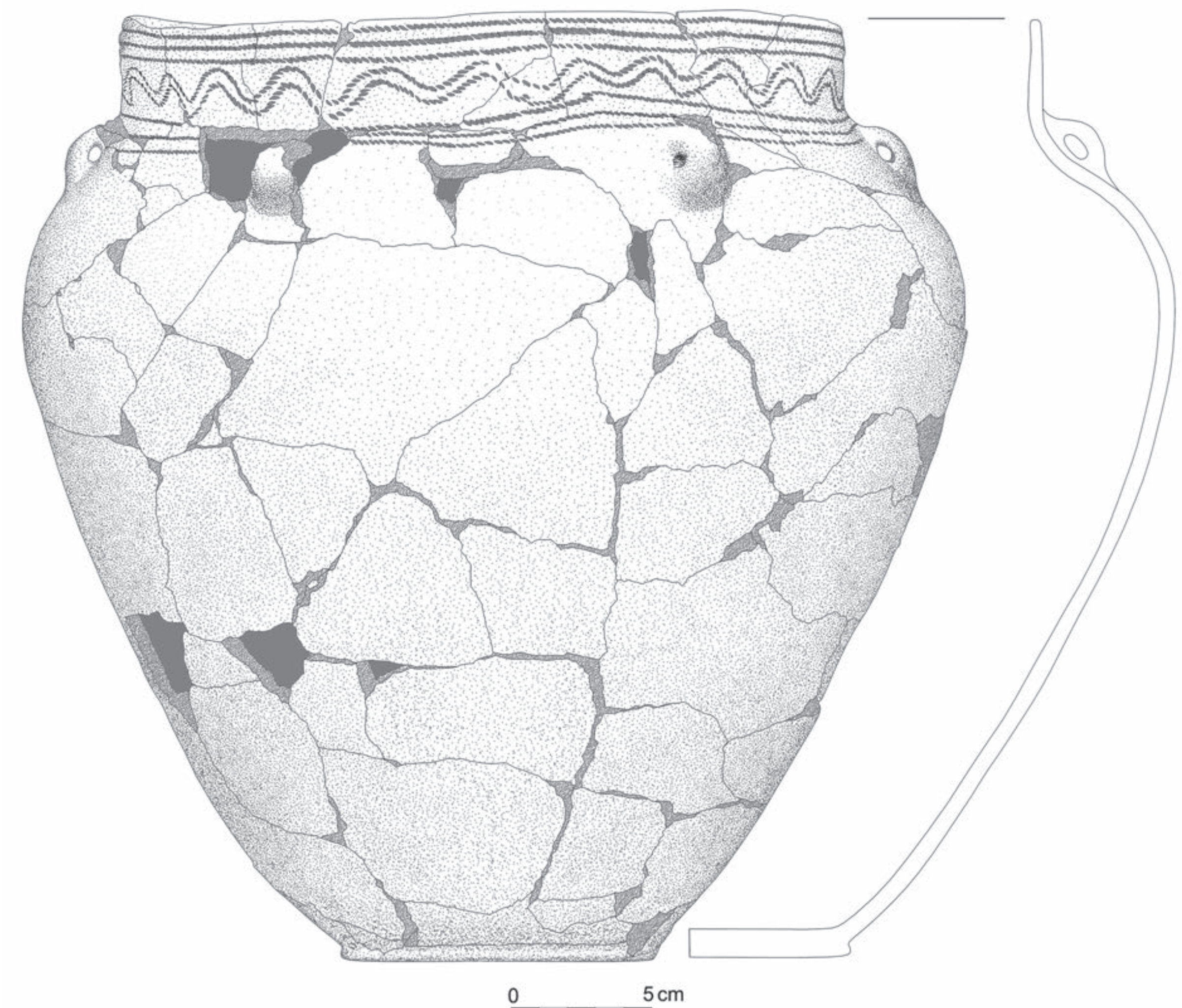

Fig. 4. Sadowie, Opatów dist., site 23. A pottery vessel – an amphora from the inventory of the grave No. 4 (drawn by A. Bardetsky).

phora culture from different settlement zones. A close counterpart in terms of form is known only from Złota – „Gajowizna", from an undetermined part of the site (Krzak 1977, 58, fig. 75). Contrary to the vessel from grave No. 4, it is an undecorated amphora.

Morphologically, similar items can also be identified in places quite distant from the Vistula basin. It includes, for example, a vessel from the settlement in Persopnica, on the Stubla river (Shelomentsev-Terskiy 1996, fig 3: 6), for which we have a radiocarbon determination 3910±50 BP (Kadrow, Szmyt 1996, tab. 1). However, unlike our discussed amphora, it does not have handles and is ornamented with finger imprints. A characteristic feature of the amphora from grave No. 4 is its ornamentation in the form of horizontal, multiplie and wavy cord impressions. Similar patterns of ornamentation can be found in the complexes from Mierzanowice, belonging to the younger stage of the Globular Amphora culture in the Sandomierz Upland. They are present, among others on the amphorae from pit No. 170c (Balcer 1963, tabl. III: 11) and in the vicinity of pit No. 194 (Balcer 1963, tabl. VII: 17). It is worth noting that the amphora from grave 4 resembles in shape (a wide belly with a highly located shoulder converging towards a small base) vessels from the Yamna culture inventories (e.g. Shmagliy and Chernyakov 1970). Relations of a broadly understood circle of the Yamna culture with the materials from the Globular Amphora culture were found in the area of the forest-steppe between the Prut and Dniester rivers. There are many burial sites with the Globular Amphora culture material from this area (e.g. Szmyt 1996b, 22–24; 1999, 107–108; 2001, 185–191, figs. 17–21).

Grave No. 7

At the level of discovery (30 cm from the ground surface), the grave presented an oval outline and dimensions of 2.1 × 1.5 m, with an orientation along the north-west – south-east axis (Fig. 5: A). In its cross-section, it was characterized by a regular, rectangular shape with a flat bottom reaching up to 43 cm (Fig. 5: C). At the bottom, at a depth of 30 cm, in the north-west part of the grave, there was an animal burial (No. 1), most likely a cattle one, secondarily damaged, with some bone missing (Fig. 5: B). The arrangement of the preserved fragments of the skull and vertebrae indicates that the individual was originally placed on its side, with its head facing north-west. There was also a trace of a trench made for ritual or robbery purposes. In addition, the burial included single fragments of two damaged vessels (Figs. 6: 2, 3) and a flint lump (the initial form of an axe?; Fig. 7) in its fill. Another burial (No. 2) was registered in the south-eastern part, under a large stone block. These were the bones of the front limbs and torso of cattle, lying in a crouched position on their side, with the head facing the south-east. Above the head bones was a pottery vessel of the Globular Amphora culture – an amphora decorated with imprints of a vertical stamp and a zigzag (Fig. 6: 1).

Artefacts:

1) a pottery vessel – a small, asymmetrical, amphora (mass find No. 472/2016; Fig. 6: 1) similar to forms of type IIA1 according to Wiślański (1966, 28, 29, data sheet II) and the so-called „amphora of the Kuyavian type" in Nosek's terms (1967, 292–295, tabl. III–IV). In the classification made by Szmyt, it can be classified as type VBIII1-21-2b-cb (1996a, 31). The amphora has four tunnelled handles, located at the bottom of a well-defined neck, at the transition to the belly. The edge of the rim has a clearly marked overhang. On the neck and in the area between the handles, there is an ornament in the form of band arrangements of a row of vertical stamp impressions, underlined by circumferential horizontal rows of zigzag impressions. The belly is strongly defined, the base is slightly separated in the form of a small foot. With reference to the clay paste, it contains a large amount of medium and coarse-grained grog with whitish coarse-grained sand. The surfaces of the walls are smooth, have a uniform, orange colour and darker, brown spots in some places. The pottery firing is quite good, the fracture is compact, and the surfaces are medium-hard. Weight: 1322 g. Dimensions: height – about 20 cm; rim diameter – 11.5–12 cm; neck height – 4 cm; the largest belly diameter – 23 cm; base diameter – 9–9.5 cm; wall thickness – near the rim 4–5 mm; in the middle part of the belly – 5.5–6.5 mm; above the base – 6–7 mm; base thickness – 10–11 mm.
2) the lower part of a medium-sized vessel (amphora?), graphically reconstructed (22 fragments- mass find Nos. 462, 463, 465–468, 470, 471/2016; Fig. 6: 2). It has a spherical belly and a weakly separated base. No decorations were found on the preserved fragments of the vessel. The clay paste contains an admixture of stone of a whitish colour and various grains. The surfaces of the walls are smooth, slightly shiny, have a uniform black colour and in some places lighter, dark grey spots. An inner surface has traces of brushing with grass or straw. The firing of the vessel is quite good, the fracture is compact, and the surfaces are quite hard. Weight: 383 g. Dimensions: the largest belly diameter – about 25 cm;

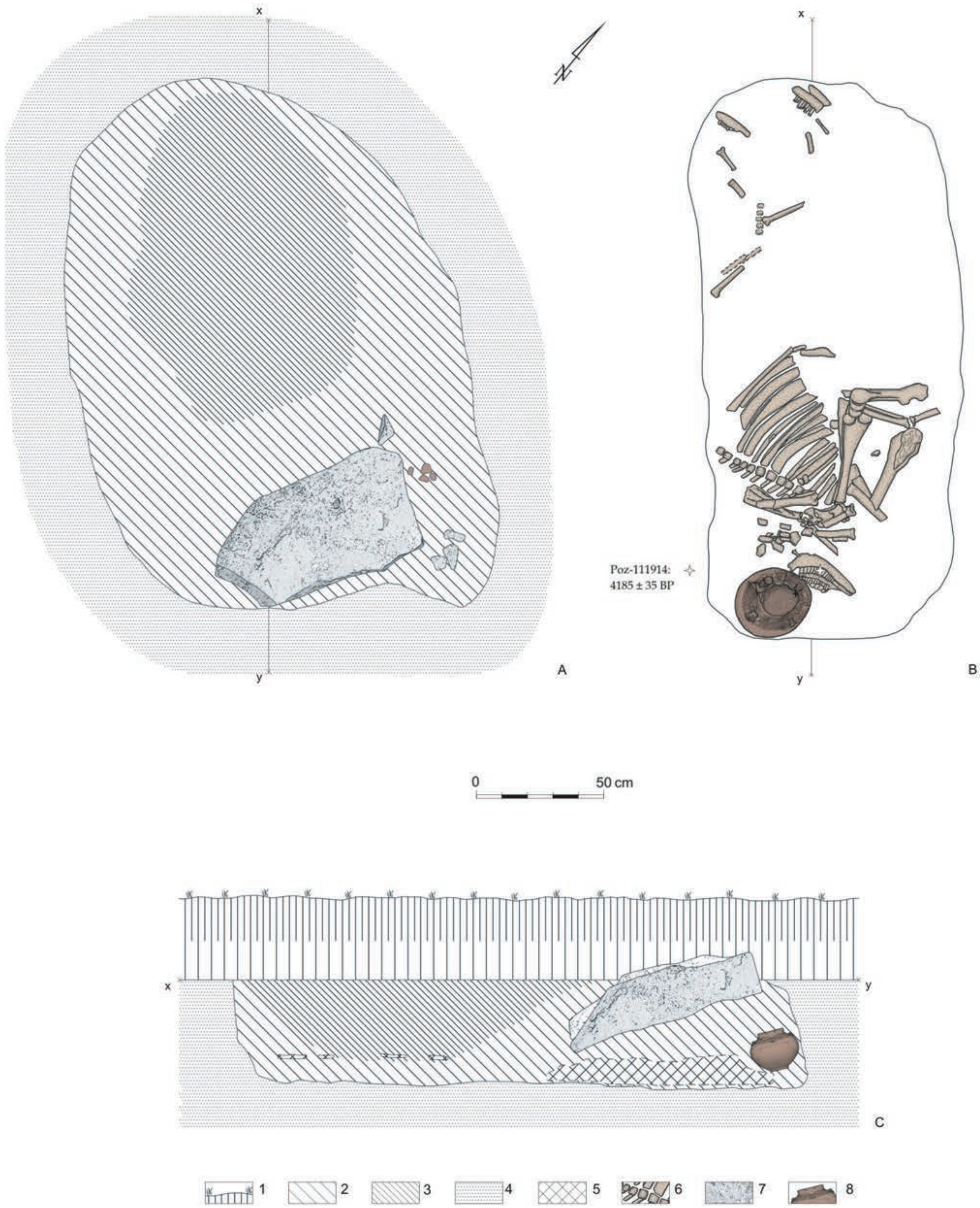

Fig. 5. Sadowie, Opatów dist., site 23. Documentation of the animal grave No. 7: A – plan view, profile of the burial pit, location of animal skeletons and inventory. The figure shows the ^{14}C date from the sample collected in the indicated place. Legend: 1 – surface layer; 2 – brown fills of feature; 3 – dark grey fills of feature; 4 – loess subsoil; 5, 6 – bone remains; 7 – stone; 8 – pottery vessel (drawn by A. Bardetsky).

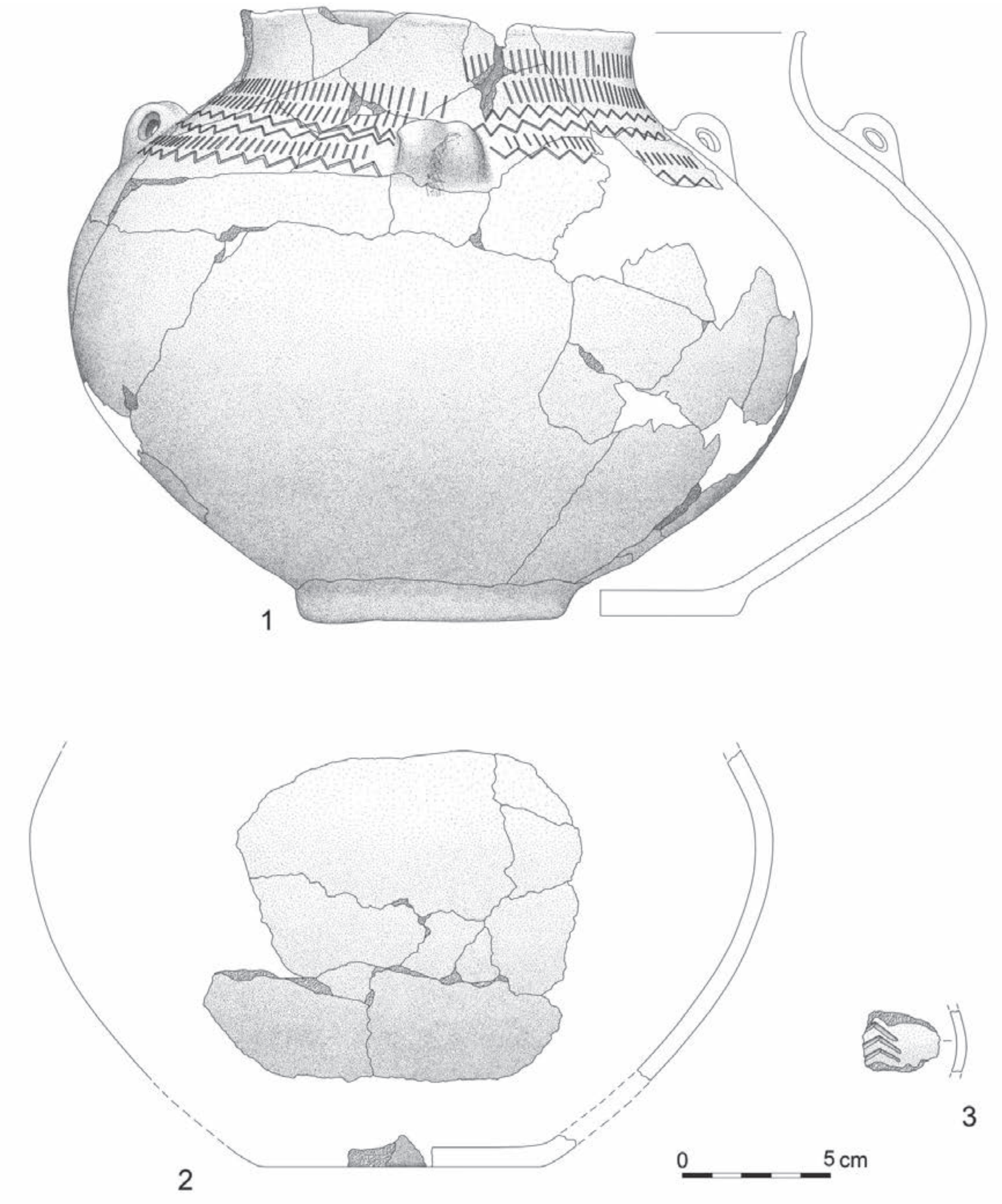

Fig. 6. Sadowie, Opatów dist., site 23. Pottery from the grave inventory No. 7 (drawn by A. Bardetsky).

base diameter – 9–9.5 cm; wall thickness – 5 mm in the place of the largest belly diameter; above the base – 6 mm; base thickness – 7 mm.

3) small pottery sherds, including one item decorated with the impressions of a rectangular stamp in the form of a vertical herringbone (mass find Nos. 462, 464, 469/2016; Fig. 6: 3). The clay paste contains a large content of medium and large-grained, sharp-edged stone admixture, whitish in colour. The surfaces of the walls are carefully smoothed, have a grey colour from the outside and inside surfaces, and grey-brown fractures. Weight: 7 g. Dimensions: thickness of the walls: 3–4 mm.
4) 1 flint lump with traces of knapping (most likely the initial form of an axe; registered find No. 32/2016; Fig. 7). Cortex visible on one side. Striped flint. Dimensions: length – 95 mm, width in the middle: 59 mm, thickness in the middle – 31 mm.

With reference to the items that can be dated from the inventory of grave No. 7, it is necessary to mention

Fig. 7. Sadowie, Opatów dist., site 23. A flint artefact from the grave No. 7 (photo by author).

the „Kujavian-type amphora" decorated with stamp impressions and zigzag, with four handles. As for the form, it is a typical vessel for the ceramic artefacts of the Globular Amphora culture (e.g. Wiślański 1966, 28, 29, data sheet II; Nosek 1967, 292–295, tabl. III, IV; Szmyt 1996a, 31; 1999, 23, fig. 4). The amphora has numerous references to the burial complexes of the discussed culture from the Lublin Upland, including radiocarbon-dated inventories. It is worth mentioning a vessel from a grave in Świerszczów, Hrubieszów dist., site 5 (Ścibior *et al.* 1991, 82, figs. 3: g, f) for which ^{14}C dating: 4170±35 BP was obtained (Kadrow and Szmyt 1996, tab. 1). Good analogies can also be found in terms of form and decoration in Trzeszkowice, Świdnik dist., site 14 discovered among the grave goods in the burial (Polańska 2016, 36, fig. 3: 3). The age of the grave was determined by the date ^{14}C: 4170±35 BP as a result of bone analysis (Polańska 2016, 42). This vessel also has analogies in many places of the Globular Amphora culture in the basin of the upper Vistula, including the Sandomierz Upland. In terms of style, similar forms are known from the settlement in Mierzanowice, site 1 among the pottery inventory from pit No. 211 (Balcer 1963, tabl. IX: 3, 19) and from Złota – "Gajowizna" (Krzak 1977, 34, fig. 42).

Grave No.11

At the level of discovery, only 20 cm above the ground, a regular, rectangular outline with rounded corners and orientation along the north-west-south-east axis has been discovered (Fig. 8: A). Its overall dimensions were 2.6 × 1.2 m. In its vertical section, the grave had a regular, rectangular shape with an uneven, slightly concave bottom, reaching 37 cm (Fig. 8: C). In the north-west side there was a stone paving, made of several large, irregular lumps of sandstone. From a depth of 15 cm to the bottom of the pit, there were the remains of an animal-cattle burial (so-called double burial) and some elements of grave goods (Fig. 8: B). The first skeleton lay in the eastern part of the grave, placed on the right side, the right forelimb was bent, the left one and the hind limbs were straightened, possibly due to postmortem concentration. A few vertebrae were missing in the thoracic part of the spinal column, indicating that the body of the cattle might have been cut in two before being deposited in the grave. In the western part of the pit, there was another cattle skeleton (No. 2; Fig. 8). The arrangement of the preserved bones indicates that it was placed on the left side, with the head facing east, towards skeleton No. 1. The limbs were slightly bent and leaned against the side walls of the grave. Between the skeletons, near the shoulder blades of the animals, pottery vessels were discovered inside the pit, i.e. a four-handled amphora decorated with impressions of a vertical stamp, triangles and a zigzag (Fig. 9: 1), as well as a two-handled, undecorated amphora (Fig. 9: 2). Moreover, in various parts of the burial pit and at different levels, fragments of other, at least four incomplete vessels (Figs. 9: 3, 4) and a fragment of flint blade were also found. In addition, near the bones of the lower limbs of skeleton No. 1 a flint axe (Fig. 10) and two tusks of a wild boar or

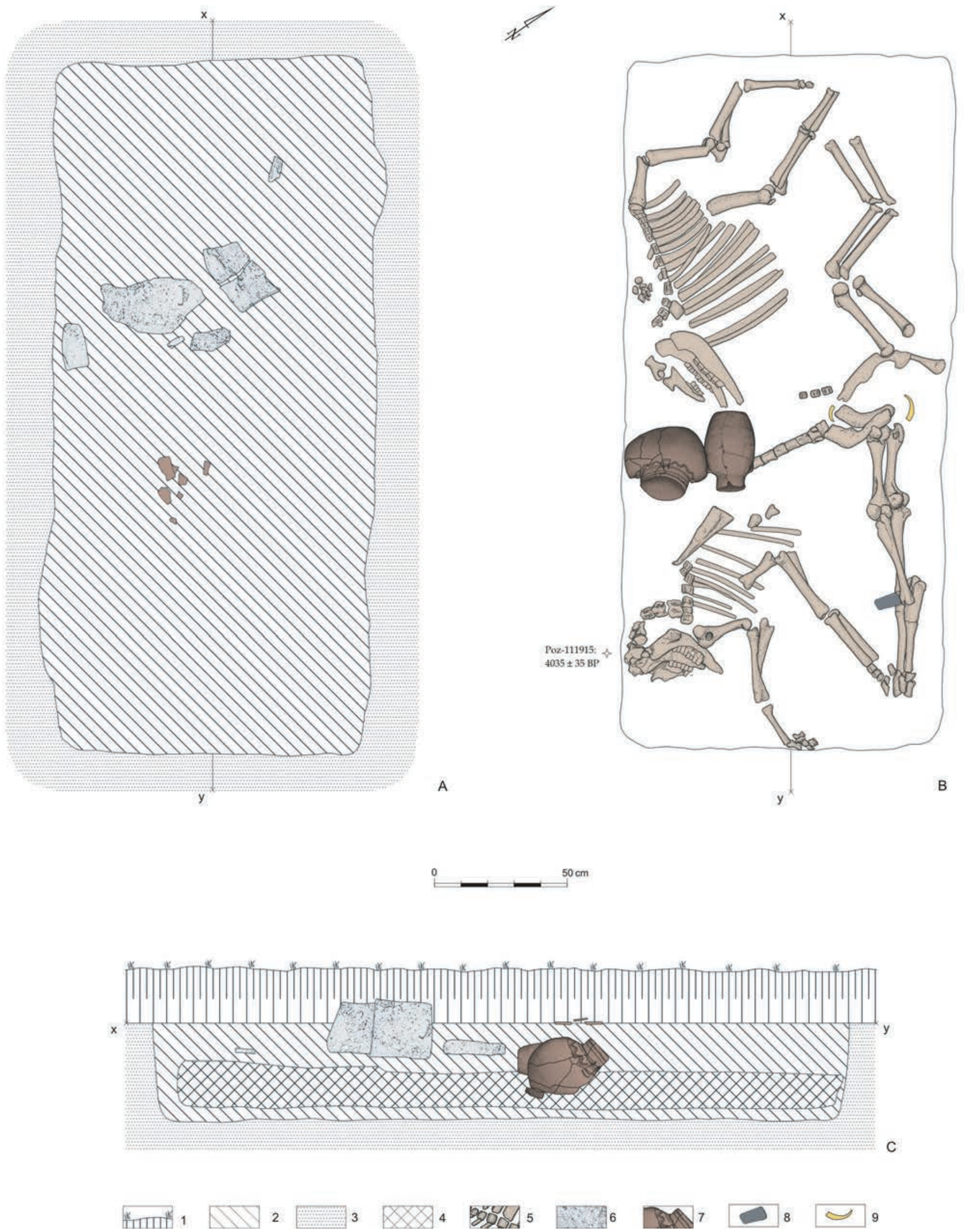

Fig. 8. Sadowie, Opatów dist., site 23. Documentation of the animal grave No. 11: A – plan view, profile of the burial pit, location of animal skeletons and inventory. The figure shows the ^{14}C date from the sample collected in the indicated place. Legend: 1 – surface layer; 2 – brown fills of feature; 3 – loess subsoil; 4, 5 – bone remains; 6 – stone; 7 – pottery vessel; 8 – flint axe; 9 – wild boar or pig tusk (drawn by A. Bardetsky).

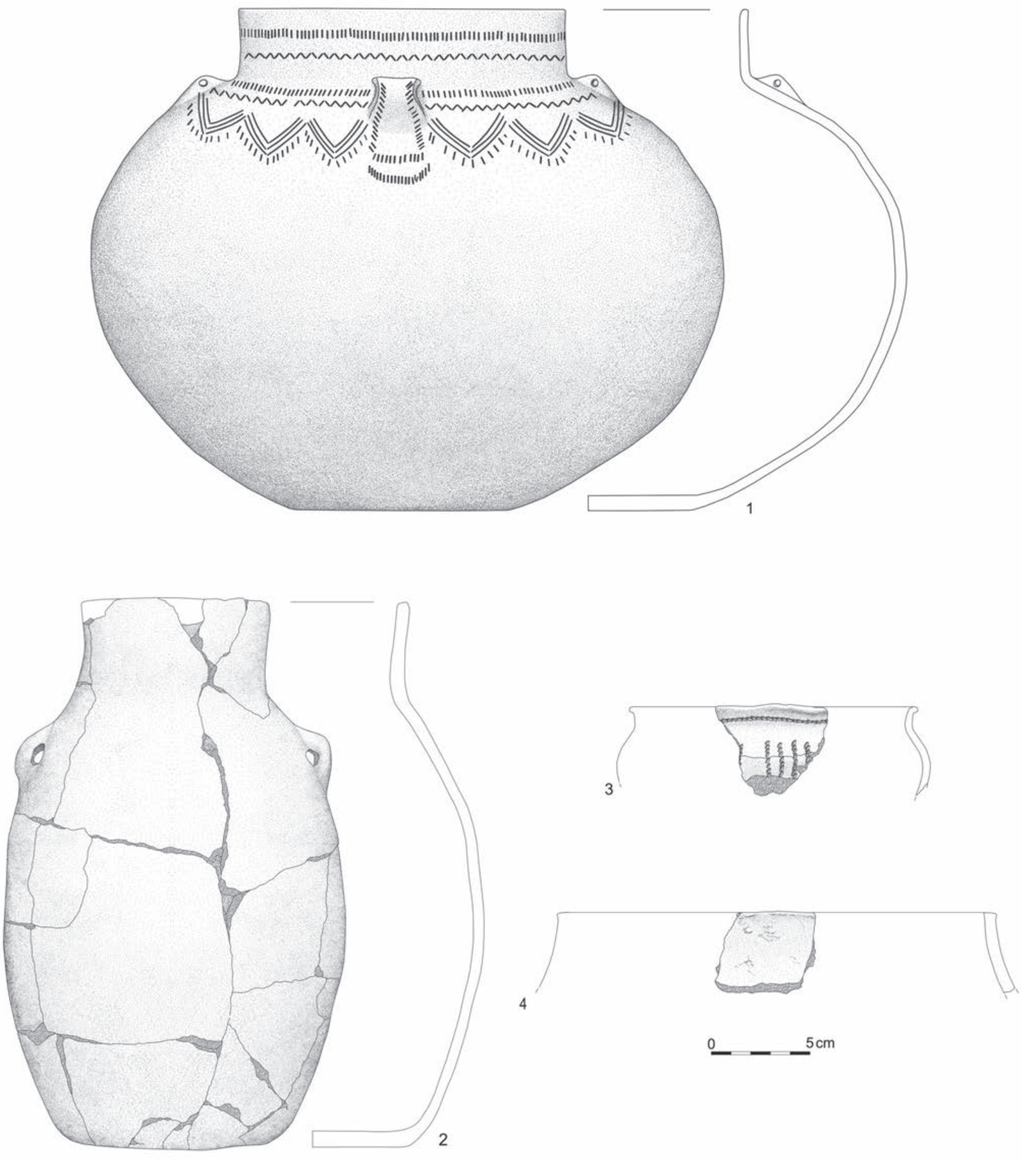

Fig. 9. Sadowie, Opatów dist., site 23. Grave inventory of the grave No. 11. Pottery vessels – amphorae (1-graphic reconstruction; drawn by A. Bardetsky).

pig were found (Fig. 11). Fragments of pig bones were also found as a grave inventory.

Artefacts:

1) a pottery vessel – a graphically reconstructed amphora (mass find No. 1098/2017; Fig. 9: 1) similar to forms of type IIA1 according to Wiślański (1966, 28, 29, data sheet II), the so-called „amphora of the Kuyavian type" by Nosek (1967, 292–295, tabl. III–IV) and in typological terms presented by Szmyt – amphora type VBIII (1996a, 31). It has a cylindrical, medium-high neck with four vertical handles in the upper part of the belly. Below the rim and at the point where the neck changes into the belly, there is a circumferential motif composed of stamps and zigzags. Below, in the space between the handles, there are symmetrically arranged angles composed of three or four lines, pointing with their tips down. These motives were made in the technique of deep punctures and impressions of a short stamp, incised lines and partially lines impressed with a long arch stamp. At the bottom, they are highlighted by small imprints located vertically. The decoration is also covered on handles. The vessel is made of clay with tempering material including grog (chamotte). The surfaces of the walls are carefully smoothed, have an orange-brown colour, sometimes with grey spots. The firing of the vessel is good, the fractures are compact, and the surfaces are hard. Weight: 3294 g. Dimensions: height 29.5 cm; neck height – 4 cm; rim diameter 19 cm; the largest belly diameter 37.5 cm; base diameter 12.5 cm; wall thickness – 5–5.5 mm near the rim; in the middle part of the belly – approx. 7 mm; near the base – 6.5 mm; base thickness – 6.5 mm.
2) a pottery vessel – a slender, undecorated amphora with two vertical handles placed symmetrically on the sides (mass find No. 1099/2017; Fig. 9: 2). Its form is related to some amphorae type I A2 and I C2 according to Wiślański (1966, 26–28, data sheet 1). In the typological analysis made by Nosek, it represents the so-called an "egg-shaped amphora" (1967, 291–292, tabl. 2), whereas in the systematic prepared by Szmyt, it belongs to the vessels of the VB group (specifically VBI1-21-2c-cb-cα; 1996a, 31). The neck of the described amphora is not high, slightly conical, widening towards the bottom. The belly is egg-shaped, with the largest belly diameter slightly above the middle of the vessel height, and its base is poorly defined. The clay contains a lot of sand and whitish crushed stone. The surfaces of the walls are carefully smoothed, have a black and grey colour on the outer surface and black inside. The firing of the vessel is good, the surfaces are medium hard. Weight: 1958 g. Dimensions: height 29 cm; rim diameter 9.5 and 10.5 cm; neck height – 5 cm; the largest belly diameter 17.5 cm, base diameter 10–11 cm; wall thickness – below the rim 5 mm; in the middle part of the belly – 5.5 mm; near the base – 5.5 mm; base thickness – 8–9 mm.
3) twelve fragments of a pottery vessel, presenting a rim slightly bent inside (mass find Nos. 1087, 1088, 1090–1092, 1094–1096/2017; Fig. 9: 4). Clay paste contains crushed stone tempering of a whitish colour and of various grains, and fine gravel. The surfaces of the walls are smooth, have a uniform, light brown colour and traces of the brushing of the internal surfaces with grass or straw. The firing of the vessel is quite good, the fracture is compact, and the surfaces are hard. Weight: 352 g. Dimensions: rim diameter – about 21 cm; wall thickness – 6 mm below the rim, others – 4–7 mm.
4) six tiny fragments of a pottery vessel decorated with dual cord impressions, most probably in the form of arches of semicircles (mass find No. 1087/2017). Clay paste contains fine and medium-grained crushed whitish stone. The surfaces of the walls are carefully smoothed, have a black colour, sometimes with grey spots. The firing of the vessel is good, the fracture is compact, and the surfaces are hard. Weight: 48 g. Dimensions: wall thickness – 5–5.5 mm.
5) a fragment of the upper part of a pottery vessel – most likely a vase, with a defined and outcurved neck, gently transiting into a spherical belly (mass find No. 1093/2017; Fig. 9: 3). The ornamental motif has been preserved, consisting of two horizontal lines made with cord impressions, supplemented at the bottom by short, vertical lines. Clay paste contains fine and medium-grained crushed stone with a whitish colour. The surfaces of the walls are smooth, and they are in a black and brown colour outside and inside, and a fracture is light brown. The firing is good and the surfaces are hard. Weight: 14 g. Dimensions: diameter of the outlet: 14–15 cm; wall thickness – below the rim 4 mm, near the largest belly diameter – 5 mm.
6) three fragments of a pottery vessel (mass find Nos. 1089, 1093, 1097/2017). They were made of clay with the admixture of medium- and coarse-grained crushed whitish stone. The surfaces of the walls are smooth, have a non-uniform, brown colour on the outer surface and black inside, as well as brown fractures. It is fragile ceramics, poorly

compact in fracture. Weight: 99 g. Dimensions: wall thickness: 5.5–6.5 mm.

7) a flint tetrahedral axe (registered find No. 55/2017; Fig. 10) of an irregular, trapezoidal shape, polished over the entire surface. It has a slightly asymmetrical arched cutting edge, and a narrow butt damaged at one of the ends. In the upper part, the negatives of the flat retouch coming from the forming stage are visible, and on the inter-negative ridges there are traces of obliterating and gloss caused by using the tool in a setting. One of the sides has a visible layer of white patina – most likely limestone; striped flint; dimensions: length–128 mm, width–31 mm at the cutting edge, 46 mm in the middle, at the butt 50 mm; thickness: at the butt – 23 mm, in the middle – 24 mm, at the cutting edge – 20 mm.
8) a fragment of a blade (with its butt) with retouching of both sides on the upper side (registered find No. 52/2017); chocolate flint; dim. 20×15×3 mm.
9) a wild boar or pig tusk (registered find No. 53/2017; Fig. 11: 1); height: 83 mm, maximum width: 19 mm; maximum thickness: 9 mm.
10) a wild boar or pig tusk (registered find No. 54/2017; Fig. 11: 2); height: 57 mm, maximum width: 13 mm; maximum thickness: 10 mm.

The pottery vessels discovered in grave No. 11 have analogies in the complexes of the Globular Amphora culture from the upper Vistula basin, both of a sepulchral and a settlement nature. The amphora with two handles with an egg-shaped belly is a form with wide chronological frames. It is present in the inventory of the feature (grave) No. 30 in the cemetery in Złota (Krzak 1977, 53, fig. 69) and among the material remains from grave No. II in Sandomierz, site 78 (Ścibior and Ścibior 1990, 162, Fig. 4: c). A similar form can be found in the settlement materials from nearby Mierzanowice, site 1, in the pit No. 173 ab and 226 (Balcer 1963, tabl. V: 6; XI: 15). Equivalents of two-handle amphorae are present in the Lublin Upland, e.g. at the settlement in Podlodów, Chełm dist., site 2 (Bagińska and Taras 1997, 32, fig. 2: e), for which the date 4160±45 BP was established (Szmyt 1999, 235). Almost identical vessels were found in Klementowice, site 2 (Nosek 1967, 220, Fig. 157: 17) associated with the late stage of development of the Globular Amphora

Fig. 10. Sadowie, Opatów dist., site 23. A flint axe from the inventory of the grave No. 11 (photo by author).

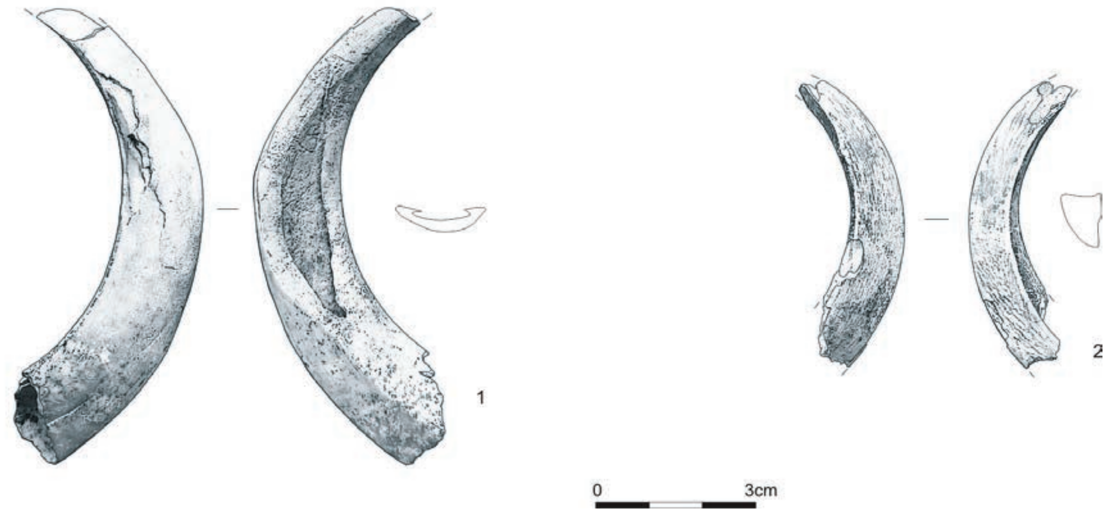

Fig. 11. Sadowie, Opatów dist., site 23. Wild boar tusks from the grave inventory No. 11 (drawn by A. Bardetsky).

culture (findings by Włodarczak and Przybyła 2013, 234). Similar, two-handle, undecorated amphorae in an egg shape can be identified in the assemblage from grave No. I at site 18 in Las Stocki, Puławy dist. (Nosek 1967, 234, figs. 167: 8–9).

The inventory of the grave also includes a „Kuyavian-type amphora" with four handles. In terms of morphological features, it refers to the vessels found in the complexes from the Nałęczów group and the Eastern-Lublin group of the Globular Amphora culture. Close analogies can be found in the vessels from the grave in Łopiennik Dolny-Kolonia, Krasnystaw dist., site 1 (Gołub 1996, 49, fig. 5: 2), for which the ^{14}C dating determination is: 4010±30 BP (Kadrow and Szmyt 1996, tab. 1). Very similar items can also be found in inventories from younger periods. An example is a vessel from a grave in Czułczyce Kolonia, Chełm dist., site 6 (Bronicki 2000, 184, fig. 4: 2) for which four radiocarbon determinations were obtained: 4035±90 BP, 4020±90 BP, 3940±85 BP (Bronicki 2000, tab. 1), and 3995±35 BP (Włodarczak 2016, tab. 2). Close analogies to the amphora from grave No. 11 can be found in two vessels from Klementowice, site 2 (Nosek 1967, 220, figs. 157: 1, 15). They were ornamented in the incision and perforation techniques like our amphora. What is more, analogies in terms of forms and decorations are provided by more than one vessel from graves in Ulwówek near Hrubieszów (Nosek 1967, 211, fig. 149: 1) and in Serebryszcze (currently Srebrzyszcze), Chełm dist., site 23 (Bronicki 2016, 183, 184, figs. 135, 136: 1).

Regarding the described complex, it is also possible to distinguish a fragment of the upper part of the vase decorated with cord impressions (Fig. 9: 3). Similar motifs, arranged in zones (straight and arched patterns), are typical of the Globular Amphora culture in the Sandomierz-Opatów loess and they are found, among others, in quite late complexes, such as Mierzanowice, site 1 (Balcer 1963, tabl. XII). In the case of the item from grave No. 11, it is difficult to indicate exact analogies due to the fragmentary preservation of the ornament.

Apart from pottery relics, the collection from grave No. 11 also includes flint (an axe, a fragment of a blade) and bone artefacts. Flint axes occur as a typical component of burial equipment in various areas of settlement of the Globular Amphora culture and in graves of various chronology (Nosek 1967; Beier 1988; Wiślański 1966; Szmyt 1996a). Wild boar tusks are also common elements in graves and do not constitute explicit dating objects. They are especially numerous in the upper Vistula basin, in male graves, where they were deposited as objects of symbolic importance (e.g. Bronicki 2016, 240, 242, 246, 247, tab. 10–12, 250). Such artefacts were found, among others, in grave No. 2 in Klementowice (4 items; Nosek 1954/55, 71, fig. 5) and in the burials in Nałęczów (3 items; Nosek 1967, 236) and Włostowice, Puławy dist., site 1 (4 items; Gurba *et al.* 1978, 139). Very numerous (as many as 13 items) were also found in the collective grave in Koszyce, site 3 (Przybyła *et al.* 2013, tabl. 10–14). As for the tusks discovered there, some of them had traces of treatment which suggests their use as tools. Wild boar or pig tusks, also in their natural form, have not yet been recorded in graves containing animal skeletons of the Globular Amphora Culture.

Results of radiocarbon analysis

Only cattle molar teeth from graves No. 4, 7 and 11 were used for radiocarbon analysis performed at the Poznań Radiocarbon Laboratory. In one of the samples (grave No. 11, skeleton No. 2, bone No. 11/79), an insufficient amount of collagen was found. These very low values were beyond the test standard. The remaining samples, from the point of view of the requirements necessary in radiocarbon analysis, had a sufficient collagen content allowing for a reliable measurement (Table 1). In addition to the quantitative criterion, the quality indicator in terms of collagen contained in bones is the ratio expressed as the amount of obtained collagen to the size of the sample. According to the findings of Oxford ^{14}C Laboratory, this level should be 1% (Brock *et al.* 2012). Recent analyzes of the Poznań Radiocarbon Laboratory in case of establishing dating for burial complexes of the Yamna culture have shown that bone samples containing 0.5–1% of collagen are sufficient to obtain a reliable determination (Goslar *et al.* 2015). Another criterion of sample quality is the ratio of C: N atoms, which should be in the range of 2.9–3.6 (DeNiro 1985) or 3.1–3.5 (van Klinken 1999; Brock *et al.* 2010; Bronk Ramsey *et al.* 2004). The percentage by weight of carbon and nitrogen (% C and % N) is also an indicator of the quality of collagen. In well-preserved bone, it should be at least 13% for carbon and 4.8% for nitrogen (Ambrose 1990). As a result of tests carried out on the material, three dates were obtained: Poz-111913: 3995±35 BP (grave No. 4); Poz-111914: 4185±35 BP (grave No. 7); Poz-111915: 4035±35 BP (grave No. 11; tab. 1, Fig. 12). The dating values after calibration are respectively: for the sample Poz-111913: 3995±35 BP with a probability of 68.2%: 2568–2470 BC and 2623–2411 BC with a probability of 95.4%, for the date Poz-111914: 4185±35 BP it was 2882–2698 BC and 2891–2632 BC respectively. For the date Poz-111915: 4035±35 BP we have obtained a fairly wide range, with the probability of a single standard deviation being 2580–2476 BC; and in the case of double – 2834–2467 BC.

Interpretation of the obtained radiocarbon determinations

The obtained results are consistent with the assumption that the age of graves No. 4, 7 and 11 are from the period ranging from the beginning to the

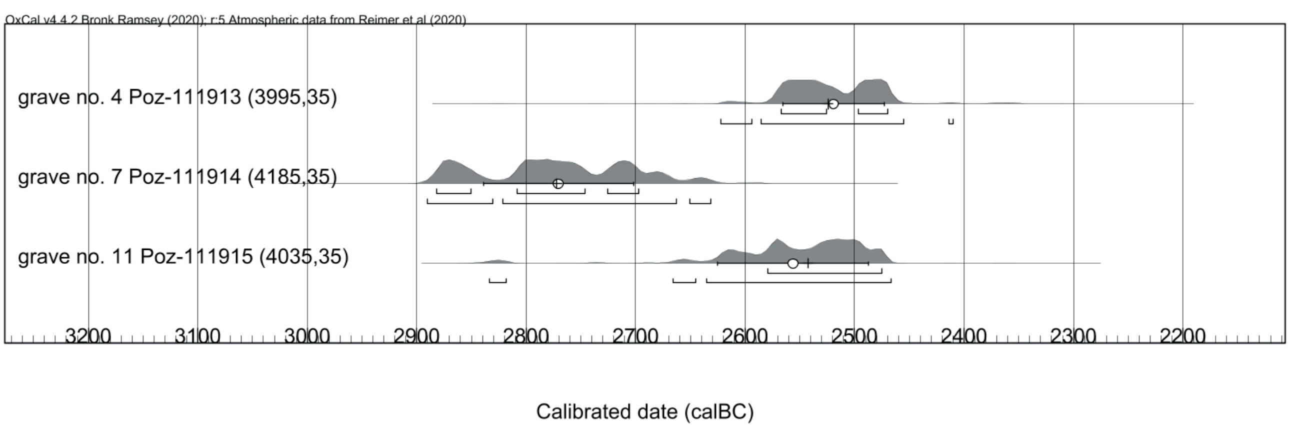

Fig. 12. Sadowie, Opatów dist., site 23. Calibration results of radiocarbon dates obtained for the graves No. 4, 7 and 11. In calibration the software OxCal v 4.4.2. Bronk Ramsey (2020) was used.

Table 1. Sadowie, Opatów dist., site 23. ^{14}C dating obtained for animal graves of the Globular Amphora culture.

Grave number	Skeleton number	Bone number	Lab number	BP	BC (1σ)	BC (2σ)	%coll	C%	N%	C/N (at)
4	1	179/2015	Poz-111913	3995±35	2568–2470	2623–2411	1,8	46,3	16,7	3,23
7	2	829/2016	Poz-111914	4185±35	2882–2698	2891–2632	0,7	49,8	17,7	3,28
11	1	11/11	Poz-111915	4035±35	2580–2476	2834–2467	1,7	47,1	16,8	3,26

second half of the third millennium BC. This is a time frame referring to the settlement of the community of the Globular Amphora culture in the basin of the Upper Vistula (Ścibior and Ścibior 1990, 192; Ścibior 1991, 51–54; Kadrow and Szmyt 1996, tab. 1; Kruk and Milisauskas 1999, 190–193; Włodarczak and Przybyła 2013, 235–240; Włodarczak 2016). Graves No. 4 and 11 obtained similar radiocarbon determinations, characterized by a high degree of agreement. They relate to the end of the first half and the beginning of the second half of the third millennium BC, oscillating between the range of 2600–2400 BC. In the case of grave No. 7, its determination corresponds to the earlier period. The range of calendar age for the bone sample refers to the first half of the third millennium BC (2882–2698 BC). These values have their equivalents among other burial and settlement complexes from south-eastern Poland dated by radiocarbon technique (Table 2). It is worth noting that the ^{14}C results obtained are conditioned by the flattening on the calibration curve. For the first half of the third millennium (specifically 2880–2580 BC and 2620–2480 BC), there is an extensive plateau, which makes it impossible to set the dates accurately on an absolute timescale (Furholt 2003, 15, Abb. 1; Walanus and Goslar 2004, 64–68). The significance of this phenomenon for the calibration of late Neolithic dates in Europe is discussed in more detail in: Furholt 2003; Włodarczak 2007, 37–39; 2016, 539, 540.

The earliest date obtained for grave No. 7 only has references in the Lublin Upland. A similar determination comes from grave No. 7 in the cemetery in Klementowice, site 4 (IV, cemetery D; 4175±30 BP; 2921–2888 BC; 4300±30 BP; 2904–2774 BC; Kowalczyk 1968, 368; more details with reference to dating: Włodarczak 2016, 540). The age of other features from the Nałęczów and Eastern-Lublin groups is very similar, e.g. from Las Stocki, site 16 (cemetery C; 4180±35 BP; 2881–2696 BC; Włodarczak 2016, tab. 2), Świerszczów, site 27 (5; 4170±35 BP; 2877–2677 BC; Kadrow, Szmyt 1996, tab. 1) and settlements in Podlodów, site 2 (4160±45 BP; 2874–2671 BC; Szmyt 1999, 235). What is more, grave No. 523 from Koszyce, on the Proszowice Plateau, should also be referred to these determinations (Włodarczak and Przybyła 2013, tab. 5, 6; Schroeder *et al.* 2019, Dataset 1). The range of the obtained dates for the 28 samples refers to the first half of the third millennium BC (2880–2776 BC).

In the case of graves No. 4 and 11, the dates coincide with the absolute age obtained, especially for the features of the Eastern-Lublin group of the Globular Amphora culture. A very similar time span is established for the series of determinations for Łopiennik Dolny-Kolonia, site 1 (4010±30 BP; Kadrow, Szmyt 1996, 109; 4110±30 BP; 2851–2586 BP; P. Włodarczak 2016, table 2) and Czułczyce-Kolonia, site 6 (4035±90 BP; 4020±90 BP; 3940±85 BP; Bronicki 2000, tab. 1; 3995±35 BP; Włodarczak 2016, tab. 2) and Serebryszcze, site 23 (4045±35 BP; Włodarczak 2016, tab. 2). The series of determinations correspond to the end of the first and the very beginning of the second half of the third millennium BC. At the present stage of research, it is very difficult to relate the inventories from Sadowie to other burial features from the Sandomierz Upland due to the small number of radiocarbon determinations. Thus far, only a single date has been published for grave No. VIII from site 78 in Sandomierz (Ścibior and Ścibior 1990, 192). It was established to 4370±70BP (3092–2905 BC) and is the oldest designation for the Globular Amphora culture in the upper Vistula basin.

The absolute dating for graves No. 4, 7 and 11 is consistent with the results of the relative chronology of the vessels included as grave goods. The analysis of the material remains shows that the most analogies can be found in the complexes from the Sandomierz Upland. Individual components of the inventories have numerous analogies in the assemblages from the settlement in Mierzanowice, site 1 and from the cemetery in Złota – „Gajowizna". Regarding the set of forms and vessels, it is possible to indicate similarities to the sites from the neighbouring settlement zones of the Globular Amphora culture. These are, among others, references to inventories from the area of the Nałęczów and Eastern-Lublin groups. The presence of these materials acquires a different meaning, especially in the context of the identification of graves of the Nałęczów type (with non-cist, stone structures) at the site (unpublished research results). These groups are a manifestation of the penetration of the Sandomierz Upland by the communities of the Globular Amphora culture from the Lublin region, a phenomenon that might have been related to the local striped flint deposits.

It is worth adding that the material remains from individual graves show some differences in the forms of vessels, ornamental motifs and various decorative techniques. This may indicate the time distance between the aforementioned graves. It also confirms the thesis about the chronological stratification of the cemetery of the Globular Amphora culture and individual clusters of graves.

Table 2. List of radiocarbon datings for burial and settlement features of the Małopolska (Kielce), Sandomierz–Opatów, Nałęczów and Eastern-Lublin Globular Amphora culture groups.

No.	Site	Grave number/ feature number/skeleton number	Globular Amphora culture group	Lab number	^{14}C age (BP)	Calibrated age (BC, 1σ range)	Calibrated age (BC, 2σ range)	Dated material	Literature
1.	Koszyce, Proszowice dist., site 3	grave-feature 506, skeleton 1	Małopolska (Kielce)	Poz-47437	4125±35	2858–2625	2871–2578	animal bone	Włodarczak and Przybyła 2013, Table 5
2.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 1	Małopolska (Kielce)	Poz-47439	4085±35	2842–2504	2864–2492	human bone	Włodarczak and Przybyła 2013, Table 5
3.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 5	Małopolska (Kielce)	Poz-47441	4190±35	2883–2700	2893–2635	human bone	Włodarczak and Przybyła 2013, Table 5
4.	Koszyce, Proszowice dist., site 3	grave -obiekt 523 szkielet nr 9	Małopolska (Kielce)	Poz-47442	4165±35	2874–2675	2881–2630	human bone	Włodarczak, Przybyła 2013, Table 5
5.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 12	Małopolska (Kielce)	Poz-47440	4215±35	2893–2705	2905–2672	human bone	Włodarczak and Przybyła 2013, Table 5
6.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 1	Małopolska (Kielce)	Ua-45617	4226±46	2902–2703	2915–2636	human bone	Włodarczak and Przybyła 2013, Table 6
7.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 6	Małopolska (Kielce)	Ua-45618	3960±44	2569–2351	2576–2301	human bone	Włodarczak and Przybyła 2013, Table 6
8.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 9	Małopolska (Kielce)	Ua-45619	3985±38	2569–2466	2620–2349	human bone	Włodarczak and Przybyła 2013, Table 6
9.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 14	Małopolska (Kielce)	Ua-45620	4119±38	2857–2584	2872–2575	human bone	Włodarczak and Przybyła 2013, Table 6
10.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 1	Małopolska (Kielce)	AAR-28702	4208 ±35	2891–2703	2901–2670	human bone	Schroeder *et al.* 2019, Dataset 1
11.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 2	Małopolska (Kielce)	AAR-28703	4187±36	2883–2698	2892–2633	human bone	Schroeder *et al.* 2019, Dataset 1
12.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 3	Małopolska (Kielce)	AAR-28704	4230±36	2902–2707	2912–2676	human bone	Schroeder *et al.* 2019, Dataset 1
13.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 4	Małopolska (Kielce)	AAR-26315	4239±33	2905–2777	2915–2698	human bone	Schroeder *et al.* 2019, Dataset 1
14.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 5	Małopolska (Kielce)	AAR-28705	4202±36	2888–2702	2900–2638	human bone	Schroeder *et al.* 2019, Dataset 1
15.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 6	Małopolska (Kielce)	AAR-26316	4014±45	2574–2472	2842–2357	human bone	Schroeder *et al.* 2019, Dataset 1

No.	Site	Grave number/ feature number/skeleton number	Globular Amphora culture group	Lab number	^{14}C age (BP)	Calibrated age (BC, 1σ range)	Calibrated age (BC, 2σ range)	Dated material	Literature
16.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 7	Małopolska (Kielce)	AAR-28706	4220±34	2895–2706	2906–2675	human bone	Schroeder *et al.* 2019, Dataset 1
17.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 8	Małopolska (Kielce)	AAR-26317	4330±34	3010–2898	3072–2888	human bone	Schroeder *et al.* 2019, Dataset 1
18.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 9	Małopolska (Kielce)	AAR-26318	4204±44	2892–2699	2903–2632	human bone	Schroeder *et al.* 2019, Dataset 1
19.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 10	Małopolska (Kielce)	AAR-26319	4126±36	2859–2625	2872–2578	human bone	Schroeder *et al.* 2019, Dataset 1
20.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 11	Małopolska (Kielce)	AAR-28707	4215±35	2893–2705	2905–2672	human bone	Schroeder *et al.* 2019, Dataset 1
21.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 13	Małopolska (Kielce)	AAR-28708	4211±40	2893–2702	2906–2636	human bone	Schroeder *et al.* 2019, Dataset 1
22.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 13	Małopolska (Kielce)	AAR-28709	4264±34	2911–2878	3004–2703	human bone	Schroeder *et al.* 2019, Dataset 1
23.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 14	Małopolska (Kielce)	AAR-28710	4379±32	3022–2922	3093–2911	human bone	Schroeder *et al.* 2019, Dataset 1
24.	Koszyce, Proszowice dist., site 3	grave-feature 523, skeleton 15	Małopolska (Kielce)	AAR-26320	4099±53	2854–2574	2875–2492	human bone	Schroeder *et al.* 2019, Dataset 1
25.	Koszyce, Proszowice dist., site 3	grave-feature 523, single bone (sheep)	Małopolska (Kielce)	AAR-27613	4222±23	2895–2776	2901–2701	animal bone	Schroeder *et al.* 2019, Dataset 1
26.	Sandomierz, *loco* dist., site 78	grave VIII	Sandomierz-Opatów	Gd-2452	4370±70	3092–2905	3332–2885	charcoal from the fill of the grave	Ścibior and Ścibior 1990, 192
27.	Klementowice, Puławy dist., site 4 (IV, cemetery D)	grave 7	Nałęczów	KN-255	4300±30	2904–2774	2914–2695	charcoal from the fill of the grave	Kowalczyk 1968, 368
28.	Klementowice, Puławy dist., site 4 (IV, cemetery D)	grave 7	Nałęczów	GrN-5046	4175±30	2921–2888	3011–2881	charcoal from the fill of the grave	Kowalczyk 1968, 368
29.	Klementowice, Puławy dist. site 1 (I, cemetery A)	grave 1	Nałęczów	Poz-61735	4235±35	2878–2697	2886–2633	human bone	Włodarczak 2016, Table 2
30.	Las Stocki, Puławy dist., site 16 (cemetery C)	grave II	Nałęczów	Poz-61732	4180±35	2881–2696	2888–2632	human bone	Włodarczak 2016, Table 2
31.	Parchatka, Puławy dist., cemetery A	grave	Nałęczów	Poz-61733	4230±35	2901–2707	2911–2677	animal bone	Włodarczak 2016, Table 2

No.	Site	Grave number/ feature number/skeleton number	Globular Amphora culture group	Lab number	^{14}C age (BP)	Calibrated age (BC, 1σ range)	Calibrated age (BC, 2σ range)	Dated material	Literature
32.	Puławy-Włostowice, Puławy dist., site 1	grave	Nałęczów	Poz-61734	4040±35	2622–2488	2836–2468	human bone	Włodarczak 2016, Table 2
33.	Trzeszkowice, Świdnik dist., site 14	grave-feature 1	Nałęczów	Poz-58111	4170±35	2877–2677	2884–2631	human bone	Polańska 2016b, 42
34.	Czułczyce-Kolonia, Chełm dist., site 6	grave-northern chamber, western skeleton	Eastern-Lublin	Ki-7831	4035±90	2848–2463	2877–2310	human bone	Bronicki 2000, Table 1
35.	Czułczyce-Kolonia, Chełm dist., site 6	grave-northern chamber, eastern skeleton	Eastern-Lublin	Ki-7830	4020±90	2847–2411	2873–2297	human bone	Bronicki 2000, Table 1
36.	Czułczyce-Kolonia, Chełm dist., site 6	grave-southern chamber, western skeleton	Eastern-Lublin	Ki-7829	3940±85	2569–2297	2842–2146	human bone	Bronicki 2000, Tabela 1
37.	Czułczyce-Kolonia, Chełm dist., site 6	grave-southern chamber, eastern skeleton	Eastern-Lublin	Poz-61739	3995±35	2568–2470	2623–2411	human bone	Włodarczak 2016, Table 2
38.	Krasnystaw, *loco* dist., site 8	grave	Eastern-Lublin	Ki-5841	4120±30	2854–2623	2868–2577	human bone	Kadrow and Szmyt 1996, Table 1
39.	Łopiennik Dolny-Kolonia, Krasnystaw dist., site 1	grave	Eastern-Lublin	Ki-5434	4010±30	2569–2475	2618–2465	human bone	Kadrow and Szmyt 1996, Table 1
40.	Łopiennik Dolny-Kolonia, Krasnystaw dist., site 1	grave	Eastern-Lublin	Poz-58148	4110±30	2848–2583	2867–2573	human bone	Włodarczak 2016, Table 2
41.	Depułtycze Nowe-Kolonia (now Nowe Depułtycze), Chełm dist., site 12	grave	Eastern-Lublin	OxA-23438	4136±28	2861–2631	2873–2583	–	Bronicki 2016, 59
42.	Podlodów, Tomaszów Lubelski dist., site 2	pit 15	Eastern-Lublin	Ki-6545	4160±45	2874–2671	2885–2584	animal bone	Szmyt 1999, 235
43.	Raciborowice-Kolonia, Chełm dist., site 2	grave-feature 5/56	Eastern-Lublin	Poz-58109	4335±35	3011–2901	3076–2890	human bone	Polańska 2016a, 28
44.	Sajczyce, Chełm dist., site 18	grave	Eastern-Lublin	OxA-23437	4115±28	2850–2585	2866–2576	–	Bronicki 2016, 178
45.	Serebryszcze, Chełm dist., site. 23	grave 1	Eastern-Lublin	Poz-61738	4045±35	2624–2491	2839–2469	human bone	Włodarczak 2016, Table 2
46.	Świerszczów, Hrubieszów dist., site 27 (5)	grave	Eastern-Lublin	Ki-5433	4170±35	2877–2677	2884–2631	human bone	Kadrow and Szmyt 1996, Table 1

Summary

The dates obtained for the graves in Sadowie are the first determinations for the Globular Amphora culture from the Opatów loess and contribute to the discussion on the chronology of the Sandomierz-Opatów group. It is worth noting that the dating of the discussed cemetery does not determine the order in which the cemetery used to function, and its chronological framework, but only episodes in the functioning of three different zones are established. Defining the chronological relationship and sequels between the graves included in the clusters will require dating more samples and a detailed analysis of artefacts. In the longer term, it will allow the presentation of the chronological system for the Globular Amphora culture in the Opatów loess and will make it possible to build a diagram of the cultural changes in the late Neolithic.

Translation: Beata Kizowska-Lepiejza

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The early Bronze Age feature from Wilczyce, site 10, Sandomierz district – An interpretation of its functioning in light of multidimensional analysis

Abstract

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The aim of this paper is to present the multidimensional characteristics of the feature number 4 at the site in Wilczyce located on the Sandomierz Upland. During exploration of the pit rich flint material, fragments of pottery vessels and animal bones were found and just above the bottom a "deposit" involved a human skull of the young female, two cattle mandibles, a sheep/goat tibia and astragalus, a damaged cattle scapula and radius, and a polishing stone were deposited. The C_{14} date obtained from the tooth from the cattle jaw was 3790 ± 35 BP. Based on the shape and the size of discovered feature it is possible to classify it as a typical storage pit but presence of "deposit" enable to postulate a ritual character of assemblage that reflect some kind of burial practices of the Mierzanowice culture. Rituals in the form of interring the dead or parts of their bodies can be found also in the Unietice culture so such features may indicate the emergence of a certain supra-regional and cross-cultural trend in the early Bronze Age

Key words: Mierzanowice culture, Sandomierz Upland, funeral rite, settlement feature

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Introduction

The site in Wilczyce, located on the Sandomierz Upland (Fig. 1: a), was discovered in 1994 during a field survey carried out as a part of the Polish Archaeological Record (*Archeologiczne Zdjęcie Polski*) project by H. Kowalewska-Marszałek from the Institute of Archaeology and Ethnology of the Polish Academy of Sciences (Kowalewska-Marszałek and Włodarczak 2002, 21). It was marked as site number 10 and is situated at the top of the slope of a loess hill that rises directly above the Opatówka River valley. Detailed information about the history of archaeological investigations, the geomorphology of the hill and the loess sedimentation were presented in the monograph of the Magdalenian culture settlement published in 2014 (Schild 2014) and in separate papers (Bałaga *et al.* 2008). In addition, during the subsequent excavations, archaeologists discovered numerous features from the Neolithic period, both associated with the occupation of the site and of a funerary nature (Fig. 1: b; Boroń 2013; 2017; Włodarczak *et al.* 2016). The research was financed by the Voivodeship Heritage Protection Office (*Wojewódzki Urząd Ochrony Zabytków*) in Kielce, the Institute of Archaeology and Ethnology of the Polish Academy of Sciences in Warsaw, and Karpacka Spółka Gazownictwa sp. z o.o. – Sandomierz Division. The aim of this paper is to present the multidimensional characteristics of the feature labelled as number 4, which allows us to formulate hypotheses concerning its purpose and its functioning.

The structure of the feature

The feature was discovered under an arable layer, approximately 40 cm below the ground surface. In its maximum range, it had a circular shape with a diameter of 2 m and depth of 1.2 m, with almost vertical walls and a slightly bowl-shaped bottom. The upper part of the fill constituted a homogeneous dark soil that gradually turned into light grey layers mixed with layers of yellow loess (Fig. 2).

A human skull was discovered approximately 1 meter below the ceiling of the feature – placed next to its wall, with two cattle mandibles on the left and

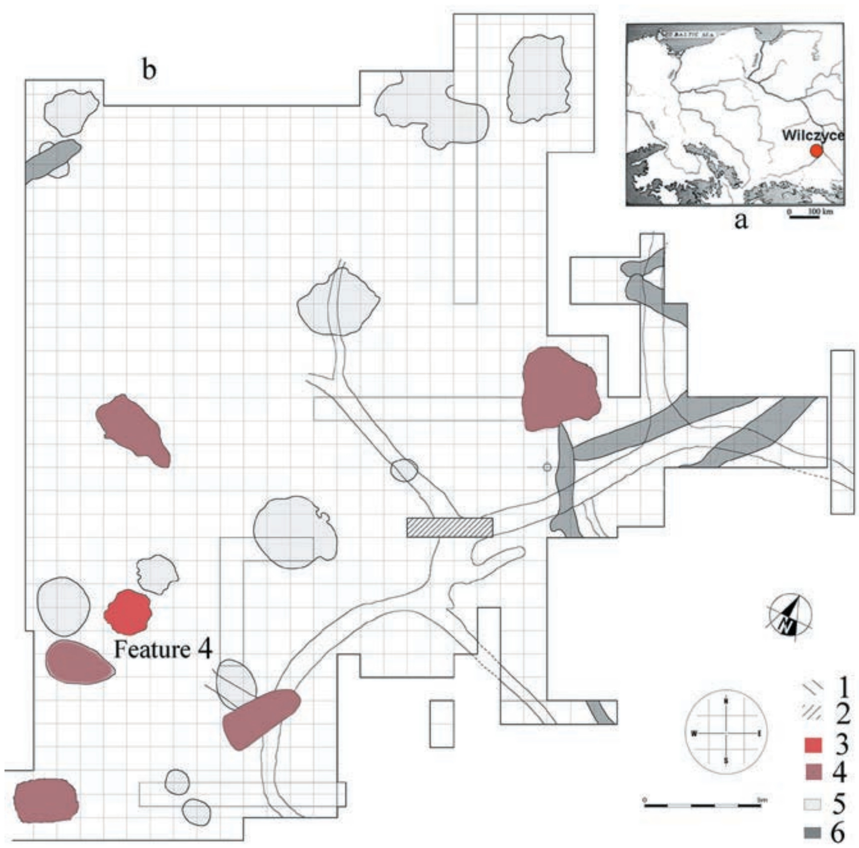

Fig. 1. a – geographical location of Wilczyce, Sandomierz district, site 10; b – plan of the trench; 1 – ice wedge cast; 2 – unexcavated area with settlement materials of the Magdalenian culture (balk); 3 – funeral feature of the Mierzanowice culture; 4 – feature of the Corded Ware culture; 5 – other Neolithic features; 6 – WWI trenches (according to Schild 2014, 88, with supplementary information by T. Boroń)

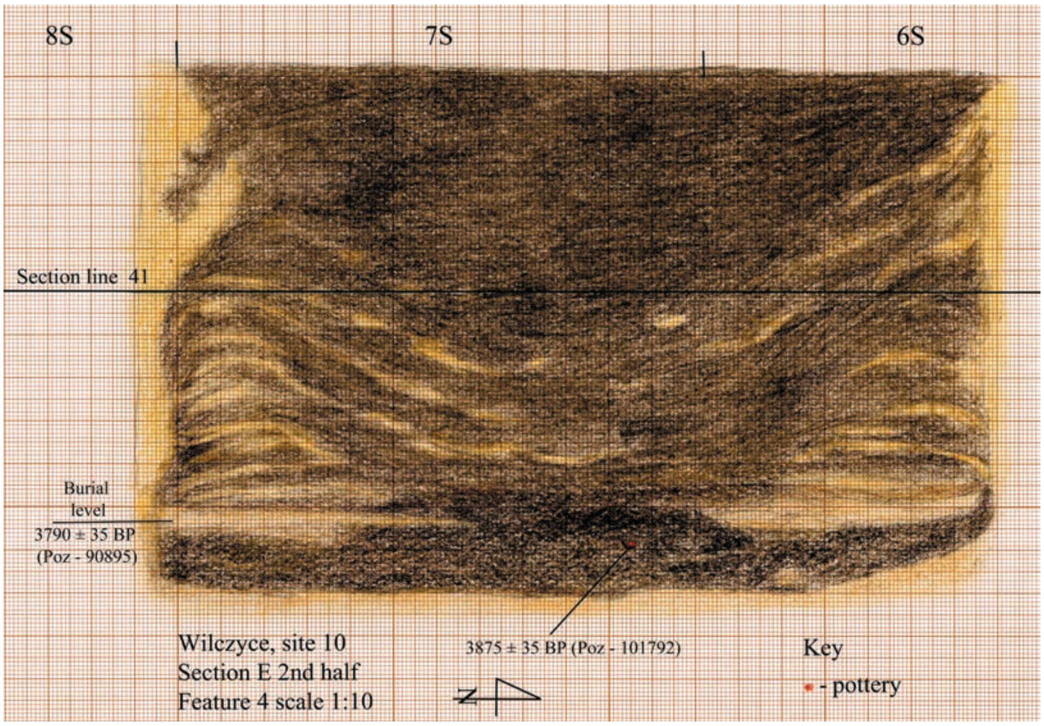

Fig. 2. Wilczyce, Sandomierz district, site 10. Cross-section of feature 4, with the indication of places from which samples for the C_{14} dating were taken. Drawing by E. Gumińska (digitally remastered by A. Sołodko)

a sheep/goat tibia and astragalus, a damaged cattle scapula and radius, and a polishing stone. Next to the wall, on the north-western side, another stone was discovered (Fig. 3). The C_{14} date obtained from the tooth from the cattle jaw was 3790 ± 35 BP (Poz-90895). Below the "deposit" consisting of human and animal remains, archaeologists also recorded a dark layer of soil between 20 and 25 cm thick. The radiocarbon date obtained for the charcoal discovered in that layer was 3875 ± 35 BP (Poz-101792). Radiocarbon dating was financed from the National Science Centre (NCN) grants number 2014/12/S/HS3/00355 and 2016/20/S/HS3/00307.

The exploration of the pit yielded rich flint material, fragments of pottery vessels and animal bones, which were present both below and above the level on which the human skull was discovered.

Archaeological material from the fill of the feature

Flints

During the exploration of the feature, archaeologists discovered around 500 flints, including three splintered pieces, 130 flakes, ten blades, 18 tools, one burin spall, and several hundred chips and flint waste.

Splintered pieces. Three specimens were identified. They are bipolar forms and forms with one pole with a flat cross-section (Fig. 4: 1–3). Dimensions of the splintered pieces and tools are presented in Table 1.

Flakes. The assemblage consists of 130 specimens (Fig. 4: 4–13; 5: 1–5), of which 94 belong to scar categories. The remaining ones are cortex, partly cortex and natural forms. 26 flakes have two-directional and multi-directional scars and 90 have one-directional scars. The majority are flakes with smooth butts (55 specimens). The second-largest group are specimens with prepared butts (23 specimens). The remaining types of butts: cortex, dihedral, natural, linear and punctiform butts were identified on 45 specimens.

The greatest concentration of points indicating the size of the flakes falls into the length range between 10 and 30 mm, with a width of 10 to 32 mm. In the case of thickness, they ranged between 2 and 6 mm with a width between 13 and 40 mm (Fig. 6).

Blades. That group includes eight whole specimens and two top fragments. Their length ranges from 25 to 70 mm. They usually have an irregular outline and sometimes are slightly twisted in the longitudinal cross-section (Fig. 5: 6–11).

Sidescrapers. Only one such artefact was recorded. Regular edge retouching is present on the transverse and lateral edges (Fig. 7: 4).

Table 1. Wilczyce, Sandomierz district, site 10, feature 4. Classification of tools.

Inventory category	Length in mm	Width in mm	Thickness in mm	Raw material	Figures
Splintered piece	27,5	40	7,5	Świeciechów flint	4:1
Splintered piece	32,3	15	5,2	Świeciechów flint	4:2
Splintered piece	13	7,3	3	Świeciechów flint	4:3
Sidescraper	37	60	6,5	Świeciechów flint	7:4
Endscraper	63	37	5,5	Świeciechów flint	7:1
Endscraper	17,5	20	5	Świeciechów flint	7:6
truncated blade	40	17,5	4	Chocolate flint	7:2
truncated blade	28,5	6	3,5	Świeciechów flint	7:3
Borer	30	35	7	Świeciechów flint	7:7
Notched tool	15,5	28	3,5	Świeciechów flint	7:5
Retouched blade	30	36	8,5	Świeciechów flint	8:1
Retouched blade	46	14,5	5,5	Chocolate flint	8:2
Retouched blade	35	32,5	8,5	Świeciechów flint	8:12
Retouched flake	46,6	35,8	6,5	Świeciechów flint	8:5
Retouched flake	43,2	54,6	8,4	Świeciechów flint	8:10
Retouched flake	27,4	24	4,2	Świeciechów flint	8:3
Retouched flake	32,3	35,8	9,8	Świeciechów flint	8:8
Retouched flake	30	28,6	5,8	Świeciechów flint	8:7
Retouched flake	21,3	33,5	5,3	Świeciechów flint	8:6
Retouched flake	28,3	16,8	5,6	Świeciechów flint	8:4
Others	33,2	22,6	13,6	Świeciechów flint	8:11
Burin spalls	28,5	6	3,5	Świeciechów flint	8:9

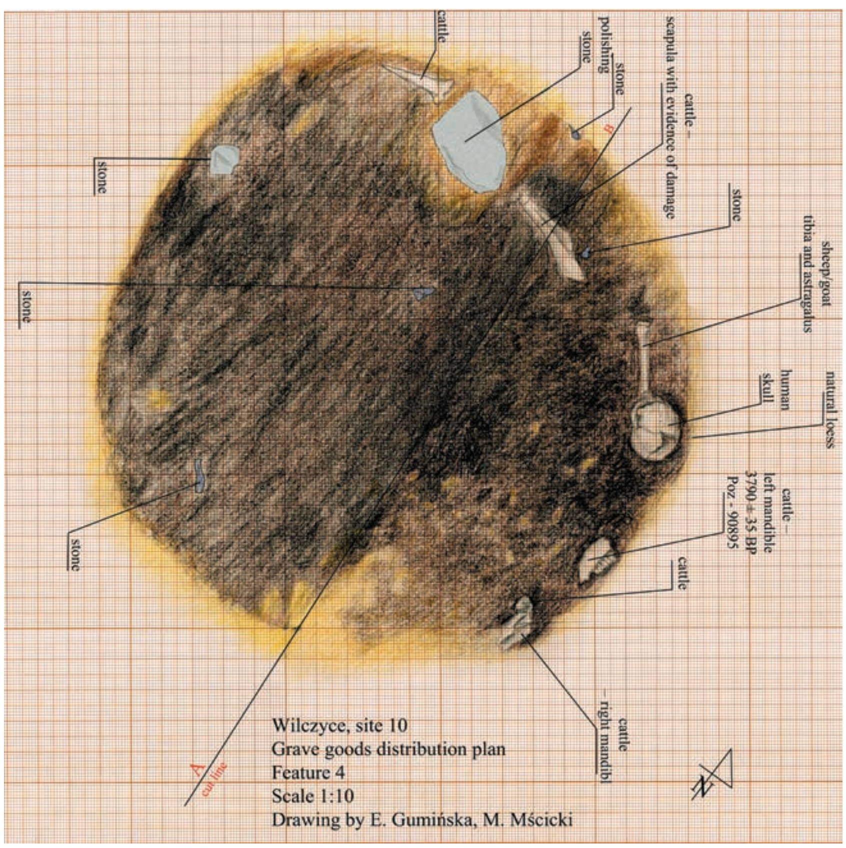

Fig. 3. Wilczyce, Sandomierz district, site 10, feature 4. Plan showing the spread of artefacts in relation to the location of the skull. Drawing by E. Gumińska, M. Mścicki (digitally remastered by A. Sołodko)

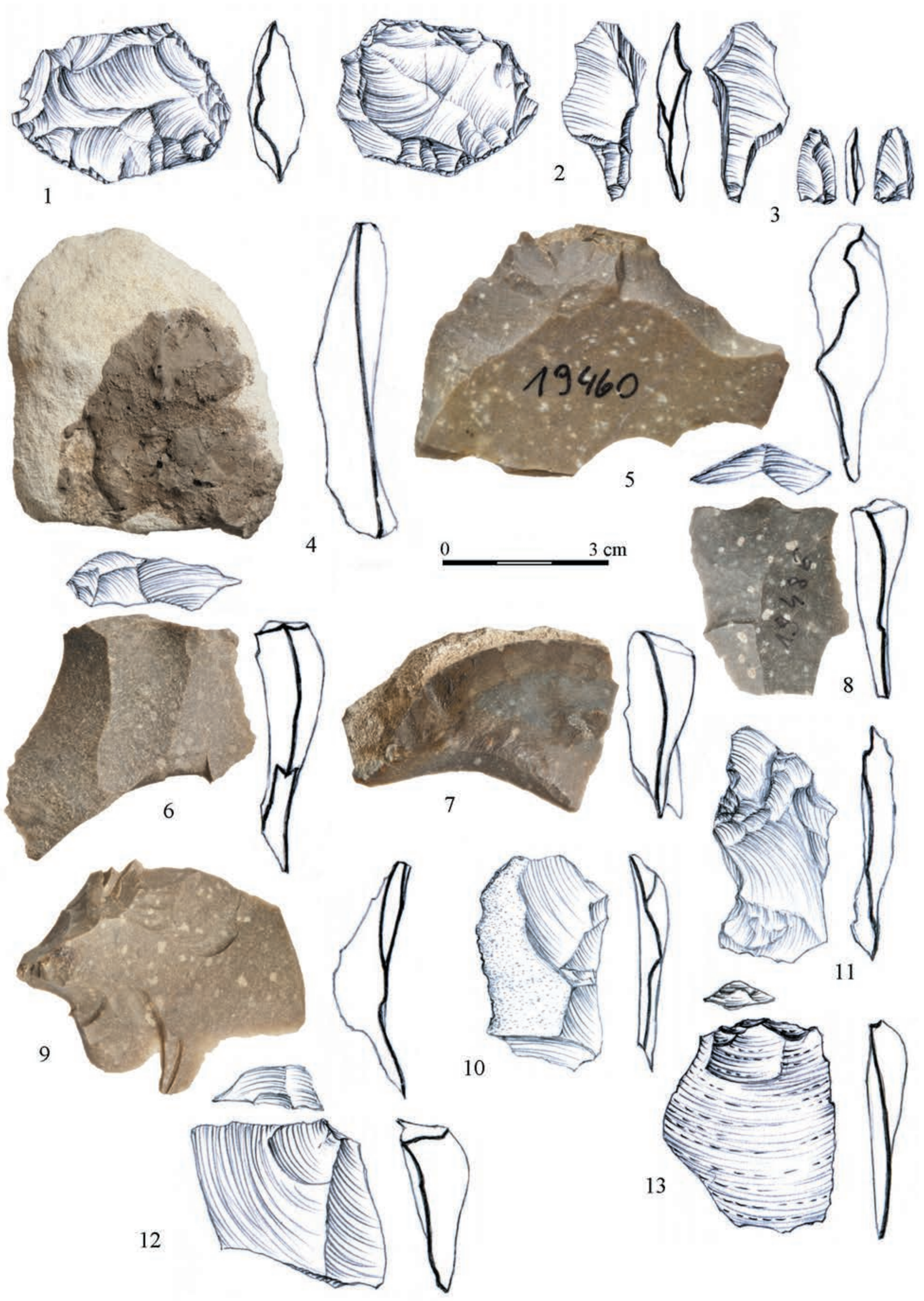

Fig. 4. Wilczyce, Sandomierz district, site 10, feature 4. Flint material from the backfill of the feature.
Photo by M. Osiadacz, drawing by E. Gumińska

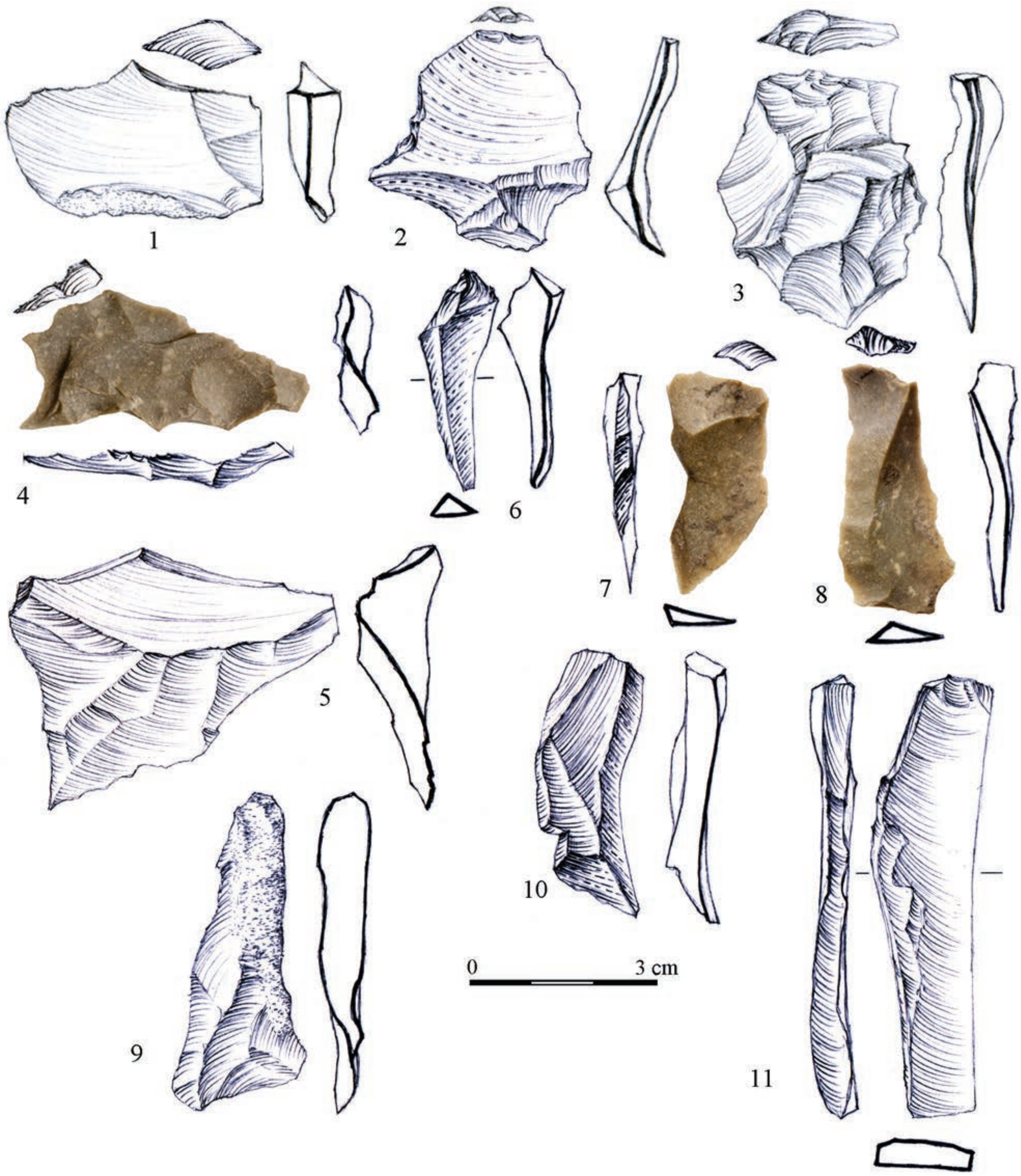

Fig. 5. Wilczyce, Sandomierz district, site 10, feature 4. Flint material from the backfill of the feature. Photo by M. Osiadacz, drawing by E. Gumińska

Endscrapers. Two specimens made from blades were identified. The first one is made from a large and chunky semi-raw material, and in addition, it has a retouched notch on the lateral edge (Fig. 7: 1), whereas the second specimen, with a rounded end-scraper front, was made from a blade with regular sides (Fig. 7: 6).

Truncated blades. Two specimens were identified. They were made from a blade of semi-raw material. In the case of the first one, the truncation was formed with a regular semi-abrupt retouching (Fig. 7: 2), while the other one has a fine edge retouching (Fig. 7: 3).

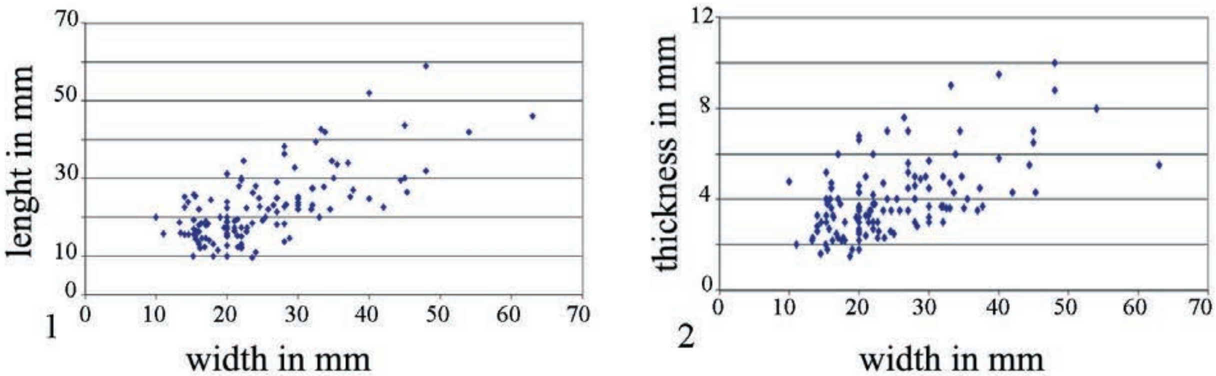

Fig. 6. Wilczyce, Sandomierz district, site 10, feature 4. Metric diagrams of flakes
Processing by T. Boroń.

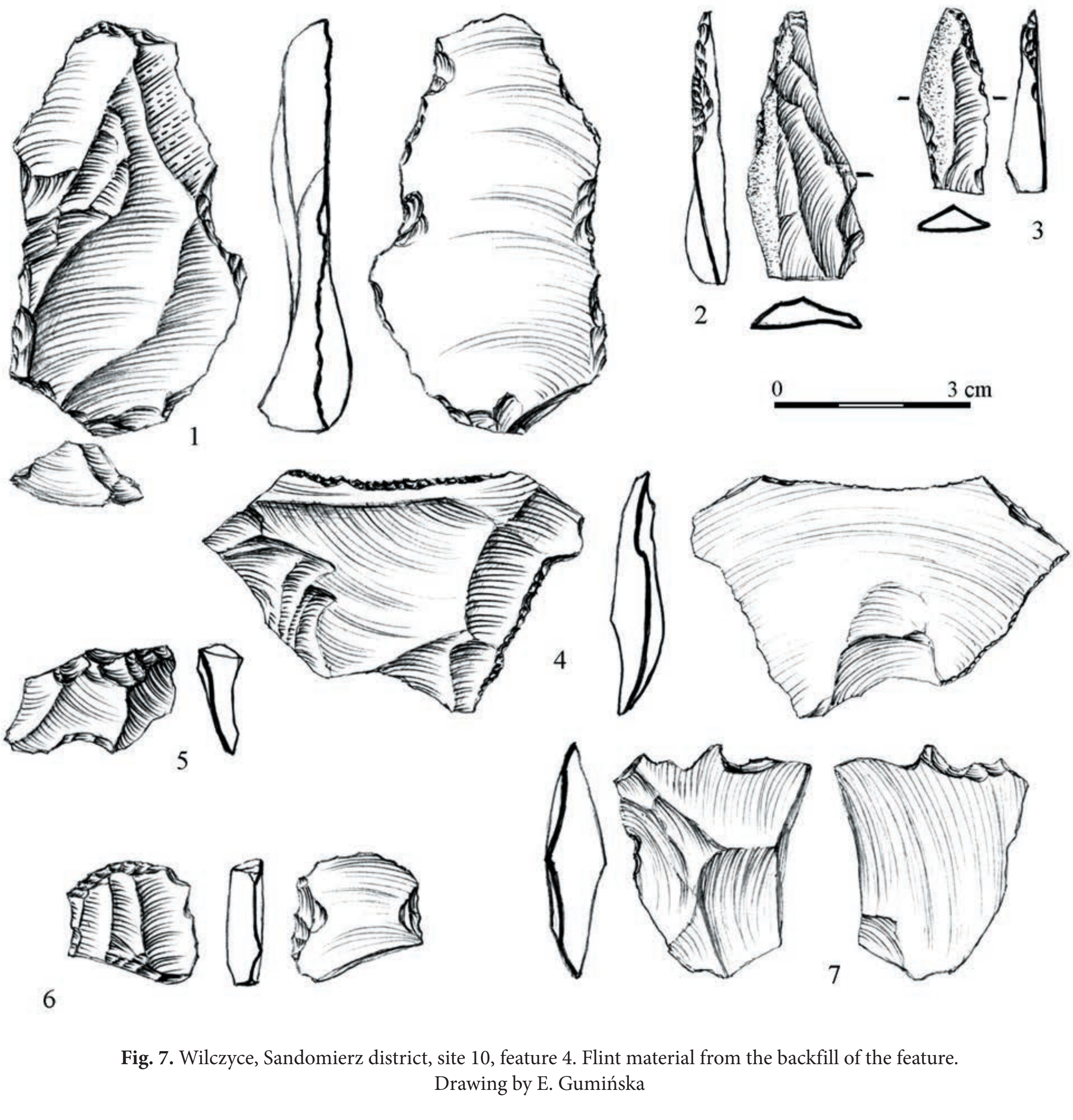

Fig. 7. Wilczyce, Sandomierz district, site 10, feature 4. Flint material from the backfill of the feature.
Drawing by E. Gumińska

Borers. There was only one specimen. The sting was formed with an abrupt retouching on the lateral edge of the blade (Fig. 7: 7).

Notched blades. One such specimen made from a flake was identified. The notch was formed with an abrupt retouching on the dorsal surface (Fig. 7: 5).

Retouched blades. There were three artefacts – one complete and two fragments. The retouching covers small sections of the edges and its abrupt, along the edge and flat (Fig. 8: 1–2, 12).

Retouched flakes. Seven specimens were identified. Their length ranges from 17 to 46.5 mm and the width from 14 to 54 mm. Edges are usually finely and irregularly retouched – less often abruptly retouched (Fig. 8: 3–8, 10).

Miscellaneous. Only one specimen was allocated to that category. It is a form with a plano-convex cross-section and a bifacial flint work on the dorsal surface. The base is oblique, while the sides are slightly arched (Fig. 8: 11).

Burin spalls. One waste was recorded (Fig. 8: 9).

Except for four specimens, (three made from chocolate flint and one from Jurassic flint), all remaining artefacts were made from Świeciechów flint. Taking into consideration the small distance between the site and the deposits of that raw material, this seems more than justified (Balcer 1971; 1975; Libera and Zakościelna 2002). However, as evidenced by studies on the use of the flint material on the Sandomierz Upland, the increase in the percentage of Świeciechów flint in the inventories from the Late Neolithic is a visible tendency (Kowalewska-Marszałek 2002).

Discoveries of that raw material are characterised not only by the number of specimens, but also larger size compared to the chocolate and Jurassic flint specimens – the length of the latter does not exceed 2.5 cm.

The largest group of finds retrieved from the fill of the discussed feature are made up of flakes. Many have technical properties such as dihedral butts, two- and multidirectional scars, and in particular, those correcting lateral surfaces and the broad side of the axe (Arnold 1981; Hansen and Madsen 1983, 53; Kopacz and Pelisiak 1988; Valde-Nowak 1994; Sałaciński and Migal 1997, 342; Mitura 2007; Boroń 2017).

During the experimental production of four-sided forms, researchers also removed blades characterised by specific parameters (Migal and Sałaciński 1996, 126) as well as those that can be referred to as pseudo-crested blades (Haßmann 2000, 137). Similar forms were identified in the assemblage of finds from feature 4 (Fig. 5: 6–8), whereas the blade presented in figure 5: 11 was removed from the lateral side of the axe. Only a few specimens indicate potential intentional blade exploitation (Fig. 5: 9).

We may almost certainly rule out the suggestion concerning the presence of technical forms indicating the preparation of blade cores, as the analysed material does not contain any evident examples of the blade semi-raw material from regular core exploitation.

Tools were produced mainly from large and chunky semi-raw material having a thickness of over 4 mm (Fig. 9).

It seems that, based on the description and the characteristic of the flakes and individual tools, the entire flint material represents a morphologically and technically homogeneous assemblage of artefacts. This is important since there are significant differences in the obtained C_{14} dates for the fill of the feature and the burial. The cultural uniformity of the finds is primarily stressed by the presence of flakes removed during the production of four-sided axes.

Of course, one could also consider the possibility of the production of bifacial bilateral tools. However, in such a case the flakes are usually fan-shaped and are slightly arched (Fouéré and Fourloubey 2012, 62; Grużdź 2012, 24).

Only the tool with the bifacially treated dorsal surface can be rather clearly linked to the early Bronze Age occupation of the site.

Functional analysis of selected flint artefacts

Selected flint artefacts discovered during the excavations of feature number 4 were subjected to microscopic analyses. Studies aimed at identifying the function of specific artefacts were conducted in relation to 17 flint tools and three splintered pieces.

Observations were performed with a stereoscopic and metallographic microscope using enlargements ranging from several to several hundred times. All identified transformations in the form of damage, wear, rounding, or burnishing were the basis for determining whether a specific find was used or not.

The conducted observations indicated the presence of microwear in the case of eight specimens. The first endscraper (Fig. 10: 1; 11: 1) has wear marks and burnishing that indicates its use for scraping hides. The retouching and burnishing visible on its side edges are the result of mounting it in a haft. The second endscraper (Fig. 10: 2; 11: 2, 3) has broken off pieces and retouching on both lateral edges that were used for processing bone or antler. In the case of the borer, no

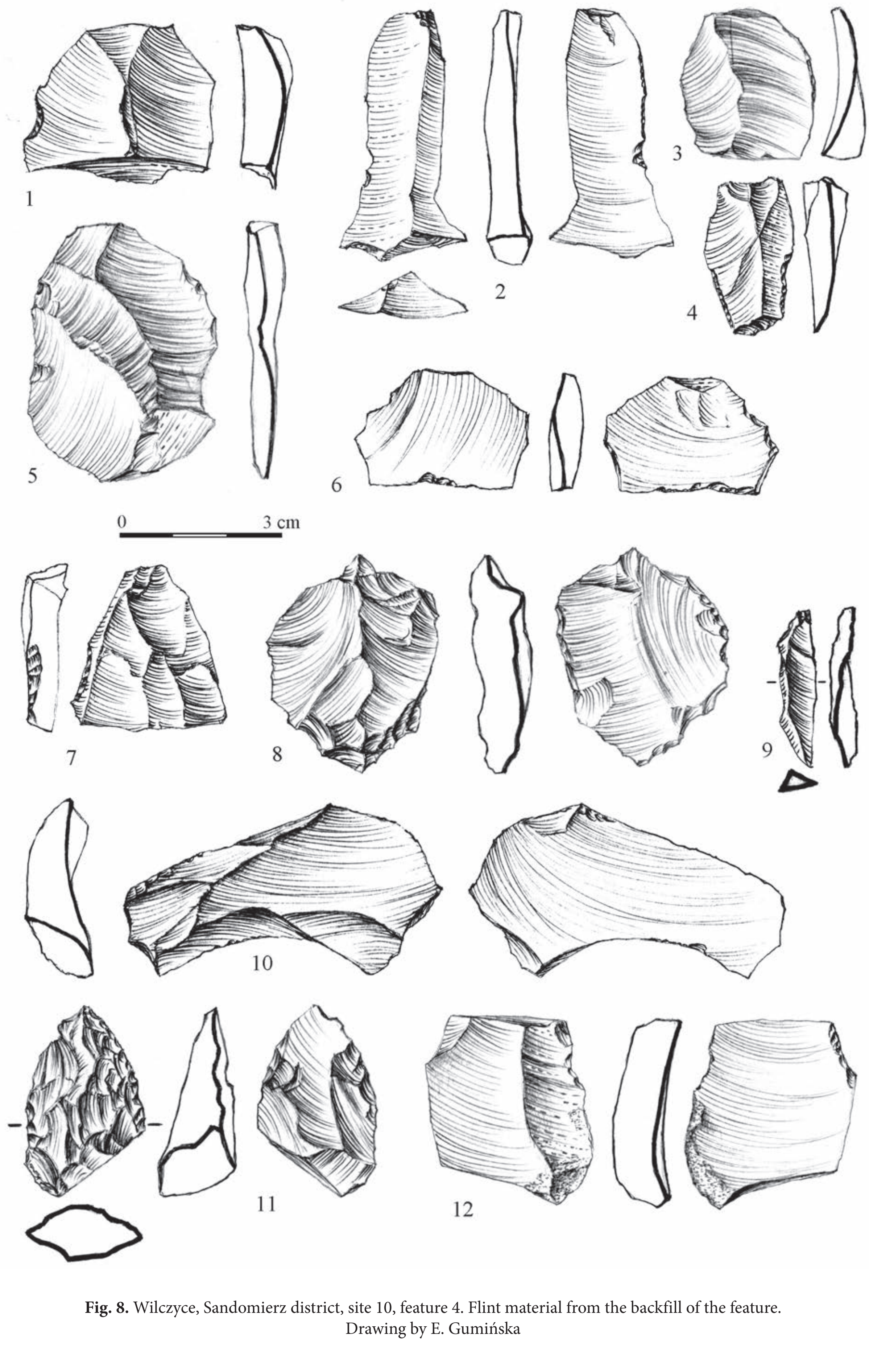

Fig. 8. Wilczyce, Sandomierz district, site 10, feature 4. Flint material from the backfill of the feature.
Drawing by E. Gumińska

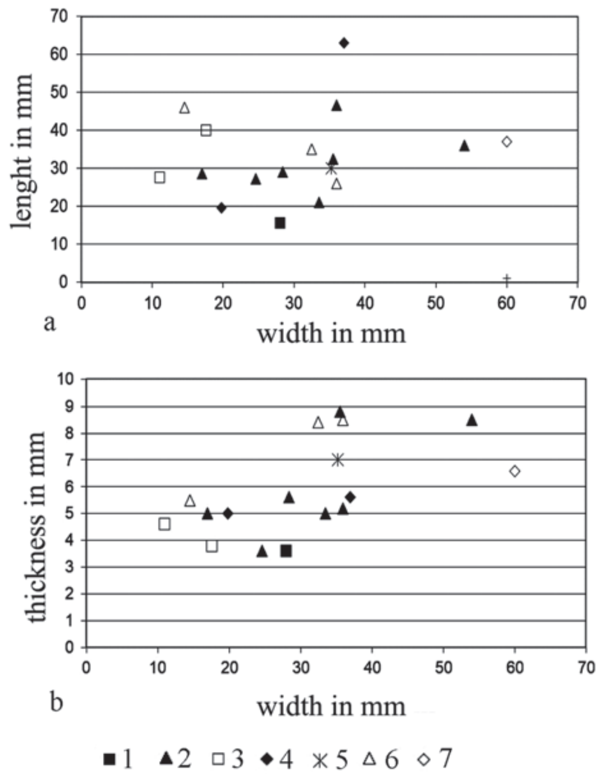

Fig. 9. Wilczyce, Sandomierz district, site 10, feature 4. Metric diagrams of tools. 1 – notched tools; 2 – retouched flakes; 3 – truncated blades; 4 – Endscrapers; 5 – borers; 6 – retouched blades; 7 – sidescraper. Processing by T. Boroń.

unequivocal evidence of its intentional use was recorded. Of the two truncated blades subjected to the analysis, one (Fig. 10: 3) was used for scraping some sort of a soft material. Transformations are visible both on the retouched edge and on the opposite, lateral edge, on which observations revealed very fine damage and burnishing, whereas in the case of the second truncated blade and the notched blade no use-wear was recorded. In the group of the three analysed retouched blades only one (Fig. 10: 4; 11: 4) had microwear on the side edge. The rounding and burnishing of the edges indicate its use for scraping hides. Three of the analysed retouched flakes had use-ware transformations. Damage recorded on the edge of the first specimen was caused by using it for cutting hide (Fig. 10: 5), another one (Fig. 10: 6; 11: 5) was used for working in wood, while the third one was used for scraping some sort of an unidentified material (Fig. 10: 7). The sidescraper was most probably used for scraping bone and meat (Fig. 10: 8), although in several places there are also traces indicating contact with hide, which may suggest work associated with meat jointing. In the case of the splintered pieces, no unequivocal evidence of their intentional use was identified.

The traseological analysis of finds revealed use-wear transformations on edges and surfaces of eight tools. They were specimens used for scraping and cutting hide, working with bone/antler, wood, scraping bone and meat and scraping other unknown soft material.

Stone material

In the fill of the grave pit, archaeologists recorded eight small scattered rock fragments. Some of them were forms that constituted parts of tools used for grinding or polishing, including a piece of an artefact that was perhaps originally a polishing stone (Fig. 15: 1) with a well-preserved, flat bottom surface and the roughly formed sides that were at a straight angle with the base and probably also with the originally present but now lost working surface. The discussed specimen was made of silica quartzite sandstone.

Also worth noting is the small fragment with three intentionally smoothed flat surfaces – the top one and two side surfaces. Originally it may have been a part of a polishing stone or another larger tool for grinding that after being damaged was adapted as a grinding stone (Fig. 15: 2). That tool was also made from a silica quartzite sandstone.

In the fill assemblage, there was one more tool for grinding or polishing made from an organogenic detrital limestone (Fig. 15: 3). It is a small fragment with only roughly defined features of its original morphology, with one smoothed flat surface. It is not characteristic enough to determine its specific function. However, the soft material from which it was made is interesting – it seems that this disqualifies that artefact as a potential quern.

The remaining specimens are probably natural rock fragments without traces of any treatment, which, however, may be non-specific pieces of larger tools.

Pottery

From the fill of feature 4 archaeologists retrieved 256 pieces of pottery vessels. The analysed material is characterised by strong fragmentation. The largest shard was 60×40 mm, while most fragments were under 20 mm. For this reason, it was not possible to determine the morphological types of the vessels from which they possibly came from. It was also impossible to identify shards that would allow the reconstruction of larger fragments of pottery containers. Thirteen fragments were classified as rim elements, five as bottom parts, and the remaining ones (238) were parts of bodies. The majority of the pottery material came from

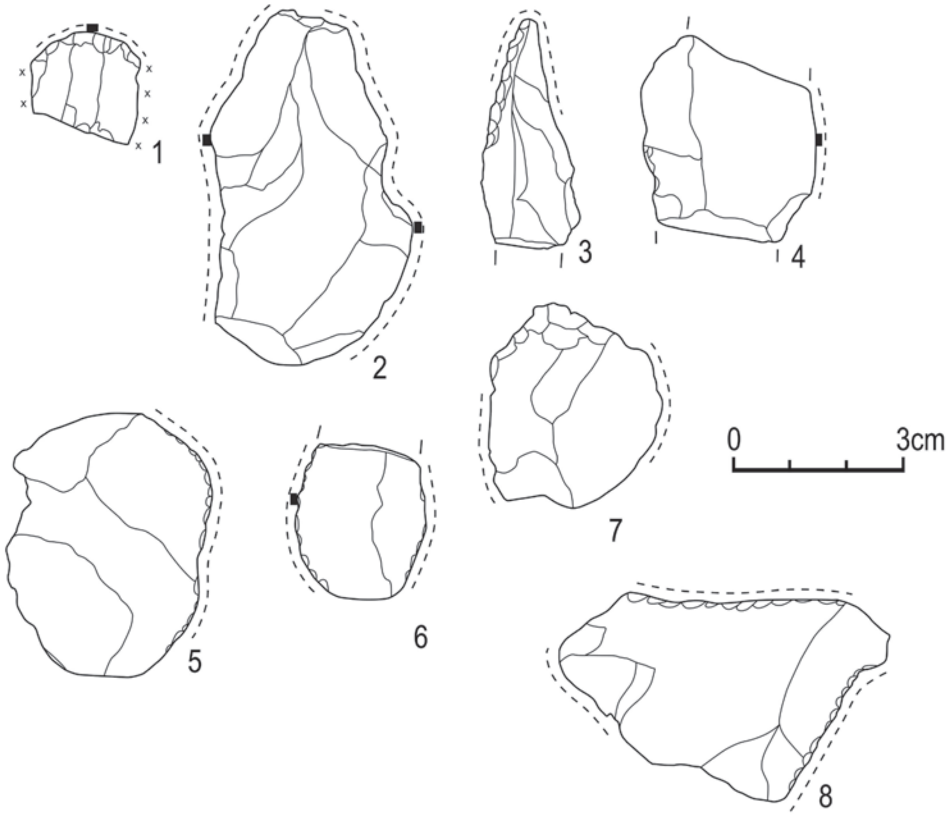

Fig. 10. Wilczyce, Sandomierz district, site 10, feature 4. Artefacts with evidence of use-wear: 1–2 endscrapers; 3 – truncated blade; 4 – retouched blade; 5–7 – retouched flakes; 8 – sidescraper. Drawing by M. Winiarska-Kabacińska.

vessels with fine or medium-thick walls, i.e. between 4 and 7 mm. The greatest recorded thickness of a pottery fragment was 10 mm. The presence of an intentional temper in the ceramic mass was observed in over half of the analysed shards (145 specimens). In each case it was a mineral temper, mostly fine-grain (grains with the diameter not exceeding 1 mm) or sometimes fine- and medium-grain. The lack of temper detected through macroscopic observations was recorded in the case of 109 fragments. Twelve of the discussed fragments (5 rims and 7 body parts) have traces of ornaments in the form of multiple horizontal impressions of a double-stranded twisted cord (Fig. 12: 1, 2). Four fragments of vessel body parts are decorated with impressions of rows of short vertical stamps (Fig. 12: 3), whereas the surface of one piece is fully covered with smudges made with a wisp of straw. In addition to the remains of pottery vessels, the fill of the pit included 41 small (33×29 mm or less) lumps of daub.

The allocation of the analysed pottery fragments to specific cultural provenance was very difficult because of their poor state of preservation and the deposition context. However, an attempt to do so was made, and it was established that the discussed material is definitely non-homogeneous. Some fragments were made from clay with the addition of pink and white quartz rubble and fine-grain sand, which is the most typical temper in the case of the Globular Amphora culture vessels (Szmyt 2010, 184; Czebreszuk *et al.* 2006). Also, the smooth and dark surface of some of the fragments have analogies with the pottery of the above-mentioned culture known from Wilczyce. A larger part of the fragments in the assemblage is characterised by light, matt surfaces and a small addition of temper in the form of fine-grained sand, which is characteristic of pottery vessels of the Corded Ware culture observed on the discussed site (Włodarczak *et al.* 2016, 36). This also applies to fragments decorated with impressions of the double-stranded, left twisted cord placed horizontally (Fig. 12: 1, 2) – a motif that is characteristic of the Corded Ware culture on the Sandomierz Upland (Włodarczak 2006, 16, 84). The archaeologists did not record any pottery fragments that would be characteristic of other Neolithic cultures, while several pieces were attributed to the early Bronze Age Mierzanowice culture. By way of summary, we can state that the discussed pottery assemblage has a Late Neolithic chronology or may

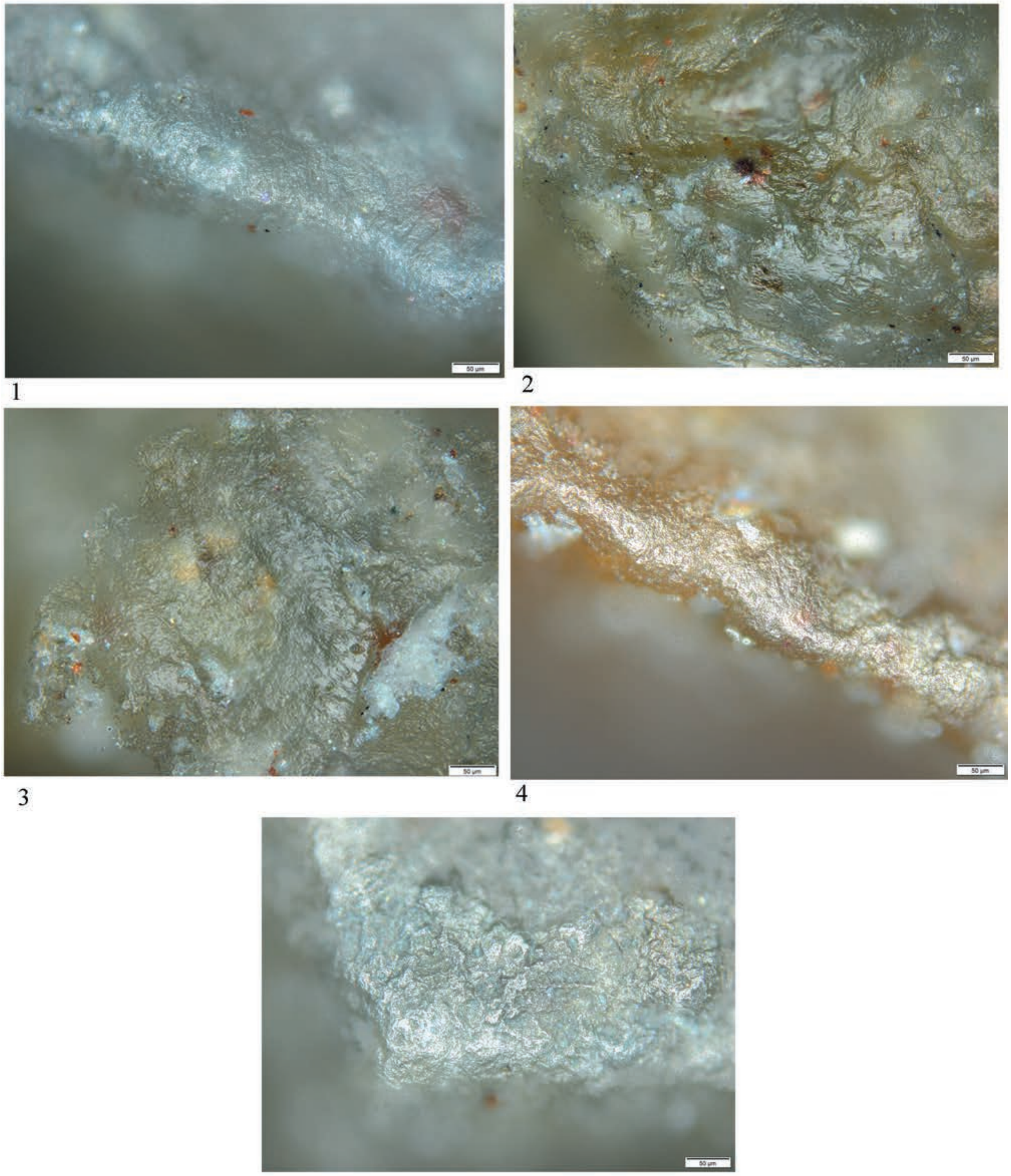

Fig. 11. Wilczyce, Sandomierz district, site 10, feature 4. Microscopic photographs: 1 – endscraper, scraping hide; 2–3 – endscraper, processing bone/antler; 4 – retouched blade, scraping hide; 5 – retouched flake, processing wood.
Photo by Drawing by M. Winiarska-Kabacińska.

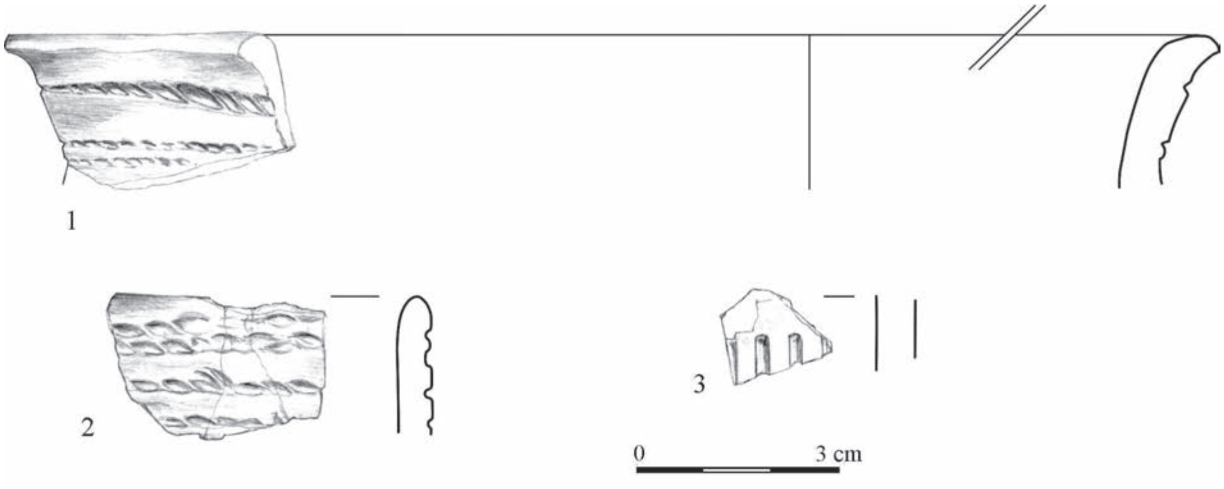

Fig. 12. Wilczyce, Sandomierz district, site 10, feature 4. Pottery material from the fill of the feature.
1–2 – rim fragments of the Corded Ware culture vessels decorated with cord impressions; 3 – a piece of a Globular Amphora culture vessel – body fragment decorated with a row of impressed vertical lines. Drawing by U. Nieckuła-Skwara.

be with a component dated to the turn of the Neolithic and the Bronze Age, which corresponds with the material discovered to date on the Wilczyce site. The depth of the deposition of individual fragments is not helpful for their cultural identification and dating. The material is mixed and thus it is only possible to state that the majority of vessel fragments (5 pieces), which most probably belonged to the Mierzanowice culture inventories, were possibly located in the upper parts of the fill of the feature. However, with such a small sample resulting from the poor state of the archaeological material, this data does not seem to be significant.

Bone artefacts and ornaments

During the exploration of the fill of feature 4, archaeologists discovered 2 artefacts: a bead and a perforator.

The bead is made from a long bone of an unspecified animal species. It has an irregular outline, and its surface is not smoothed. The hole bored in it has conical walls – with the larger diameter of 5 mm and the smaller one of 2.5 mm – and is visibly moved to the side of the artefact (Fig. 13: 1).

The perforator is made from a sheep/goat metatarsal bone. It is 26 mm long and 16.5 mm wide at the base, with a smoothed and rounded end (Fig. 13: 2).

Animal bones

The zooarchaeological analysis covered osteological material from the fill of feature number 4 consisting of fragments of bones and animal teeth, 282 animal remains in total, of which the majority – 271 – were animal bones.

The state of preservation of animal remains submitted for the analysis was relatively good, as indi-

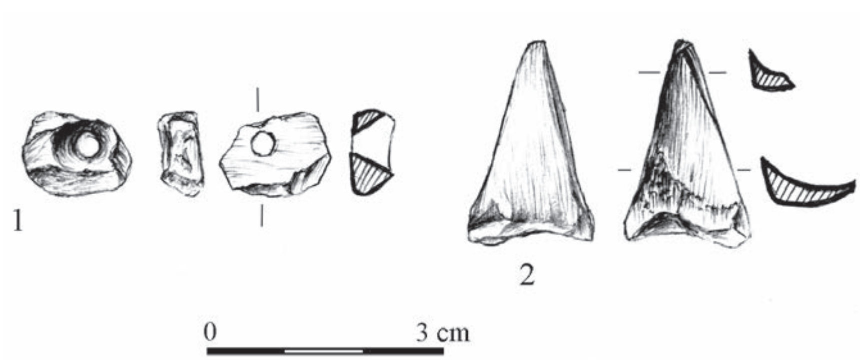

Fig. 13. Wilczyce, Sandomierz district, site 10, feature 4. Bone artefacts and ornaments from the backfill of the feature.
Drawing by E. Gumińska.

cated by the percentage of fragments that were identifiable in the terms of their species and anatomical origin (Table 2). The remains were broken into small fragments and some pieces were only parts of cortical bone without distinctive features. The greatest impact on the state of preservation of the osteological material in terms of taphonomy had the third, diagenetic stage. Bone remains were largely deprived of organic components, which resulted in their substantial fragility. They were deposited in the environment characterised by the relatively intensive penetration of groundwaters, which had a damaging effect on the general state of preservation of organic sources. The long period of the deposition of the osteological material in the soil also took its toll.

Table 2. Wilczyce, Sandomierz district, site 10, feature 4. Animal remains – general assessment.

	N	%
remains identified	240	85,1
remains unidentified	42	14,9
Total	**282**	**100**

The scientific value of the animal remains was additionally affected by biostratinomic factors. Undoubtedly, the large part of the remains was treated during consumption, including their strong fragmentation. This was indicated by the shape of some fragments, as well as the damage recorded through macroscopic observations – the result of using tools for meat jointing.

In the course of the standard zooarchaeological analysis, researchers identified species and anatomic parts of both bone fragments and teeth. The remains were also analysed in terms of age, sex, and the potential identification of the morphological type of animals.

Bone remains of sheep and goat, because of the morphological similarity of their skeletons, were analysed as one group – "sheep/goat", in accordance with the rules of identification described by zoologists (Schramm 1967; Halstead *et al.* 2002; Zeder and Lapham 2010; Zeder and Pilaar 2010) – which is commonly applied a practice in zooarchaeological analyses (Lasota-Moskalewska 2008).

The bone material was analysed in the context of its discovery, taking into consideration two identified locations: (1) the fill of the feature and (2) bones construed as elements of deposit associated with the with human skull.

The anatomical identification consisted of the cataloguing of individual parts of the skeleton from which the given animal remains came from. On that basis, it was possible to create anatomical distributions of the fragments of the identified species, and then divide the material into seven groups depending on their location in the skeleton: 1. the *head* – skull, horn cores, antlers, hyoid bone, mandible, teeth; 2. the *trunk* – vertebra, sacrum, sternum, rib; 3. *proximal forelimb* – scapula, humerus, radius, ulna; 4. *distal forelimb* – carpal bones, metacarpal bones; 5. *proximal hindlimb* – hip bones, femur, patella, tibia, fibula; 6. *distal hindlimb* – tarsal bones, metatarsal bones; and 7. *digital bones* – phalanges I, phalanges II, phalanges III (Fig. 14).

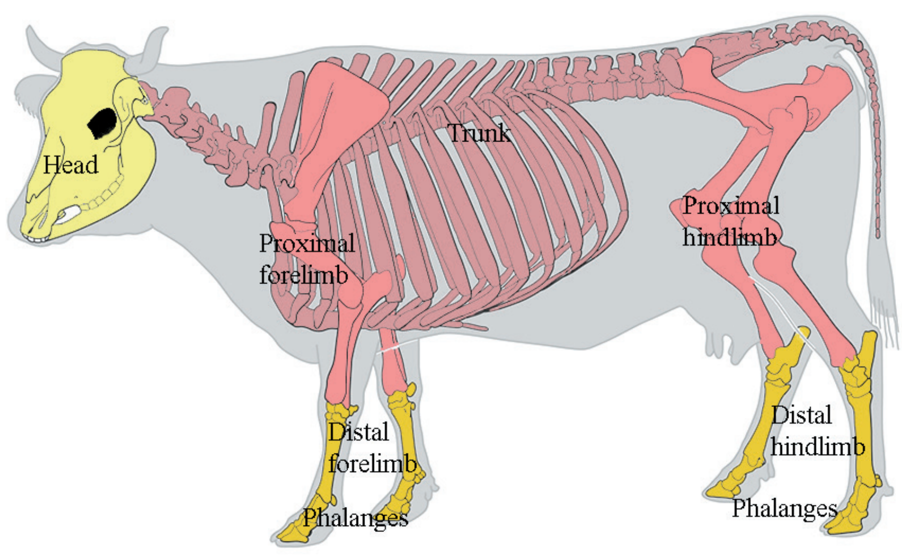

Fig. 14. Technological division of carcase chart (according to Krysiak *et al.*, 2007, with supplementary information by M. Osypińska; downloaded from: www.://ilsewielage.nl/en/scientific-illustration/).

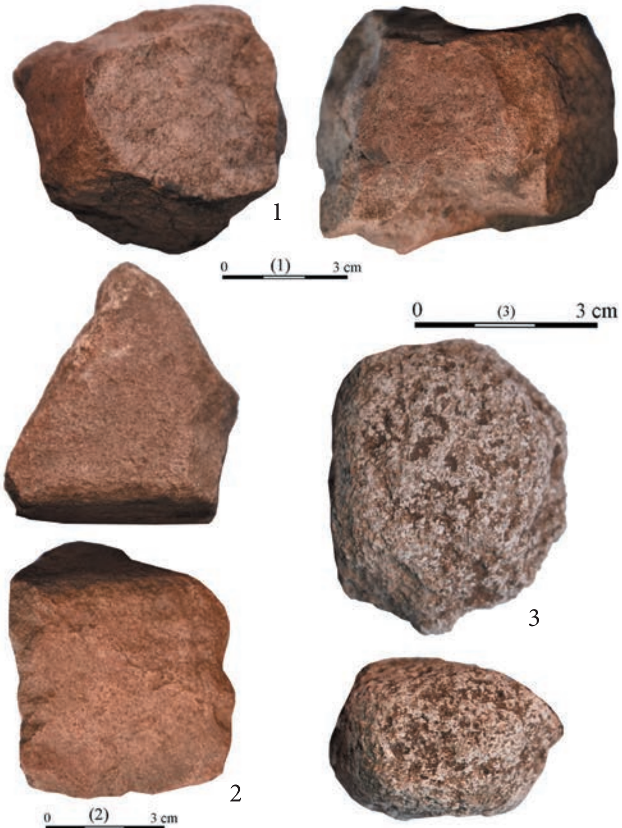

Fig. 15. Wilczyce, Sandomierz district, site 10, feature 4. Stone material from the backfill of the feature. Photo by K. Kerneder-Gubała.

The number of the anatomically identified remains is stated in accordance with the division into above-mentioned groups. The analysis covered anatomical distributions for cattle, pig, and sheep/goat, with special attention paid to the presence of phalanges and the balance between the number of bones of the forelimb and hindlimb. The lack of balance between those two categories of remains was defined as the difference of 10% or more.

When discussing the results of the analysis, the following terms were used: a part of the carcass which was attractive or unattractive in terms of consumption. Attractive are those animal body parts that have the most muscles and fat. Thus, according to the division adopted in this paper, these were: the trunk and proximal forelimb and hindlimb, while the head, distal forelimb and hindlimb, and phalanges have less value for the consumer (Lasota-Moskalewska 2008). The main criterion of the above-mentioned division is the energy value of the part of the carcass associated with individual anatomical elements.

Reference lists of bones in skeletons of relevant species obtained through experiments (Lasota-Moskalewska, 2008) were compared with the analysed finds in order to check to what extent the anatomical composition of the remains from the feature number 4 had been modified.

The evaluation of the animals' death age was done by observing the progress of the degree of the ontogenetic development of bones and teeth (Kolda 1936; Chaplin 1971; Lutnicki 1972; Müller 1973). Bones with preserved diagnostic morphological elements were subjected to the osteometric study based on standardised data (Driesch von den 1976). The state of teeth development was analysed based on data collected by Müller (1973). The age at death was also evaluated by looking at the degree of long bone fusion (Kolda 1936; Chaplin 1971). Based on those methods, it was possible to identify the bones and teeth of adolescent and very young animals. The first category includes animals that are already grown but still morphologically immature.

The analysis of the morphology was conducted based on the measurements performed in accordance with the rules unified by Driesch (1976) and using the relevant coefficients (according to Całkin, Schramm, Teichert, Kiselwalter, Matolcsi, Koudelka quoting von den Driesch and Boessnackiem 1974). The morphological type of cattle was reconstructed using the point scales constructed by Lasota-Moskalewska, Kobryń and Świeżyński (1987). That method enables the conversion of absolute metric values into relative values expressed in the scale from 0 to 100 points. In the case of cattle, the point scale was divided into three groups representing small (0–3 points), average (31–69 points), and large (70–100) size.

Animal remains discovered in the fill of feature number 4 only belonged to mammals (*Mammalia*). Most of them (53.44%) are fragments of skeletons of small wild-living rodents naturally present in the discussed habitat (Table 3), whereas the remaining part of the osteological material constituted bones of breeding animals – sheep, goat, pig, and cattle (Table 3). Generally speaking, the largest group consists of skeletal fragments of small ruminants – sheep and goat (33.19%), where only sheep bones (*Ovis orientalis* f. *domestica*) were precisely identified. The second largest group constituted remains of domestic pig (*Sus scrofa* f. *domestica*) and the *Suidae* family. The third species identified in feature number 4 was cattle (*Bos primigenius* f. *domestica*), the remains of which constituted only a small percentage of the osteological material (2.15%). The analysis of the anatomical distribution, due to the relatively small frequencies of remains in species groups, was carried out only with re-

Table 3. Wilczyce, Sandomierz district, site 10, feature 4. Species distribution of animal remains in feature fill.

Taxon	N	%
sheep / goat *Ovis orientalis* f. *domestica*/ *Capra aegagrus* f. *domestica*	74	33,19
sheep	3	
pig *Sus scrofa* f. *domestica*	20	11,20
suidae Suidae	6	
cattle *Bos primigenius* f. *domestica*	5	2,15
rodent *Rodentia*	124	53,44
identified (NISP)	**232**	**100/ 85,60**
mammals *mammalia*	11	14,40
unidentified	28	
Total	**271**	**100**

Table 4. Wilczyce, Sandomierz district, site 10, feature 4. Anatomical distribution of sheep / goat, pig and cattle remains in the feature fill.

Bone	Sheep/goat		pig	cattle	
	fill	deposit	fill	fill	deposit
cranium	7				
maxilla					2
dentes	5		10		
vertebrae	25				
costae	5				
scapula					1
humerus			3	1	
radius	3		1		2
ulna	1				
o. metacarpalia	3			1	
o. carpi					1
femur	7		2		
tibia	3	1	4		
talus		1			
o. tarsi	3				
o. metatarsi				1	
Long bone	15			2	

gard to putting together numeric and frequency data (Table 4). In terms of anatomy, the skeleton of small ruminants was the most completely represented (Table 4). In the fill, archaeologists recorded fragments of skull, teeth, fragments of the vertebra, radius, metacarpal bones, ulna, femur, tibia, and tarsal bones. In terms of division according to meat jointing, remains of the small ruminants were dominated by elements of the trunk (Table 5). A relatively high frequency was also observed in relation to fragments of the head and the proximal hindlimb (Table 5). There were several fragments from the proximal forelimb, distal forelimb, and distal hindlimb. The fragments of pig bones discovered in the fill of the grave generally came from three parts of the carcass: the head, proximal forelimb, and proximal hindlimb, i.e. elements believed to be the most attractive for consumption purposes. Cattle remains discovered in the fill of feature number 4 came from three parts of the carcass according to the meat jointing division: the proximal forelimb, distal forelimb, and the distal hindlimb (Table 5). Remains of immature animals were recorded only in the group of pig bones. These were several elements of the skeleton from an individual which was slaughtered or died at a very young age (around 1-month-old), and a bone of an animal that was killed as a juvenile.

Due to the lack of distinctive features on the preserved animal remains it was not possible to identify their sex. Also, obtaining data concerning the morphology of breeding animals was very limited because of the significant fragmentation of finds, particularly in the case of the remains discovered in the fill of feature number 4. There were no ruminant horn cores recorded in the assemblage.

None of the analysed bones had evidence of pathological changes, whereas in the fill of feature number 4 archaeologists discovered bone fragments bearing marks associated with use-wear or craft and butchery (Table 6). Damage associated with consumption included burn marks on bones, charring, and cuts

Table 5. Wilczyce, Sandomierz district, site 10, feature 4. Anatomical distribution of animal remains according to technological segregation.

Carcass part	Cattle		sheep / goat		pig
	fill	deposit	fill	deposit	deposit
head	0	2	13	0	10
trung	0		30	0	0
Proximal part of the forelimb	1	3	4	0	4
Distal part of the forelimb	1	1	3	0	0
Proximal part of the hindlimb	0	0	10	1	6
Distal part of the hindlimb	1	0	3	1	0
phalanges	0	0	0	0	0

that were made when dividing carcasses into smaller meat joints (Table 6).

Table 6. Wilczyce, Sandomierz district, site 10, feature 4. Taphonomy.

Inventory	Species	Bone	damages
19285	sheep	femur	traces o burning
19350	unidentified	long bone fr.	charred
19472	cattle	scapula	Marks of damages by blade
19658	sheep/goat	vertebra fr.	Traces of cutmarks

Plant macroremains

The site in Wilczyce is located on loesses that form the northern European loess belt (Solarska *et al.* 2013). Some xerophile steppic plant communities survived there, including the most well-known concentrations of such plants on the hills near the town of Sandomierz – Góry Pieprzowe (Głazek 1980). Based on the maps of the potential natural vegetation (Matuszkiewicz 2008) in the contemporary climate, the site should be covered mostly by subcontinental lime-hornbeam forests of the *Tilio cordatae-Carpinetum betuli* class and on relatively large areas by thermophilous oak woods *Potentillo albae-Quercetum* (Matuszkiewicz 2007). Currently, those fertile lands are largely under cultivation.

In total, 126 samples of wood were taken for analysis. The size of individual charcoals was similar, with the smallest dimension of around 5 mm.

The taxonomic identification was performed based on the difference in the anatomic structure of wood, using F. Schweingruber's key (1976) and the author's own anthracological reference collection.

Several identifications of samples were left at the genus level, since the identification of some tree species on the basis of their anatomical structure alone is impossible or very unreliable (Lityńska-Zając and Wasylikowa 2005).

In the discussed feature, archaeologists discovered the remains of two taxons of woody plants. In terms of numbers, the dominant taxon was oak *Quercus* sp. – 121 burnt fragments of wood belonging to that genus were identified. The second taxon discovered in the sample was Baltic pine *Pinus sylvestris*, represented by only 5 charcoal specimens. The wood of both representatives of trees came from trunks or thick branches.

In the case of human activity, such a small variety of species is puzzling. It is possible that due to the method of taking samples (charcoals from selected concentrations were collected) we deal with remains that come from individual logs that fell apart into small fragments creating accumulations of charcoals.

However, we must remember that charcoal remains should be interpreted in the relevant context, i.e. in relation to the archaeologically analysed evidence of human activity. There are three key context groups of anthracological finds: wood sourced selectively because of its desirable properties, wood having ritual value, and wood collected accidentally (Chabal 1988, 195). Without doubts, we may also presume that firewood was selected already at the time of the functioning of the settlements. Oak wood has very high energy value and thus constitutes a desirable fuel.

Despite the too small number of identified charcoals that are required to create a paleoenvironmental reconstruction (Théry-Parisot *et al.* 2010), the analysed material may constitute remains of wood that reflect the actual species composition of forest communities that were present at the discussed site in the Preboreal period.

Isopollen maps (Ralska-Jasiewiczowa *et al.* 2004) indicate a relatively large percentage of oak pollen in the discussed area at the time of the Globular Amphora culture occupation of the site (Milecka *et al.* 2004). The same applies to pine (Latałowa *et al.* 2004). Results of palynological analyses from Czajkowo (Szczepanek 1971), Krasne (Kołaczek 2007), and Poręby Wojsławskie (Chodorowski *et al.* 2013) located relatively close to Wilczyce also present a high spectrum of both taxons in parts of the profiles identified with the Preboreal period.

Thus, it is possible that around 4,000 years BC the environs of Wilczyce were covered by thermophilous oak woods, close to the contemporary *Potentillo albae-Quercetum* forest communities dominated by oak with the steady participation of pine.

As the result of the activity of the early farmers tribes (primarily animal husbandry), oak woods that survived from the Atlantic period were transformed into light forests dominated by one taxon. An analogous situation probably also took place in the case of the Miechów Upland (Moskal-del Hoyo *et al.* 2017).

Human remains

Anthropological analysis

The anthropological analysis was carried out in accordance with the commonly adopted standards for determining sex and assessing age at death (White and Folkens 2005).

The skull (19476) had a delicate structure, the right part of the skullcap had suffered secondary damage. It has unfused sutures and non-ossified spheno-occipital synchondrosis. On the squamous part of the frontal bone, the frontal suture – *sutura metopica* – was preserved, frontal tubers defined, sharp supra-orbital margin, squamous part of the occipital bone rather delicately defined, left mastoid part of the temporal bone is small, the right one is damaged (Fig. 16).

Based on the values of the cranial indices (Table 7), it can be classified as mesocephalic (the value of the main index 76) with a broad forehead (the forehead breadth index of 71.6). The face part almost complete, damaged right zygomatic arch. Orbits symmetrical, high (the orbital index: 88.2), moderate nose (the nasal index: 48.9), with a slight convex profile. *Tuberculum marginale* of the zygomatic bone present on the right side. *Foramen magnum* narrow (the foramen magnum index: 77.1). All cranial bones with a visible perforation of the bone tissue of various intensity, particularly strongly observable on maxillas, indicating the presence of scurvy (Brickley and Ives 2006)

Recorded on the right side of the cranial base was the enlargement of the jugular foramen with smoothed edges (Fig. 17).

Fig. 16. Wilczyce, Sandomierz district, site 10, feature 4, skull 1947: a – *norma frontalis,* b – *norma lateralis*. Photo by A. Szczepanek.

Fig. 17. Wilczyce, Sandomierz district, site 10, feature 4, skull 1947 – *norma basilaris*. Photo by A. Szczepanek.

The asymmetrically enlarged jugular foramen with smooth edges may be a variation of the anatomical structure of that part of the skull or may result from a disease process caused by the thrombophlebitis of the internal jugular vein, arteriovenous malformations (angiomas), nerve sheath tumour or a meningioma (Caldemeyer *et. al.* 1997). The larger foramen on the right side is recorded more often (Skrzat *et. al.* 2016). The above-mentioned disease entities have similar symptoms that primarily manifest themselves in long-term headaches and tinnitus (Yang *et al.* 1997). Modern health diagnostics that allows establishing the aetiology of the disease process is based on various imagining techniques (CT scan, NMR spectroscopy) combined with the histopathologic analysis and recording clinical symptoms. Those medical exams allow health practitioners to make a correct diagnosis and then start a relevant treatment. In the case of bone material such a complex approach is not possible, but even assuming that the enlargement of the jugular foramen was pathological, it was not the direct cause of death.

The maxillas has all of its permanent teeth, only slightly worn. The M3 molars are in the eruption stage while the maxillary lateral incisors show partial rotation (Fig. 16).

M3	M2	M1	P2	P1	C	I2	I1	I1	I2	C	P1	P2	M1	M2	M3

Based on the state of the progress of the morphological development of the skull, the age at death was established as *Iuvenis*, and the delicate structure of the bones suggests that the skull belonged to a female.

Finds discovered at the level of the skull

Animal bones

Finds from feature number 4 discovered at the same level as the human skull included a small assemblage of bone fragments belonging to two species of breeding animals: cattle (*Bos primigenius* f. *domestica*) and sheep (*Ovis orientalis* f. *domestica*). In the case of cattle, the entire mandible and fragments of the right forelimb – the scapula (Fig. 18) – were deposited next to the skull. Sheep remains came from the hindlimb. These were the tibia and the astragalus from the right limb (Fig. 19).

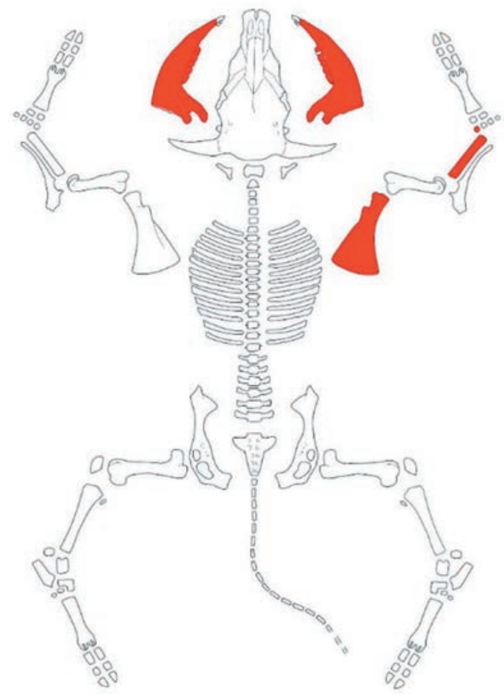

Fig. 18. Wilczyce, Sandomierz district, site 10, feature 4. Elements of cattle skeleton deposited in the vicinity of the human skull (according to M. Coutureau, after D. Helmer, 1987: n. 1, fig. 5, with supplementary information by M. Osypińska).

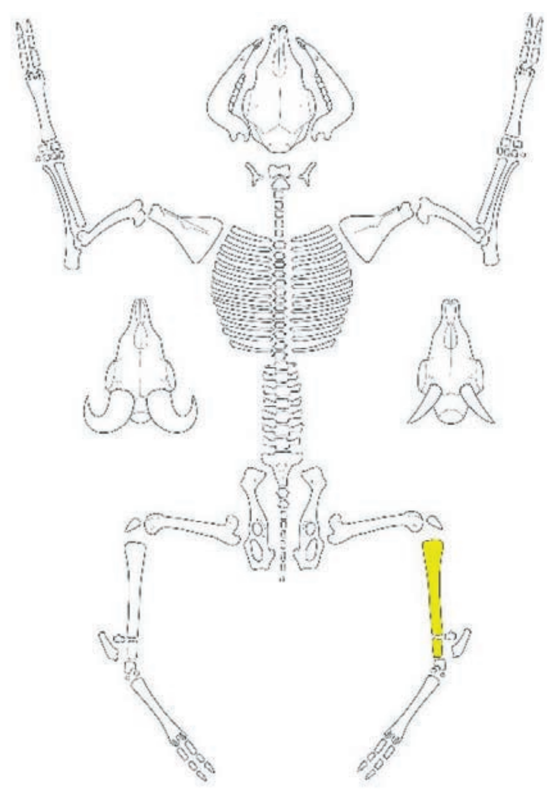

Fig. 19. Wilczyce, Sandomierz district, site 10, feature 4. Elements of sheep skeleton deposited in the vicinity of the human skull (according to M. Coutureau, after D. Helmer, 1987: n. 1, fig. 6, with supplementary information by M. Osypińska).

The only cattle bones with preserved features allowing for making measurements were discovered in the deposit (Table 8). Both values obtained through measurements were transposed to point scales (Lasota-Moskalewska 2008), providing the basis for the evaluation of the size of the individual(s) from which they came from – they corresponded with the properties of a medium-large and large cattle (Table 7).

Table 7. Wilczyce, Sandomierz district, site 10, feature 4. Measurements and skull indexes.

Measurement		**Index**	
g-op	175	eu-eu/g-op	76,57
eu-eu	134	ba-b/g-op	76,57
ft-ft	96	ba-b/eu-eu	100,00
ba-b	134	ft-ft/eu-eu	71,64
mf-ek	34	n-pr/zy-zy	53,85
sbk-spa	30	szer.a.pir/n-ns	48,98
szer. a. pir.	24	sbk-spa/mf-ek	88,24
n-ns	49	szer.f.m./ba-o	77,14
n-pr	63		
zy-zy	117		
ba-o	35		
szer.f.m.	27		

Table 8. Wilczyce, Sandomierz district, site 10, feature 4. Osteometry – cattle remains which are the part of the deposit.

Bone	Measurements (mm)	Points
scapula	SLC-59,01	79
radius	Bp-89,11	49

Also, the two sheep bones subjected to the osteometric study came from the deposit. The obtained data made it possible to calculate the approximate withers height of the individual (Table 9). It was a relatively large animal, with a withers height of approximately 74.8 cm.

Data collected through the above-mentioned zooarchaeological analyses provides the basis to propose a preliminary hypothesis that the animal bones discovered as elements of deposit associated with feature number 4 may have been "consumption offerings", i.e. providing the deceased with meat, whereas they were not meant to ensure the company of animals as such. We can also tentatively assume that beef in particular may have been a prestigious deposit. It is difficult to assess the importance of furnishing the burial with the entire cattle mandible. Because of the low consumption value of that part of the beef carcass, the symbolic meaning of the presence of the cattle mandible in the "equipment of the deceased" seems probable. However, it is possible to hypothesize that other remains were intended for consumption. In the case of cattle, this was the "shoulder", while in the case of sheep – the "leg".

Table 9. Wilczyce, Sandomierz district, site 10, feature 4. Osteometry – sheep remains which are the part of the deposit.

Bone	**Measurements (mm)**	**withers height (cm)**
tibia	Bd-29; SD-17	
talus	GLI-33; GLm-30,3; Bd-20,02	74,8

Stone material

Four stone artefacts were discovered in feature number 4, at the level of the human skull. The first one is a piece of a chunky tool with a concave working surface and the surviving natural structure of the rock. The bottom of that artefact is unworked and convex. Its sides create a straight angle with the working surface. Evidence of use-wear in the form of scratches or crushed surface are not legible (Fig. 20: 1). Both the concave shape of the working surface and its angle vis- à -vis the back surface and the sides, as well as the bulk of the tool, suggest that it may have been used as a quern. However, it possible that it was subsequently reused as a polishing stone, as such artefacts often have similar forms (Balcer 2006).

The second specimen was located in a similar context – on the perimeter on the floor of the feature. It is probably a slab with an amorphic shape and one flat surface with visible traces of use in the form of hollows, scratches, and chips (Fig. 20: 2).

Those specimens were made from local sedimentary rock. The quern was produced from a silica quartz sandstone, which is a very durable, hard, good quality raw material appropriate for long-term rubbing and grinding. The slab is made from an organogenic detrital limestone, also of local provenance, from Tertiary sediments, which is loosely compacted and prone to weathering, thus it is not a good raw material for making querns.

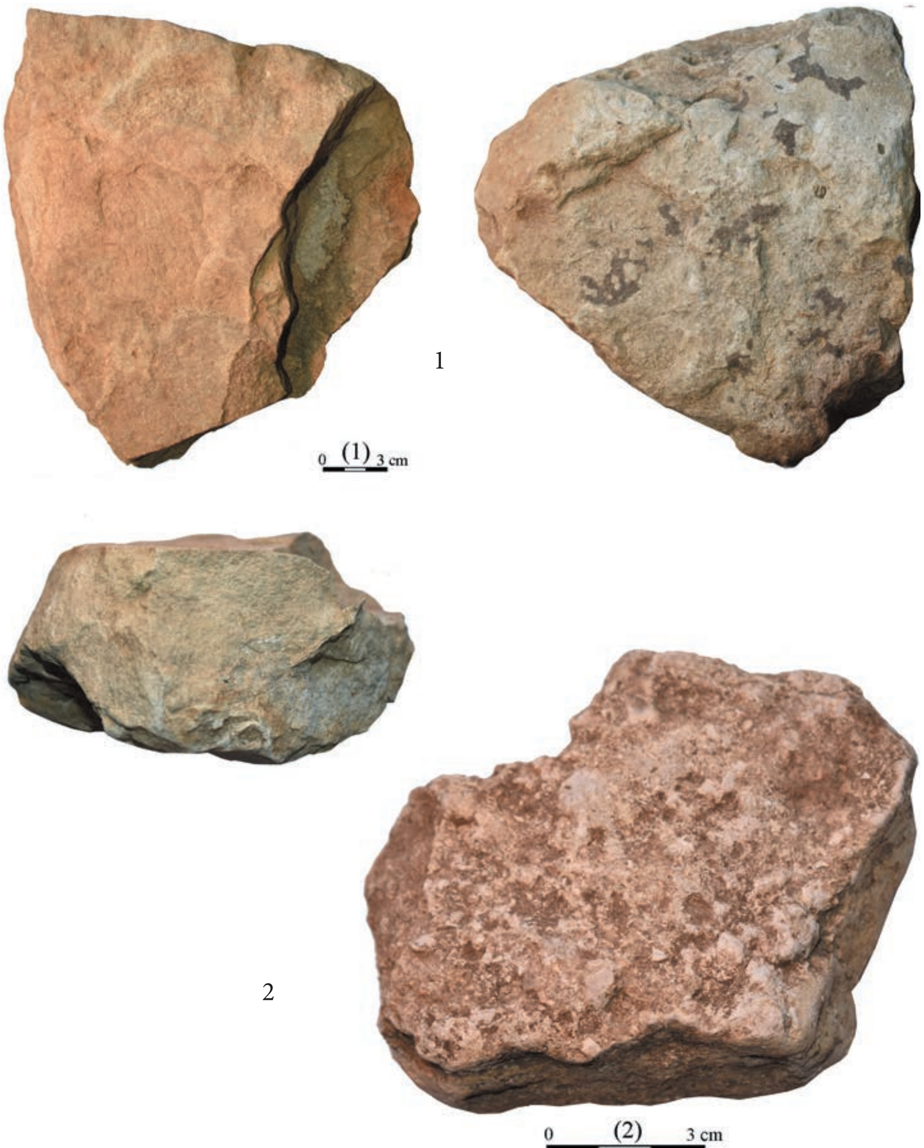

Fig. 20. Wilczyce, Sandomierz district, site 10, feature 4. Artefact at the level of the human skull: 1–2 stones. Photo by K. Kerneder-Gubała.

Because of the context of the discovery of both specimens, we may assume that their final function differed from the original one. They may have constituted some sort of stands or biers for other important objects such as animal or human bones, however, their function cannot be unequivocally established on the basis of the surviving data.

Dating of the feature

Archaeological material discovered in Wilczyce did not contain any finds that would enable us to date the feature, therefore its chronology was based on the obtained radiocarbon dates. For the sample of the charcoal discovered in a layer located below the "deposit" of human and animal bones, the following dates was obtained: 3875 ± 35 BP (Poz-101792), which with the 68.2% probability refers to the years 2455–2297 BC (Fig. 21: 1). The second date – obtained from the cattle mandible – is 3790 ± 35 BP (Poz-90895) and with the 68.2% probability that it refers to the years 2286 – 2146 BC (Fig. 21: 2).

The earlier of the above-mentioned dates falls into the range of the Final Neolithic (Poz-101792), and the later date (Poz-90895) allows us to associate the feature with the settlement of the proto- and early phase of the Mierzanowice culture. It seems that

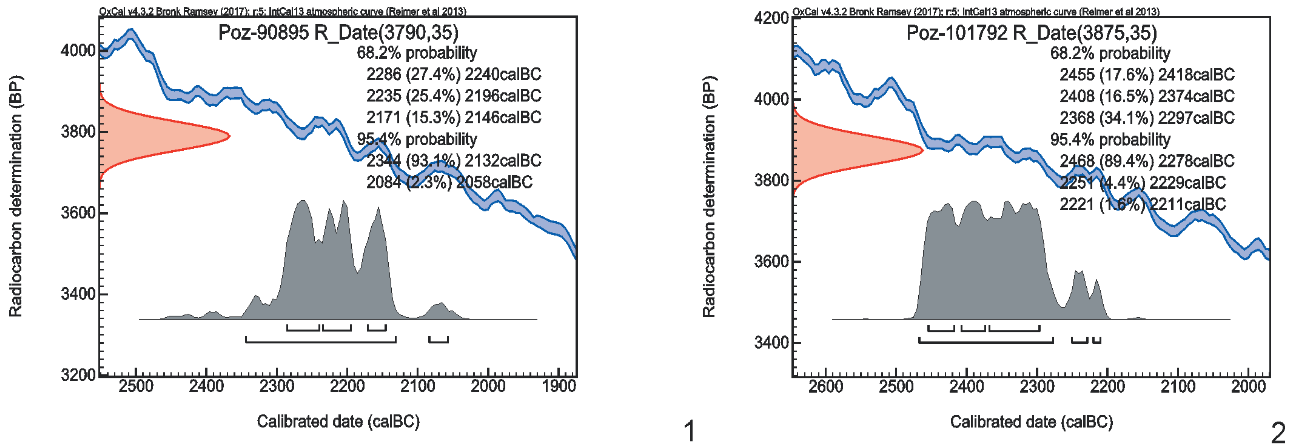

Fig. 21. Wilczyce, Sandomierz district, site 10, feature 4. Calibration chart for dates obtained for the analysed feature.

the binding date is the marking obtained for animal bone, as the charcoal could have been deposited in the fill of the feature during the process of its natural filling. Comparable early dates for human and animal bones in the settlement pits of the Mierzanowice culture were obtained for several features in the upper Vistula and San rivers basin, e.g. Mirocin, site 24, feature 16 – 3815 ± 35BP (Pos-54042); Szarbia, site 9, feature 1 / V – 3810 ± 35BP, Opatkowice, site 2, feature 4 – 3780 ± 30BP (Poz-34735), Książnice, site 2, feature 1/03 – 3780 ± 30BP (Poz-34696), Karwin, site 43, feature 39 – 3770 ± 35BP (Poz-34733) (Górski *et al.* 2013; Jarosz *et al.* 2018; Jarosz, and Mazurek 2020). Correspondingly early data were obtained for charcoals from site 243 in Skołoszów, site 7 – 3795 ± 35 BP (Pos-31697). In this case, the dating does not correspond to the material discovered in the feature, which can be associated with the classical phase of the Mierzanowice culture (Pelisiak and Rybicka 2019, 71–73, Table 1, Fig. 2, 3).

The acquired date (Poz-90895) expands the small database of radiocarbon dates associated with features from the chronologically connected with proto- and the beginning of early phases of the Mierzanowice culture (see Górski *et al.* 2013; Jarosz *et al.* 2018) and together with the older date at the same is the example of difficulties that sometimes arise during the interpretation of research results (compare with radiocarbon dates from feature 33, in Skołoszów, site 7; Pelisiak and Rybicka 2019, 72, Table 1).

The interpretation of the feature's function

The reconstruction of the functioning of the discussed feature must take into consideration the material discovered in the pit and its detailed analysis. The presence of permanent settlement in the early Bronze Age gave the basis to create the image of the "typical" remains of storage pits and features where evidence of ritual practices such as human and animal burials were discovered.

Based on the shape of the horizontal plan (round) and its vertical cross-section (trapezoid) and the size of discovered feature at Wilczyce, it is possible to classify it as a typical storage pit, as those known, for instance, from settlements in Iwanowice (Kadrow 1991) and Dobkowice (Jarosz *et al.* 2018). The human skull of the young female, animal bones and polishing stone were deposited around 25 cm above the bottom of the feature, near its wall, which at that time already did not have any economic functions. Following the deposition of the said remains, it gradually filled up naturally, as indicated by the layout of the strata recorded in the cross-section (Fig. 2). Deposition of human remains by walls of the feature were noticed at e.g. Dobkowicach site 39, feature 54, individual I (in this case with polishing stone), site 37, feature 13, individual I and II and feature 120 (Jarosz *et al.* 2018, 46, Fot. 19; 73, tabl. 5: 1, 86, tab. 13) and Mirocin, site 24, feature 16 (Jarosz and Mazurek 2020).

The reusing of storage pits as places for depositing burials or individual human bones is often observed in settlements of the early Mierzanowice culture. Usually, this refers to young individuals, often females (aged 14–18) or children (see Jarosz *et al.* 2018; Szczepanek 2018; 2020; Jarosz and Mazurek 2020), which means that the feature from Wilczyce conforms with the above-mentioned observations. The presence of human remains together with animal bones in storage pits is known from other settlements of the Mierzanowice culture and sometimes they are unequivocally construed as features of a special (ritual) character (Kołodziej 2010). In some features, archaeologists discovered human remains accompanied by dog bones – Iwanowice and Książnice, Busko district (Kadrow and Makowicz-Poliszot 2000; Górski *et al.* 2013, 100, fig. 5, 113). In pit number 54 on site 39 in Dobkowice, in addition to human remains there were found bones of dogs, cattle and sheep/goat (see Jarosz *et al.* 2018; Makowicz-Poliszot 2018). A further example is a burial of young female in feature 16 at site 24 in Mirocin, where a large cattle skull was discovered (Jarosz and Mazurek 2020, tabl. 4: 1). In the context of storage pits of the Mierzanowice culture containing human burials, our attention is drawn to the fact that the human skull discovered in the feature from Wilczyce had no mandible – and for this reason we must consider whether this was an intentional partial burial or perhaps the skull got to the fill by accident and comes from a feature of an older provenance, e.g., a damaged grave.

Due to the current state of the source base, the burial rite of the people of the early phases of the Mierzanowice culture is not yet very well-known. We know of individual graves and small concentrations of burials dated to that period from the Lesser Poland Upland, including, among others, Żerniki Górne, Busko district (Włodarczak 1998) and Modlnica (Włodarczak *et al.* 2011, 331–336), Typical funerary features are dominated by burials of adult individuals (see Kadrow and Machnik 1997, 44, 45; Jarosz and Szczepanek 2019), while in the case of settlements, archaeologists have recorded storage pits reused to deposit bodies of children and young adults. For this reason, the presence of the skull of the *Iuvenis* female in the feature from Wilczyce could be construed as the manifestation of burial practices of the Mierzanowice culture. Similar rituals in the form of interring the dead or parts of their bodies in settlement pits, especially heads, can be found in the Unietice culture. This indicates the emergence of a certain supra-regional and cross-cultural trend in the early Bronze Age (Gralak 2009; Knipper *et al.* 2016). Another matter are the elements that accompanied the human skull – animal bones and stone artefacts. The key problem is that of their presumed contemporaneity, since they are often interpreted as an assemblage of a ritual character. The attractiveness of that hypothesis and the right choice of analogies often preclude the adoption of an opposing view, i.e. an alternative sequence of events that led to the accidental deposition of the finds discovered in the discussed feature.

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New finds of antler cheekpieces and horse burials from the Trzciniec Culture in the territory of western Little Poland

Abstract

Przybyła M.M. 2020. New finds of antler cheekpieces and horse burials from the Trzciniec Culture in the territory of western Little Poland. *Analecta Archaeologica Ressoviensia* 15, 103–138

The subject of this paper are the new discoveries of antler cheekpieces of horse harness at Trzciniec Culture sites in Morawianki, Miechów and Jakuszowice (Little Poland, Poland). It also addresses the issue of double horse burials being parts of sepulchral complexes, with barrows at their centres. The article tackles the problem of the occurrence of such burials and cheekpieces in the Danubian regions, the steppe zone of Eastern Europe and in the territory of Greece. It also considers the function of cheekpieces, as parts of horse gear used for harnessing a horse to a chariot.

Keywords: antler cheekpieces, horse burials, chariots, barrows, Trzciniec Culture, bronze age

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Introduction

Antler cheekpieces, being elements of horse harness encountered at various sites of the Trzciniec Culture (TC), are artefacts revealing the strongest connections with the influences coming from the Carpathian Basin (Fig. 1). Until the present, such finds were mostly recorded in the territory of western Little Poland, at the settlement in Jakuszowice, in particular. However, in recent years successive artefacts of this type have been discovered not only in settlements but also from collective burials of horses. Moreover, such burials are recorded increasingly often in sepulchral complexes of the Trzciniec Culture. This article presents the artefacts coming from three archaeological sites, namely Morawianki, dist. Kazimierza Wielka, Miechów, dist. Miechów and Jakuszowice, dist. Kazimierza Wielka, as well as the horse burials discovered in Morawianki. The author of this paper has also made an attempt to determine the chronology of the utilisation of cheekpieces within the Trzciniec Cultural Circle (TCC) and the context of their usage by human communities of that time. An attempt will be made to establish the directions of external influences that lead to the emergence of the above-mentioned traits within the Trzciniec Culture environment. The analysis will firstly cover the relationships with the Danubian regions and the East European steppe zone.

New finds of antler cheekpieces and horse burials

Morawianki, dist. Kazimierza Wielka site 10

A complex of features of the Trzciniec Culture (TC) connected with a barrow was discovered at the multicultural site in Morawianki, the mound of which has not preserved to the present day. It contained a collective human grave and two collective horse burials (feat. nos. 38 and 56). Reconstruction of the extent of the barrow mound was only possible based on observations of the horizontal planigraphy of younger features, namely graves from the Early Iron Age, Roman Period and the Migration Period. In the area where the barrow, with a diameter of a dozen or so meters, had been primarily erected, no younger features were

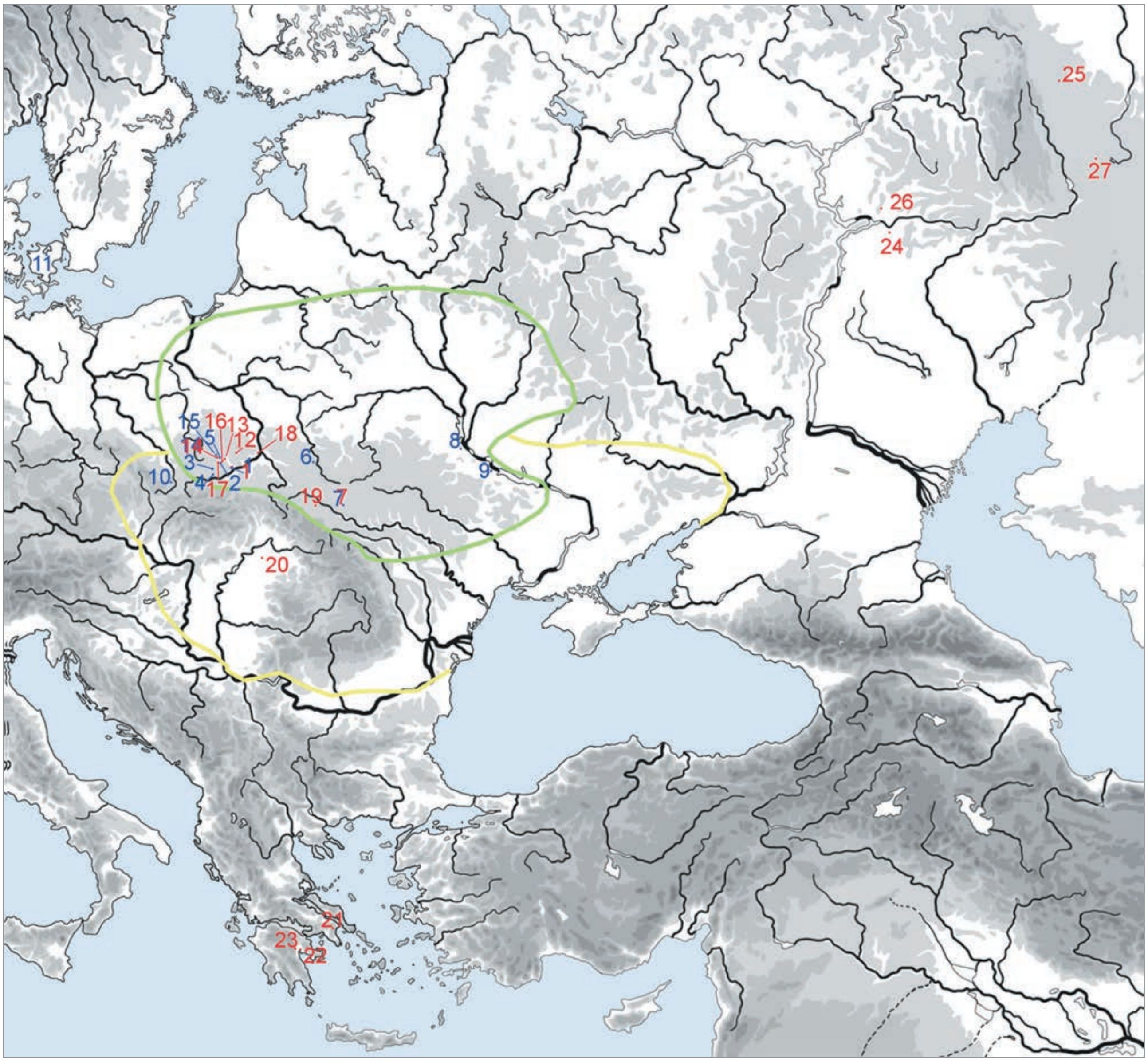

Fig. 1. Boundaries of the Trzciniec Cultural Circle (acc. to Makarowicz 2010, Fig. 1.1) – green line, and the extent of occurrence of rod cheekpieces (acc. to Hüttel 1981, Tab. 24–26; Pankovskiy 2016, Fig. 1) – yellow line. Blue colour: location of the TCC sites (as well as Kietrz and Østrup Bymark), where antler cheekpieces were recorded: 1 – Morawianki, 2 – Miechów, 3 – Jakuszowice, 4 – Kraków–Cło, 5 – Pełczyska, 6 – Belz; 7 – Gusyatin, 8 – Kozarovychy, 9 – Trachtemirov, 10 – Kietrz, 11 – Østrup Bymark, 14 – Michałowice, 15 – Dębiany. Red colour – location of double horse burials: 1 – Morawianki, 7 – Gusyatin, 12 – Żerniki Górne, 13 – Miernów, 14 – Michałowice, 16 – Gabułtów, 17 – Kazimierza Wielka, 18 – Wilczyce, 19 – Bukivna, 20 – Oarţa de Sus, 21 – Marathon, 22 – Dendra, 23 – Kokla, 24 – Utyovka, 25 – Krivoe Ozero, 26 – Potapovka, 27 – Sintashta.

encountered. In particular, the lack of a grove-like feature from the Roman Period that was expected to be found in this location was striking. The south-eastern, southern and south-western boundaries of the barrow were marked with a presence of skeletal burials dated to the Roman and Migration Periods, lying along the outline of the former mound. An identical situation associated with the location of the Roman Period cemetery around a very similar TC sepulchral complex with an alleged mound which has not survived to the present day, was recorded in Michałowice, dist Kazimierza Wielka (Zagórska-Telega *et al.* 2011, 203).

The first animal burial (feature no. 38) was primarily situated under the barrow mound, in its south-western part. This grave (Fig. 2: 1–4) was an irregularly rectangular pit with dimensions of 3.5 × 2 m and a depth of 1.6 m (below the present ground level). At its bottom there was a single skeleton of a mature horse (no. 1), placed in anatomical order, lying on its left side along a N-S axis, with its head directed south-

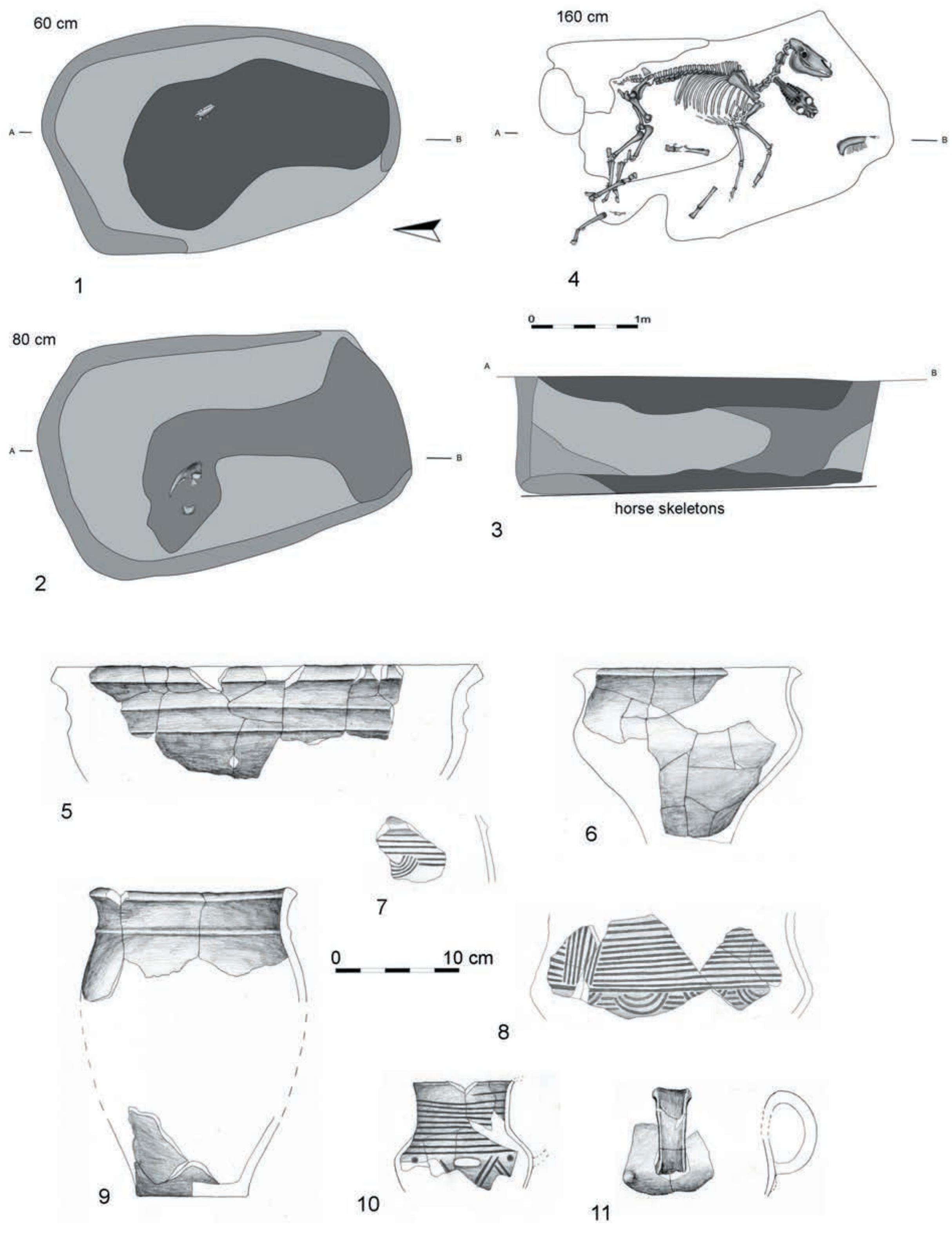

Fig. 2. Morawianki, dist. Kazimierza Wielka. Grave No. 38. 1–3 – horizontal views of the grave, 4 – cross section of the grave, 5–11 – vessels encountered in the ceiling of the grave (drawn by M. Podsiadło)

ward. The second horse remains (no. 2) were of a residual nature. They only consisted of a skull and a few long bones of limbs, displaced from their anatomical order. The alignment of the layers of sediments filling up the grave pit indicated that the grave chamber had originally been closed, most likely with some wooden elements. In the ceiling of this feature very numerous fragments of pottery were encountered, along with animal bones (including fragments of horse skulls) and a stone polishing tablet. The occurrence of these artefacts may be considered evidence of some sort of ritual, most likely connected with the establishment of the animal burial and the erection of the barrow. Next to the skull of horse no. 1, a set of antler elements of a horse harness (bridle) were found, namely two cheekpieces (placed by the animal's jaws, slightly displaced due to the post depositional processes), two knob strap junctions (lying on both sides of the skull; on one side on the upper part of the ramus of the mandible, on the other side, on the zygomatic process of the temporal bone). Behind the skull, at the position of the first cervical vertebra, a double-cone antler knob was encountered. During the exploration of the sediments from the surroundings of the skull, a fragment of another bead and an antler shaft were found.

The latter animal burial (feature no. 56) was situated outside of the barrow mound, on its south-western side. It had been dug into a sandy substratum, the properties of which affected the condition of the horse remains; only the largest, most massive bones have been preserved until the present day. In addition, it had been disturbed by the digging of two graves of a younger chronology, dated to the Roman and Migration Periods. The skeletons of three horses were placed into a rectangular pit (Fig. 3: 1–3) with dimensions of 3 × 2 m and a depth of 130 cm (below the present ground level). At the depth of 80 cm, the skeleton of horse no. 1 was found, lying on its right side, along the N-S axis and with its head directed southward. At the depth of 120 cm, skeletons of two horses were recorded, aligned symmetrically to one another, one on the right, the other on its left side, along the N-S axis, both with their heads directed southward. Unfortunately, the skull of horse no. 2 was destroyed by t grave no. 58 from the Migration Period (Fig. 4: 1–3). Next to the skull of the horse no. 3, an individual cheekpiece was found, lying on the horse's jaws, at the position of the alveolar ridge (Fig. 5: 2). Noteworthy is the fact that this was the first rod cheekpiece discovered next to an animal lying in an undisturbed anatomical order. It is clearly discernible that the bolt (preserved in a rudimentary condition) was fixed in the upper position, while a thickened head was in the lower position. Analogical positions were recorded for two cheekpieces encountered in a horse grave in Gusyatin, however, at the latter site they were found lying directly on the animal's skull (Ilchyshyn 2016, fig. 5: b).

Description of the artefacts:

Grave no. 38

Cheekpiece (Fig. 3: 1). Preserved length: 88 mm (primarily ca. 110 mm). Circular cross-section, diameter between 6–12 mm. The artefact is decorated on its head with six ovals. There is a groove running around above the ovals, complemented with a motif of "hanging triangles". The head is mounted with an engraved circle with a central point inside. The body is decorated with two bands of double "toothed ovals", each of them divided into two "triangular" fields containing circles with central points inside. The ovals are separated with an additional circle with a central point inside. The bands of the ornament are framed (from the top and the bottom) with double bands of tiny "hanging triangles" running around. There were two oval-shaped perforations: one with dimensions of 8 × 5 mm in the frontal plane; another identical one in the side plane, drilled with a movable shaft and having a diameter of 2 mm. The upper bolt, ornamented with plastic knobs, was split off.

Cheekpiece (Fig. 3: 2). Preserved length: 75 mm (primarily ca. 110 mm). The other dimensions and decoration are identical to cheekpiece no. 1, described above. The only difference is that the adjoining ovals in the main bands of the ornament are not separated by circles with central points inside. The upper band of the ornamentation was only partially preserved. The upper bolt, ornamented with plastic knobs, had been split off.

Antler bit – knob (Fig. 3: 3). In the horizontal view, it is circular with a diameter of 20 mm. In the longitudinal view, it is convex-concave with a thickness of 2.5 mm. The eyelet was only partially preserved. The eyelet width is 5.5 mm, its diameter – 7.5 mm.

Antler bit – knob (Fig. 3: 4). In the horizontal view it is circular, with a diameter of 17 mm. In the longitudinal view, it is convex-concave with a thickness of 2 mm. The eyelet width is 5 mm, its diameter – 4 mm.

Knob (Fig. 3: 5). In the horizontal view it is circular, with a diameter of 20 mm, with a drilled perforation 10 mm in diameter. In the longitudinal view, it forms a double-cone, 12 mm in height.

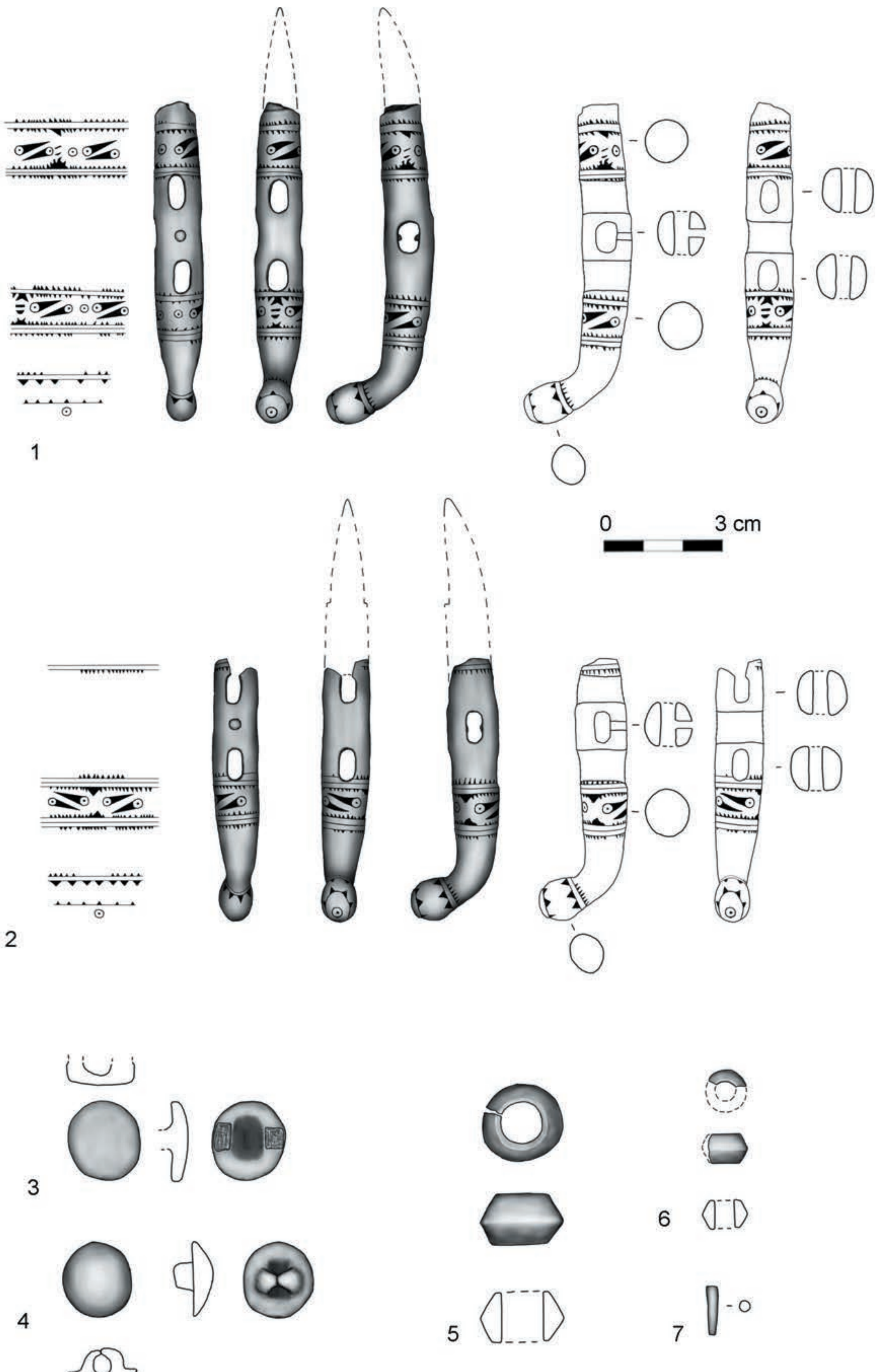

Fig. 3. Morawianki, dist. Kazimierza Wielka. Grave No. 38. Antler elements of horse harness found on the skull of horse No. 1 (drawn by M. Podsiadło)

Knob (only half of it has preserved, Fig. 3: 6). In the horizontal view it is circular, with a diameter of 9 mm, with a drilled perforation 5 mm in diameter. In the longitudinal view it forms a double-cone, 7 mm in height.

Shaft (Fig. 3: 7). Preserved length: 11.5 mm, diameter: 1–2 mm. Irregularly circular in its cross-section.

Grave no. 56

Cheekpiece (Fig. 4: 4). Preserved length: 86 mm (primarily ca. 100 mm).

Irregularly circular in its cross-section, with a diameter of 1–14 mm. The head is slightly flattened. Two oval-shaped perforations with dimensions of 10×5 mm in the frontal plane. One identical perforation in the side plane. The upper part of the cheekpiece, ornamented with plastic knobs, was split off and only preserved in the upper part.

Miechów, dist. Miechów site 3

A considerably small settlement of the Trzciniec Culture was discovered at the multicultural site in Miechów, having functioned in its classical phase. Within a shallow, oval-shaped pit no. 4668 (Fig. 6: 3) an antler cheekpiece was found preserved in perfect condition. It was accompanied by very numerous archaeological materials, including large fragments of a dozen or so vessels (Fig. 7: 1–7) and a partly preserved stone axe (Fig. 6: 4). Another antler cheekpiece was encountered within the cultural layer. In its surroundings were a small number of ceramic materials associated with the Trzciniec Culture (Fig. 6: 8–10).

Description of the artefacts:

Cheekpiece of the "Y" letter shape preserved entirely, found in feature no. 4668 (Fig. 6: 2). Its maximum dimensions are 62×71 mm, thickness: 5–7 mm.

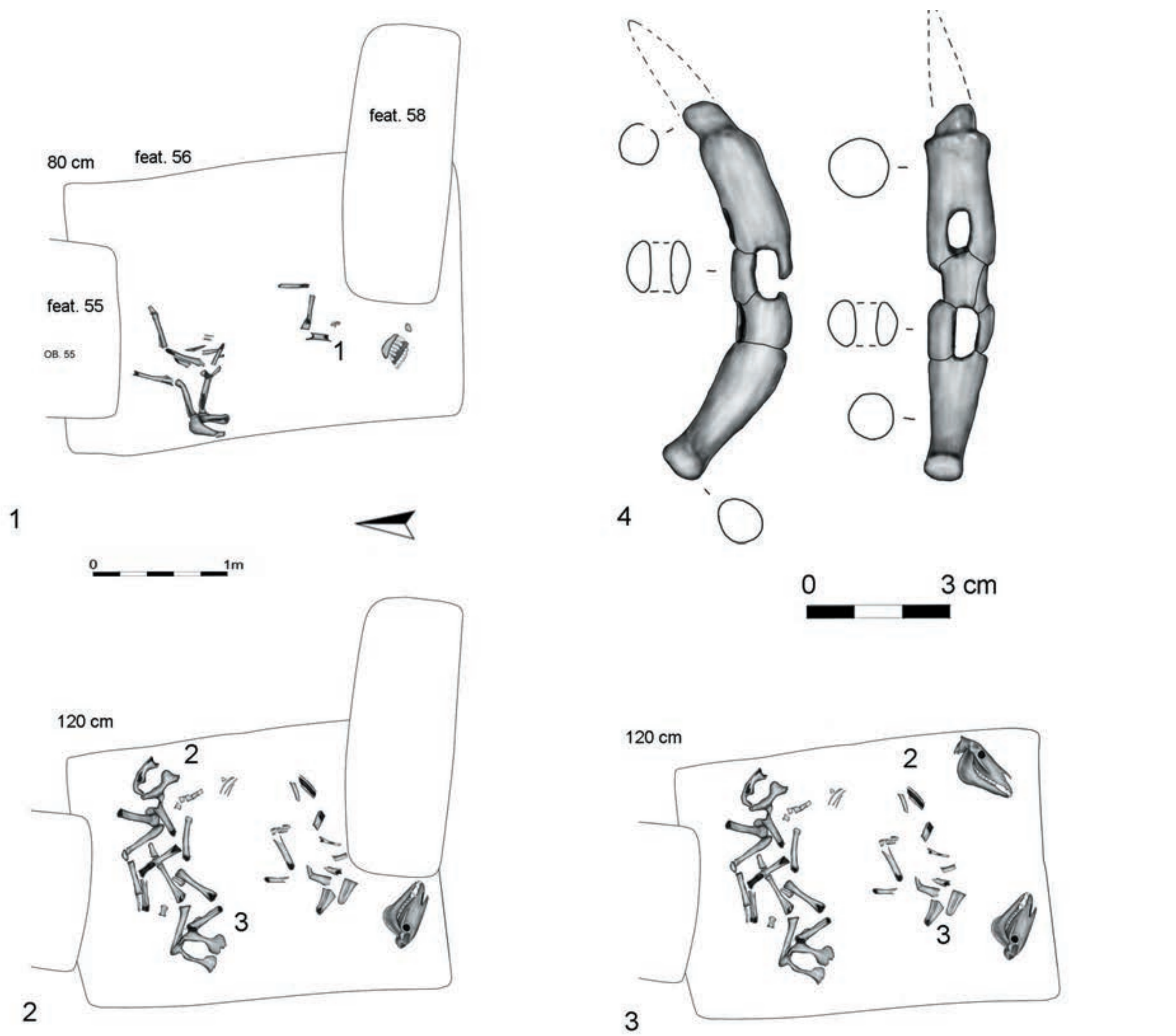

Fig. 4. Morawianki, dist. Kazimierza Wielka. Grave No. 56. 1 – horizontal view at the depth of 80 cm, burial of horse No. 1; 2 – horizontal view at the depth of 120 cm, burials of horses Nos. 2 and 3; 3 – reconstruction of the primary alignment of skeletons of horses Nos. 2 and 3 (before the skeleton No. 2 was disturbed by feature No. 58); 4 – cheekpiece found next to the skull of horse No. 3 (drawn by M. Podsiadło)

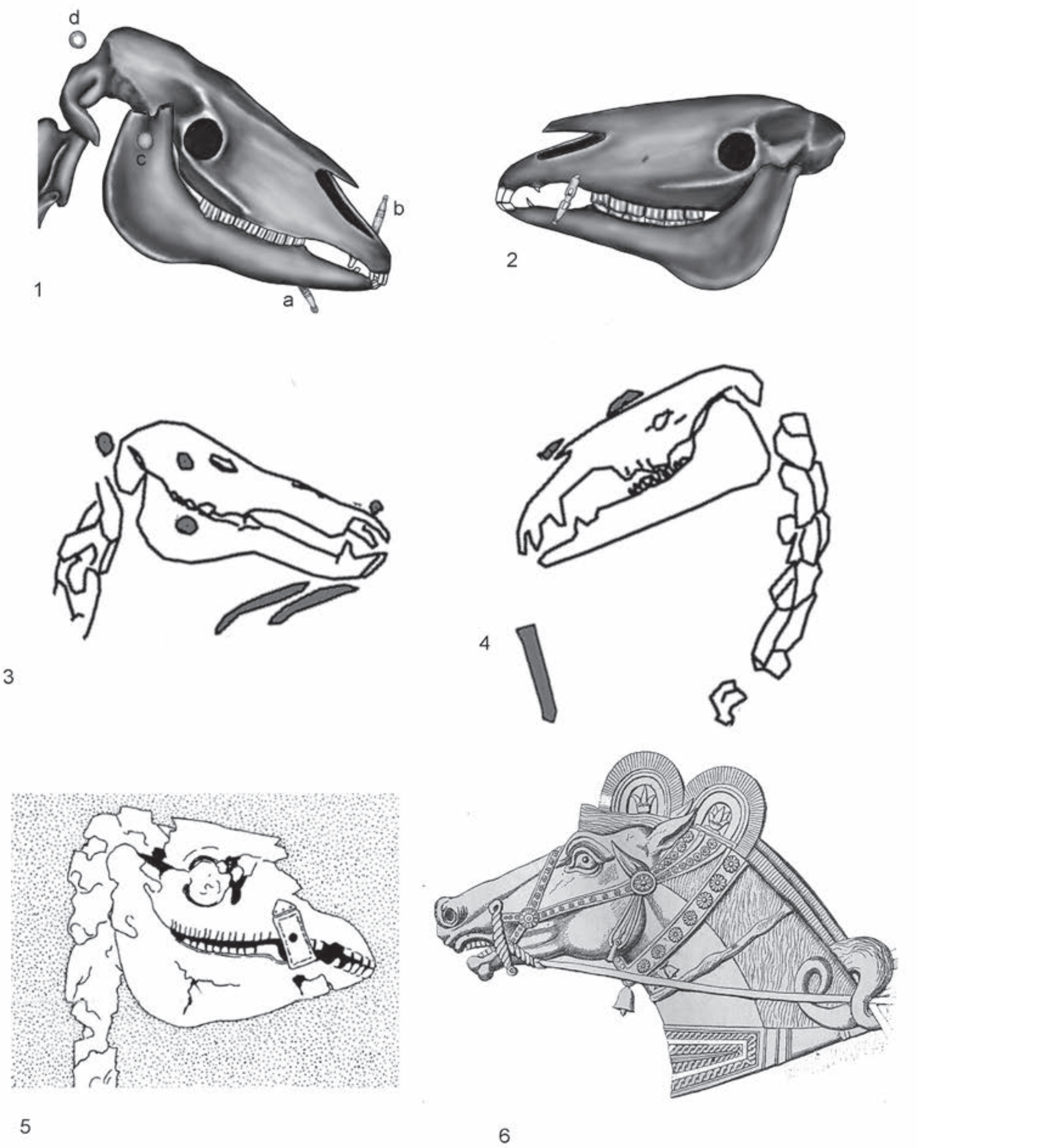

Fig. 5. Examples of horse harness. 1 – found next to the skull of the horse No. 1 from the grave No. 38 in Morawianki; 2 – found next to the skull of the horse No. 3 from the grave No. 56 in Morawianki; 3, 4 – found within the grave from Gusyatin (acc. to Ilchyshyn 2016, Fig. 5); 5 – found within the grave from Komarovka (acc. to Hüttel 1981, Tab. 28); 6 – bridle of a horse harnessed to a chariot presented on the Assyrian relief from Koyunjik (acc. to Rawlinson 2016, Tab. 93: 3)

It is equipped with a centrally placed large perforation with dimensions of 12 × 10 mm, above which another perforation was placed, with a diameter of 8 mm, and three further smaller ones, with a diameter of 3 mm each. The other two cheekpiece branches have one perforation per each, 4 mm in diameter. Another such perforation is located at the edge of the cheekpiece.

Cheekpiece from the cultural layer (Fig. 6: 1). Preserved length: 142 mm (primarily ca. 150 mm), width: 14–19 mm, thickness: 9–18 mm. It is irregularly oval-shaped in its cross-section. The external side planes, as well as the frontal and rear planes, are thoroughly smoothed. The internal side plane, with a preserved sponge structure, is strongly eroded. In the side plane there are two large, centrally placed and oval-shaped perforations with dimensions of 14 × 4.5 mm. At its bottom end there are also two circular perforations with diameters of 2 and 4 mm, respectively. Both endings of the cheekpiece are decorated with longitudinal and transverse incisions. Both of them are damaged, one preserved rudimentarily (reconstructed ornamentation). On the side plane there are two transverse bands of a wave-banded ornament, made with the use of a tool of a compass type. The lower band consists

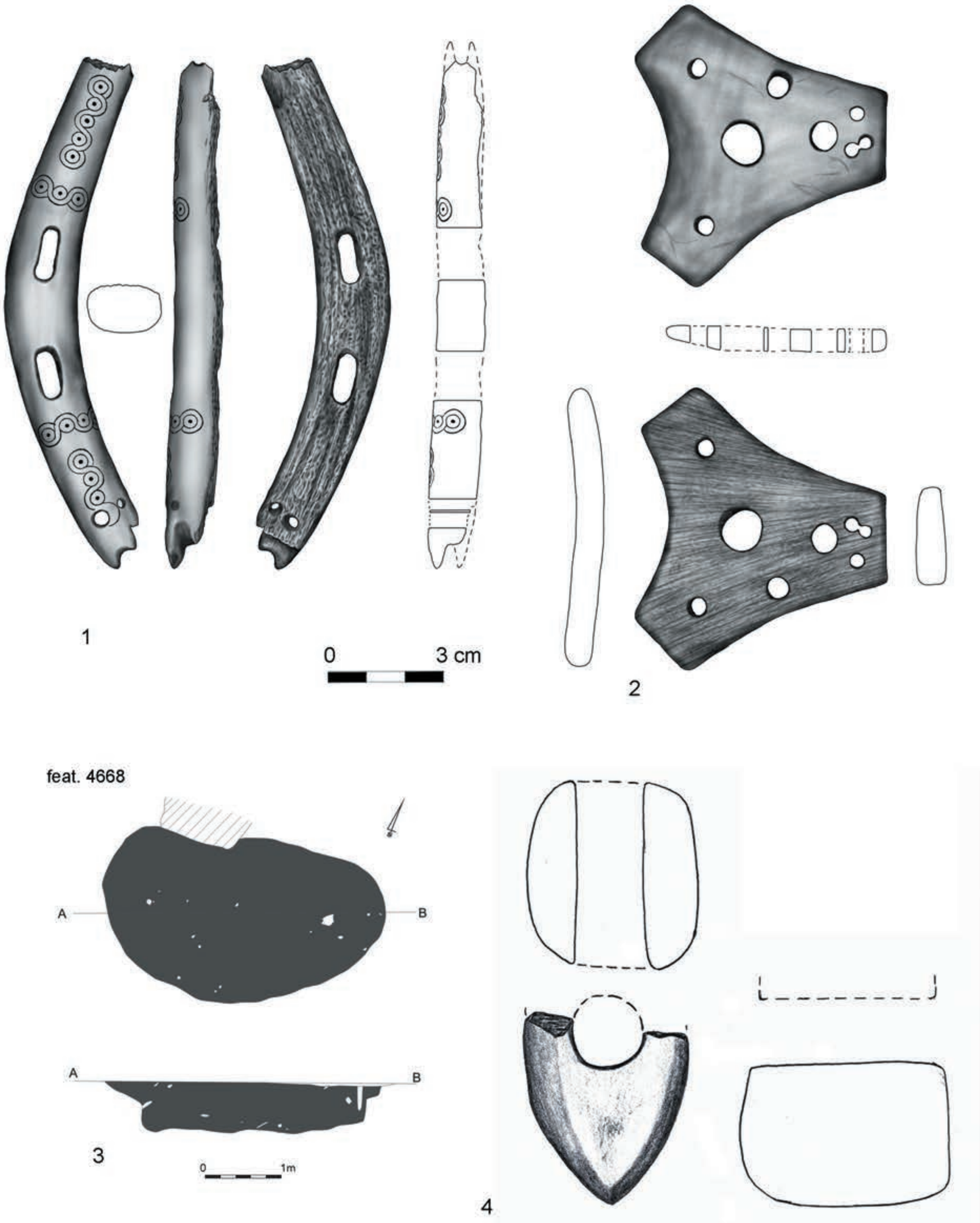

Fig. 6. Miechów, dist. *loco*. 1 – cheekpiece found within the cultural layer; 2 – cheekpiece from feature No. 4668; 3 – horizontal view and cross-section of the feature No. 4668; 4 – fragment of a stone axe from feature No. 4668 (drawn by M. Podsiadło)

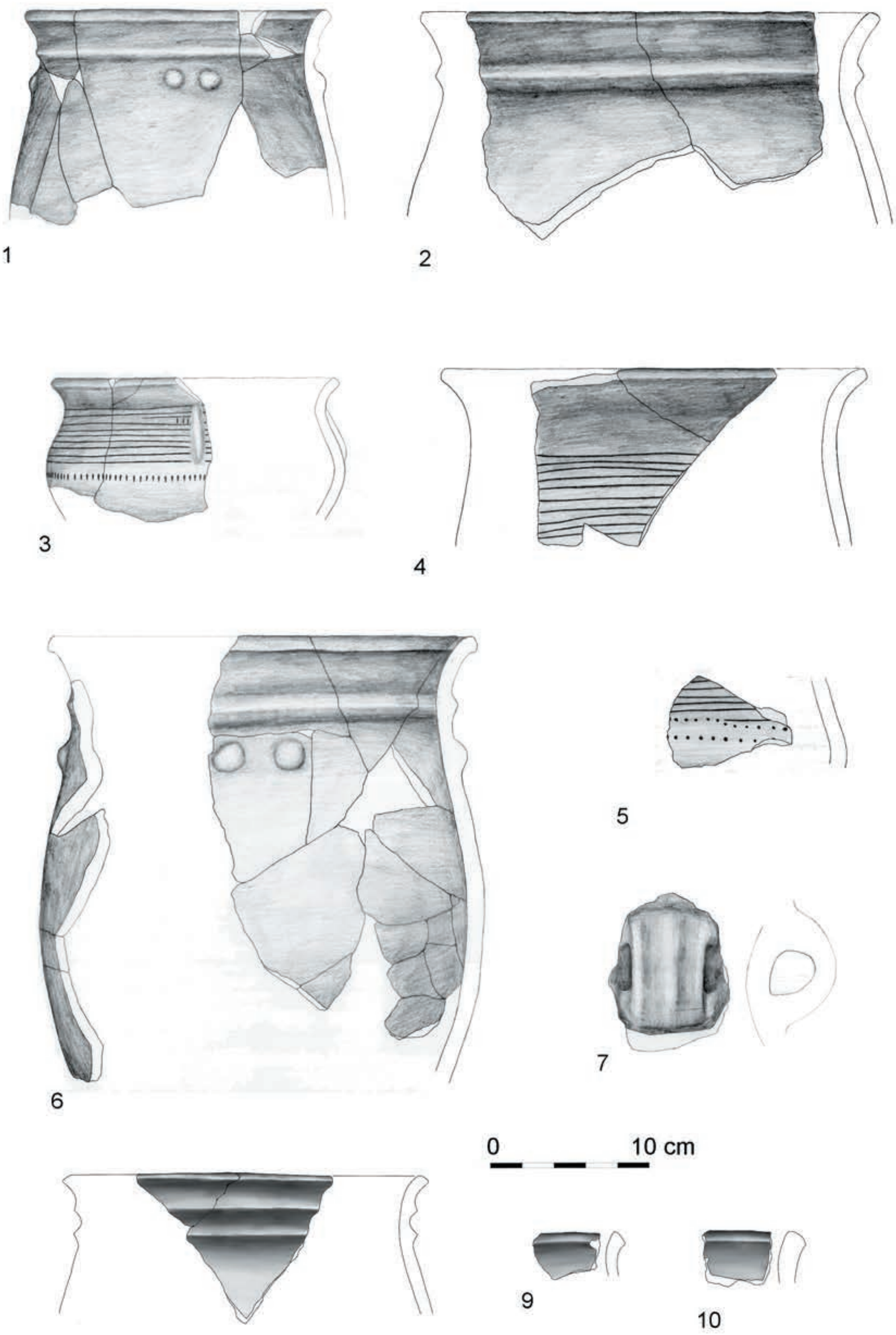

Fig. 7. Miechów, dist. *loco*. 1–7 – fragments of vessels from feature No. 4668; 8–10 – fragments of vessels accompanying the cheekpiece from the cultural layer (drawn by M. Podsiadło and S. Rupiński)

of four waves, the upper of three waves. By the endings of the cheekpiece there are bands with analogical ornamentation, one of which consists of five waves, the other one of four waves. Within the latter band, a circular perforation is to be found.

Jakuszowice, dist. Kazimierza Wielka site 2

At the multicultural site in Jakuszowice, a very abundant, multiphase settlement of the Trzciniec Culture was discovered (Górski 1990). To date it has already delivered five finds of cheekpieces of the Spiš type (Bąk 1992; Godłowski and Rodzińska-Nowak 1995; Górski and Przybyła 2014). Another cheekpiece was encountered in the small feature no. 2271, trapezoid in shape, (Fig. 8: 2), and accompanied by numerous fragments of pottery of the Trzciniec Culture (Fig. 8: 3–4)

Description of the artefact:

Cheekpiece (Fig. 8: 1). Preserved length: 62 mm. Oval-shaped in its cross-section, with a diameter of 10 × 12 mm. In its lower (?) part the cheekpiece has a mushroom cap-like head, clearly distinguished from the body. Directly above the head there is an oval-shaped perforation with dimensions of 10 × 5 mm. The artefact is undecorated.

Typology and ornamentation of cheekpieces

Both of the above-mentioned cheekpieces from the grave no. 38 in Morawianki should undoubtedly be classified as belonging to the Spiš type (Vladar 1971, 8; Hüttel 1981, 82–83). This type corresponds with the Borjas type acc. to Mozsolics (Mozsolics 1953, 95–97) or the type IVb acc. to Boroffka (Boroffka 1998, 100–101). However, in this paper, the name of the Spiš type will be adopted since it is well known and commonly used in the related Polish literature (Bąk 1992; Gedl 1988, 85). Cheekpieces of this type are associated with the Carpathian Basin (Hüttel 1981, tab. 26). Determination of its variants is mostly based on the analysis of the number and alignment of knobs ornamenting the bolt (Hüttel 1981, 83; Boroffka 1998,

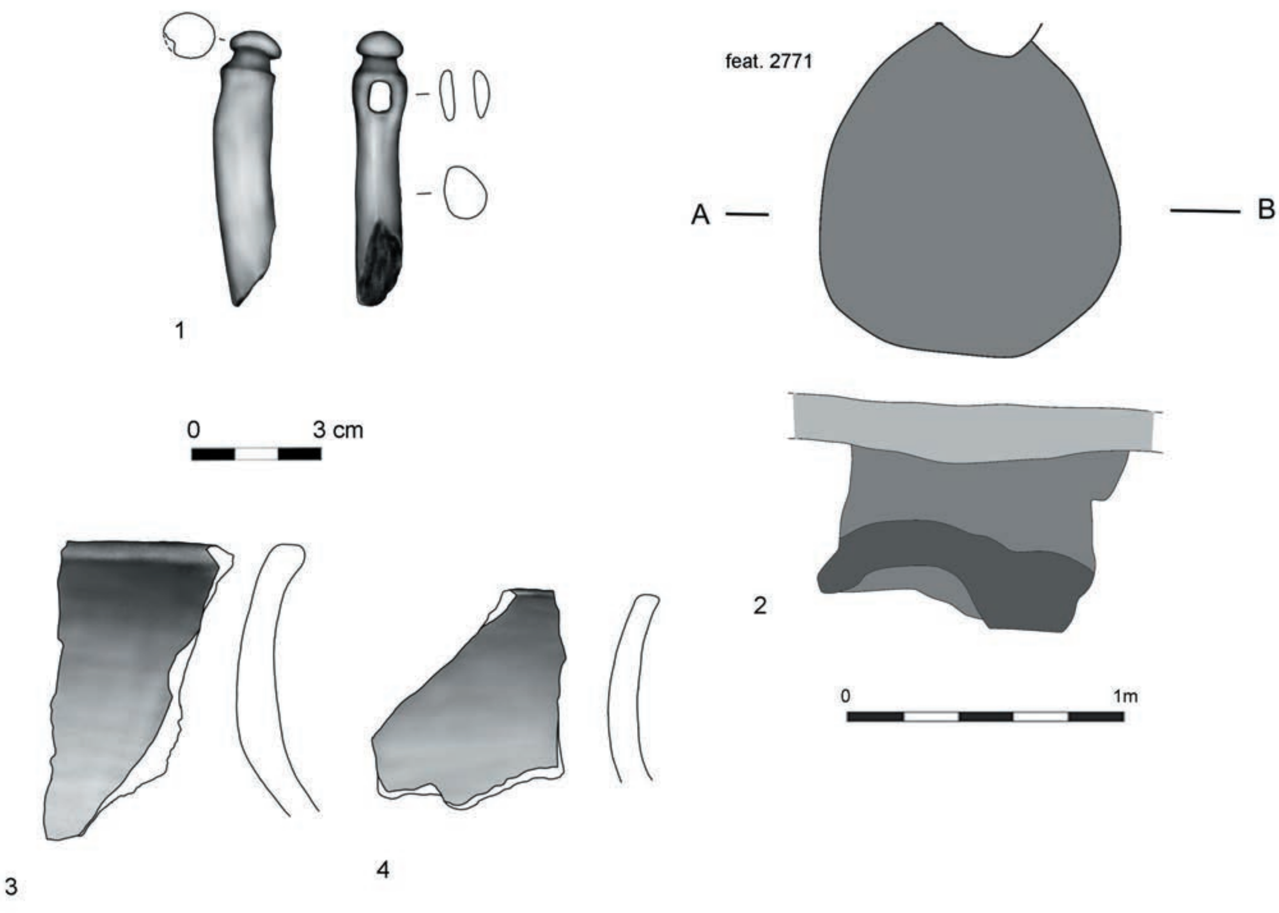

Fig. 8. Jakuszowice, dist. Kazimierza Wielka. 1 – fragment of a cheekpiece found in feature No. 2271; 2 – horizontal view and cross-section of feature No. 2771; 3–4 – fragments of vessels from feature No. 2271 (drawn by M. Podsiadło)

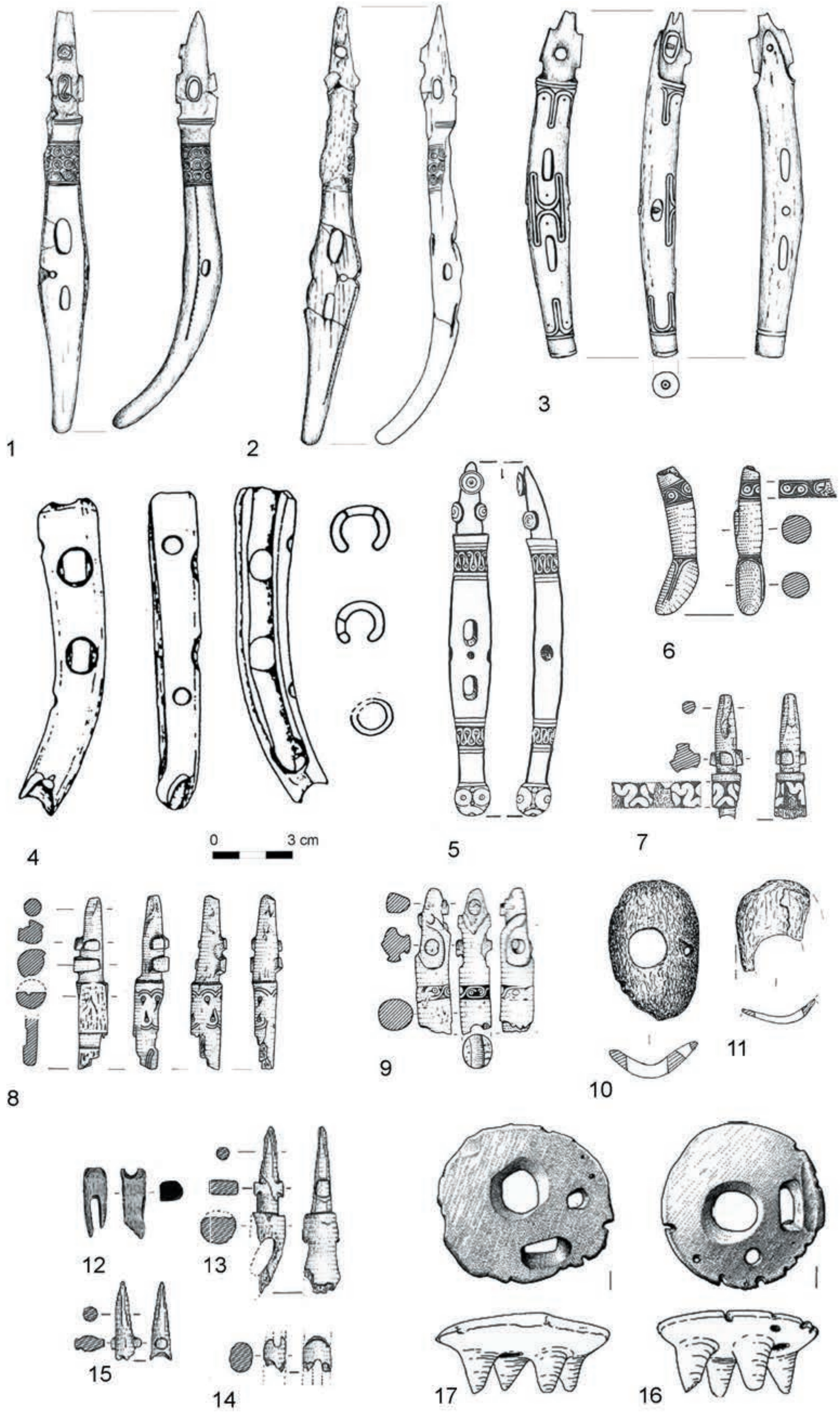

Fig. 9. Antler cheekpieces from the extent of the Trzciniec Cultural Circle and cheekpieces from Kietrz. 1–3 – Gusyatin, Ukraine (Ilchyshyn, 2016, Fig. 4); Kraków–Cło, Poland (Górski 2007, Tab. 64A: ł); 5 – Belz, Ukraine (Bukowski 1976, Tab. I: 1); 6–9 – Jakuszowice, Poland (Bąk 1992, Fig. 1: 1–2; Godłowski 1992, Tab. 2: 1; Godłowski, Rodzińska-Nowak 1995, Tab. 2: 1–2); 10–11 – Kozarovychy, Ukraine (S. Lisenko 1999, Tab. 5:1–2); 12–15 – Kietrz, Poland (Gedl 1988, Fig. 1: b–c, 3: a); 16–17 – Trachtemirov, Ukraine (Hüttel 1981, Tab. 2: 14, 15)

100–101). Unfortunately, with regard to the specimens under scrutiny, this particular element has been split off. However, a closer examination of cheekpiece no. 1 shows that the rear wall of the shaft forms a common plane with the bolt wall. As a result, the knobs could only have been placed on three quarters of the bolt's circumference. Most likely, the ornamentation was limited to only three knobs, making it somewhat untypical of the Spiš type (Hüttel 1981, 83). Nevertheless, it cannot be excluded that the number of knobs was originally greater. An ornamentation consisting of six knobs aligned in two rows was recorded for the Tószeg variant of the Spiš type (Hüttel 1981, 83, tab. 8: 76). Taking into account the alignment of oval-shaped slots for straps and their shape in general, the cheekpieces from Morawianki are close to three artefacts coming from Spišsky Štvrtok in Slovakia, which are characterised with an analogical alignment of oval-shaped slots and the occurrence of an additional perforation for fixing a pin (Hüttel 1981, tab. 8: 72, 72A; tab. 9: 86).

Both cheekpieces from grave no. 38 bear finely developed and well-preserved ornamentation covering the body and head of the specimens. Decoration of the body consists of two horizontal bands of ornamentation, placed below and above the slots for straps. This alignment is commonly encountered on cheekpieces of the Spiš type. Examples include among others, artefacts from Belz, Ukraine (Fig. 9: 5; Bukowski 1976, tab. I: 1), Cârlomănesti – Cetătuia, Romania (Fig. 10: 7; Motzoi-Chicideanu *et al.* 2012), Budapeszt-Lágymános, Hungary (Fig. 10: 5; Hüttel 1981, Tab. 8: 71), Spišsky Štvrtok, Slovakia (Fig. 10: 4; Hüttel 1981, tab. 8: 72A) and Østrup Bymark, Denmark (Fig. 10: 1; Hüttel 1981, tab. 11: 110–111). It seems very likely that the decoration was also present on three fragmentarily preserved cheekpieces known from Jakuszowice, dist. Kazimierza Wielka (Fig. 9: 6–8; Bąk 1992, fig. 2: 1–2; Godłowski 1992, tab. 2: 2). On the other hand, a detailed analysis of the ornamentation motif contained within both bands of the decoration indicates its uniqueness. With a certain simplification, one can state that two adjoining ovals were placed in each band of the ornament covering both cheekpieces, inside of which there is an image of two antithetically aligned "tear drops", in the wider parts of which there is a circle with a central point inside. The outline of the ovals is "toothed", consisting of tiny triangles forming an ornament of the "hanging triangles" type. Such motifs also frame the main ornamentation bands, from the top and the bottom. This ornament was placed on the basis of the cheekpiece head as well. The above-mentioned ornamentation motif of ovals and tear drops is very rare yet some analogues can be found. The closest, which is not very surprising, are those from Jakuszowice (Bąk 1992, fig. 1: 2; Godłowski 1995, tab. 2: 2). One of the cheekpieces discovered there is decorated with a very similar ornamentation, containing an identically expressed motif of "tear drops". However, the ornamentation in this case is aligned vertically, not horizontally; moreover, the element of "hanging triangles" is missing (Fig. 13: 2). Similar ornamentation is present on the artefacts from Spišsky Štvrtok (Fig. 13: 6; Vladar 1971, tab. 14). Another two cheekpieces from Jakuszowice are decorated with a motif of ovals and "tear drops" aligned horizontally, but formed by clearly discernible engraved lines (Fig. 9: 6, 9; 13: 3). There is one more analogue coming from a significantly larger distance. Ornamentation consisting of horizontally aligned spirals with centrally placed circles with central points inside, which conjoin one with another to form oval-shaped patterns, was recorded on two cheekpieces from Østrup Bymark on the Danish island of Zeeland (Fig. 13: 4; Hüttel 1981, tab. 11: 110–111). Similar decoration is also present on the cheekpiece from Budapest-Lágymános (Fig. 10: 5; Hüttel 1981, tab. 8: 71). The motif of ovals and "tear drops" discussed above evolved from a classical wave ornament, namely from a variant consisting of very high and tight waves, like in the case of a cheekpiece from Belz (Fig. 9: 5; Bukowski 1976, tab. I: 1). The rotation of this motif by 90 degrees to a horizontal position led to the creation of oval and "tear drops" ornamentation.

The motif of tiny "hanging triangles", legible on both of the cheekpieces discussed in this paper, is much more common. It was encountered on cheekpieces of the Spiš type coming from Gîrbovăţ, Romania and Tószeg, Hungary (Hüttel 1981, tab. 8: 74 and 76), as well as on one of the cheekpieces from Gusyatin, Ukraine (Ilchyshyn, 2016, fig. 4: 5). It occurs more frequently on cheekpieces of the Füzesabony type, for instance, on artefacts coming from Nitrianský Hrádok, Slovakia (Hüttel 1981, tab. 5: 39), where it is accompanied by wave ornamentation, or as an exclusive decoration motif on specimens from Köröstarcsa and Mezöcsát-Pástidomb, Hungary (Hüttel 1981, tab. 6: 52, 53). The heads of both of these cheekpieces are decorated with a motif of empty ovals. Although identical ornamentation has not been encountered on any other artefact, some other motifs showing a great resemblance to the former are well known. A very similar decoration, even though it consists of circles instead of ovals, was recorded on the head of a cheek-

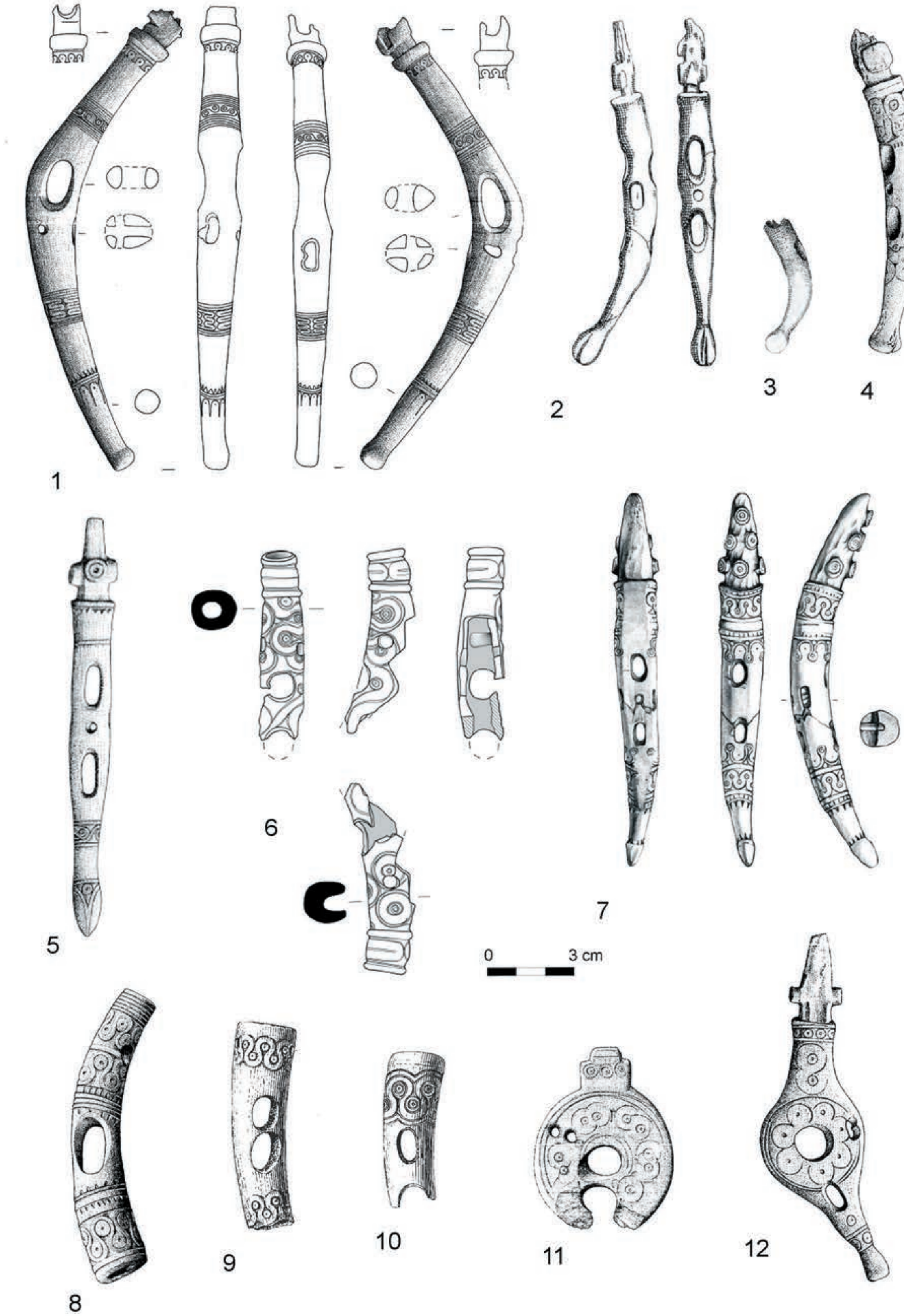

Fig. 10. Antler cheekpieces discussed in this paper: 1 – Østrup Bymark, Denmark (Hüttel 1981, Tab. 11: 110–111); 2, 3 – Spišsky Štvrtok, Slovakia (ibidem, Tab. 8: 72, 86); 4 – Spišsky Štvrtok, Slovakia (ibidem, Tab. 8: 72A); 5 – Budapest–Lágymános, Hungary (ibidem, Tab. 8: 71); 6 – Mitrou, Greece (Maran, van de Moortel 2014, Fig. 6); 7 – Cârlomănesti – Cetătuia, Romania (Motzoi - Chicideanu, *et al.* Matei 2012); 8 – Nitrianský Hrádok, Slovakia (Hüttel 1981, Tab. 5: 39); 9 – Malé Kosihy; 10 – Veselé, Slovakia (Točik 1959. Tab. 2: 3; 3: 6); 11, 12 – Tószeg, Hungary (Hüttel 1981, Tab. 3: 26; 4: 28)

piece from Belz (Fig. 9: 5). A similar decoration, although only consisting of two large ovals, is present on the specimen from Budapest-Lágymános (Fig. 10: 5). The head of one of the cheekpieces from Jakuszowice bears two ovals which are not entirely closed on their bottoms (Fig. 9: 6). There are two further specimens from Østrup Bymark and Gusyatin, decorated with a motif of a half of an oval (Fig. 10: 1, 2; 9: 1, 3; Hüttel 1981, Tab. 11: 110–111; Ilchyshyn, 2016, fig. 3:3), although they are placed on the cheekpiece body instead of its head.

The latter decorative elements are singular circles with central points inside, mounting the top of the cheekpiece heads. An identical ornamentation motif is known from the above quoted artefacts from Belz and Gusyatin (Fig. 9: 5, 3).

Summarising the overview of ornamentation motifs encountered on the cheekpieces from the grave no. 38, it must be stressed that, although all of them have their analogues in the Danubian cultural environment, the artefacts decorated in such manner constitute a strongly distinctive group located in the northern foothills of the Carpathians, within the circle of the Trzciniec Culture (cheekpieces from Morawianki, Jakuszowice, Gusyatin and Belz). In addition, this group also includes a cheekpiece from Østrup Bymark, although the latter is isolated in terms of its geographic location.

The undecorated cheekpiece from grave no. 56 in Morawianki also represents the Spiš type. Its association with the above-mentioned specimens is expressed by its general shape, although its body is more arched-shaped. However, the strongest connection is discernible in the alignment of the slots for straps. On the other hand, the major differences include: no ornamentation at all, a lack of a linchpin, and the bolt shaped around the body, instead of embracing the three-fourth of its circumference. Also a greater part of the bolt was split off in this case, which hinders the determination of the nature of its decoration.

Similar, undecorated specimens with an arched-shaped body and a distinctive head (Fig. 10: 2, 3) are known from Spišsky Štvrtok (Hüttel 1981, tab. 8: 72, 86; Vladar 1971, 8, fig. 3: 1, 3).

A separate issue are the knobs found in grave no. 38. Two of them have eyelets, which can be determined as strap junctions (antler bits). They have no ideal analogues in assemblages of other published sites. The closest analogues for the artefacts from Morawianki are represented by knobs with eyelets known from the Monteoru Culture (Fig. 12: 1, 2; Diaconu and Sîrbu 2014, fig. 1: 2, 7). Similar artefacts are common in the Noua Culture, where they are always equipped with bronze shaft instead of an antler eyelet. In this cultural environment they are considered variously as parts of an outfit, amulets or elements of horse harness (Diaconu and Sîrbu 2014, 125). An argument for connecting them with elements of horse harness is strongly supported by a discovery of such knobs equipped with bronze shafts on the skulls of horses in the animal burial in Gusyatin (Fig. 12: 3–8; Ilchyshyn 2016, fig. 4). Artefacts resembling the specimens from Morawianki, although made of bronze, became more common from the Cimmerian horizon onwards (period V of the Bronze Age). In the territory of Poland, an undercoated bronze bit-knob dated to the HaA1 period was found in Samborowice, dist. Racibórz, 72 (Bugaj 2005, 69).

The abundantly decorated cheekpiece from Miechów, in contrast to the above-mentioned specimens from Morawianki, belongs to the group of artefacts of the Füzesabony type, variant B. According to Hüttel, cheekpieces of this type, with an arched-shaped body and lacking a distinctive bolt, are divided into variant A, with a singular perforation in the side plane of the cheekpiece, and variant B, with two slots for straps (Hüttel 1981, 66–67). Mozsolics classified cheekpieces with two slots as the Tószeg type (Mozsolics 1953, 95–97). On the other hand, according to Boroffka, the specimen from Miechów, due to an occurrence of smaller perforations placed by the cheekpiece ending, should be counted as type II, variant IIa (Boroffka 1998, 100). Cheekpieces of the Füzesabony type are associated with the Carpathian Basin (Hüttel 1981, tab. 26). However, almost 30 of them were also found at the sites of the Sabatinowka Culture and the early phase of the Bilozerka Culture on the northern shore of the Black Sea, where they are dated to the period BrD-HaA (Pankovskiy 2016, 239–240).

The specimen from Miechów is distinctive amongst the artefacts of the Füzesabony type due to a few features. Its body is oval-shaped, slightly flattened in its cross-section, in contrast to other cheekpieces which usually have a circular body in their cross-sections. The artefact in question is most likely the only one of its kind known from the related literature, with decorated endings of identical width (usually one of the endings is wider). A specimen resembling the one from Miechów, to some extent at least, comes from Tiszafüred, Hungary (Hüttel 1981, tab. 6: 56, p. 70). The latter is also slightly flattened and equipped with two small perforations drilled next to its upper ending (although their alignment is different). The cheekpiece from Miechów, however, is not the first artefact of this type known from the extent of the Trzciniec Culture. An undecorated cheekpiece of the Füzesabony type was encountered at the site Kraków – Cło, in Poland (Górski 2007, tab. 46A: ł).

Ornamentation on the cheekpiece from Miechów has no perfect analogues amongst the artefacts published in the existing literature. It is decorated with two horizontal bands of wave-banded ornament embracing approximately half of the body circumference, placed below and above the central part of the cheekpiece equipped with two slots for straps. This alignment of ornaments is typical of many artefacts of this kind (Hüttel 1981, tab. 5: 39; 40, 42). Moreover, there appear two further fragments of analogical ornamentation placed vertically, along the axis of the specimen, in its upper and lower part, which must be considered a solution which has not been recorded on any other cheekpiece. A characteristic trait of the ornament on the cheekpiece from Miechów is the manner of its execution, namely using a tool of the compass type. The ornament consists of waves formed by fragments of circles and entire circles engraved with the use of the compass tip. Clearly readable is the point where the steady leg of the compass was anchored, used as an element of decoration as well. Cheekpieces of various types, ornamented using the above-described technique are known, among others, from Tószeg, Hungary (including a specimen decorated in the so-called "Mycenaean style", Fig. 10: 11, 12; Hüttel 1981, tab. 3: 26; 4: 28), Malé Kosihy and Veselé, Slovakia (Fig. 10: 9–10; Točik 1959, tab. 2: 3; 3: 6), Nitrianský Hrádok, Slovakia (Fig. 10: 8; Hüttel 1981, Tab. 5: 39) and Cârlomănesti – Cetătuia, Romania (Fig. 10: 6; Motzoi-Chicideanu *et al.* 2012, tab. 11). Recently, a cheekpiece decorated using this technique has been discovered in Greece, within a building of an elite nature at the Mitrou site (Maran and van de Moortel 2014, fig. 6). The ornament under discussion corresponds well with the so-called *karpatenländischostmediterrane Wellenbandornamentik,* namely the Carpathian and east Mediterranean wave-banded ornamentation. This is the type of stylistics that developed within the circle of the Danubian cultural units, such as Maďarovce-Věteřov-Böheimkirchen, Vatya, Mureş, Vatin, Otomani - Füzesabony, Wietenberg and Monteoru Cultures (David 2007, 412–413). Artefacts decorated in this style are encountered in the territory of the middle basin of the Danube River, in the Peloponnesian peninsula and western Asia. Such ornaments are recorded on fittings, boxes of the pyxis type, cheekpieces, and stone stelae. In Greece, artefacts decorated in this manner are concentrated within three sites, namely Mycenae, Kakovatos and Staphylos, where they were found in tholos tombs and shaft graves, always accompanying abundantly furnished burials while in the Danubian zone they are significantly more common. In the latter region they were usually made of animal bones and antler, but metal specimens were also recorded, even those made of gold. Such artefacts are more frequently found within tells or fortresses. The existence of this ornamentation style evidences the close relationships between the cultural environments of the Carpathian Basin and Mycenaean Greece (David 2007, 412–414). Other scholars have suggested that the genesis of this type of ornamentation should be sought elsewhere, in the cultural environment of the Pontic steppe, where cheekpieces decorated in the style under scrutiny can also be found (Penner 1998, 20–22).

Another artefact found in Miechów is a cheekpiece in the shape of the letter "Y". It belongs to the type much less common than the specimens discussed above. In the existing literature, identical artefacts can be found classified as strap junctions, namely elements of a horse harness placed above the cheekpiece, on the upper part of the horse's jaw (Bandi 1963; Choyke 2005, 140). S. Penner (Penner 1998) presented various possible interpretations of artefacts of this type. They could have been used as both strap junctions or cheekpieces, transitional forms between plate and rod types, and characteristic only for the Carpathian regions. The above-mentioned scholar distinguished them as the ypsilon type, and mapped all of the known, rare artefacts of this type (Penner 1998, 52–54, 55–58; tab. 9). The best matching analogues for the specimen from Miechów come from the territory of Hungary. These are represented by undecorated cheekpieces from Jászdózsa – Kápolnahalom (Fig. 11: 2; Choyke 2005, tab. V: 1), Tiszafüred (Fig. 11: 3; Penner 1998, tab. 9: 7) and Tószeg (Fig. 11: 4; Penner 1998, tab. 9: 6). Another formally close, albeit geographically very remote, analogue comes from Turkey, from the Alaça Höyük site (Fig. 11: 9; Hüttel 1981, tab. 42: III.1). An argument for considering the above-mentioned artefacts as cheekpieces instead of strap junctions is provided by an analysis of the sizes and alignment of perforations drilled within them. Similarly to circular plate cheekpieces from Füzesabony and Tiszafüred, Hungary, or Trachtemirov, Ukraine (Fig. 11: 5, 6, 7; Hüttel 1981, tab.3: 24; 3: 24A; 2: 14, 15), they are equipped with centrally drilled large perforations, accompanied by another slightly smaller one. Around these two perforations there are other tiny perforations in a changeable configuration. If we consider these artefacts to be strap junctions, the central per-

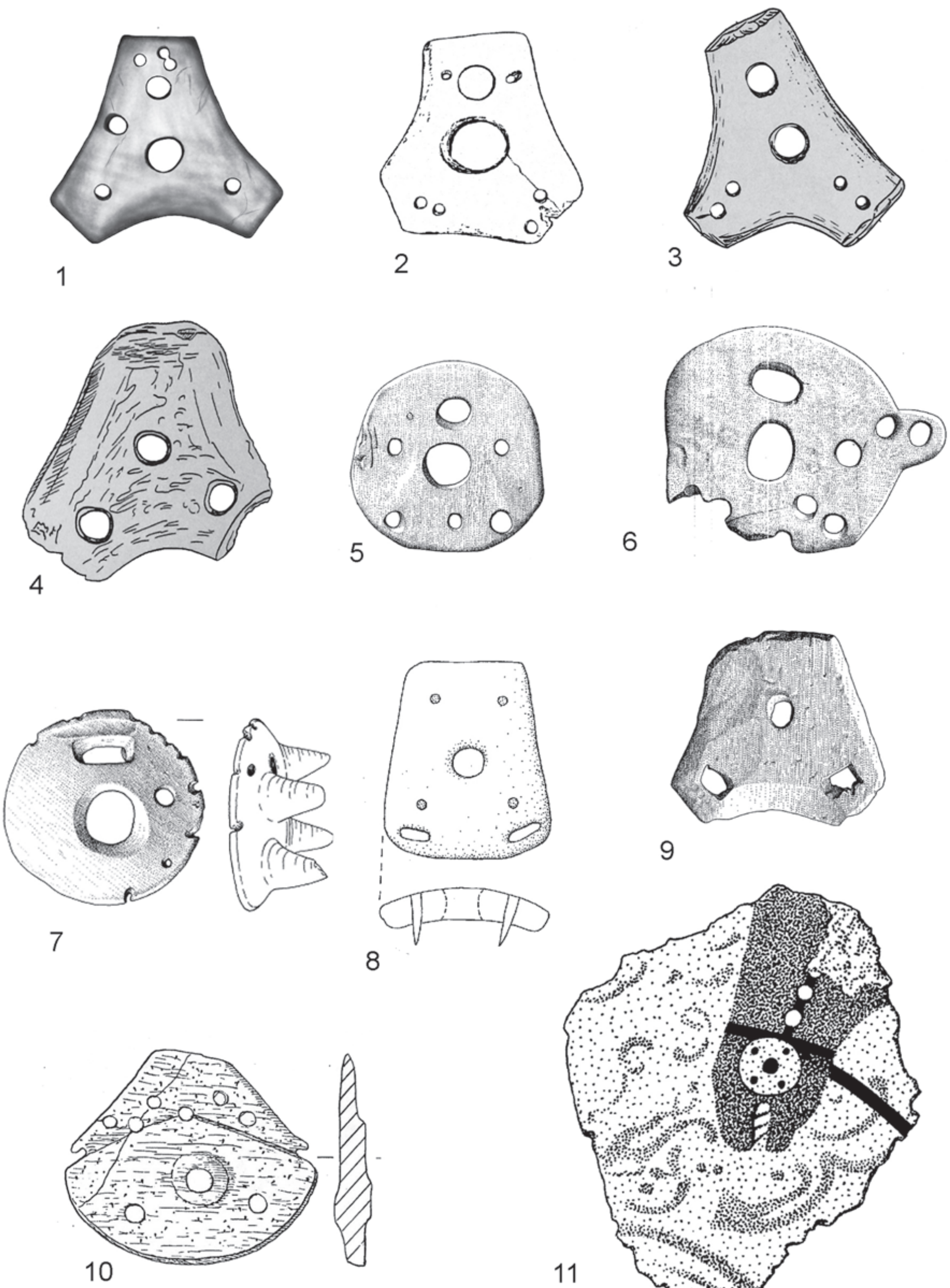

Fig. 11. Antler cheekpieces of the ypsilon type and associated plate forms: 1 – Miechów, Poland; 2 – Jászdózsa-Kápolnahalom, Hungary (Choyke 2005, Tab. V: 1); 3 – Tiszafüred, Hungary (Penner 1998, Tab. 9: 7); 4 – Tószeg, Hungary (Penner 1998, Tab. 9: 6); 5 – Füzesabony; 6 – Tiszafüred, Hungary (Hüttel 1981 Tab. 3: 24; 3: 24A); 7 – Trachtemirov, Ukraine (Hüttel 1981 Tab. 2: 14, 15); 8 – Oarţa de Sus, Romania (8; Boroffka 1998, Tab. 9: 1); 9 – Alaça Höyük, Turkey (Hüttel 1981, Tab. 42: III.1); 10 – Sintashta, Russia (Gening1992, Fig. 114); 11 – fragment of a fresco from Tiryns, Greece, with a visible harness on a head of a horse harnessed to a chariot (Hüttel 1981, Tab. 1: 9b)

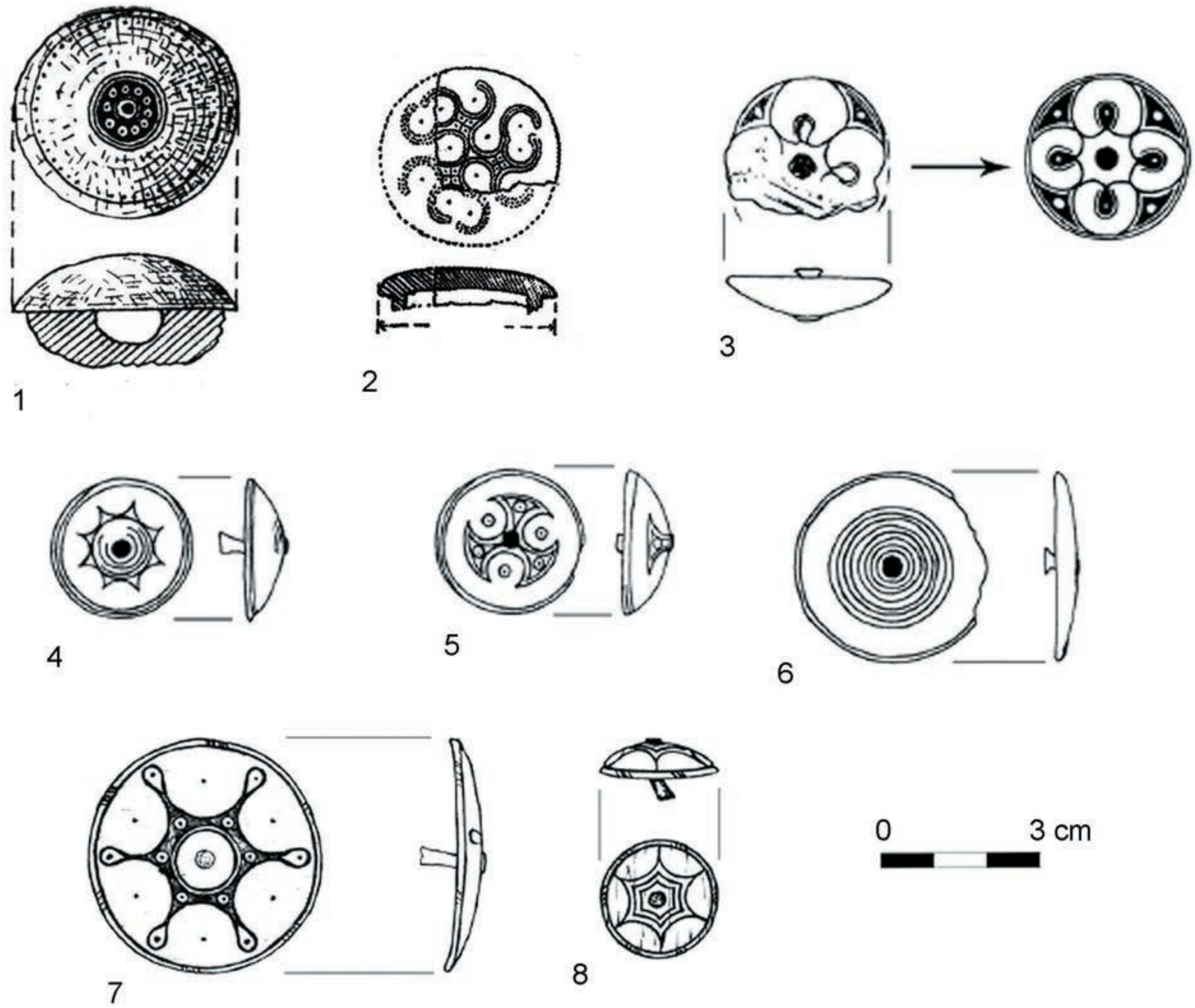

Fig. 12. Antler knobs: 1, 2 – from the sites of the Monteoru Culture (Diaconu, Sîrbu 2014, Fig. 1: 2, 7); 3–8 – and from Gusyatin, Ukraine (Ilchyshyn 2016, Fig. 4)

foration becomes absolutely useless. A characteristic shape of cheekpieces of the ypsilon type is inscribed within a circle, which leads us to assume that they were used identically as circular plate cheekpieces, in fact being one of their variants. Also noteworthy is the existence of a certain number of cheekpieces deriving from the circular specimens, trapezoid in shape, such as the artefact from Oarța de Sus (Fig. 11: 8; Boroffka 1998, tab. 9: 1), as well as the commonly encountered plate cheekpieces in the Sintashta Culture, which are semi-circular and trapezoid in shape (Fig. 11: 10; Gening 1992, fig. 114), the formal position of which is between the circular and ypsilon type cheekpieces.

The last discussed artefact was found in Jakuszowice. Its apparently trivial form hinders its classification to any type of rod cheekpieces described in the related literature. It differs from the specimens of the Spiš type due to the location of the perforation drilled in the frontal plane directly above the cheekpiece head. Solutions of this sort are recorded for cheekpieces of the Füzesabony type. However, with regard to the latter, cheekpieces with plastically distinguished heads have never been encountered. In such a case we should consider the artefact under study as a local variant, combining traits of both of these types.

Cheekpieces within the Trzciniec Cultural Circle

The cheekpieces discussed in this paper are not the first artefacts of this type known either from the extent of the Trzciniec Culture, or the widely considered Trzciniec Cultural Circle (TCC– referring to the Trzciniec-Komarov-Sośnica cultural circle; Makarowicz 2010, 15–16). The settlement in Jakuszowice has delivered as many as six cheekpieces of the Spiš type, all of which preserved fragmentarily. Four of them

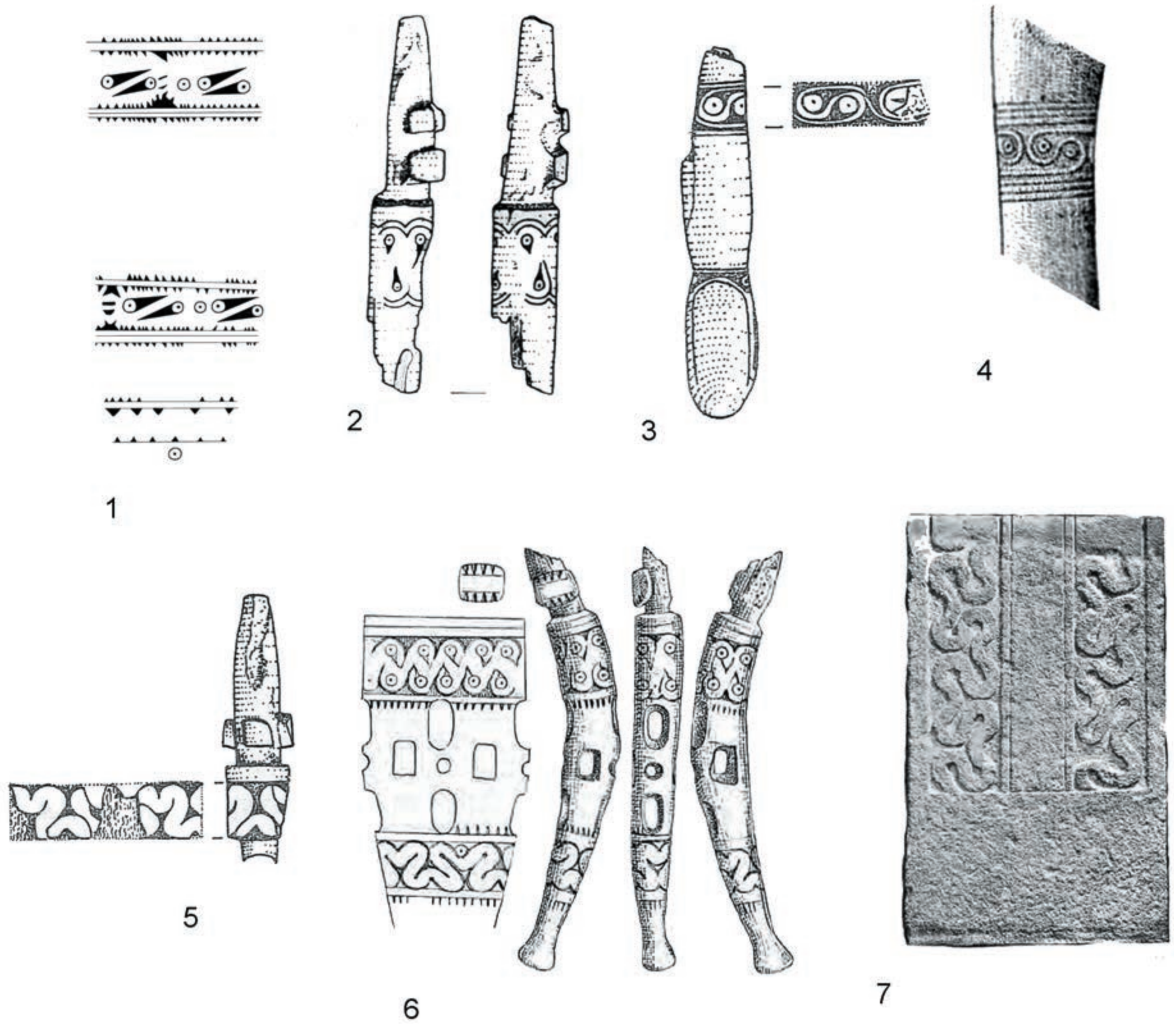

Fig. 13. Examples of wave-banded ornamentation: 1 – ornament on a cheekpiece from grave No. 38 in Morawianki; 2, 3 – decorated cheekpieces from Jakuszowice, Poland (Godłowski, Rodzińska-Nowak 1995, Tab. 2: 1, 2); 4 – Østrup Bymark, Denmark (Hüttel 1981, Tab. 11: 110); 5 – Jakuszowice (Bąk 1992, Fig. 1: 1); 6 – Spišsky Štvrtok, Slovakia (Vladar 1971, 8, Fig. 3: 1, 3); 7 – Mycenae, Greece (David 2009, 420, Tab. CV: d4)

represent forms abundantly decorated with wave-banded ornament (Fig. 9: 6–9). Three of them were found within the cultural layer (Bąk 1992; Godłowski 1992, Godłowski and Rodzińska-Nowak 1995), the fourth one – in a small feature, trapezoid in shape. The scarce fragments of pottery accompanying the latter (Bąk 1992, fig. 1, 2: 3–7) can be associated in general with the classical phase of the Trzciniec Culture development (assemblages of type A acc. to Górski 1997). Particularly noteworthy is the cheekpiece preserved only in its lower part, decorated with a very specific ornament of "soft", plastic, waved band, not containing any circular elements, engraved with the use of a compass (Fig. 9: 7). This motif is encountered extremely rarely in the Danubian zone. The closest analogue for the above-mentioned motif is represented by the upper band of the ornament recorded on the cheekpiece of the Spiš type from Spišsky Štvrtok (Fig. 13: 6; Vladar 1981, tab. 14). On the other hand, close analogues for decoration of this type are very easy to find in Greece, where it appears on both metal (grave no. 56 in Mycenae and David 2007, 420, tab. CV: d1) or stone artefacts (e.g. stelae from the shaft grave no. II in the grave complex A, fig. 13: 7; David 2007, 420, tab. CV: d4). The fifth cheekpiece from Jakuszowice is an undecorated specimen, belonging to the Spiš type, and was found within the cultural layer (Górski and Przybyła 2014).

Another cheekpiece should also be linked with the Trzciniec Culture, one oft-mentioned in the existing literature from Belz, reg. Sokal in Ukraine (Fig. 9: 5; Bukowski 1976, tab. I: 1). The context of its discovery is unknown, as a result of which the determination of its cultural affiliation and dating are varied. According to the former scholars it should be linked with the Scythian or Thraco-Cimmerian Culture, the early phase of the Lusatian Culture or late phase of the Trzciniec Culture (Bukowski 1976, 13–14). It has also been associated with the Noua Culture as well (Bąk 1992, 160). Its chronology is sometimes connected with the period Br D/HaA, but based on the results of analyses Hüttel ultimately dated the cheekpiece in question to the decline of the period Br A and the older phase of the period Br B (Hüttel 1981, 87–88; tab. 46). Its affiliation with the Noua Culture must be definitively rejected since Belz is located outside of this ecumene's boundaries, within the extent of the Trzciniec Culture (Makarowicz 2010, fig. 1.1). With regard to the dating issue, due to very legible relationships of details of its ornamentation with cheekpieces from the grave no. 38 in Morawianki, a grave from Gusyatin and cheekpieces from Cârlomănesti – Cetătuia, Budapest-Lagymanyos, and Østrup Bymark even, it should be decisively associated with the period A2 and the beginning of the period B of the Bronze Age.

There is a very interesting find of cheekpieces and a full horse bridle from Gusyatin reg. Ternopil. A grave of two horses was discovered there, covered with a barrow mound, and associated with the Proto-Komarov Culture. One cheekpiece of the Spiš type was encountered on the skull of horse no. 1, while on the skull of horse no. 2 there were another two cheekpieces of this type. In addition, next to these artefacts there were found respectively two and four antler knobs with bronze shafts (Ilchyshyn 2016). The above-mentioned specimens were subject to detailed analysis in terms of their stylistics and chronology, ultimately being were dated to the second half of the period BrA2 (Bandrivskyi 2016).

From the settlement of the Trzciniec Culture at the Kraków – Cło site, an undecorated cheekpiece is known (Górski 2007, 61; tab. 46A: ł), counted to the Füzesabony type. It was discovered within a feature of trapezoid shape (ibidem, Tab. 46; 46A). The cheekpiece was accompanied by pottery that can be linked with the classical phase of the Trzciniec Culture in western Little Poland, with the subtype A2 dated to the phases A2 and B of the Bronze Age to be exact (ibidem, 57–61, tab. 34). An unpublished antler cheekpiece was also encountered in Pełczyska, dist. Pińczów (Makarowicz 2012, 195), in Michałowice (oral information provided by the grave explorer, Joanna Telega-Zagórska) and in Dębiany dist. Pińczów (discovered by M. Przybyła and J. Bulas in 2020).

The latter finds of cheekpieces found within the Trzciniec Cultural Circle mentioned in this paper come from its eastern extreme. In the locality of Kozarovychy, Ukraine, two cheekpieces were discovered on the surface of a small cemetery, coming from a devastated grave or a deposit of some other sort. However, these specimens belong to a completely different type, namely convex plate cheekpieces (Fig. 9: 10, 11), widely spread within the environment of the Multi-cordoned Ware (Mnogovalikovaya) Culture (S. Lisenko 1999, 70; tab. 5:1–2). It is possible that another discovery of a pair of plate cheekpieces of the type A can be linked with the Trzciniec Cultural Circle, one coming from Trachtemirov, Ukraine. Cheekpieces are frequently quoted with reference to their resemblance to artefacts known from Mycenae. The circumstances of the discovery of the cheekpieces from Trachtemirov remain unknown (Fig. 9: 16, 17; Hüttel 1981, 38, tab. 2: 14, 15). However, it should be stressed that they were found within the extent of the TCC settlement.

From the territory of Poland there is only one site not connected with the Trzciniec Culture that delivered finds of antler cheekpieces of horse harness. This site is the cemetery of the Lusatian Culture in Kietrz, dist. Głubczyce in Upper Silesia. Within three cinerary graves from the early phase of this cultural unit, tiny charred fragments of four cheekpieces were found (Fig. 9: 12–15). They are dated to period III of the Bronze Age (Gedl, M. 1988). Their occurrence at the cemetery in Kietrz undoubtedly evidences the existence of influences coming from the Transcarpathian cultural environment as well. However, their chronology and context are completely different from those of the above-mentioned artefacts.

The chronology of the occurrence of antler cheekpieces within the Trzciniec Cultural Circle

It seems that the emergence of cheekpieces within the TCC has certain chronological frames, narrower than those determined for the particular types of these artefacts in their genetic areas. The general dating of all types of both rod and plate cheekpieces may be enclosed within the period between the Early and the Late Bronze Age (Br A2-Br D; Borrofka 1998, 103–104). Cheekpieces of the Füzesabony type are dated to the period Br A and the early phase of the period Br B. They were encountered mostly in the Hatvan, Otomani - Füzesabony and Madarovce Cultures (Hüttel 1981, 69–72). The chronology of cheekpieces of the

Spiš type is even longer, since they were utilised from the A2 period of the Bronze Age until the formation of the Urnfield Culture (Hüttel 1981, 82–86).

Chronological frames of artefacts discovered at the TCC sites and their best analogues from the Danubian zone are, however, narrower. A horse burial from Gusyatin is dated to the second half of phase A2 (Bandrivskyi 2016, 598). A cheekpiece from Østrup Bymark in Denmark is dated to the period B of the Bronze Age, ca. 1600 BC (Vandkilde 2014, 605–606). An abundantly decorated cheekpiece from Spišsky Štvrtok is associated with the development of the classical phase of the Otomani Culture (Hüttel 1981, 86, tab. 8: 73), i.e. with the period A2/B of the Bronze Age. A cheekpiece from Cârlomănesti - Cetătuia in Romania is dated to the very same period, having been linked with the late phase of the Monteoru Culture development and also dated to the period between 1640 and 1520 cal BC (Motzoi-Chicideanu *et al.* 2012, 69). Also very significant is the dating of the Carpathian and Mycenae wave-banded ornamentation style (*karpatenländischostmediterrane Wellenbandornamentik)*, with which the decorated cheekpieces from Morawianki, Miechów, Jakuszowice, Belz and Gusyatin correspond very well. This style developed in the period A2b and the early phase of the period B of the Bronze Age (David 2007, 415; Hüttel 1981, 87–88).

There are very few cheekpieces of the ypsilon type that have been precisely dated. An artefact of this type from Tószeg in Hungary is linked with phase A2/B1 of the Bronze Age (Penner 1998, 58), whereas a cheekpiece from Jászdózsa–Kápolnahalom was found within a layer associated with the late Hatvan Culture, dated to the years 1550–1450 cal BC (Choyke 2005, 133). However, it seems that this layer, and consequently the cheekpiece itself, should be dated much earlier, namely to the period between 2024 and 1750 BC (Raczky *et al.* 1994, 43–44).

At many sites of the Trzciniec Culture cheekpieces were encountered in both settlement features as well as graves, often accompanying ceramic artefacts. The pottery found in grave no. 38 in Morawianki, as well as in feature no. 4688 in Miechów and at the Kraków – Cło site (Górski 2007, 61; tab. 46A) bear traits typical of the classical phase of the Trzciniec Culture in western Little Poland. It was represented by profiled vessels (pots, bowls and beakers), equipped with thickened and trimmed rims, and decorated with horizontal, plastic bands. There were also numerous vessels decorated on their necks with an ornament of multiplied engraved lines. In general, they meet the criteria to count them as subtype A2 acc. to Górski (Górski 2007, 57–63). Nevertheless, with regard to the ceramic assemblage from grave no. 38 in Moriawianki, there occurred fragments of two vases decorated with an ornament of horizontal engraved lines and groups of arched engraved lines, which makes them typical of the oldest assemblages of the Trzciniec Culture in Little Poland, classified as subtype A1 and representing an early stage of its classical phase, from period A2 of the Bronze Age (Górski 1997:18; 2007:47; 2013:97). Such an early dating based on typological traits is supported by a relatively early radiocarbon date obtained from the skeleton of horse no. 1, namely 3360±70 BP (1742–1535 BC within the interval 68.2%). This grave also delivered two jug type vessels, referring in terms of their form and ornamentation to artefacts known from the environment of the Otomani Culture, like those from the cemetery in Nižna Myšl'a in Slovakia. In the abovementioned region, similar jugs are associated with the younger classical phase of the Otomani Culture, dated to the decline of the Bronze Age A (Br A3; Olexa, Nováček 2013, 17–19, fig. 4). In general, other fragments of pottery should also be linked with the classical phase of the Trzciniec Culture, such as those coming from feature no. 585 (Bąk 1992, fig. 2: 3–7) and feature no. 2271 in Jakuszowice. Early classical ceramic assemblages of subtype A1, classical sets of subtype A2, and assemblages characterised with an occurrence of vessel forms affected by Transcarpathian influences of the subtype A4, are placed within considerably wide chronological frames, i.e. BrA2 – BrB1/B2 (Górski 2007, 89–91). Noteworthy is the fact that such dating is consistent with the chronology of the above-mentioned cheekpieces from outside of the territory of Poland and the development of the wave-banded ornamentation style. Therefore, it can be assumed that the episode of the emergence and existence of cheekpieces within the Trzciniec Culture in western Little Poland may be enclosed within the period A2-B of the Bronze Age (17th–15th century BC).

Collective horse burials within the Trzciniec Cultural Circle

The issue of the emergence of cheekpieces within the TCC is associated with an occurrence of collective horse burials. Features containing horse bones are quite commonly encountered within the Trzciniec Culture. They enclose settlement pits with small amounts of horse bones (Koszyce, Poland; Górski 2008, 106), or entire skeletons (Smroków, Poland; Górski and Włodarczak 2010). Horse remains were also recorded in the context of human burials. This is best exemplified by a collective grave of five humans and 14–16 horse skeletons from Pełczyska in Poland. A horse skull was also discovered in one of the graves at the cemetery in Małopołoveckoje, Ukraine (Górski 2008, 112; Makarowicz 2010, 258–259).

However, there is a very distinctive group of horse burials (mainly containing two horses) placed into large, rectangular pits situated under a barrow mound or on its boundary. In most cases, graves of this type enclose the skeletons of two horses, placed symmetrically along a N-S axis and with their heads directed towards each other, southward. Within grave no. 56 in Morawianki, three horses were buried on two levels. In the upper level the corpse of one individual was laid while in the lower level two other animals were placed, aligned accordingly with the rules described above (Fig. 14: 4).

A fine example of a double, symmetrical burial of horses comes from Gusyatin, Ukraine (Fig. 15: 1). Fragments of horse harness were found buried next to the skulls of horses, allowing their precise dating. According to the description (unfortunately, the plan of the entire barrow has not been published), the horse grave was located five meters to the south of the centre of the barrow, but still under its mound (Ilchyshyn 2016, 78, Fig. 2). Another double burial of horses known from the territory of Ukraine comes from Bukivna and was discovered within the barrow at the cinerary cemetery of the Komarov Culture (Bandrivskyi 2016, 112). In the territory of Poland, a well preserved grave of this type was recorded in Michałowice, where a complex of features of the Trzciniec Culture was uncovered, including human graves and two double horse burials (Fig. 15: 2), one partly destroyed by younger features. These features were the remains of the TC barrow construction like the one in Morawianki (Zagórska-Telega *et al.* 2011, 200–203). An existence of the mound that has not preserved until present is evidenced by the organisation of a younger cemetery of the Przeworsk Culture, obviously surrounding the TC barrow which must have survived until the Roman Period (Fig. 17: 4). The burial of horses did not contain any artefacts. However, within one of the human graves, a bronze pin and a number of ceramic vessels were found (Zagórska-Telega *et al.* 2011, p. 203, Fig. 3–6), which can be dated to phase A2-B of the Bronze Age. A burial of two horses, preserved in a worse condition than those mentioned above, was discovered under the mound of barrow no. II in Miernów, dist. Pińczów (feature no. 10, Fig. 14: 4). It was different from the former since the skeletons of horses were placed along a W-E axis, within a very large pit that also contained human remains (Fig. 14: 5). The grave description mentioned only one skeleton of a horse, whereas the analysis of its plan evidently indicated the occurrence of skulls and lower limb bones belonging to two horses, arranged in a very specific alignment. The discrepancy between these two interpretations was most likely due to a poor state of preservation of bones (merely skulls and few massive long bones had been preserved). The barrow no. II in Miernów consisted of an older mound of the Corded Ware Culture, covered by an overbuilt mound of the Trzciniec Culture. The author of the barrow's publication linked the burial under scrutiny with the Corded Ware Culture (Kempisty 1978, 22–23, Fig. 5, 17). However, taking into account the absolute lack of such horse burials in the Corded Ware Culture on one hand, and their common occurrence in the Trzciniec Culture on the other, the affiliation of the barrow in question with the latter is practically certain. The grave no. 10 was situated in the eastern part of the mound, slightly to the south of the W-E axis of the barrow (Fig. 17: 2). Noteworthy was the lack of any other burial of the Trzciniec Culture under the mound, while in its central part there was only one feature, namely the pit no. 7 containing a vessel of this cultural unit (Kempisty 1978, 12–17). As a result, grave no. 10, with its human and horse remains, becomes the most crucial element of the entire sepulchral complex of the Trzciniec Culture. In terms of typology, ceramic vessels encountered within the mound no. II in Miernów are associated with assemblages of the type A1 acc. to Górski, namely the oldest phase of the Trzciniec Culture development in Little Poland, dated to the period A2-B1 of the Bronze Age (Górski 2007, 50, 85–87).

In particular, less numerous cases, the alignment of horse skeletons do not follow the pattern discussed above. Such a situation was observed with regard to grave no. 38 in Morawianki, where only one skeleton was placed in anatomical order (Fig. 14: 1), while the other was incomplete, with particular elements having been relocated. Another case like this was encountered within a grave under the barrow mound in Żerniki Górne, dist. Busko Zdrój (grave no. 41, Fig. 14: 2). At this site, the skeletons of a mare and a foal were placed into a rectangular pit, while the latter lay in the corner of the pit. This burial, like the grave in Miernów, was hypothetically ascribed to the Corded Ware Culture, a presence of which was manifested by graves discovered under the barrow mound, in companionship of burials of the Trzciniec Culture (Kempisty 1978, 49–50, fig. 37, 57). Having marked this fea-

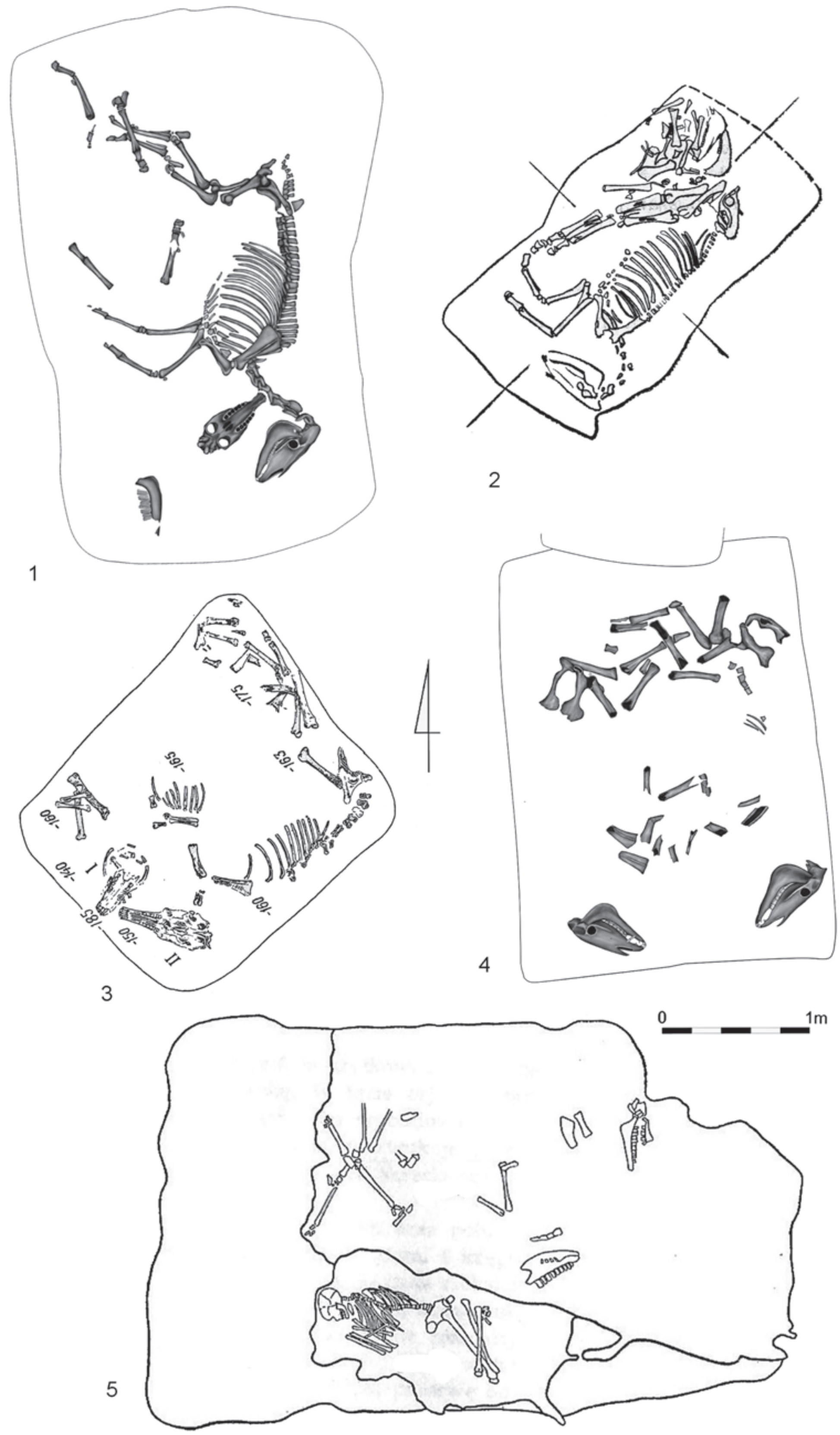

Fig. 14. Double horse burials: 1 – Morawianki, grave No. 38; 2 – Żerniki Górne, Poland (Kempisty 1978, Fig. 57); 3 – Sintashta, Russia (Gening *et al.* 1992, Fig. 102: 3); 4 – Morawianki, grave No. 56; 5 – Miernów, Poland (Kempisty 1978, Fig. 17)

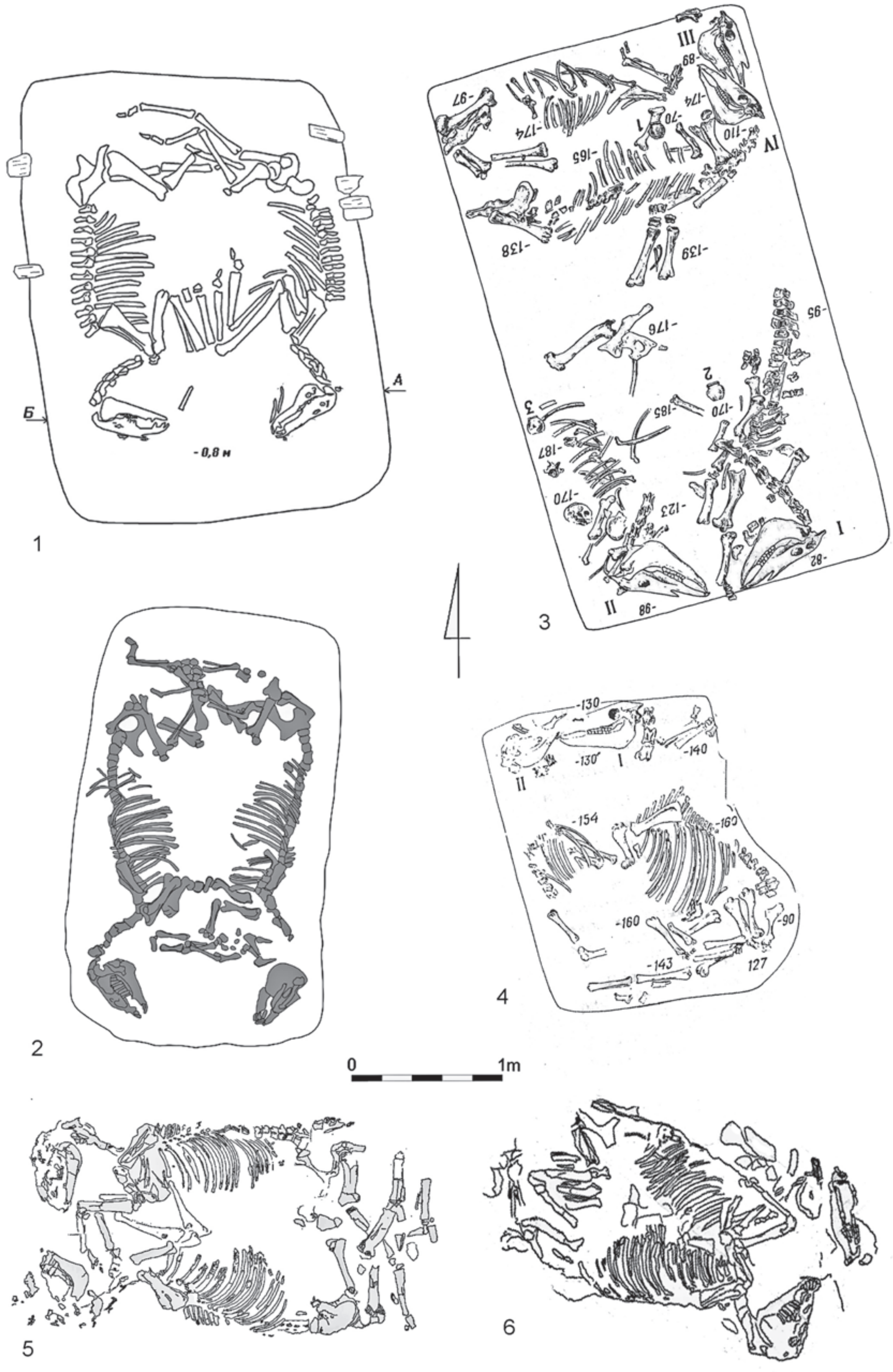

Fig. 15. Double horse burials: 1 – Gusyatin, Ukraine (Ilchyshyn 2016, Fig. 2); 2 – Michałowice, Poland (Zagórska-Telega *et al.* 2011, p. 203, Fig. 6); 3, 4 – Sintashta, Russia (Gening *et al.* 1992, Fig. 109: 1, 90); 5, 6 – Dendra, Greece (Pappi, Isaakidou 2015, Fig. 4, 8)

ture on the plan of the Trzciniec cemetery, it became obvious that it had been located in the western part of the mound, slightly to the south of its W-E axis, on the edge of one of the stone circles (Fig. 17: 2).

Another burial of this type was found in Gabułtów, dist. Kazimierza Wielka, where a barrow of a nearly entirely preserved mound was explored. It contained graves of the Corded Ware and Trzciniec Cultures: one animal and three human burials (Górski, Jarosz 2006). Their alignment refers to the model known from Morawianki and Michałowice. Within rectangular pit no. 3, the scarce bones of two horses were found, including those of a lower limb and the skull of one individual, as well as a few bones of the limbs of the other. Moreover, under the mound in the southern part of the barrow, another five concentrations of bones were discovered which would have belonged to no fewer than seven horses (Abłamowicz, Kubiak 2006). The barrow's explorer, Górski, suggested that the horse burial had marked the centre of the mound of the Trzciniec Culture (Górski 2008, 112). However, it seems that the horse grave was rather situated in the southern part of the mound, while the human remains were buried outside of the mound's boundaries (Fig. 17: 5).

A very interesting discovery has been made recently in Kazimierza Wielkia, dist. *loco*, where archaeologists explored a barrow with two phases of utilisation: an older one associated with the Corded Ware Culture, and a younger one with the Trzciniec Culture. With the latter, two collective human and two collective horse burials were connected. One of the latter contained six skeletons aligned symmetrically along a N-S axis, with the heads of some of them directed southward, the others' – northward. All of the burials were locatsed in the zone adjacent to the barrow in the south-west (oral information provided by the barrow's explorer, Krzysztof Tunia). A double, symmetrical burial of horses was also explored in 2020 in Dębiany (researched by M. Przybyła and J. Bulas). Another sepulchral complex containing human burials and a collective horse grave was encountered in Wilczyca, dist. Sandomierz (oral information provided by the site's explorer, Tomasz Boroń). This is the first burial of this type recorded in central Little Poland.

At this point a question about the genesis of burials of this type should be raised. In this regard, an existing correlation between barrows with collective horse graves and the occurrence of elements of horse harness is very meaningful. Within the Trzciniec TCC, both of these elements only coexisted in the territory of Little Poland and Ukraine. Seeking the genesis of horse burials in the Danubian cultural environment is an obvious direction due to the fact that this is the area of origins of all types of cheekpieces encountered in the Trzciniec Culture. Nevertheless, it turns out that graves of this sort are practically unknown in the Carpathian Basin. Only at the fortress of the Wietenberg Culture in Oarța de Sus (Romania) has a double horse burial been discovered, where one of the skeletons was accompanied by two cheekpieces (Boroffka 1998, 92).

A large concentration of horse burials or graves containing the bones of horses was recorded in Greece. In this territory ten sites with horse graves have been discovered which have been dated to the Bronze Age (another 15 were associated with the Iron Age). Two further sites were encountered on Crete (Kosmetatou 1993; Recht 2018, 84–85). The most famous of these is the cemetery in Dendra (Fig. 18: 3; Pappi, Isaakidou 2015, fig. 1, 2, 4, 8) previously dated to the Middle Helladic Period (Kosmetatou 1993, 37). However, more recent chronological determinations support their later dating, no sooner than to the Late Helladic Period III (1431–1132 cal BC; Pappi, Isaakidou 2015, 476). At this cemetery as many as four double horse graves were encountered, including two with a symmetrical alignment of skeletons (Fig. 15: 5, 6). Primarily, they were believed to have accompanied two tumulus tombs, however, this interpretation is currently questioned (ibidem, 471). Nevertheless, noteworthy is the fact that all of the horse burials were situated near the dromoi, leading to chamber graves, in the area adjacent to the graves in the south-west (Fig. 15: 2). Further burials, albeit containing individual horse skeletons, were recorded in Argolis and dated to the Late Helladic Period I-III (1600–1200 BC). A double horse grave, with symmetrically aligned skeletons, is known from the tholos tomb in Marathon (Fig. 18: 1), dated to the Late Helladic Period II (1500–1400 BC). In the corridor leading to the grave (dromos) two horse skeletons were placed in a symmetrical alignment (Daux 1959, 583–586; Kosmetatou 1993, 37–38). Unfortunately, the orientation of this burial cannot be determined based on the published materials. A collective burial of four horses was also recorded in a chamber tomb in Kokla, dated to the Late Helladic Period III (Pappi and Isaakidou 2015, 477).

Although horse graves with a symmetrical alignment of skeletons are recorded in Greece, they are not sufficiently numerous and, most likely, with too late a chronology for us to consider Greece as a generic area for this type of burial. A common cradle of the phenomenon in question for both of the regions mentioned above should be sought elsewhere. The issue of the emergence of this type of grave in Greece has drawn the attention of scholars for quite some time. Some of them formulated the opinion that horse graves and the skill of chariot driving came from the north, from the Carpathian Basin or the eastern European and Asian steppes. One of the most essential pieces of evidence supporting the above-quoted opinion is the emergence of antler cheekpieces in Greece together with the artefacts discovered, among others, in shaft grave no. IV in Mycenae (Diamant 1988; Harding A. 2005). At this point it should be stressed that there are also scientists who claim that horse burials in the Mycenaean Culture had Middle Eastern origins (Recht 2018). However, it seems that animal burials from the

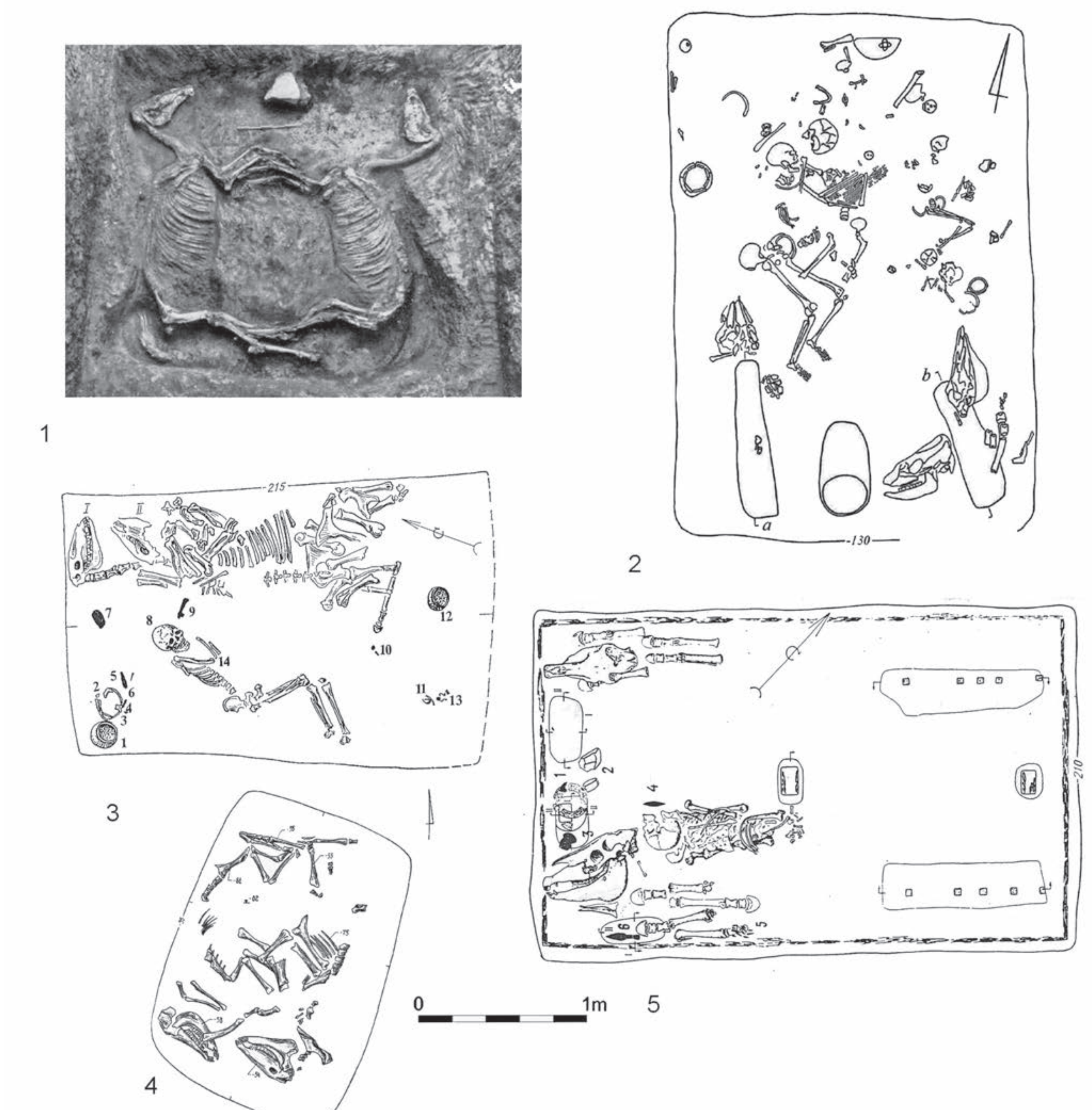

Fig. 16. Double horse burials: 1– Marathon, Greece (Stikas 1958, Fig 23); 2 – Kamennyi Ambar, Russia, (Chechushkov, Epimakhov, 2018, Fig. 5); 3 – Sintashta (Gening *et al.* 1992, Fig. 48); 4 – Stepnoe, Russia (Kupriyanova, Zdanovich 2015, Fig. 106); 5 – Sintashta (Gening *et al.* 1992, Fig. 111)

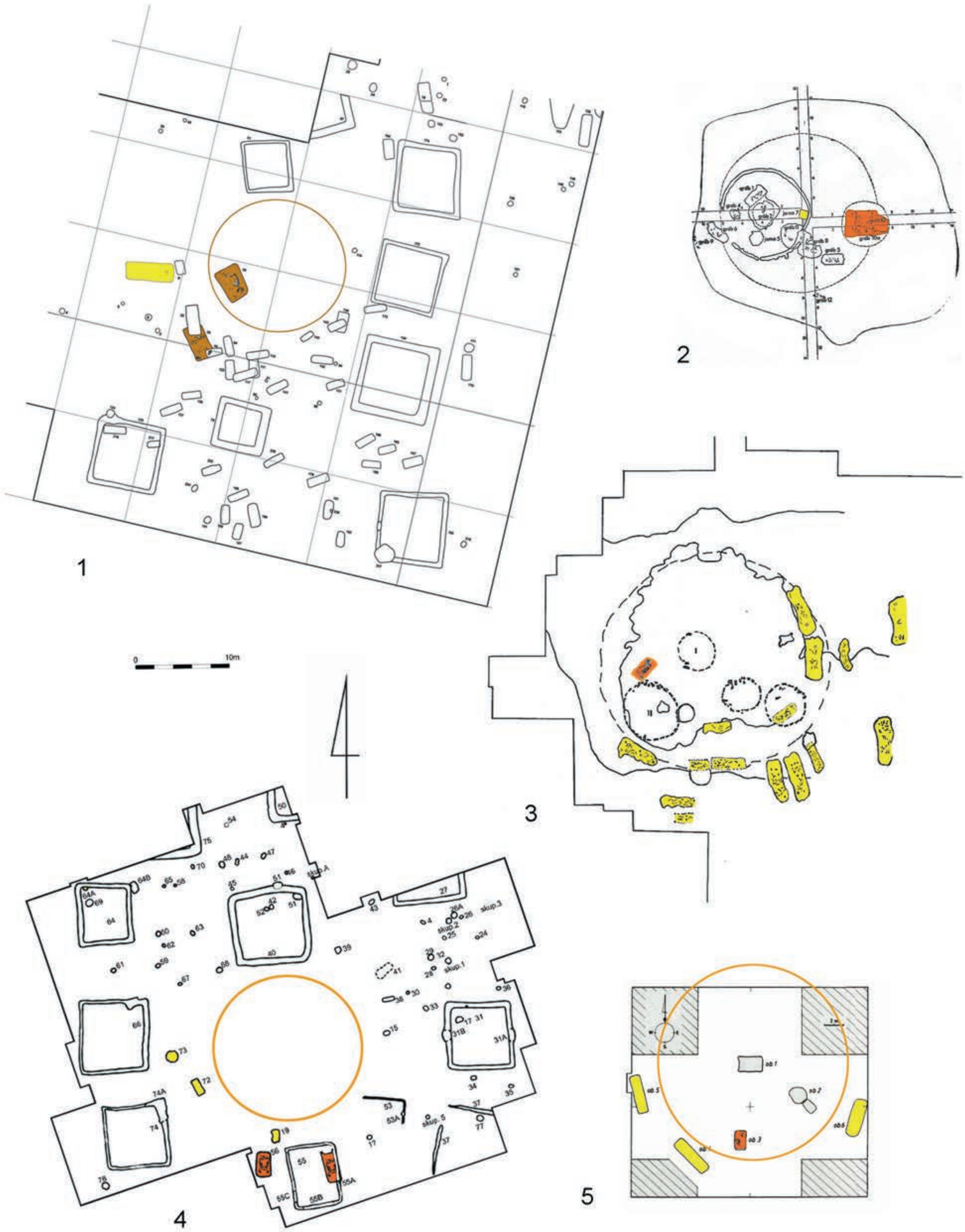

Fig. 17. Sepulchral complexes with centrally situated barrows within the extent of the Trzciniec Culture. Orange colour marks double horse burials. The yellow colour is for other features of the Trzciniec Culture. 1 – Morawianki; 2 – Miernów, Poland (acc. to Kempisty 1978, Fig. 5); Żerniki Górne, Poland (acc. to Kempisty 1978, Fig. 37); 4 – Michałowice (acc. to Zagórska-Telega *et al.* 2011, s. 203, Fig. 1); 5 – Gabułtów, Poland (acc. to Górski, Jarosz 2006, Fig. 3)

It seems that in the territory of western Little Poland, a collective horse grave was an immanent feature of a sepulchral complex, the centre of which was constituted by a barrow. This is very well exemplified by recently discovered sites, such as Michałowice, Morawianki, Gabułtów, Kazimierza Wielka, and thanks to renewed analysis of archival sources (Miernów II, Żerniki Górne). During earlier explorations of TC barrows in western Little Poland, horse burials had not been discovered. However, we must keep in mind that in most cases their explorers focused exclusively on the barrow mounds (e.g. Rosiejów – Reyman 1934, 49–51). Most likely this was the reason why human and animal graves surrounding the mound had not been revealed. The pattern of the functioning of horse graves within a sepulchral complex, with a barrow in its centre, seems to be very clear. Horse burials, like human graves, were situated at the foot of the barrow, within a zone adjacent to the mound in the south. Graves could have also been established under the barrow mound. In the latter case they were aligned along the W-E axis of the barrow or in its southern part. These rules are strikingly similar to the analogical rules discernible in establishing graves in the steppe zone. The SM cemetery in Sintashta was situated at the foot of the Great Barrow, on its south-western side. The rule under scrutiny is also clearly legible in the previously discussed barrows in the steppe zone from Utevka, Komarovka, Kamennyi Ambar or Stepnoe, as well as in the case of locating horse burials in relation to human graves in the cemeteries of the Mycenaean Culture in Dendra.

Recently obtained dates from graves with chariots (established under the mounds or surrounding them), encountered at cemeteries of the Sintashta Culture such as those known from the sites in Sintashta, Krivoe Ozero, Utyovka, are enclosed within the time frame of 1950 and 1750 BC (Kuznetsov 2006, 643). According to other authors, the beginning of the Sintashta Culture should be dated to even as early as ca. 2100 BC (Anthony 2009, 59; Outram *et al.* 2011). Consequently, the earliest emergence of the abovementioned set of features (barrow – horse burial – cheekpieces) must have taken place in the steppes of the Volga River and the Ural Mountains. Shortly afterwards, these elements also occurred in Central Europe and in the Balkans, however, their reception was not identical in all these regions. With regard to Helladic Greece, horse graves were scarce, while horse harness was represented by plate cheekpieces. Riding a chariot must have been common in those times, an assertion supported by the occurrence of images of horses harnessed to a chariot decorating the stelae of shaft graves in Mycenae (Harding 2005, 297), and also present on frescoes, pottery and gems (Littauer 1972).

In the Carpathian Basin, the most legible element coming from the Pontic environment was the occurrence of plate cheekpieces, and consequently, the popularity of chariots (obviously, not to mention influences of other sorts, such as earrings of the Sibin type – Ginalski *et al.* 2019, 468–469; Lichardus and Vládar 1996: 31). Whereas, in the Trzciniec environment Pontic influences are manifested by the spreading of the tradition of erecting barrows, and the emergence of horse burials. What is interesting, plate cheekpieces are practically absent in this region (except for the easternmost site in Kozarovychy, and possibly another one in Trachtemirov). All of the other finds of cheekpieces within the TCC reveal very close connections with the Carpathian Basin.

The function of antler cheekpieces within the Trzciniec Cultural Circle

Having analysed the emergence of horses and elements of their harness, we must ask ourselves a question about the function they played in the communities that used them. They seem to undoubtedly confirm the utilisation of chariots pulled by two horses, which is strongly supported by the common occurrence of double horse burials. The emergence of antler elements of horse harness in Central Europe is frequently associated with the emergence of chariots, together with the new opportunities they brought in the practical zone (military), as well as prestigious and ideological spheres (Boroffka 1998, 117). Nevertheless, doubts have been in the existing literature referring to the potential utilisation of horse harness for riding on horseback as well (Harding 2005, 296; Kadrow 2001, 142). In cultural units developed in the steppe zone a horse burial, mostly accompanied by a four-wheeled cart or chariot, was one of the ways to express the high position and status of the dead (Outram *et al.* 2011, 119). Very numerous graves equipped with carts, wheels or models of carts were discovered within the context of the Pit Grave Culture. They are believed to have been burials of individuals with high social status (Ivanovaa and Tsimidanov 1993, 23–34). This tradition was continued by the communities of the Catacomb Grave Culture (Shishlina *et al.* 2014, 378, 391), and in the younger cultural units of the Bronze Age (Outram *et al.* 2011, 119). However, in this cultural environment there are no graves that could be considered burials of riders. This was due to

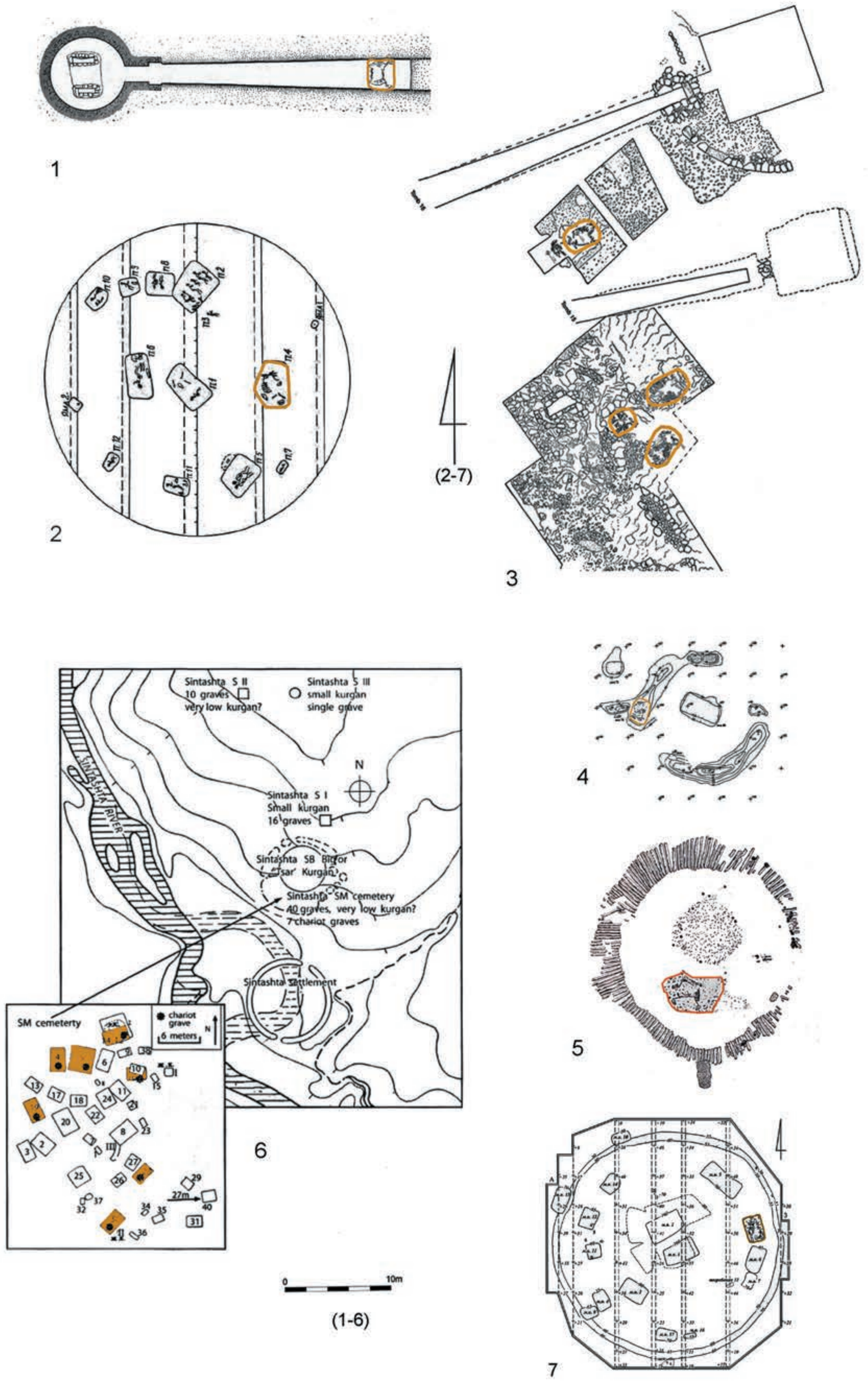

Fig. 18. Sepulchral complexes with double horse burials (marked with an orange colour): 1 – Marathon, Greece (acc. to Stikas 1958, Fig. 22); 2 – Utyovka, Russia (acc. to Lichardus, Vladar 1996, Tab. 15); 3 – Dendra, Greece (acc. to Pappi, Isaakidou 2015, Fig. 1); 4 – Stepnoe, Russia (acc. to Kupriyanova, Zdanovich 2015, 135; Fig. 106); 5 – Komarovka, Russia (acc. to Penner 1998, 78, Tab. 22); 6 – Sintashta, Russia (acc. to Hanks et. al. 2012, Fig. 20.4); 7 – Kamennyi Ambar, Russia, (acc. to Chechushkov, Epimakhov, 2018, Fig. 5)

Middle East, quoted in this paper as analogues (often containing remains of donkeys, instead of horses), are different in terms of their form and chronology from those discovered in Greece.

When searching for the region where collective horse burials which can be dated to the times under scrutiny are the most numerous, one should take into consideration the Sintashta Culture, which developed in the steppes of the Volga River and the Ural Mountains, on the borderland of present day Russia and Kazakhstan. The largest number of collective horse graves was delivered by investigations carried out at the SM site, namely a flat cemetery situated at the foot of the Great Barrow in Sintashta, Russia, adjacent to the latter in the south-west (Fig. 18: 6; Hanks *et al.* 2012, Fig. 20.4). At this cemetery, horse graves of various configurations were encountered, containing either two (Fig. 16: 3) or several skeletons. The horse skeletons were very often accompanied by antler plate cheekpieces and the burials were frequently multistoreyed. In the successive storeys relics of sacrificial rites were found (hearths, remains of consumables, like in the grave no. 38 in Morawianki), horse burials, human graves and relics of chariots. Chariots were often placed at the bottom of the grave chambers or in one storey (Fig. 16: 5) altogether with the skeletons of humans and horses (Gening *et al.* 1992, 111–241). Amongst the horse graves one can highlight those that formally resemble the symmetrical alignments known from the Trzciniec and Helladic Cultures (e.g. graves nos. 19 and 29; Fig. 15: 3, 4), or the burials of a single horse in a anatomical order, accompanied by displaced remains of another individual (grave no. 26, Fig. 14: 3; Gening *et al.* 1992, fig. 90, 102, 109). Identical burials of horses or humans and horses are being recorded at successive sites of the Sintashta Culture, for instance, in Utyovka, Krivoe Ozero and Potapovka in Russia (Kuznetsov 2006, 641). At the site in Utyovka a double, symmetrical burial of horses was found, placed in the eastern part of the barrow (Fig. 18: 2), along the W-E axis of the mound (Lichardus and Vladar 1996, tab. 15), like in barrow no. II in Miernów. Under a large barrow mound of the Sintashta Culture in Kamennyi Ambar, Russia, there was discovered a grave containing the remains of two horses, a chariot and three humans (Fig. 16: 2). The above-mentioned grave was situated in the eastern part of the mound, along the W-E axis of the barrow (Fig. 18: 7; Chechushkov and Epimakhov, 2018, fig. 5). At the site in Stepnoe, Russia, a barrow of the Petrovka Culture was discovered, closely associated with the Sintashta Culture. The barrow contained a double, symmetrical burial of horses, aligned along the N-S axis (Fig. 16: 4), and situated in the western part of the sepulchral complex (Fig. 18: 4; Kupriyanova, Zdanovich 2015, 135; fig. 106, 111). Similar alignments within graves are also known from other regions of the steppe. In barrow no. 5 in Komarovka, Russia, ascribed to the Timber-grave (Srubnaya) Culture, a symmetrical grave of two horses was recorded (Fig. 18: 5), placed at a distance of a few meters to the south of the barrow's centre (Penner 1998, 78, tab. 22), analogically to the case of the barrow from Gusyatin.

The impact of the steppe environment on both the cultural units of the Early Bronze Age in the Carpathian Basin as well as the Mycenaean Culture, with the significant contribution of the Sintashta Culture, has already been widely discussed in the related literature (Diamant 1988; Lichardus and Vladar 1996; Penner 1998; Anthony 2009). However, these opinions have met with the criticism of some authors (Kadrow 2001, 199–201). In recent years, additional arguments for the occurrence of the steppe-related elements in the Mycenaean Culture have been provided by genetic studies, which indicated that certain genes of "steppe" origins could be found in individuals of the Greek elites of the Bronze Age (Lazaridis *et al.* 2017).

The occurrence of steppe-related elements was also noted in the TCC, discernible in the particular details of burial rites and ceramic vessel stylistics (Makarowicz *et al.* 2013, 164–184). It seems that the emergence of horse graves is further evidence supporting the existence of the eastern trend within the TCC. In the period A2-B of the Bronze Age in some areas within the TCC extent, enclosing Little Poland and western Ukraine, a triad of specific traits evolved. This triad consisted of barrows, collective horse graves and the occurrence of antler cheekpieces. The attempts to explain the genesis and function of the barrows in the Trzciniec Culture have been addressed in many publications (Górski 1996; Makarowicz 2011). The origins of erecting earthen mounds are most frequently seen in the local tradition deriving from the environment of the Corded Ware Culture, possibly complemented by the influences of other cultural units from Central Europe, such as Únětice, Tumuli or Iwno Cultures (Makarowicz 2012, 155). If we include the element of horse burials into our considerations on the genesis of barrows, suggesting their local origins is simply insufficient. This is due to an absolute lack of a tradition of burying horses under mounds in the Corded Ware Culture and the other cultural units that developed in the Early Bronze Age in Central Europe.

the fact that a high level of prestige was expressed by riding a chariot (Levine *et al.* 1999, 7), but also that the skill of horse riding was unknown in the Early and Middle Bronze Age. Having analysed the history of the domestication of horses, one can state that the skill of riding a horse developed much later than the skill of driving a chariot. The domestication of horses took place in the steppe regions of Eastern Europe and Central Asia. According to some studies, based mostly on the osteological analysis of horse teeth revealing traces of the utilisation of snaffle bits in the Botai and Tersek Cultures, humans rode on horseback as early as in ca. 3500 BC, or even earlier (Anthony and Brown 2011, 152–155). These opinions are, however, strongly criticised (e.g. Kosintsev and Kuznetsov 2013). In addition, it should be stressed that the utilisation of horse harness does not necessarily indicate riding on horseback exclusively, since the bridle used for driving a chariot is practically identical (Fig. 5: 6). With great certainty, the domestication of horses is dated to the end of the third millennium BC (Levine *et al.* 1999, 7). With regard to the Sintashta Culture, there are no doubts that chariots were already in use, with evidence in that environment from the 20th century BC (Kuznetsov 2006), or even earlier than 2000 BC (Anthony 2009, 59). They might have derived from even older two-wheeled carts of the Catacomb Grave Culture, dated to the period between 2400 and 2200 BC (Chechushkov and Epimakhov 2018, 478). The earliest images of two-wheeled chariots are known from the region of the Middle East and Iran no sooner than the years 1900–1800 BC (Anthony 2009, 59–61). The Hyxos introduced them in Egypt in ca. 1800 BC, in Mycenaean Greece they appeared before 1600 BC (Chondros *et al.* 2016, 230), while evidence for riding on horseback is significantly younger. Excluding an enigmatic horse skeleton from the Egyptian fortress Buhen in Nubia, dated to ca. 1675 BC, there is some evidence for the practice of riding on horseback in Egypt, Syria and the Hittite Kingdom since the 15th century BC, demonstrated by images of riders, although the role they played in contemporary military forces was absolutely marginal (Kelder 2012, 8, 10–12). The oldest images of riders on horseback in the art of the Mycenaean Greece are dated to the 13th century BC, while the popularisation of horse riding took place no sooner than in the 11th–8th century BC (Anthony and Brown 2011, 155; Kelder 2012, 1). It is noteworthy that a very similar rhythm of changes in the utilisation of horses was recorded in eastern Eurasia. According to the results of studies conducted in Mongolia, chariots were supposed to have been used there in the Early and Middle Bronze Age, in the years 3000–1500 BC, while riding on horseback became more common in the Late Bronze Age and the Early Iron Age, after 1200 BC (Taylor 2020 *et al.*, fig. 8).

With regard to the Trzciniec Culture, there is no direct evidence of the utilisation of chariots confirmed by the occurrence of carriages of this type in burials. However, particularly noteworthy is the somewhat untypical organisation of a grave containing human and horse remains in barrow no. II in Miernów. In the central part of a large grave chamber, a burial of horses was placed accompanied by the bones of a human while the entire western part of the pit, with dimensions of ca. 120 × 310 cm, was empty. It seems that this space could have originally been occupied by a chariot. The alignment of the remains in the grave from Miernów strikingly resembles the plans of burials known from the Sintashta Culture (Fig. 16: 2, 3, 5). The maximum length of a chariot from the Bronze Age, including the drawbar, amounted to 330 cm (the box itself had a length of ca. 50 cm), and the maximum width reached 205 cm (Chechushkov and Epimakhov 2018, tab. 3). Thus, it is obvious that the space left in the above-mentioned grave chamber would not have been enough for a carriage of this type. Chariots might have also been placed in other horse burials, for instance, in grave no. 38 in Morawianki, with dimensions of 350 × 200 cm and a depth of more than 160 cm. As indicated by various examples known from the Sintastha Culture (Fig. 16: 3), in certain cases the remains of horses and a chariot took up a common space; it was possible that the chariot was placed above the horse corpses.

There is also evidence of another sort proving that chariots were used in North and Central Europe in the Middle Bronze Age since they are represented by a few iconographic images of chariots. The closest images of this kind in terms of geographical location were recorded on a vessel of the Suciu de Sus Culture in Veľké Raškovce, Slovakia (Fig. 19: 1; Vladár 1981, tab. 22). This image displayed multiple chariots pulled by two horses. The dating of this find is slightly controversial; most likely it should be associated with phase D of the Bronze Age (Furmanek1997, 156–159). Some very suggestive images are known from southern Scandinavia. A collective image of a dozen or so chariots, to all of which two horses were harnessed, decorated a rock block in Frännarp, Sweden, in the form of an engraving (Fig. 19: 3). This engraved image is dated to the period between 15th and 13th century BC. Similar dating (period II–III of the Bronze Age) was determined for a famous image of the "chariot of

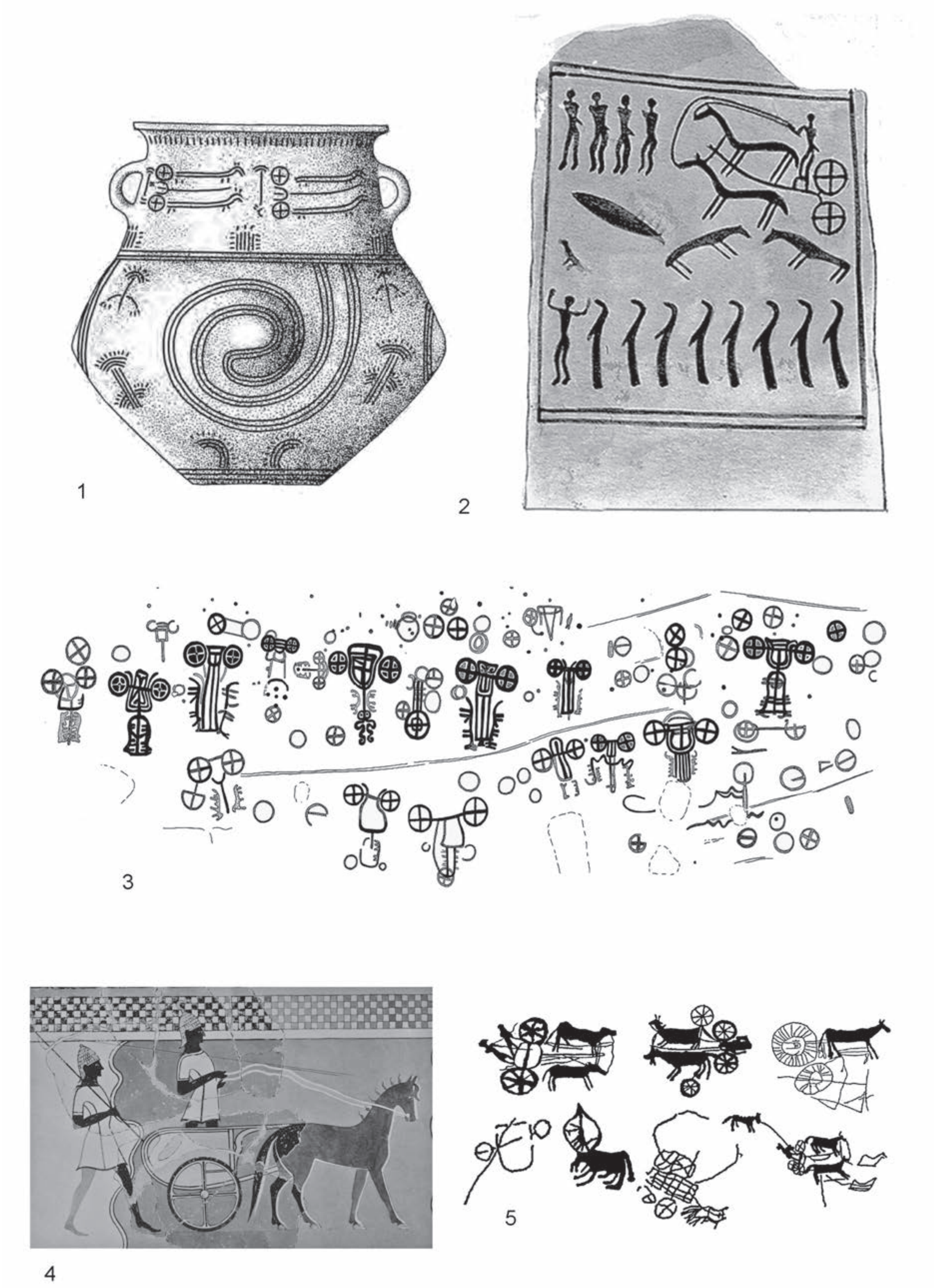

Fig. 19. Images of chariots from the Bronze Age. 1: Veľké Raškovce, Slovakia (acc. to Vladár 1981, Tab. 22); 2 – Kivik, Sweden (acc. to Goldhahn 2009, Fig. 7); 3 – Frännarp, Sweden (acc. to Coles 2002, Tab. 1); 4 – Pylos, Greece (acc. to Lang 1969; Tab. 123); 5 – various sites, Kazakhstan (acc. to Chechushkov, Epimakhov, 2018, Fig. 8).

the Sun" in the form of a bronze statue from Trundholm (Coles 2002, 242, tab. 1). Another image of two horses harnessed to a chariot comes from a tomb in Kivik, Sweden, where it decorated one of the walls of the tomb (Fig. 19: 2). Its chronology was placed between the years 1400–1300 BC (Goldhahn 2009, 368, fig. 7). Formally, these images are close to the pictures of chariots pulled by a pair of horses from Kazakhstan that have been dated to the Bronze Age (Fig. 19: 5; Chechushkov and Epimakhov, 2018, 444, fig. 8).

Further analysis of the figural expressions in the territory of North and Central Europe adds weight to the conclusion that the popularisation of riding on horseback took place no earlier than in the Iron Age. This is the period from which, also in the territory of Poland, images of riders decorating ceramic vessels of the Lusatian Culture are known (Gediga 1970, 137). Nevertheless, the popularisation of horseback riding did not necessarily involve the abandonment of chariots, a fact confirmed, among others, by the find of two clay models of spoke wheels encountered in the grave no. 1287 in Zbrojewsko, dated to the period V of the Bronze Age (Gedl 2004, 69, 74, Tab. 15), and an image of a chariot decorating a vessel from Sobiejuchy and dated to the period HaC (Gediga 1970, 136–139).

Conclusion

The emergence of horse burials, horse harness and chariots, associated with the former, must have been connected with the organisational changes that took place within the communities of the Trzciniec Culture. In the existing literature there appear opinions, based mostly on the analysis of grave furnishing, that the communities of the Trzciniec Culture were egalitarian and poorly stratified, and that this cultural unit had an outstandingly "non-military" character (Makarowicz 2010, 322, 335). However, it seems that in western Little Poland there evolved more complicated social structures than those recorded in other regions within the TCC. In the younger period A2 of the Bronze Age, an extremely stable and permanent settlement network developed in the loess zone around Cracow (Górski 2017, 100). This region was situated outside of the settlement zone of the Transcarpathian cultural units in Poland, though, it was characterised with an extremely strong contribution of their influences that became even more intense after 1650 BC. Political and economical impact of the latter must have led to formation of the local elites (Górski 2017, 105–108).

It was here also that considerably numerous, usually very large, defensive settlements emerged (Przybyła *et al.* 2019, 331–332), and which are not encountered in other parts of the TC ecumene. In terms of economy, the strength of the local elites could have been based on the production of salt obtained from brine springs (Przybyła 2017, 374–375). The emergence of cheekpieces and horse graves in this area, proving the use of chariots, seems to be a significant sign confirming the existence of a distinct group of warriors/aristocrats, which has its analogues in the Danubian, Mycenaean and Pontic environments. Vandkilde indicated that a community formed conjoining the elites of the Nordic Bronze Age with the cultural units that developed in the Carpathian Basin in the 17th century BC. This was the period which saw the emergence of warriorhood, fighting techniques, a common cosmology, and when significant social changes took place. The message bearing all this content came from the south (Mycenae), and spread through the Carpathian Basin, finally reaching Northern Europe as well. The influence of Carpathian stylistics are clearly legible in the Scandinavian metallurgic craft. The most crucial compounds of the warrior's rank were horses, chariots, horse harness and weapon; these elements constituted their high position in the hierarchy. One piece of evidence supporting the above-formulated theory is the occurrence of cheekpieces (found in Østrup Bymark) and fittings of a riding crop of the Carpathian type in Scandinavia (Vandkilde 2014). Therefore, it seems that the occurrence of numerous cheekpieces in the context of the Trzciniec Culture (a dozen or so specimens from several sites) must be considered proof that a local military elite had also evolved in this environment, and was included into the above-mentioned community. The utilisation of chariots pulled by horses must have required the existence of a group of warriors who had developed the requisite skills essential to use those means, as well as resources to create them and ensure their maintenance.

During the development of the Trzciniec Culture, western Little Poland was characterised by a great abundance of finds of horse harness elements and double horse burials. The issue of the existence of the traits discussed in this paper within the Trzciniec Culture environment has only been outlined in this paper. It is certainly an issue which requires further study, in particular research which engages complementary methods, such as microwear analysis of traces preserved on cheekpieces, and the archaeozoological examination of horse skeletons.

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The Castle Hill in Biecz and fortified stronghold in Kobylanka. The results of interdisciplinary research from 2019

Abstract

Kocańda P., Pisz M., Rajchel B., Filipowicz M. 2020. The Castle Hill in Biecz and fortified stronghold in Kobylanka. The results of interdisciplinary research from 2019. *Analecta Archaeologica Ressoviensia* 15, 139–163

In 2019, new research was initiated at two archaeological sites located on the Ropa River, in Gorlice County, in the south-eastern part of Małopolska Province. The first site was the Castle Hill in Biecz, and the second one was the fortified stronghold in Kobylanka. The research consisted of three stages. Firstly, extensive archival and library queries were conducted in order to gather basic information about both sites. Secondly, surface research was performed in order to collect any movable monuments. During the third stage, a reconnaissance by means of GPR, electrical resistivity imaging and geo-magnetic survey was carried out. These provided plenty of new valuable information on the spatial layout of both sites. In the case of the Castle Hill, the analysis of the discovered anomalies allowed for the interpretation of some of the finds as remnants of the brick elements of the castle, e.g. the tower, which corresponds with the plan from 1877. The results of the analyses of the anomalies from the fortified stronghold in Kobylanka, with its ramparts made of stone and earth as well as inner circular housing, were far more ambiguous. Its chronology may date back to the early Middle Ages.

Key words: castle, medieval archaeology, archaeological geophysics, ground-penetrating radar, magnetometry, stronghold.

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1. Introduction

Non-invasive archaeological research involving modern methods of prospection (ground-penetrating radar, LiDAR, geophysical research) is becoming increasingly popular. Among the significant number of researchers who utilize such technologies are an increasing number of medieval archaeologists, who investigate remains dating back to the Middle Ages and the early modern period (see: Bewley *et al.* 2005, 636–647; Pilszyk and Szmyd 2017, 169–176; Legut-Pintal 2013, 209–223; Ostrowski *et al.* 2014, 307–314; Zapłata 2013). Such popularity is evident primarily in the number of recent discoveries and the growing number of publications. In order to validate the above thesis, we refer to a handful of randomly selected yet spectacular discoveries. As such, it is crucial to mention the location of the medieval town founded in 1424 by Władysław Jagiełło in Kujawy (Stępień 2015, 81–116; Wroniecki and Jaworski 2015, 167–199), the discovery of the settlement complex in Dzwonów in Wielkopolskie (i.e. *Greater Poland*) province, which turned out to be one of the residences belonging to the Nałęcz family (Bogacki 2017, 141–147; Wroniecki 2017, 178–193), as well as the uncovering of the long-lost castle in Żelechów, which belonged to the Ciołek family (Bis *et al.* 2018, 351–359), or the new findings associated with the Teutonic Knights' castles in

Starogród, Unisław and Lipienko (Wiewióra *et al*. 2016, 109–111).Within the Podkarpacie Province, it is necessary to mention the discoveries of field fortifications connected with the Bar confederates in Izby, Łupków, Roztoki and Muszynka (Filipowicz 2018, in print). The results obtained in the course of such research are complementary to other historical items, including written and cartographic sources, as well as archaeological and architectural surveys. The following interdisciplinary research will serve as an example of such a situation.

The aim of the present article is to discuss the historical and geophysical research as well as the surface surveys conducted on two sites by the Ropa River in Gorlice county, namely Góra Zamkowa (the Castle Hill) in Biecz and the fortified stronghold in Kobylanka. Such works were the very first of their kind on both sites and for this reason the reported findings are somewhat innovative, as they provide plenty of valuable information concerning both features. The paper has been divided into several parts, which describe particular elements of the research, i.e. historical and surface surveys, as well as the results obtained via ground-penetrating radar, electrical resistivity imaging and geomagnetic surveying. It is worth mentioning that the presented results constitute a contribution to the subsequent research, aimed at performing comprehensive archaeological explorations.

2. Location

Biecz and Kobylanka are two towns located in southern Poland, more specifically, in Lesser Poland Province, Gorlice County. The first is a small town, with just over four thousand inhabitants and a long medieval tradition going back to the mid-13th century. The second one, on the other hand, is a large village, whose origins date back to the first half of the 14th century. From the taxonomical perspective, both are located in the valley of the Ropa River, in the area of the Gorlice Depression, which in turn, is a part of the Central Beskidian Piedmont (Fig. 1; Kondracki 1998, 336–337, 341–342). Pursuing this further, the Gorlice Depression is located between the Ciężkowice Piedmont in the north and the Low Beskids in the south. By all appearances, it was formed as the result of denudation processes within the poorly resistant layers made of Carpathian flysch (Kondracki 1998, 341).

The non-invasive exploration described in this article was carried out in the area of two archaeological sites. The first one was Góra Zamkowa (literally *the Castle Hill*, Fig. 2) in Biecz, also known as Góra Królowej Jadwigi (*Queen Jadwiga's Hill*) (or Salomonowa Góra, i.e. *Solomon's Hill*), which is situated south-west of the center of the Old Town, approximately 660 meters in a straight line from the town square. The said elevation (about 291 meters above sea level) resembles an oval cone, with a truncated flattened peak measuring 20×42 meters. Moreover, its south-eastern hillside includes a semicircular, small flat area. In archaeological nomenclature, it is marked as the site No. 2/2 in Biecz – an ancient, early medieval stronghold and a brick castle built in the 14th–16th century, located in the AZP 109–69 area.

The second site is a newly discovered, supposed stronghold with an unknown chronology that has not yet been recorded in the register of monuments in the Lesser Poland province. The said stronghold is located in the western part of Kobylanka, about 1.8 km north-west of the village center (Fig. 3). More specifically, it is situated on the right bank of the Ropa River, on a promontory that remains separated by natural ravines from the north, south, and southeast. The only convenient access to the area leads through meadows from the east. Furthermore, the site has been partially destroyed on the north-western side by a landslide. The whole area is covered with forest, with the prevalence of deciduous trees.

3. The history of the features and the state of research

The research was preceded by both archival and historical query, as well as the analysis of the literature and records from the previous excavations. The queries were carried out in the Regional Historical Monuments Conservation Office in Cracow and in the delegation of the same office located in Nowy Sącz, as well as in the Regional Museum in Rzeszów, the Museum of the Biecko Land and the National Archives in Cracow. The basic historical data about Biecz and Kobylanka have been collected through the following entries: Biecz, Biecz – stronghold, castle and starostwo (literally *eldership*), Biecz – castellan, Biecz – county land and Kobylanka Dolna and Kobylanka Górna, published in individual volumes of the Historical and Geographical Dictionary of the Kraków Province compiled by F. Sikora (1980, 72–88) and J. Kurtyka (1993, 626–637). Meanwhile, the primary literature consists of monographs devoted to both towns (see Głowacka-Grądalska 2014; Kaleta 1963a), which discuss the history of the settlement, spatial development, social topography, culture, ownership changes, economy and trade. The more detailed stud-

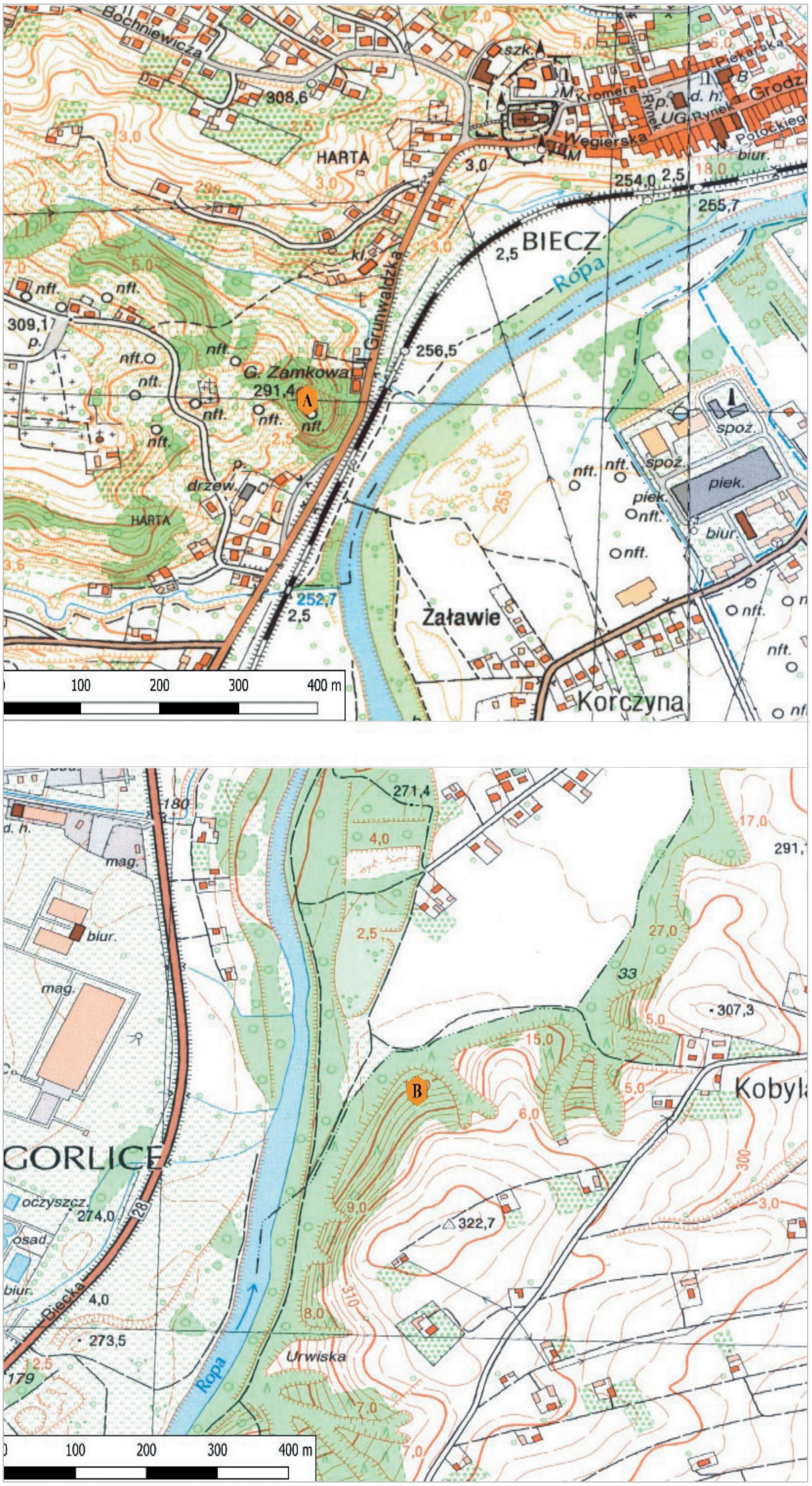


Fig. 1. Location of both sites: A – the Castle Hill in Biecz; B – Stronghold in Kobylanka

Fig. 2. the Castle Hill in Biecz, view from the east (photo taken by P. Kocańda, 2019)

Fig. 3. Fortified stronghold in Kobylanka, view from the south (photo taken by P. Kocańda, 2019)

ies by F. Kiryk (1968, 93–119; 1985, 33–45), J. Bogdanowski (1966, 602–606), A. Kunysz (1963, 64–81; 1968a, 39–60), B. Krasnowolski (2004, 13–19), T. Ślawski (2002) and J. Widawski (1973, 90–100) also constitute a valuable source of information. What should also be mentioned is the exceptional, albeit unpublished and, in some respects, obsolete urban study of Biecz by J. Barut (1959). Some issues related to the castle on the Castle Hill in Biecz have been discussed by R. Kaleta (1963b, 82–115), B. Guerquin (1974, 90) and the authors of the Lexicon of Castles in Poland (Kajzer *et al.* 2010, 92). The available information pertaining to the status and the history of the foregoing archaeological and architectural explorations were compiled and summarized by Paweł Kocańda (2018, 1–22).

3.1 Biecz and Góra Zamkowa (the Castle Hill)

The first credible written mention of Biecz can be found in a document issued in 1184 by Gedka, the Bishop of Cracow, in which he granted the collegiate church of St. Florian in Krakow a tithe from the Biecz region. However, in the light of historians' findings, it can be assumed that the beginnings of the urban settlement in Biecz date back to the second half of the 13th century, namely the reign of Bolesław the Chaste, the Duke of Krakow–Sandomierz. Unfortunately, it remains unknown when the document granting German law to the settlement was issued, since it has not been preserved to our times. In 1363, King Casimir III the Great confirmed the Magdeburg law to the town by awarding it numerous privileges (Kiryk 1985, 33–36; Krasnowolski 2004, 13–19). The Castle Hill in Biecz is an extremely important element in various considerations pertaining to the beginnings of the settlements, both within the city and the whole region. The archaeological research that was conducted there in the 1960s led to the discovery of the remains of houses associated with Lusatian culture (Kunysz 1963,72–76; see Kocańda 2018a, 10–11). Moreover, the site is also related to the functioning of the castellan stronghold, dating back to the 11th–13th century (Kunysz 1963, 72–74; Żaki 1963, 53–63). Unfortunately, no relics of it have been found to date. The reason for this lies in the construction of a brick castle at the turn of the 13th and 14th centuries, which replaced the older wooden-earth fortress, whose remains were thereby destroyed. The stone structure was founded by Wenceslaus II of the Přemyslid dynasty, who bestowed the castle upon the Bishop of Krakow, Jan Muscat, in 1303 (Kaleta 1963, 85–94; Kocańda 2018b, 326). In the following years, the castle was systematically extended. It served as the seat of the burgrave, who was responsible for managing the Biecz district, the residence of the monarch, as well as the border fortress. In the 15th century, the castle ceased to function, as evidenced by the document issued in 1475 by King Casimir Jagiellon, according to which the building was abandoned. At the beginning of the next century, the demolition of the castle began (Kajzer *et al.* 2010, 92; Kaleta 1963, 94–98).

The ruins of the castle were first encountered between 1876 and 1877. At that time, researchers unearthed the perimeter walls, a 10-meter diameter cylindrical tower and some inner structures. However, the excavations were quickly finalized. What remained of them was a not very accurately recreated plan of the castle which included the rooms uncovered during the debris removal (Kocańda 2018a, 6; Tomkowicz 1900, 242–245; see Fig. 4). The first professional archaeological reconnaissance on the Castle Hill in Biecz was conducted in the 1950s by Andrzej Żaki (Kocańda 2018a, 7). Meanwhile, the first, and thus far only, large excavations took place in 1961. At that time, the stratigraphy of the hill was identified; furthermore, the defensive tower and outlines of the castle were uncovered again. Additionally, it was revealed that the courtyard was covered with stone paving (Kocańda. 2018a 10–11; Kunysz 1963, 72–74). Unfortunately, the results of the archaeological exploration were not properly documented. For this reason, it is necessary to undertake fresh research to verify the previous findings. To some extent, new data have already been provided by the presented non-invasive reconnaissance.

3.2 Kobylanka

The beginnings of the settlement in Kobylanka have not yet been properly identified. The village itself, formerly known as Kobylanka Dolna, was established after 1327 and before 1342, in the northern part of the forests which belonged to the early medieval Dominikowice, owned by the Odrowąż family yet abandoned at the turn of the 13th and 14th centuries. After some time, Kobylanka Dolna was created to the south-east of the village; then, since the 16th century, it became known as Dominikowice (Kurtyka 1993, 626–632). The supposed fortified stronghold is neither mentioned in written reports, nor is it marked on any of the cartographic sources. The object of our interest, under the name of Wizna Góra, which can be translated as Łysa Góra (the Bald Mountain) is found only on the so-called Austrian Mieg map from the years 1779–1783 (Bukowski *et al.* 2015, section 68B1).

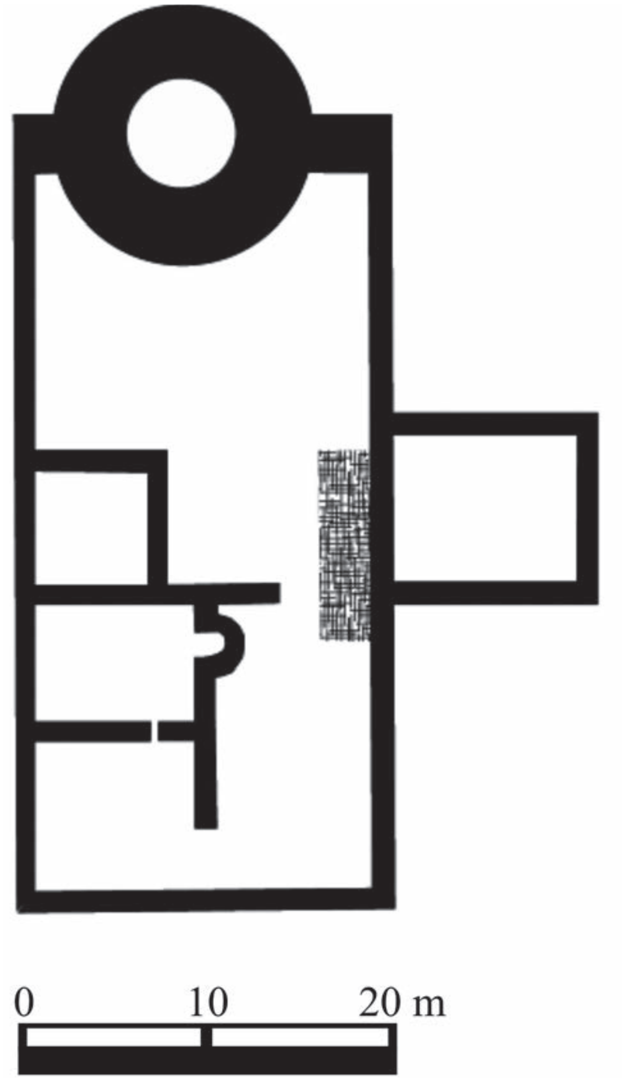


Fig. 4. The plan of the castle prepared by Stanisław Tomkowicz based on the research from 1877 (1900, 245)

In addition to the above-mentioned distinct anthropogenic structures in the form of ramparts and ditches (observed during fieldwork), the site is also highly transparent in terms of remote sensing data (LiDAR, Fig. 5). Based on these results, we can determine the shape of the fortification and define its exact dimensions. More specifically, we are dealing here with an irregular, oval object, 50×48 meters long, located on a promontory, on the edge of a steep slope – the terraces of the Ropa river, cut off by gullies from the north-east and south. Despite its oval shape, it appears to be quite regular in its north-eastern part. In this area, it is clearly divided into three curtains, curved at sharp angles, whose length, starting from the north, is respectively: 16, 23 and 21 meters long. Then, from the south, the rampart turns into a curvilinear section that is 37 meters long and turns at a right angle at the edge of the slope (from the west) into a 4-meter long section of the embankment. This is where the fortifications of the defensive structure end. Considering the prominent landslide from the north-western side, it could be assumed that the remaining elements of the fortifications could have gone down along with some parts of the slope. Nevertheless, this is by no means certain, as the object in this area could have been enclosed only with a wooden palisade, or it might not have any fortifications at all. Inside the building, one can notice a breastwork reaching the height of 1–1.5 meters in certain places; a ditch which is up to 1 meter deep and a maidan which is clearly separated from the fortification and has the outline of an irregular rectangle measuring 27×26 meters in length. Additionally, in the southern area at the top of the rampart, there was a rifle-pit made in 1915 – most probably associated with the presence of the Russian army. The moat is located at the front of the defensive structure, i.e. on the south-eastern side and is connected with the southern gully. The fortifications in this part are the most massive. What is more, there are remnants of a gate in their central section, however this observation requires further verification by means of excavations.

4. The results of the archaeological field surveys

The geophysical surveys were preceded by a surface prospection of both sites, during which movable material was collected from the ground. Metal detectors were also used for this purpose. Artefacts were collected from the surface and the humus layer to the depth of 0–20/30 cm.

The stronghold in Kobylanka was first discovered in 2014 by Piotr Szmyd and Joanna Pilszyk from Jasło, but at that time it was neither included in the Register of Historic Monuments, nor granted protection as an archaeological site. Regardless of the first explorers, while analyzing the LiDAR maps in March 2019 (Fig. 5), Paweł Kocańda came across this object, which was later identified during a field trip (Fig. 6). Even back then, it was obvious that we were dealing with an anthropogenic structure of a defensive type, most probably a stronghold. Unfortunately, in the case of this feature, the surface surveys did not yield any artifacts that could be used to determine the chronology of the castle. In fact, there were only a few pieces of metal, one forged nail and a horseshoe-shaped heel tap. Since only the latter deserves a more extensive coverage, we shall focus exclusively on this object. Bearing in mind the analogies from the Czech Republic, Wrocław and

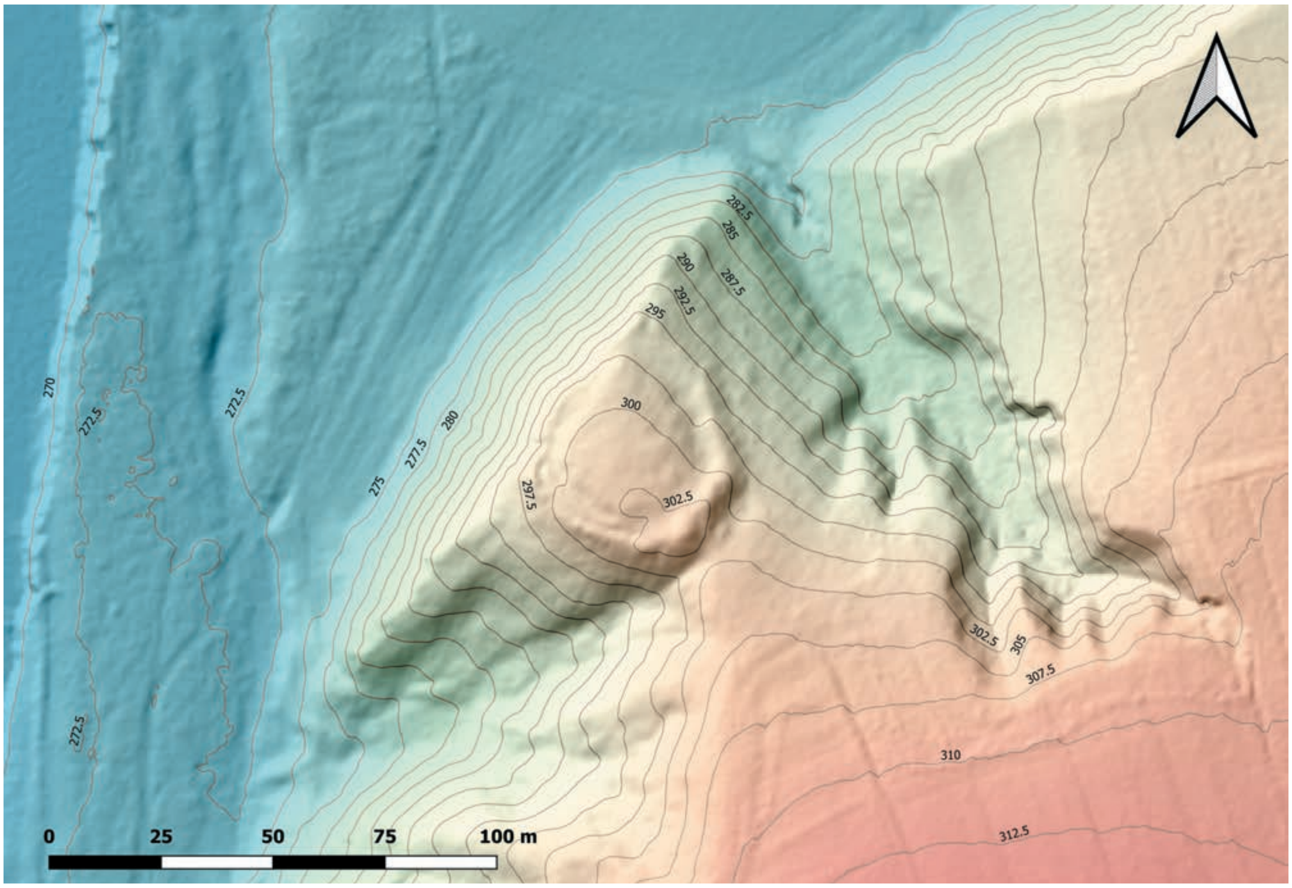


Fig. 5. Stronghold in Kobylanka shown on a map with a numerical model of the terrain – ISOK Project – GRID1m – shading (prepared by M. Pisz)

Fig. 6. Field inspection of the fortified stronghold in Kobylanka (photo taken by P. Kocańda, 2019)

Rzeszów, this item qualifies as a flat horseshoe-shaped heel tap (type III according to T. Cymbalak) with holes for studs. Such pieces are dated quite widely, from the 18th to 20th century. The fact that such an object was obtained from the surface would indicate the upper limit of its functioning (Cymbalak 2006, 264–282; Kocańda *et al*. 2018, 154–155; Konczewska and Konczewski 2004, 106).

A much greater and definitely more interesting collection of artefacts was obtained during the research on the Castle Hill in Biecz. Of course, this group comprises objects that are either hardly representative and difficult to identify (such as metal plates, iron clods, rods), or chronologically insensitive and widely dated (various types of nails, fragments of horseshoes, spoons and knives); furthermore, the collection also includes contemporary items (a button from an English uniform from World War II, cartridge cases, coins from the 20th century). Among the remaining metal artefacts we should mention two horseshoe-shaped heel taps. In accordance with Cymbalak's classification (2006, 264–282), the first one represents type III – the same as the one found in Kobylanka. More specifically, it is an arch-shaped, flat, hammered heel tap with a distinctive tip and three holes for studs. The second object, on the other hand, is a fragment of a heel tap with a spike which enables it to be attached to the shoe and a base that appears to be square-shaped in the cross-section. Such pieces are dated between the 16th and the beginning of the 17th century (Cymbalak 2008, 272–273). A few words should also be said about the crossbow bolts, three of which were discovered at the site. Two of them represent forms with a rhomboid cross-section with a casing, found en masse on medieval sites and dating back to the period between the 12th and 15th centuries; the third one is also a bolt with a rhomboid cross-section of the blade, but equipped with a tang (Kotowicz 2006, 13–14; Nadolski 1990, p. 149–150). However, the most valuable metal artefact is a small denarius of Kazimierz Jagiellończyk, minted in the years 1447–1492. The location of the selected metal relics discovered in the area of the Castle Hill in Biecz is shown in Fig. 7 and Table 1 below (see Fig. 7 and Table 1).

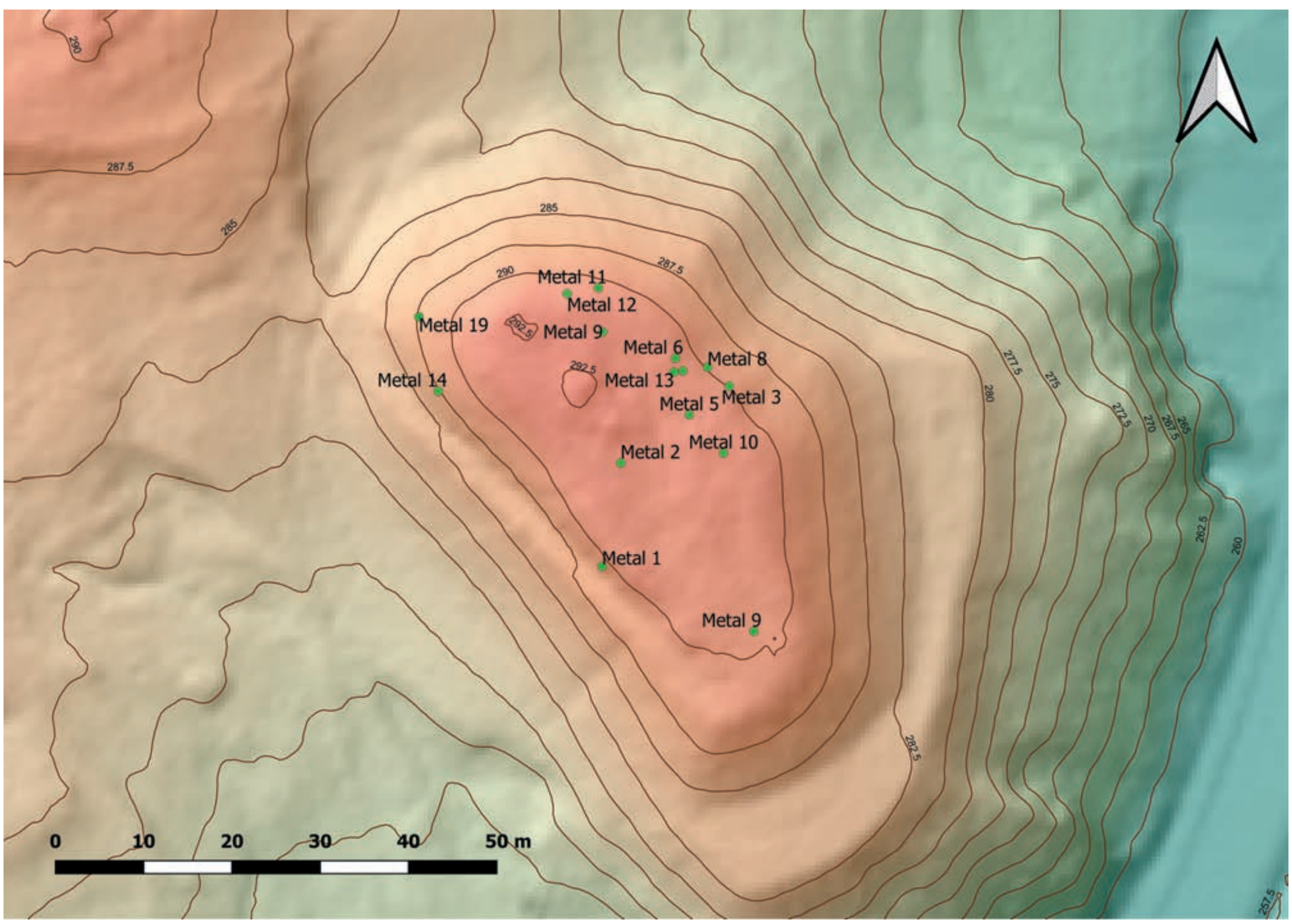


Fig. 7. Location of the selected metal relics discovered on the Castle Hill (with the use of GPS tracking, prepared by M. Pisz and P. Kocańda)

No.	No. on the map	Type of an artifact
1	Metal 1	metal plate
2	Metal 2	nail
3	Metal 3	nail
4	Metal 5	nail
5	Metal 6	English button
6	Metal 7	a piece of a knife
7	Metal 8	coin (1 heller 1901 r.)
8	Metal 9	coin (5 groszy, 1925 r.)
9	Metal 10	bolt
10	Metal 11	nail
11	Metal 12	bolt
12	Metal 13	lumps of metal
13	Metal 14	coin (denarius of Kazimierz Jagiellończyk)
14	Metal 19	bolt

The ceramic material is represented by 17 fragments of vessels, 14 of which can be categorized as middle sections, one piece from a bottom, another one is a part of the pouring lip and the last one is a handle. Most of the vessels were fired at a reduction temperature; their surface is grey. Only 6 fragments were fired at oxidizing temperature, and as a result, they are brick-red. All of them were made from well-dredged ferrous clays on a high-speed potter's wheel. Their fractures are monochromatic; however, one may notice a fine-grained admixture in the form of crushed stone. None of the fragments have any ornamentation; nonetheless, there are clear traces of turning in the form of horizontal lines, with only one piece showing traces of diagonal grooves made with a nail or a stylus. As far as the middle and bottom parts are concerned, their condition prevents any morphological and typological identification. The handle must have come from a jug or a pot, fired in a reductive atmosphere – the piece was glued to the vessel and has two fingerprints. A fragment of the pouring lip comes from a pot or jug. It has a characteristic flange, typical of the late-medieval vessels, a notch for the lid and a pouring lip which is slightly curved outwards. In accordance with Lenarczyk's (1983, 146–148) classification, it can be categorized as type 27. On the basis of analogies from Kraków, the author associates such vessels with the period from the 13th to 15th century. Similar pouring lips can also be found among the samples unearthed in the chartered city – not surprisingly, they are also dated to this period (Rembisz-Niziołek 2010, 78–82). Hence, the foregoing chronology should also be adopted for the discovered fragment, whereas the remaining pieces should be placed in a wide period of time – from the Middle Ages to late modernity.

All of the movable historical objects from the Castle Hill represent a relatively long chronological range. It is worth noting, however, that some of them, precisely the bolts, the fragment of the pouring lip, and above all, the denarius of Kazimierz Jagiellończyk, coincide in time with the demolition of the castle, which took place around 1475. This means that the fortress was not intensively penetrated after the downfall, as it served only as a source of building material, a viewpoint and a venue for strolls. As a side-note, we shall add that Kazimierz Jagiellończyk was the one to order the demolition of the castle (Bujak 1914, no. 62; Kaleta 1963b, 96–97).

5. GPR Research

5.1 Measurement methods

GPR measurements were performed with the help of Detector Duo equipped with two shielded antennae with frequencies of 250 MHz and 700 MHz; the apparatus was discussed in detail in Pasterkiewicz and Rajchel (2017, 271–284). During the GPR profiling, the antenna is moved along the defined profile. In this way, we are able to record information in a perpetual manner at each point of the profile, including the data on the structure of the subsurface layers that exist along the delimited profile.

5.2 The results of the measurements

A number of GPR profiles (echograms) were generated in the designated area. Some of the most interesting ones were recorded, a selection of which is discussed in the article. Each time a figure with the echogram is included in the paper, it features a 250 MHz antenna profile in the upper part and 700 MHz antenna profile in the lower part. In total, more than 60 profiles of different lengths were made.

During the first stage (1), the research was carried out on the Castle Hill, at the site where – according to the archaeological data – a castellan stronghold was located; in the course of time, said stronghold was replaced with a brick castle. Here, we established three measurement spots. At the first point (1a), 14 GPR profiles were generated and recorded by establishing a grid – 11 profiles (echograms AA – AK) that were parallel to each other, and then 3 profiles (echograms AL – AN) that were perpendicular to the previous ones. The second designated place (1b) on the Castle Hill (the central part of the investigated area) had 5 GPR profiles (AO – AS echograms) made and recorded on the grid: 3 that were parallel to each other and 2 that were perpendicular to the previous ones. The third place (1c), located near the entrance of the examined area, was where 3 GPR profiles were generated (AT-AV echograms). Additionally, measurements were taken in the fourth place (1d), located below the upper part of the Castle Hill. Here, 4 GPR profiles were recorded (BE – BH echograms).

As far as the second stage of the research is concerned (2), it was conducted on Łysa Góra (the Bald Mountain) in Kobylanka, where 4 profiles were recorded.

5.3 Interpretation of the results and conclusions

Upon the completion of GPR surveys (selected echograms are shown in the figure below, see Fig. 8A-D), an area with suspected brick structures was marked in spot 1a – it is probably the outline of the tower walls (Fig. 9). The specified area is not perfectly circular, which may be caused by the soil sliding down from the slope. In place 1b (Fig. 8E), a second, small area with GPR anomalies was marked, possibly originating from the pre-existing object located there. In the third place (1c), near the exit from the research area, another zone with some interesting anomalies was marked (Fig. 8F). It should be added that the results of GPR measurements in the surveyed area may have been partially disturbed by the remains of the infrastructure used for oil extraction which remains in the ground (Fig. 8G). Furthermore, no anomalies were recorded when measurements were taken below the designated location of the tower (1d) (Fig. 8H).

The GPR surveys carried out on Łysa Góra (stage 2), both on the surface of the rampart (Fig. 8I) and in the inner area, did not show any anthropogenic objects. The few recorded anomalies came mainly from tree roots – this fact was confirmed on site in some points.

On the basis of the above-described investigation, the following two conclusions can be drawn. First of all, following the GPR measurements in the designated area, we came across an interesting zone that includes an outline of the fragments of the tower walls. In addition, we identified two smaller areas which may hide the location of the remaining objects of the castle. Second of all, no anomalies were observed on the Castle Hill below the tower and on the fortified stronghold in Kobylanka.

6. The results of magnetometry and earth resistance survey

The aim of the research was to identify expected archaeological remains in the area of the castle hill in Biecz and to conduct the first identification of the supposed motte / stronghold in Kobylanka, which was discovered in the DEM LiDAR data.

The architectural remains were expected to be detected in Biecz, since the site was partly excavated back in 2020. However, the modest documentation and imprecise plan only gave a very general idea of how this object might have looked like in the past. In Kobylanka the situation was very different – the site has never been researched before, nor was it evidenced in any official archaeological registry.

6.1 Surveying conditions and methodology

The geophysical research was planned and executed according to the European Archaeological Council guidelines (Schmidt *et al.* 2015). In case of Biecz, the survey was considered to be a Level III investigation, aiming at the characterisation of the archaeological remains, while in Kobylanka it was a Level II investigation (Gaffney and Gater 2003, 88–91; Schmidt *et al.* 2015, 10–11, 42), since the site was never researched before but its limits were determined by the terrain form.

The site in Biecz is located on the terraced top of the hill called Góra Zamkowa. The surface of the plateau on the top of the hill was cleaned of vegetation in advance in order to facilitate the measurements. The area of the hillfort in Kobylanka was just briefly cleaned of overlaying branches. A grid-based survey was implemented in each case, since it was the only reasonable method due to the presence of the trees which impeded the proper functioning of the RTK GPS. Gridded measurements allow further data processing, which was performed in Geoplot 4 software.

On both sites two archeo-geophysical prospecting methods were applied. The first one was magnetometry, a passive geophysical method, consisting in the measurement of the naturally occurring Earth's magnetic field (Aspinall *et al.* 2008; Fassbinder 2015; Gaffney and Gater, 2003, 36–42). Measurements have been carried out with a fluxgate magnetometer Geoscan Research FM256 (Gaffney and Gater 2003, 62–64). The

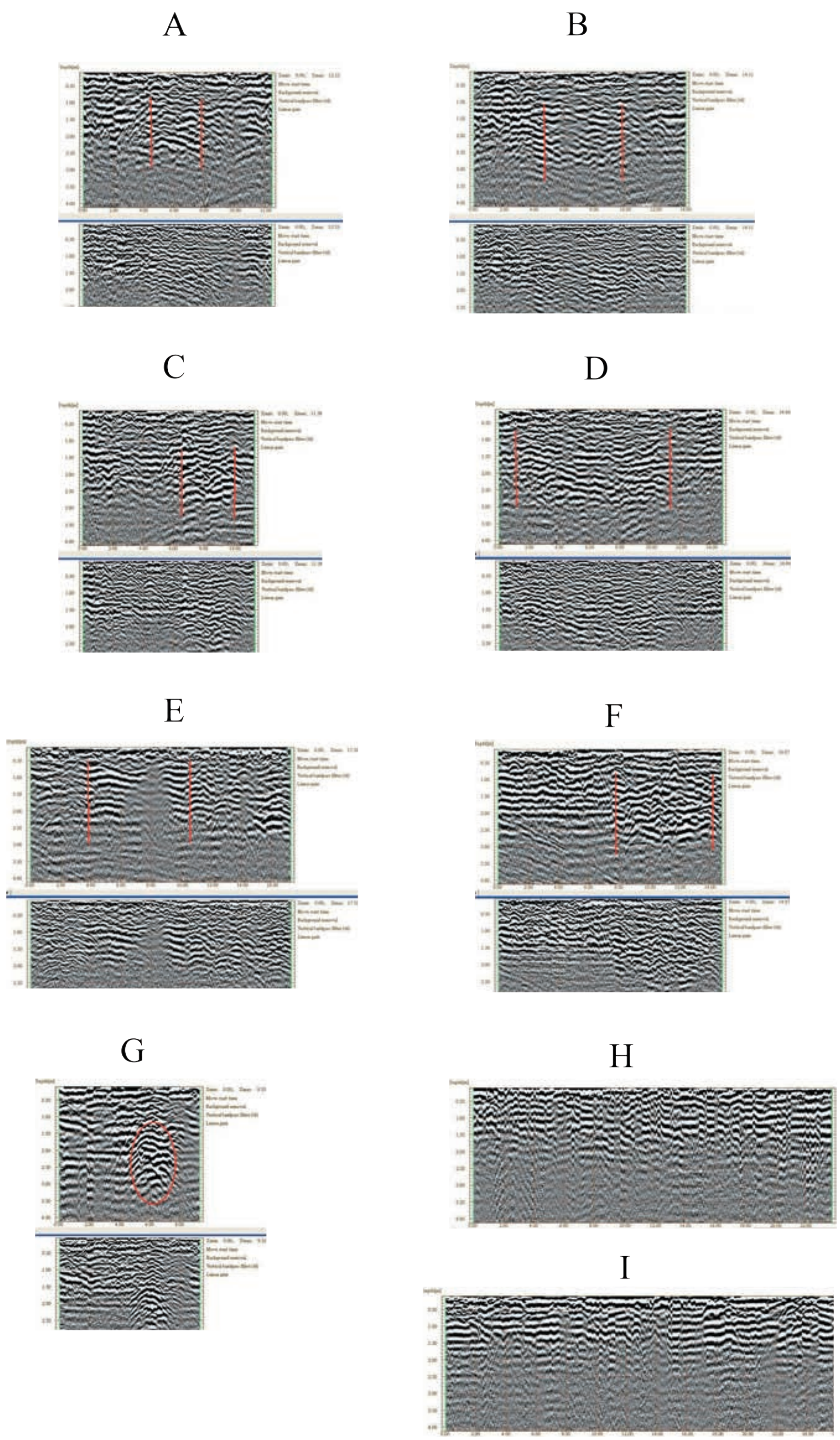


Fig. 8. Echograms developed on the basis of GPR surveys (prepared by B. Rajchel): A – Echogram AB. Anomaly visible on the profile length of approx. 5 m to 8 m. Georadar Detector Duo, IDS, shielded antennas, 250 MHz and 700 MHz; B – Echogram AB. Anomaly visible on the profile length of approx. 5 m to 8 m. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz;C – AE echogram. Anomaly visible on the profile length of approx. 6.5 m to 10 m. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz; D – AM echogram, perpendicular to the previous ones. Anomaly visible on the profile length of approx. 1 m to 11 m. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz; E – AP echogram. Anomaly visible on the profile length of approx. 4 m to approx. 11 m. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz; F – AV echogram. Anomaly visible on the profile length of approx. 8 m to 14 m. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz; G – AY echogram. The marked anomaly arises due to a fragment of drilling infrastructure. Georadar Detector Duo, IDS, shielded antennas 250 MHz and 700 MHz; H – Echogram BF. No visible anomalies. Georadar Detector Duo, IDS, shielded antenna 250 MHz; I – Echogram BI. Measurement made on the surface of the rampart. No visible anomalies. Georadar Detector Duo, IDS, shielded antenna 250.

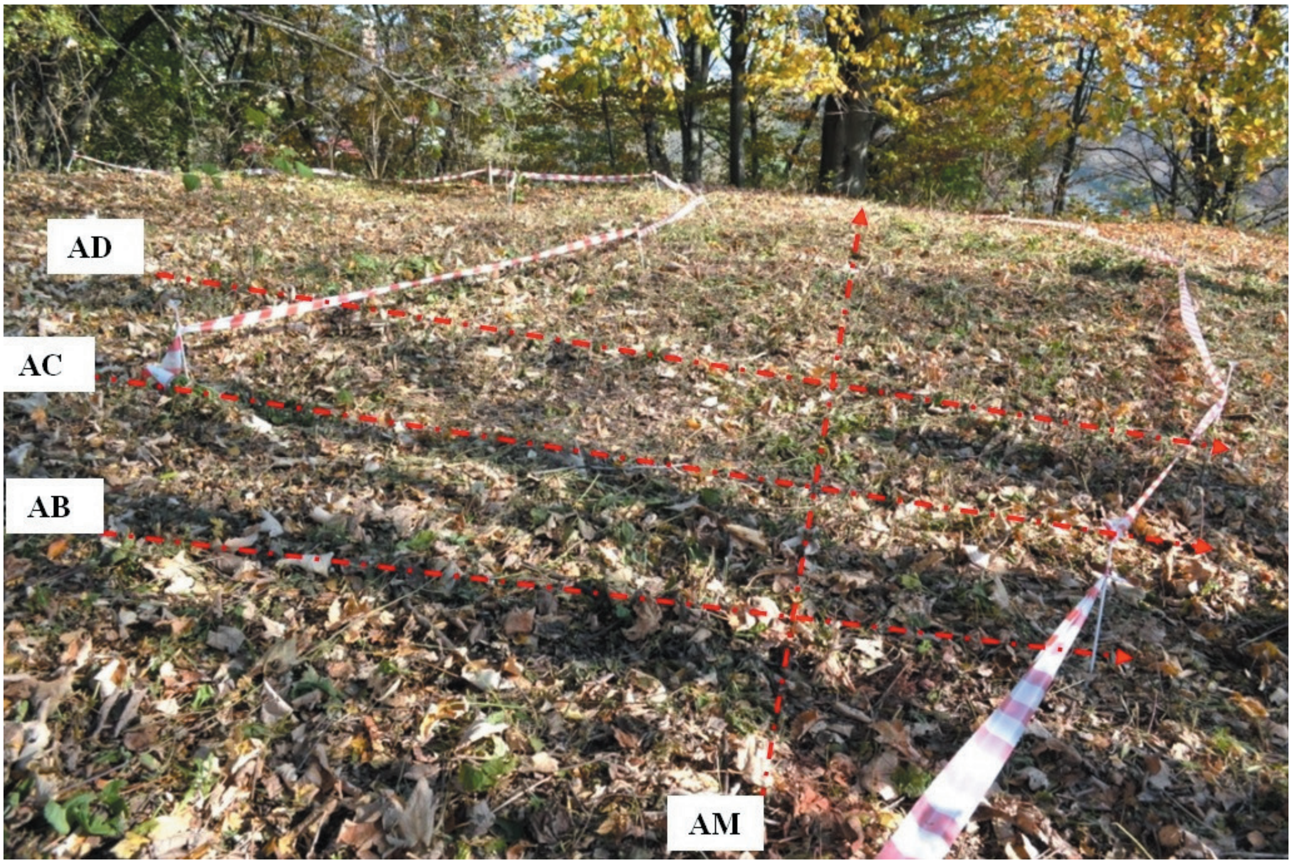


Fig. 9. The schematic distribution of GPR profiles on the investigated site 1a (prepared by B. Rajchel 2019)

second applied method was earth resistance survey, complementary to the magnetometry method. It consists in feeding electric currents into the ground and measuring the resistance of their flow (Gaffney and Gater 2003, 26–36; Schmidt 2013) Earth resistance measurements were carried out with a state-of-the-art meter Geoscan Research RM85 MPX, a successor of the RM15 (Gaffney and Gater 2003, 57–60). In each case a grid-based survey was conducted.

The survey resolution was set according to the EAC guidelines and the level of investigation. Hence, magnetometry was carried out with 0.5 and 1 m of traverse interval, while sample interval was 0.125 and 0.25 for Biecz and Kobylanka respectively. An earth resistance survey was carried out with different probe array electrode configurations. In Biecz a multi-depth investigation was carried out with the use of twin-probe multiplexed array (Schmidt 2013, 41–42). Mobile probes (AM) separation distances were: AM1 = 0.5 m, AM2 = 1 m and AM3 = 1.5 m, what provided the maximum depths of prospection up to ca. 0.25 m, 0.5 m and 0.75 m respectively (Schmidt 2013, 79–80). The survey resolution in Biecz was 1 × 0.5 m, where the smaller interval stands for sampling. In Kobylanka a Wenner electrode array configuration was used with 0.5 m separation distance between the electrodes (Schmidt 2013, 40–41). The Wenner array was considered to be much more versatile and convenient for surveying in the woods, since it does not require the use of remote probes (Pisz and Olszacki 2017).

The magnetometry survey covered the estimated area of 0.33 ha (ca. 7 ares in Biecz and 26 ares in Kobylanka), while the earth resistance survey was conducted within the extent of ca. 0.31 ha (8 and 23 ares for Biecz and Kobylanka respectively). A mesh of 10 × 10 m grids was set in Biecz, while 20 × 20 m grids were used in Kobylanka. Points of grids were staked out with the use of Total Station and/or GPS RTK. The corners of the mesh were measured with the GPS RTK in Polish national Coordinate Reference System PUWG 1992. Reference points were measured in FIXED solution, with ASG EUPOS corrections, providing a cubic accuracy of below 3 cm.

The main reason for such a choice of prospecting methods was their complementarity, which allowed us to obtain the information about the different physical parameters of the ground and buried objects. Most of the geophysical methods widely applied in archaeology are complementary with each other, however our choice was based on the good practice in geophysical prospection in archaeology, as well as the assumed Level of Investigation (Gaffney and Gater 2003, 88–91; Schmidt *et al.* 2015, 10–11). Another factor taken under consideration were the limitations of geophysical methods in woodland (Kobylanka) and anthropogenically changed areas (Biecz).

The area of investigation in Biecz was relatively small, well accessible for the measurements, but heavily affected by recent anthropogenic activity. On the other hand, the site in Kobylanka has not been affected by human activity, but was heavily damaged by natural factors, e.g. landslides.

The results of the measurements were processed and visualised with the use of dedicated software for geophysical data development – Geoplot 4. The results have been presented as 2-dimensional maps of the horizontal distribution of measured values of physical fields at various stages of data processing, according to the European guidelines (Schmidt *et al.* 2015, 100–104).

6.2 Results of the prospection

Biecz

The magnetometry survey in Biecz (fig. 10A) resulted in a series of extremely strong dipolar anomalies being registered. The magnetic map is dominated by an extensive dipolar anomaly, whose dynamics exceeded the measurement range of the FM256 fluxgate magnetometer, located in the southern part of the area. It was a complex of the magnetic field disturbances caused by the infrastructure of a borehole and ferrous elements of its infrastructure, e.g. chains, shaft, etc. Hence, the image of possible archaeological remains in this area has been fully disturbed in this part of the surveyed area. The northern part of the area has not been affected in such an extreme way like the southern one, however numerous dipolar anomalies have been registered there as well. Most probably they were caused by the contemporary remains related to the time of the drilling of the shaft. In general, the data visualised in the scale below ±10 nT was noisy and illegible. In conclusion, the results of the magnetometry survey in Biecz could be described as strongly domintated by the remains of contemporary infrastructure. The dynamics of the archaeological remains rarely exceeds a range of ±20 nT, hence even few positive point magnetic anomalies registered in this area could not be interpreted as archaeological remains, due to the general magnetic noise in the area.

On the other hand, earth resistance survey brought a very different picture. Since the earth resistance measurements are not that strongly affected by the ferrous infrastructure and debris, a lot of interesting anomalies of probable archaeological origin have been registered. Despite that, also in the resistance distribution maps an anomaly from the drilling shaft occurred. It was a quite large, negative anomaly, suggesting that the shaft was made from a highly conductive material.

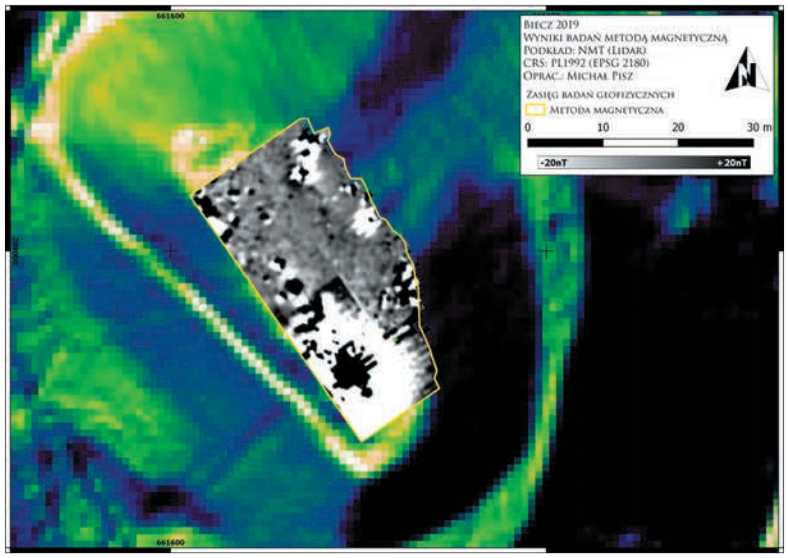
Earth resistance measurements results might be considered very good in comparison with magnetometry (fig. 10B). All three maximum depths of prospection (D1 = 0.25 m for AM = 0.5 m, D2 = 0.5 m for AM = 1 m and D3 = 0.75 m for AM = 1.5 m) provided slightly varied but still comparative images of horizontal distribution of apparent resistivity. The most important achievement of this part of the survey was registering a few relatively clear though not strong electrical anomalies which, despite the discussive state of preservation of the castle relics, are almost undoubtedly caused by architectural remains.

The prospection at all three depth levels (D1, D2, D3) allowed us to register quite similar anomalies, which differed mostly in terms of their dynamics and contrast. Due to the lack of any significant differences between three levels, we propose one common interpretation for earth resistance survey results, without any distinction between particular levels.

The most interesting features were detected on northern and southern edges of the plateau (fig. 10C). In the northern part we captured a faint, circular high resistance zone anomaly, which is around 9 m in diameter. This round zone anomaly has a slightly higher resistive border at its edges. We interpret this feature as the remains of a tower (bergfried). The outer, stronger anomaly might be related to the remains of its wall or foundations, while the inner, weaker zone of high resistance anomaly might be caused by the rubble from collapsed walls. This interpretation is considered to be quite certain, since the anomaly relates well to the archival plans, which were apparently not very precise.

Another interesting electrical anomaly is a square zone high resistance feature, which is joined to the bergfried from the south. The dynamics of this anomaly suggests that we could be dealing with an inhomogeneous soil of very similar parameters to the inside of bergfried. Perhaps this feature is caused by some previously unknown object, nonetheless no higher resistance anomaly outlines the feature as it was in case of bergfried anomaly, which puts in question the presence of actual walls or foundation relics.

A



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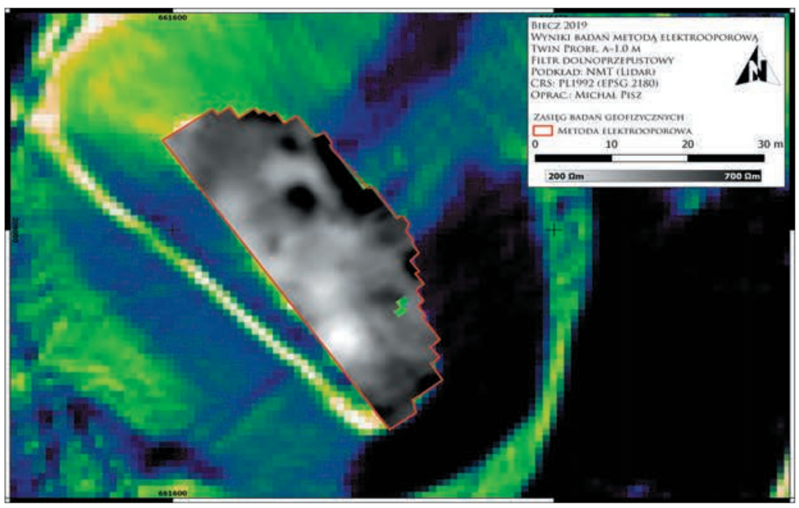

C

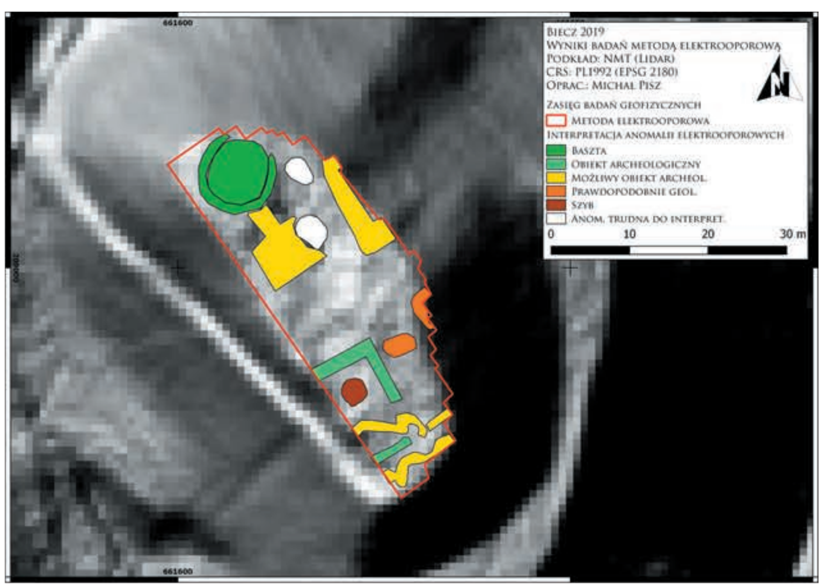

Fig. 10 A–C. The results of non-invasive research on the Castle Hill in Biecz (compiled by M. Pisz);
A – magnetometry survey; B – earth resistance survey. ERI to inna metoda;
C – the initial proposal for the interpretation of the results

In the eastern part of the surveyed area, by the edge of the plateau, we registered strong high resistance zone anomalies of unknown origin. Neither their properties nor lack of analogies provide any evidence that this anomaly is caused by an archaeological object so perhaps it is caused by a shallow geological structure or recent earthworks.

The complex of linear high resistance perpendicular anomalies in the southern part of the plateau can certainly be interpreted as architectonic relics. We concluded this on the basis of both the properties of the registered anomalies (moderate to faint dynamics, high resistance, not very thick, linear, perpendicular) and by a comparative analysis of the archival plan of the site. Some of them, however, are unclear and cannot be fully explained. For instance, some of the southernmost anomalies were not evidenced in the archival plan, although it might mean that these objects were simply not located or documented. Some other features cross with the others, confirmed anomalies at the angle of *ca.* 45°, which would mean that they are not architectonically related to the other walls, unless we are dealing with some linear infrastructure which is not a wall or building foundation.

Our interpretation of geophysical survey results in Biecz seems to be certain, though to fully understand the site a thoroughly planned verification of particular features is strongly advised.

Kobylanka

The geophysical survey in Kobylanka brought a lot of emerging and important information about the site. In this chapter we will briefly present the results, however we would like to stress that advanced discussions and comparative analysis are in progress and the discovery of the Kobylanka hillfort with non-destructive methods will described further in a separate scientific paper.

The measurements from the sampling resolution in the case of Kobylanka was lower than in Biecz due to the conditions on the site – the presence of forests and big denivelations of the terrain.

In opposition to Biecz, the magnetometry survey in Kobylanka delivered much new information about the site (Fig. 11B). Regarding the geophysical value of the measurements, they could be described as relatively noisy and unclear results. This is due to the very faint contrast between background anomalies and disturbances caused by the features themselves. Nevertheless, after proper data treatment, we have been able to distinguish numerous anomalies which, regarding their physical properties, are most likely caused by archaeological objects. These are mostly very weak, linear positive anomalies which are located next to each other in a ring shape. They surround the middle of the maidan where no anomalies of such a type have been detected. Beside a few strong dipolar anomalies, which were most probably caused by some contemporary ferrous wastes, the whole dynamics of the registered magnetic anomalies is extremely low. Also, no signals have been detected within the extent of the hillfort's embankment. That could mean that it was solely made of the earth and / or stones, or it has a different type of construction but was not burnt.

Magnetometry results (Fig. 11C) are the subject of further analysis and will constitute the basis for further research.

An earth resistance survey allowed us to visualise the distribution of soil apparent resistivity up to *ca.* 0.25 m depth. The wide range of registered resistivity values is worth mentioning. They start from a few dozens of Ωm and reach more than 1500 Ωm. This might be a result of a diverse shallow geology (perhaps the presence of high resistant sandstones and low resistant shales) as well as the topography of the terrain (steep slopes). In the extent of the maidan, no significant earth resistance anomalies have been registered. In the extent of the embankment, some very faint low resistant anomalies have been registered. It might indicate that the embankment was earthen, or wooden-earthen, and it might have been partly made of silt or clay (Fig. 11A).

7. Conclusions, summary and research proposals

The interdisciplinary research carried out in 2019 on two archaeological sites, the Castle Hill in Biecz and the newly discovered stronghold in Kobylanka, was implemented in several phases (Fig. 12). The first one consisted of library and archive queries aimed at collecting basic information, pertaining to the history of the sites and the current state of research. The second phase included field surveys, during which movable historical material was collected from the surface. In the case of Kobylanka, we expected that the acquired historical objects would enable us to determine the initial chronology. Unfortunately, as shown above, this was not possible. The third stage focused on performing GPR research, while the fourth stage comprised electrical resistivity imaging and geomagnetic exploration. In both of the latter cases, our aim was to try to identify potential archaeological relics in the area of both sites. As far as the Castle Mountain is concerned,

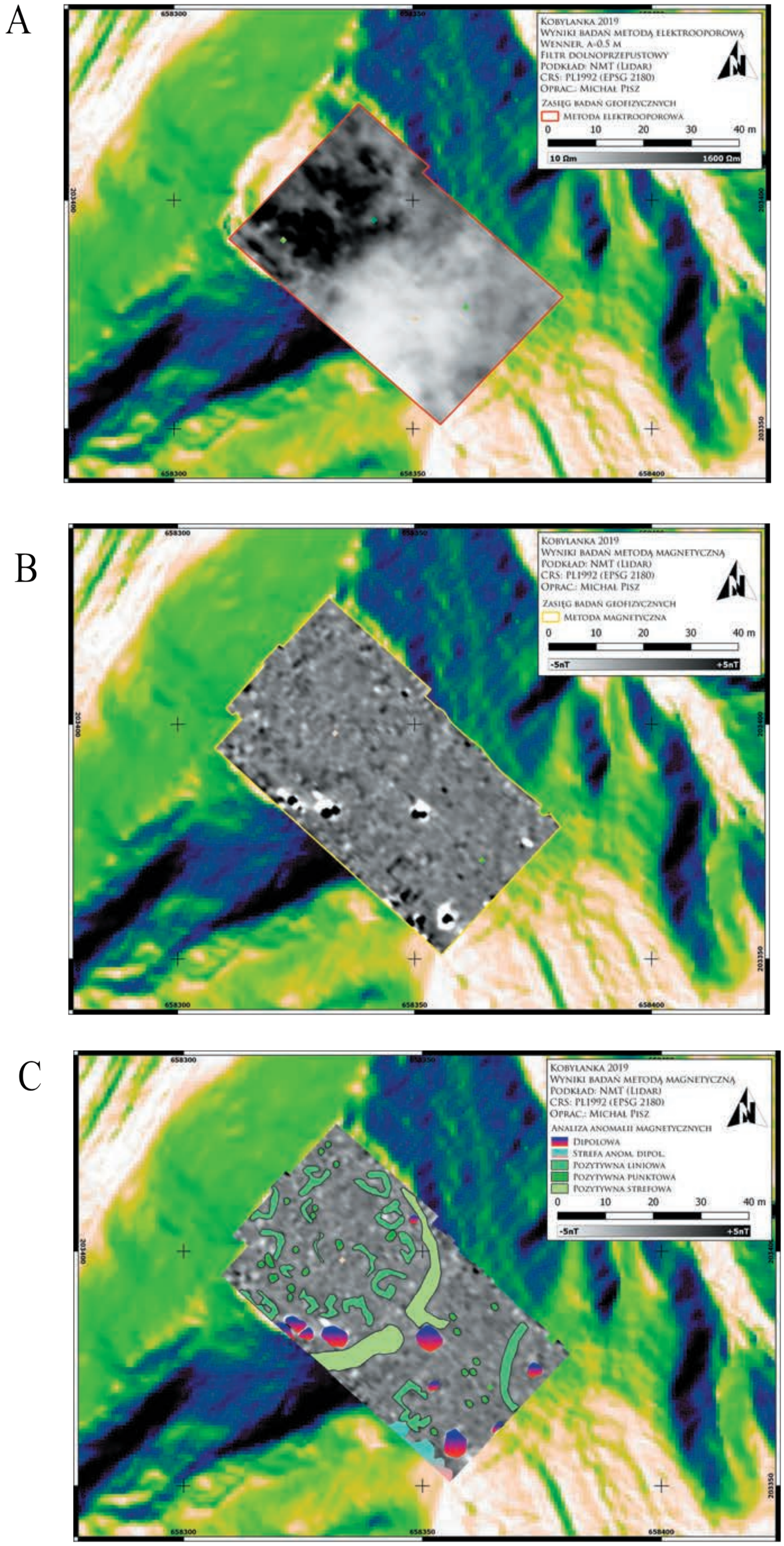

Fig. 11 A–C. The results of non-invasive research in the Kobylanka stronghold (compiled by M. Pisz); A – earth resistance survey; B – magnetometry survey; C – the initial proposal of the interpretation of the results

Fig. 12. The researchers conducting the earth resistance survey (photo taken by P. Kocańda, 2019)

the remains of the brick structures of a defunct medieval castle were sought. The obtained results were also supposed to facilitate the process of finding previous research excavations and linking the archival excavation documentation to the contemporary topographical situation. In Kobylanka, the research was aimed at performing preliminary recognition of the site with regard to the presence of possible archaeological features. An important secondary objective of the research was to assess the risks associated with – among other things – landslides.

All of the above-described types of work brought novel, thought-provoking pieces of information about both archaeological sites. To exemplify, the queries allowed us to summarize the existing findings; this proved to be particularly important in the case of the Biecz castle, where the first excavations took place in the 1870s, followed by subsequent research carried out in the first decades of the second half of the 20th century. The results of the first research project (published by Tomkowicz, 1900, 242–245), which are known only vicariously, raise many doubts, primarily owing to their unprofessional character. An important remnant of Father Jaszczor's work is the hand-drawn projection of the walls, which to this day constitutes the basic plan of the Biecz Castle (Fig. 4); nevertheless, the projection does not match the topography of the hill. For this reason, verification by means of excavation is necessary. Unfortunately, this task was not fulfilled during the archaeological works from the years 1957–1958 and 1961, conducted by Antoni Kunysz (see Kunysz 1961, 12–16; 1963, 72–74). Despite providing plenty of valuable data on the chronology of the site and the phases of the settlement, the above-mentioned explorations were, in many respects, characterized by a number of shortcomings. To start with, the discovery of the remains of the castle was not marked on the plan (despite the creation of the hill's height projection), which makes it difficult to verify and compare with the 1877 sketch. Also, the historical material, which is still stored in the warehouses of the Biecz Land Museum, has not been analyzed. To complicate things further, the conclusions drawn on the basis of these studies were published by Kunysz only in the form of short announcements. Having said that, some new data became available through a query in the National Archive in Kraków, where the correspondence between Tomasz Jaszczor and Józef Łepkowski was found; however, due to the limited framework of the present article, this topic will be discussed in a separate paper. Moreover, the non-invasive research described above also provided additional information. In the case of Kobylanka, the query did not produce any answers pertaining to the discovered stronghold, which has not been mentioned in any written and/or cartographic sources. It is worth adding that the defensive structure in Kobylanka should not be confused with the well-known 16th century manor house, located on the border of the same village and Dominikowice, which was investigated in 1965 (A. Kunysz 1968b, 53–54).

Still, the most interesting results were provided by dint of GPR examination, to which we shall devote a little more attention. In order to provide more insight into the subject matter, both Biecz and Kobylanka will be discussed separately.

7.1. The Castle Hill in Biecz

Concerning the Castle Hill in Biecz, a considerable challenge the researchers had to face was the possibility of a disturbance in readings caused by the oil derrick that was constructed on its top by the Germans in 1939–1945 (Kaleta 1963, 115). The said machinery is noticeable in many photographs from that period. The erection of the oil derrick was connected with the excavation of a deep, small-diameter well, in which a drilling auger was placed. In addition, the implementation of the derrick was accompanied by the construction of all the necessary wooden and metal infrastructure (pipes, chains, pipelines, platforms). Unfortunately, the actions undertaken by the Germans led to some far-reaching consequences, including the destruction of the site and the walls located there, as well as the undue interference into the cultural stratigraphy in this part of the castle. The existence of a large metal construction, in the form of an oil well, also affected the research results; this is particularly visible in the graphs presenting geomagnetic reconnaissance, which display a large area of dipole anomaly. Thus, we had to deal with considerable interference prompted by the metal structures located underground.

Having analyzed the results of the GPR surveys for possible archaeological features and the relics of the brick castle, it should be stated that some of the anomalies coincide with the sketch drawn in 1877 (see Fig. 10C). We are referring here to the cylindrical tower, located in the north-western part of the structure, which is considered to be the oldest element of the brick castle, dating back to the end of the 13th century and connected with the work of King Wacław II and his supporters (Kajzer *et al.* 2010, 92; Kocańda 2018b, 326). In the previous literature on the subject (see Kajzer *et al.* 2010, 92; Kunysz 1963, 73; Tomkowicz 1900, 245), it was assumed that its diameter was 10 m, which allowed it to be placed in one row with similar bergfrieds in Czorsztyn (10 m), Myślenice (10.2 m), Kazimierz Dolny (10 m) and Będzin (10.7 m).The results of electrical resistivity imaging have shown that its diameter may be one meter smaller, which makes it possible to compare it with the towers in Dobczyce (9 m), Rytro (9–9.5 m), Lipowiec (9 m) or Slovakian Stara Lubowla (8.4 m). Of course, the difference may result from a measurement error or a loss in the surface of the external walls of the tower. Furthermore, on the basis of the research carried out, we can assume that the walls of the tower are relatively well preserved, while the interior is now covered with debris (Fig. 13 and Fig. 14). Therefore, any doubts connected with the tower of the Biecz Castle

Fig. 13. Cylindrical tower in Czchów castle from the late 13th century analogous to the tower of Biecz castle (photo taken by P. Kocańda, 2018)

should be resolved by means of an invasive method. An interesting regional anomaly with a regular quadrilateral shape was discovered on the south side of the tower. Its layout suggests that we are dealing with an anthropogenic object with non-homogeneous base (similarly as inside the tower). It seems possible, then, that we are dealing with a previously unknown castle building, since no structure is situated in this particular place on Jaszczor's plan. Another possibility is to interpret this anomaly as the remains of cobblestones, fragments of which were discovered as early as 1961. Since the cobbles were adjacent to the tower, one may venture a guess that both elements were built at the same time (Kunysz 1961, 13–14; 1963, 73). Finally, we may be dealing with an old archaeological excavation from 1877 or from the post-war research. Other options include a dismantling negative filled with rubble, or a heap created during the demolition of the castle. Again, a verification by means of excavation will be required here. Another interesting piece of data was provided by the research in the northern part of the hill's peak. Two oval anomalies, very difficult to interpret, were revealed there. Perhaps we are dealing here with some archaeological feature or a dismantling negative. However, it is also possible that one of the oval points will turn out to be a well. Water storage facilities, whether in the form of a cistern or a well that was dug deep in the rocks of the castle hills, were an indispensable element of any medieval stronghold. It is difficult to assume that the residents of the castle brought water from the nearby Ropa river (Hislop 2013, 224–227) and certainly such an object also existed within the castle in Biecz. In the said area, there is also an oblong anomaly, with its ends turning in the north-eastern direction (see fig. 10C). This may be the remains of the building, located in the eastern part on the outside of the walls on Tomkowicz's plan. According to the authors, it must be the entrance gate to the castle. A number of other castles in Lesser Poland provide an analogy in this case, especially in Rytro and Czchów, where gates were erected in the 15th century in the form of a separate tower building located in front of the walls (see Dworaczyński 2014, 143–157; Szpunar 2003, 497–514). Linear, oblong anomalies were also revealed in the southern part of the structure. Their arrangement suggests that we are dealing with the remains of the residential part of the castle. Some of them can be compared with the buildings on the plan from 1877.At present, their layout can only be reconstructed after excavations.

The geophysical surveys failed to reveal any anomalies that should be interpreted as the peripheral walls of the castle. Their absence can be explained by a number of possibilities. First of all, due to the layout of the slopes, as well as the fact of them being covered with dense bushes and trees, it was impossible to reach the very edge of the hill with the equipment. Secondly, the walls could have been heavily demolished or they could have partially slid down the slopes. Possibly, the only things left of them were all the negatives and demolition layers.

Fig. 14. The cylindrical tower in Rytro Castle, built at the end of the 13th century; most likely a similar tower to the one that used function in Biecz (photo taken by P. Kocanda, 2018).

The above-mentioned results of the non-invasive research in the area of the Biecz Castle yielded extremely important and valuable findings, which coincide closely with the plan published by S. Tomkowicz. We know that we are dealing there with debris-covered rooms and dismantling negatives or full walls. In the latter case, it is certainly a cylindrical tower, as evidenced by the fact that it has been captured by all research methods. The anomalies presented in the visualizations were analyzed not only on the basis of the results obtained during the previous excavations or by dint of archival and source queries, as we have also relied on the observations of other researchers conducting non-invasive diagnoses on various medieval sites in Poland. Among such objects we should mention the castle – monastery of Blessed Salomea in Grodzisk pod Skałą (Domagała and Mościcki 2006, 405–418) and Teutonic castles in Starogród, Unisław and Kowalewo Pomorskie (Wiewióra 2018, 95–98; Wiewióra *et al*. 2016; 109–111; 2020. 1–28). The above constructions, as in the case of Biecz, are sometimes covered by a thick layer of soil and rubble. For this reason, the classification of some of the anomalies may be similar, whereas the differences may arise due to their interpretation – such a situation is caused by the fact that we are dealing with relatively diverse constructions. Unfortunately, in the case of the Biecz Castle, the written sources are scarce, and the results of the previous research are not very detailed. Meanwhile, the inventories and surveys from the 17th century and onwards, which would prove extremely valuable for the reconstruction of the building, are not available. This, in turn, can be ascribed to the early demolition of the castle, which took place in the second half of the 15th century. As a result, the only possible way to reconstruct the spatial layout of the stronghold would be to use the outcomes of the planned archaeological excavations, which at the same time, could be used to verify the findings of the non-invasive reconnaissance presented in this article. It is therefore necessary to undertake a new series of excavation works, which shall lead to a full recognition of the site. Such an identification would prove extremely important for the Polish castellology, since the castle in Biecz serves as an example of a stronghold erected in the first stage of the construction of brick castles in Lesser Poland, which dates back to the second half of the 13th and the beginning of the 14th century and is related to the reign of the Czech monarch Wacław II, Duke of Cracow in 1291–1300 and the Polish king from 1300 to 1305 (see Guerquin 1974, 43–47; Kajzer *et al*. 2010, 30–40; Kocańda 2017, 93–104; Kołodziejski 2017, 62–66). Identifying the castle will also bring other benefits. For instance, it might serve as an important contribution to the partial reconstruction of the castle, which will consequently boost the tourist appeal of Biecz.

7.2. Stronghold in Kobylanka

The electrical resistivity imaging and geomagnetic surveys carried out within the Kobylanka stronghold have produced a number of fascinating anomalies, which can be interpreted in many ways (Fig. 11C). The GPR, on the other hand, did not provide any interesting data. While analyzing the graphs depicting the results of the research, we encountered linear, regional and point positive anomalies, which were arranged in areas reflected in the topography of the site. Among the most noticeable elements, we should distinguish two very large linear anomalies, running in a curved fashion along the line of the preserved rampart. This is, of course, the reflection of this defensive structure, the dynamics of which may indicate a burnt structure. Additional data were provided by the electrical resistivity imaging, which recorded a depression within the rampart; this, in turn, may point to an earthen or wood-earthen structure. The graphs show that the two anomalies running along the rampart lines are not in contact with each other; moreover, the south-eastern one ends with a characteristic protrusion, which is directed at a right angle and runs further to the south. Certainly, we are dealing here with clear remnants of the gate and the entrance to the facility. Attention should also be paid to the linear positive anomalies, running in rings, along and next to the ramparts, as well as to the small oval points between them. Regrettably, their interpretation at this point in time, creates various difficulties. Perhaps the stronger point anomalies can be associated with hearths, while the linear ones may come from archaeological features of the residential type (dugouts, storage pits?). The central part of the maidan is an "empty" area; there are only a few points there. The north-western part includes some relics from the period of the World War I occupation; the existence of such objects was confirmed by the conducted research. Certain archeological works were also carried out on the southern side of the structure –here, two positive linear anomalies were found, the first one being arched-shaped and the second one being fairly regular and quadrilateral. In addition, several point "objects" appeared there.

The results of the measurements confirm that we are dealing with an anthropogenic object, one comparable with a stronghold. Nonetheless, at the present stage of the analysis and interpretation, it is impossible to reconstruct its spatial layout and determine its chronology. However, an attempt can be made to open the discussion on this structure. The well-preserved field form reinforces our belief that it is a defensive building. Taking into account its appearance, location and character, the first association one could make would be to identify the structure as a motte-and-bailey castle. Such defensive buildings were extremely popular in the Middle Ages, not only on Polish lands but also in Western and Central Europe. Structures of this type are primarily associated with knighthood (see Kajzer 1993a, 93–112; Kołodziejski 1994, 5–110; Marciniak-Kajzer 2016; Nowakowski 2017, for further literature). A few of them are located in the vicinity of Biecz and Kobylanka, e.g. in Jeżów, Berdechów and Żmigród Stary (Kołodziejski 1994, 141–142, 188–189, 204–205). Bearing in mind the above remarks, the authors initially assumed that we are dealing with the foregoing type of building. It was expected that the non-invasive research would lead to the discovery of an anomaly in the shape of a quadrilateral building, which could then be identified as a residential and defensive tower. Such structures appeared, for example, during the geomagnetic reconnaissance on motte-and-bailey castles in Pniów and Stare Tarnowice (Michnik *et al*. 2016, 85–88). Yet the results of the non-invasive surveys that were obtained in Kobylanka forced the authors to re-consider the original concept more thoroughly. The first suggestions came up during the query of the written records, which revealed that the investigated building is not mentioned in any historical sources; this, in turn, leads to the assumption that it did not function in the late Middle Ages. Moreover, both the oval and quadrilateral outlines of archaeological features that run in circles along the ramparts and appear next to them, should be interpreted as the relics of buildings buried in the ground, most probably household pits or residential houses, which might have been burnt. If such an interpretation proves correct – as excavations should verify – it will be possible to classify the site as a defensive settlement or a stronghold with buildings accumulated near the inner wall of the rampart. The chronology of the structure may turn out to be an intriguing issue. The strongholds with dwellings located near the ramparts or with circular housing are characteristic of both the early Middle Ages and subsequent periods, namely the late Middle Ages and modernity. As regards the second case, the stronghold in Mymoń, studied by M. Cabalska in 1969, is worth mentioning, as it was inhabited in three chronological phases: the prehistoric, early medieval and 14th–15th centuries. Obviously, the phase that seems to be the most relevant for our study is the third stage, which is related to the motte-and-bailey castle and the buildings situated both in the central part of the structure and by the ramparts (see Kotowicz 2007, 51–67, earlier literature there). Furthermore, we should also mention the stronghold in Raciąż, which was erected in the 13th century as the residence of the castellan, where houses were located along the ramparts thereby forming a kind of an inner ring (Barnycz-Gupieniec1983, 91–123). In the third case, i.e. the period that includes modern times, objects of this type (as proved by L. Kajzer's findings, 1993b, 33–43), were motte-and-bailey castles transformed into the so-called manor houses on a mound. Here, within the hill as well as its fortifications, one could encounter not only the manor house but also some additional farm buildings. Still, the oval (ring-type) stronghold with buildings located by the ramparts was the most common in the early Middle Ages. The examples which corroborate the foregoing statement are manifold, hence we shall restrict ourselves only to a few. For instance, in Upper Silesia there are Lędziny and Lubomia, which are dated from the end of the 8th to the middle of the 10th century (Tomczak 2012, 100–102), in the Lubelskie region we shall mention Jurów, Strzyżew and Turów (Banasiewicz-Szykuła 2019, 219–232; Bania 2019a, 323–328; 2019b, 329–332), and finally, as far as Lesser Poland is concerned, objects that are adjacent to the inner wall were discovered in Naszacowice (Poleski 2004, 266–274). Similar solutions can be found, among others, in strongholds in Gilów and Dobromierz in Silesia (Jaworski 2005, 199–224), as well as in Łodygów site 1 and Kamionka site 9 in the Iławskie Lake District (Kobyliński 2019, 18, 373).

The discovery of an early medieval stronghold would not be surprising, as there are numerous early medieval settlements in the vicinity. The settlements from that period were located in several points of Biecz, Libusza, Korczyna and GrudnaKępska. Unfortunately, their chronology is difficult to establish, however, it may reach back to the 8th–10th century tribal times (Parczewski 1991, 24–43; Poleski 2013, 161–170). The strongholds, on the other hand, existed in Trzcinica, Brzezowa, Wietrzna-Bóbrka, Braciejowa, Przeczyca and Lisów (Kunysz 1968b, 43–45, 56, 63–65, 76–78, 80–81; Poleski 2013, Katalog (CD), 10–11, 96–97, 117–121, 122–124).

Attention should be drawn to the shape of the object, which – as suggested earlier – is quite regular in some of its parts. This is not a major exception, as it should be borne in mind that other fortified strongholds are also partly symmetrical. Here, we shall mention one example, namely the site in Brzezowa, situated less than 25 km away (Parczewski, 2010, 431–441); still, such a regularity is quite rare among the early medieval defensive structures. Generally speaking, newer fortifications used to be rather regular in shape, especially the modern ones in the form of sconces and redoubts. Consequently, one may consider whether this might be a more recent object, or whether it was reused in the subsequent centuries for the military needs. Undoubtedly, during World War I, some individuals entrenched themselves there and most probably these were the Russians. Following the history of the region, we should also mention the earlier conflicts that swept through the area. Such a disturbance was the Bar Confederation – an armed association of the Polish nobility established on 29 February 1768 in the village of Bar in Podolia, which aimed at restoring old noble privileges, weakening the royal power and rejecting the reforms imposed by Russia. Since the very beginning of the four-year period (1768–1772) of uprising, the main military actions moved to the mountainous areas of Małopolska A chain of Confederate fortresses ran from Lanckorona in the Wieliczka Foothills to the Upper Roztoki in the Bieszczady Mountains. In 1769, a camp was established in Kobylanka, which was soon abandoned after the Russian invasion (Konopczyński 1931, 83; Pułaski 1909, 19–22; Śliwa 2019, 41). We do not know, however, whether the base was fortified with sconces or if it was open in the form of, for example, an ordinary camp. Even the very location of Kobylanka, i.e. a plateau with steep slopes falling towards the valley of the Ropa River, renders this area a defensive position.

When analyzing the outline of the object and measuring its surface, one can spot a number of evident contradictions with the nearby fortifications of the Bar confederates. Of course, the most striking contrast is that of the outline, which is regular in the case of the majority of confederate fortifications. There is also a considerable disparity between their surface areas. The position in Kobylanka measures only 20 ares, while the confederate camps in Muszynka, Izbach, Wysowa or Roztoki Górne are huge defensive structures of over 1 ha (Muszynka, Wysowa) and up to approximately 4–6 ha, as far as the camp in Izby is concerned. The deployment of fortifications in the prospective area of military operations is also quite important. The Confederate camps were planned in a way that allowed for a quick escape, with the main fortifications facing away from the front of the structure, and the neck that was usually less fortified. In addition, they provided a wide view of the entire area. Even though these were not entirely well thought-out structures, they still allowed for a quick evacuation and quite effective defense (Filipowicz 2018). In the case of Kobylanka, which is located on a promontory, under a hill and additionally separated on the sides by steep gullies, one cannot consider neither the possibility of a quick and trouble-free evacuation, nor the effective defense or insight into the foreground. Moreover, the fortification can be easily bypassed from the back, as one may position himself up against it and shoot from above, i.e., a much more advantageous position. Also, the breastwork does not protect against the penetration of bullets that could fall into the maidan, thereby wreaking havoc. Therefore, it is unlikely that these fortifications were erected by the confederates. Perhaps they used the former ramparts, slightly modifying them for their military needs and making them some sort of an observation and control point. However, without strengthening the structure with some additional sconces that would flank it, this location (according to the standards of the fortification craft of that time) is deprived of any military value. The structure itself, placed on the edge of the slope and the forest, resembles a deeply hidden refuge in which the population wished to hide rather than to engage in fierce resistance.

To sum up the current findings from Kobylanka, it should be stated that the electrical resistivity imaging and geomagnetic research have provided a lot of interesting information about the stronghold. The results enable us to make a few assumptions about its function, spatial arrangement and chronology. However, the verification of the above speculations will be possible only by means of field excavations, which should provide us with the data necessary to formulate definitive conclusions. Nevertheless, we can confidently state that a new, interesting defensive structure has appeared on the archaeological map of Lesser Poland.

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The stronghold on Kirkut Hill in Lublin. The state of recognition of the remains of the former stronghold and its role in the medieval Lublin agglomeration

Abstract

Niedźwiadek R., Rozwałka A. 2020. The stronghold on Kirkut Hill in Lublin. The state of recognition of the remains of the former stronghold and its role in the medieval Lublin agglomeration. *Analecta Archaeologica Ressoviensia* 15, 165–185

The aim of the article is to present the state of the research conducted on the remains of a medieval stronghold on Grodzisko Hill, also known as Kirkut Hill (due to the Jewish cemetery from the late Middle Ages and early modern period located on its top), as well as to show the latest approach to dating the remains of the stronghold and its role in the medieval Lublin agglomeration. Archaeological research carried out on the hill and at its foot in the 1960s and 1970s was of limited range due to the existence of the Jewish cemetery. However, it can be considered that they provided an amount of data that enables the reconstruction of stratigraphy of the stronghold and recognition of the structure of its rampart running along the edge of the hill. After many discussions, both among historians and Lublin archaeologists, a certain consensus regarding the chronology and the function of the former stronghold on Grodzisko Hill has now been reached. It seems that it was in the 13th century that the stronghold was built and, then, before the century ended, it was destroyed. It coexisted with an older structure – probably built in the 12th century – namely the castellan stronghold on Zamkowe Hill. Recent research indicates that during the second half of 13th century, or at the turn of the 13th and 14th centuries, a new line of ramparts was built on Staromiejskie Hill. This is how three parts of the Lublin agglomeration were distinguished. Perhaps, in this structure, the stronghold on Kirkut Hill could have functioned as a guard post for a part of the long-distance route located in the area of today's Kalinowszczyzna Street. The 13th century, and especially its second half, was the time of numerous Yotvingian, Lithuanian, Mongolian, Ruthenian and Tatar invasions.

Keywords: Eastern Poland, Lublin, Grodzisko Hill, remains of a medieval stronghold, archaeological research

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1. Introduction

Lublin is crossed by the Bystrzyca River, which flows into the Wieprz River and then with it into the Vistula. The Bystrzyca has formed a wide valley within the borders of the modern city. In the past, it was swampy, making it difficult to access the Staromiejskie and Zamkowe hills. It is upon these that the main sections of the agglomeration were built. Both hills rise steeply above another valley – that of the Czechówka. This river, east of the Old Town complex, flows into the Bystrzyca. From the north, into the interconnected river valleys, enters the loess headland adjacent to the loess plateau (Fig. 1). Later use of the area, and especially the creation of Kalinowszczyzna Street, resulted in the formation of a gap. From the east, the border of the promontory is marked by a natural gorge, where Floriańska Street (formerly Podmiejska Street) is located. Further to the east, there is a hill called Białkowska Góra. It was named after Baltazar Białkowski, who took the area in 1552. In 1602 he established his own jurydyka here, which he tried to

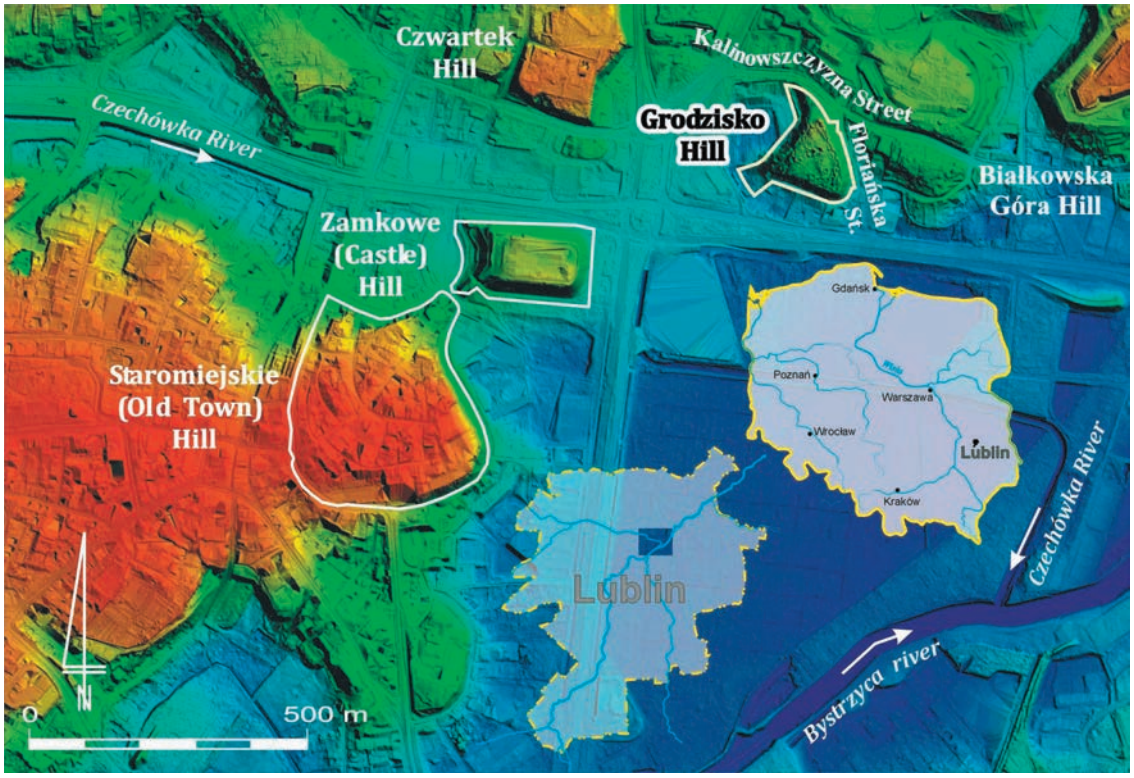

Fig. 1. Grodzisko (Kirkut) Hill. Digital terrain model by G. Mączka, based on ASL data (after R. Niedźwiadek 2019).

separate from the town's lands. His attempt was unsuccessful, but the jurydyka survived. It was abolished by the provisions of the Constitution of May 3, 1791 (Wojciechowski *et al.* 1986, 29). Białkowska Góra might have been a part of the stronghold complex where craft settlement might have been located (cf. Rozwałka *et al.* 2006, 81–83).

The first preserved reference to the said promontory comes from 1502, when it was called "grodzisko (stronghold) mountain", while in 1508 it was described as "the old stronghold before Lublin" (Kuraś, 127). The phrase "the hill called grodzisko", however, was found in a document from 1555, when the Jews living in Lublin Podzamcze leased a third of the area to turn it into a Jewish cemetery (Wojciechowski *et al.* 1986, 29). In the cited sources one can notice the record of a process to which this landform was subjected – from a place recognised in the first half of the 16th century as a stronghold to a necropolis, which finally covered its entire area (Fig. 2). For these reasons, two names are used simultaneously – Grodzisko and Kirkut (from the German kirchhof). In the first half of the 17th century, at the base of the hill occupied by the necropolis, a massive fence wall was built. The wall separated the hill even more visibly from the surrounding space (Fig. 3). Three tombstones of Ashkenazi Jews located closest to Kalinowszczyzna Street entrance have been preserved. The dates on them are older than the confirmed date of leasing the area to create the cemetery: 1541 – matzeva of Jaakow Kopelman (a Talmudist and rabbi), and next to it there are tombstones of cantor Abraham, son of Uszaj (who died in 1543) and a woman named Chana, who died in 1552 (after Trzciński 1990).

Grodzisko Hill covers an area of about 1.3 hectares. In plan view, its shape is similar to a triangle, with its obtuse angle is located in the west corner. The northern top meets the loess hilltop, the opposite one goes deeply into the valley zone, while the north-west side has a characteristic concavity (Fig. 1–2). The surface of Grodzisko falls slightly towards the south – to an elevation of about 185.00 m a.s.l. In the northern part, however, there is a section rampart, the culmination of which approaches 190.00 m a.s.l. The panorama of this site is characterised by steep slopes with the base, on the southern side, located about 173.00 m a.s.l. (Fig. 4). We can therefore conclude that from the side of the river valleys, the edge of the hill was elevated to, at least, 12 m. In the Middle Ages, the promontory was at least 1.5 meters higher because such was the thickness of contemporary and early modern period embankment layers found in the valley area, under the present Floriańska and Sienna Streets that

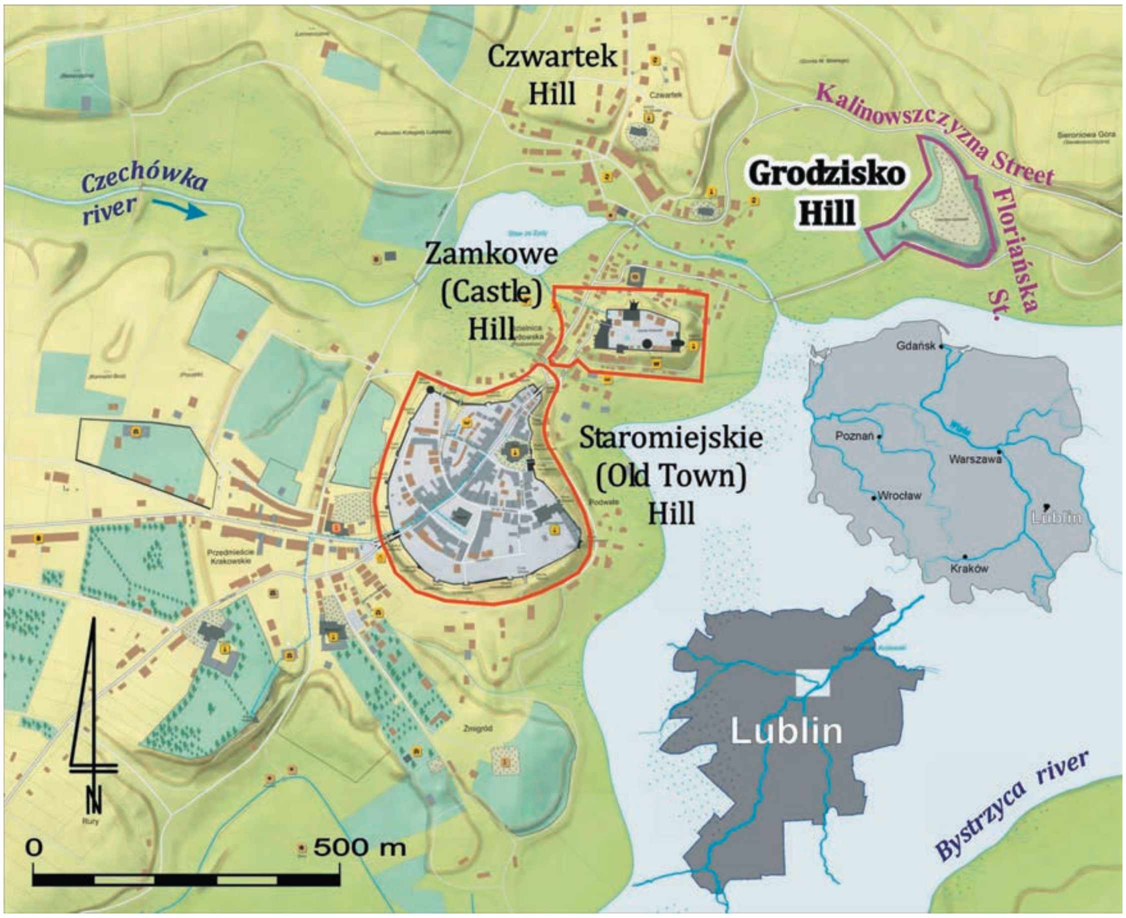

Fig. 2. Grodzisko (Kirkut) Hill, Czwartek Hill, Staromiejskie (Old Town) and Zamkowe (Castle) Hill in the cartographic reconstruction of Lublin from the Union of Lublin period by Jakub Kuna (after R. Niedźwiadek 2019).

Fig. 3. Grodzisko (Kirkut) Hill. View from the south-east, present times (after A. Rozwałka, R. Niedźwiadek, M. Stasiak 2006).

Fig. 4. View of the Grodzisko (Kirkut) Hill from the south-east. Aerial photography by P. Krassowski from 1964 (after R. Niedźwiadek 2019).

surround the discussed site from the east and south (Niedźwiadek and Zimny 2019, 21, 32, 87).

The defensive advantages such as natural steepness of the slopes, were also strengthened by periodic fluctuations of water level (Fig. 2). As for the period between 1200 and 1400, when the stronghold on Grodzisko Hill probably existed, it has been found that, compared to the previous cycle, the climate was wetter and colder (Maruszczak 1974, 46–47; Maruszczak 1991, 182–190). At that time, peat-forming processes occurred at the bottoms of the Lublin river valleys. The swamping of river valleys became an obstacle to the economic development of Lublin but it led to improvement of its defences (Kociuba 2011, 84–87). At that time, the gorge separating Grodzisko Hill from Białkowska Góra appeared, as well as the road connecting Czechówka River valley and the entrance of the stronghold on Grodzisko Hill (Kociuba 2011, 87 – note no. 43; Rodzoś and Mroczek 2017, 312–315). No paleo-environmental research has been carried out on the site and its surroundings. One can, however, picture the water relations due to the partial recognition of the former Franciscan monastery complex (now Salesians) adjacent to the west side of Grodzisko Hill (Fig. 4). The southern and western wing of the monastery buildings, protruding into the Bystrzyca valley, was erected on a wooden grate put on river silt (Hunicz 1970, 2–3).

If we look, even briefly, at the history of the research on Grodzisko Hill, we will undoubtedly admit that the scientific interest in this site has been led by historians. Teresa Wąsowicz thought that in the period between 11–12th centuries more than one stronghold might have functioned in Lublin. The first of them would have been on Zamkowe Hill, and the second one on Grodzisko (Kirkut) Hill. Both were supposed to guard the river crossing and the ford leading to the area of today's Stare Miasto (Old Town) (Wąsowicz 1961, 223–224, note 57). Stefan Wojciechowski also argued for the synchronous existence of the strongholds on Kirkut Hill and Zamkowe Hill. In his opinion, both hills had almost the same defensive values, and their strategic location afforded control over the wide valley of connected rivers. The fortress located on Grodzisko could, additionally, guard the Ruthenian trail and the settlements on Czwartek Hill (Figs. 1–2). Within its ramparts, there was probably a settlement consisting of several dozen houses (Wojciechowski 1965, 11–23). Aleksander Gardawski was the first archaeologist to comment on the analysed site, and he believed that the hypothetical tribal defence system located in the northern part of Czwartek Hill was moved to the Kirkut area. He believed that Grodzisko, together with the neighbouring Białkowska Góra Hill, formed one settlement complex. The next translocation was to Zamkowe Hill and during the relocation of the stronghold both structures could function simultaneously, defending in the 12th century the settlement centre of the Lublin agglomeration (Gardawski 1965, 24–29).

2. History of the research and methods

In 1968, the first excavation research was carried out on Grodzisko-Kirkut Hill (Fig. 5) (Hoczyk 1969, 260–262). It should be noted that the end of the 1960s and the beginning of the next decade of the 20th century was a period of intensive research aimed at discovering traces of Slavic settlements. In 1968, the second excavation campaign on one of the most important sites – the settlement on Czwartek Hill – ended (Młynarska-Kaletyn 1966, 79–122). That year, the first excavations on Staromiejskie Hill (Hoczyk-Siwkowa 1974, 97–113), were also started, and, in the following season, systematic archaeological research on Zamkowe Hill began (Hoczyk, Ślusarski. 1971, 53–77). The research has continued, with varying degrees of intensity, to this day. The excavation campaigns from 50 years ago were followed by surface survey of the river valleys, both within and outside the city (Libera 1985–1986, 249–256). All these actions contributed to rapid increase in the amount of gathered data, which, since then, has been an invaluable source of information about Lublin settlement throughout the early Middle Ages.

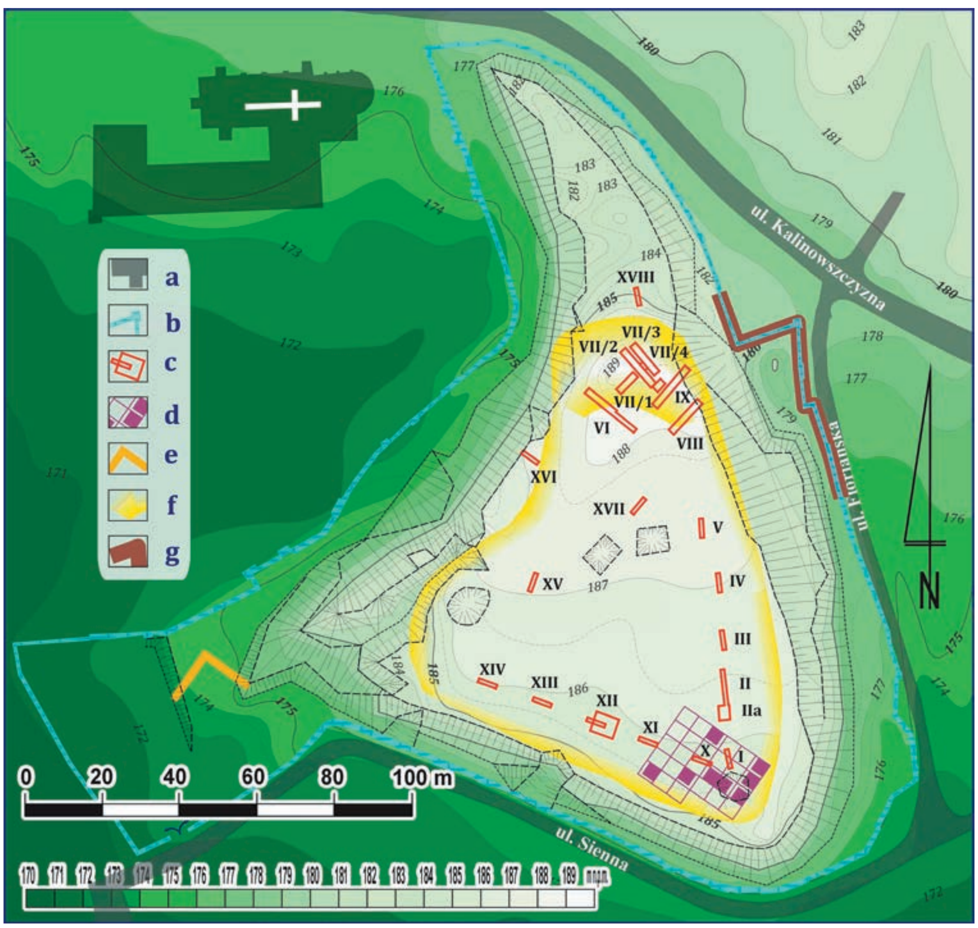

Fig. 5. Lublin – Grodzisko Hill. Range of archaeological recognition: a – the outline of the former Franciscan complex, b – fence wall of the Jewish cemetery, c – excavations of S. Hoczyk-Siwkowa from 1968, d – are grid and excavations of I. Kutyłowska from 1974, e – surveys by I. Kutyłowska from 1976 , f – range of ramparts of the stronghold proposed by S. Hoczyk-Siwkowa, g – sections of the fence wall which were renovated with archaeological prospection carried out by ARCHEE studio (after R. Niedźwiadek 2019)

Compared to the sites mentioned earlier […] *only Grodzisko (Kirkut) Hill was not archaeologically investigated.* Stanisława Hoczyk-Siwkowa included such words in the documentation of these works, and this is probably how she expressed the need to start the investigation. The researcher carried out the archaeological research with the support of Maria Chyżewska (Sułowska). Although S. Hoczyk-Siwkowa is the only author in the publications presenting the archaeological excavation research results, it is necessary to point out that the researcher herself, in the text of the documentation and the latest article summarising the work, mentions the input of Maria Chyżewska (Sułowska). According to the opinion expressed by S. Hoczyk-Siwkowa, Maria Chyżewska (Sułowska) should also be treated as the author of the research, but this fact has not been used in literature so far. The researcher recalls: [...] *because at the same time I was already conducting field work on the above-mentioned sites, we invited Maria Chyżewska, a graduate of the University of Łódź, employed at the Department of Polish Archeology of the Catholic University of Lublin, to work on Grodzisko Hill* (Hoczyk 2012, 170). Elsewhere, S. Hoczyk-Siwkowa states – *It is because of her that this site was then as well recognised as the others. With cheerful approval, she supervised the daily progress of works, labelled artefacts, drew plans and profiles* [...] (Hoczyk 2009, 13).

In the 1968 season, the survey excavation method was chosen. The size of the excavations was 1 × 5 m with 10 meters distance between them (Fig. 5). The excavations were attempted to be located near the edge of the stronghold. By the eastern escarpment there were five excavations – marked with numbers from I to V. Along the southern border of the hill, a line of 5 ditches was marked out (no. X–XIV). After the discovery of settlement features from the tribal period, the scope of exploration was expanded to fully capture their outlines and contents. In the northern part, where the remains of the ramparts were located, the grid of excavations – nos. VI, VII/1, VII/2, VII/3, VII/4, VIII, IX – was significantly thicker, and the excavations themselves were enlarged to a length of even 14 meters. At the western edge, the survey excavation XV was located, while excavations nos. XVI and XVII run across the parade ground. Near the northern base of the rampart, the last excavation no. XVIII was marked out.

As S. Hoczyk-Siwkowa explains – the choice of the described method was the optimal compromise that reduced to minimum the possible damage to the site surface (Hoczyk 2009, 2). Placing survey excavation along almost all sides resulted in a fairly good picture of the stratigraphy. It should be remembered, above all, that the Grodzisko parade ground hides the remains of the first Jewish cemetery in Lublin where, despite the devastation from the Nazi occupation period and the People's Republic of Poland times, many tombstones survived (Fig. 6). In such a situation, free planning of excavations was not an option.

In total, during field works that took place between June 18th and July 27th, 1968, an area of over 2 ares was investigated, which was approximately 1.5% of the entire stronghold area. While deepening the excavations, the "arbitrary levels" method was used, but for the infills of features the method chosen was excavation by natural levels (Hoczyk 2012, 172).

In 1974, in connection with the planned construction of the future Open Air Village Museum in Lublin, seven excavations covering a total area of 120 m^2 were established in the south-eastern part of the site (Fig. 5, 7). The research was conducted by Irena Kutyłowska under the supervision of Jan Gurba. Within the excavations, early medieval features as well as levels and graves created during the use of the cemetery were found (Kutyłowska 1977, 211–212). I. Ku-

Fig. 6. Grodzisko (Kirkut) Hill. View from north-east, present times (photo Marek Stasiak)

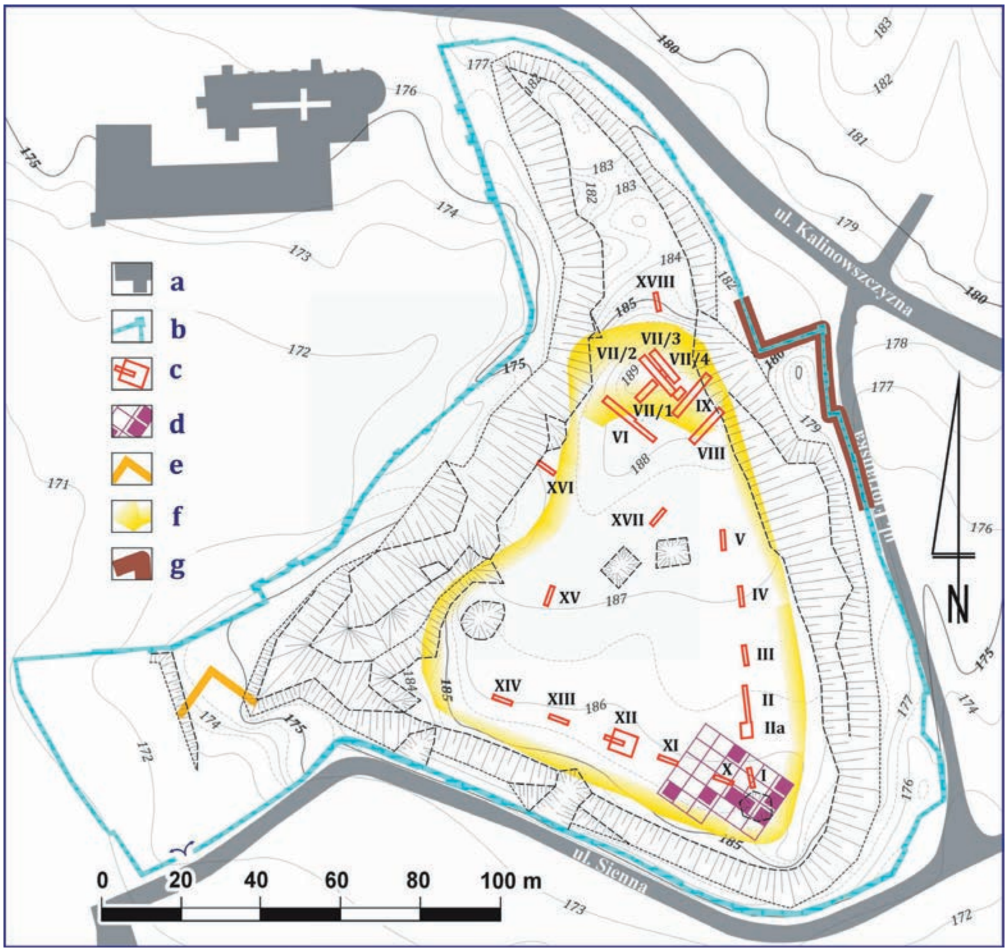

Fig. 7. Lublin – Grodzisko Hill. Range of archaeological recognition: a – the outline of the former Franciscan complex, b – fence wall of the Jewish cemetery, c – excavations of S. Hoczyk-Siwkowa from 1968, d – are grid and excavations of I. Kutyłowska from 1974, e – surveys by I. Kutyłowska from 1976 , f – range of ramparts of the stronghold proposed by S. Hoczyk-Siwkowa, g – sections of the fence wall which were renovated with archaeological prospection carried out by ARCHEE studio (after R. Niedźwiadek 2019)

tyłowska returned to the site in question in 1976 and conducted some survey research. This time, at the foot of Grodzisko Hill, on its south-west side, where levelling was carried out before the construction of a car park, two cross excavations were established. The survey no. 1 on the north-south axis was 13 meters long and 2 meters wide while the east-west excavation was 2 meters longer with the same width as no. 1. Under the turf there were levels of loess. The deposits were 2.0 to 2.5 meters thick and might have been the result of anthropogenic levelling or denudation processes. 21 early modern period graves from the Jewish cemetery were dug in these layers. Below, there was a cultural layer dated, after clay vessels fragments analysis, to the VII–VIII century. It was a layer of [...] *brown-black soil, 50 cm thick, with fragments of early medieval ceramics from VII–VIII century, clods of daub and, in the western part of the excavation, remains of decayed wood in the form of two vertically embedded, 10–15 cm thick, stilts connected with thinner, plaited branches. A more detailed interpretation of the wood remains is not possible due to the narrow width of the excavations* (Kutyłowska 1975, 180).

In later years, archaeologists no longer had access to the site. Archaeological research around the stronghold was limited to the supervision of line excavations. Usually, they were shallow trenches for telecommunication infrastructure. Limited observation possibilities resulted in a small amount of data on land economy in the early Middle Ages. Only obtaining a fragment of a clay pot dated to XII to XIII century can be considered as significant. The artefact was found in the *settlement layer* located at a depth of about 100 cm below the surface of Sienna street (Hunicz 2009, 182).

The results of most of this significant and pioneering research, carried out on the Lublin hills in the late 1960s or early 1970s, usually not long after their completion, were published and thus included in the scientific circulation. In terms of publications, the results of excavation research on Grodzisko Hill were not so lucky. For the first time they were discussed in the unpublished doctoral dissertation of Stanisława Hoczyk. Particularly large part of it was devoted to the description and analysis of artefacts and settlement features from the tribal period (Hoczyk 1971). One of the chapters was titled *Defence Structures*, and it provides brief information about the results of the 1968 research (Hoczyk 1971, 74–76). In subsequent publications, the researcher repeatedly referred to the results achieved, but in a briefer manner than in the source work. Each of the following articles lacked layers characteristics, stratigraphic system analysis, layers chronology, and presentation of, at least, some parts of the field work documentation.

The importance of the excavation research carried out in 1968 on Grodzisko Hill clearly contrasted with the impossibility of gaining a deeper insight into the results. Thus, many contradictory and, sometimes, mutually exclusive hypotheses regarding the dating of the site and even its function have arisen (Rozwałka *et al.* 2006, 81–83; Florek 2014, 171–188).

This text is not meant to be a synthesis, and the authors do not intend to reinterpret the findings. The article is an attempt to present the results of all the archaeological research done on Grodzisko Hill. Those who wrote these words obtained the permission to view S. Hoczyk-Siwkowa's doctoral dissertation, to which the author refers in many publications, and it should be clearly emphasized that the typescript of the dissertation was the first and most complete source of information about the research results from this site until 2012. In terms of movable material, it is still the most comprehensive information resource. In 2009, the cited researcher submitted documentation of the excavations to the Provincial Office for the Protection of Monuments in Lublin. The study contains 13 pages of text, 12 tables with drawings of fragments of ceramics, a plan of excavations and a photocopy of selected drawings from field documentation, which were coloured (the originals are stored in the Lublin Castle Museum). Documentation from field research should be the first and basic source of information about the archaeological site. However, in the case of the object in question, the elaboration of results was labelled: "Only for official use. The copyright of the authors of field works documentation (drawings and photographs) and the priority of publication reserved." The objection could impede the use of this source. S. Hoczyk published the text of the cited documentation, after expanding and supplementing it, in *Studia i Materiały Lubelskie*. Thus, it can be considered that the restrictive clause has expired. The study was accompanied by a copy of Paweł Fijałkowski's article on the funeral rite of Polish Jews, writing of which he used, among others, the results of excavations carried out in 1968, 1974 and 1976 (Fijałkowski 1989, 25–42).

The last article by S. Hoczyk-Siwkowa in *Studia i Materiały Lubelskie* (2012, 167–205) regarding the research on Kirkut Hill can be treated as the only synthesis where the sequence of layers from the entire site was determined, individual units were described, phases of use were separated, and the final dating was discussed and decided. The Grodzisko Hill area was divided into two parts. The flatter, southern one, resembling a *plateau*, is number 2a, while the northern one – with preserved remains of rampart embankment was marked as 2b (Fig. 5, 7). In this publication, after graphic processing, some selected drawings were included – the plan of the site showing the location of excavations, tables with examples of movable artefacts, views and cross-sections of several features of the tribal period, as well as views and cross-sections of excavations VIII, IX presenting the stratigraphy of the rampart (Fig. 8 b–c). Therefore, the 1968 discoveries seem to be a reliable source of information to refer to. On the other hand, I. Kutyłowska did not submit documentation from two seasons of her own archaeological research until 2019. In this situation, apart from short references in *Informator Archeologiczny* and hypotheses expressed in the habilitation dissertation from 1990 (Kutyłowska 1990), we have only an extensive article by the researcher provided with scarce picture material (Kutyłowska 2003, 249–258).

S. Hoczyk, in her doctoral dissertation, outlined the stratigraphy of the site for the first time. "Primary humus" (No. 1) was located over the sterile earth loess, layers 2 and 3 would correspond to the rampart, while unit no. 4 was *clay put on the rampart debris, probably in attempt to rebuild It* (Hoczyk 1971, 217–218). The sequence was intersected by grave ditches and trenches from World War II (Hoczyk 1971, 74).

I. Kutyłowska introduced a different numbering when she discussed the results of her own excavations. Sterile earth loess was marked as no. 1. Above, there was the primary humus – layer no. 2. Fills of all the tribal period features – pits and farmsteads – as well as charcoal and ash clusters were described as number 2a. The researcher did not distinguish the units the rampart was built of, but there was another, very important category – layers that allow distinguishing

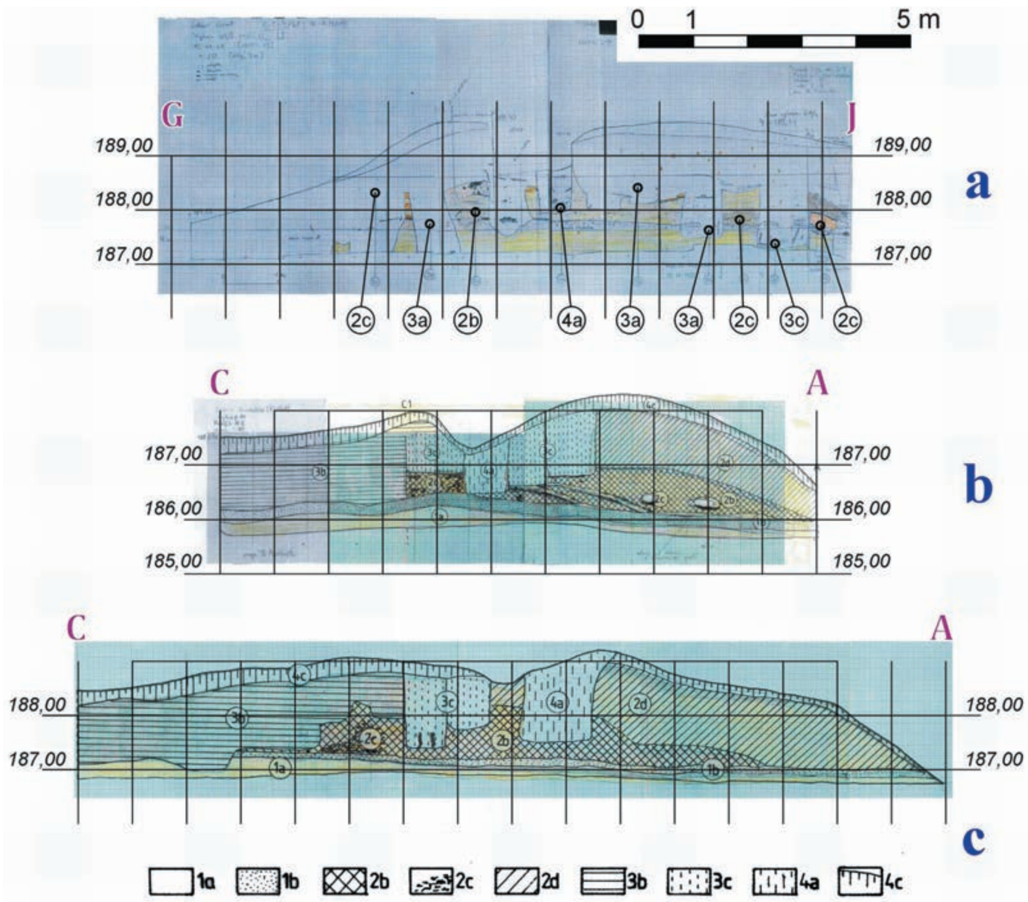

Fig. 8. Lublin – Grodzisko Hill – vertical cross-sections of the stronghold rampart (along profiles of excavations: a – No VII/2, b – No VIII, c – No IX, after S. Hoczyk 2009, 2012). Legend: 1a – geological loess, 1b – primary humus, 2b – light brown loess – embankment of rampart I, 2c – burnt clay soil with fragments of wooden beams and charcoal pieces, 2d – yellow-gray soil (embankment II), 3b – gray "embankment" soil , 3a – burial pit, 4a – shooting trench, 4b – humus (according to R. Niedźwiadek 2019).

the phases of use of the cemetery. Grave pits from the older horizon – marked as 2b – intersected the units 1, 2 and 2a. Above, there was layer no. 3 – a levelling layer consisting of loess and "grey soil" with an admixture of limestone stones, lumps of daub and charcoal pieces. During the deposition of this unit, the backfills of graves from the older phase were partially levelled, the depth of the burial pits, however, was in the range of 60–120 cm. The thickness of layer no. 3 exceeded 100 cm. A younger series of graves was found in its ceiling, some of them contained coins issued after the mid-17th century. Among the obtained numismatic items, the silver royal shilling of Sigismund III Vasa (from 1616) was introduced the earliest. Above the sepulchral levels there was contemporary humus – unit no. 4 (Kutyłowska 2003, 252–253).

I. Kutyłowska's findings about the two phases of Kirkut Hill's use are confirmed by written sources. In the inspection from 1614 it was noted that [...] *Jews pay the funeral rent annuatim* [three zlotys] *and for the area they dug in later, four zlotys* (Rabinin 1938, 74). The quoted note can be interpreted not only as a confirmation of a kind of "renewal" of the burial space, but also as a result of its enlargement, because before adding the land, Jews paid 3 zlotys of rent for 1614, and after re-levelling the rent increased to 4 zlotys. The need to cover 16th century graves may indicate that there was no more space left for burying the dead. It was also done to follow one of the most important principles of a funeral rite – the integrity of burial. In light of the findings of I. Kutyłowska, the spreading of layer 3 could also go beyond the original outline of the stronghold, because in the excavations from 1976 she discovered that the thickness of the rampart at the foot of the southern escarpment of the hill reached up to 3 meters (Kutyłowska 2003, 255). Discriminating the phases of the use of the necropolis one can also refer to the earlier role of the site when it served as a stronghold. This situation was registered in the drawing documentation of the 1968 season (Hoczyk 2009, 7–8,picture material; Hoczyk 2012, 194, 197, Figs. 10, 13). The graves from the earlier stage were dug in the level of the ceiling of early medieval cultural layers or in the remains of the rampart. Younger graves, however, were dug in the level of the 17th century levelling (Fig. 8).

The results of two excavation campaigns shown above, conducted by two researchers, show different reconstructions of layer sequences, although they relate to the same site. Unification, therefore, was proposed by S. Hoczyk-Siwkowa in the documentation of the first season of field works (Hoczyk 2009, 7–8). In her latest article, a correction to the description and numbering of the lowest-lying units was included (Hoczyk 2012, 177–178, 192). Let us present the final findings, which were also used to prepare the figures included in the cited article. S. Hoczyk-Siwkowa distinguished 4 stratigraphic levels, which are also chronological horizons: 1 – primary formation; 1a – yellow sterile earth loess; 1b – "gray-brown primary humus"; 2 – early medieval levels (VI/VII–XIII century); 2a – settlement remains – feature backfills and cultural layer – dated to the tribal period; 2b – "embankment of rampart I", also called "the lower one"; 2c – "elements of the structure of burnt rampart in the embankment" (stronghold burnt in the XIII century); 2d – embankment of rampart II consisting of "yellow loess"; 3 – use of the Jewish cemetery (~ 1541/1555–1830); 3a – grave pits from the older phase; 3b – a layer of soil increasing the level of the cemetery; 3c – grave pits from the younger phase; 4 – World War II and modern times; 4a – shooting trenches and their fillings; 4b – soil deposited during construction of trenches; 4c – contemporary turf.

From the list above, the main stages of the use of the site emerge. A relatively large number of surveys would allow an attempt to determine the primary morphology, e.g. using 3D modelling. As has been mentioned many times, however – due to the author's restrictions – access to drawing documentation is very limited. After reviewing the field works documentation stored in Lublin Castle Museum, we can conclude that as for the part of the site marked as 2a, some drawings are missing.

I. Kutyłowska believed that the use of the cemetery during the first phase resulted in the removal of significant amount of primary humus, sometimes to the point of reaching geological loess (Kutyłowska 2003, 253). However, in most drawings made by M. Chyżewska (Sułowska), we can see the presence of this unit also under the embankment of the rampart. It is not intersected by any features. S. Hoczyk-Siwkowa noted that, in its ceiling, there were fragments of vessels from the tribal period and *younger phases of the early Middle Ages* [...] *This may mean that the surface of the hill was deforested and, most probably, used for farming for many centuries* (Hoczyk 2009, 7). It is possible that, due to the removal of trees, the erosion process was started, because, in the southern part of the site, greater thickness of layer 1a was noted. The presence of artefacts in its ceiling, however, may suggest that it could, to some extent, also be a cultural layer. This, on the other hand, contrasts with the function assigned to layer 2a. Based on the available materials, this doubt cannot be resolved. The one thing that seems likely is the assumption that the site, throughout the early Middle Ages, was not abandoned for a longer period of time.

In the results of both excavation campaigns, we find features assigned to the tribal settlement phase. In the course of the study from 1974, four shallow pithouses and a "pear-shaped" storage pits were uncovered – most of them dated to the VIII–IX century, one of the houses contained older fragments of ceramics (6/7–8th century) (Kutyłowska 2003, 254–255). S. Hoczyk-Siwkowa distinguished similar time horizons. The earliest stage of Slavic settlement – phase I – is represented, among others, by repeatedly cited hut 29 with a stone oven, captured in excavation XII (Parczewski 1988, 166, 223, table XVIII). Also in other surveys, with the exception of the northern part occupied by the rampart, several features of the tribal period were discovered (phase II) (Hoczyk 2012, 182–186). Summing up the revealed remains of the settlement of the tribal period, S. Hoczyk-Siwkowa states that the southern part of the hill was occupied by a small settlement with residential buildings. But at the same time the author also states that, and it is important as for the next period of use – [...] *there is no settlement layer between the features, which may suggest a periodic use of the hill* Hoczyk 2012, 189).

In the latest publication, S. Hoczyk-Siwkowa does not connect any residential features with the third phase, i.e. 10–11th century. In the documentation stored in the WUOZ archives this phase is not included at all – immediately after the settlement of the tribal period, phase IV (the second half of the 11th century – 1317) is presented. Some information about material remains of the phase can be found in the typescript of the doctoral dissertation, where detailed presentation of spatial distribution of the artefacts assigned to phase IV is included. According to the words written there, the cultural layer was found not only in excavations XV, XVI, XVII (central part of the parade ground and the western edge). As for the rest of the surveys, the following frequency of ceramic fragments was noted – [...] *in excavation I – 4 fragments, II – 17, III – 8, IV – 22, V – 17, X – 12, XI – 6, XII – 36, XIII – 5* (Hoczyk 1971, 221). S. Hoczyk-Siwkowa also mentions the presence of this unit in another publication – [...] *a cultural layer up to 20 cm thick with a small amount of ceramics dated, generally, to the pre-foundation phase* (Hoczyk-Siwkowa 1975, 152). Therefore, contrary to statements that sometimes are formulated, most of the stronghold plateau should be treated as an area used economically, although the type of the use cannot be determined.

In each of the works, S. Hoczyk-Siwkowa dates the creation of stronghold ramparts (structure no. 6 from the 1968 season) to the fourth phase. As described in the guidebook by S. Wojciechowski and J. Siennicki from 1931, remains of the stronghold embankments were visible in the interwar period (Kutyłowska 2003, 250). Today, most of them are covered by trenches dug during World War II (see Fig. 4). A dense network of surveys made in 1968 in the northern part of the site allowed tracing the remains on a 70 meters long piece of land and an area of about 85 m^2 (excavations VI, VII, VIII and IX from 1968) (Hoczyk 2009, 5; Hoczyk 2012, 192). The defensive structure within the excavation VII, divided into 4 parts, was damaged mostly by burial pits (Fig. 7, 8, 9). But as for surveys VIII and IX, located southeast, the embankment elements were much better preserved (Hoczyk 1971, 75). Probably for these reasons, in an article from 2012, there were graphically processed figures from these excavations only (Fig. 8 b–c). The author first reports that the rampart core was 5.0 meters wide (Hoczyk 2012, 193), but then it is stated that the width is 8.6 m (Hoczyk 2012, 193). When confronting these data with the measurement found in the published figures, it must be assumed that the parameter is in the range of 6–7 m. The preserved height was not greater than 1.0 m, which certainly cannot be its the original size (Hoczyk 2012, figs. 10, 13). Finally, S. Hoczyk determined that the base of the rampart – within the range of excavations VIII and IX – might have been 8 to 10 meters wide (Hoczyk 2012, 196).

What is interesting, the way given sections of the rampart were build differs, which was discovered in the series of excavations. An embankment made of light brown earth containing thin strands (interlayers) is

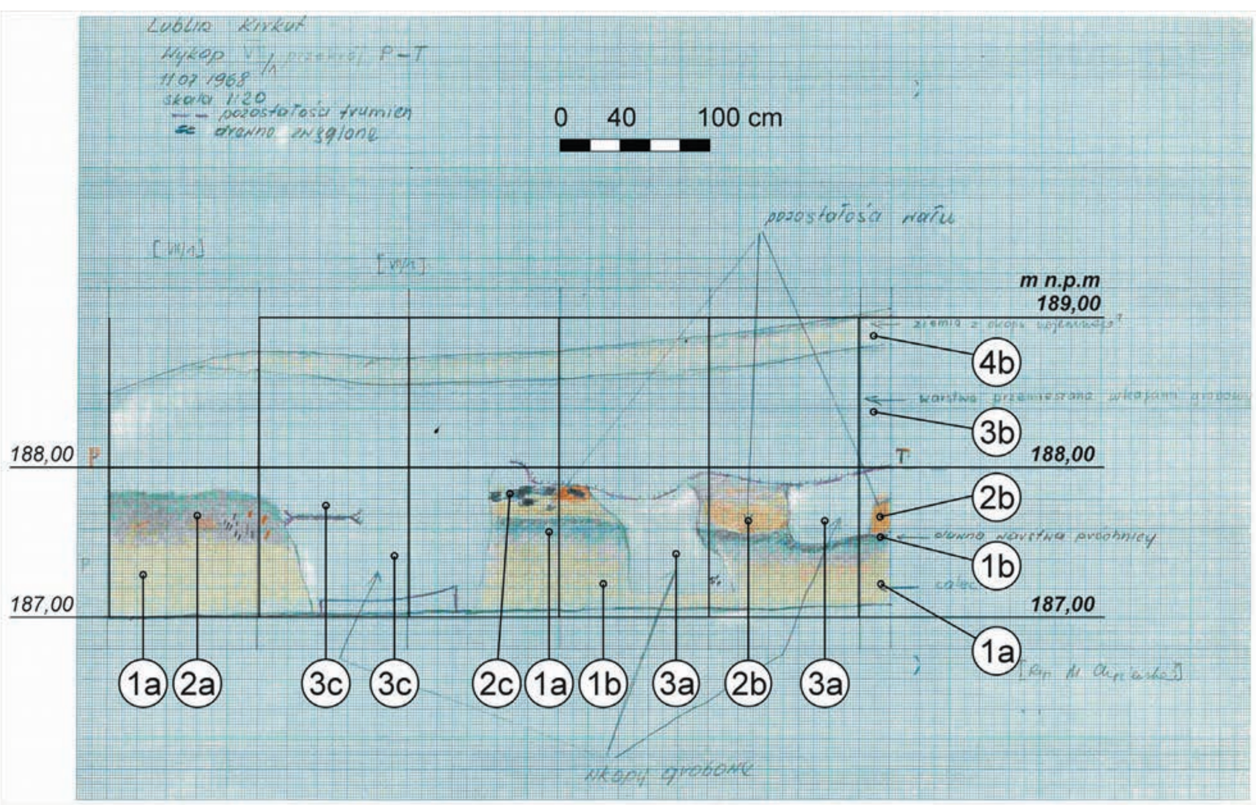

Fig. 9. Lublin – Grodzisko Hill. Lolongitudinal cross-section of the stronghold rampart along the SW profile of excavation VII/1 (drawn M. Chyżewska, 1968).

common to all fragments of the rampart. In excavation VI, some burned material was found, but the amount was smaller than in other excavations (Fig. 9). The absence of daub and stones was also noted there. Elsewhere in the tapescript of the dissertation, it was said that in excavation VI there was dark gray earth, 50 cm thick and, moreover, *It contained charcoal and traces of two burned beams. It was spatially limited (length of 2.60 m) and it was probably a part of enlarged rampart core*. (Hoczyk 1971, 75). This information, based on available visual materials, cannot be verified, however – analysing the isohypse plan – it can be concluded that the rampart embankment may have run through the central and north-eastern part of excavation VI.

However, in surveys VIII and IX, in addition to burnt clay, pieces of coal and stones were registered and they were only found on the inner side of the embankment. The largest number of damaged artefacts was registered in excavations VII/1 – VII/2, where [...] *there was a huge amount of burned daub and stones, which made the excavation difficult to explore* (Hoczyk 1971, 75). A dense level of debris was also located on the inner side of the rampart, which preserved height reached 40 to 60 cm. Given fragments of these remains can be found in the description, as well as in figures (Fig. 10). From the cited observations, it can be concluded that the embankment on the inner side had a kind of facing or formwork that protected the escarpment against slipping (layer 2c – according to the taxonomy adopted by S. Hoczyk in the last article from 2012).

In the latest study of the results of the first research season, one can find a comprehensive description of the rampart structure, which includes drawings and reproduced photographs (Fig. 8, 9, 10) (Hoczyk 2012, 192–193, figs. 10, 11a, 11b, c, 13). Wooden beams, 20–30 cm in diameter, were used to build the rampart grate. They were arranged at an angle to the line of the embankment with 1 meter distance between them. Near the beams, pieces of limestone and lumps of daub were found, but their role was not interpreted here. More details concerning the relationship between wood, stones and clay can be found in the typescript of the doctoral dissertation. S. Hoczyk stated that, excluding excavations VII/1–4 [...] *the rest of the sections of the embankment were made with less effort* (Hoczyk

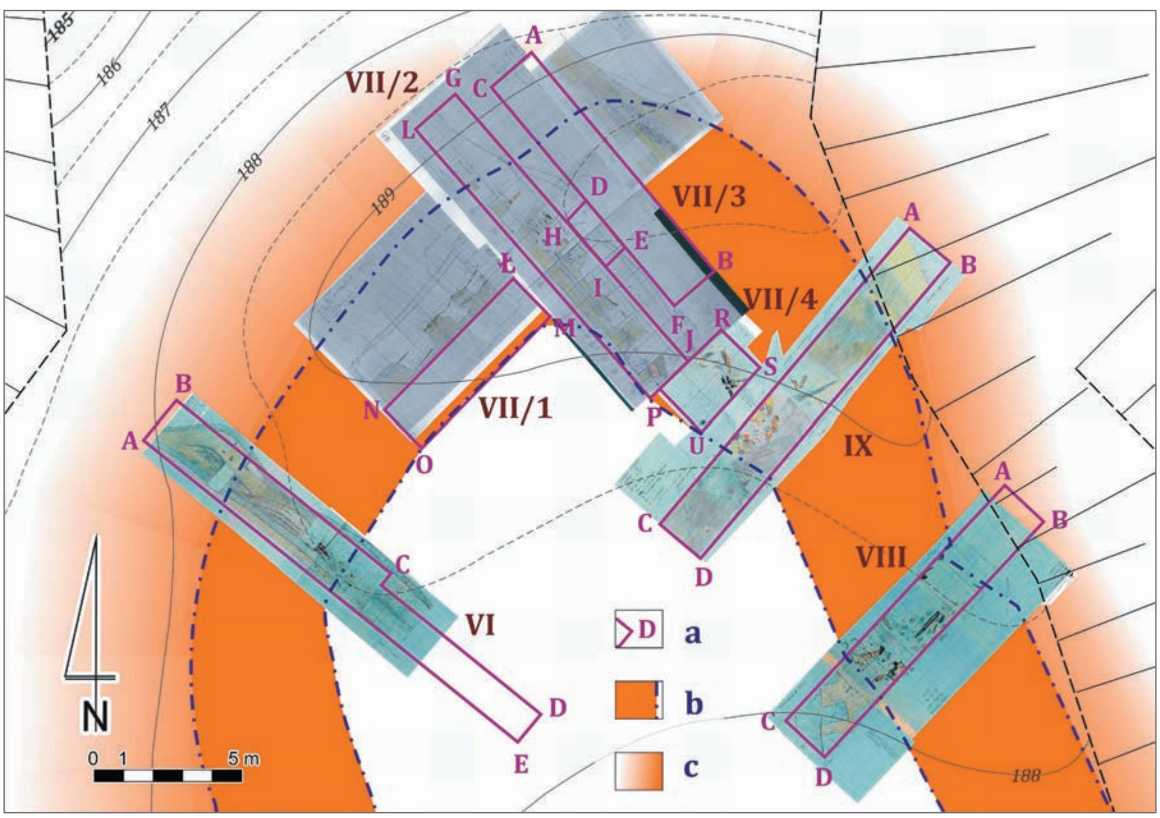

Fig. 10. Lublin – Grodzisko Hill. An attempt to reconstruct the ramparts location in the northern part of the site. In the base – the contour plan used in Fig. 7 and scaled drawings from documentation of excavations VI, VII / 1, VII / 2, VII / 3, VII / 4, VIII, IX (drawn S. Hoczyk): a – the excavations from 1968 and their corners marking, b – reconstructed rampart base, c – rampart slopes (after R. Niedźwiadek 2019).

1971, 76). In the balk between excavations VII/2 and VII/3, the most complex system was revealed, its main component was [...] *burnt beams. They were not arranged in the same way. At a depth of 1.3 m there were traces of parallel beams (the first was 23 cm thick, the second was 12 cm thick) laid in the N-S direction. Slightly higher (1.08 m), in the uncovered section, there were another two beams touching each other at right angle by the wall N of the excavation. They were surrounded by burnt matter and baked, brick colour clay. The debris of the rampart discovered here, on an area of 1m^2, was on the outer side of the peak* (Hoczyk 1971, 217–218). On the following pages of the cited work a similar description of the situation found in excavation VII/4 can be found. It was located about 3 m south-east to the balk mentioned above (Fig. 10). At this point, on the inner side, the embankment was secured against spreading with formwork made of wooden beams with an average diameter of about 20 cm. Within the excavation, several levels of the structure were registered. *The beams were surrounded by clay burned orange. In the horizontal plane, slag clay occurred from a depth of 1.30 m. At a depth of 1.50–1.80 m, the remains of several burned beams, still arranged N-S and E-W, were also discovered. Visible in the profile, the beams went upwards diagonally and they were, probably, the internal facing of the rampart base* (Hoczyk 1971, 219–220). The depth values used by S. Hoczyk-Siwkowa are relative, they were measured in relation to ground level.

From the quote cited in extenso, at least two conclusions can be drawn. First of all – joints and gaps between wooden logs were filled with clay. Secondly – this description evokes associations with a crossed logs ramparts or box ramparts (Bogdanowski 1996, 41, fig. 26). It is confirmed on another page of the work, where the author mentions finding a large number of lumps of daub (however, even their approximate number is nowhere to be found). On some of them there were traces of growth rings, which could mean that, actually, the clay tightly filled the gaps between the logs. Further in the text, fragments of lumps of daub with traces of beams arranged alternately, which most likely touched one another at right angles, are discussed (Hoczyk 1971, 218).

In her work from 1971, S. Hoczyk did not provide a clear and unambiguous interpretation of these discoveries. It was in the article from 2012 where she clearly stated that the beam system registered in excavations VII/2 and VII/3 should be interpreted as [...] *a fragment of the corner of a quadrangular foundation, this is the only example of such a tight connection of beams on the site, therefore part of the structure was treated by the author as a fragment of the corner of the gate base.* (Hoczyk 2012, 199). Both the proposed interpretation and argumentation seem justified – only from the north it was possible to enter the stronghold and only there it was necessary to build a gate, and the gate had to be more solid than the other sections of the ramparts. In the dissertation, this section was defined as follows: "*... clearly the form of a rampart blocking the access to the hill from Kalinowszczyzna Street.*" (Hoczyk 1971, 76).

The arguments cited above appear to be consistent. Based on the discoveries from 1968, it should be clearly stated that in the northern part of the hill, near the narrow piece of land connecting the plateaus, there was a section rampart with a base width of 8–10 m (Fig. 10). Its preserved height in the excavated material did not exceed 1.0 m (Fig. 8–9). It seems obvious that, originally, it had to be larger. However, this parameter cannot be reliably reconstructed. For example, it can be assumed that the maximum height did not exceed half of the width of the base (combining these parameters, we get the cross section most similar to an equilateral triangle). In this approach, the analyzed site gets close to the definition proposed by Janusz Bogdanowski, which says that a stronghold is a synonym of a fenced place, but the separation does not mean securing property – e.g. as in a case of a farm with an ordinary fence, but it means a conscious construction of a fortified place that provides protection against hostile intentions of other people (Bogdanowski 1996, 43). It is worth mentioning that this defensive structure is reflected in Indo-European languages, while in all Slavic languages it has a very similar pronunciation (Bogdanowski 1996, 522).

It has been frequently mentioned that the foundations of Grodzisko ramparts were laid directly on primary humus (Figs. 8–9). During research in the 1968 season, only in the outer part of the VII/3 excavation a pit crossing the original soil profile was registered (no information about this feature was found anywhere). However, in excavation VIII, on the ceiling of the humus layer, an open hearth was exposed, where 10 fragments of a thin-walled vessel were found, and the vessel had traces of secondary burning. The artefact was made using the coiling and throwing technique with careful trimming, it was ornamented with shallow flutes located around the vessel. Its edge was rounded and curled inwards. In stratigraphic view- the use of this furnace precedes the construction of the rampart, thus determining the post quem terminus for the construction of the defensive structures. S. Hoczyk-Siwkowa does not present more detailed chronology of this item. But, in the same paragraph, she mentions that among burnt wooden elements of the rampart, similar, in terms of technique and ornamentation, pieces of ceramics were obtained. In total, there were 44 items (Fig. 11) (Hoczyk 2012, 199, fig. 13). These artefacts are discussed in the chapters on phase IV – the state period – 11th–13th century (Hoczyk 2012, 191) or the second half of the 11th century – 1317 (Hoczyk 1971, 2) – and this is how their chronology should be read (Hoczyk 1971, 74–75, 219–221; Hoczyk 2012, 191–201). The chronology of the ceramic artefacts lying under or among the destroyed structures should be the same as the dating of the fortifications.

In relation to the findings presented in her own doctorate, S. Hoczyk-Siwkowa mentions in the last work on Kirkut Hill [...] *in the first study, "frame" dating was used, so the construction, use and burning of the rampart was put in a wider chronological range, determined on the basis of vessel ceramics from its embankment*." (Hoczyk 1971, 217–218; Hoczyk 2012, 201). Until the publication of the 2012 article, Grodzisko Hill was dated according to this "broad frame dating " that was based on the chronology of the ceramics and resulted with the periods between XI–XIII century or between the second half of XI century – 1317. These suggestions were repeated in subsequent articles of the cited researcher (Hoczyk-Siwkowa 1974, 109–111). The proposed time range and the function of the site were included in Andrzej Rozwałka's analysis of the transformations of Lublin's Staromiejskie Hill. At that time, a hypothesis was formulated that the location of the stronghold was moved to the Kirkut Hill from the area of the present Stare Miasto, where the tribal period stronghold ceased to exist. The translocation might have taken place around the middle of the XI century, when the Piasts created a new network of strongholds, and when the cited work was being written, no other Lublin stronghold had a chronology that was even partly related to XI century (Rozwałka 1997, 63–64). This concept was once more used in *Early Medieval Lublin* monograph (Rozwałka *et al.* 2006). It was believed then that the continuity of the functioning of the administrative center for the entire agglomeration had to be maintained. It was believed that the center of "judiciary and police" power located on Grodzisko Hill would have been located closer to the long-distance trade route, and thus might have exercised more effective control over people and goods moving along the route (Rozwałka, Niedźwiadek, Stasiak 2006, 81, 83). Let us emphasize again – views on the discussed site were formulated on the basis of scarce information available in publications and studies. What is surprising, S. Hoczyk-Siwkowa's expressed indignation, or at least misunderstanding of the used arguments, in the last article, where she mistakenly dated the use of the stronghold to X–XI century (Hoczyk-Siwkowa 2012, 176).

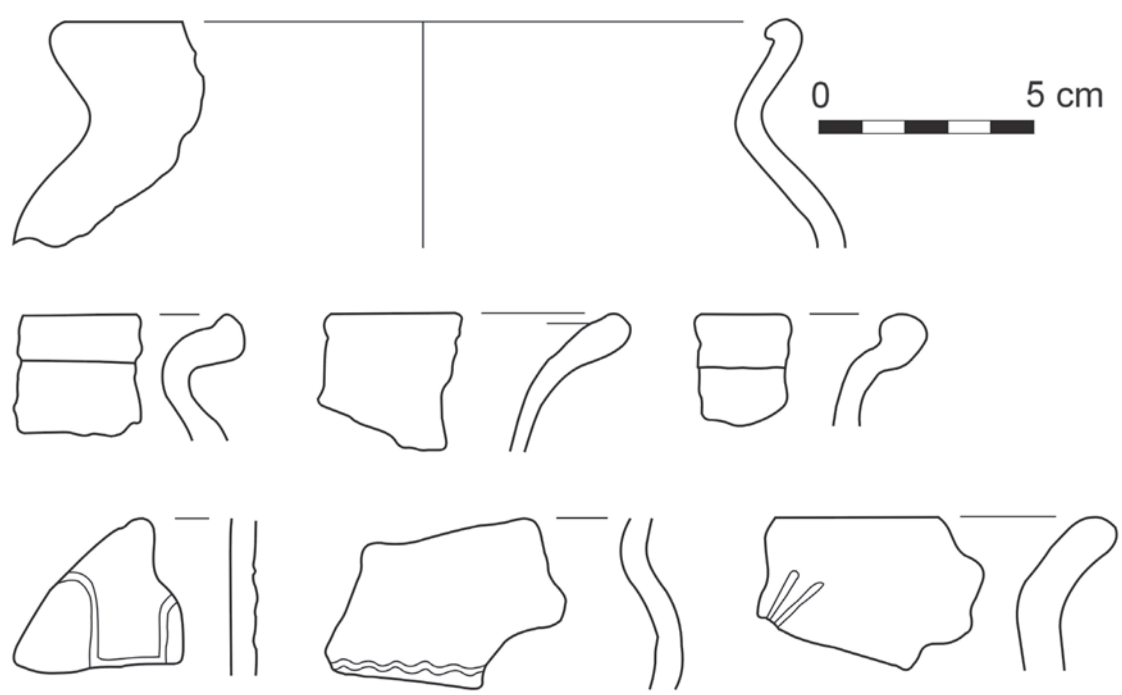

Fig. 11. Lublin – Grodzisko Hill. Selection of fragments of vessels from excavation VIII (after R. Niedźwiadek 2019).

Summing up the discussion that has been continued for years, one must state that the present knowledge of the subject is a direct derivative of the availability of the research results related to it. An example of a totally different view on the dating of the stronghold on Kirkut-Grodzisk Hill is the hypothesis of I. Kutyłowska, who did not come across any remains of the embankment elements during her own research, although she must have had knowledge about their presence and state of preservation. I. Kutyłowska discovered only settlement features of the tribal period, but due to complex argumentation, based on the relation of the said features to burials from the first phase of the use of the cemetery, she tried to prove that the stronghold was built in the period between VI/VII and VIII century (Kutyłowska 1990, 68–70). As this concept was not accepted and it was popularly rejected, it can be treated as a curiosity and a kind of experiment within the mainstream discussion.

3. New proposition

In her latest work, S. Hoczyk-Siwkowa, proposed an alternative solution that may, until new data is obtained, suspend the discussion about dating the stronghold on the Kirkut Hill. The starting point is about 200 pieces of ceramics obtained in 1968 and dated to the younger phase of the early Middle Ages (11th–13th century). There is no reason to question the presented time frame, it should be remembered that it was proposed by the author of the Lublin typology of early medieval ceramics, who consulted her own findings with renowned experts on the period and pottery production methods used then – professors Zofia Kurnatowska, Michał Parczewski and Wojciech Szymański (Hoczyk-Siwkowa 1978, 189–220).

Some of this pieces of ceramics , like the researcher herself emphasizes, were found in situ, i.e. among damaged elements of the rampart (Fig. 12). Let us remind that in most of the parade ground, the cultural layer and levels including preserved original soil profile were registered. If these layers head been removed and built into the embankment of the rampart, one might think that the artefacts were moved to a secondary context. But the indicated items were captured in profiles. It must therefore be assumed that the vessels found among the remains of the rampart structure were broken during its construction. In this approach, they should be synchronous with the time of building of the stronghold. The author has seen the materials, which were taken to the Lublin Castle Museum. The collection consists of 3 envelopes with labels signed by M. Chyżewska. The first two envelopes contain ceramic material collected from a depth of 1.2–1.3 m. They contain both modern and early medieval fragments. The mixing of artefacts should be explained by the context in which they were found. The stratigraphy indicates that the levels at the indicated depth should be connected only with the functioning of the Jewish cemetery. In the study by P. Fijałkowski, we find information on placing fragments of ceramics into the eye sockets and the mouth of the dead. For this purpose, fragments of vessels were sometimes cut into regular figures – triangles, rectangles and trapezoids. It is confirmed by both archaeological material and written documents (Fijałkowski 1989, 27–28). Therefore, the presence of fragments of modern vessels is not surprising.

The third envelope has a label informing that the items were found in excavation IX, at a depth of 120–150 cm, "on the rampart". The last information is particularly important, because inside the envelope there are only fragments of early medieval ceramics. Their production technique – throwing, high quality firing, horizontal flutes ornament – confirm the time period between 11th and 13th century proposed by S. Hoczyk-Siwkowa (Fig. 13). Let us emphasize – the set of ceramic artefacts found in the debris of the rampart is quite homogeneous, looking at details, however, one can notice some differences in terms of the shape of spout edges, the technology of mixing ceramic mass, the firing atmosphere, as well as the style of ornamentation and parts of a vessel it covers.

In the latest publication about the Kirkut Hill, S. Hoczyk-Siwkowa attempted to show the similarity between materials found in remains of the rampart and the collection of ceramics obtained by Andrzej Hunicz from excavation I/73 located in the northern part of Zamkowe Hill. The set of artefacts from excavation I/73 was found in the bottom fill of a log house Hunicz 1984, 9–10, table II, 10–18, table III). Comparing the graphic presentations of these collections, it is difficult to find such visible similarities as those suggested by S. Hoczyk-Siwkowa, in the pictures one can see not only the different drawing styles the authors used but also the way some of the vessel edges are shaped (Hoczyk 2012, 201–203, figs. 12, 15, 16).

Apart from ceramics, there was a spur which the researcher included in type III which is dated to XI–XIII century, according to the classification of Andrzej Nadolski (Nadolski 1954, 83–84). The same artefact, according to the typology of Zofia Hilczerówna, was assigned to the variety 5 type II, dated to the second half of 13th century (Hilczer 1956, 16–20, 49–58. As

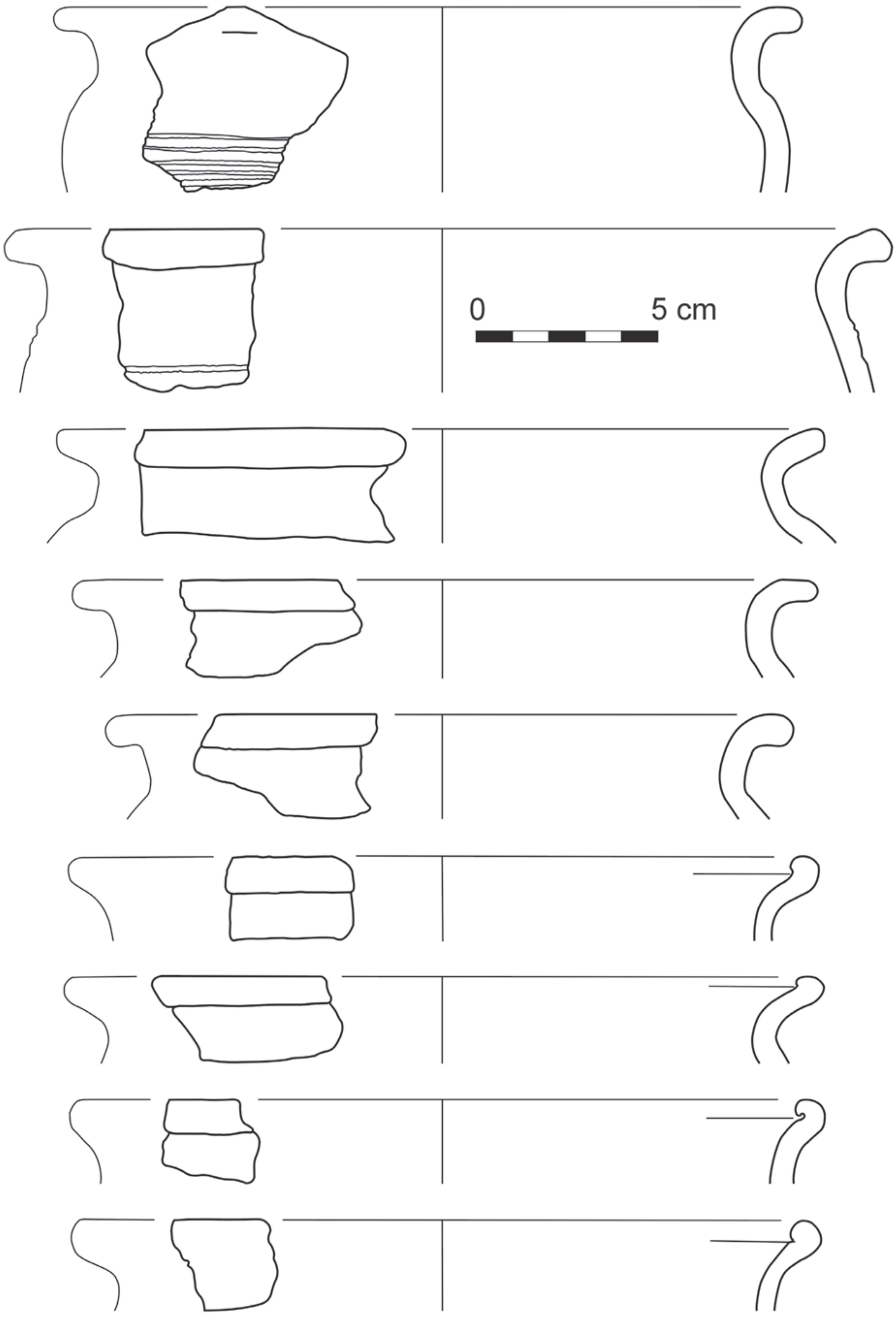

Fig. 12. Lublin – Grodzisko Hill. Selection of fragments of vessels from excavation IX (after R. Niedźwiadek 2019).

Fig. 13. Lublin – Grodzisko Hill. Selection of fragments of vessels from excavation IX, depth 1,20–1,50 or 1,50 m (after R. Niedźwiadek 2019).

for A. Hunicz's research, the formal analyses of the artefacts were supplemented with dendrochronological dating of the wood from the structure of the house (Dąbrowski, Hunicz, Kardasz 1975, 27–36). As many as 10 beams were chosen for specialist tests. Before discussing the results of the absolute dating, one should mention the reservations expressed by Mieczysław Dąbrowski and Margarita Kardasz – the authors of the analysis. The researchers emphasized that, in the early 1970s, works began to establish the basis for applying the dendrochronological method to excavated materials, but only in the long run it will be possible to create a scale and a kind of "calendar" (Dąbrowski *et al.* 1975, 30). Carrying out the measurements, it was found that the tested material contains trees at a relative age of 39 to 70 years that grew in two habitats and belonged to two genetic populations (Dąbrowski, Hunicz, Kardasz 1975, 33). The obtained calendar dates for the Lublin material ranged between 1272 and 1288, but the authors highlighted that the comparative material for the analyzed samples came from Sieradz and Germany (Dąbrowski *et al.* 1975, 34–35). The efforts made should be considered extremely important and valuable, but at the same time one should be aware that the proposed results should be corrected using current dendrochronological scales.

Concluding the latest dating proposed by S. Hoczyk-Siwkowa, it should be argued that the stronghold on Grodzisko Hill was built at the beginning of the last quarter of the 13th century and was destroyed in the same century (Hoczyk 2012, 203). The researcher believes that the next stage was the reconstruction – [...] *probably after the structure was burnt, it was decided to repair the rampart by elevating its surface, there are no traces of any supporting elements made of wood or stones* (Hoczyk 2012, 193, 199). The attempt can be seen in piling up the loess layer with a thickness of 1,4–1,6 m, which in the cited publication was numbered as 2d (Fig. 8). This chain of evidence lacks some explanation – when, in what circumstances and for what purpose was it necessary to rebuild the castle? These questions seem to be impossible to answer.

The unit 2d is parallel to layer 3b which was created as a result of the renovation of the cemetery surface before the second phase of its use. The first of these units covers the outer side of the damaged wooden constructions and as a result of natural denudation processes it partially slid down towards the base of the hill. The second, containing lumps of daub, almost completely consisted of "loose soil". In the original drawings from the field documentation, these differences in composition were presented with a different drawing manner. It is impossible to undertake further analysis, because color photographs were not taken at that time. We only have some interpreted figures from the article in *Studia i Materiały Lubelskie* (Fig. 8 b–c). However, the relationship between these layers, visible in the profiles of excavations VIII and IX, is rather thought-provoking.

4. Conclusions

In conclusion, let us try to look again at the possible functions that the early medieval fortress on Grodzisko Hill might have had (Fig. 14). If, following the suggestions of S. Hoczyk-Siwkowa, we reject the early dating that goes back to the mid-11th century and lean to the 13th century dating, it will turn out that the fortress had to coexist with the castellan stronghold on Zamkowe Hill. When it comes to the military function of Zamkowe Hill in Lublin and the time when the castellan castle town was founded and functioned, for more than 50 years, there has been a discussion in the literature, but researchers have not found a clear, even partly convergent conclusion. It seems that the latest archaeological research – started in 2019 at three points of the southern wing – will provide new, more convincing data, including chronological and stratigraphic determinants (see Tkaczyk 2019).

This is a clear turn towards the first concepts of T. Wąsowicz, S. Wojciechowski and A. Gardawski. We should also consider the latest data showing that during the second half of the 13th century, or at the turn of 13th and 14th centuries, a new line of ramparts was

Fig. 14. Grodzisko (Kirkut) Hill. View from Działkowa Street, present times (after R. Niedźwiadek 2017).

built on Staromiejskie Hill (Rozwałka *et al.* 2016, 215–220). This is how three parts of the Lublin agglomeration were distinguished. Perhaps, in this structure, the stronghold on Kirkut Hill, according to older assumptions, could function as a guarding post for a part of the long-distance route located in the area of today's Kalinowszczyzna street. The route location hypothesis may be supported by the high, compared to other districts of modern Lublin, number of numismatic finds in this part of the city, Among the numismatic finds there were the following series: Bavarian of Henry IV (995–1002) and Henry V (1004–1009, 1017–1026); Swabian of Henry II (973–1024); Czech of Udalric (1012–1034); Hungarian of Stephen I (1000–1038) and Andrew I (1046–1061); French of Philip Augustus (1180–1223); denarii of Władysław Herman (1079–1102); coins of Władysław II (1138–1146); coins of Bolesław the Curly (1146–1173); 26 cross coins including basic-cross type and pearl-cross type; 19 cross coins of bishop's staff type (Niedźwiadek 2017, 316–337).

A network of settlements grew and developed along the long-distance route, and now they are systematically recognized thanks to archaeological research. An archaeological site within the contemporary borders of Lublin-Świdniczka, next to which a village was founded, may be one of the most interesting examples (Niedźwiadek 2017, 265–276). During the field works accompanying the construction of the northern ring road of Lublin, a vast settlement was investigated, with clear dating to 12–13th century (Piasecka, Piasecki 2012).

The necessity of establishing a stronghold on Grodzisko Hill could also result from a military threat. The 13th century, and especially its second half, was the time of unprecedented series of Yotvingian, Lithuanian, Mongolian, Ruthenian and Tatar invasions, which usually came from the east or north-east (Fig. 1–2) (Chachaj 2019, 123–155). In the context of these events, S. Hoczyk-Siwkowa sees the need to establish an advanced post, which she calls a "barrier stronghold" and which would protect the central stronghold on the Zamkowe Hill. For the researcher, the presence of 3 centers – on Staromiejskie Hill, Zamkowe Hill and Kirkut Hill – reflects the layout of the main cities of Lesser Poland – Kraków and Sandomierz (Hoczyk 2012, 204).

Postulating further excavation research seems to be obvious, and in the case of the site in question the need is more than well founded. The research carried out more than half a century ago was extremely important and ground-breaking (Fig. 15). However, access to the results is still limited, so it is difficult to verify the findings. At present, it is not possible to

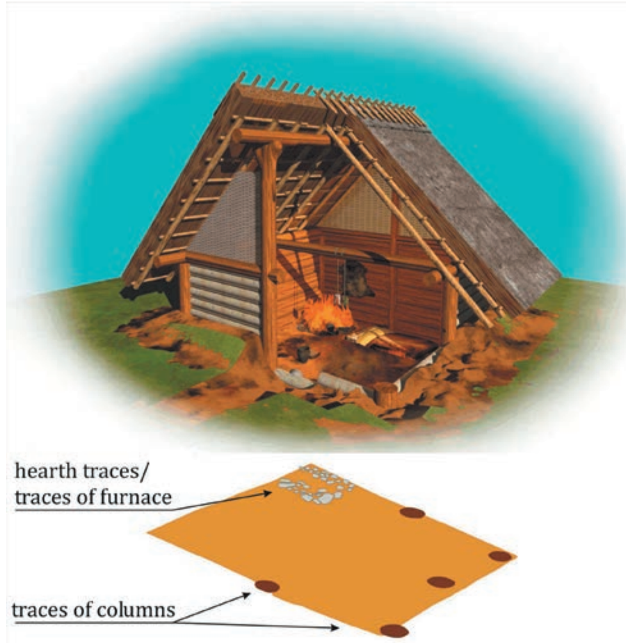

Fig. 15. Lublin – Grodzisko Hill. Reconstruction of a Slavic residential pithouse from Grodzisko Hill – hut No. 29, discovered in 1968 (after D. Bednarski 2017, R. Niedźwiadek 2019).

excavate the inner part of the stronghold, and the excavations carried out and the accompanying archaeological surveys are limited only to cleaning works (Tkaczyk 2014a). With the hope of discovering new facts, renovation of the fence wall on the Floriańska street side was done under archaeological supervision. Despite the limited range of the excavations and the damage found afterwards, it was possible to capture the eastern base of the hill escarpment, with the original soil profile preserved. This is how we obtained some data that helped in the reconstruction of the primary morphology (Tkaczyk 2014b). The findings may pave the way for starting excavations, because no Jewish burials are registered in this part of the hill. The steep escarpments seem to be enough to conclude that the dead were not buried there. Perhaps, in this part of the site, the base of the rampart could be exposed to take samples for absolute dating so that new important information about the chronology of the settlement could be obtained.

Without new field research, re-analysis of available materials is all that can be done. Modern techniques allow more precise compilation of plans and field profiles. In order to write this article, an attempt was made to synchronize the plans and profiles of the excavations from 1968. Thanks to this procedure, the location of ramparts could be more reliably estimated. In our opinion, the proposed location is closer both to the historical reality and to the results of the excavation research of S. Hoczyk-Siwkowa and M. Chyżewska (see Fig. 5, 7, 10).

The article is an edited version of a publication by Rafał Niedźwiadek titled "Lublin Wzgórze Grodzisko – Kirkut. Stan rozpoznania stanowiska" ("Lublin Grodzisko – Kirkut Hill. The progress of investigation on the site"). It was published, in Polish, in the popular science series called "Skarby z Przeszłości" ("Treasures from the Past"), vol. XX, Ewa Banasiewicz-Szykuła (ed.), under the title of "Grody Lubelszczyzny od XI do XIV wieku" ("Strongholds of the Lublin region from the 11th to the 14th century"), Lublin 2019, 233–257.

Translated by Maciej Pondel

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Archaeology in a scrapyard, or how a monument ceases to be a monument

Abstract

Florek M., Kokowski A. Archaeology in a scrapyard, or how a monument ceases to be a monument. *Analecta Archaeologica Ressoviensia* 15, 187–193

Amateur searches for archaeological artefacts, most frequently with the use of metal detectors, are generally aimed at building up private collections. They have also become a source of income in the illegal trade in artefacts. Collecting ancient artefacts as recyclable metal is a new phenomenon. At the scrapyard in Milczany, Sandomierz district, several kilograms of such scrap were found, among which two fibulae from the Roman period, Almgren 67 and 43, were recognised. They are valuable in the research into the history of the Przeworsk Culture. The authors also note the widespread practice of collecting striped flint, used by modern jewellers, which has resulted in the devastation of several sites which were relics of ancient mines of this material. The authors consider the scientific value of the recovered artefacts, which often cannot be localised precisely. They call for the unceasing promotion of the value of archaeological artefacts and indicate its effectiveness in the Hrubieszów Basin.

Keywords: Protection of archaeological cultural heritage, metal detectors, ancient materials, modern materials, Roman period, fibulae

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The problem of the devastation of archaeological sites caused by prospectors using metal detectors was recognised by archaeologists and conservators in the 1990s (e.g. Brzeziński and Kobyliński 1999). Obviously, the debate it ignited focused on the protection of archaeological heritage and finding a way to reduce the plague of illegal prospecting. Although the problem mainly concerns prospectors with electronic equipment, it also pertains to searches conducted by other methods, whereby "amateur archaeologists" regularly collect archaeological artefacts from the surface of sites known from the literature, creating considerable, often specialised collections. An example of the latter are regular surface searches of Neolithic settlements near Mozgawa (Pińczów district), conducted by one such amateur. Over the course of several years he had collected an ample collection of flint and stone objects, and items made of other materials, mainly those of the Funnelbeaker Culture (cf. Florek and Wiśniewski 2008).

Nevertheless, two approaches to this problem have developed. The first one opts for a radical ban enforced by law, with severe punishments imposed on artefact seekers. The second one, becoming more common, based on Scandinavian, English (e.g. Bland 2017) and German models (e.g. von Carnap-Bornheim *et al.* 2017) attempts to foster collaboration with prospectors by imposing rules and regulations on the explorations they conduct (Trzciński 2017). The debate on this subject has long moved beyond archaeological circles and been held by the media, for example in an interview with Katarzyna Zalasińska, who specialises in the law of the protection of monuments in the article "*Nie ryj jak świnka*" ("Don't snarl like a pig") by Agnieszka Krzemińska, published in "*Polityka*" (no. 11 (3202), 13.02–19.03.2019). The text discusses the rules of the legal use of metal detectors in amateur searches, and the consequences for violating the applicable laws of the act on the protection and guardianship of monuments. However, it should be emphasised that, according to the act (The Act of 23 July 2003 on the protection and care of monuments (consolidated text, Journal of Laws of 2020: 282), more specifically Art. 36, exploration permits are only required for the use of electronic devices and diving gear, whereas explorations conducted by other methods, including searches for archaeological artefacts, do not require them (Florek 2019). This is either, putting it mildly, a legislative defect, or intentional disregard, possibly resulting from an unawareness of the threats to archaeological heritage other than those connected with the use of metal detectors.

In fact, it is all about preventing the total destruction of archaeological sites. The most infamous examples in the Lublin region are sites of votive practices of the Germanic Bastarnae peoples from the later pre-Roman period, discovered in the town of Pikule in the Janów Lubelski district (Kokowski and Łuczkiewicz 2002), the robbing of sites forming an early medieval Czermno-Czerwień settlement complex, and the late Roman cemetery from Ulów – both in the Tomaszów Lubelski district. These examples stir conflicting emotions among archaeologists (Kokowski 2004a). The first and last of the above-mentioned sites, located in woody areas, were discovered by prospectors (who most often describe themselves as "explorers"), and if it had not been for their activity, we would not be aware of the existence of the sites now. We can even speak of mitigating factors here, as the prospectors were not seeking archaeological artefacts but militaria from the Second World War. The second site has been known and examined for decades (Florek and Wołoszyn 2016), thus the illegal explorers must have been aware of the fact that they were committing an offence.

Archaeologists' attitudes towards discoveries made in such a way are also interesting and in this instance we can also speak of extremes. While some think that artefacts obtained illegally should be ignored by archaeologists from the ethical point of view, others constituting the majority claim that, even though the artefacts are deprecated, they contribute to the scientific assessment of cultural transformations in antiquity (Barford 1999, 135–136; Bursche 2000). We will return to this issue later.

This text, however, is a reaction to the way in which we came into possession of the artefacts described below. To date, it has been claimed that prospectors are driven by a desire to expand private collections, or by the pure satisfaction derived from discovering interesting objects. In the latter case, they do not necessarily want to keep artefacts; what counts to them is the race with archaeologists, and proving that they are more effective. It is well-known that artefacts are sold to other collections, and, depending on the attractiveness of the discovery, even to foreign ones (see the case of the cemetery of the Przeworsk Culture from the town of Radawa, Jarosław district (Kokowski 2000a; Kokowski 2000b; Gładysz-Juścińska and Juściński 2003). Only some artefacts are given directly to museums. However, it transpires that some prospectors are not interested in the historical value of the discovered objects but are motivated by the material they are made of. Clearly, this results from a lack of knowledge on the objects, which are simply treated as colourful scrap and used for earning money.

The owner of a scrapyard from the town of Milczany (Sandomierz district) reported some objects to *Urząd Ochrony Zabytków* (Heritage Protection Office) in Sandomierz. He noticed small objects made of copper alloys, which even at a casual glance could not have bean ordinary modern waste. They were covered with a layer of "old" patina, and the seller had taken it off in places, using a grinder, in order to assess the material.

Among several kilograms of such scrap, at least two archaeological artefacts of significant cognitive value were distinguished:

1. A large fragment of a strongly profiled fibula with a massive head, trough-shaped cover of a spring, length – 50 mm, height – 21 mm (Fig. 1a; Fig. 2b); most probably Almgren 67. 2. Almost complete fibula (broken off catch-plate, missing spring) with a bow in the shape of the letter "X", with a massive comb on its prominence with a groove, length – 35 mm, width – 30 mm (fig. 1b, fig. 2a); Almgren 43;

Both specimens bear traces of grinder "exploration" of the material they were made of.

The place of discovery is obviously unknown, but it should be assumed that it is in the vicinity of the town of Milczany, as other scrapyards are within a 10–12 km radius.

However, a much earlier example of an archaeological discovery at a scrapyard escaped public attention, possibly because it was treated as a one-off exception to the rules governing the circulation of artefacts found with a metal detector. In 1997, Stanisław

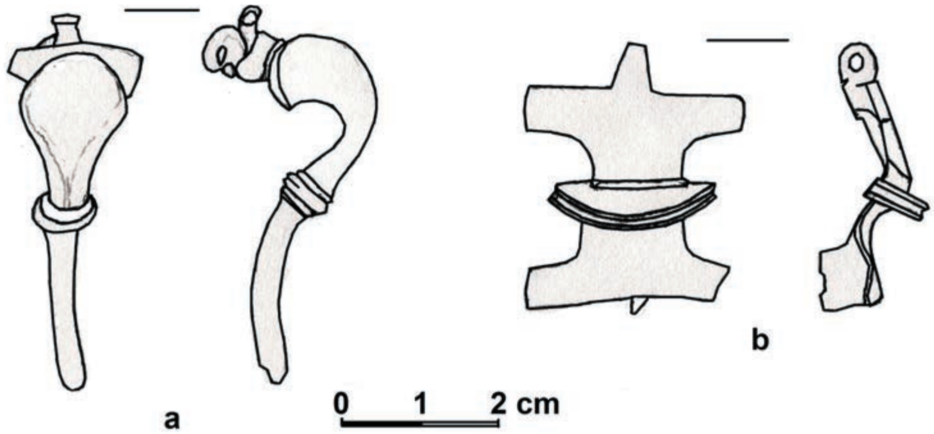

Fig. 1. Fibulae from the scrapyard in Milczany. Drawn by A. Kokowski.

Kwiatkowski, a visual artist and art conservator from Opatów, "fished out" a striking armband with spiral discs of the Błogocice type in a scrapyard in Jasice (Opatów district). The object (dated to phase BrB1–HaA1 – Florek 1998, 20, 21 plate IIIa) was later given to the Regional Museum in Sandomierz (Fig. 3). This should have been a warning sign, indicating a new practice of handling artefacts but sadly this danger was not noted.

The assessment of the artefacts is as follows.

The fibulae of Almgren type 67 in the area of *Barbaricum* are regarded as provincial Roman imports and are among the most important determinants of the earliest phase of the Roman period in Polish lands. A detailed classification of this type was compiled by Stefan Demetz (1998), based on which we can claim that in our case we are dealing with an earlier variant of such fibulae, described as type A.67.a (Demetz 1998, 140–141). The dissemination of such fibulae in the area of barbaric Europe (that is, beyond the border of the Roman Empire), in this case in the Polish lands, might be connected with the activity on the Amber Road, and their concentration in the *Illiricum* province, which is regarded as its starting point, clearly supports this thesis (Kokowski 2009, 332).

Fibulae of the Almgren type 43 are regarded as the most characteristic articles of the broadly-understood Przeworsk Culture. They appeared during the period of the Marcomannic Wars in 166–180 AD. In archaeology, their occurrence is associated with the middle Roman period (phases B2/C1-C1a), yet they were most common in phase B2/C1. Fibulae of type A.41 are of great significance to the determination of migration of the Przeworsk Culture. The participation of its representatives as "*superiores barbari*", understood as Vandal tribes, in military activities are

Fig. 2. Traces of the "exploration" of the material on the fibulae from the scrapyard in Milczany. Photograph by A. Kokowski.

Fig. 3. Bracelet from the scrapyard in Jasice, Wojciechowice commune. Photograph: Archive of the WUOZ (Provincial Monuments Protection Office) regional office in Sandomierz.

confirmed by written sources (Godłowski 1982, 48–50). The places of the concentration of these fibulae outside the area of the Przeworsk culture document new territories this population reached, not only as they wanted to take part in a conflict (Kokowski and Maleev 1999), but also as they fled under the pressure of Gothic tribes recognised as the Wielbark Culture (Kokowski 2006, 249–260). The latest summary of the importance of A.41 fibulae to the examination of these historical processes has been prepared by Slovakian archaeologist Jan Rajtár (Rajtár 2018), and the discovery from the vicinity of Milczany supplements the catalogue he compiled of 90 specimens from 60 sites and a map drawn based on it.

Another question addresses the significance of such finds to scientific debate. It should be clearly emphasised that artefacts found with a metal detector are commonly described in publications. The more civilised form of obtaining them, that is with the full documentation of the place of discovery according to conservation guidelines, makes it possible to draw responsible, interesting and often revolutionary conclusions, a classic example of which is the monograph by Jan Schuster for the area of Schleswig-Holstein (Schuster 2016; Schuster 2017). The above-mentioned monograph by Jan Rajtár (2018) was also written based on new finds discovered with a metal detector.

The further east we go, the slimmer the chance of gaining precise information on the location of such finds. This is best documented by the Russian magazine edited by Ilia A. Bažan "*KSAN – Korpus slučajnych archeologičeskich nachodok*" (KSAN – Corpus of accidental archaeological finds; for example, the first booklet is entitled *expressis verbis* "*Archeologičeskie predmety iz slučajnych nachodok na territorii Vostočnoj Evropy*" 2009–2011 – Archaeological objects from accidental finds in the area of Eastern Europe), edited mainly on the basis of the exploration of internet forums which attract prospectors. However, even the least precise information on the location of artefacts (marked only with an administrative area, such as the commune, district, etc.) can contribute to tackling interesting problems. A perfect example of this is a monograph by Jacek Andrzejowski (2017) on openwork ring pendants from the Roman period, known from the sites of the Wielbark Culture and the Przeworsk Culture. In the east (meaning to the east of the Bug river), they occurred beyond the scope of the settlement of the above-mentioned cultures, far beyond the Dnieper, which was determined based on of such imprecise data. There are numerous similar examples, but focusing only on the categories of fibulae, one should mention the text by Barbara Niezabitowska-Wiśniewska (2017) on the scope of occurrence of fibulae corresponding morphologically to the Prussian series of group III by Oscar Almgren, which she distinguished as the Husynne type. Without the information on finds of uncertain location, made by amateurs prospecting with metal detectors, conclusions based only on finds from professional archaeological research could be erroneous.

The new threats to archaeological sites call for the intervention of conservators. Clearly, it would be easiest to inform owners of scrapyards about the possibility of prospectors offering them archaeological artefacts as recyclable waste, or for conservators and museum service representatives to monitor such places. However, without making society aware of the importance of archaeological finds to European cultural heritage, for example through local media, the effectiveness of such administrative activities would be minimal, and any positive result merely coincidental. The vigilance of the owner of a scrapyard in Milczany increased thanks to articles promoting archaeology which had been published, among other places, in the local press. Owing to this, his action was not an isolated instance in the Świętokrzyskie province. It can be said that where the policy of promoting has been employed for several years, the frequency of reporting accidental discoveries, even those which are spectacular from the commercial point of view, has increased. A key example is the area of the Hrubieszów Basin, where awareness of the significance of archaeology to the image of the region has been built for decades (for example, Kokowski 2004; Gurba 2003). One of the numerous effects of this policy was the accidental discovery of a striking necklace made of massive silver from the Migration period, found in Podhorce, Hrubieszów district, which is now part of the collection of the Reverend Stanisław Staszic Museum in Hrubieszów (Bartecki 2018).

Our text does not exhaust the subject of defining the scope of the practice of treating archaeological artefacts as recyclable waste. At the same time, another practice is thriving, which follows the fashion of wearing jewellery made of striped flint. Obtaining this material from prehistoric flint mines, mainly in Wojciechówka (Opatów district), Ruda Kościelna-Borownia and Krzemionki (Ostrowiec Świętokrzyski district), not only from the surface but also by digging into mine slag heaps and the relics of flint workshops, has contributed to the irretrievable devastation and destruction of almost 50% of the surface of the mining field in Wojciechówka (Florek 2014; Florek 2015; Jedynak 2015). The scope of collecting this material in the form of production waste, semi-finished products from mining fields and mine workshops (fig. 4–6) for "souvenir collectors" and jewellers, including ready ancient objects, can be assessed not only by visiting antique fairs and mineral fairs, where artefacts appear in large numbers and with collectors going unpunished. This is also attested to by the fact that this activity has been the main source of income of a large group of inhabitants of a village neighbouring ancient mines of striped flint for quite some time.

The use of recovered archaeological artefacts as raw material for further processing is not an entirely new phenomenon, but so far it certainly has been overlooked as a significant risk threatening archaeological heritage. Moreover, the mitigation of this issue is not well supported by the existing legislation.

Fig. 4. Semi-finished products, production waste and lumps of material from "Korycizna" striped flint mine in Wojciechówka waiting to be sold to souvenir manufacturers by one of the inhabitants of the village. Photograph: Archive of the WUOZ regional office in Sandomierz.

Fig. 5. Mining field of "Korycizna" mine in Wojciechówka dug out by the prospectors looking for striped flint. Photograph: Archive of the WUOZ regional office in Sandomierz.

Fig. 6. A sack and a bag with flint material from the mining field of "Korycizna" mine in Wojciechówka abandoned by prospectors. Photograph: Archive of the WUOZ regional office in Sandomierz.

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