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MAN, FLINT AND ROCK'N'ROLL

Somewhere on the archaeological trail… (Jerzy Libera's archive)

As incredible as it may sound, our friend and eminent scholar, Assoc. Prof. Jerzy Libera, teacher of many archaeology graduates, is reaching retirement age. On this occasion, we would like to present a collection of articles dedicated to his greatest passion, which has always been, and still is, prehistoric flint-knapping technology. This interest started during his writing of his master's seminar under the supervision of Prof. Stefan K. Kozłowski, when Jerzy explored the secrets of the flint tool production of the Funnel Beaker culture (master's thesis in 1980, published in 1985). He followed it with his research of the remains of the Palaeolithic and Mesolithic settlements across east-central Poland (doctoral dissertation in 1992; published in 1995 and 1998), and next – in 2001 – in a monumental monograph dedicated to bifacial flint products, which was the basis for his post-doctoral proceedings. With time, Jerzy Libera broadened the chronological range of his research to include much later periods of the human history, also the Modern period. He paid particular interest to the question of the use, processing and distribution of different flint materials, especially Volhynian flint, Turonian flints from the Rachów anticline and Rejowiec flint from the Chełm Hills. The results of this research became an important reference point for many subsequent studies of the raw material economy of prehistoric societies. He especially contributed to the research of the so-called final flint-knapping techniques linked with the societies of the Late Bronze and Early Iron Ages.

The scholarly interests of Jerzy Libera were strictly linked with his numerous field investigations. We will mention here the most important: work conducted on Final Palaeolithic and Mesolithic camps in Potoczek and Baraki Stare; Upper and Final Palaeolithic flint workshops in Pawłów and Kopiec near Świeciechów; Neolithic cemeteries in Malice Kościelne and Ostrów; Early Bronze Age burial mounds in Stryjów and Jawczyce. Jerzy published the results of his research (alone or as a co-author) in over 250 scholarly publications, in numerous prominent archaeological journals and multi-author monographs, in Poland and abroad. He is also the author of three books which have entered the canon of works dedicated to flint-knapping techniques in the Stone and Early Bronze Ages.

Almost from the beginning of his professional career, Jerzy Libera has been associated with the Maria Curie-Skłodowska University in Lublin. In March 1984, he was employed in what was at that time the Department (later Institute) of Archaeology, where he worked for the following 38 years, achieving academic degrees and occupying new posts: starting with the title of Teaching Assistant, then Assistant Professor and Associate Professor. Other academic posts held by him include that of the vice-director of the Institute of Archaeology (2003-2010), director of the Stone Age Department (2003-2017) and administrator of the Bronze Age Institute (2006-2008). He has also occupied numerous positions in the collegial bodies of the University and Institute. As an academic educator, he has taught many archaeologists and museologists currently professionally active. Because Jerzy supervised several dozen master's and bachelor's theses, as well as two PhD dissertations, we can say that some of his students caught the bug of his greatest passion. Although he used to be severe and highly critical as an educator and supervisor, he was always open for cooperation and eager to help, often outside of his working days and hours.

Jerzy also actively worked for the organisation of education in various central institutions. He was a member of the Evaluation Team of the Academic Accreditation Committee, expert of the Polish Accreditation Committee, expert of the Minister of Culture, member of a team of experts in history, archaeology and ethnology of the Ministry of Science and Higher Education and a member of such bodies as the Committee for the Final Neolithic and Early Bronze Age, the Committee for Prehistoric and Protohistoric Sciences of the Polish Academy of Sciences, the Team of Experts of the National Science Centre and the Control Team of the National Institute of Cultural Heritage.

Jerzy's scholarly activity and his interest in flint-knapping techniques were nearly always and everywhere accompanied by his other passion – rock music. This has always been the source of his inspiration and virtually boundless energy expended on work for the Institute and University. Despite the fact that Jerzy is approaching his retirement age, we are sure that he will remain active as a scholar and author of new publications. Jerzy will surely not put his guitar on the stand. He will not leave the stage in felt slippers! This is our ardent wish for him and for ourselves!

Marcin Szeliga, Anna Zakościelna, Piotr Włodarczak

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ARTICLES

Radosław Dobrowolski[1], Sławomir Terpiłowski[2], Marcin Szeliga[3], Tadeusz Wiśniewski[4]

FLINTS OF THE CHEŁM HILLS (REJOWIEC FLINTS) – ORIGIN, SEDIMENTATION ENVIRONMENT AND EXPLOITATION IN PREHISTORY – A CASE STUDY FROM THE LECHÓWKA SITE

ABSTRACT

Dobrowolski R., Terpiłowski S., Szeliga M. and Wiśniewski T. 2022. Flints of the Chełm Hills (Rejowiec flints) – origin, sedimentation environment and exploitation in prehistory – a case study from the Lechówka site. *Sprawozdania Archeologiczne* 74/1, 11-29.

Rejowiec flint from the Chełm Hills occur among glacigenic sediments of the Odranian glaciation and is referred to as erratic flints. The authors, based on the analysis of the sedimentary succession of a kame in Lechówka – within the boundaries of the largest outcrop, in so-called 'Region I' (Rejowiec region) – indicate that: (1) the probable source of the flints were older series of glacigenic sediments – from before the Odranian glaciation, (2) their great accumulation directly under the surface and – as a result – their considerable accessibility for exploitation in prehistory were caused by the 'upfreezing of stones' in the conditions of a periglacial environment during successive glacial periods (Odranian, Wartanian and Vistulian glaciations). The analysis of archaeological data confirmed the use of the local flints as early as in the Middle Palaeolithic and their most intense exploitation during two main periods – the final stage of the Palaeolithic and a period from the Late Neolithic to the Early Iron Age.

Keywords: erratic flints, Rejowiec flint, glacigenic deposits, Chełm Hills, prehistoric use
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INTRODUCTION

The presence of flints accompanying glacigenic sediments within the range of the Chełm Hills has been known in the archaeological literature for nearly one hundred years (Krukowski 1939-1948), although the beginning of the considerable interest in this topic goes back to as late as the 1980s (*cf*. Libera *et al*. 2014, earlier literature there). This was the first time when, based on flint samples collected in the vicinities of Rejowiec, the local raw material was referred to as Rejowiec flint, and its macroscopic diversity became the base for the first classification (Rejniewicz 1985, 13). Somewhat later, the term Rejowiec-Sobibór flint was coined. This term conveys the much greater extent of the surface distribution of the raw material across the Chełm Hills, not limited to the vicinities of Rejowiec (Kozłowski 1989, 31). In the 1980s and 1990s, there was a dramatic increase in archaeological finds, especially flint artefacts, as a result of conducting intense surface survey within the framework of the Polish Archaeological Record (Polish: AZP). This had a considerable influence on gradually improving our knowledge of the range and character of processing local flints and the scale of using them in prehistory, which was later reflected by papers discussing archaeological materials, microregional studies (*e.g*., Bargieł and Libera 1989; Bronicki 1990; 1993; Gołub 1990) and synthetic publications (*cf*. Kozłowski 1989; Libera 1995; 1998; 2001; Taras 1995; Zakościelna 1996).

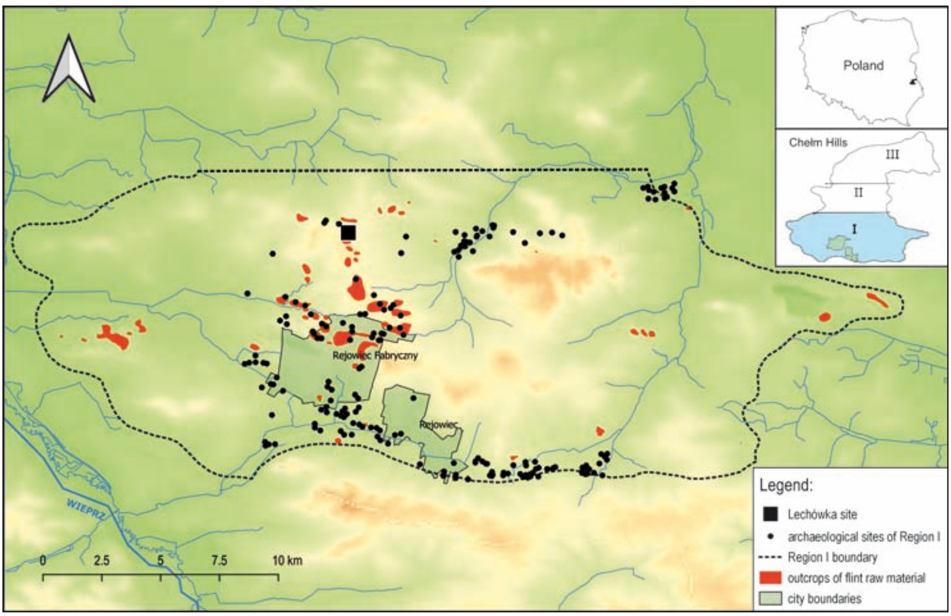

Fig. 1. Location of the analysed area and Lechówka site, as well as known archaeological sites (according to Libera and Szeliga 2006; Libera *et al*. 2014; 2016, modified by T. Wiśniewski)

The essential field and desk research of flints from the Chełm Hills – under the supervision of J. Libera – was initiated within the framework of a project entitled "Studies in the Occurrence of Flint Rock and its Mining, Processing and Distribution in the Territory of the Lublin Region" in 2002. The research – conducted at intervals until 2014 – mainly focused on determining the distribution ranges of local raw materials, cataloguing and presenting the chronological-cultural classification of archaeological sites associated with the exploitation and processing of such materials as well as on determining the provenance of the flints and attempting to classify them (Rejniewicz 1985; Libera and Szeliga 2006). The latter question recently became the subject of interdisciplinary research, where the main interest shifted to sedimentology and geomorphology (Libera *et al.* 2014; 2016). In the present article – which is a continuation of this approach – we are attempting to answer the following, still relevant, questions based on a detailed sedimentological analysis of glacigenic sediments from the site of Lechówka in the Chełm Hills. The first concerns the original source of the flints, which currently occur directly below the topographic surface, in the glacigenic sediments, the second issue is the mechanism of the deposition of the flint material. The third concerns what factors might have caused its widespread accessibility, and a fourth issue concerns the scale and degree of using the local flints in prehistory in the light of the present state of archaeological knowledge.

ARCHAEOLOGICAL BACKGROUND

The surface survey conducted within the limits of the Chełm Hills was carried out in the years 2002-2014, and resulted in documenting over 120 zones of flint surface occurrences – having the areas from several to several dozen hectares – as well as in discovering and verifying the total number of over 2800 archaeological sites representing various periods (from the Palaeolithic to the Middle Ages) and cultural attribution (Libera *et al.* 2014; 2016). Observations of the outcrops made it possible to classify flint concretions deposited within their ranges into two essential types having distinct shapes, sizes and being of different preservation states (*e.g.*, presence or absence of cortex), macroscopic features, and – which is especially important – their technological qualities (Libera and Szeliga 2006, 162, 163; Libera *et al.* 2014, 61). The great majority of the discovered artefacts were products made of the local flints, which indicated the intense and diverse character of activities performed by prehistoric communities within the limits of the outcrops and in their nearest vicinities. The presence of diagnostic artefacts made it possible to distinguish two essential phases of the exploitation of Rejowiec flint, which generally correspond to the Late Palaeolithic and a period from the Late Neolithic to the Early Iron Age (Libera and Szeliga 2006; Libera *et al.* 2014, 65-67). Certain discovered artefacts also attest to the presence of human groups as early as in the Middle and Upper Palaeolithic as well as in the Mesolithic, Early and Middle Neolithic and in the Iron Age (Libera 2006a; 2006b; Libera and Szeliga 2006; Libera *et al.* 2014, 62; 2016, 159-165). Based on the layouts of the discovered sites, three main concentration zones were distinguished. They overlapped with the areas of intense surface occurrences of flints (Libera and Szeliga 2006, fig. 1). Especially numerous sites were recorded in areas included in so-called 'Region I' (Libera *et al.* 2014, fig. 3) located within the south-western part of the Chełm Hills, surrounding Rejowiec and Rejowiec Fabryczny (Fig. 1). This territory – where the largest, best preserved concretions of the best quality occurred – is the main focus of this paper. It appears to have a vital importance for understanding the process and conditions of the sedimentation of the local flint deposits, as well as for answering all questions concerning their exploitation and processing in prehistory.

AREA OF THE STUDY – GEOLOGICAL AND GEOMORPHOLOGICAL BACKGROUND

The Chełm Hills are a unique physical-geographical mesoregion in comparison with other territories of the European Plain (Fig. 1), characterised by the prominent transitory character of its landform. Elements typical of Polesie (vast basins with peat in their floors) co-occur with upland landforms – isolated remnant hills of variable heights (elevated from 10 to 80 m above the floor) and geological structure (Upper Cretaceous opokas often covered with sediments from the Neogene and/or glacial Pleistocene). Due to the fact that this is a territory where morphological features typical of the Polish Uplands co-occur with those of the Eastern Baltic-Belarusian Lowland, the discussed region is attributed either to the Lublin Upland or to Polesie (Chałubińska and Wilgat 1954, 11, 12; Kondracki 2002, 293, 294; Solon *et al.* 2018, 170; Dobrowolski and Chabudziński 2021, 585-590).

The present relief is the result of complex morphogenetic processes that shaped this territory from the Paleogene to the Holocene (Harasimiuk 1975). Still, the main morphological elements clearly refer to the lithology and structure of the bedrock. This relief determined the character of successive ice-sheet advances – including the last of them occurring in this territory and linked with the Odranian glaciation – and the areal character of its deglaciation (Jahn 1956, 315-321; Maruszczak 1972). It was the Odranian glaciation (the maximum stage of the Mid-Polish/Saalian glaciation according to traditional nomenclature) that notably influenced the morphogenesis of the discussed area. Its maximum stage and retreat stages – indicated by the occurrence of marginal accumulation forms – overlap with the main elements of pre-Pleistocene landforms (fossil Cretaceous hills and ridges) and are *de facto* the morphological boundaries of the Chełm Hills.

The predominant role in the geological composition of the Chełm Hills is played by the complex of carbonate rocks from the Mesozoic (mainly Cretaceous) and Cenozoic (especially glacial Pleistocene). The thickness of the Upper Cretaceous formations – making the main component of the Mesozoic complex – changes from *ca* 450 m in the north-eastern part of the discussed region to c. 600 m in its south-western region (Krassowska and Niemczycka 1984, 45-52; Buraczyński and Wojtanowicz 1988, 31). As to the lithology, the Upper Cretaceous series is mainly composed of carbonate (limestones, chalk), marly (marl) and carbonate-siliceous (opokas) facies that represent all of its stratigraphic units. The top part, having the greatest thickness (*ca* 160 m) and the most diverse lithology, is composed of Maastrichtian rocks. They are commonly exposed in the most elevated parts of the terrain. Only in certain places are they covered with Cenozoic sediments – mainly Pleistocene glacigenic formations formed during the maximum extent of the Odranian glaciation (also during the retreat stages): tills of terminal moraines, sands and muds of crevasse fillings, as well as the sands and gravels of kames. In less elevated areas, the compact and thicker series of glacigenic sediments constitute the filling of fossil deep basins and valleys, including the valley of the Wieprz River.

REJOWIEC FLINT – ORIGIN AND DISTRIBUTION

Rejowiec flint is a cryptocrystalline sedimentary rock mainly composed of silica, with accessory calcite and clay minerals. It is genetically linked with the Upper Cretaceous carbonate rocks; it is mainly present *in situ* in the lower lithostratigraphic units of this complex. Its presence has been commonly attested in drill cores, especially in limestones and chalks from the Turonian, Coniacian, Santonian and – to a lesser degree – Campanian phases. At the same time, it is virtually absent in the Maastrichtian sediments (Krassowska and Niemczycka 1984, 46). On the surface, Rejowiec flint is redeposited and occur in relatively large accumulations within genetically diverse glacigenic forms from the Odranian glaciation (Libera *et al.* 2016, 149-155). This is why it is unanimously referred to as erratic flints (Krukowski 1920). The colours of Rejowiec flint are diverse, from white, grey, light brown-grey, to yellow, dark brown or black. It occurs in two main forms: a) rounded, flattened nodules with thin cortex, both regular, close to lenticular or and irregular, branched or even "knotty" with numerous notches (Fig. 2: A-C), and b) small and very small sharp-edged clasts without cortex and often having aeolised surfaces (Fig. 2: D).

Erratic flints are widespread across Poland. Their occurrences correspond to the zones of maximum advances and retreat stages of ice sheets during successive glaciations (*e.g.,* Sobkowiak-Tabaka *et al.* 2016). The sources of flint materials in the environment of glacimarginal zones were: (1) glacial megablocks, rafts, or floes, various intrusions and diapirs – effect of glacitectonic disturbances that engaged the structures of the Cretaceous bedrock in the deformation process (Wyrwicka and Wyrwicki 1986; Dobrowolski and Terpiłowski 2006, 214-215; Aber and Ber 2007; Libera *et al.* 2016, 82) and/or (2) sediments carried from the ice bed (often accumulated during earlier glacial cycles) and next redeposited from the surface of the ice sheet (during the last glacial cycle occurring in

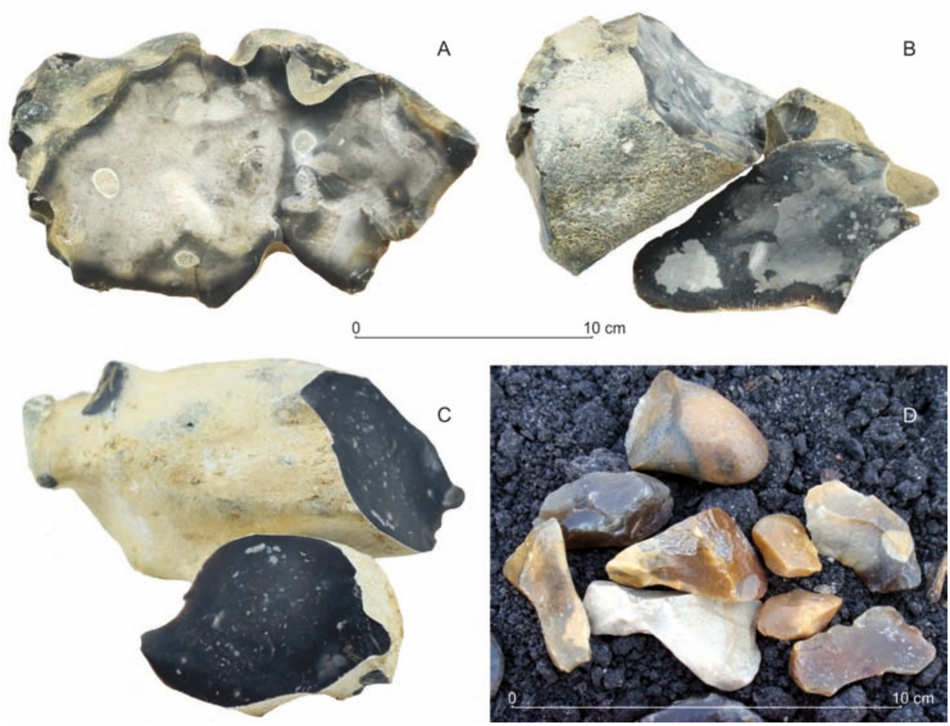

Fig. 2. Rejowiec flint nodules – examples from Lechówka (A-D), Chełm County (photo by T. Wiśniewski)

a particular area); they build glacimarginal forms – terminal moraines, dead-ice moraines or kames (Zieliński 1992; Terpiłowski 2008).

Although the sources of Scandinavian erratics deposited by ice sheets across the Polish territories are well documented (Górska-Zabielska 2008; Czubla 2015), the exact localisations of the original sources of erratic flints remain not fully known. The same applies to the occurrence of Rejowiec flint.

SEDIMENTARY AND POSTSEDIMENTARY ENVIRONMENT OF KAME DEPOSITS IN LECHÓWKA

Considering the above-mentioned key features characterising the geological structure and relief of the Chełm Hills, the site in Lechówka encompasses one of the most extensive flint deposits in so-called 'Region I' (Rejowiec region; Libera *et al.* 2016, 162, 170-171; Figs. 4-5). The extent of this deposit corresponds to a morphologically distinguished kame, which is a glacimarginal form from the Odranian glaciation (Harasimiuk *et al.* 2016). It is

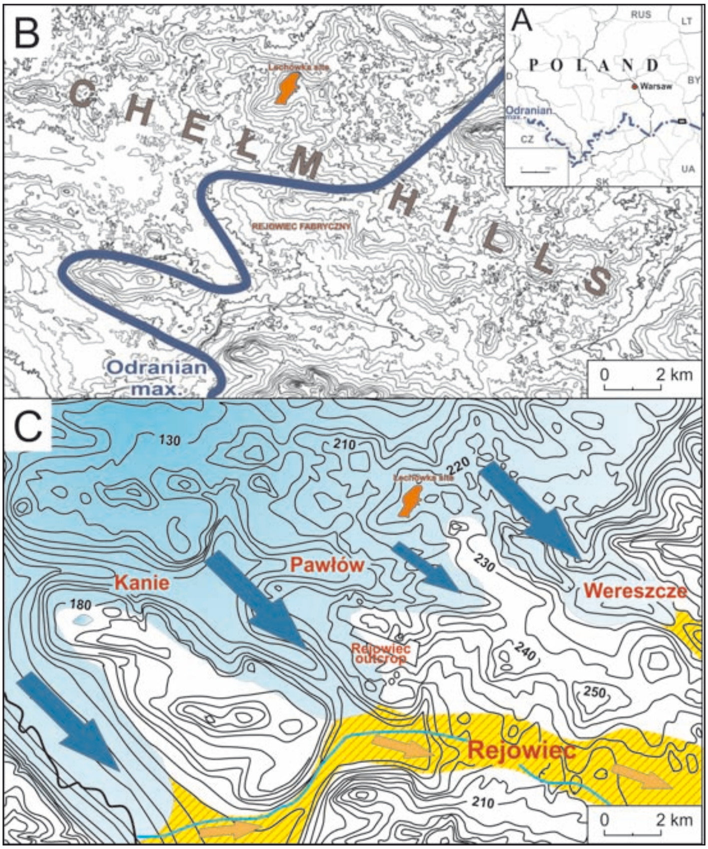

Fig. 3. Lechówka site against the background of the maximum extent of the Odranian ice sheet in Poland (A), the morphology of the western part of the Chełm Hills (B) and the reconstructed palaeomorphological situation of the western part of the Chełm Hills during the maximum advance of the Odranian ice sheet (after Dobrowolski and Terpiłowski 2006) (C)

a ridge, 500 m long and 20 m high, which has a submeridional orientation parallel to the lobe arrangement of the terminal forms of the Odranian ice sheet (Fig. 3; Harasimiuk *et al.* 2016; Marks *et al.* 2016). This form – composed of sands with gravels, sands and silts – covers an elevation of the Upper Cretaceous bedrock. The outcrops of the Upper Cretaceous (Maastrichtian) carbonate rocks are common in the vicinity of the kame. In places – mainly in land depressions (Pawłów basin, Wieprz River valley) they are covered with compact, thick layer of Pleistocene sediments. Their oldest units, predating the last (Odranian) glaciation occurring in this territory, are represented by tills, as well as by sands and gravels from the Sanian glaciation (Buraczyński and Wojtanowicz 1987, Harasimiuk *et al.* 2016; Albrycht 2020).

LITHOLOGY

The succession of the kame sediments in Lechówka (Fig. 4: A) is composed of three lithofacial units (Fig. 4: B-C): a – rhythmite of horizontally bedded sands and horizontally laminated silty sands (lithofacies Sh, SFh); b – rhythmite of massive gravelly sands and horizontally bedded sands (lithofacies SGm, Sh); c – rhythmite of massive sandy-gravelly diamictons and horizontally bedded sands (lithofacies SGDm, Sh).

Among the coarse-clastic fractions of the sediments (gravels), Scandinavian material is predominant. The presence of flints is accessory, usually as single nodules of a considerable size with thin, usually white cortex and various colours – from hues of grey to black (Fig. 2: A-C). In contrast, the unusual considerable accumulation of flints is somewhat common in the uppermost section of the sediment succession (up to the depth of 1 m). Fine and very fine clasts, sharp-edged, often vertically oriented and lacking cortex – referred to as concretions – are predominant (Fig. 2: D).

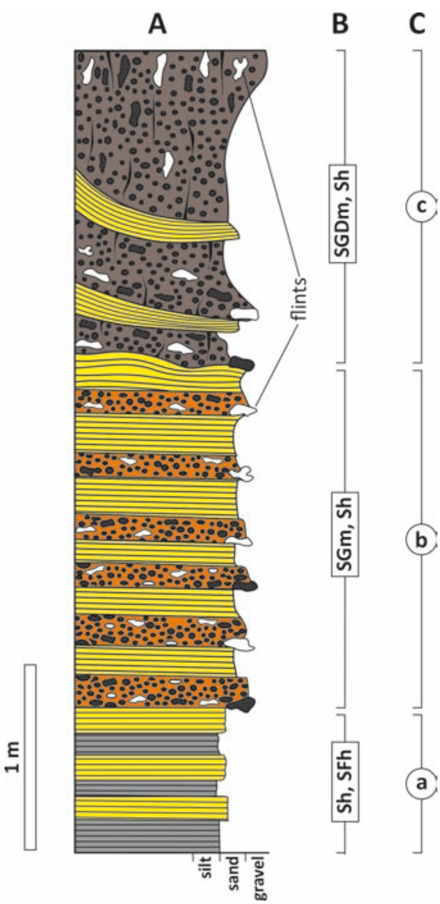

Fig. 4. Kame sediments in Lechówka: A – synthetic profile, B – lithofacies, C – lithofacial units. Remaining explanations in the text

INTERPRETATION

The geomorphological situation and lithology of the sediments from Lechówka indicate that they are linked with the processes of glacigenic deposition in the submarginal zone of the Odranian ice sheet as well as with the post-deposition periglacial processes (Fig. 5: A). At the same time, the original lithofacial features of the sediments suggest their fluvial deposition and deposition from mass flows in the form of an alluvial fan (Fig. 5: B). Originally, it was an environment of short-lived sheet flows – where sediments were deposited during shallow flows, periodically disrupted by the deposition of suspended solids in virtually stagnant waters (origin of lithofacies Sh, SFh, of unit a). Next, the dynamics of meltwaters increased. During the cycles of high water, sandy-gravelly materials were deposited. When the water level was low, they were substituted with sandy sediments (origin of lithofacies SGm, Sh of unit b). At the end, a visible reduction in the share of meltwaters occurred. Mineral materials covering the ice were redeposited mainly in the form of dense mass flows, and only in the final cycles they underwent fluvial redeposition (origin of lithofacies SGDm, Sh of unit c).

The upper, near-the-surface diamicton units (to a depth about 1 m) have the marks of post-sedimentation transformations. They can be attributed to periglacial conditions (forelands of ice sheets), which are characterized by frost and aeolian processes (Fig. 5: C). The considerable accumulation of the flints is probably an effect of the "upfreezing of stones" in the active layer of the permafrost (*cf.* Penner 1962, Xia 2006). Vertically-oriented flints are the indicators of this process. The great concentration of the flints might have also resulted from the disintegration of larger clasts caused by frost weathering. This would explain their small size and the shape of the concretions. Those with smooth surfaces have the features of ventifacts, which means that they were shaped by aeolian activity of wind – corrasion (*cf.* Antczak-Górka 2005).

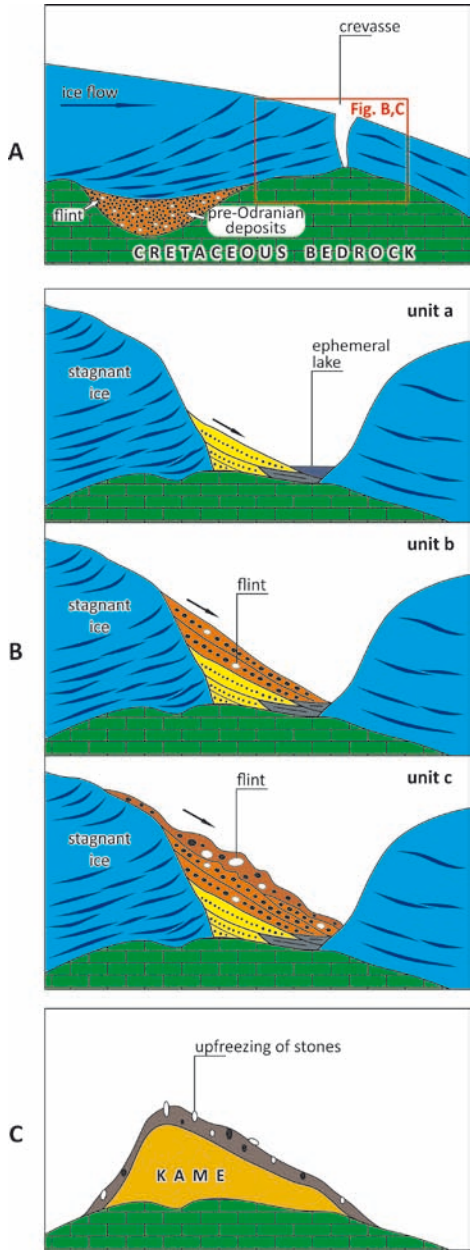

Fig. 5. Palaeoenvironmental model of the kame in Lechówka: A) forming of an ice crevasse, B) glacigenic phases of filling the crevasse with sediments, C) phase of post-glacial (periglacial) sediment transformations. Remaining explanations in the text

THE USE OF REJOWIEC FLINT IN PREHISTORY

So far, the surface survey of the analysed territory has led to discovering 35 areas of surface occurrence of flints and 211 archaeological sites localized within

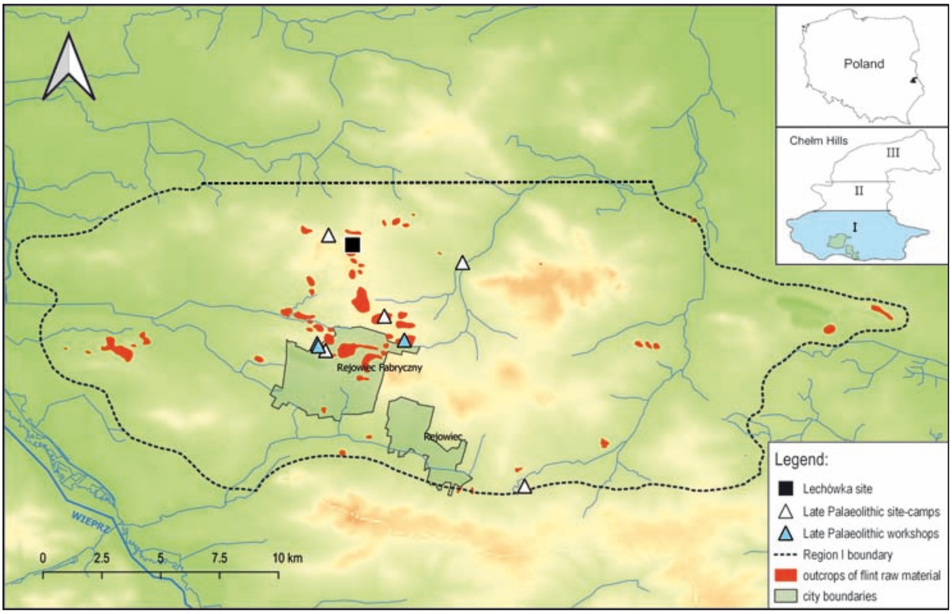

Fig. 6. Distribution of Late Palaeolithic sites within analysed 'Region I' (acc. to Libera and Szeliga 2006; Libera *et al*. 2014, modified by T. Wiśniewski)

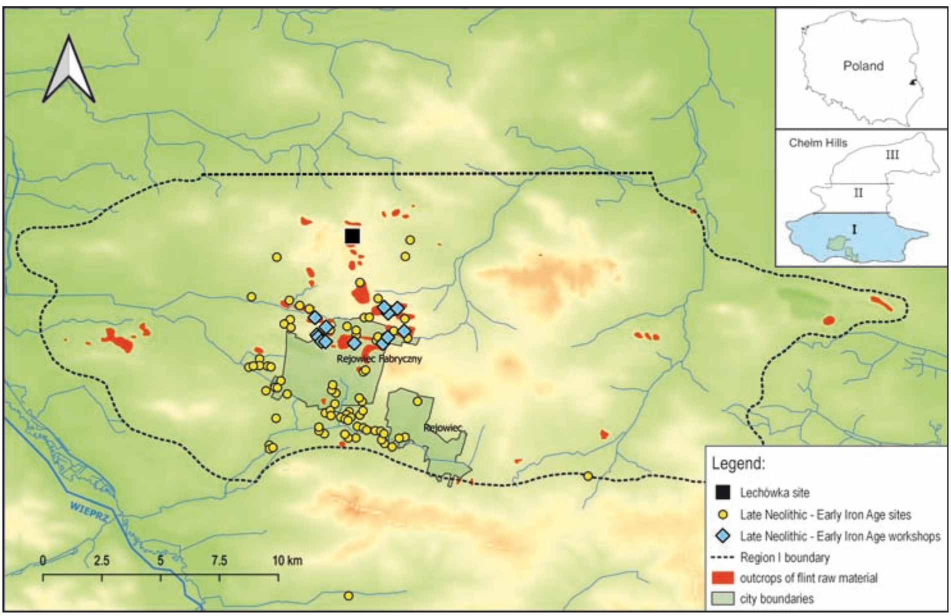

Fig. 7. Distribution of sites dated from the Late Neolithic to the Early Bronze Age within analysed 'Region I' (acc. to Libera *et al*. 2014; 2016, modified by T. Wiśniewski)

these zones or in their vicinities (Fig. 1). The majority of the sites yielded artefacts made only of the local flint, represented by diverse series of finds that encompass from one to several dozens or even more specimens. The morphological and metric analysis of the features of particular artefacts made it possible to suggest a chronological and cultural classification of 122 sites (*ca.* 53% of the total number). It was impossible to conclusively attribute the remaining 99 sites to particular archaeological cultures. They yielded only sparse and non-diagnostic artefacts.

The earliest chronological horizon is determined by single, strongly aeolised diagnostic forms dated to the Middle Palaeolithic and represented by tools (*e.g.,* side scrapers) as well as by Levallois cores – discovered in Hruszów and Lechówka – attributed to the Mousterian and Micoquian cultural traditions (Libera *et al.* 2014, fig. 4: 1, 2; 2016, fig. 8: 1-6). From a later time – probably Upper Palaeolithic – comes a small number of aeolised cores, flake/blade half-products and tools discovered in Niedziałowice, Chełm, Kamień and Strachosław. Unfortunately, the morphometric qualities of these materials make it impossible to conclusively attribute them to particular cultures, whereas the character and small number of the finds prevent us from determining the functional identification of given sites.

A somewhat larger – although definitely more numerous at particular sites – group of finds represent sites of the Final Palaeolithic. In total, at least eight sites have been discovered in the discussed area (Fig. 6). They mark the first horizon of the most intense use and exploitation of the local flint outcrops and are represented – besides loose finds – by the remains of at least three mine-type workshops and/or near-mine workshops having various areas reaching up to several dozen ares (Rejowiec Fabryczny, Aleksandria Krzywowolska, Pawłów) (Fig. 6). Blade cores discovered at these sites – including double striking platform cores – discarded at various exploitation stages as well as pre-cores and abundant flake/blade debitage suggest technological features typical of the Mazovian cycle (*cf.* Libera and Szeliga 2006). Scarce finds of diagnostic tools – especially tanged points, which include specimens made of imported raw materials (for example, *Chocolate flint*) – correspond to this observation (*cf.* Libera and Szeliga 2006, tabl. V: 7; IX: 5). A completely different cultural tradition (associated with the Final Palaeolithic) is represented by a small number of single platform cores from Hruszów – bearing marks of being exploited with the use of a hard hammerstone in order to obtain irregular blades – and several medium-sized backed blades found in Kobyle and Aleksandria Krzywowolska (Libera and Szeliga 2006, tabl. V: 8). The morphometric and typological features of the above-mentioned artefacts corroborate the assumption that they should be linked with the backed blade complex (Libera *et al.* 2014, 65; 2016, 162).

Another groups of finds are artefacts attributed to the Mesolithic and/or Early Neolithic represented mainly by blade cores, blades and a small number of microliths discovered at six sites concentrated mainly in the vicinities of Rejowiec Fabryczny (Libera *et al.* 2014, fig. 5: 4, 5). Unfortunately, the character of these finds makes it impossible to propose conclusive and detailed cultural and functional classifications of particular sites.

There is an analogous problem with sites generally attributed to the Neolithic which yielded only a few non-diagnostic artefacts (*e.g.*, cores and fragments of tetrahedral axes or chisels) only sporadically accompanied by non-characteristic pottery (Libera *et al.* 2016, 165).

The latest – and at the same time the most numerous – group of finds are remains of settlement activity generally dated from the Late Neolithic to the Early Iron Age (92 sites). An especially important group among them are the remains of 14 workshops associated with the production of small and very small dihedral axes (Libera *et al.* 2014, fig. 6: 1). They are concentrated in a relatively small area in the vicinities of Rejowiec Fabryczny (Fig. 7). The surfaces of these sites yielded large groups of artefacts – represented by axe half-products (from several to several dozen specimens) (Libera *et al.* 2016, fig. 11, 12; 13: 2, 3) and great amounts of production debris from different stages of tool production (*e.g.*, diagnostic plunging flakes). The production character of the products together with lack of pottery make it impossible to perform chronological and cultural classifications of particular workshops. Still, the morphometric features of the finds allow us to narrow down the most plausible period of their functioning to the Late Neolithic and/or an unspecified phase of the Bronze Age (*cf.* Bargieł and Libera 2002, 28; Libera 2003, fig. 3; Libera *et al.* 2014, 67; 2016, 165). Undoubtedly, sites that yielded flakes, para-blades and cores processed with a hard hammerstone, as well as characteristic tools – *e.g.*, backed knives, side-scrapers, denticulate and notch tools, perforators with tips retouched from both edges and a small number of bifacial forms – are linked with this period and with later times (Early Iron Age; Libera *et al.* 2016, 165, fig. 14: 7). The technological and typological features of a considerable part of the artefacts appear to find analogies in the canon of the final stage of flint knapping tradition, including the so-called Kosin industry of the Tarnobrzeg Lusatian culture (Libera 2004; 2005; Libera and Zakościelna 2019, tab. 1), although they are often similar to older assemblages attributed to the Late Neolithic and Early Bronze Age. This fact makes it impossible to perform a detailed chronological and cultural classification of the discussed group of finds/sites, including the selection of assemblages linked with the Lusatian culture from the Late Bronze Age and Early Iron Age. The same applies to the functional classifications of particular sites, although in this case it appears that relatively few sites are linked with workshops, whereas the majority are the remains of strictly settlement activity performed by the local communities of the Lusatian culture.

DISCUSSION

Model of erratic flints deposition in the Chełm Hills

The universal model of Pleistocene ice-sheet advances across the Polish territories supposes that they were mainly supplied by bedrock deposits as a result of cyclic regelation processes linked with the incorporation of materials into the ice bed (Brodzikowski and

Van Loon 1991). They were transported and successively deposited in a form of basal tills, which compose the essential part of modern moraine plateaus (Kasprzak 2003). In marginal zones, in compressive ice conditions (with sliding surfaces tilted upwards), mineral materials were transported from the subglacial to the supraglacial position. Here, the material released from the sliding surfaces underwent fluvial redeposition (often also in the form of mass flow) at the ice front or in crevasses. Diverse lithogenetic glacigenic forms were formed this way – *e.g.*, accumulation terminal moraines or kames, which are mainly composed of glacifluvial and diamicton deposits (Zieliński 1992; Terpiłowski 2008).

The sedimentary succession of the glacigenic series from the site in Lechówka corresponds to this deposition model. The kame in Lechówka was formed as a result of the redeposition of supraglacial mineral materials from the ice of the ice sheet. Based on the morphological and geological conditions and reconstructed sedimentary environments, we can state (Fig. 5: A-B):

1) The place of the sediment deposition was a crevasse. It was formed as a result of ice tension above an elevation of the Upper Cretaceous bedrock during the advance of the Odranian ice sheet (Fig. 5: A ; *cf*. Godlewska and Terpiłowski 2012).

2) The sediments were redeposited from tilted upwards sliding surfaces during the progressive areal decline of stagnant ice sheet. The compression of ice was caused by the ice-oriented slopes of an elevation of the Upper Cretaceous bedrock (Fig. 5: B; *cf*. Terpiłowski 2008).

3) The sediment deposition occurred in the form of a glacigenic fan from sheet flows and mass flows. Coarse-clastic sediment fractions – including, to a lesser degree, flint nodules – were deposited during the two final phases (Fig. 5: B, unit b and c): (a) in the cycles of sandy-gravelly deposition from sheet flows during increased ablation of ice, and next (b) in the cycles of diamicton mass flows during the general reduction of ice ablation.

In the light of the suggested model of glacigenic deposition, the flints from Lechówka are redeposited allochthonous rocks representing so-called erratic flints. This raises the question of where they had come from. Their origin cannot be linked with the thick series dated to the Upper Maastrichtian – admittedly widespread across the Chełm Hills but extremely poor in this raw material. It is also very unlikely that it was transported from remote regions – from the Baltic Basin – area of the alimentation of the Scandinavian ice sheets. *Wallstein* type flints – representing lower stratigraphic units of the Upper Cretaceous and considered as indicative of this region – have diagnostic features differing from those of Rejowiec flint (Czubla 2015). The features and frequency of raw material occurring in Lechówka are generally similar to those present in chronologically and genetically diverse glacial sediments from Poland – their proportion in coarse-clastic fraction >20 mm in tills, flow diamictons and glacifluvial sediments does not exceed several percent (Górska-Zabielska 2008, Czubla 2015). They are believed to be local rocks, transported at short distances and subjected to repeated redeposition during successive Pleistocene glaciations. Where in this case can we find the original source of the Rejowiec flint from the site in Lechówka? We suspect that in an extreme case the source of the flints might have been series of older glacigenic sediments (glacial or glacifluvial) from before the advance of the Odranian ice sheet, i.e. dated to the Sanian glaciation, that filled the Pawłów Basin or the Wieprz River valley near Trawniki and Łęczna or a bit further towards the north – the Bug river valley in the vicinity of Włodawa or Brest.

Archaeology of flint use vs. geological context

Despite clear evidence of early settlement in the discussed 'Region I' of the Rejowiec flint outcrops, as well as its long-lasting and multicultural character, data obtained so far allow us to distinguish two distinct horizons of their exploitation that generally correspond to the Final Palaeolithic and – generally – to a period encompassed between the Late Neolithic and the Early Iron Age. This fact concurs previous observations made in other areas of the Chełm Hills (Libera *et. al.* 2014; 2016). The scope of the presently available data does not allow us to rule out the possibility that the local deposits were also intensely exploited in this region during other periods of human presence confirmed by the sources. Currently, this assumption cannot be definitely corroborated due to the lack of a satisfying number of workshop sites with diagnostic artefacts.

The earlier horizon (Final Palaeolithic) is represented by the remains of workshops, which were most probably sited near seasonal settlements of migrating hunting groups, and by single diagnostic artefacts (*e.g.*, tanged points) probably lost/left during hunting expeditions (Fig. 6). This functional diversity corresponds to data obtained from other regions located within flint deposit zones or in their nearest vicinities, *e.g.*, by the upper Warta River (Ginter 1967), in Załęcze Meander (Zakole Załęczańskie) of the Warta River valley (Cyrek 1996), in the valley of the lower Narew River (Więckowska 1985) or across the territories of north-eastern Poland and the adjacent parts of Lithuania and Belarus (Szymczak 1992), constituting a direct reflection of the raw material economy model greatly determined by a considerable mobility of hunting groups associated with the tanged point and backed blade cultures.

During the later horizon (Late Neolithic until the Early Iron Age), the distribution of the workshops was clearly concentrated in the central part of the analysed territory, in a relatively small area (*ca.* 6 sq. km; Fig. 7). This fact indicates a limitation of the zone where the local materials were exploited and processed to the richest part of their outcrops. It also suggests that the workshops were established in direct proximity to settlements, which were usually located within the valleys of the nearby watercourses. The structure of finds made within the workshops indicates that they were highly specialized (production of small dihedral axes), which has analogies in deposits of other flint materials exploited from the Late Neolithic to the Early Bronze Age (Grużdź and Budziszewski 2014; Zakościelna 2019; Grużdź 2020). It should be stressed that in the context of the current state of archaeological prospection the question of the local production of bifacial tools other than axes (like sickles, projectile points) remains unanswered.

The considerable accessibility of flints to different cultures from the Final Palaeolithic to the Early Iron Age contradicts the original conditions of their deposition documented by the example of the site in Lechówka. A small number of flint clasts occur here in a thick series of glacifluvial and mass-flow sediments (Fig. 4, units b, c). The post-deposition indicators of transformations taking place in the upper, subsurface part (Fig. 4, unit c) appear to explain this contradiction. They allow us to suspect that the considerable concentration of the flints and, as a result, their considerable accessibility for groups representing different cultures should be linked with their 'upfreezing' in periglacial conditions that occurred mainly during successive glacial cycles (from the Odranian to the Vistulian glaciation) (Fig. 5: C). The great accumulation of Rejowiec flint on the land surface is thus the result of swelling and dynamic cryoturbation – accompanying the processes of freezing and thawing of the ground – that caused a gradual movement of flint nodules to the surface and their progressive frost disintegration (gelifraction).

CONCLUSIONS

1) The majority of sedimentological premises associate Rejowiec flint with lithostratigraphic units of the Upper Cretaceous lower than the Maastrichtian. They also indicate their relatively close source area linked with the northern foreland of the Chełm Hills. Glacial transport – whose origin, time and dynamics were probably diverse – occurred in stages, maybe during different advance phases of the Odranian glaciation. The boldest assumption associates the origin of Rejowiec flint with the earlier glacial cycle (Sanian glaciation) and their redeposition from the land surface to ice crevasses during the Odranian glaciation.

2) The wide distribution of flints in 'Region I' (Rejowiec region) is a result of post-deposition processes occurring in the periglacial environment of successive glacial cycles (Odranian, Wartanian and Vistulian glaciations). Their considerable concentration near the ground surface was caused by frost processes taking place in the active layer of permafrost and was linked with their 'upfreezing' that is gradual movement to the surface accompanied by a progressive frost destruction.

3) Despite the still unsatisfactory state of research and necessity to continue the work, it appears that 'Region I' is the area of the greatest flint accumulations in the entire territory of the Chełm Hills. At the same time, from among three selected zones (see: Libera and Szeliga 2006; Libera *et al.* 2014; 2016), the greatest accumulation of archaeological sites has been discovered in the above-discussed area.

4) This fact allows us to consider the analysed territory as crucial in the perspective of research on using and processing local Rejowiec flint, whose presence in this area was one

of the most important factors determining local settlement processes in prehistory. The outstanding technological features of this raw material and the adequate size of its concretions made it possible to fulfil various requirements of flint-knappers from the Middle Palaeolithic to the Early Iron Age.

5) The current state of research indicates that Rejowiec flint was the most intensely exploited and processed in the Final Palaeolithic and from the Late Neolithic to the Early Iron Age. Finds made in the discussed region allow us to suspect that it was a place where functioned dynamic local centres of mining, processing and (possibly) distribution of the local materials.

6) The clear dispersion of Final Palaeolithic workshops (Fig. 6) was probably caused by the considerable mobility of hunting groups operating across this territory and, as a result, their seasonal visits (during hunting) in areas located within the ranges of the outcrops and in their vicinities.

7) The greatest accumulation of workshops dated from the Late Neolithic to the Early Iron Age clearly corresponds to the distribution of settlements in river valleys (workshops located near settlements) (Fig. 7), indirectly suggesting the long-lived and continuous character of their activity (parallel to that of the settlements).

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SILICITE („FLINT") FROM OPOLE-GROSZOWICE: CONTRIBUTION TO RECOGNITION OF THE RAW MATERIALS USED DURING PREHISTORY IN THE ODRA RIVER VALLEY

ABSTRACT

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Until recently, all the erratic flints found at the Stone Age sites in the upper part of the Odra Valley were identified with silicites from the Baltic Sea. The age of Baltic flints is associated with the Uppermost Cretaceous, more precisely with the Maastrichtian or Palaeogene. However, it turned out that among these rocks, there are also silicites that are of different ages and origins. They were first found in outcrops of sands and gravels around Opole-Groszowice. So far, these flints have been distinguished in archaeological assemblages but they were usually regarded as imports from the Cracow-Częstochowa Jurassic Plateau.

The petrographic analysis proves that these silicites of brown colour are of the Jurassic age. They entered the glacial sediments via the lobes of the Drenthe glaciation. They were used in the same way as raw materials of Baltic origin. In this paper, we show some examples of Palaeolithic and younger sites, where artefacts made of brown silicite occurred.

Keywords: Odra Valley, Stone Age, Jurassic age, brown silicite, erratic raw material
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1. INTRODUCTION

The area of the Odra valley from Opole to the Opava Basin contains numerous sites with lithic artefacts that are referred to as the Palaeolithic, Mesolithic, Neolithic and Early Bronze Age (Burdukiewicz 1977; 1999; Foltyn *et al.* 1995; Ginter 1974; Kozłowski 1964; Wiśniewski 2006).

Among them, finds made of siliceous rocks of glacial origin dominate. Rocks that were brought to the area from distant outcrops are also present, such as the so-called Jurassic flint from the Cracow-Częstochowa Upland, Drahany type quartzite from Moravia (Janák and Přichystal, 2007; Kozłowski, 1964), or radiolarites (Wiśniewski *et al.* 2012; Wiśniewski *et al.* 2021). However, imported raw materials form minor admixtures of most assemblages.

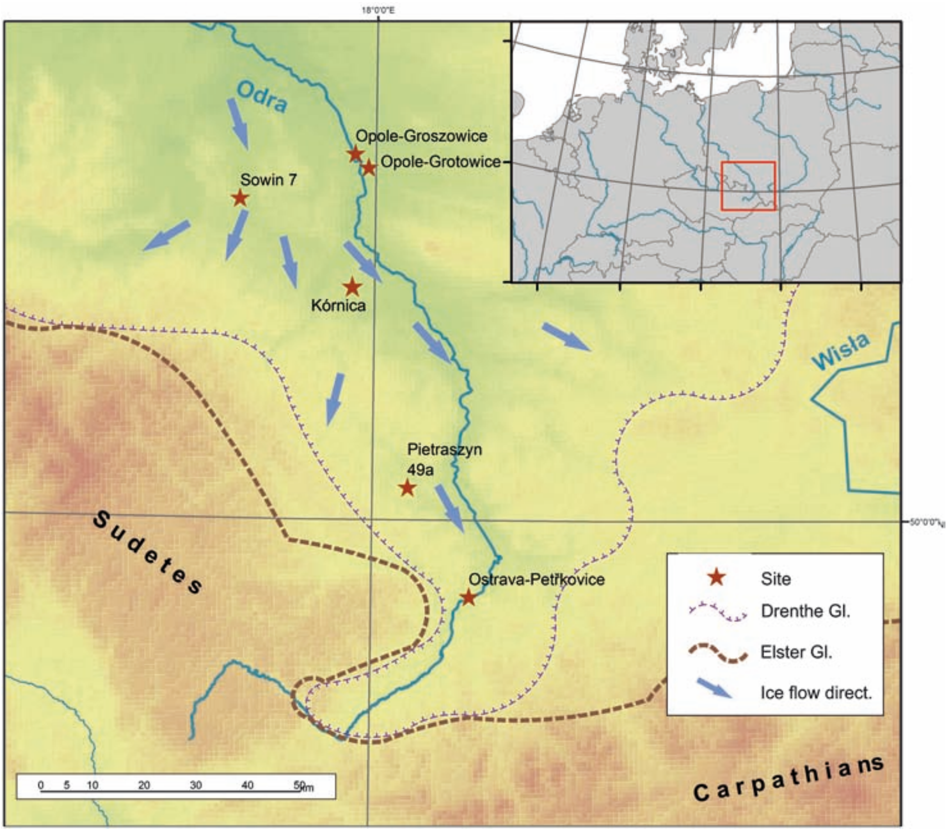

Fig. 1. Location of main sites discussed in the text, maximal extend of glaciations and direction of ice streams (after Salamon 2012)

Until recently, it was thought that among the siliceous rocks of erratic origin in the discussed area, the so-called flints from the Baltic Sea basin, usually with a homogeneous mass structure, were dominant and were associated with the Cretaceous, more precisely with the Maastrichtian or Palaeogene, *i.e.*, Danian. However, it has turned out that among these rocks, there are also silicites that are of different ages, namely of Jurassic origin. They were first found in outcrops of sands and gravels around Opole-Groszowice, Opole Province (Přichystal 2013, 105). So far, these silicites had not been recognized in archaeological assemblages.

Our work aims to present the main features of the siliceous rocks from Opole-Groszowice and to show examples of them that we have come across in collections of archaeological sites located in the Odra valley and its tributaries (Fig. 1).

The implications of this discovery are significant for considering the raw material supply strategies and contacts of early prehistoric societies living in the Odra valley. First, the presence of more erratic raw materials in the Odra belt may partly explain the occurrence of so many sites with flint materials compared to, for example, the western part of the Silesian Lowlands. The presence of siliceous rocks must have provided a significant impetus for the activity directed towards the manufacture and use of tools by the early prehistoric population. Secondly, the disclosure of the presence of Jurassic raw materials should draw the attention of researchers who have hitherto considered such raw materials as evidence of contact with the Cracow-Częstochowa Upland.

This paper consists of a geological part presenting the macro-and microscopic features of the silicites from Opole-Groszowice. We also present the current model of the ice sheet development, showing the reconstruction of directions and range of its lobes, which are the source of silica raw materials. Finally, we refer to archaeological sites where erratic raw material examples from Jurassic deposits have been found.

2. OVERVIEW OF THE OLDER OPINIONS ON THE PLEISTOCENE GRAVELS IN UPPER SILESIA

As far as older opinions are concerned, the most important papers are probably those of H. Lindner and M. Schwarzbach published in the local Upper Silesian geological journal in Gleiwitz (now Gliwice). H. Lindner (1938) studied Pliocene and Pleistocene gravels in the southern part of Upper Silesia. From our point of view, his conclusions concerning Pleistocene gravels deposited by glacial meltwater (Schmelzwasserschotter) are the most interesting. He divided the rock material of the gravels into „southern components" (i. e. coming from the Bohemian Massif) and „North Silesian components" from the Polish Jurassic, Silesian Triassic, Upper Silesian Cretaceous and Upper Silesian Tertiary. The southern components are represented by pebbles of Culmian greywacke and shale from Gesenke (the Nízký Jeseník Highland), Cretaceous (Cenomanian) rocks from the area of

Leobschütz (now Głubczyce), granite of the Friedberg (now Žulová) massif and amphibolite, diabase, phyllite from Altvatergebirge (the Hrubý Jeseník Mountains).

On the other hand, rocks of North Silesian origin are not rare. According to H. Lindner, flints of yellowish to brown colour with white grey, light-grey or black-grey weathering surfaces are always present. Based on the inclusions of fossils, H. Lindner believed them to be from the Polish Jurassic, and he also mentioned that they can be found especially around Oppeln (now Opole) and more to the south (Ratibor, now Racibórz). He also mentioned the locality of Rosenberg (now Olesno 42 km to the NE of Opole) where the Jurassic flints were dominant in a local gravel pit.

Triassic erratic boulders are represented by Upper Silesian „Muschelkalk", on the other hand, the Triassic cherts are not mentioned in the Pleistocene gravels. Whitish and yellowish Cretaceous (Cenomanian) sandstones are found up to Racibórz.

He considered silicified woods that can be found on both sides of the Odra River as erratic boulders of the Tertiary age. So-called Leitha limestone is rarer, and it appears only to the west of the Odra River with primary occurrences around Leobschütz (Głubczyce). Occasional basalt blocks come from various Upper Silesian Tertiary volcanic outcrops.

Another interesting contribution by M. Schwarzbach (1938) is the description of silicified corals of the Cretaceous age found in Pleistocene gravels along the Odra between Racibórz and Opole-Groszowice. He supposed the corals come from Klogsdorf (now Příbor-Klokočov), a very known palaeontological locality in northern Moravia. The origin of the corals is still a matter of discussion, in any case, our survey in Opole-Groszowice (see below) revealed the occurrence of rocks from the flysch belt of the Carpathians, which is from the same direction.

3. THE INVESTIGATION OF SILICITES FROM SAND PITS AT OPOLE-GROSZOWICE AND THE SURROUNDING AREA

Our attention has been focused on unusually numerous siliceous rocks in the Pleistocene gravel at Opole-Groszowice (Fig. 2). Because there are different opinions (*e.g.* in the Polish textbook of petrography by Bolewski and Parachoniak 1978, 137: the difference is based on the shape of siliceous rocks) on the classification of siliceous rocks originating in Poland, especially concerning the terms flint (*krzemień*) and chert (*rogowiec*). We prefer to use the more general term silicite for all siliceous rocks with different opinions on their designation. According to the prevalent meaning in the Anglophone geological dictionaries, „flint is a variety of chert which occurs commonly as nodules or bands in chalk" (Allaby and Allaby 2003; Murawski and Meyer 1998; Přichystal 2010; Brandl 2010). That is why we classify as flints only silicites coming from the Maastrichtian (Uppermost Creta-

Fig. 2. View of sand and gravel outcrops. Brown flint is extracted from the bottom during exploration (state in August 2017). Photo by A. Wiśniewski

ceous) chalk or maybe also the Danian (Lowermost Tertiary) limestones around the Baltic Sea because it is sometimes impossible to distinguish between them.

Sampling silicites in modern sand pits east of Opole-Groszowice has been carried out since 2005. It is evident that the composition of siliceous rocks within the erratic material here is substantially different compared with other sources in glacial deposits of southern Poland, Czech Silesia, northern Moravia, and northern Bohemia. Maastrichtian and Danian silicites (flints) are relatively rare and big pieces of concretional brownish silicite prevail. For example, we collected about 100 kg of brown silicites with nine students for half an hour in 2019. Some of the boulders have dimensions up to 18 × 15 cm and weigh almost 6 kilos. Zdeněk Gába, a Czech specialist on erratic materials in glacial sediments estimates their content in the rock fraction 5-10 cm at Groszowice about 30% (the authors thank him for the oral information).

Together with them, we found also pieces of silicified Tertiary woods (up to 40 cm), numerous sandstones and big blocks of Tertiary olivine basaltic rocks with intensive weathering surface in the sand pits at Opole-Groszowice. On the other hand, rocks from the Western Flysch Carpathians are also present, for example, dark layered menilite chert or so-called révaite (weathered silicified siltstone with a nice, banded structure) – for more detail see Přichystal and Vožďová (2014).

4. ANALYSIS OF SILICITES FROM OPOLE-GROSZOWICE

4.1. Macroscopic appearance (Figs 3-5)

The silicites of Opole-Groszowice type have prevalently dark yellowish brown to dusky yellowish brown colour (Munsell 10YR 4/2 – 10YR 2/2) or to greyish brown (Munsell 5YR 4/1 – 5YR 3/2), at the first glance similar to the colours of silicites from the Cracow-Częstochowa Jurassic that occur in red weathered clays. Their surface is without the characteristic rough cortex that we know on the Neolithic raw material mined around Cracow and transported also to Moravia or Bohemia. They have only a smooth thin relict layer of often whitish cortex, sometimes with small hard overgrowths (2-3 mm) that represent parts of fossils. The shape of silicite pieces is commonly oval, the surface is without cavities (non-rugged).

4.2. Study of silicite chips in water immersion under a stereomicroscope (Figs 6 and 7)

Investigation of silicite pieces in water immersion under a stereomicroscope revealed similar signs, as can be seen in silicites from the Cracow-Częstochowa Jurassic (Přichystal 2013, 102-105); the silicite groundmass is partly translucent, partly cloudy because of a suspension of very fine orange to red pigment and it contains numerous chips of whitish fossils in some places. Some pieces contain relics of big fossils – echinoids, their spines, corals and molluscs.

4.3. Study of the thin section under a polarising microscope (Fig. 8)

A very fine-grained groundmass composed of cryptocrystalline quartz can be seen in thin section under the polarising microscope. Relics of microfossils are filled with bigger chalcedony fibres or large ones even by quartz crystals with a diameter of around 50 microns. Small accumulations of Fe-oxides/hydroxides are spread in the groundmass but especially microfossils with quartz grains are accompanied by their higher occurrence. Similar microfossil relics filled with "megaquartz" (more than 20 microns in diameter) were described by A. Świerczewska (1997) from Jurassic chert in the surroundings of Cracow.

4.4. Density

We tried to characterize the studied silicites also by their densities. Generally, it is possible to suppose that the groundmass of older silicites is more transformed from modifications with water content (opal, chalcedony) to quartz without water. According to this supposition, the silicites of the Proterozoic and Palaeozoic ages would have higher density

Fig. 3. Examples of the brown silicite from Opole-Groszowice.
Photos by A. Přichystal and A. Wiśniewski

Fig. 4. Detail of the surface with small hard overgrowths.
Photo by A. Přichystal

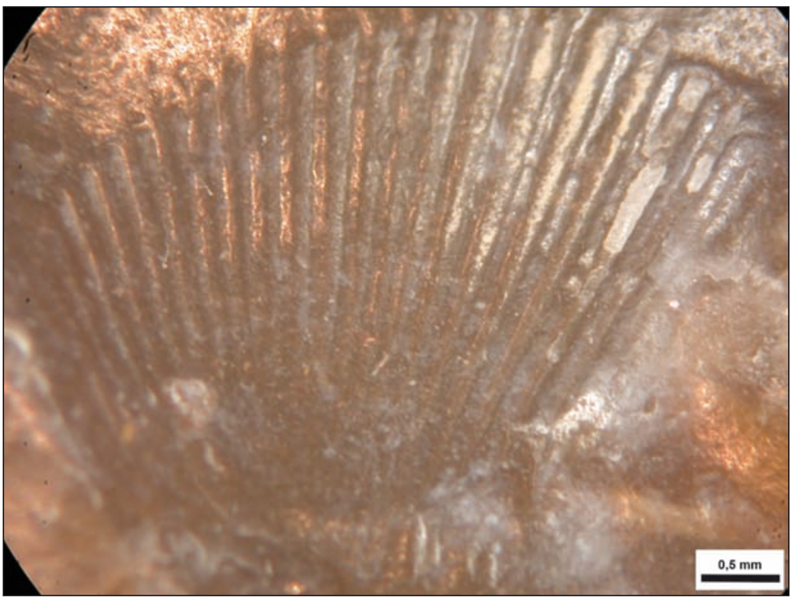

Fig. 5. The imprint of a mollusc shell on the surface of brown silicite.
Photo by A. Přichystal

Fig. 6. Accumulation of red pigment in the siliceous mass of the Opole-Groszowice silicite. Investigated in water immersion under a stereomicroscope. Photo by A. Přichystal

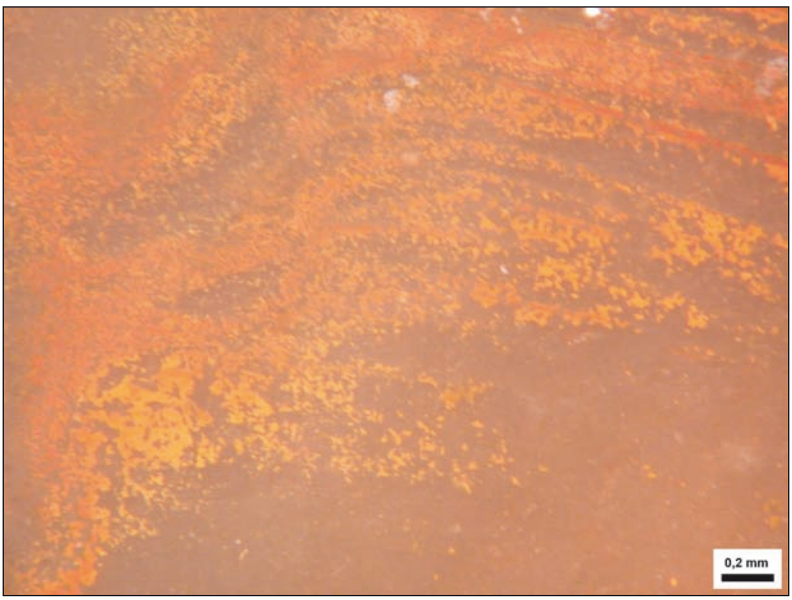

Fig. 7. Micro-cracks in the brown silicite are covered by Fe-compounds. It is evidence of the original occurrence of nodules in red clays, products of intensive weathering of probably Jurassic limestone. Investigated in water immersion under a stereomicroscope. Photo by A. Přichystal

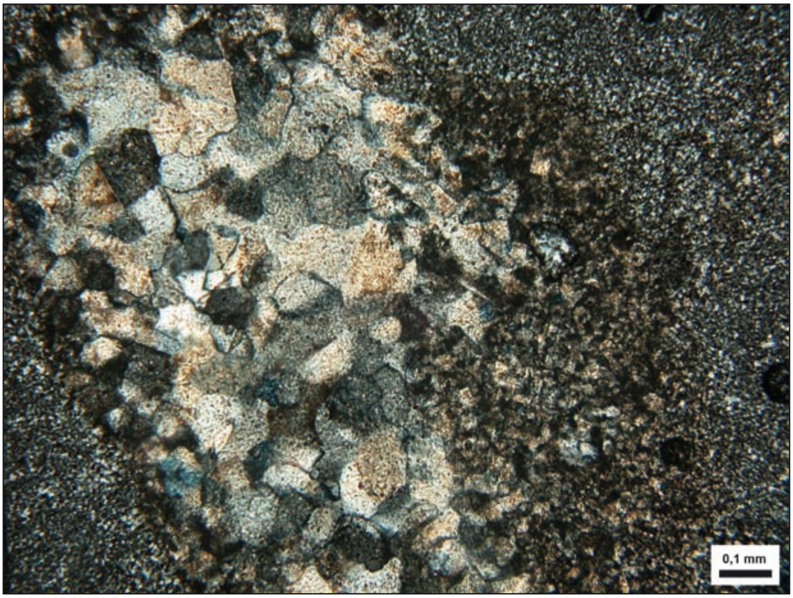

Fig. 8. Thin section of the Opole-Groszowice silicite under a polarising microscope, crossed nicols. The relict of a fossil is filled with bigger quartz crystals and intensively clouded by Fe-pigment. Surrounded by microcrystalline quartz in the groundmass. Photo by A. Přichystal

comparing the Mesozoic and Tertiary ones. We may see it on Proterozoic phthanites from Bohemia (26 samples) with their average density 2.62 ± 0.06 g/cm³ (Eliáš and Uhmann 1968), similarly, six samples of Palaeozoic (Devonian) cherts from the Barrandian area in Bohemia have also high densities, in fact with the same average value 2.62 ± 0.015 g/cm³ as the Proterozoic ones. On the other hand, the Oligocene menilite cherts (two samples) yielded only 2.52 g/cm³.

The Jurassic silicite (variety A) from the southern part of Cracow-Częstochowa Jurassic (three samples from Brzoskwinia, Piekary and Mników) has a lower average density 2.589 ± 0.004 g/cm³ and 10 Neolithic artefacts made of Jurassic silicite (probably variety G, samples given by A. Brzeska-Zastawna), yielded 2.568 ± 0.018 g/cm³ (Přichystal *et al.* 2020). In our study, we also determined the average density of three brown silicites from Opole-Groszowice: 2.594 ± 0.004 g/cm³, a value that is very similar to the variety A from the surroundings of Cracow.

4.5. Loss on ignition (LOI)

The loss on ignition occurs when a sample of the material is heated to high temperatures allowing volatile substances (H_2O^+, CO_2, organic matter) to escape. The first step represents desiccation up to 100°C ($H2O^-$), and then the heating continues up to 1200°C. If the LOI were only determined by the concentration of hydrates and labile hydroxy-compounds, Proterozoic phthanite and Palaeozoic lydite would have the lowest values, while Tertiary cherts would have the highest. For example, in 14 Proterozoic phthanites from Bohemia H2O+ is under 0.33% (Dubanská *et al.* 1977).

Unfortunately, especially Mesozoic silicites also contain carbonates very often (prevalently CaCO3) and they also play an important role in the values of LOI. That is why our results are ambiguous. According to our measurement, the Triassic chert from Górażdże shows a low LOI = 0.99%, and a similar LOI published by J. Stawin (1970) for Triassic chert from Imielin near Jaworzno (0.97%). Three brown silicites from Opole-Groszowice have LOI = 0.97-1.27%. J. Lech (1980) informed us about the LOI of 14 Jurassic “flints” from natural outcrops in the Cracow region with dispersion 1.07-2.41%. Our sample from Piekary gives 1.06 % and from Gojść – 1.60%. It is evident, that the Jurassic silicites from the Cracow-Częstochowa (Wieluń) Upland have a large dispersion of LOI and the brown silicites from Opole-Groszowice yielded similar data.

4.6. Possible origin

There is no doubt the silicite from Opole-Groszowice does not correspond to the main two types of silicite rocks of northern origin in glaciogenic deposits, *i.e.* Maastrichtian and Danian flints. Neither can it be derived from the southern sources because there are no similar cherts in the Cretaceous platform covering the Bohemian Massif at the border of Czech Silesia/Poland, in the area between Osoblaha/Osobłoga (Czech Silesia) and Głubczyce (Polish Silesia). Local Cretaceous spongolite forms a layered chalcedony bed of light grey to honey-brown colour. Similarly, cherts from occurrences in the Flysch Carpathians (the menilite chert, Baška chert or Mikuszowice chert) are layered and different. According to density, we can exclude silicites of the Proterozoic and Palaeozoic ages.

Concerning the local Triassic concretional chert, we know its primary occurrence in the Górażdże beds near the village Górażdże about 15 km distance SSE from Opole, which means relatively close to Opole-Groszowice. However, they have a grey and brecciated non-translucent appearance and form only small occurrences, so they cannot be the silicites of the Opole-Groszowice type.

All these data testify to the conclusion that the Opole-Groszowice silicites can be compared with „flints” from the Cracow-Częstochowa Jurassic. Of course, we cannot exclude the possibility that the name Opole-Groszowice silicite covers more varieties of siliceous rocks from southern Poland but with no doubt, the Jurassic silicite (“flint”) prevails.

The natural occurrence of brown silicites is the most frequent at Opole-Groszowice. The silicites of this appearance can be followed in substantially less concentration to the south, they can be found rarely within glacial sediments in the territory of the Czech Republic (Ostrava-Opava regions).

4.7. Glacial sediments and silicites

Based on studies of glacial sediments located in the Niemodlin Plain and the Racibórz Basin as well as the Głubczyce Plateau and the Rybnik Plateau, traces of two glaciations were identified: the Elsterian and Drenthe (Saale-Odra) glaciations (Badura and Przybylski 1998; Lewandowski 1988, 2001). The better preserved forms and sediments of the Drenthe glaciation made it possible to isolate the main lobe and several sublobes, which were responsible for the transport of erratic material towards the south, including silicites known from Opole-Groszowice (Fig. 1). The main flow of the Upper Odra ice lobe is thought to have intruded southwards through a relatively narrow 40 km wide corridor between the Middle Triassic Ridge in the east and the foothills of the Eastern Sudetes in the west. South of this area, sublobe activity has been documented, including the Nysa Sublobe on the western side and the Odra Sublobe in the central part (Salamon 2015). The former, among other things, led to the deposition of the material in the Niemodlin Wall where Sowin is located, while the latter is in the area south of Racibórz.

5. EXAMPLES OF SILICITES OF THE OPOLE-GROSZOWICE TYPE FROM ARCHAEOLOGICAL SITES

Artefacts made of Opole-Groszowice-type raw material have been found in inventories located in the Odra valley. The oldest artefacts come from the Pietraszyn 49a site near Racibórz (Fig. 1). This site is dated to the beginning of MIS 3, *i.e.*, about 58 thousand years old, and is associated with the Central European Micoquian Complex (Wiśniewski *et al.* 2019). It is located in the southern part of the Głubczyce Plateau, on the southern slope of the Troja valley. Among the finds obtained so far, a large bifacial knife with a natural back, a rounded tip and a cutting edge of about 2/3 of the edge length stand out (Fig. 9). The white cortex is present on the surface. The siliceous mass is opaque and contains fragments of fragmented organisms. The mass is brown in colour. The knife was made on the spot because one of us (AW) found conjoining pieces connected with tool shaping. Thus, it can be assumed that the lump of flint was found in nearby sediments of glacial origin, deposited probably during the Odra glaciation.

Further elements come from the site Sowin 7, Nysa region, located within the Niemodlin Wall which connects the Głubczyce Plateau with the Odra valley (Fig. 1). This site provided traces of two cultural complexes, *i.e.*, the Epigravettian and Magdalenian located in sandy sediments dated to 16.2-15.4 thousand years BP and 14.7-13.8 thousand years BP, respectively (Furmanek *et al.* 2001; Wiśniewski *et al.* 2012; Wiśniewski *et al.* 2017). Among others, two retouched tools that correspond to the characteristics of the raw material from Opole-Groszowice occurred in the Epigravettian assemblage, a burin and an endscraper (Fig. 10). It is uncertain whether the raw material in both cases comes from the immediate

Fig. 9. The Micoquian site Pietraszyn 49a. A bifacial knife made of Opole-Groszowice silicite. Photo by A. Wiśniewski

Fig. 10. Artefacts from the Epigravettian layer of site 7 in Sowin. The burin and endscraper are made of brown silicite. Photo by A. Wiśniewski

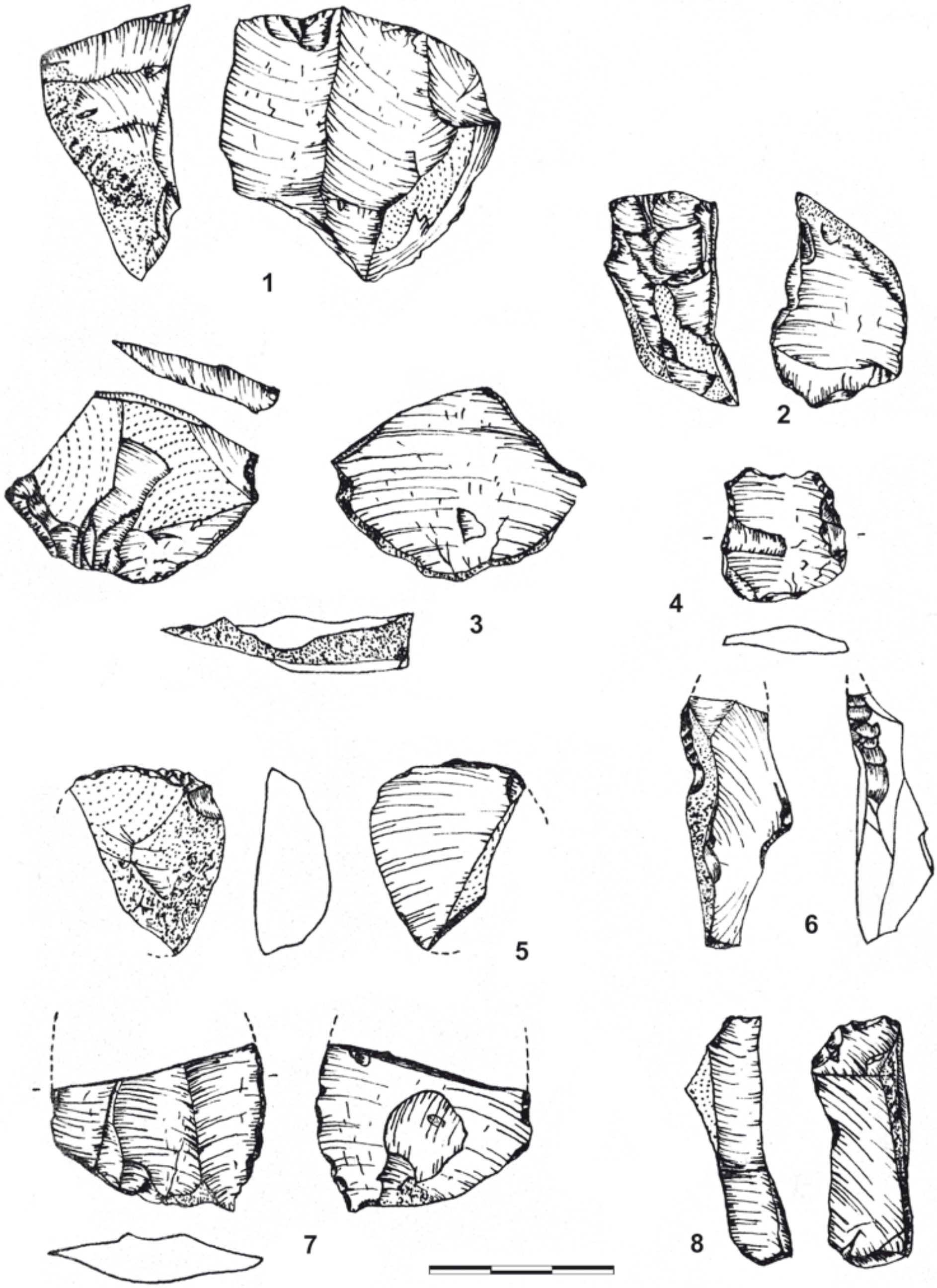

Fig. 11. Late Palaeolithic site Opole-Grotowice 41.
The artefacts were made of brown silicite (after Burdukiewicz 1977)

vicinity, but the state of preservation of the burin, an expedient tool, suggests that it was made locally. The endscraper, on the other hand, bears numerous signs of use-wear indicating that it may have been used longer and possibly transported from outside (Wiśniewski *et al.* 2021).

Several collections of the discussed silicite type were collected in 1975 during the rescue archaeological research in the area of building the industrial quarter of Opole (Fig. 1), located slightly south of Opole-Groszowice (Burdukiewicz 1977). There were recognized brown silicite nodules and discovered new sites with artefacts made of the same raw material. The site Opole-Grotowice 41 (AZP 91-37-17) delivered 24 artefacts made of brown silicite: a single-platform core, a core with changed orientation, two plunging blades, a burin on unprepared end, damaged flake endscraper, retouched blade and retouched chunk (Fig. 11).

Another site Opole-Grotowice 42 (AZP 91-37-17) delivered nine brown silicite artefacts including a damaged core, a perforator, and a fragment of a retouched blade. The third site Opole-Grotowice 40 (AZP 91-37-18) had five brown silicite artefacts including two cores. Another ten brown silicite artefacts were isolated finds.

Most of the brown silicite artefacts from Opole-Grotowice can be related to the end of the Pleistocene, especially the Allerød (Federmesser technocomplex?) and the younger Dryas periods. It can be related to the Świderian point discovered in nearby Opole-Groszowice (Ginter 1974). Some brown silicite artefacts from Opole-Grotowice could also be from the Mesolithic and Neolithic ages.

Another site with a brown silicite artefact is located near Kórnica (site 3), Krapkowice district (Wiśniewski 2006). A chunk with traces of retouching was found on the terrace of a small watercourse on the surface of an arable field (Fig. 1). This artefact is not dated, but its state of preservation indicates that it may be dated to the Neolithic or Bronze Age rather than the Middle Palaeolithic as was suggested by the discoverers (K. Bykowski and S. Pazda). The tool was made from a brown silicite resembling that of Opole-Groszowice.

Other data comes from the area of the Czech Republic. It is possible to mention a Gravettian site Ostrava-Petřkovice I (Svoboda ed. 2008) on the Landek Hill with the Odra River flowing just under the hill (Fig. 1). The locality is known by the famous Petřkovice (Landek) Venus, a female figurine made of massive hematite. Investigation of chipped artefacts obtained during excavations in 1952-1953 and 1995-1996 revealed among the prevalent silicites (flints) of erratic origin also 34 artefacts made of brown silicite with spread red mineral pigment in their siliceous mass on the one hand, on the other hand with only relics of the smooth thin whitish cortex as is characteristic for the Opole-Groszowice silicite (Přichystal 2008). So, it was concluded the Petřkovice hunters had probably followed the Odra River to the north towards Opole-Groszowice and collected brown silicite there.

6. FINAL REMARKS

The silicites of Opole-Groszowice were investigated using geological criteria including geological context, specific macro-and microscopic features, and usage of this raw material on archaeological sites. These silicites were abundant in glacial deposits of Drenthe Glaciation exposed in sand pits in Opole-Groszowice and the surrounding region, and rarely to the south of Upper Silesia, like within glacial sediments in the Ostrava-Opava region (Czech Republic). Brown silicites from Opole-Groszowice were found as erratic raw material transported probably from Jurassic deposits. However, we cannot exclude that the Opole-Groszowice silicite set covers more varieties of siliceous rocks.

The Opole-Groszowice silicite in groundmass is partly translucent, relatively cloudy by very fine orange to red pigment and it contains in places numerous chips of whitish fossils. The average density of three brown silicites from Opole-Groszowice is 2.594 ± 0.004 g/cm^3 and such value is very similar to the variety of Jurassic silicite A from the surroundings of Cracow. In addition to that, the Jurassic silicites from the Cracow-Częstochowa (Wieluń) Upland have a large dispersion of LOI and are similar to brown silicite from Opole-Groszowice.

Artefacts made of Opole-Groszowice silicites were discovered at several sites in the Odra Valley in Poland dated to the Middle Palaeolithic (Micoquian site Pietraszyn 49a near Racibórz), Upper Palaeolithic (Epigravettian and Magdalenian in Sowin, near Niemodlin) and the most abundant in Late Palaeolithic, Mesolithic and possibly Neolithic (Opole-Grotowice sites located close to the outcrops with the silicites). Another larger collection of Opole-Groszowice raw material was found in the Gravettian site Ostrava-Petřkovice I.

The silicites of Opole-Groszowice of the Jurassic age were significant raw materials for Palaeolithic hunter-gatherers in Upper Silesia. The detailed characteristics of this silicite will contribute to the identification of such raw material in other lithic collections in Silesia and neighbouring areas.

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ONE CENTURY OF STUDIES ON CHOCOLATE FLINT. AND WHAT DO WE REALLY KNOW ABOUT IT?...

ABSTRACT

Sudoł-Procyk M. 2022. One century of studies on chocolate flint. And what do we really know about it?... *Sprawozdania Archeologiczne* 74/1, 49-65.

The so-called "chocolate flint" is one of the most popular and the highest quality flint raw material used in prehistoric times in Central Europe. It was known and utilised since the Middle Palaeolithic until the Iron Age. It has been the focus of research for almost 100 years, but the questions related to extraction, processing and distribution of chocolate flint are still valid and taken up by many scholars. To a large extent, this has been the result of the discovery of chocolate flint deposits and places of its extraction in the area of the Kraków-Częstochowa Upland at some distance from the previously-known outcrops, which has significantly changed the current state of knowledge. This article is an attempt to synthesize the knowledge on this flint as a raw material of exceptional quality, widely used by prehistoric communities.

Keywords: Poland, Holy Cross Mountains, Kraków-Częstochowa Upland, chocolate flint, distribution, prehistoric communities
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1. INTRODUCTION

The Vistula basin is rich in deposits of several kinds of flint that were widely used in prehistoric times. The varieties of these lithic materials include "chocolate", grey white-spotted, striped (also called banded), Jurassic-Cracow flints, as well as "cretaceous" raw materials. Amongst them, the so-called "chocolate flint" is one of the most popular, distinctive in terms of both, technical and aesthetic values (Domański and Webb 2000).

The history of research on this flint is at present almost one hundred years old, but in spite of this, there are still many issues related to extraction and processing of chocolate flint in Poland that remain unresolved and are being taken up by many scholars. Moreover, new discoveries are being made, changing the current state of knowledge, and stimulating formulation of new research questions. Therefore, in order to sort out the knowledge on the so-called "chocolate flint" (in Polish: krzemień czekoladowy), the author proposes in the title for this text, addressing "what do we really know about" this raw material and will try to list the further research perspectives.

Archaeological sources prove that chocolate flint was known and utilised since the Middle Palaeolithic until the Early Iron Age in almost all of the regions of Poland as well

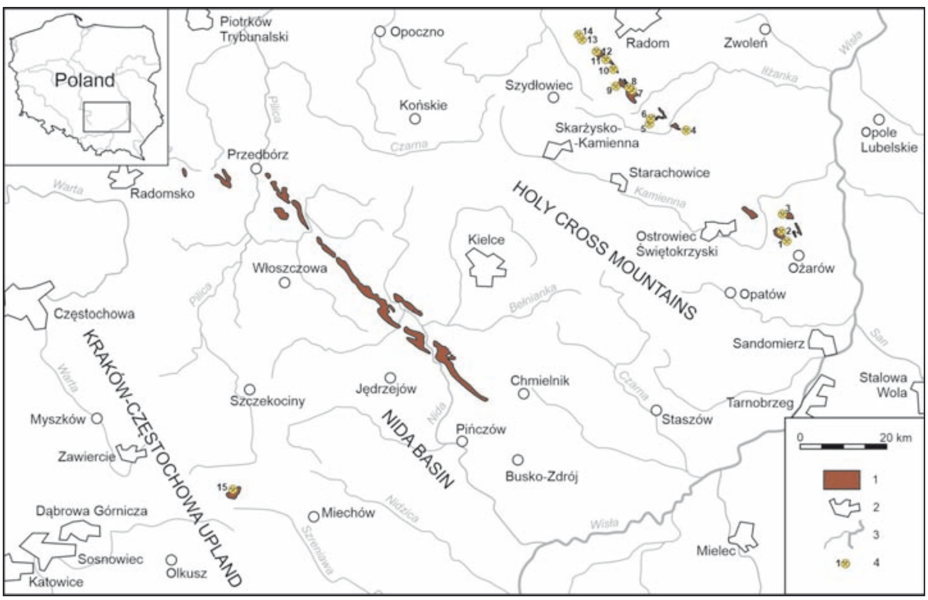

Fig. 1. Localization of known outcrops of rock bearing chocolate flint (after Krajcarz *et al.* 2012 with author's changes) and prehistoric most important points of exploitation of chocolate flint.
1 – Kimmeridgian rocks with chocolate silicite, 2 – the biggest towns and cities, 3 – the biggest rivers, 4 – location of sites (1 – Śródborze, 2 – Gliniany, 3 – Duranów, 4 – Prędocin, 5 – Seredzice, 6 – Pakosław, 7 – Polany, 8 – Polany Kolonia, 9 – Wierzbica, 10 – Iłża, 11 – Tomaszów, 12 – Orońsko, 13 – Guzów, 14 – Chronów Kolonia, 15 – Poręba Dzierżna)

as in neighbouring countries, mostly in Central Europe (Sudoł-Procyk *et al.* 2021a). The most recognised and investigated zone of its occurrence is the north-eastern margin of the Holy Cross Mountains (Fig. 1), which for many years was believed to be the only region where this raw material could be found. This is the reason why all of the studies conducted until present adopted one model assuming that chocolate flint was extracted exclusively from the outcrops situated in the NE region of the Holy Cross Mountains (Fig. 1; Krajcarz *et al.* 2012). This viewpoint has been changed by a discovery of outcrops of this raw material almost 200 km westward, in the Kraków-Częstochowa Upland. This finding affected significantly all of the previous interpretations of its utilisation and distribution on a Polish, as well as European scale (Sudoł-Procyk 2021a).

2. CURRENT STATE OF KNOWLEDGE

The first macroscopic description of chocolate flints was created by S. Krukowski, who characterised their variability and initial localisation of their outcrops based on material obtained from archaeological sites (Krukowski 1920). He induced an interest in the issue of this flint occurrence in a geologist named Jan Samsonowicz, who joined him in a field survey of this raw material. As early as in 1922, the above-mentioned scholars discovered numerous deposits of chocolate flint within both, secondary and primary (*in situ*) sediments; the latter in a form of exposures in the walls of quarries and surface weathered limestones with chunks of flint (Budziszewski 2008) and a great number of artefacts, being the relics of prehistoric flint workshops (Krukowski 1922, Samsonowicz 1923). The successive years delivered many more discoveries of chocolate flint outcrops accompanied by flint workshops in the region of the north-eastern margins of the Holy Cross Mountains (Samsonowicz 1934).

The 1930s were a period of intense investigations of flint chocolate outcrops carried out by S. Z. Różycki (1939), W. Pożarski (1948), but above all by S. Krukowski, who at that time localised large extraction sites near Wierzbica, Orońsko and Tomaszów (Krukowski 1939-1948).

Another revival of interest in the issues of identification, location and exploitation of chocolate flint falls at the 1960s and 1970s, mostly thanks to investigations carried out by the research team headed by R. Schild (1971; 1976; 1987; 1995a; 1995b; 1997; Schild *et al.* 1977). These ventures resulted in the creation of a detailed classification of chocolate flint and documentation of a reference collection of particular types of this raw material from the north-eastern margins of the Holy Cross Mountains (Schild 1971).

Until the end of the 20th century, studies on chocolate flint had been undertaken repeatedly by many scholars, such as M. Chmielewska (1973; 1980; 1988), W. Chmielewski (1975), M. Kaczanowska and J. Lech (1977), H. Lech and J. Lech (1984; 1995; 1997), J. Lech (1987; 1990; 1997), T. Herbich and J. Lech (1995), J. Budziszewski (1987; 1991b; 2008), M. Bednarz and J. Budziszewski (1997), B. Bargieł, A. Zakościelna, J. Libera (Libera and

Za-kościelna 1990; 2000; 2003), among many others. Regardless of field surveys, these were the times when numerous scientific works were announced, addressing the issues of utilisation and distribution of chocolate flints in particular periods of prehistory, as well as from the perspective of a regional approach (*e.g.*, Cyrek 1981; 1983; 1995; Cyrek and Sudoł 2008; Schild 1987; Schild *et al.* 1997; Sulgostowska 1997; 2005; 2008; Balcer 1983; Kaczanowska 1985; Lech 1987; 1990; Domańska 1988; 1995; 1996; Małecka-Kukawka 1992; 1994; 1997; Prinke and Rajchmajda 1988; Zakościelna 1996; Budziszewski 1987; 1990; 1991a; 2008; Domański and Webb 2000).

The beginnings of the 21st century have brought a deeper reflection and more thorough exploration of the contemporary knowledge on chocolate flint, based on the data obtained in the previous century (Borkowski *et al.* 2008; Přichystal 2009; 2013; Kerneder-Gubała 2018; Burget 2018). Research on the technical quality of chocolate flints, in particular using mechanical properties, particularly fracture toughness, confirmed the excellent technical qualities of this raw material (Domański and Webb 2000). Now, in the second decade of this century, we are certain that the issues of extraction and processing of chocolate flint in the north-eastern region of the Holy Cross Mountains still raise many questions that need to be answered and are undertaken within various research projects, a great example of which are verification investigations in the chocolate flint mine in Orońsko (since 2016) (Kerneder-Gubała 2018; 2019; Osipowicz *et al.* 2019) and Iłża (Gróżdź *et al.* 2021). Moreover, there were made attempts to obtain a diagnostic set of data characteristic for various outcrops of "chocolate" flints from Central Poland, based on geochemical methods of siliceous rocks identification (Grafka *et al.* 2014; Hughes *et al.* 2016; Parish and Werra 2018; Brandl *et al.* 2016; Werra and Siuda 2022).

The first years of the 21st century were also the time when M. T. Krajcarz (geologist) and M. Krajcarz (archaeologist) undertook verification investigations (Krajcarz and Krajcarz, 2009) in the scope of occurrence of chocolate flint in the south-western zone of the Holy Cross Mountains (Fig. 1). Until then the so-called chocolate flint in the region in question was reported in the related literature only sporadically (Kutek 1962; Migaszewski and Olszewska 2002; Migaszewski *et al.* 2006).

The theoretical potential of the chocolate flint outcrop on the south-western edge of the Holy Cross Mountains is currently not reflected in the presence of raw material extraction points in this region. One of the reasons may be the poor state of research, using modern methods of analyzing the land surface in terms of documenting anthropogenic transformations. The current state of knowledge, based on surface studies of the outcrop area, has shown only a small number of sites using this raw material. This could be for many reasons, *e.g.* the raw material was unknown or may have been difficult to access in the past, or the prehistoric miners were for some other reason more interested in other regions. Future research should also include comparative analyses between chocolate flint outcrops in terms of technical values and suitability for use, because we cannot exclude that the raw material from some outcrops could also be of lower quality.

The findings made by M. T. and M. Krajcarz, confirming and describing the occurrence of this raw material in the south-western zone of the Holy Cross Mountains, provided the grounds for further studies upon deposits of chocolate flint that can be found within a much larger extent than it had been previously assumed, namely over the entire area of outcrops of rocks of the Upper Oxford and the Lower Kimmeridgian stages (Krajcarz *et al.* 2012).

In this respect the central part of the Kraków-Częstochowa Upland (the Ryczów Upland, in particular) turned out to be exceptionally interesting. This is the region where in the recent decade, the research team headed by the geologist M.T. Krajcarz carried out intense research in order to reveal and document outcrops of siliceous materials. These investigations proved a great variability of flint materials and an existence of new outcrops. Amongst these outcrops there are distinctive deposits of high quality chocolate flint located in the region of the Udorka Valley (Krajcarz *et al.* 2012; Sudoł-Procyk *et al.* 2018; Sudoł-Procyk and Krajcarz 2021; Sudoł-Procyk *et al.* 2021a; 2021b). The studies, aimed at determination of the extent of outcrops of this raw material in the Kraków-Częstochowa Upland and its extraction points outside of the Holy Cross Mountains region, are presently being continued by an interdisciplinary research team headed by the author of this paper within the five-year grant financed by the National Science Centre.

3. CHOCOLATE FLINT IN THE KRAKÓW-CZĘSTOCHOWA UPLAND – NEW DATA

The research on the occurrence of flint outcrops in the central part of the Kraków-Częstochowa Upland, as already mentioned above, was started by the research team headed by M. T. Krajcarz in 2007.

During the field surveys carried out in this region, fragments of chocolate flint were found within the currently dry river bed in the Udorka Valley (Fig. 2). Later on, fragments of this raw material were also recognised in other areas in the vicinity of this valley. In the area of outcrops in the Udorka Valley, namely near the site Poręba Dzierżna 24, pits of anthropogenic origins and the remains of mine workshops related to the initial processing of raw materials were an extraordinary discovery (Sudoł-Procyk *et al.* 2018).

Apart from the site Poręba Dzierżna 24, where detailed multi-aspect excavations have been carried out since 2018 (Sudoł-Procyk *et al.* 2021b), field surveys supported by analyses of the digital terrain model revealed similar, though considerably smaller anomalies in other parts of the chocolate flint outcrops in the southern region of the Ryczów Upland (near the villages Poręba Dzierżna, Kąpiele Wielkie and Załęże). They will be the subject of further verification studies focused on the identification of potential new flint mines.

Until present, the best recognised site is the extraction point of chocolate flint in Poręba Dzierżna 24, which was firstly investigated in the scope of its landform, using the LiDAR survey data (Sudoł-Procyk *et al.* 2018). The terrain in question is highly diversified due to

Fig. 2. Chocolate flint nodules in the riverbed of the Udorka stream (photo by M. Sudoł-Procyk)

the width and the depth of relics of quarry pits and their location in relation to the slope of the Udorka Valley. The results of excavation, supported by the stratigraphic data and datings, confirmed that there were multiple episodes of prehistoric activity at the site at the end of the Pleistocene and the beginning of the Holocene (Sudoł-Procyk *et al.* 2021b).

In the region of the site Poręba Dzierżna 24, there were recorded three levels of chocolate flint occurrence: level "0" – from regolith, and levels "1" and "2" – from weathered rock (Fig. 3). Extraction pits and flint workshops in their closest surroundings proved that the raw material obtained from all of the deposits available in the past was tested on spot. Further studies conducted at the site will focus on more accurate determination of the extent of mining shafts (Fig. 3), their nature and possible diversification in terms of their chronological and cultural affiliation.

4. DISCUSSION

All this new information raises one question: what do we really know about chocolate flint?

Without any doubt, this raw material was used in all periods of prehistory, and its finds are known from almost all regions of Poland, as well as neighbouring countries, mainly in Central Europe (Sudoł-Procyk *et al.* 2021a).

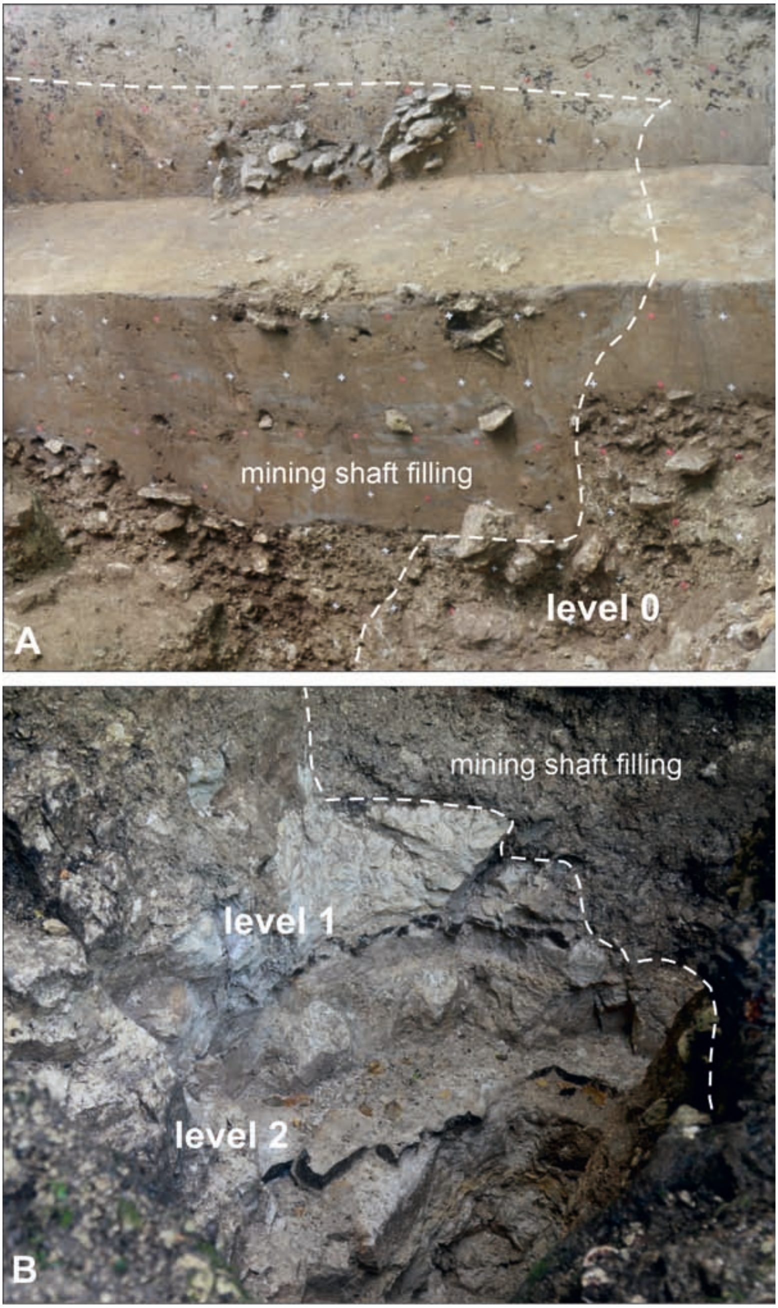

Fig. 3. Levels of chocolate flint and outline of mining shafts in the site Poręba Dzierżna 24, com. Wolbrom, małopolskie voiv. (photo by T. Wiśniewski).
A – level "0" – from regolith in Trench II, B – levels "1" and "2" – from weathered rock in Trench IV

It is also a fact that deposits of chocolate flint in the north-eastern edge of the Holy Cross Mountains (Fig. 1) have been very well recognised, mapped and described in the course of a century of research that has continued until the present day.

We know that the deposits of chocolate flint, outside of the Holy Cross Mountains zone are also located in the central part of the eastern margin of the Kraków-Częstochowa Upland (Fig. 1; Krajcarz *et al.* 2012) and, importantly, we have got evidence that prehistoric communities exploited deposits of chocolate flint both in the Holy Cross Mountains and in the above-mentioned area of the Kraków-Częstochowa Upland (Fig. 1).

Taking into account all of the facts quoted above, there are many new questions and issues that need to be tackled.

Firstly, knowing that chocolate flint was exploited by prehistoric communities in the region of the Holy Cross Mountains and Polish Jura, it is absolutely necessary to identify the provenance of raw materials found at particular archaeological sites in Poland and Europe (Sudoł-Procyk *et al.* 2021a). The answer to the question about the route travelled by a particular flint product (*i.e.* where the raw material was excavated and what happened to it) is crucial for understanding the mechanisms of human activity in the past (Sudoł-Procyk 2021).

With confirmed chocolate flint outcrops in the central part of the Kraków-Częstochowa Upland we should also raise the question whether it can also be found in other parts of this region, and if the answer is yes, will it occur in the same geological context? In turn, this leads us to further questions, such as: are there any other zones, apart from the one in question, where chocolate flint was extracted and initially prepared? Was it exploited by the same communities?

And finally, there is one more crucial issue: are there any unique petrological and/or geochemical properties of flints from the Kraków-Częstochowa Upland? Is it possible to distinguish chocolate flints from the outcrops in the Holy Cross Mountains from those coming from the Kraków-Częstochowa Upland?

The issue of identification of siliceous raw materials raises may controversies in the scientific environment nowadays, especially among part of geologists (Kochman *et al.* 2020; Matyczkiewicz and Kochman 2020). Silica rocks used in the production of tools in the past are subject to identification, among others on analyzes based on microscopic observations of thin sections which reveal the primary microfacies of limestones subjected to silicification, and X-ray diffraction analyses, including the determination of the crystallinity index of SiO_2 (Kochman *et al.* 2020). These research methods do not allow for identification of the varieties of flint nodules to an extent that would permit them to be even roughly connected with particular outcrops or, at least, with particular regions of the occurrence of siliceous raw materials on a Pan-European scale (Kochman *et al.* 2020).

The Multi-Layered Chert Sourcing Approach (MLA) by combining macroscopic, microscopic and geochemical analyses using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), seems to offer other possibilities (Högberg and Olausson 2007; Andreeva *et al.* 2014; Brandl 2016; Brandl *et al.* 2018; Bradley *et al.* 2020). Recently, the analysis of samples of chocolate flint form Holy Cross Mountains region revealed clear possibilities to differentiate chocolate flint from Jurassic-Kraków flint based on characteristic microfossil inclusions and trace element contents (Brandl *et al.* 2016). On the other hand, separation of the Holy Cross Mountains chocolate flint is possible to a certain extent only, due to certain limitations resulting from their geographic proximity and consequently, similar geologic environments of their origins.

Searching for answers to the above questions and doubts is crucial from the viewpoint of acquiring new knowledge on raw material distribution. Tracing the routes of its spreading reflects past economic process and behaviours of human groups, which in turn allows us to reconstruct the inter-group contacts, being the channels for exchange of various information, and most likely, genetic material between remote societies.

5. RESEARCH PERSPECTIVES

The identification of new outcrops of chocolate flint have supplemented and verified the current knowledge of its occurrence and use in particular periods of the prehistory, mainly in the immediate vicinity of the outcrop, and influenced the reinterpretation of opinions on long-range imports of this type of lithic material from the Holy Cross Mountains to the Upland and the possibility of exporting it to other regions (Krajcarz *et al.* 2012; Sudoł-Procyk *et al.* 2021a). We know that also in the southern part of the Cracow-Częstochowa Upland assemblages with chocolate flint products have been documented. These are sites from the Middle Palaeolithic period to the Mesolithic, and Neolithic sites are also known near the highlands (Sudoł-Procyk 2021). The discovery of chocolate flint outcrops in the central part of the Upland and – in the context thereof – the Late Paleolithic and Mesolithic open-air and cave sites and workshops, constitutes an important criterion for considering the exploitation of local deposits and their use in particular periods in prehistory (Sudoł-Procyk and Krajcarz 2021).

The awareness of the importance of discovering new chocolate flint outcrops and exploitation sites in the Ryczów Upland (middle part Kraków-Częstochowa Upland), resulted in the decision to expand the research area to the entire Kraków-Częstochowa Upland. As a part of the project financed by the National Science Centre, there are designed interdisciplinary studies aimed at the identification of chocolate flint outcrops in the Kraków-Częstochowa Upland, and the spots of this raw material exploitation and utilisation. Moreover, it is planned to conduct a research on the importance and the role played by this flint in particular periods of prehistory (Sudoł-Procyk 2021).

In the first phase of the work, a detailed geological map of chocolate flint occurrence will be prepared. The Kraków-Częstochowa Upland has a monoclonal geological structure. Therefore, it is expected that other chocolate flint-bearing outcrops are to be found in the eastern edge of the Upland.

The second step of the research will be to conduct detailed archaeological surveys in the outcrop area, in order to detect prehistoric sites, potentially related to the exploitation and processing of chocolate flint. In the central part of the Kraków-Częstochowa Upland, several such sites are already known, including a flint mine and workshops. As for today, we know that there is a prehistoric chocolate flint mine with, at least, three deposits of this raw material. At the site there were identified mining features, including shafts. Preliminary proxies based on stratigraphic premises, as well as first OSL and ^{14}C dating, confirm that chocolate flint from this region was known and obtained by hunter-gatherer communities at least since the final Pleistocene and the Early Holocene (Sudoł-Procyk *et al.* 2021b).

The last stage of research is to search for chocolate flint artefacts at archaeological sites situated in both the Kraków-Częstochowa Upland and beyond this region, in Poland and neighbouring countries. The exact number of sites, quantities of chocolate flint artefacts at these sites, and the nature of these artefacts (knapped locally or imported as finished products) have never been fully evaluated. One of the goals of this ongoing project is to create a database that will gather information on all of the chocolate flint artefacts from archaeological sites in Central Europe. This will allow the reconstruction of the prehistoric networks of chocolate flint distribution. However, this requires a tool for identification of chocolate flints and distinguishing them from other flints, and then, for classification of chocolate flint artefacts into those that had come from the outcrops localised in the area of the Holy Cross Mountains, and those from the outcrop (or outcrops) in the Kraków-Częstochowa Upland.

For this purpose, the Multi-Layered Chert Sourcing Approach (MLA), method is planned, combining macroscopic, microscopic and geochemical analyses using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). First, three deposits of chocolate flint obtained *in situ* from the rock and rock weathering, located at the mining site in the Udorka Valley will be analysed. The results will be compared with the samples already tested, coming from the deposits at the north-eastern foot slopes of the Holy Cross Mountains and other Jurassic flints from Polish Jura.

Considering that MLA has been successfully employed to sourcing lithic material in previous studies upon flint materials from other parts of Poland, for example chocolade flint from Holy Cross Mountains and Jurassic flint from Kraków (Brandl *et al.* 2016) and Europe (*e.g.*, Scandinavian flint, Brandl 2016; Brandl *et al.* 2018), it is planned to apply this method in this studies as well. Perhaps it will be possible to answer the question whether it is possible to distinguish between chocolate raw materials from the Holy Cross Mountains and the Kraków-Częstochowa Upland.

6. CONCLUSIONS

The current state of knowledge indicates very clearly that the outcrops of chocolate flint from the NE edge of the Holy Cross Mountains played the most important role in prehistory, especially when it comes to the Early Stone Age. Although we have identified the sites where this raw material was mined and processed we know that the chocolate flint from the Udorka Valley was mainly of local importance. Further research will allow to verify the issue of what role, if at all, it played on a supra-regional scale.

The study on the geological and geomorphological context of the discovered outcrops, aimed at determination of their availability in the past, will allow us to evaluate the economic importance of these deposits for prehistoric societies.

An accurate identification of chocolate flint from the Kraków-Częstochowa Upland, which is macroscopically similar to that known from the Holy Cross Mountains, will allow us to verify the current state of knowledge on the issue of distribution of this raw material. The results will be important for future research, not only in the Upland itself, but also in other regions located both, in Poland as well as in neighbouring countries.

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SETTLEMENT BASE OF THE NEOLITHIC BANDED FLINT MINES IN KRZEMIONKI OPATOWSKIE – AN OUTLINE OF THE ISSUES

ABSTRACT

Sałacińska B. and Sałaciński S. 2022. Settlement base of the Neolithic banded flint mines in Krzemionki Opatowskie – an outline of the issues. *Sprawozdania Archeologiczne* 74/1, 67-104.

The analysis of the Middle and Late Neolithic settlement pattern confirms the thesis of the significant role of the middle Kamienna river basin in the region of the Sandomierz Upland and the Iłża Forehills as the settlement base for banded flint mines in the area of Krzemionki Opatowskie. Some of the settlements of the Funnel Beaker culture located in the northern and central part of the Sandomierz Upland could be related to exploitation and processing of the: banded and the Świeciechów flint raw materials. The area of the right-bank tributaries of the Kamienna river is considered a settlement base for the prehistoric banded flint mines of the Globular Amphora culture.

The surface survey and test excavation carried out in the middle course of the Kamienna river in the Iłża Forehills, as well as archaeological excavations in the mining field, showed the existence of quite numerous sites from the Neolithic and the Early Bronze Age.

Keywords: Funnel Beaker culture, Globular Amphora culture, Sandomierz Upland, Iłża Forehills, Neolithic settlement, flint raw materials

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INTRODUCTION

The prehistoric banded flint mines in Krzemionki Opatowskie, Ostrowiec Świętokrzyski district, were discovered in 1922 by the outstanding geologist Jan Samsonowicz. The mines have been studied by several generations of Polish archaeologists, and the results of their work have been published in specialist and popular science national and European publications. The main focus was on the issues of prehistoric mining, production and distribution of products and conservation issues (Sałaciński 1997; Matraszek and Sałaciński 2005, 74-89; Sałacińska and Sałaciński 2007; Bąbel 2015, 28-41). The on-mine and next-to-mine settlement was dealt with on a smaller scale. Naturally, all researchers recorded facts related to this issue (Krukowski 1939, 79-83; Żurowski 1962, 28; Borkowski *et al.* 1989, 196-207; Zalewski 1989; Sałaciński 1997, 22-23; Bąbel 2015, 129-131, 183-199; Gamble *et al.* 2018, 73).

In this article, we want to pay attention to the issues related to the settlement base of communities that carried out prehistoric exploitation of banded flint in the mines in Krzemionki Opatowskie. We focus on selected archaeological sites, mentioning their location, chronology and cultural affiliation. The full development of this issue would, however, exceed the volume of this type of publication.

The territorial coverage of the study includes the southern fringes of the Iłża Forehills (the central part of the Kamienna river basin, the immediate vicinity of the complex of banded flint mines in Krzemionki Opatowskie) and the northern edge of the Sandomierz Upland (basin of the Kamionka, Obręczówka, Gierczanka and upper Opatówka rivers), located within the Kielce Upland (Kondracki 1994, 207, 212, 213). The chronological and cultural scope of the study covers the Neolithic (the Funnel Beaker culture – FBC, the Globular Amphora culture – GAC) and marginally the Early Bronze Age (the Mierzanowice culture – MC).

GEOLOGICAL AND ENVIRONMENTAL CONDITIONS

The Iłża Forehills and the Sandomierz Upland are two different regions in terms of geology, geomorphology and environment. The Iłża Forehills is located within the outcropping of rocks of the Jurassic period, and in its eastern part, in the lower reaches of the Kamienna river – of the Cretaceous period ones. It lies in the so-called north eastern Mesozoic fringe of the Holy Cross Mountains. In prehistory, this region was a place of extracting various siliceous rocks – "chocolate" flints, banded flints, Świeciechów and Ożarów flints.

The landform of the region is characterised by low ranges of hills. There are mainly sandy and sandy-rocky podzolic and pseudo-podzolic soils here. The most important river is the Kamienna river, and except for this, the area is largely devoid of surface waters.

Small, essentially periodic watercourses and surface ponding occur in Ostrowiec Świętokrzyski and Kolonia Miłkowska (Budziszewski and Michniak 1989, 151; Kondracki 1994, 207; Kowalski 1997, 19; Jedynak *et al.* 2008, 49-51).

The foundation of the Sandomierz Upland is a geological continuation of the Holy Cross Mountains. The whole upland is covered by loess deposits of considerable thickness. The land area is quite flat, cut by the valley systems of the Vistula tributaries – Koprzywianka and Opatówka rivers, and the tributaries of the Kamienna river – Świślina, Kamionka, Obręczówka and Gierczanka rivers (some of the river names have been changed: Gierczanka to Przepaść, and Obręczówka to Krzczonowianka; some rivers on physical and geographical maps have different names: Kamionka/Szewnianka, Garbutka/Garbatka; the article uses the old names of rivers, accepted and still used in the archaeological literature: *cf.* Kowalski 1975b; Jedynak 2009, 157; Kaptur 2010, 55; Gałka 2016; Kowalewska-Marszałek 2019, 128). The northern border of the upland is formed by the Kamienna river valley and the slope of the loess cover between Ćmielów and Zawichost. The fertile loess soils belong to the brown earth class, and sometimes to the black earth class (Kondracki 1994, 207, 212, 213). It is a region that was seen as conducive to settlement and farming already since the Neolithic (Kowalewska-Marszałek 2019, further literature there).

The two analysed regions are geographically separated by the Kamienna river valley, and in terms of communication, as a water communication route – it connects them.

CHRONOLOGICAL AND CULTURAL FRAMEWORK

Since the discovery of the mining complex in Krzemionki Opatowskie, several generations of Polish archaeologists and other researchers related to archaeology, initially on a secondary basis, and then on a larger scale, dealt with the problem of the settlement base of Neolithic banded flint mines. The traces of settlement located within mine complexes, in places adjacent to the mining field in the area of natural water reservoirs – sinkholes, in staged flint processing camps located between mines and miners' mother settlements, as well as in users' settlements were analysed (selected works: Krukowski 1939; Krzak 1961; 1962; 1993; Żurowski 1962; Kruk 1973; 1980; 2008; Balcer 1975; 2002; Kowalewska-Marszałek 1986; 2018; 2019; Borkowski *et al.* 1989; 1991; Migal and Jaworowska 1992; Zalewski 1996; Sałaciński 1997; Kruk and Milisauskas 1999; Jedynak *et al.* 2008; Jedynak and Kaptur 2008; Uzarowicz-Chmielewska and Sałacińska 2013; Bąbel 2014; 2015; Sałaciński and Sałacińska 2020).

The complex of banded flint mines in Krzemionki Opatowskie itself is located in the Iłża Forehills. In terms of geological structure, it is located in the north-eastern periphery of the Holy Cross Mountains, in the area of the Magoń-Folwarczysko syncline (Budziszewski and Michniak 1989). It is situated about 3-3.5 km from the Kamienna valley (distance measured in a straight line to the east).

The prehistoric exploitation of banded flint in Krzemionki Opatowskie was carried out in the form of surface pits, pit-niche, stall-and-pillar and stall mines. The population of the FBC began the extraction of the banded flint with use of mining methods. They exploited shallow pit and pit-niche mines. This is confirmed by the finds of FBC pottery sherds, coming from the outer part of the mining field. The population of the GAC continued to exploit and developed extractive mining techniques – exploitation was carried out in stall-and-pillar and stall mines. This is confirmed by the finds of pottery fragments of this culture and the forms of roughouts and of tool semi-finished products with quadrilateral section – axe blades and chisels.

After the end of GAC, the exploitation of banded flint disappears, and products made of this raw material are rarely found in the inventories of the Corded Ware (CWC) and Złocka culture. Such a break could last from the end of the GAC to the beginning of the Bronze Age and amounted to about 400-500 years (Balcer and Kowalski 1978, 138-139).

There was a renewal of use of the mine on a limited scale in the Early Bronze Age when communities of the MC began activity in the mining area re-digging Neolithic waste heaps. This is confirmed, among other things, by pottery sherds, semi-finished products of bifacial axes and remains of hoes (Borkowski *et al.* 1989, 201-203; Migal and Jaworowska 1992, 52, 54, 56; Krakowska 1996; Migal and Sałaciński 1997, 105; Sałaciński 1997, 23; Balcer 2002, 21; Bąbel 2014, 80; 2015, 113, 114, 185-193; Sałaciński and Sałacińska 2020, 363-368). In the Sandomierz Upland, mainly bifacial axes and heart-shaped projectile points were found in MC assemblages and in the form of loose finds. Furthermore traces of banded flint tools are known from the sites of the Trzciniec culture in the Sandomierz and Lublin Uplands, proving the use of banded material to a negligible extent in the Bronze Age (Balcer and Kowalski 1978, 139, 140).

Of utmost significance for research on the importance of prehistoric exploitation of banded flint are the analysis of Bogdan Balcer and Krzysztof Kowalski on the distribution of products of this raw material, mainly axe blades and chisels with quadrilateral section in the FBC and GAC, and bifacial axes in contexts of the MC. The maximum range of occurrence of banded flint artefacts in the FBC was 250 km from the deposits, and in the GAC – 660 km from the deposits, while in the MC – 65 km from the deposits (Balcer and Kowalski 1978; Balcer 2015, 128, 129).

A very important issue is the dating of the mine complex in Krzemionki Opatowskie and of the banded flint exploitation of the settlement base. The earliest phases of banded flint exploitation occurs in the years 5000-4700 BC. On the other hand, the most intensive mining work was carried out in the period of 3600-3000 BC, with most of the analysed samples falling within a shorter range of approx. 300 years – from 3300 to 3000 BC (Borkowski and Zalewski 1992; Pazdur *et al.* 1992; Nowak 2009, 327, 334; Bąbel 2015, 124-128). The exploitation of banded flint in niche mines was estimated at around 3340 BC or 3220 BC, in pillar mines around 3370 BC or 3340 BC, 3210 BC and in stall mines 3270 BC or 3110 BC, 3070 BC (Borkowski and Zalewski 1992; Pazdur *et al.* 1992) .

In the Sandomierz Upland, the beginnings of the FBC settlement are set at 3650/3600 BC, the intensification of FBC settlement falls in the years 3500-3300 BC, and its development could last until 2900/2800 BC.

The settlement in loess areas is considered representative for the south-eastern group of the FBC. On the Sandomierz Upland, there was one of the concentrations of the settlement of this culture. The aforementioned group appeared in different areas replacing the earlier settlement of the Lublin-Volhynian culture from its late stage. Its chronology was determined in older publications and was presented in detail by Piotr Włodarczak, who states that the determinations of the absolute age of assemblages from the Sandomierz Upland are consistent with the results of typological analyses developed for the materials of the south-eastern group of the FBC. Its inventories should be linked with the middle and the late stages of the classical phase of development, with the existence of large settlements, with two development stages: II (phase II-IIIA – from 3650 BC to 3400/3300 BC), and III (phase IIIB-IV from 3400/3300 BC to 2900/2800 BC), which can be synchronised with the two main classic development phases from the KPL settlement in Bronocice, Pińczów district (BR II and BR III). According to P. Włodarczak, it is possible to divide stage III into two shorter time sections IIIA and IIIB (Włodarczak 2006; Nowak 2009, 325-344; Kadrow 2009, 140-142; Kruk and Milisauskas 2018, 116-132, older literature there).

In the Sandomierz Upland, the GAC settlement began at the turn of the 4th and 3rd millennium BC, and perhaps the first centuries of the 3rd millennium BC. Until then, there were undoubtedly stable FBC settlements. Their disappearance probably took place during the first two centuries of the 3rd millennium BC as a result of the GAC population expansion, and – soon after – the CWC population expansion (Włodarczak 2006, 56, 57).

The Globular Amphora culture, according to Janusz Kruk and Sarunas Milisauskas, is dated in the Sandomierz and Lublin Uplands (Kruk and Milisauskas 1999, 192) to the range of approx. 2900 BC (2400 bc) to 2500 BC (2060 bc). These data are based also on the studies of Józef Ścibior and findings of Sławomir Kadrow and Marzena Szmyt for the eastern group of the Globular Amphora culture dated from 2950 to 2350 BC (Ścibior 1991; Kadrow and Szmyt 1996, 103-111).

SETTLEMENT TRACES WITHIN THE MINING FIELD IN KRZEMIONKI OPATOWSKIE (ON-MINE ENCAMPMENTS)

Stefan Krukowski, the author of an excellent monograph of banded flint mines (Krukowski 1939), was a precursor of research on prehistoric flint mining in Poland, and at the same time an outstanding expert in Krzemionki Opatowskie. He argued that the miners established encampments on the mining field and beyond it. These were not suitable for use in winter and their occupation was limited to the warmer seasons, they were located every year as open-air or sites with shelters. Population groups involved in the extraction of banded flint were coming to the mines in the spring and were going back to their villages in the fall. Exploitation was discontinued for the winter. The miners also camped in the vicinity of the sinkholes, adjacent to the mines which were constituting for them a source of rainwater (Krukowski 1939, 77-80).

Traces of Neolithic and Early Bronze miners' camps (mainly in the form of pottery sherds of the FBC, the GAC and the MC) were discovered directly at the exploited mines (Borkowski *et al*. 1989, 201-203; Migal and Jaworowska 1992, 52, 54, 56; Migal and Sałaciński 1997, 105; Bąbel 2014, 80; 2015, 185-193).

In the area of the shaft of the deep stall mine 7/610, during the excavation work carried out by the Team for the Study of Prehistoric Flint Mining of the State Archaeological Museum in Warsaw, sixteen variously oriented post-holes were found and interpreted as the remains of a roofing structure covering the shaft. Also discovered were a miners' encampment, a complex of a domestic nature, bonfire traces and a flint processing workshop where axe blades were produced and mining tools of stone and flint were repaired. Apart from mass flint materials, fragments of the GAC ceramics were discovered in two clusters (Migal and Jaworowska 1992; Borkowski 1997, 46, 47). Vessels analogous to them have been discovered, among other places, at the settlement of the GAC in Mierzanowice (Balcer 1963, Pl. II: 3, IV: 4, V: 8, VII: 20, 21). The shaft roofing structure confirms the multi-season nature of mining works (Bąbel 2015, 97, 98). According to the radiocarbon dates, the settlement complex on the surface (encampment) should be dated to the calendar age range to 3280-2940 BC. From the excavations of the underground mine, dates of between 3460 and 2970 BC were obtained. Differences in chronological terms are explained by the influence of natural external factors (Migal and Jaworowska 1992, 55).

SETTLEMENTS WITH DEBRIS FROM VARIOUS STAGES OF FLINT PROCESSING LOCATED IN THE IMMEDIATE VICINITY OF THE MINING EXPLOITATION FIELD IN KRZEMIONKI OPATOWSKIE, IN THE AREA OF SINKHOLES

Traces of Neolithic and Early Bronze settlement in the area of the sinkholes (Fig. 1) by the banded flint mines, neighbouring with the exploitation field in Krzemionki Opatowskie, were recorded during inspections and surface surveys conducted by S. Krukowski in the 20^{s} and 30^{s} of the 20th century. The material gathered included artefacts obtained from the local population and collected at his request (Krukowski 1939; Sałaciński and Sałacińska 2020). Close to the sinkholes, in addition to artefacts of domestic type, including FBC and GAC ceramic fragments (Bąbel 2015, 183-199). Neolithic flint processing workshops of the on-mine type were also discovered, in which roughouts and semi-finished products of axes were produced, having strict analogies to artefacts originating from the mining field (Figs 2: b, d, 3: a; Sałaciński and Sałacińska 2020, 361, figs 9-11). On a smaller scale there was

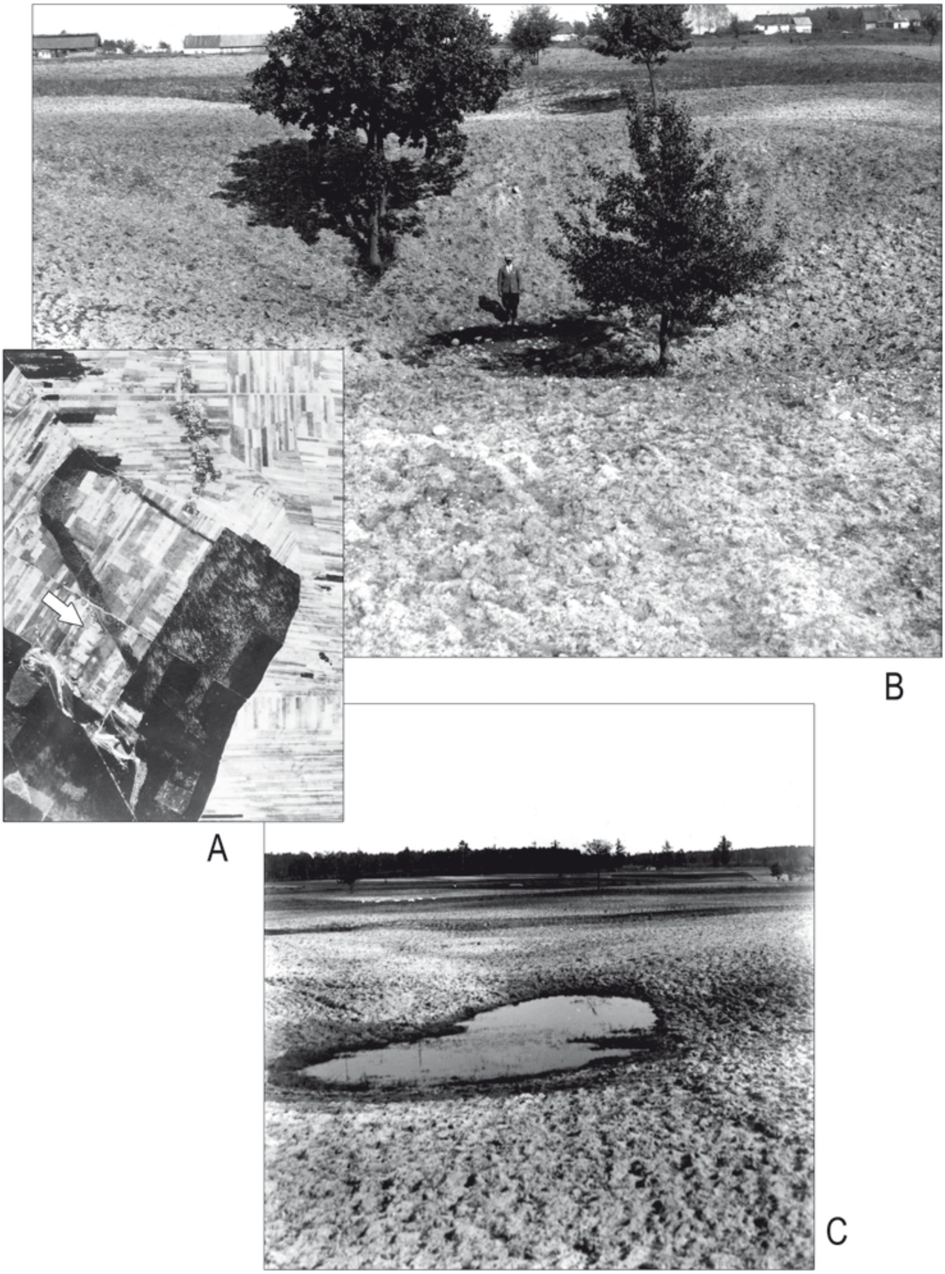

Fig. 1. Krzemionki Opatowskie, Ostrowiec Świętokrzyski district.
A – location of the exploitation field, aerial photo, the 1960s; B – the Kał Hutny Dół sinkhole in the 1930s; C – the Kał Dwojak sinkhole in the 1930s.
Photo from the collection of the State Archaeological Museum in Warsaw

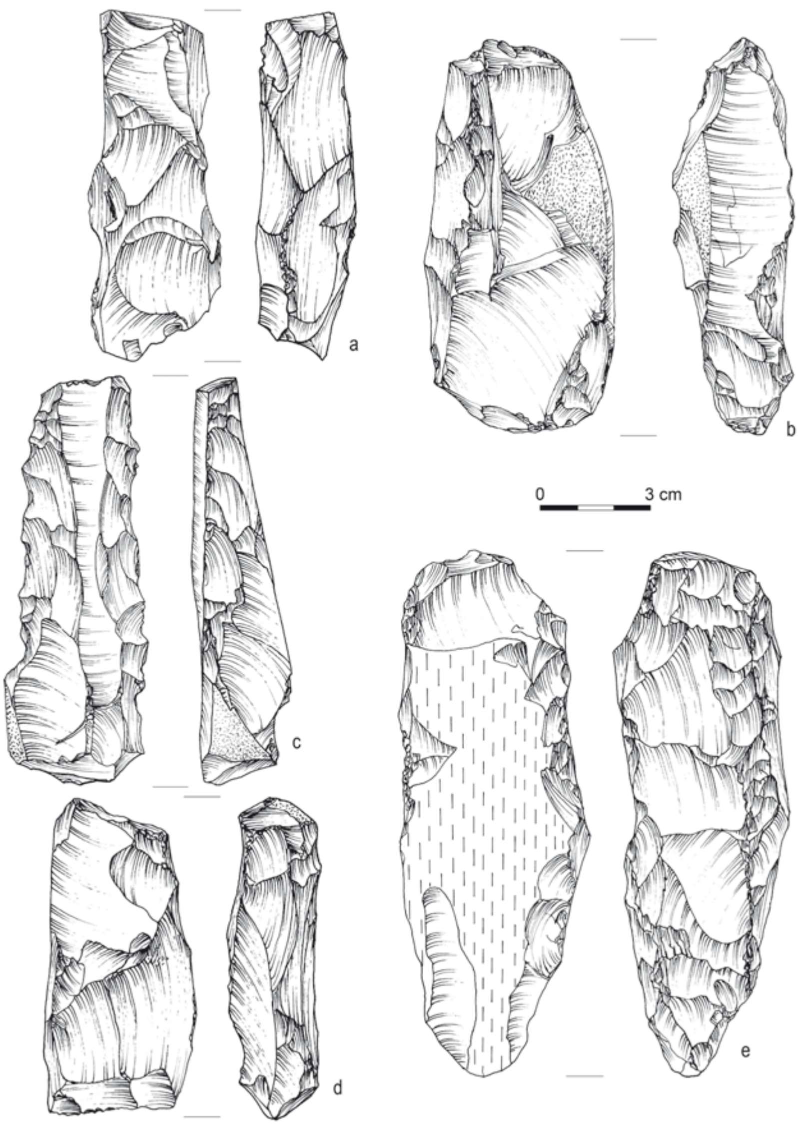

Fig. 2. Core forms of banded flint from encampments located at sinkholes: a – Krzemionki Opatowskie, Ostrowiec Świętokrzyski district, the Kał Plinik sinkhole, semi-finished product of a chisel with quadrilateral section, Globular Amphora culture; b – Krzemionki Opatowskie, Ostrowiec Świętokrzyski district, the Kał Chodnik sinkhole, semi-finished product of an axe with quadrilateral section, Funnel Beaker culture/Globular Amphora culture; c – Krzemionki Opatowskie, Ostrowiec Świętokrzyski district, the Kał Trojak sinkhole, semi-finished product of a chisel with quadrilateral section, Globular Amphora culture; d – Kąty near Jelenia Góra (now part of the village of Sudół), Ostrowiec Świętokrzyski district, semi-finished product of an axe with quadrilateral section, Funnel Beaker culture/Globular Amphora culture; e – Kąty near Jelenia Góra (now part of the village of Sudół), Ostrowiec Świętokrzyski district, pick, Globular Amphora culture. Drawn by B. Karch, graphic design by B. Sałacińska

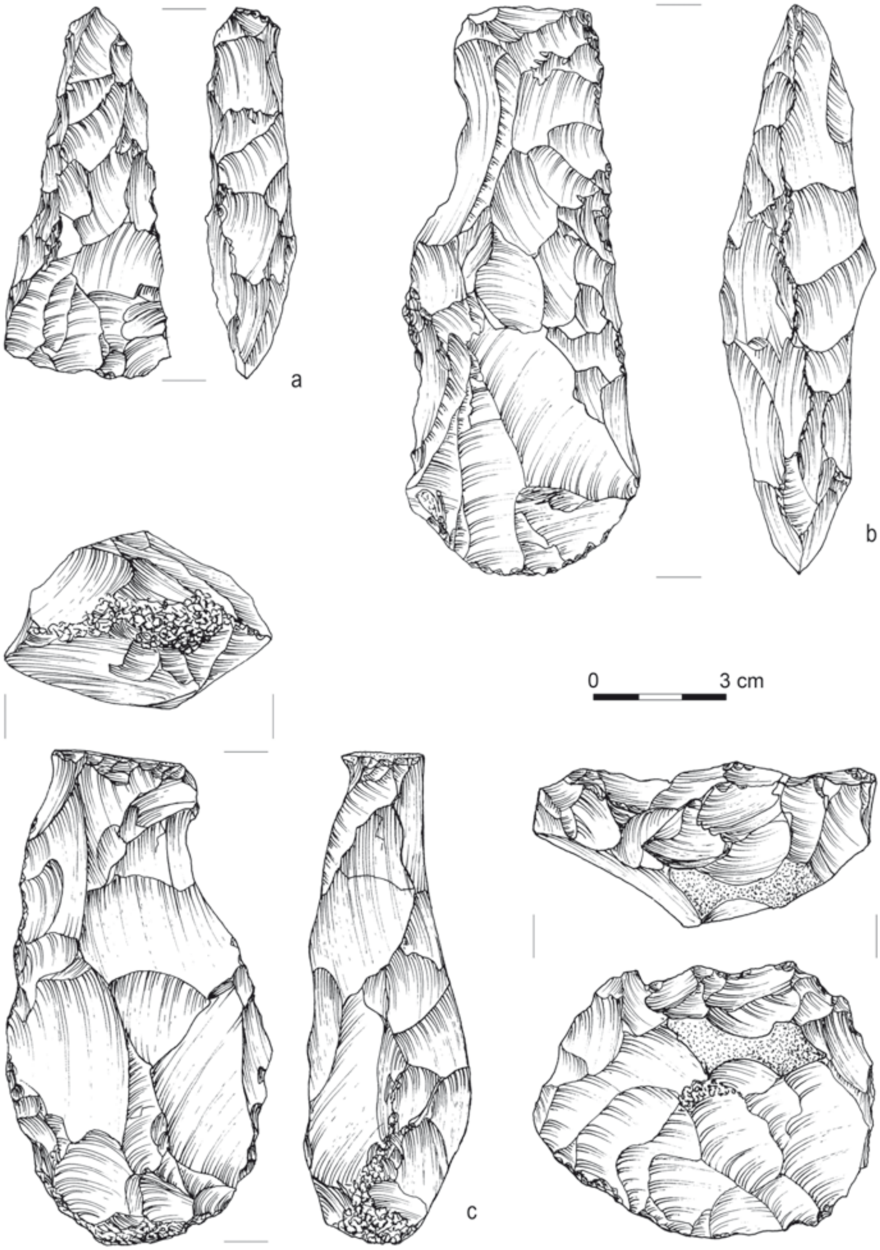

Fig. 3. Krzemionki Opatowskie, Ostrowiec Świętokrzyski district, the Kał Wielki Lej Krasowy or Kał Wielki Dół sinkhole), core forms of banded flint from an encampment located at the sinkhole: a – semi-finished product of an axe with quadrilateral section, Funnel Beaker culture/Globular Amphora culture; b – semi-finished product of a bifacial axe, Mierzanowice culture; c – hoe, Mierzanowice culture; d – flake core, Mierzanowice culture. Drawn by B. Karch, graphic design by B. Sałacińska

evidence for the production of chisel-forms (Fig. 2: a, c; Sałaciński and Sałacińska 2020, 361, figs 12, 13). The close relations with the nearby mines are also confirmed by the mining tools distinguished in the materials from the camps situated by the sinkholes – flint wedges and picks made of banded flint material (Fig. 2: e; Sałaciński and Sałacińska 2020, 364, fig. 17).

Among the tools made of banded flint, both from mine fields and from sinkholes, hoes were also distinguished (Fig. 3: c). They functionally served as digger-tools to work in the upper parts of the shafts and digging up waste heaps to obtain flint chunks. They are dated to the Early Bronze Age and are associated with the MC (Sałaciński and Sałacińska 2020, 364, 367, figs 9: a, 19: a, 20). The semi-finished products of bifacial axe blades are also associated with the MC (Fig. 3: b; Sałaciński and Sałacińska 2020, 361, 364, figs 14, 15) and small cores intended for obtaining flakes for the production of arrowheads (Fig. 3: d; Sałaciński and Sałacińska 2020, 371, figs 21: a, 23).

In the years 1986-1988, Marek Zalewski from the Team for Research on Prehistoric Flint Mining of the State Archaeological Museum in Warsaw conducted excavations near one of the sinkhole called by the archaeologists 'Kał Cebuli' or 'Kał Smużek', located southwest of the border of the mining field. One of the main goals of this work was an attempt to define the connections between the camp and the mines. The analysis of the historic material obtained from the research shows that all production steps of the flint axes of the FBC or the GAC have been produced here, from the initial stage – raw nodules, rough outs, massive cortical flakes, through shaping – scar flakes of several series, to the finishing stages of axe blades – fragments of grindstones (Zalewski 1996).

The workshop-type material discovered at the sinkholes are a testimony to the stages of processing of banded flint in the camps. Excavation research in the area of Kał Cebuli confirmed the findings of S. Krukowski about the great importance of natural water reservoirs in sinkholes for the camp of Neolithic and Early Bronze miners exploiting banded flint in nearby mines (Zalewski 1996, 359, 373; Sałaciński 1997, 23).

In the times of operation of the mines in Krzemionki Opatowskie, not only rough outs and semi-finished axes reached the miners' home settlements, but also, although on a much smaller scale, fragments of flint nodules (concretions) used for other types of products, *e.g.* cores, blade-and-flake blanks and ultimately retouched tools (Sałaciński 1989). The production of semi-finished axes of banded flint on a mass scale was also carried out in flint processing workshops at settlements of the FBC, *e.g.* in Podgrodzie, Ostrowiec Świętokrzyski district (Krzak 1966; Balcer 1975, 185), and above all at the site on Gawroniec Hill in Ćmielów, Ostrowiec Świętokrzyski district (Krukowski 1939, 89; Balcer 2002, 130-145).

Apart from the traces of encampment within the mine area and at the sinkholes neighbouring the mining field, B. Balcer distinguished the mother settlement, the production settlements and the users' settlements (Balcer 1975, 30).

SETTLEMENTS OF THE FUNNEL BEAKER CULTURE IN THE NORTHERN PART OF THE SANDOMIERZ UPLAND

The Sandomierz Upland, especially its northern part (Fig. 4), is considered a settlement base for the population of the FBC that exploited banded flint in the mines in Krzemionki Opatowskie (Krukowski 1939, 84-97; Wiślański 1979b, 246-248; Balcer 1975, 247; Kruk 1980, 105).

This finding is supported by the results of the analyses carried out by Hanna Kowalewska-Marszałek on the Neolithic settlement, which indicate that the Sandomierz Upland is an area of compact, intensive settlement of the FBC (*e.g.*, Kowalewska-Marszałek 2018;

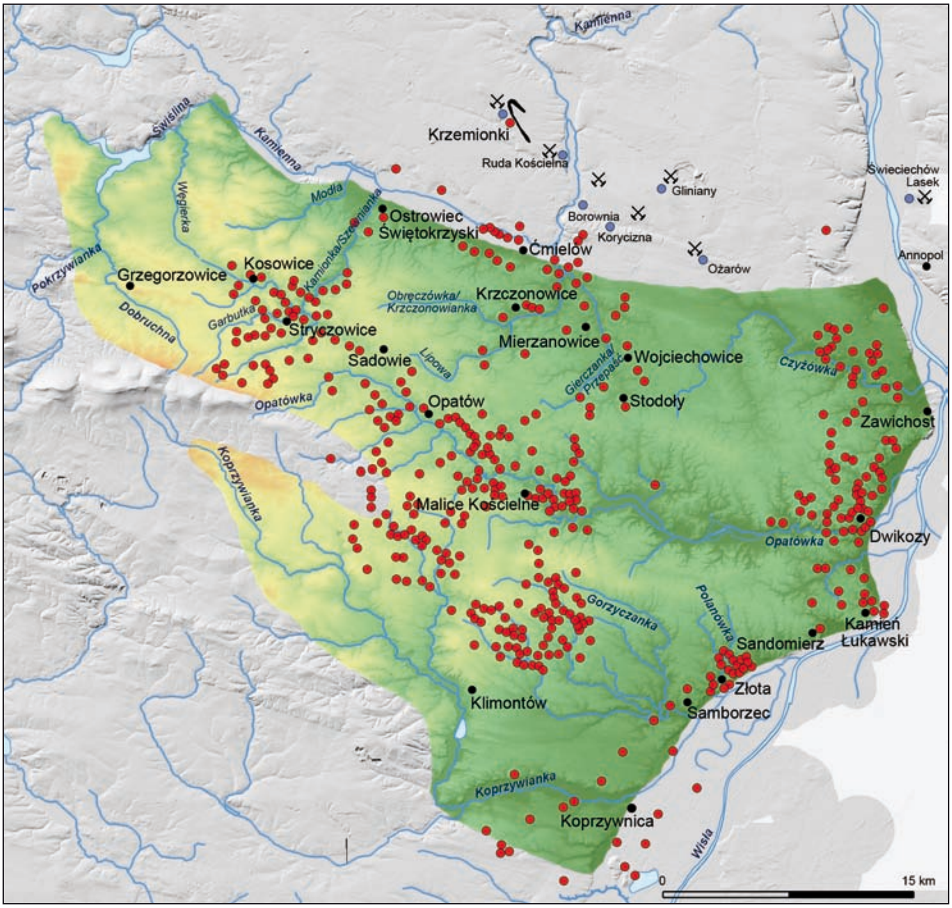

Fig. 4. Sandomierz Upland. Maps of the distribution of settlement points of the Funnel Beaker culture. Based on: Balcer 1971, Fig. 1; Bąbel 2015, Fig. 174; Kowalewska-Marszałek 2019, Fig. 1: a, source: digital terrain model Head Office of Geodesy and Cartography. Graphic design by B. Sałacińska, W. Grużdź

2019, further literature there). The settlement network of this culture is characterised by high uniformity, as well as a preference for regions with similar environmental conditions. The distribution of settlement points is divided into three latitudinal zones: northern, central and southern. Larger concentrations of settlements of the FBC are visible over the upper Gorzyczanka river, the upper Kamionka river, in the Opatówka river basin and in some sections of the Vistula escarpment (around Złota, the area between the Pepper Mountains north of Sandomierz and Zawichost). In the central-western zone, as well as in the northern zone, the most common are large settlements, usually characterised by a high intensity of use. Medium-sized settlements predominate in the central-eastern part. A special category are the so-called upland settlements: situated in places with natural defensive values, including in Stryczowice, site 1, Ćmielów, Gawroniec site, Grzegorzowice, Diabli Piec site, Nikisiałka Duża, site 1 (Kowalewska-Marszałek 2018, 320; 2019, 120-127, 132, figs 1: a, 2: a).

According to H. Kowalewska-Marszałek, the settlement of the FBC in the northern and central part of the Sandomierz Upland may be related to the exploitation and processing of flint raw materials: banded and Świeciechów flints, the outcrops of which are located north and north-east of the Upland (Kowalewska-Marszałek 2019, 127).

The mother settlement of the miners from Krzemionki Opatowskie on the Gawroniec Hill in Ćmielów, Ostrowiec Świętokrzyski district

The mother settlement of miners from Krzemionki Opatowskie, according to S. Krukowski, was located at the site on Gawroniec Hill in Ćmielów (Krukowski 1939, 84-97). The settlement is situated on a loess hill on the northern edge of the Sandomierz Upland, in the Kamienna river valley, which separates the upland from the Iłża Forehills (Fig. 5). The river bed is located approximately 1 km from the settlement.

The site was discovered by an amateur archaeologist, Zdzisław Lenartowicz (Lenartowicz 1922), in the years 1928-1939, it was surface tested by S. Krukowski (Sałaciński 1982; 1989). Open-area excavation research was carried out in the years 1947-1961 (six seasons) by Zofia Podkowińska, and one campaign by Zygmunt Krzak (Podkowińska 1950; 1952; Krzak 1963). During the research, 255 pits were discovered, 245 have been explored.

The connections of the settlement of the FBC in Ćmielów with mining activities and processing of banded flint were emphasised by S. Krukowski, Z. Podkowińska, Z. Krzak and B. Balcer (Krukowski 1939, 84-97; Podkowińska 1950, 165; 1952; Krzak 1962; Balcer 2002, 161-162). Flint products were produced there on a mass scale, above all semi-finished products of axe blades with quadrilateral section were finished there (Figs 6, 7; Balcer 2002, 88). According to S. Krukowski, each year seasonal teams of miners and helpers were sent to the mines in Krzemionki Opatowskie, and the crews were provisioned. There had to be also a market place, most often in the fall (after the grain harvest), where

Fig. 5. Ćmielów, Gawroniec site, Ostrowiec Świętokrzyski district.
A – view of the site, photo M. Bogacki, photo from the collection of the Historical and Archaeological Museum in Ostrowiec Świętokrzyski; B – view of the site, east side, 1982, photo S. Sałaciński; C – view of the site, 2019, photo B. Sałacińska

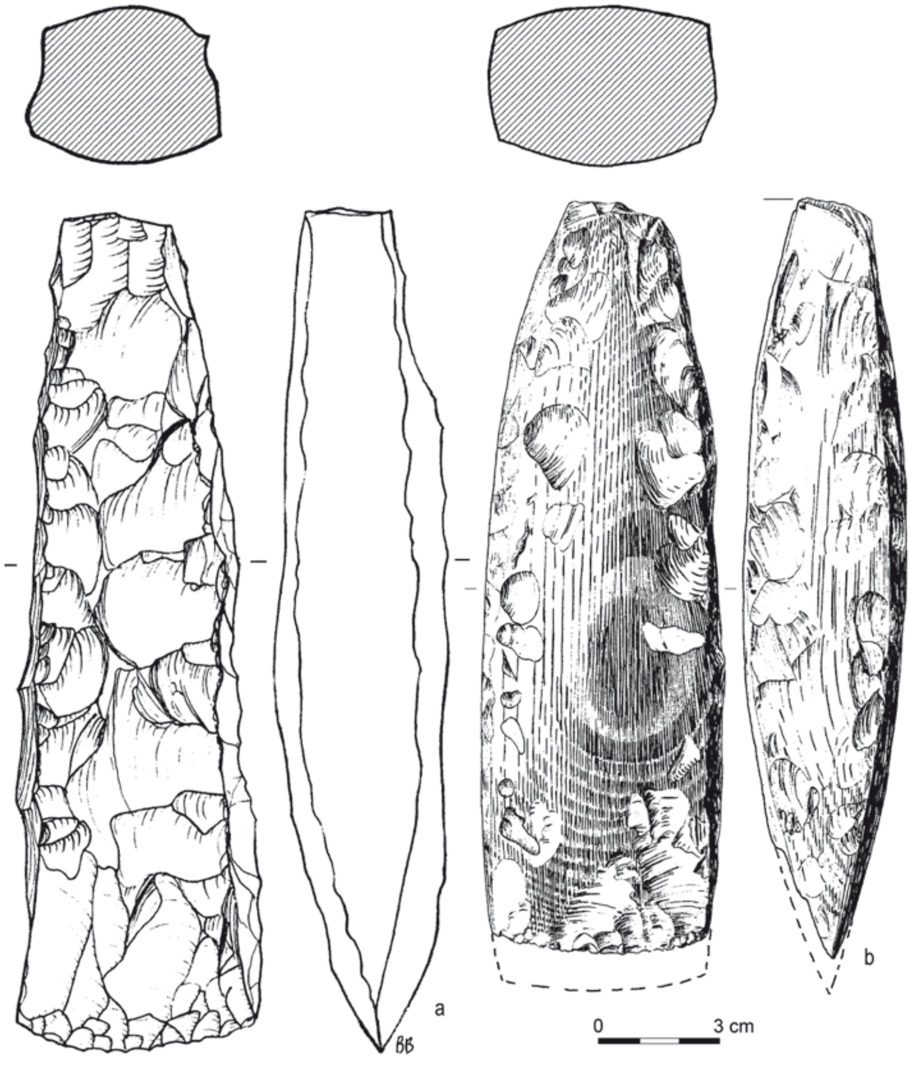

Fig. 6. Ćmielów, Gawroniec site, Ostrowiec Świętokrzyski district.
The biggest banded flint axes of the Funnel Beaker culture (a) and the Globular Amphora culture (b).
After Balcer 2002, fig. 34

a barter trade took place and various agricultural products were obtained from the inhabitants of various villages in exchange for flint products and flint raw material (Krukowski 1939, 105-107). In addition, the commercial importance of the settlement in Ćmielów has been demonstrated by Kazimierz Krysiak, who claimed that the remains of young individuals, which are present in large quantities among animal bones, were obtained during

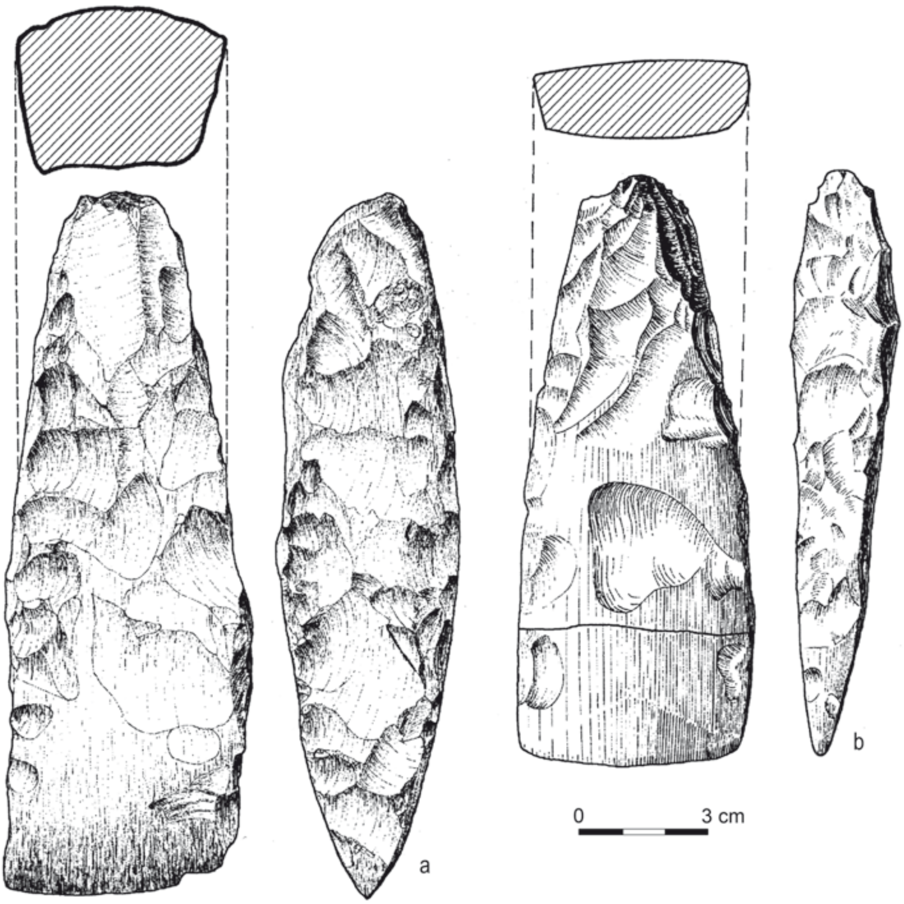

Fig. 7. Ćmielów, Gawroniec site, Ostrowiec Świętokrzyski district.
Axes of banded flint of the Funnel Beaker culture. After Balcer 2002, fig. 35: a, b

the exchange of goods (Krysiak 1950, 166; Podkowińska 1950, 131). K. Krysiak believed that it was a fact worth emphasising that a large number of deer antlers, with a negligible proportion of the bones of these animals, also testifies to their imported origin (Krysiak 1952, 243, 244). However, he did not take into account that they may have come from collecting shed antlers (Sałaciński 1982, 13).

Bogdan Balcer argued that the large number and type of production residues discovered at the Gawroniec site in Ćmielów indicate that the banded and Świeciechów flint came from independent exploitation. He considered the settlement at the site on Gawroniec Hill to be a model production site (Balcer 2002, 147). He believed that the connections between the settlement in Ćmielów and the deposits of the Świeciechów raw material were of greater importance than with the nearby of the banded flints ones. This was because most of the cores, blades and blade retouched tools from this settlement are made of the Świeciechów raw material (Krukowski 1939, 89, 91; Balcer 2002, 130). Both raw materials could be obtained by opencast methods. Within the mining field in Krzemionki Opatowskie, banded flint was mined in area of shallow pit and niche mines, on the outside part of the band of outcrops. More controversially, B. Balcer does not rule out the use of the more labour-intensive method of underground mining in the stall units at the end of the existence of the Gawroniec settlement in Ćmielów or after its collapse (Balcer 2002, 130).

Based on radiocarbon dates, the operation of the settlement of the FBC at the Gawroniec site in Ćmielów covers the period of approx. 3500-3200 BC (approx. 2865-2625 bc) (Balcer 2002, 15).

Specialised teams of miners from the settlement at the Gawroniec site in Ćmielów could reach the area of banded flint deposits in Krzemionki Opatowskie in two ways – on foot through the forest areas of the Kamienna river valley, along well-worn trails, or by foot and by water using the Kamienna river. The raw flint material was initially worked in the mines and then transported to the mother village. There were also places of multi-staged processing, but the scale of processing at such points was not large (Balcer 2002, 155, 161).

Finds of banded flint raw material in the FBC in the form of axe blades and their fragments occur within a radius of 250 km from the deposits, mainly, however, near the mines, on the Sandomierz Upland. In other loess parts of the Lesser Poland Upland and on the fringes of the West-Volhynian Upland, the proportion of banded flint in the assemblages is already small (Balcer and Kowalski 1978).

Settlement of the Funnel Beaker culture in Stryczowice, Ostrowiec Świętokrzyski district

One of the settlements that is linked to the extraction of banded flint in Krzemionki Opatowskie is the settlement of the FBC in Stryczowice, site 1. The site is located in the Sandomierz Upland, on the plateau of the loess upland, between the Garbutka and the Kamionka rivers (Fig. 8). It was discovered in 1970 by Jerzy Tomasz Bąbel (Bąbel 1975, 539). The excavations were carried out in the years 1976-1985 (with breaks for 7 seasons) on behalf of the State Archaeological Museum in Warsaw by Anna Uzarowicz-Chmielewska. Over 17 ares were examined, including 32 settlements features (Uzarowicz-Chmielewska and Sałacińska 2013, 239; further literature there). In the artefacts of banded flint (234 specimens), 12 axes with quadrilateral section were identified (Fig. 9: b-d), partially polished with various degrees of functional damage (Sałaciński 2013, 260). Most of the features were interpreted as various types of economic pits of a storage nature, they certainly had different roofings, three features were described as water tanks. The site in Stryczowice can be associated with multi-path settlements of chaotic development and irregular shape with a zonal arrangement of buildings (Uzarowicz-Chmielewska and Sałacińska

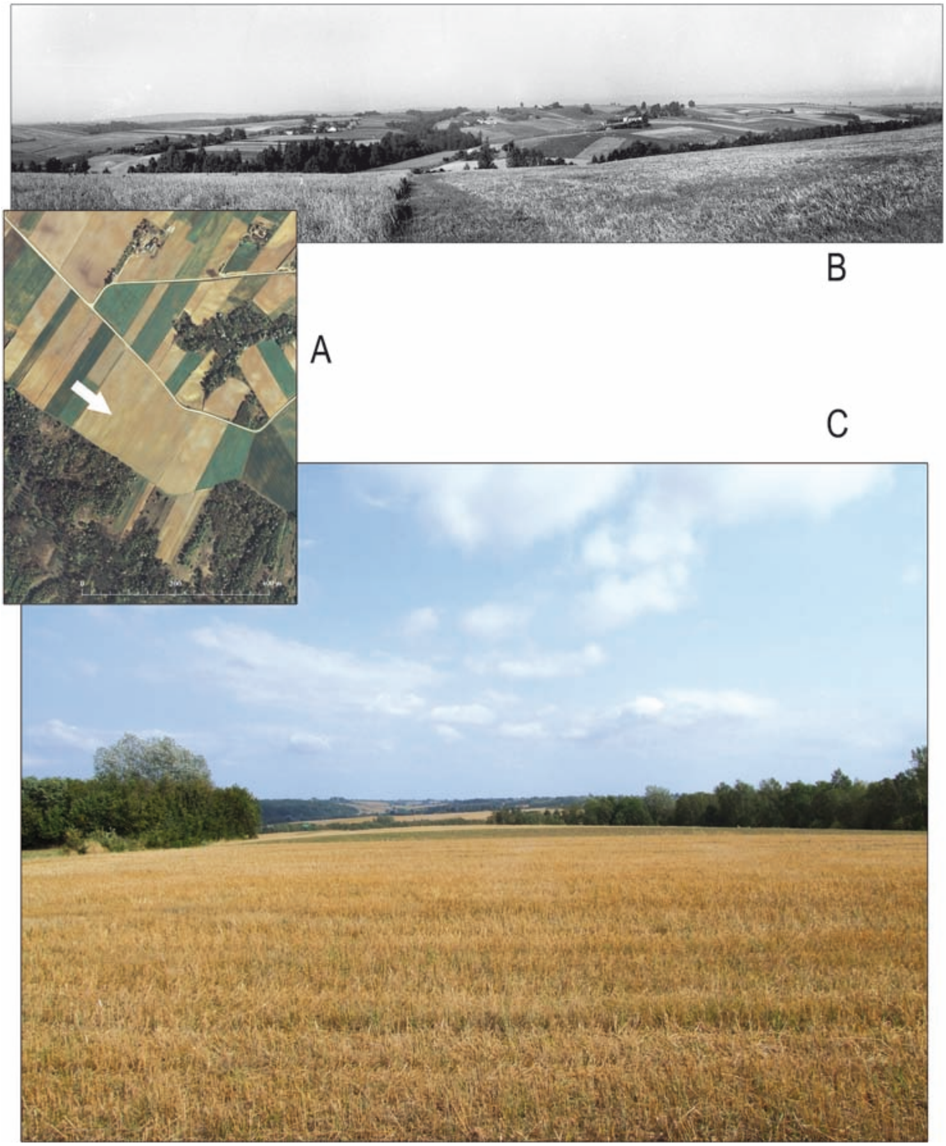

Fig. 8. Stryczowice, site 1, Ostrowiec Świętokrzyski district. A – orthophotomap of the vicinity of the site, source: digital terrain model Head Office of Geodesy and Cartography, after Uzarowicz-Chmielewska and Sałacińska 2013, fig. 3; B – the view from the site at Stryczowice to its surrounding area, 1983, computer image processing R. Sofuł, photo from the collection of the State Archaeological Museum in Warsaw, after Uzarowicz-Chmielewska and Sałacińska 2013, fig. 5; C – view of the site, 2017, photo B. Sałacińska

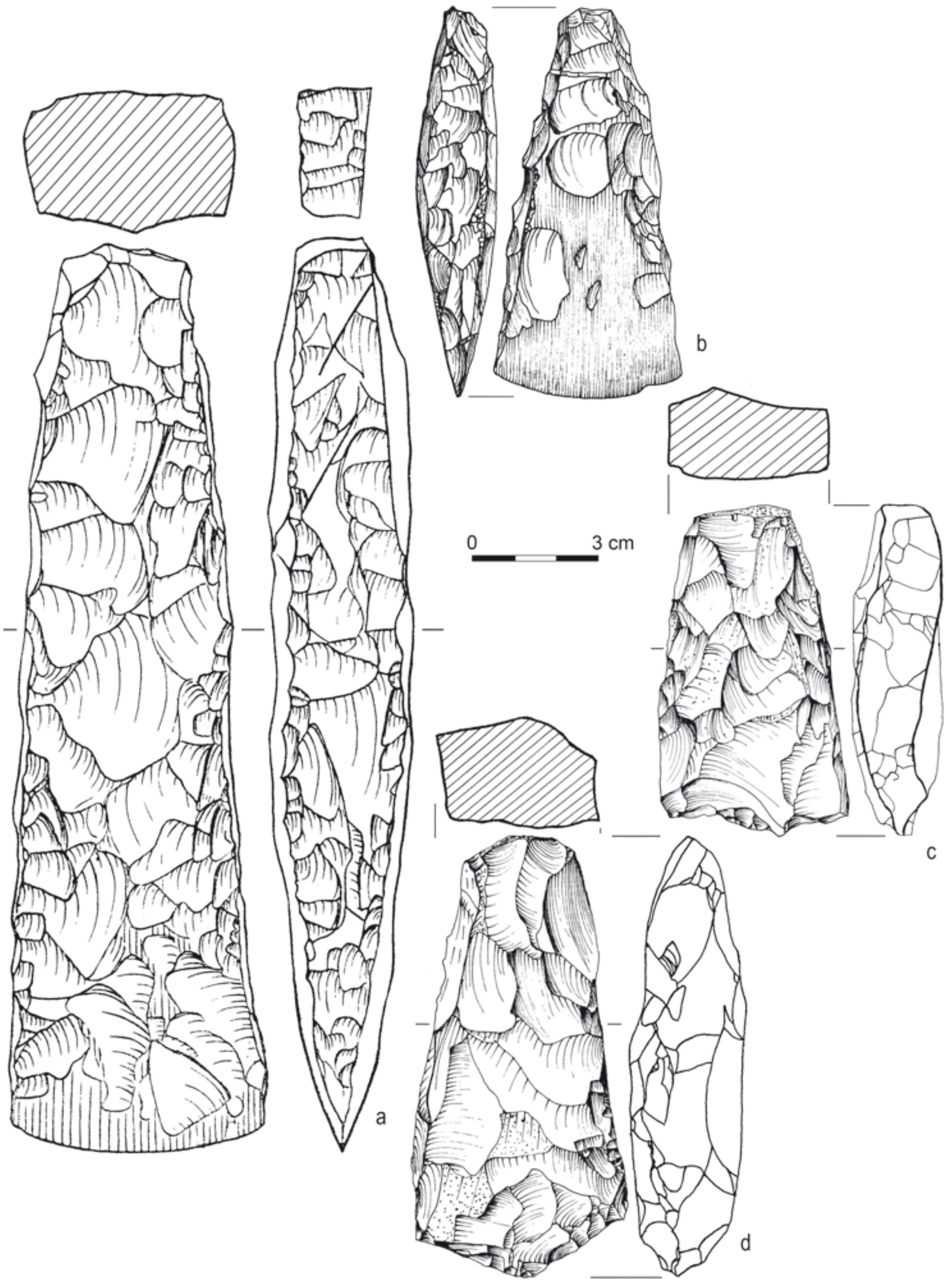

Fig. 9. Axes of banded flint, Funnel Beaker culture.
A – Ostrowiec Świętokrzyski, site 1, Ostrowiec Świętokrzyski district, after Balcer 1983, fig. 21: 13;
b–d – Stryczowice, site 1, Ostrowiec Świętokrzyski district,
after Uzarowicz-Chmielewska and Sałacińska 2013, Figs 29: 1, 2, 149: 4

2013, 223-227). One of the research hypotheses has connected the settlement with the mines in Krzemionki Opatowskie. The mere presence of products of banded flint is not, however, automatic evidence of such relationships. The above assessment may be confirmed by the discovery of a stone pick made of gabbro, which could have been used as a mining tool (Uzarowicz-Chmielewska and Sałacińska 2013, 214, fig. 195). Similar stone picks were discovered in Krzemionki Opatowskie (Borkowski *et al.* 1989, fig. 26). However, this is a single piece of circumstantial evidence in assessing the above hypothesis.

The acquired assemblage of vessel ceramics shows high homogeneity and should be associated with the classical phase of the south-eastern group of the FBC (Uzarowicz-Chmielewska and Sałacińska 2013, 229-232). According to P. Włodarczak, the obtained radiocarbon dates may indicate that the material from Stryczowice is contemporary to the younger dated assemblages from Ćmielów. Their age can most likely be estimated at around 3520-3310 BC, that is the late sub-period of the classical phase, synchronised with the BR III A stage (Włodarczak 2006, 42).

Settlement of the Funnel Beaker culture in Ostrowiec Świętokrzyski, Ostrowiec Świętokrzyski district

Another site of the FBC settlements identified by excavation is the settlement in Ostrowiec Świętokrzyski, site I. The site is located on the northern edge of the Sandomierz Upland, on a loess headland, on the Kamionka river, close to its confluence with Kamienna river. The excavations were carried out in 1942 by Konrad Jażdżewski and Kazimierz Salewicz. During the research, copious Neolithic material was discovered, among other things, a settlement of the FBC functioned here (Fig. 9: a). Ceramics and flint artefacts related to the GAC and the MC were also discovered. A unique find is the vessel of the FBC with an ornament interpreted as a schematic representation of a four-wheeled cart (Uzarowiczowa 1975; Uzarowicz-Chmielewska 1978).

SETTLEMENTS OF THE GLOBULAR AMPHORA CULTURE IN THE NORTHERN PART OF THE SANDOMIERZ UPLAND

The problem of the settlement model at the time of existence of the GAC, related to the extraction of banded flint, according to B. Balcer, has not been resolved definitively and reliably. The production of axe blades from banded raw material within this culture and the distribution of polished specimens over a distance of over 600 kilometres and the stabilisation of the settlement, indicate the enormous importance of deposits, mining and processing in the life of the these communities (Bąbel 2015, 145).

The region of the right tributaries of the Kamienna river – Kamionka, Obręczówka and Gierczanka rivers is treated as a settlement base for the population of the GAC (Fig. 10)

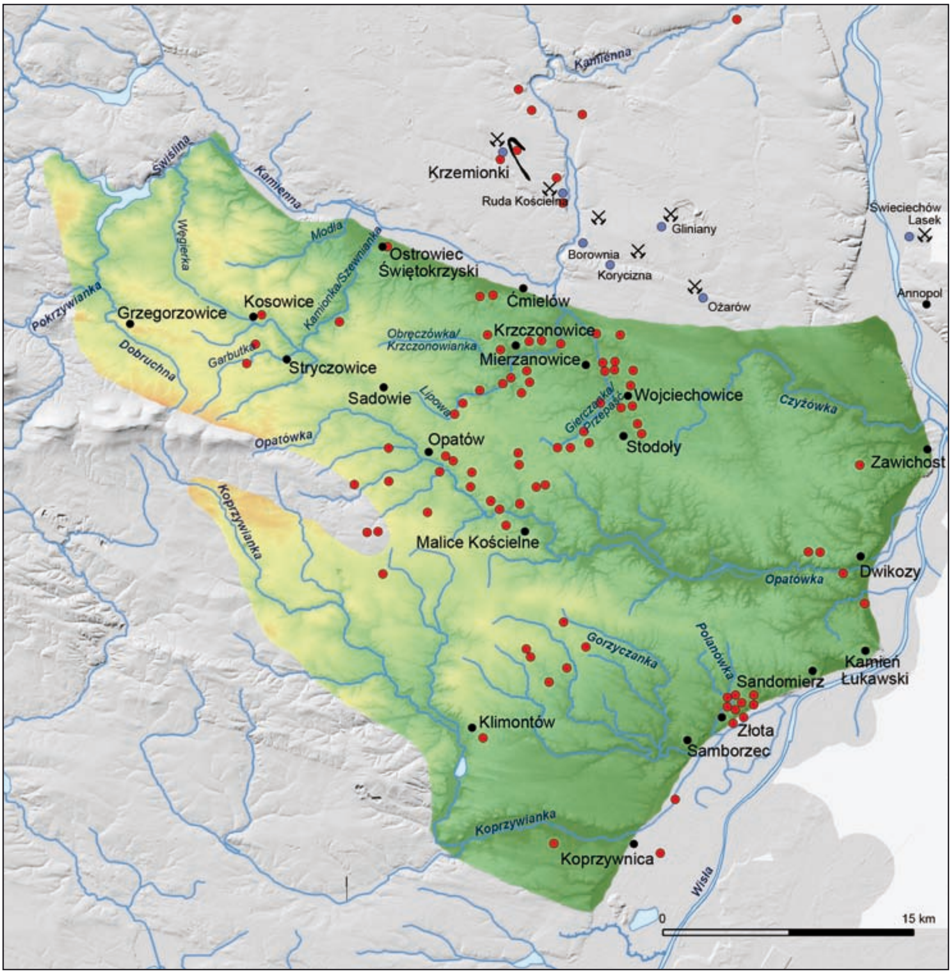

Fig. 10. Sandomierz Upland.
Maps of the distribution of settlement points of the Globular Amphora culture.
Based on: Balcer 1971, fig. 1; Bąbel 2015, fig. 179; Kowalewska-Marszałek 2019, fig. 1: b,
source: digital terrain model Head Office of Geodesy and Cartography.
Graphic design by B. Sałacińska, W. Grużdź

exploiting banded flint in the mines in Krzemionki Opatowskie (Kowalewska-Marszałek 1986, 13, 20, map 4; 2019, 127-139; Jedynak 2009, 166).

According to H. Kowalewska-Marszałek the compact range of occurrence of the settlement of the GAC is confined to the north-western part of the Sandomierz Upland, from the Kamionka river in the west to Gierczanka river in the east, and to the tributaries of the upper and central Opatówka river in the south. Small concentrations of sites are also visible on the upper reaches of Gorzyczanka and Polanówka rivers in the area of Złota, Sandomierz district. In the eastern and southern part of the Upland, only single sites of this culture can be found (Kowalewska-Marszałek 2019, 127-130, figs 1: b, 2: b).

The intensive exploitation of banded flint in the middle and late section of the Neolithic and in the Early Bronze Age undoubtedly required the existence of a settlement base in close proximity of the mines of this raw material. There is much evidence that this role was played primarily by the Sandomierz Upland, which was the natural context of the functioning of the flint mines located in the area of Krzemionki Opatowskie (*e.g.*, Krukowski 1939, 84-97; Balcer 1975, 247; Wiślański 1979b, 246-248; Kruk 1980, 105; Kowalewska-Marszałek 2019, 132).

A detailed analysis of the settlement of the Middle and Late Neolithic fully confirms the thesis about the significant role of the Sandomierz Upland as a settlement base for the banded flint mines in the Krzemionki region. Taking into account all the analysed features of the settlement network of this area, it can be concluded that the relationship with the banded flint mines is more pronounced in the case of the GAC. This is evidenced primarily by the clear concentration of sites of this culture in the northern part of the Upland, in close proximity to the outcrop of this raw material, in the absence of similar concentrations in other regions. There is no such clear accumulation of sites within the FBC, and large settlements of this culture (*e.g.*, Ćmielów, Gawroniec site, Stryczowice, site 1) show a partial relationship with the processing of banded flint (Balcer 2002, 147; Sałaciński 2013; Kowalewska-Marszałek 2019, 132).

Settlement of the Globular Amphora culture in Mierzanowice, Opatów district

One of the studied sites of the GAC is the settlement in Mierzanowice, located on the Sandomierz Upland, in the Gierczanka river valley. The excavations were carried out by K. Salewicz in 1936 (Salewicz 1939) and in 1957 by Aleksander Gardawski and Jacek Miśkiewicz (Gardawski and Miśkiewicz 1958).

The site in Mierzanowice is considered to be a large, stabilised village of farmers and breeders. K. Salewicz mentioned the discovery of dug-out dwellings there. Alongside the features sunk into the ground, there were probably above-ground buildings with lumps of construction daub with impressions of wooden logs and reeds (Salewicz 1939). The investigators, A. Gardawski and J. Miśkiewicz, confirmed the existence of of buildings of such a character. They discovered several large pits with circular outlines, and three of them were forming a compact complex, similarly as in the settlements of the FBC (Gardawski and Miśkiewicz 1958).

K. Salewicz stated on the basis of ceramics that in the case of the GAC we are not dealing here with its pure form, but with its transitional stage to the Złota culture, which he called the Early Złota culture (Salewicz 1939).

The site of the GAC in Mierzanowice is certainly one of the permanent settlements of this culture in the Sandomierz Upland. This is shown by the ownership of deposits and also evidence of mining and processing specialisations. During the existence of the GAC, one settlement was inhabited by a dozen or so people at the same time. The extent of the settlements was to be influenced by the subsequent stages of settling (Balcer 1963, 99-142; 2012, 137, 138; Bąbel 2015, 144, 145).

Settlement of the Globular Amphora culture in Kosowice, Ostrowiec Świętokrzyski district

One site of the GAC in the Kamionka river valley recognised by excavation is the settlement in Kosowice. It was discovered during a surface survey by J.T. Bąbel in 1970. It is situated within the Sandomierz Upland, at the culmination of a loess hill, which slopes south towards the left tributary of the Kamionka river (Bąbel 1975, 553). In 1972, J. T. Bąbel and K. Kowalski conducted test excavations on the site. In one of the trenches, 10 pits were discovered, and seven have been explored (Bąbel and Kowalski 1975, 307).

The obtained historic material is dominated by richly ornamented pottery fragments, characterised by a high homogeneity. Among flint artefacts, relatively few specimens of banded raw material were distinguished, including one flake from a polished axe blade. The most interesting is a semi-finished product of chisel with quadrilateral section – a typical tool in the production inventories of the GAC (Bąbel and Kowalski 1975, 308-312, fig. 18: o). Analogous forms are quite common in the workshop-type materials from the mine area in Krzemionki Opatowskie (Sałaciński 2000, 285, fig. 1; Bąbel 2015, fig. 143: b, 149: b).

All the tested pits and ceramics from the surface of the site belong to the GAC. J.T. Bąbel and K. Kowalski claim that it was a permanent settlement of this culture. The whole ceramic material is similar to the specimens from Mierzanowice. The authors concluded that both sites represent the same chronological horizon, *i.e.* the first quarter of the second millennium BC (Bąbel and Kowalski 1975, 314).

Settlement of the Globular Amphora culture in Krzczonowice, Ostrowiec Świętokrzyski district

Another site of the GAC identified by excavation is the settlement in Krzczonowice, located in the northern part of the Sandomierz Upland, on a loess headland that cuts deep into the valley of the right tributary of the Obręczówka river. The site was discovered during surface survey in the early 1970s by K. Kowalski from the State Archaeological Museum in Warsaw. In 1996 and 1997, it was verified during surface survey carried out as part of the Archaeological Picture of Poland (AZP) campaign by the research team of the Institute of Archaeology of the Maria Curie-Skłodowska University in Lublin.

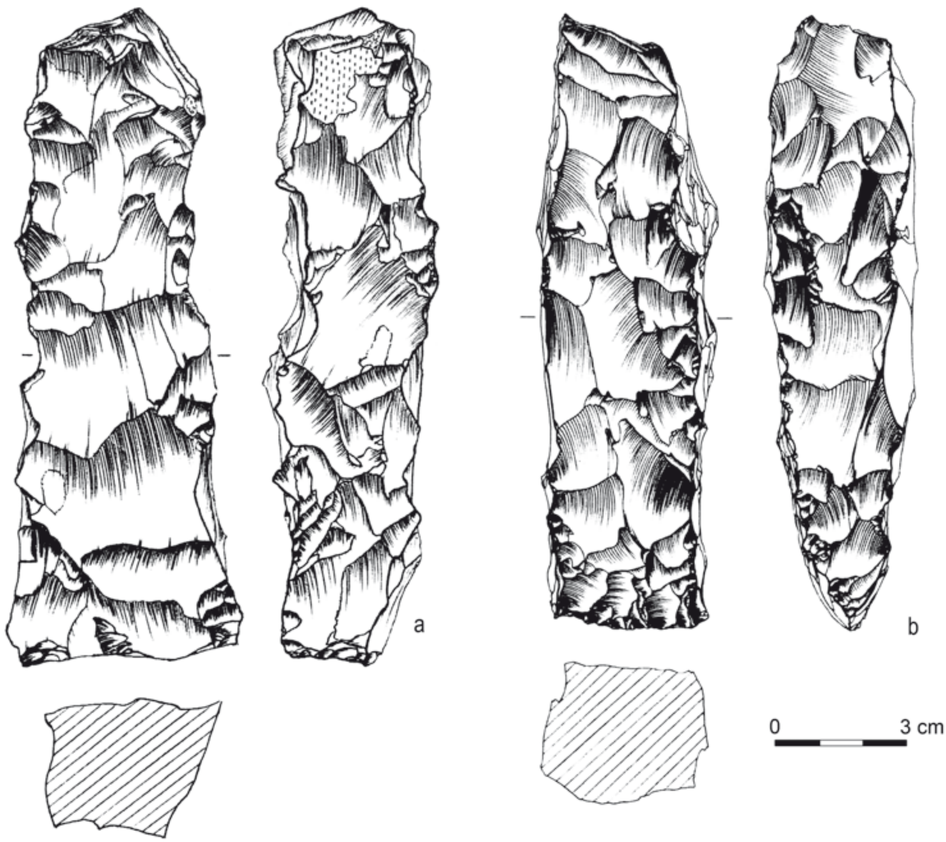

Fig. 11. Krzczonowice, site 63, Ostrowiec Świętokrzyski district. Semi-finished products of chisels with quadrilateral section of banded flint, Globular Amphora culture. After Jedynak 2009, figs 4, 5

In 2006, rescue excavations were carried out by Artur Jedynak and Kamil Kaptur from the Museum and Archaeological and Natural Reserve "Krzemionki", the Branch of the Historical and Archaeological Museum in Ostrowiec Świętokrzyski. The work covered an area of 2.1 ares. 11 features were discovered, including 10 farm pits and a skeleton grave. In one of the features a depression in the bottom was explored, which is most probably the place where the pit roofing or the communication ladder support was attached (Jedynak and Kaptur 2008, 23, fig. 1). The original find is a deposit of four half-products of banded flint, two of chisels with quadrilateral section (Fig. 11) and two of axes with quadrilateral section (Fig. 12). Based on the presence of historic material on the surface, it was found that the settlement occupied an area of approx. 1 hectare. The concentration of features of the GAC was uneven, their size and stratigraphic system, as well as the number of artefacts in fills, suggest the longer lasting of the settlement. The analysis of flint artefacts showed

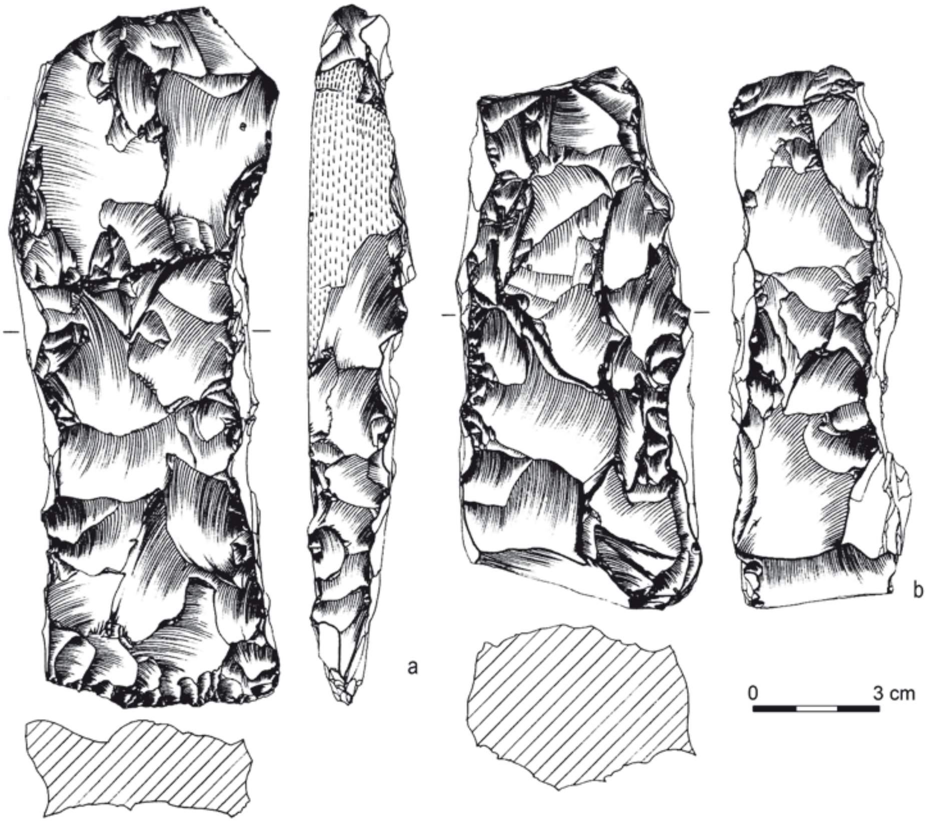

Fig. 12. Krzczonowice, site 63, Ostrowiec Świętokrzyski district.
Semi-finished products of axes with quadrilateral section of banded flint, Globular Amphora culture.
After Jedynak 2009, figs 6, 7

that the site featured materials typical for the home facies – a large percentage of tools (Jedynak and Kaptur 2008, 19, 25, fig. 3). Further excavation research would allow us to obtain evidence of the connections between the inhabitants of the settlement and the area of exploitation of this raw material, situated north of the Kamienna river valley. Dating ceramics using the thermoluminescence method put its age at the years 2716-2069 BC (Jedynak and Kaptur 2008, 20).

Settlement of the Globular Amphora culture in Ostrowiec Świętokrzyski, Ostrowiec Świętokrzyski district

One of the sites of the GAC in the Kamienna river valley, on the northern edge of the loess Sandomierz Upland, is the Globular Amphora settlement in Ostrowiec Świętokrzyski.

It is located in the south-eastern part of the city called Górki. It was examined in 1958 by Janusz Kuczyński during rescue excavations, during which he discovered nine pits of the GAC (Kuczyński 1960).

RELATIONSHIPS OF NEOLITHIC SETTLEMENTS WITH THE BANDED FLINT MINES IN KRZEMIONKI OPATOWSKIE IN THE LIGHT OF SURFACE SURVEY, SOUNDING AND RESCUE EXAMINATION

Z. Krzak was a pioneer in conducting systematic surface surveys in the Sandomierz Upland. He conducted numerous investigatioons in the 1950s, 60s and 70s. He also conducted test excavations at selected sites. Z. Krzak conducted mainly research in the Kamienna river basin and in the north-eastern part of the Sandomierz Upland, including along the right-bank tributaries of the Kamienna and the upper Opatówka rivers (Krzak 1961; 1962; 1993). In 1959, he investigated the areas of banded flint mines in Krzemionki Opatowskie, Borownia, Ostrowiec Świętokrzyski district, and Korycizna, Opatów district, and recognised many settlement sites. Among the discovered sites, more than 20 were Neolithic sites, mainly associated with the FBC. Some of the discovered settlements exhibited an industrial character and connections with the nearby Neolithic and Early Bronze banded flint mines in Krzemionki Opatowskie, Ruda Kościelna, Ostrowiec Świętokrzyski district, Borownia and Korycizna, the “chocolate” flint mines in Gliniany, Opatów district, and the Ożarów flint mines in Ożarów, Opatów district (Krzak 1961).

The research carried out by Z. Krzak in the Kamienna river valley has produced interesting results in the form of discoveries of settlements and encampments of the FBC. In some settlements, including in Grójec and Podgrodzie, both within the Ostrowiec Świętokrzyski district, Z. Krzak distinguished settlement parts with flint processing workshops. An interesting settlement in Podgrodzie, situated on the Kamienna river on the western edge of a loess hill, was cut by numerous ravines and created, hard-to-reach promontories. In one of them, a part of the site with flint processing workshops was located. The site procduced fragments of vessels belonging to the FBC. The flint artefacts were made of several types of raw material. The main compenent was flakes of various sizes made of banded flint, which were produced by the finishing of semi-finished products of axe blades with quadrilateral section. A lot of fragments of repaired polished axes and semi-finished products of axes with quadrilateral section (some were reused as pestles) and retouched flake tools were also discovered within the settlement (Krzak 1961; 1962, 32-34).

Another site, discovered during the surface prospecting by Z. Krzak and surveyed, is located in Skała, now it is part of the town of Ćmielów, Ostrowiec Świętokrzyski district. The site is located on the edge of a sandy and rocky ground moraine, on the right bank of the Kamienna river. Z. Krzak found traces of settlements there: pits and postholes from a wooden structure. The obtained pottery fragments represented two cultures – the FBC and the CWC (Krzak 1962, 37, 38).

In Smyków, Ostrowiec Świętokrzyski district, Z. Krzak accidentally discovered a FBC settlement pit located on the dune on the edge of the right terrace of the Kamienna river, with pottery fragments of FBC together with flint artefacts of several raw materials – the Świeciechów, banded and "chocolate" flint (Krzak 1962).

In 1960, in the Kamienna river valley – in Piaski Ćmielowskie and Przepaść (both sites are now located in the part of the town of Ćmielów, Ostrowiec Świętokrzyski district), Z. Krzak discovered camps where banded flint was processed on an *ad hoc* basis (Krzak 1962, 39-44). The collected material was dominated by the production waste from semi-finished axe blades (Balcer 1975, 185). In Piaski Ćmielowskie, the camp of the FBC was located on the left, accumulation terrace of the Kamienna river. Z. Krzak located there the outlines of settlement pits and traces of posts. Among the discovered flint artefacts, mainly flake tools, banded flint was the dominant material (Krzak 1962, 39, 42).

According to B. Balcer, the production camps were the predecessors of the later large settlements where banded flint was processed on a larger scale, and they come from older periods, when agriculture was not yet dominant. They could also be satellite settlements of groups periodically remaining outside the area of their mother settlements or they are traces of settlement after the fall of great upland settlements (Balcer 1975, 185, 186).

In 1960, Z. Krzak conducted research in the area of the alleged route connecting the industrial settlements of the FBC on the Kamienna river with similar settlements on the Vistula river. The starting point was, on the one hand, the settlement at the Gawroniec site in Ćmielów, and, on the other, an analogous settlement: the Zbrza Wielka site in Zawichost, Sandomierz district. The settlement of the FBC on the Gawroniec site in Ćmielów is one of the largest ones, using banded flint from Krzemionki Opatowskie, and the settlement of the FBC at the Zbrza Wielka site in Zawichost is among similar ones, primarily using the Świeciechów raw material, exploited in Świeciechów, district Kraśnik, from which artefacts were also found in Ćmielów. The above-mentioned settlements are situated 25 km apart in a straight line, separated by a loess upland, cut by numerous streams flowing into the Kamienna river on one side, and into the Vistula and Opatówka rivers on the other. He discovered numerous Neolithic and Early Bronze sites – settlements and cemeteries of the FBC, including Cieszkówek, Opatów district, of the GAC – Podgajcze, Opatów district (Krzak 1962).

In 1969, Z. Krzak, together with Iwona Kupczyk, also conducted surface survey in the basin of the upper Opatówka river, from its sources to the village of Nikisiałka Mała. Opatówka flows out of the Holy Cross Mountains Range and is a left tributary of the Vistula. The study area is adjacent to the Jeleniowskie Range on the south-west. The catalogue attached to the publication contains information on 67 sites, 36 of which were considered Neolithic, including 17 FBC and 4 GAC sites. Few characteristic forms were distinguished among the obtained historic materials of the FBC made of banded flint, *e.g.* flakes chipped from polished axes in Zochcin, Zochcinek, Nikisiałka Mała, all within Opatów district, and a hammer made of an axe with quadrilateral section from Wąworków, Opatów district. Artefacts belonging to the GAC, including those made of banded material, are few. In Nikisiałka Duża, Opatów district, apart from flakes, a fragment of a half-product of an axe with quadrilateral section was discovered in the flint inventory (Krzak 1993).

In the late 1960s and early 1970s, further surface surveys in the right-bank tributaries of the Kamienna river in the analysed part of the Sandomierz Upland were carried out by K. Kowalski and J. T. Bąbel. In 1969, K. Kowalski carried out a survey in the basin of the Obręczówka river, which is part of the basin of the Kamienna river. He recorded 43 previously unknown sites, dated mainly to the Neolithic (Kowalski 1975b). In 1970, J. T. Bąbel carried out surface research in the Kamionka river basin, focusing on the location of Neolithic and Early Bronze sites. He discovered and verified 125 settlement points (Bąbel 1975). In 1983, J. T. Bąbel carried out surface research in the Gierczanka river basin, in the area of Mierzanowice and Wojciechowice, both localities in the district of Opatów (Bąbel 1985).

Systematic surface research in the Sandomierz Upland in the 1980s, 1990s and in the first decade of the 21st century, as part of the Archaeological Picture of Poland (AZP) project, was conducted by Barbara Bargieł, Marek Florek, Jerzy Libera, Anna Zakościelna (Institute of Archaeology, of the Maria Curie-Skłodowska University in Lublin), Janusz Budziszewski (then the Institute of Archaeology of the University of Warsaw), Hanna Kowalewska-Marszałek (Institute of Archaeology and Ethnology of the Polish Academy of Sciences in Warsaw), Sławomir Sałaciński (State Archaeological Museum in Warsaw), Szymon Orzechowski (then the Provincial Office for the Protection of Monuments in Kielce), Tadeusz Wichman, Ryszard Naglik (Archaeological Museum in Krakow), Urszula Jedynak and Artur Jedynak, Kamil Kaptur (Archaeological Museum and Reserve "Krzemionki", Branch of the Historical and Archaeological Museum in Ostrowiec Świętokrzyski). The above-mentioned surface studies focused on the area of some districts – Ostrowiec Świętokrzyski and Opatów, intensively inhabited in the Neolithic period, with a clear predominance of FBC sites. Each sheet of the Archaeological Picture of Poland survey contains several hundred settlement points, including camps and larger settlements. Their concentrations were noted especially in the communes of Ćmielów and Opatów, and on a smaller scale – in the commune of Ożarów. Flint processing workshops of the FBC were discovered in Opatów district. During his surface research in the 1980s, S. Sałaciński located in the vicinity of Ćmielów several settlements of the FBC, quite extensive, with household materials and a large number of flint artefacts similar to those discovered at the site on Gawroniec Hill in Ćmielów. They formed a settlement network of considerable importance in spatial and economic systems. B. Balcer treated this information sceptically, sustaining the uniqueness of the settlement on the Gawroniec Hill in Ćmielów (Balcer 2002, 161). S. Sałaciński's opinions partially confirm the results of rescue excavations, carried out in 2016-2017, preceding the construction of the Ćmielów ringroad. In the limited belt of the development, Edmund Mitrus discovered and explored part of the FBC settlement in Brzóstowa, site 25, Ostrowiec Świętokrzyski district (31 features, 1,100 pottery fragments, 141 flint artefacts, 134 animal bones), and settlements of the FBC in Ćmielów, site 80, Ostrowiec Świętokrzyski district (4 features, 37 pottery fragments, 2 flint artefacts, 18 bones).

Sławomir Sałaciński dealt with the settlement base of the banded flint mines in Krzemionki Opatowskie in the Stone Age in the Kamienna river basin (Sałaciński 1986). In 1987, S. Sałaciński with M. Zalewski conducted surface research in the vicinity of the village of Stodoły, Opatów district. The research covered the edge of the loess hill and its slope falling towards the narrow valley of Gierczanka river, which is the left tributary of the Obręczówka river (the right tributary of the Kamienna river). The site, which was the object of detailed penetration, was defined as a large, homogeneous settlement of the GAC, and this is something that is rare on the scale of the entire settlement of this culture. The issue of the size and the alleged multi-phase nature of the settlement in Stodoły and its possible connections with banded flint mines has been raised many times in the literature. Their existence was to be proved by finds of artefacts produced of this raw material (among other works Wiślański 1979b, 278). During the surface research, the focus was on finding possible processing places of the banded flint, determining their character (phases of production processes) and possible connections with the mines in Krzemionki Opatowskie. The historical material was found in a large area, stretching about 600 m along the valley, in a strip about 100 m wide. Compact clusters of artefacts have been distinguished within this zone; zones of occurrence of artefacts of the FBC, the GAC and the CWC were highlighted. There were also traces of the later settlement of the Mierzanowice, the Lusatian and the Przeworsk cultures (Zalewski and Sałaciński 1996).

The material discovered during surface studies allow for the determination of two main settlement phases. The oldest traces of the presence of human groups date back to the Middle Neolithic and are related to the FBC, they have been discovered over the entire surface of the site. Artefacts of the MC mark the next phase of settlement. In addition, material confirming the use of the site by the population of the GAC were also located, but they were assessed as of short duration. In connection with the above, the opinions functioning in the literature on the homogeneity and the size of the GAC settlement were questioned. During the described research, no traces of flint processing were found on the site's surface. The presence of banded flint artefacts only confirms the existence of direct or indirect contact with the mines in Krzemionki Opatowskie. Moreover, S. Sałaciński and M. Zalewski stated that in the case of the GAC, the scheme: mines – production settlements and user settlements, formulated for the FBC by B. Balcer, should not be automatically transferred to this period too. The conclusions were based solely on the results of surface studies, and therefore require further verification (Zalewski and Sałaciński 1996).

In the years 2004-2006, Artur Jedynak, Urszula Jedynak and Kamil Kaptur carried out surface surveys to identify prehistoric and later settlements north and west of the middle and lower reaches of the Kamienna river in the Iłża Forehills, in the context of exploring the settlement base of the mine complex in Krzemionki Opatowskie. In the studied area, sites from the Neolithic and the Early Bronze Age are quite numerous. In the immediate vicinity of the exploitation field in Krzemionki Opatowskie, a large number of flint processing workshops were discovered, among other places in the area of the village of Sudół (Sudół, site 17, Ostrowiec Świętokrzyski district) and traces of flint work (Sudół, sites 11, 15, 19-21, Ostrowiec Świętokrzyski district), in the area between the village of Magonie and the Ostrowiec Świętokrzyski – Bałtów highway and the northern arm of the exploitation field in Krzemionki Opatowskie. No remains of large settlements have been discovered in the immediate vicinity of the mines. Settlement related to the FBC was registered in the Kamienna river valley, below the village of Skarbka, including Skarbka, site 26, Pętkowice, site 12, Okół, site 20, all in the Ostrowiec Świętokrzyski district (Jedynak *et al.* 2008).

The collection of the State Archaeological Museum in Warsaw includes loose Neolithic finds from the Sandomierz Upland and the Iłża Forehills. They were obtained in the prewar period of the 20th century, and even from the 19th century. Some of them are made of banded flint and are linked to, among others, the FBC and the GAC. The rich inventory of the FBC comes from the localities of Grzegorzowice and Grzegorzowice-Zagaje, Ostrowiec Świętokrzyski district, including numerous polished axes with quadrilateral section and their fragments. A stone axe with a knobbed shaft-hole and fragments of ceramics, mainly of the FBC (Kowalski 1975a). The collection of flint materials from the collection of the State Archaeological Museum in Warsaw – 644 artefacts, was created by Aneta Sierosławska with S. Sałaciński's substantive consultation (Sierosławska 2012). Some of these materials come from the Diabli Piec site in Grzegorzowice-Zagaje, Ostrowiec Świętokrzyski district, from the FBC settlement (now administratively within the village of Czajęcice), dug up by amateur Józef Budzisz in 1940-1942. This site is located on a loess headland with heavily undercut slopes, on the edge of the Dobruchna river valley, separating the Sandomierz Upland from the Wilkowski Depression in the northern part of the Holy Cross Mountains mesoregion.

Axeheads of the GAC were distinguished, among other places, in material from Jelenia Góra, Lemierz, Stoki Stare (2 half-products), all within the Ostrowiec Świętokrzyski district, which are located in the immediate vicinity of Krzemionki Opatowskie on the Iłża Forehills, as well as in the material from Malice, Podgajcze, Tomin, Zawady, all within the Opatów district, located in the Sandomierz Upland (Kowalski 1975a).

A FEW SYNTHESISING REMARKS

The relationships of the Neolithic flint mining, including the production of banded flint, with the settlement have been the subject of research of many prehistorians, some of them treated this issue briefly, for others it constituted a very serious aspect in their analyses.

Synthetic studies on the Neolithic economic foundations have repeatedly pointed to the nature of the complex of banded flint mines in Krzemionki Opatowskie as the central mining centre, important for the development of flint working and mining. The importance of FBC settlements located in the immediate vicinity of the loess Sandomierz Upland was also emphasised, especially for the Gawroniec site in Ćmielów, primarily as the mother-settlements of the miners involved in the exploitation of banded flint and as production centres of banded flint products, which also participated in the development of long-distance exchange (Tabaczyński 1970, 276-282; Wiślański 1979a, 286-291; 1979b, 249-250; Kruk 1980, 51; 2008, 72).

Janusz Kruk deals with settlement phenomena in the Neolithic period, which were shaped under the influence of a number of natural (environmental) and cultural conditions (among others Kruk 1973). According to J. Kruk, the land-take process was based on the selection of suitable habitats. The main reasons for the development of spatial forms of settlement should be sought in the set of cultural processes, especially in the structure of the economy. J. Kruk dealt with the reconstruction of the forms of gaining control over the environment by the communities of Neolithic cultures. The appearance of the FBC resulted in substantial changes in forms of the mastery of the natural environment. The studied sites showed a tendency to occupy higher areas. They were located at the fringes of the high plains, on average 30-60 meters above the plains of the river accumulation (Kruk 1973, 11, 99).

The results of the analysis of the structure of settlement clusters suggest the possibility of the existence of close connections between permanent central settlements and the traces of temporary residence deployed in their wide surroundings. The loess areas were taken over by the FBC tribes probably at the end of the Atlantic period, around 3000 BC (Kruk 1973, 180). The nature of the encampments is different than that of the great loess villages. Among them are encountered both short-term places of stay and semi-permanent settlements that could have exist for one economic season, for example, in summer (Kruk 1973, 212).

Tadeusz Wiślański was an outstanding researcher of the Neolithic settlement issues. Among the loess settlements of the FBC he distinguished three categories – large, medium and small ones. The large ones were established only on highlands, the medium ones also preferred higher points, but sometimes they were located in valleys. The most common site type were small camps occupying *e.g.* high plains. The extensive loess settlements were multi-phase and they did not always cover the entire area of multi-hectare hills at the same time. As a rule, they did not exceed 25-40 households. Medium-sized settlements with 15 homesteads and smaller villages composed of several houses prevailed (Wiślański 1979b, 208-210).

According to T. Wiślański, individual mines in the depression of the terrain on the north-eastern slopes of the Holy Cross Mountains had connections with extensive mining and production villages. An open question is how the inhabitants of these villages were procuring the necessary half-products. They could wander to the outcrops themselves and produce them there in situ. The mediation of the inhabitants of large loess production estates or camps associated with them also seems probable (Wiślański 1979b, 249).

Regarding the culture of GAC, the oldest complexes were confined, according to T. Wiślański to the lowland areas, but they quickly took over the loess zone as well. The spread of settlement of this culture shows some similarities to the FBC. T. Wiślański distinguished two categories of settlements – seasonal camps and permanent settlements, which, however, are rare. Extensive late-phase settlements on the loesses of the Sandomierz Upland (*e.g.*, Mierzanowice, Stodoły, Złota) were multi-phase and showed connections with the flint-bearing basin. Permanent estates were located on the hills, closer to water reservoirs than the encampments. Various types of pits with different functions were discovered there – garbage dumps, cellars, granaries, furnaces. The most common form of settlement were seasonal camps. They occurred both in the lowlands and in loess areas. They were often short-term staging points (Wiślański 1979a, 277-280).

In common use were axes and chisels with the entire surface carefully polished, made mainly of banded flint material. There was a specialisation in mining and flint processing in the GAC, which started in the Holy Cross Mountains region of the FBC. In the GAC, banded flint products were distributed en masse throughout the basin of the Vistula and Oder rivers, reaching Moravia and Saxony. During this period, the popularity of this raw material was at its peak. The GAC developed a far-reaching mining and production specialisation, bringing significant benefits. Mass export of banded axes took the form of a far-reaching exchange, especially downstream along the Vistula (Wiślański 1979a, 286, 290-291).

The intensive exploitation of banded flint in the middle and late section of the Neolithic and in the Early Bronze Age undoubtedly required the existence of a settlement base in the close proximity of the mines of this raw material. There is much evidence that this role was played primarily by the Sandomierz Upland, which was the natural context of the functioning of the flint mines located in the area of Krzemionki Opatowskie (*e.g.*, Krukowski 1939, 84-97; Balcer 1975, 247; Wiślański 1979b, 246-248; Kruk 1980, 105; Kowalewska-Marszałek 2019, 132).

One of the most important analyses for determining the significance of the FBC and GAC settlements in the Sandomierz Upland are the studies of the settlements of these cultures conducted by H. Kowalewska-Marszałek. They showed that the Sandomierz Upland is an area of compact, intensive settlement of the FBC. The settlements of the FBC in the northern and central part of the Sandomierz Upland may be related to the exploitation and processing of flint raw materials: banded and Świeciechów flints, the outcrops of which are located north and north-east of the Upland (Kowalewska-Marszałek 2018, 320; 2019, 120-127, fig. 1: a, 2: a).

The compact range of occurrence of the settlement of the GAC, on the other hand, is confined to the north-western part of the Sandomierz Upland, from the Kamionka river in the west to Gierczanka river in the east, and to the tributaries of the upper and central Opatówka river in the south. Taking into account all the analysed features of the settlement network of this area, it can be concluded that the relationship with the banded flint mines is more pronounced in the case of the GAC. This is evidenced primarily by the clear concentration of sites of this culture in the northern part of the Upland, in close proximity of the raw material's outcrop, in the absence of similar concentrations in other regions. There is no such clear accumulation of sites within the FBC, and large settlements of this culture (*e.g.*, Ćmielów, Gawroniec site, Stryczowice, site 1) show a partial relationship with the processing of banded flint (Balcer 2002, 147; Sałaciński 2013; Kowalewska-Marszałek 2019, 127-130, 132, fig. 1: b, 2: b).

CONCLUSIONS

The article outlines the issues related to the settlement base of the Neolithic banded flint mines in Krzemionki Opatowskie. The focus was on the central Kamienna river basin in the region of the Sandomierz Upland and the Iłża Forehills, and on two cultures: the FBC and the GAC. It is assumed that the population of the first of them began to exploit the raw flint material by digging shallow pit shafts (up to a depth of approx. 2 m) and pit-niche shafts (of approx. 4 m in depth), while the communities of the second one dug deeper stall-pillar mines (depth up to approx. 6 m) and chamber mines (depth up to approx. 9 m). In the area of the exploitation field, especially in its north-eastern part and adjacent regions (clusters at sinkholes), fragments of pottery from both of the above-mentioned cultures and a few from the Early Bronze MC, which extracted flint in Krzemionki Opatowskie, occasionally digging Neolithic backdirt heaps were found. They were described as traces of the on-mine and next-to-mine settlement.

In the article, we have tried to outline the issues related to the settlement base of the invaluable Neolithic complex of banded flint mines in Krzemionki Opatowskie, which was of great importance in the life of the community, especially those of the FBC and the GAC. The production of artefacts from this raw flint material influenced the development of internal and intergroup contacts. These products can be found in Poland's territory as well as beyond our border.

The above-mentioned issues have been mentioned in previous publications on Krzemionki Opatowskie. This article attempts to integrate the information on the above-mentioned topic. The full synthesis of knowledge about the settlement base, against a broad background, is a task for a separate large study.

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BETWEEN THE COPYING, USE AND INNOVATION. A CONTRIBUTION TO THE STUDIES ON THE STONE TOOL INDUSTRY IN NEOLITHIC SOCIETIES OF THE GLOBULAR AMPHORA CULTURE IN THE POLISH LOWLAND (KUYAVIA)

ABSTRACT

Chachlikowski P. 2022. Between the copying, use and innovation. A contribution to the studies on the stone tool industry in Neolithic societies of the Globular Amphora Culture in the Polish Lowland (Kuyavia). *Sprawozdania Archeologiczne* 74/1, 105-124.

This article focuses on a section of studies on the Globular Amphorae Culture (GAC) stone production in Kuyavia. The source materials from this area provide evidence of heretofore unknown activity of stone workers of this culture engaged in production of adzes that copied the forms typical of Late Band Pottery Culture. The resulting observations challenge the view that GAC communities did not produce stone adzes of their own, but allegedly restricted themselves only to using ready-made adzes of other Neolithic cultures. The sources under discussion also provide documented information on an innovative contribution of Kuyavian GAC stone workers in the assortment of tool products. This assortment includes polishing plates with the shapes and dimensions that essentially differentiated them from the corresponding tools used in the area in the Neolithic. Nevertheless, the claim that the local GAC communities did not produce type of the stone adze that would be characteristic of their own still remains as valid as ever.

Keywords: stone industry, Globular Amphorae Culture, Polish Lowland, Neolithic
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INTRODUCTION

There is a prevailing view among the scholars doing their research on the earlier stages of the Stone Age that, as opposed to the majority of other Neolithic groups settled in this area, the societies of the Globular Amphora culture (GAC) in the Polish Lowland did not produce or develop characteristic types, respective of their own culture, of stone products (or more precisely, made of non-flint raw materials). The occurrences of "working" adzes only slightly differentiated morphologically and in a manner quite insignificant in terms of taxonomy and functionality traits, or forms of adzes characteristic for the communities of other Neolithic cultures, such as: Late Band Pottery culture (LBPC), Funnel Beaker culture (FBC), or perhaps Corded Ware culture (*e.g.,* Cofta-Broniewska and Kośko 1982; Nosek 1967; Wiślański 1966; 1970; 1979; Szmyt 1996), have been reported and documented only sporadically in the source materials. It is only fair to acknowledge here a number of controversies, not further discussed in this article, regarding a certain cultural affinity of culturally ambiguous adzes with the so-called comb-like axe head (type D, according to Åberg 1918) with GAC. In the scholarly debate among Central European archaeologists that has centered on this particular question (*cf.* Åberg 1918; Behrens 1973; Brandt 1967; Herfert 1962, Jażdżewski 1936; Nilius 1971; Siuchniński 1972; Wiślański 1966; Zápotocký 1966; 1992), it was only Karl Heinz Brandt that was inclined to link the adzes of type D (similarly to those of type C) to the population representing this culture in north-west Germany (Brandt 1967, 41-43).

Similar reservations apply to the production of axes in GAC communities in the Polish Lowland that include inter-cultural forms with thick butt (with faceted or rounded edges) that in fact lack any significant diagnostic value (Chachlikowski 1990; 1991a; 1997; 2000; 2013; 2016; Wiślański 1966; 1970; 1979). Products of this type were made of both flint raw material and non-flint rock (conventionally referred to as stone). However, what is indicative is the fact that the predominant raw material for axes in Kuyavia used by GAC tool makers was indeed non-flint rock raw material (Chachlikowski 1990; 1991a; 1994b; 1997; 2000; 2013; 2016; 2017; Prinke and Skoczylas 1980a; 1980b). This is hardly surprising given the geological background of this area that lacks in natural deposits of preferential first-class non-flint rock raw material suitable for the production of macrolithic tools. Our current knowledge of the absolute dominance of non-flint materials in the production of axes among the Kuyavian GAC communities clearly contradicts the belief – established as early as the 1960s – about the alleged preponderance of flint rock raw materials (in particular with reference to striped flint) used for their production in the Polish Lowland (*e.g.,* Wiślański 1966; 1970; 1979; *cf.* also Balcer 1983). The import of axes made of striped flint among these communities was relatively insignificant, and in this regard unequally reported and studied within the Kuyavian GAC oecumene. In addition to the observations on the significant disproportions in the intensity in the use of macrolithic tools made of striped flint among the GAC communities in the area of what is now Kuyavia, it is also necessary to point to distinct differences in the archaeological context in which they occurred in this area. One may come to this conclusion on the basis of the analysis of the distribution of these tools north and south of the River Zgłowiączka – Kanał Bachorze (more on that in: Chachlikowski 1990, 246, fig. 27; 1991a, 173, fig. 27; Szmyt 1996, 49-51, fig. 26; *cf.* also Fig. 1 in this article). With respect to the whole area of Kuyavia, these observations have shown the preponderance of the finds of macrolithic products made of striped flint south of the River Zgłowiączka that, significantly, were registered mainly in the GAC tomb assemblages. At the same time, north of the Zgłowiączka River, these finds are predominantly represented by the so-called loose finds, *i.e.* those that have no specifically documented archeological context of their unearthing, and by fragments of damaged "striped" macroliths unearthed within the premises of the settlements of FBC and GAC communities (Chachlikowski 1990, 246 and fig. 27; 1991, 173 and fig. 27; Szmyt 1996, 49-51 and fig. 26).

In the past, this inadequate level of knowledge of GAC stone products mainly resulted from the lack of available framework of appropriate methodical, purposeful and plan-oriented structured studies, properly documented in the source material, on the issues related to the sourcing and use of non-flint rock raw material in the area of the Polish Lowland in the Neolithic. The actual commencement of such studies with regard to Kuyavia was made possible following long-term archaeological excavation research focused on this particular problem and carried out between the 1970s and 1990s (*cf.* Chachlikowski 1989; 1990; 1991a; 1992; 1994a; 1994b; 1997; 2007a; 2007b; 2013). As a result of these investigations, rich and diverse source materials were gathered and examined. Today, this collection of source materials provides evidence of the manifestations of the activity of these communities with regard to stone tool industry, scarcely documented in the past. Since then, new areas of interest in research on the stone production among the inhabitants of the Polish Lowland have been delineated and formulated, both in terms of their methodological aspects (initial assumptions for the taxonomy of the sources and the recommendations as to their further proper analysis), as well as in conceptual assumptions (*i.e.*, the way sets of arguments for the explications of diverse, and complex manifestations of particular practices in stone production are framed). In addition, no less significant sources for improving our knowledge on the stone industry of early-agricultural societies inhabiting the region have been furnished by archaeological rescue excavation work (predominantly those that were carried out from the second half of the 1990s) at a number of sites along the course of large linear developments that crossed Kuyavia (such as the Yamal – Europe gas pipeline and the A1 and A2 motorways) as well as the archaeological rescue work carried out along the courses of less significant gas pipelines (*cf.* for example: Chachlikowski 2000; 2004; 2016; 2017).

The present article focuses on a certain section of past and current research on the stone industry of GAC settlements in Kuyavia and explores those sources that include tool profiles, *i.e.* the typological and formal assortment of stone products representing this particular production. The source material that comes from the region can serve as evidence of the already recognized phenomenon of the acquisition and use by this population of final products, *i.e.* the adzes indicative of the societies of other Neolithic cultures inhabiting the region (or more precisely those of LBPC and FBC). In addition, these sources supply documentary evidence about the range of activity of local GAC stone workers in production of stone adzes that related to the forms conventionally linked to LBPC, *i.e.* the somewhat poorly explored issue that has not yet been properly scientifically addressed and researched. Other important observations also consider the finds that would corroborate the assumption of the production and use by this population of specifically shaped polishing plates with their shapes and dimensions that are not to be found within this particular category of tools in societies of other cultures in this area in the Neolithic. The research values of the presented sources documenting the GAC stone industry in the Polish Lowland sufficiently justify further discussion on the issues indicated in the title of the present article.

1. DATASHEET OF SOURCES

The present study is based on an investigation of the collection of material remains evidencing the stone industry of GAC communities in Kuyavia that come from the excavation work at eleven archaeological sites (Fig. 1; Tables 1 and 2). In addition, a single stone relic representative of the FBC society in the form of a fragmentarily preserved adze (*cf.* Table 1), found on one of the GAC sites is also taken into account in this article (more on that in the remarks below).

The source materials include exclusively specimens whose exact location was firmly established and their treatment could be clearly interpreted as evidence of intentional use, and those that could have been relatively surely or potentially identified and linked to the manifestations of a particular stone industry of an exclusively single culture, *i.e.* those that formed relatively homogenous inventories. The basis for the cultural classification of these items, or plausible validation of the presumption of this classification, was the scrutiny of the planimetric floor plan of the archaeological excavations and on stratigraphic assumptions (in fact, the vast majority of the material had been unearthed in discrete features, whereas the instances of finds loose in a layer were sparse). The applied classification was also based on typological premises and those pertaining to the raw material used that were applicable to part of the finds (more on the assumptions of these premises and their relevance to the studies on the stone industry of early agrarian societies in Kuyavia, see *e.g.*: Chachlikowski 1992; 1994a; 1994b; 1997; 2000; 2007a; 2007b; 2016; extensive literature cited therein). The stone products under examination have all been relatively well documented within their archaeological context of their discovery, *i.e.,* the place where they have been unearthed. This have made it possible to pinpoint relatively accurately their cultural and chronological affiliation (*cf.* Tables 1 and 2).

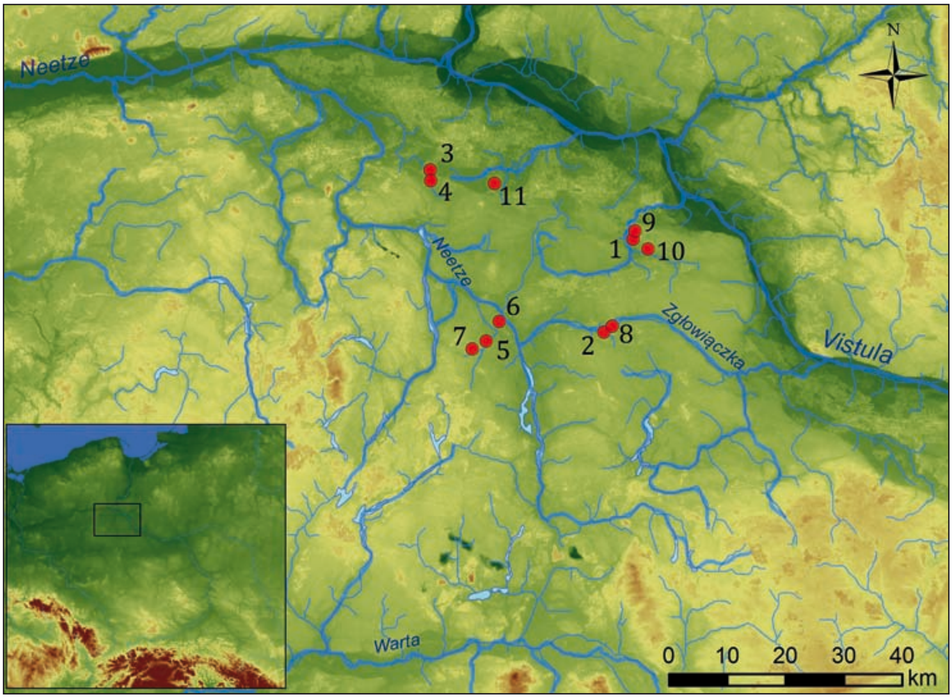

Fig. 1. Map showing GAC archaeological site locations in Kuyavia mentioned in the text from where the stone materials discussed in the article were extracted (drawing by J. Niebieszczański).
Note: Site numbers in the figure correspond to identification numbers of sites in Tables 1 and 2

The source materials that are discussed in this study represent a vast array of divergent assortment of products (in terms of their typological and formal features as well as the degree of the processing they have undergone) that are conventionally linked to the production and exploitation of non-flint rock raw material. By examining the full body of the sources linked to stone industry, it was possible to categorise them into individual groups on the basis of the following criteria: raw material used, typological, technical and functional features discussed and validated in the earlier works (Chachlikowski 1990; 1991a; 1992; 1994a; 1994b; 1997, 31-37; further extensive references therein). In all, they represent a non-uniform assortment of products (in terms of their typological and functional features) included in this production, namely those related to the production and use of adzes and polishing plates. These finds were documented in both the form of their final products (or their damaged specimens) and unfinished forms (or their damaged specimens).

There are two items in the group of adzes. The first is an unfinished form of an adze made of gneiss by a GAC stone worker and found in a pit identified as a relic of a stone workshop, unearthed within the perimeter of a settlement of this culture from Phase IIb at

Table 1. Sites of Globular Amphora communities in Kuyavia where the stone adzes were found, with their cultural and chronological affiliation, presenting their formal, technical and raw material characteristics (*cf.* Fig. 1). Notes: [a] Numbers of the sites in Table 1 correspond to the reference numbers of the sites shown in Fig. 1; [b] All localities within the administrative boundaries of the Kujawsko-Pomorskie voivodeship; [c] Petrographic characterisation of the raw material for all stone products was performed using the macroscopic method (by the naked eye or with the aid of a magnifying glass). Examinations of the type of rock of the sources were performed by the present writer with consultation of Prof. dr hab. Janusz Skoczylas of the Institute of Geology at the Adam Mickiewicz University in Poznań

Item No[a]	Location site, commune[b]	Culture/phase (after Szmyt 1996)	Formal and technical qualification (after Chachlikowski 1997)	Raw material qualification[c]	Figure
4.	Tarkowo 31, commune Nowa Wieś Wielka	GAC/IIb (or IIb/IIIa)	unfinished (initial) form	gneiss	2:1
10.	Przybranowo 10, commune Aleksandrów Kuj.	FBC/?	ready-made product (fragment of a blade)	diabase	3:3

Table 2. Sites of Globular Amphora communities in Kuyavia where the polishing plates characteristic for this population were found (*cf.* Fig. 1). Notes: see notes in Table 1

Item No[a]	Location site, commune[b]	Chronology (phase, after Szmyt 1996)	Raw material used[c]	Source (literature)	Figure
1.	Podgaj 6A, commune Aleksandrów Kuj.	IIb	quartzitic sandstone	Chachlikowski 1994a; 1997	Fig. 3:2
2.	Smarglin 51, commune Dobre	IIb	quartzite	Chachlikowski 1997	
3.	Tarkowo 49, commune Nowa Wieś Wielka	IIb	quartzitic sandstone	Chachlikowski 1997	
4.	Tarkowo 31, commune Nowa Wieś Wielka	IIb (or IIb/ IIIa)	quartzitic sandstone	Chachlikowski 1990; 1991a; 1997	Fig. 2: 1, 2, 7
5.	Bożejewice 28, commune Strzelno	IIb-IIIa	quartzitic sandstone	Chachlikowski 2000	Fig. 3:4
6.	Janowice 2, commune Lubanie	IIb-IIIa	quartzitic sandstone	Chachlikowski 2016	
7.	Żegotki 2, commune Strzelno	IIb-IIIa	quartzitic sandstone	Chachlikowski 2000	Fig. 2:6
8.	Dęby 29, commune Dobre	IIIa	quartzite, quartzitic sandstone	Chachlikowski 1992; 1997	
9.	Goszczewo 13, commune Aleksandrów Kuj.	IIIa	quartzite, quartzitic sandstone	Chachlikowski 1990; 1991a; 1994b; 1997	Fig. 2:5
10.	Przybranowo 10, commune Aleksandrów Kuj.	IIIa	quartzite, quartzitic sandstone	Chachlikowski 1990; 1991a; 1997	Fig. 2:3, 4 Fig. 3:1, 6
11.	Liszkowice 24, commune Rojewo	IIIb	quartzitic sandstone	Chachlikowski 1990; 1991a; 1997	Fig. 3:5

Site 31 at Tarkowo, Nowa Wieś Wielka commune (*cf.* Table 1 and Fig. 2: 1; more see Section 2). The other specimen is a fragment of the blade of an adze of FBC population made of diabase, registered in a GAC settlement from Phase IIIa at Site 10 at Przybranowo, Aleksandrów Kujawski commune (*cf.* Table 1 and Fig. 3: 3; see Section 2 of this text).

A separate typological and functional category of the discussed sources includes the finds related to the production and use of polishing plates manufactured by the GAC population inhabiting the region (more see Section 3 of this text). This group of stone products is presented in a separate listing in Table 2. The table provides information on the following: the location of individual sites from where the discussed finds were extracted, their chronological affiliation and the type of raw material of which they had been made. A part of these sources is presented graphically in Figs. 2: 2-7; 3: 1, 2, 4-6 (*cf.* also Fig. 4).

2. THE COPYING AND USE

Products linked to the stone industry of Globular Amphorae communities in Kuyavia include those manifestations, relatively well documented in sources, of the production and use of adzes, *i.e.* the products rarely reported on in scholarly literature (*cf.* Chachlikowski 1997; 2000; 2013; Cofta-Broniewska and Kośko 1982; Nosek 1967; Szmyt 1996; Wiślański 1966; 1970; 1979). In the stone inventories of this culture, predominantly from the classical amphorae phase stage of its development (*i.e.* from Phases IIb-IIIa, after Szmyt 1996), artefacts have been identified that testify to both the local indigenous production of adzes (from Phase IIb GAC) that typologically were related to the products of LBPC communities as well use of the forms of adzes characteristic for the FBC population (from Phase IIIa GAC).

The production of tools with late linear pottery features by the GAC population in Kuyavia can be supported by the evidence provided by the find of stone objects recorded in a Globular Amphorae settlement from late Phase IIb (or from the turn of Phase IIb/IIIa) at Site 31 at Tarkowo. This involved adze-like specimens with their features being typical for the forms of tools used by the communities of the Kuyavian LBPC groups. The material includes an unfinished (initial) form of an adze made of gneiss (*cf.* Table 1 and Fig. 2: 1), deposited within the premises of a stone workshop (see the remarks below). For its execution, a single rock block with the shape and dimensions that matched the dimensions of the final products as much as possible was used, hence no significant modifications were needed. The half-product of an adze under discussion represents a block with a low degree of treatment. Along its natural planes, traces of macroscopically discernible surface knapping and crushing were identified (discernible by the naked eye or revealed by the magnifying glass) that had been performed to remove natural roughness of the block. The sizeable dimensions of the half-product, its chunky irregular head that retained the natural surfaces of the original rock block suggest obvious similarities with the adzes produced by the population of LBPC (*e.g.*, Brandt 1967; Czerniak 1980; Grygiel 2008).

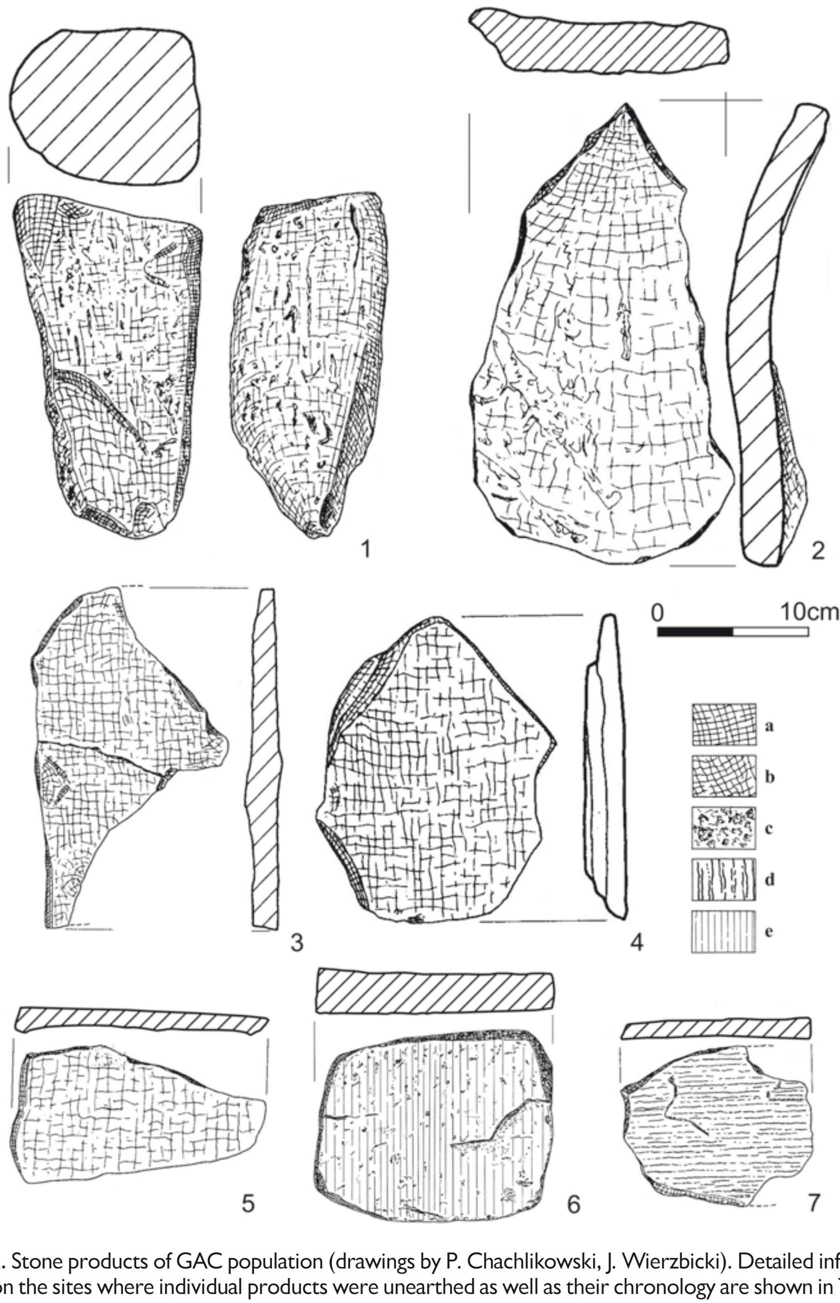

Fig. 2. Stone products of GAC population (drawings by P. Chachlikowski, J. Wierzbicki). Detailed information on the sites where individual products were unearthed as well as their chronology are shown in Tables 1 and 2. 1 – unfinished (initial) form of adze; 2-5 – unfinished forms (semi-products) of polishing plates; 6 – polishing plate; 7 – fragment of a polishing plate. Raw materials: gneiss – 1; quartzite – 3, 4; quartzitic sandstone – 2, 5-7. Key: a – natural surface; b – negative surface; c – breaks; d – surface with traces of stripping (grinding); e – surface with traces of polishing

The unfinished Tarkowo adze was found among the remnants of a supposed working place of a local stone worker, *i.e.*, a stone production workshop. The relics of the local stone processing workshop included a range of stone items deposited in a storage pit. Beside blocks of semi raw-material and unfinished forms of tools (that included beside the mentioned adze, also axes, grinders and polishing plates), other tools used for stone treatment (polishing plates) and chipped stone debitage fragments (small in amount), *i.e.*, debris from stone tool production, flakes and other material removed during the course of reducing larger stone blocks into finished tools, were also present (*cf.* Chachlikowski 1991a, fig. 2; 1997, Table 26, figs. 35-38). In the immediate vicinity of the storage pit, *i.e.* in a place where rock blocks were stored and processed until the required dimensions were achieved, the remnants of a light pole structure erected on the surface of the earth (a kind of a shed) that can be interpreted as a ground shelter for the working place of the stone worker were also reported (Chachlikowski 1997, fig. 100).

The half-product from Tarkowo is as yet the only, but a tangible, piece of evidence and proof of the production of stone adzes by late Neolithic GAC population in Kuyavia that would relate typologically and formally to the stone adzes used in LBPC groups. tone also might mention at this point the find of an unfinished adze at Site 1 at Tuczno, Kujawsko-Pomorskie voivodeship (Wiślański 1966, 40, fig. 11: 20) that would suggest the possibility of the production the adzes associated with FBC by the communities of the oldest GAC groups (those from Phase I) in the region. But the rather ambiguous context surrounding the circumstances of the find of the FBC adze half-product (Wiślański 1966, 40), and the lack of sufficient publications documenting the source materials from the study at the GAC settlement at Tuczno, inspire caution in accepting the interpretation of the cultural and chronological qualification for this particular find.

However, it is worth citing again the older data obtained from Site 1 at Tuczno that seem to corroborate the possibility of use of stone tools (or perhaps even production?) of the "late linear pottery culture" type by the local GAC communities from Phase I (Wiślański 1966, 40, fig. 11: 19; *cf.* also Cofta-Broniewska and Kośko 1982; Czerniak 1980; 1994). For the same reason, the find of a fragment of an adze (a section of its butt) at Site 5 at Kuczkowo, Kujawsko-Pomorskie voivodeship (Chachlikowski 2000, 405) is worth mentioning here. This product was reported to have been found in the so-called household pit (Feature A178) in association with GAC pottery dated probably to the Early Amphorae horizon (*i.e.* Phases I-IIa). What is interesting, the form of this specimen, with broad irregular unpolished head and made of biotitic gneiss, suggests some distinct analogies with stone adzes linked to the LPCB communities (*e.g.,* Brandt 1967; Czerniak 1980; Grygiel 2008). However, the culturally inhomogeneous character of the ceramics excavated from Feature A178 from Kuczkowo (beside the fragments of GAC utensils in question, there is a decidedly less frequent number of materials of the Linear Pottery Culture and Late Linear Pottery Culture) does not allow us to establish a definite link between the Kuczkowo adze and the local settlements of GAC population. Despite the inevitable doubts surrounding

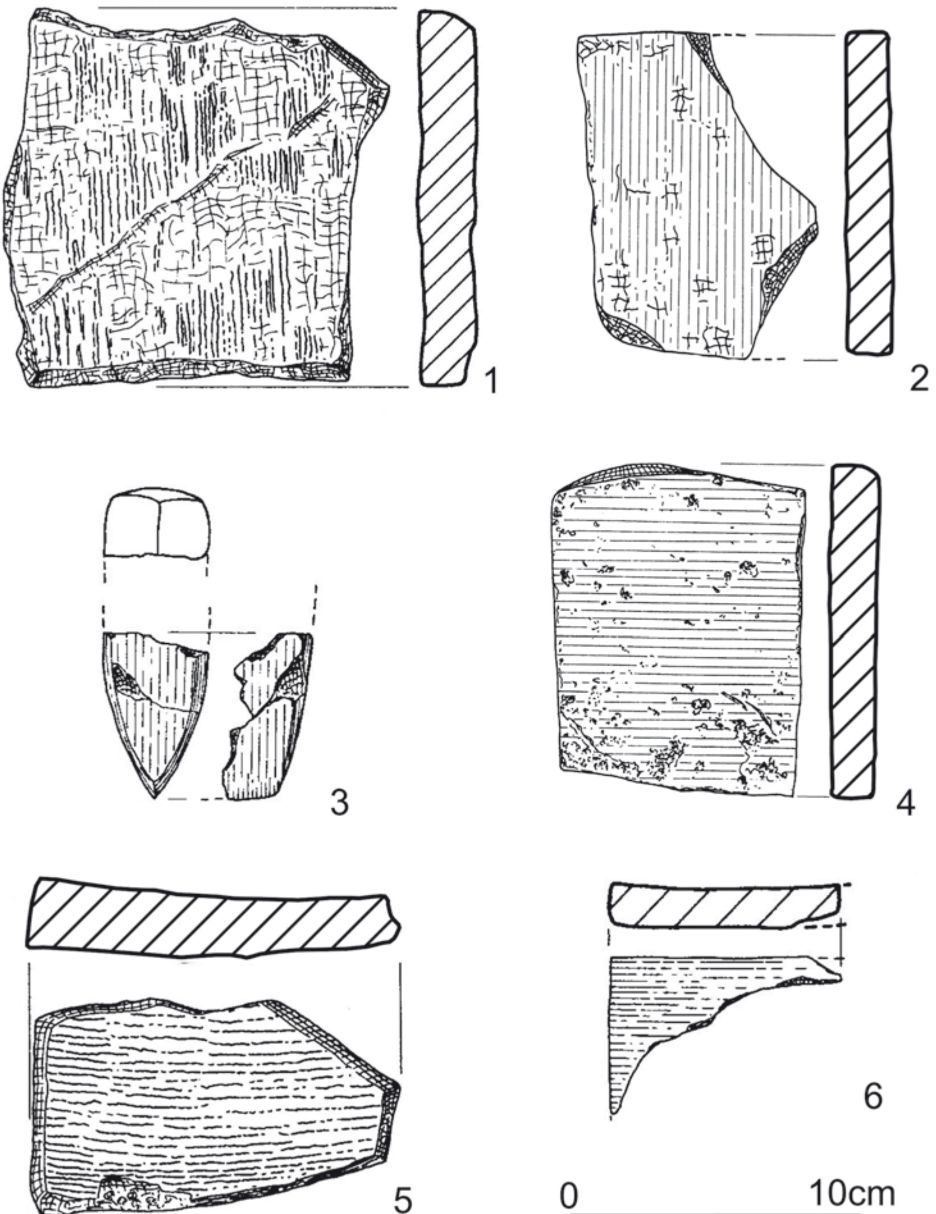

Fig. 3. Stone products of GAC population (drawings by P. Chachlikowski, J. Wierzbicki).
Detailed information on the site individual products were unearthed as well as their chronology are shown in Tables 1 and 2. 1, 5 – polishing plates; 2, 4, 6 – fragments of polishing plates; 3 – fragment of an adze. Raw materials: diabase – 3; quartzite – 6; quartzitic sandstone – 2-5

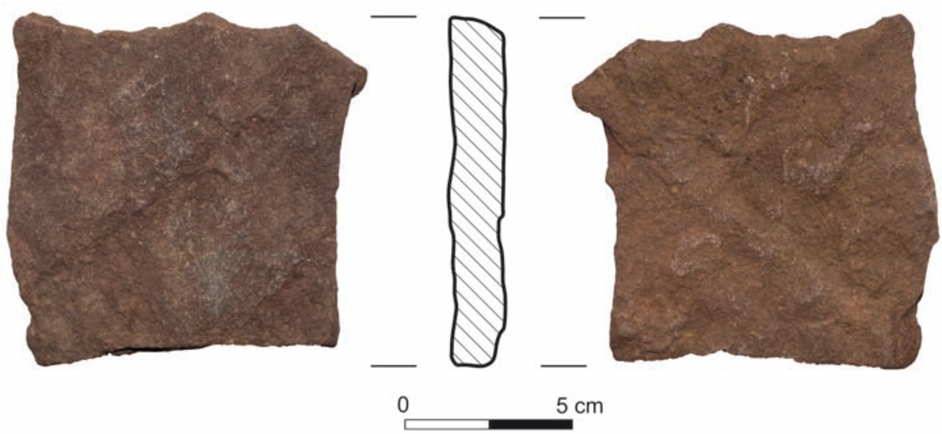

Fig. 4. Przybranowo, Kujawsko-Pomorskie voivodeship, Site 10.
Polishing plate (its initial form) made of quartzitic sandstone (*cf*. Fig. 3:1) (photo by P. Chachlikowski)

the above quoted materials from Tuczno and taking into consideration the evidence provided by the chronologically later stone sources from Tarkowo, an educated guess might be that there was indeed a relationship between the adze from the pit A178 and the "amphorae" stage of the settlement at Site 5 at Kuczkowo, and that this hypothesis is not at all groundless. Even though there is indeed ambiguous cultural and archaeological context involved here, it is still a scholarly justifiable assumption that clearly needs further research.

The phenomenon of the use of adzes typical for FBC settlements by the Kuyavian GAC communities from Phase IIIa was identified in the stone material unearthed on the multi-dwelling settlement of this population at Przybranowo, Site 10. The find in question is a damaged specimen of an adze (or more precisely, a fragment of the blade) made of diabase (*cf*. Table 1 and Fig. 3: 3). The find occurred in the layer in the immediate vicinity of two GAC habitation structures (Features Nos. 11 and 16) that represent habitation structures of the type of their construction that were partly semi-subterranean (Chachlikowski 1990, fig. 22; 1991a, fig. 22). The relationship of this particular specimen with the FBC can be validated by its stylistic traits (to be found, for example, in the tendency to preserve the symmetry of the product), and also by the raw material from which the object had been made. In view of what is currently known on non-flint rock raw materials used in the manufacture of products more characteristic culturally and/or typologically in the Polish Lowland in the Neolithic (with particular reference to stone products with chipped blade), diabase (beside amphibolite, basalt, diorite, gabbro, gneiss, biotitic gneiss and schist in its different varieties) was the type of raw material that was most frequently exploited by FBC communities, whereas it was significantly less common with the tool workers of other Neolithic cultures in this area (Chachlikowski 1994a; 1997; 2000; 2007a; 2007b; 2013;

2018; Chachlikowski and Skoczylas 2001; *cf*. also Prinke and Skoczylas 1980a; 1980b). In addition, it is important to remind the reader that with the communities of the "Funnel Beaker" culture, diabase was decidedly the dominant material (beside gabbro) in the production of stone adzes, despite the fact that it is rarely to be found among Fennoscandian erratics available in the Polish Lowland (Chachlikowski 2013; 2018).

A number of hypotheses can potentially account for the finding of the FBC adze in the GAC settlement at Site 10 in Przybranowo. The first of them assumes that what we encounter within the space of the site is the superimposition of successive GAC settlements (from Phase IIIa) built on top of the relics of the earlier settlements of FBC population, or alternatively, what would the second hypothesis postulate, the phenomenon of the abandonment of damaged final product by the populace of developmentally late FBC groups that can be registered at the site. The third hypothesis, in turn, would indicate the possibility of the production of adzes by the local GAC stone workers that imitated the forms typical for the FBC societies. Furthermore, one cannot exclude the possibility of the phenomenon of the re-utilisation of the product in question, *i.e*. instances of reusing existing FBC adzes by the inhabitants of the GAC settlement in Przybranowo. Finally, the fifth hypothesis would take into consideration the phenomenon of the use of the adze (ready-made final product) by the inhabitants of this GAC settlement that had been acquired by way of barter from contemporary late-beaker FBC groups.

The latter hypothesis seems in my opinion to be the most probable, taking into account the context of the find of the discussed FBC adze at Site 10 in Przybranowo (in the immediate vicinity of the local GAC living quarters), and also quite episodic manifestations of the FBC population settlements at this particular site (documented on the outskirts of the GAC population settlement), as well as the raw material traditions of the FBC stone industry in Kuyavia in the production of adzes (which would exclude the possibility of copying of the adzes from this culture by GAC stone workers). This hypothesis assumes that the finding of the FBC adze in the GAC settlement in Przybranowo documents the phenomenon of use of ready-made adzes produced by FBC stone workers by the inhabitants of this GAC settlement. Even if this hypothesis seems too bold at first glance, or is far too controversial, then it is surely attractive enough in terms of its cognitive value, that should not be too hastily discarded and is definitely worth considering.

3. INNOVATIVENESS

In the light of the most current and advanced studies on the stone industry of GAC communities in Kuyavia, it is possible to put forward a suggestion about "typological" cultural and chronological identification of the tool forms that so far have been considered to be culturally undistinguishable and uncharacteristic, as supposedly being taxonomically irrelevant for purposes of scientific explanation due to lacking a cultural identity.

From among the products that served as polishing stones and were used by this society, a number of polishing plates with specifically formed morphometric characteristics have been reported, *i.e.* those with quadrilateral shapes that are relatively small in dimensions and thickness not exceeding 2 cm. These were represented by finished products that had unmistakable features of previous use, evidenced by the traces of polishing or grinding (*cf.* Table 2; Figs. 2: 6, 7; 3: 1, 2, 4-6 and 4), as well as unfinished forms, *i.e.* half-products, with different degrees of treatment to achieve the desired shape and dimension of the future tool (*cf.* Fig. 2: 2-5; see the remarks below). The form and dimensions of these products of the Kuyavian GAC stone industry make them distinctively different from the corresponding tools used by the societies of other cultures inhabiting this area in the Neolithic (*e.g.* Chachlikowski 1990; 1991a; 1992; 1994a; 1994b; 1997; 2000; 2007a; 2007b; 2013; 2016; Szydłowski 2017).

Production and use of these polishing plates has been identified in the materials linked to the classical stage of the development of the local population of this culture, *i.e.* with Phase IIb-IIIa (*cf.* Table 2). Products of this type occur sporadically and do not always have the delimiting morphometric parameters (mainly in relation to their shape) in the GAC stone materials from Phase IIb (Podgaj, Site 6A; Smarglin, Site 51 and Tarkowo, Site 49). However, the most frequent finds of this particular tool form have been unearthed in the settlements of "Globular Amphora" communities from the turn of Phase IIb/IIIa (Tarkowo, Site 31) and Phase IIIa (Dęby, Site 29; Goszczewo, Site 13 and Przybranowo, Site 10). Their infrequent occurrence has also been reported among the products of the GAC stone industry from the beginning of Phase IIIb (Liszkowice, Site 24). Some of the discussed polishing plates have been reported in the inventories that are essentially linked to Phases IIb-IIIa (Bożejewice, Site 8; Janowice, Site 2 and Żegotki, Site 2).

To produce the grinding and polishing plates under discussion, GAC stone workers used exclusively quartzite and quarzitic sandstone (*cf.* Table 2), commonly available in glacially deposited rocks found in the Polish Lowland (Chachlikowski 2013; 2018). The identification of the raw material used for these tools can now be validated by the relatively well identified phenomenon of the selection of particular rock raw materials used by stone tool makers in the Polish Lowland in the Neolithic (more on that in: Chachlikowski 1997; 2013; 2018; Chachlikowski and Skoczylas 2001; *cf.* also Prinke and Skoczylas 1980a; 1980b). The above also applies to the products used as polishing plates, where we can also observe manifestations of the selection in the types of rock that were most suitable for the purpose (*i.e.* future function or operation). Given the circumstances and due to these scientifically verified dependencies, this immediately triggers the conclusion that the local population decidedly preferred only some, carefully selected, raw materials for the production of this particular tool form.

The quartzites and quartzitic sandstones used in the production of the polishing plates had specific features (technical and physical) that were particularly sought by the producers, and that these particular features sufficiently met the expectations of their users. The raw materials used for these tools belong to the types of rock that split in a natural way into slabs (with any possible thickness, *cf*. Fig. 2: 2-5). They have a natural separation (the so-called joints) that made it possible for GAC stoneworkers, the producers of the polishing plates, to obtain the required shapes and dimensions of future products more easily (Bolewski and Parachoniak 1982; Skalmowski 1937; 1972; Wojno and Pentlakowa 1956). It is easy to obtain the required form of the surface of the future tool by whittling down a large chunk of quartzite or quartzitic sandstone using a stone pestle along its natural fissures of the used raw material (typically discernible by the naked eye). The direction of the hit was to be parallel to the joint planes in a body of rock. Then, the plates obtained in this way and initially reduced to suitable pieces, were given the required shape (in this particular case, quadrilateral or quadrilateral-like) by touching up dulled edges by striking them in the opposite direction to the natural fissures in the raw material (the direction of the hit was at an angle perpendicular to the natural fracture in a body of rock). Moreover, quartzites and quartzitic sandstones are characterised by outstanding polishing or grinding properties (Skalmowski 1937; 1972; Wojno, and Pentlakowa 1956), and hence, they served as an ideal material for processing of non-flint rocks or products that would have been fabricated from flint, bone and antler.

SUMMARY AND CLOSING COMMENTS

Until as early as the initial years of the 1990s, the characteristics of the GAC stone industry in the Polish Lowland were only rarely addressed in the literature. Our knowledge was largely limited to the production of taxonomically irrelevant tools for every-day use, such as axes, polishing plates, querns or grinders, commonly used items in the household, or possibly (but equally rarely) the use of the forms of adzes by these communities that were characteristic for the societies of other Neolithic cultures inhabiting the area.

A watershed moment in the research on the stone industry of the communities inhabiting the Polish Lowland at the times of their early agrarian stage of development came with the results of long-term investigations (on site and laboratory studies) conducted in Kuyavia. With regard to the tool assortment of the GAC stone industry, the source materials discussed in this article suggest the possibility of the use (in the form of their final products) of adzes by this society linked to LBPC and FBC, earlier based only on supposition and indeed academic conjecture. However, the sources from this region mainly document manifestations, as of yet unknown among the GAC population in Kuyavia (or within a broader context, the Polish Lowland), in their attempts to produce stone adzes that would copy the types of adzes typical for LBPC communities. Equally significant conclusions refer to the GAC communities innovative contribution to the assortment of tool products in the stone industry in the Polish Lowland. This refers to polishing plates with their shapes and dimensions that significantly departed and differed from corresponding tools used by the communities of other cultures in this area in the Neolithic.

The observations presented in this article strongly support the hypothesis that assumes a continuation of the tradition of the use (production?) tool forms (adzes) characteristic of late-band pottery societies by the population of earlier GAC groups (*i.e.* those from Phase I-IIa), and later GAC groups (*i.e.,* from Phase IIb) in their development in Kuyavia. When it comes to the specimens of the GAC population evidenced at Site 31 at Tarkowo, the manifestations of the production of adzes that were characteristic in their form of LBPC have been undeniably identified. At the same time, the Tarkowo stone materials challenge the view, heretofore firmly established in literature, that the Lowland communities representing this culture did not produce stone adzes of their own, but confined and restricted themselves to acquiring and using ready-made products that came from other cultures (*i.e.* LBPC and FBC).

The evaluation of genetic relationships of the globular amphorae stone industry somewhat supports the mid-Neolithic conception of the origins of GAC that assumes "late-band" succession of this culture in Kuyavia, and at the same time a long-lasting and lingering time contact with FBC (more on that in: Chachlikowski 1991b; Czerniak 1994; Szmyt 1996; further literature therein). The conception of the origins of GAC (or more precisely of the beginning of its formatting period) as the successor of LBPC (with the fair share of FBC, Phase IIIA) also finds a fuller justification in, among other things, the assumptions about the use and production of a "late-band" form of stone tools. At the same time, it is proper to mention the earlier observations on the genetic relationships between the raw material structure of the stone production of LBPC and GAC communities of the Early Amphorae horizon (from Phases I-IIa). The identified relationships allow us to even put forward a hypothesis about a full succession of the tradition of LBPC stone industry among the earliest GAC communities in Kuyavia (more on that in: Chachlikowski 1990; 1991a; 1997; 2000; 2013). In turn, the manifestations of the relationship between the stone production of GAC communities (most thoroughly documented for the classical amphorae stage of development of these communities) and the tradition of contemporary stone industry of FBC communities seem to involve mainly the practices of rock raw material selection for the production of products with separated edges. This selection refers primarily to the use of diabase and biotitic gneiss in the production of adzes and axes (Chachlikowski 1990; 1991a; 1997; 2000; 2007a; 2007b; 2013; 2016; 2018; Chachlikowski and Skoczylas 2001, see also Prinke and Skoczylas 1980a; 1980b; Szydłowski 2017). A good example of the manifestation of the continuation in practice of the traditions of FBC stone industry by GAC communities is the use by this population of forms of stone adzes of the funnel beaker type, or possibly even their production (*e.g.* the unfinished Tuczno adze, Site 1, mentioned earlier in the text – Wiślański 1966, 40, fig. 11: 20).

This picture of the genetic relationships of GAC stone production in Kuyavia outlined above shows the diversity of production traditions impacting the activity of the stone worker of the "globular amphorae" communities. As valid as ever is, however, the claim that the Kuyavian GAC communities did not produce a type of the adze that would have characteristic features of its own and would thus constitute a proper diagnostic cultural identifier (Chachlikowski 1990; 1991a; 1997; 2000; 2013; 2016; Cofta-Broniewska and Kośko 1982; Czerniak 1980; 1994; Nosek 1967; Szmyt 1996; Wiślański 1966; 1970; 1979).

The above cannot be claimed, however, with regard to the products made by GAC communities that were used as polishing stones. This primarily refers to the polishing plates, typical for the Kuyavian globular amphora groups, with characteristically shaped morphometrics that would substantially differentiate them from the corresponding types of tools produced and used by societies of other cultures in the region in the Neolithic. In the light of the current knowledge on the stone industry of GAC communities, plates of this type occur in the materials linked to the classical stage of development of the population of this culture in Kuyavia, *i.e.* with Phases IIb-IIIa, most frequently though from the transition time of these two phases, and from Phase IIIa. They are only sporadically reported in the lithic inventories of ”Globular Amphorae” communities dated to the beginning of Phase IIIb. It is worth adding at this point that similar products were used by the population of the Trzciniec Cultural Circle at Rybiny, Site 14 and Site 17, in the Kujawskie Lake District (Chachlikowski 1989; Makarowicz 1989; 1998; 2000). There is no doubt, however, that the polishing plates of this type found within the perimeter of Trzciniec settlements relate to the tradition of GAC communities, and are also recognized in the pottery industry (more precisely in the technology involved) of these communities from Rybiny. Hence, one may conjecture that this innovative tool offer presented by Kuyavia-based GAC stone workers found its continuation in the stone production of local population groups inhabiting the area in the early Bronze Age.

The production and use of polishing plates linked to the GAC coincides with the time span of the unprecedented increase in the processing of rock raw materials by the communities of this culture at the time of the classical amphorae stage of their development in Kuyavia. Stone production among these communities reaches a scale not found in earlier and later phases of their development (more on that in: Chachlikowski 1990; 1991a; 1994b; 1997, 2000; 2013; 2016). This phenomenon has been identified so far by, among other things, a generally recognized increase in the processing of rock raw materials, primarily for products used as axes, milling utensils (querns and grinders) as well as multifunctional tools (such as polishing plates, hammerstones, polishers or stone pads), with the concurrent use of the most diversified assortment of lithic materials for the manufacture of these products. It is with this particular period of the development of the Kuyavian GAC that we can also associate the manifestations of the activation of these communities in acquisition and use of “imported” raw materials (*i.e.* those of other than Lowland provenance) from the source areas that were rich in stone deposits and located south of the Polish Lowland (Chachlikowski 1990; 1991a; 1996; 1997; 2013). The increase in the interest of these communities of the time in the production of items of stone can also be documented in the manifestations of complex (more specialised) forms of sourcing (open pit mining of local erratics) and processing of stone raw materials (in the form of separate stone workshops). Significant identifiers of this pronounced progress in the late Neolithic GAC stone industry in Kuyavia include additionally the fact that the materials started to include specifically formed (in terms of shape and dimensions) polishing plates that undoubtedly were an innovative contribution to the stone production in the Polish Lowland in the Neolithic.

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BACKED BLADELET PRODUCTION AMONG MAGDALENIAN GROUPS IN SOUTH-EASTERN POLAND – SELECTED EXAMPLES

ABSTRACT

Grużdź W. and Pyżewicz K. 2022. Backed bladelet production among Magdalenian groups in south-eastern Poland – selected examples. *Sprawozdania Archeologiczne* 74/1, 125-140.

In the presented article, we attempted to interpret Magdalenian backed bladelets in terms of recognizing the methods of their production. For this purpose, we studied the microblade technology, the intentional fracturing of blanks using specific procedures, including the microburin technique, and retouching. We applied typological, morphometrical, and morphological studies. We based our conclusions on the results of technological studies of 154 artefacts – backed bladelets and microburins, coming from three sites – Ćmielów 95 "Mały Gawroniec", Podgrodzie 16, and Maszycka Cave. As a result, we obtained preliminary data on the final stages of the *chaîne opératoire* in the production of backed bladelets.

Keywords: backed bladelets, lithic technology, microburin technique, Magdalenian, south-eastern Poland, morphometric analysis
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INTRODUCTION

In the last decade, numerous publications on the Magdalenian blade technology and the lithic tools manufacture in Poland have been published (*e.g.*, Schild *et al.* 2011, 101-125; Połtowicz-Bobak 2013; 2016; Schild 2014; Wiśniewski T. 2015; Przeździecki and Migal eds 2020; Wiśniewski A. *et al.* 2020). Most of them well document the individual stages of the *chaîne opératoire* related to the production and usage of flint tools. However, still, not enough attention has been paid to the process of the production of backed bladelets. This article aims to analyse the methods of forming backed bladelets, including, in particular, the presence of the microburin technique in the Magdalenian.

In this article, we have attempted to analyse the production of backed bladelets among the Magdalenian groups that existed in south-eastern Poland in the final stages of the Upper Palaeolithic. We have focused on the studies related to methods of fracturing lithic bladelets – microburin technique and segmentation. In addition, we have tried to determine whether the microburin technique was associated with the microlithization of blade production. For this purpose, we have analysed selected materials from the archaeological sites: Ćmielów 95 „Mały Gawroniec", Podgrodzie 16, and Maszycka Cave. In this work, we applied typological, morphometrical, as well as morphological analysis to achieve the goal. The inspiration for our studies was the article published by the jubilarian of this volume, Professor Jerzy Libera (Libera and Migal 2009).

THE PHENOMENON OF MICROBLADE TECHNOLOGY IN THE UPPER PALAEOLITHIC IN POLAND

The Upper Palaeolithic societies that inhabited the areas of today's Poland, based their blank production on blade technology. There was often a specific dichotomy of production within it. This consisted of the production of both large blades and bladelets. The first of them focused on obtaining macrolithic blades, which were processed into formal tools such as end-scrapers, burins, perforators. The second is related to the production of blades from small cores. This method, which in terms of size products can be described as microlithic, was used to produce segments. The division into two metrically differentiated blade technologies has already been noted among the Aurignacian groups (see *e.g.*, Krukowski 1939-1948; Chmielewski 1975; Sachse-Kozłowska and Kozłowski S.K. 1975; Sachse-Kozłowska 1978; 1982, Kozłowski J.K. 2000; Jarosińska 2006, Wilczyński 2016), then it appeared in the Gravettian (see *e.g.*, Wilczyński 2007; 2015; 2016a; 2016b; Wilczyński and Wojtal 2011, Wilczyński *et al.* 2015a, Płonka and Wiśniewski A. 2006; Wiśniewski A. *et al.* 2015). This phenomenon should probably be associated with a new type of composite tools in which small lithic elements were put in the hafts to comprise the working edge of the tools (*e.g.*, Bosinski 1989; 2010, Pétillon *et al.* 2011; Tomasso *et al.* 2018; Roux *et al.* 2020).

This solution should probably be related, among other things, to the properties of flint raw material, which is brittle and easily blunted when working in harder materials. To maintain its "sharpness", its edge should be renewed. The sharpest fracture is achieved among lithic blanks without being retouched. In order to obtain and maintain such a tool edge, a continuous exchange of inserts is required. Alternatively, there is a possibility of renewing the edge, such procedures are known from bifacial technologies, *e.g.* by resharpening Prądnik knives with tranchet blow. However, in the blade technologies that occurred in the Upper Palaeolithic, the inserts were most likely replaced with new ones when they were worn out and flint raw material was available. The small size of the blanks does not require a good quality raw material base, which additionally favors the adaptation and dissemination of the technology related to composite tools. The drawback of this type of product is certainly the need to standardize the flint inserts, which must be similar in size and relatively straight. Obtaining this type of small blade could be carried out with the use of various debitage techniques, but the production of inserts and segmentation process itself assumed getting rid of parts of the blanks that were too curved or thick. There were several ways to separate these types of unnecessary blade parts. This could have been done by successive retouching, the microburin technique (*e.g.*, Krukowski 1914; Ginter and Kozłowski 1990, 62, 63, 204, 205; Inizan *et al.* 1999, 82-84; Kozłowski 2009), or by percussion directed precisely at blanks lying on a pad (*e.g.*, Rankama, Kankaanpää 2011; Sørensen 2017). Of these three methods, the microburin technique is the only one that leaves characteristic waste products (see *e.g.*, Inizan *et al.* 1999, 82-84). One of the first publications describing the mentioned procedure was an article by Stefan Krukowski (1914), thanks to which the microburin technique has been relatively well known in Polish literature for years.

THE PHENOMENON OF MICROBLADE TECHNOLOGY IN THE MAGDALENIAN IN POLAND

The Magdalenian groups in Poland are known both from open and cave sites. Their main occupation started during the Oldest Dryas, and the youngest traces of settlement are dated to the Allerød (Kozłowski S.K. *et al.* 1993; Kozłowski S.K. and Pettitt 2001, Ginter and Połtowicz 2007, Połtowicz 2006; 2007, Połtowicz-Bobak 2009a; 2009b; 2013; 2016, Sobkowiak-Tabaka 2011; Kozłowski *et al.* 2012; Wiśniewski *et al.* 2012; Bobak, Połtowicz-Bobak 2014; Schild 2014, Maier 2015; Wiśniewski T. 2015; Bobak *et al.* 2017; Wiśniewski A. *et al.* 2017; Przeździecki and Migal eds 2020). In the group of formal tools, apart from macrolithic examples (end-scrapers, burins, perforator, etc.), were tool forms produced from small blanks obtained from specially prepared cores (see *e.g.*, Libera and Migal 2009; Wiśniewski T. 2015, 48; Migal *et al.* 2020; Przeździecki 2020, 92). Blade production in this concept was associated with other debitage methods and techniques. In the case of obtaining large blades, organic hammers were used, and a characteristic procedure for the striking platform was applied (*en éperon*). However, small blades were produced without the use of this procedure. Among various lithic inventories (mentioned in the text), we also observe the use of other debitage techniques in both technological groups. In the case of large blades, direct percussion with a soft organic hammer was dominant. In turn, small blades were obtained mainly with the use of soft stone hammers (at the same time, we do not rule out that some of the bladelets could have been obtained using a soft hammer made of another raw material). These data are confirmed by microscopic analysis of the butts of blades and bladelets and the striking platforms of cores (Pyżewicz 2015a; 2015b; 2020). Additionally, based on microscopic analysis, we know that formal tools from Ćmielów, Podgrodzie (Pyżewicz 2015a; Pyżewicz 2020), Klementowice-Kolonia (Pyżewicz 2015b), and Sowin (Wiśniewski A. *et al.* 2020), obtained both from large and small blades were retouched using stone retouchers. The small semi-products were divided into segments using the microburin technique. As a result of its application, the distal and proximal parts of blades were detached, leaving a straight and regular middle section. The remains of this procedure are known from Polish Magdalenian sites, *e.g.* Dzierżysław (Ginter *et al.* 2002; 2005), Wilczyce (Królik 2014), Podgrodzie (Pyżewicz *et al.* 2014), Klementowice-Kolonia (Wiśniewski T. 2015), and Ćmielów (Przeździecki 2020). The microburin technique itself could also be used in a slightly different way. One of them was suggested by Michał Przeździecki (2020). It was to be distinguished by the formation of a long notch along the longer edge of the blank, which was shaped with a steep retouch. The notch was intended to be the back of the future segment. Then the distal and proximal part of the small blade was broken off, while from the middle part of the product, from one to several segments were created. According to the author (Michał Przeździecki), this solution is analogous to some interpretations of the Palaeolithic strategies of producing backed bladelets (see Ginter and Kozłowski 1990, 63, 205; Bosinski 1989; Bolus 2012). Although the solution seems to be extremely ergonomic in the context of producing small inserts in the type of Magdalenian backed bladelets, we only have a few examples of waste parts with characteristic notches to support it (Przeździecki 2020). This may be due to the specificity of the procedure, which does not leave a lot of waste products and a small chance for researchers to create flint refittings from these types of artefacts.

ANALYSIS OF MORPHOLOGY AND MORPHOMETRY OF BACKED BLADELETS AND MICROBURINS

For the analysis we selected materials from three Magdalenian sites, differing chronologically and functionally. These are:

– Maszycka Cave – a small, basic, unique campsite, the material came from Stefan Karol Kozłowski excavations (Kozłowski S.K. and Sachse-Kozłowska 1993);

Fig. 1. Examples of backed bladelets (1-9) and microburins (10-12) from Ćmielów 95 "Mały Gawroniec" (2, 5, 7-8, 11-12) and Podgrodzie 16 (1, 3-4, 6, 9-10)

– Ćmielów 95 "Mały Gawroniec" – a large, basic camp (Przeździecki and Migal eds 2020) (Fig. 1: 2, 5, 7-8, 11-12);

– Podgrodzie 16 – a short-term camp and flint workshop (Pyżewicz *et al.* 2014) (Fig. 1: 1, 3-4, 6, 9-10).

The analyses are preliminary and were aimed more at testing if the method is reliable rather than to synthesis the data on the morphometry of Magdalenian backed bladelets. The sites such as Maszycka Cave yielded small number of specimens, but we decided to include them to present the method, although we are fully aware that the sample in not statistically valid for answering certain question.

Our studies at this stage were carried on to test if such a simple morphometric approach is reliable. We used materials attributed by some researchers to different stages of Magdalenian in Poland (Wiśniewski *et al.* 2017). Future studies could add more contextual data, but at this stage we are aware that differences between sites and their chronology can influence our conclusions.

As the studies focus on the interpretation of the last stages of the *chaîne opératoire* related to the formation of formal tools from small blades, we chose backed bladelets and microburins for analysis. In the case of the material from the "Mały Gawroniec" site at Ćmielów, numerous remains of their production and use were found, we selected the

Table 1. Analysis of the morphology of backed bladelets (bb) and microburins' (m)

site	number of artifacts	part of blank				retouch side (direction)			arrangement of break					direction of negatives				number of negatives					profile	
		proximal	mesial	dorsal	whole	dorsal	ventral	dorsal/ventral	straight	oblique	straight and oblique	other	lack	unidirectional	bidirectional	traces of cresting	?	1	2	3	4	5	striaght	curvy/ plunged
Maszycka cave	bb - 7	3	4	0	0	7	0	0	2	2	0	3	0	6	1?	0	0	0	4	2	1	0	5	2
Ćmielów	bb - 130 +6?	49	60	23+1?	3	120	12	4	33+1?	76	13	6	7	119+7?	4+1?	1+3?	1	1	79	45	10	1	108	28
Podgrodzie	bb - 16	1	12	3	0	10	5	1	1	14	1	0	0	16	0	0	0	0	9	7	0	0	15	1
Ćmielów	m - 6	5	1	0	0	4	0	2	1	5	0	0	0	6	0	0	0	0	1	5	0	0	3	3
Podgrodzie	m - 2	2	0	0	0	0	2	0	0	2	0	0	0	2	0	0	0	0	0	1	1		1	1

material consisting of 136 backed bladelets and fragments of them, and six microburins, from 171 forms distinguished by Michał Przeździecki (2020, 97). In our studies we used backed bladelets, and excluded pieces such as less extensive retouched forms that had probably played a similar role but typologically were more close to retouched blades. From inventories obtained from the sites in Podgrodzie and the Maszycka Cave, where far fewer such forms were recorded, all available specimens were examined (seven artefacts from Maszycka Cave and 18 from Podgrodzie).

The basic criterion for the selection of the backed bladelets was the existence of abrupt or semi-abrupt retouch at least on one edge of the specimen. We also noted when there was additional retouch of the base. We noted the part of the blade (proximal, mesial, distal) from which the tool was made, and the side on which the retouch was made (dorsal, ventral). As most of the backed bladelets had breaks, we examined their arrangement concerning the axis of symmetry of the tool, describing them as straight or oblique. Determining the direction of the flake scars on the dorsal side is limited to describing them as: unidirectional, bidirectional, or with traces of cresting. It is worth mentioning that, due to the small size of the specimens, the assessment of the direction of the flaking scars was often difficult. We also counted the number of flake scars – when they reached half of the specimen (minor chipping, originating, *e.g.* from trimming, was excluded). Additionally, we examined how many specimens had straight or curved/plunging profiles. Detailed analyses are presented in Table 1. We measured all analysed forms (more later in the text). Performing the measurement procedure and characterization of breaks is an important element in the discussion of intentional fractures at one or both ends. Based on these data, it can be concluded which forms have been broken by accident as a result of the use or postdepositional processes, and which are the result of intentional shortening.

The conducted analyses showed a few regularities in the production of the backed bladelets. The tested sample included 53 backed bladelets with preserved butts and seven microburins with proximal parts. There is no record of the butt preparation in the *en éperon* type on any of the specimens, which confirms the separability of technological cycles in Magdalenian. We can confirm there were two separate methods: first regarding the production of large blades and a second for making bladelets.

We can conclude that the blanks for the formation of backed bladelets were selected from small blades, and the middle parts (76 specimens) were preferred. The proximal and distal parts were also used, especially when these fragments were not plunging or the bulb was not massive. It is worth adding when the direct percussion technique with a soft hammer is applied (which was preferred during the production of the blanks of backed bladelets), the bulbs are usually less pronounced. So their presence did not have to necessitate removing them to produce an insert. We observed on the specimens with the butt preserved that the retouch was done from the side that was closer to the blade ridge. The retouched back was placed as close as possible to the ridge (Fig. 2). Based on this observation, we can conclude that most of the small blades could have in this way, a strongly re-

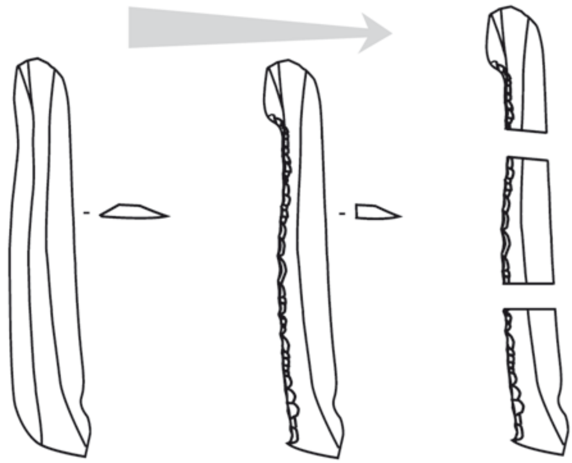

Fig. 2. The scheme of the production of backed bladelets using the microburin technique

duced flake scar surface. On the analysed forms, at least two negatives of previous removals are practically always visible – 92 pieces, or more flake scars – 66 specimens, which gives the distribution typical for most blade technologies. However, a clear trapezoidal cross-section and possible reduction of one flake scar with retouched back would indicate that flat blades with more than two negatives of previous removals were preferred. We can also conclude that there was a tendency to retouch the backed bladelets towards the dorsal side of the blank, with sporadic registration of the retouched specimens towards the ventral surface. With the application of the first type of retouch (towards the dorsal side), the back was steeper. And it was less steep when it was directed towards the ventral side of the blade. Most of the fractures were oblique (106 specimens), while straight fractures (51 specimens) were less common. We also noticed that blanks with straight profiles were used for the production of backed bladelets (128 specimens). Only individual specimens with curved/plunging profiles were recorded (31 specimens). Based on the results of the analysis of the dorsal sides, we can conclude that most of the artefacts were characterized by the unidirectional arrangement of the flake scars (148 specimens). We noticed bidirectional character or traces of cresting less frequently. Among the analysed backed bladelets, the most common blank selected for tool production was the mesial part (76 specimens), then the proximal (53 specimens), and the less numerous group was made from distal parts (27 specimens). Only three inserts were made from one whole bladelet without segmentation. Next to the tools, we recorded eight microburins that morphologically share many attributes with backed bladelets. Some of these features are break patterns and a steep retouch on one of the sides of microburin looking like the retouch on the backed bladelet.

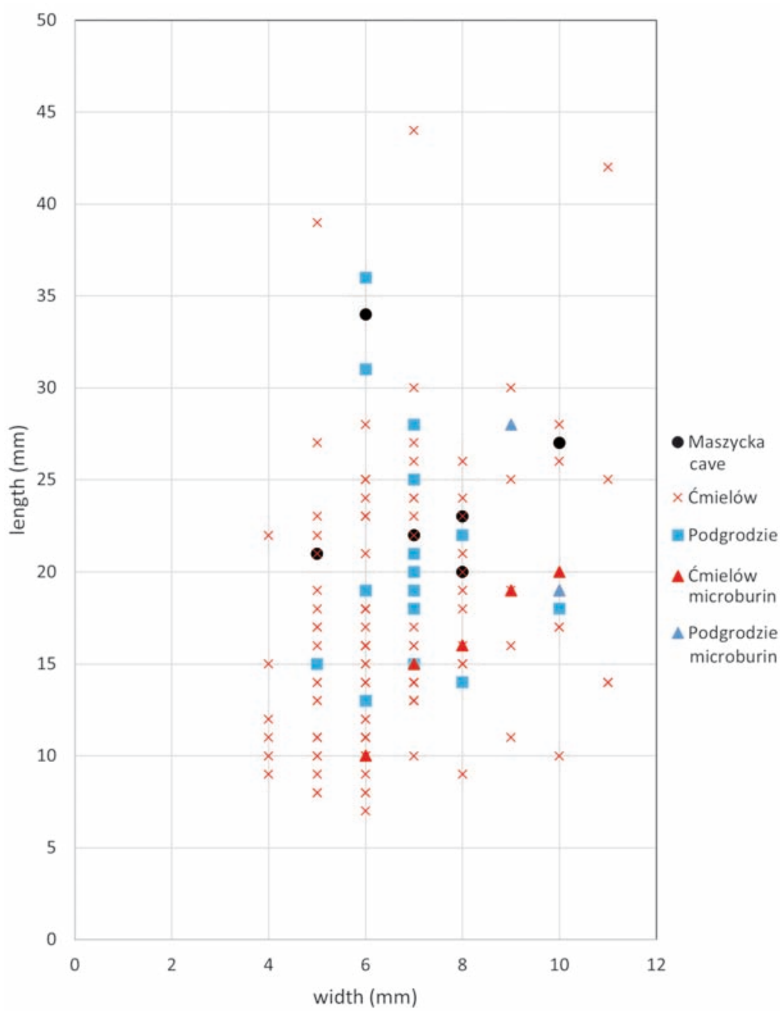

Fig. 3. Graph presenting distribution of blacked bladelets and microburins from the analysed sites

The morphometric analysis was based on the measurements of the length, width, and thickness of individual backed bladelets and microburins. Based on the quantitative and qualitative research, we decided to present the metric range of backed bladelets and check whether the microburins are within it. This would be another argument – apart from the context of finding (their coexistence at one site within layer) – that these two types of specimens should be combined into one technological set. The first observation concerns the comparison of the length and width of individual backed bladelets and microburins from the studied sites (Fig. 3).

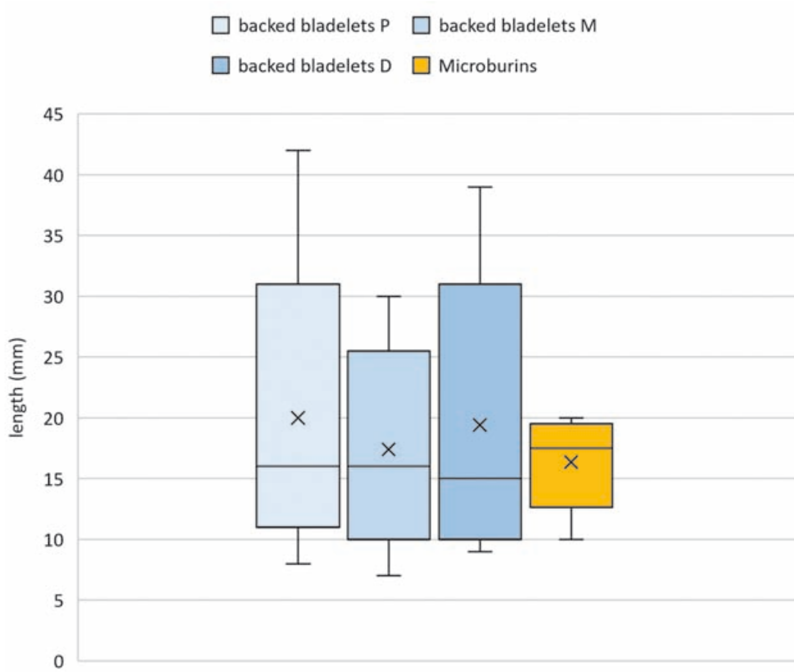

Fig. 4. Graph depicting length of backed bladelets from proximal (P), mesial (M), distal (D) parts, and microburins from Ćmielów 95 "Mały Gawroniec"

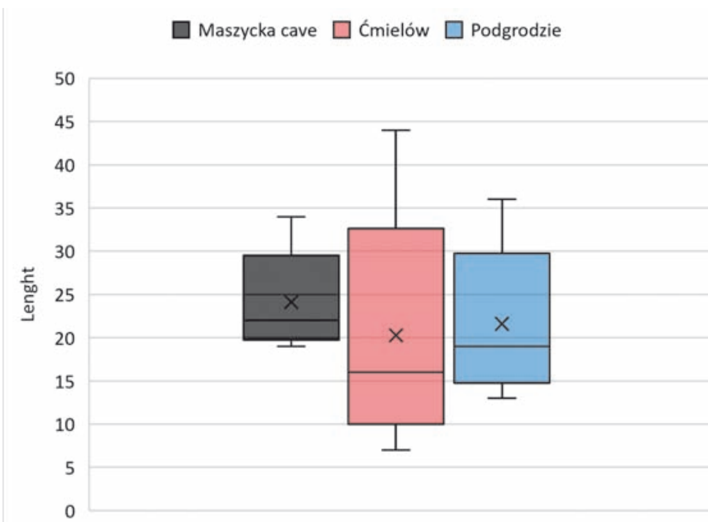

Fig. 5. Graph depicting the length of backed bladelets (different parts of bladelets altogether) from the analysed sites

The largest number of analysed backed bladelets coming from Ćmielów shows considerable variability, ranging between 4 and 11 mm in width and between 7 and 44 mm in length. The microburins compared with them fit into these morphometric ranges, they are not usually long, but more wider. The examined backed bladelets from the Maszycka Cave are usually longer than the specimens from Ćmielów, but they also contribute to the variability of the collection, similar to the specimens from Podgrodzie. It is also worth noting that microburins always fall within the ranges for their respective clusters within the corresponding sites. Their distinguishing feature is their thickness. Most of them oscillate between 1 and 2 mm, rarely being 3 mm in thickness. However, in the case of microburins, the rule is their measurements oscillate around 3 mm. Of the eight specimens, only one was 2 mm thick and another – 4 mm thick.

As the fractures always occurred on the examined backed bladelets, we decided to try to check morphometrically whether we can justify their presence by intentional production. After preliminary analysis, we noticed that the collection includes specimens with accidental fractures that may have resulted from use or postdepositional processes. Assuming that such fractures arise in various parts of bladelets because they are not controlled, we decided to examine the statistically largest collection from Ćmielów in terms of the length of backed bladelets and microburins. In addition, we decided to split up the studied collection of backed bladelets into types corresponding to the parts of the blanks – proximal, mesial, and distal. Thanks to this, we could check whether the segments from individual parts were equal, which would be a clue about their intentional execution by breaking at least one of the parts. The studied collection consisted of 133 backed bladelets, and six microburins, three non-segmented backed bladelets were excluded (Fig. 4).

The analysed data show that in each tested tool group, different fragments – proximal, mesial, and distal parts, are of a similar length, and their medians were practically identical. It is a similar case among the microburins, which, while seemingly shorter, fit into the scope of the previous tool groups. In the end, we analysed backed bladelets without dividing them into the parts from which they were made but comparing them between sites (Fig. 5).

CONCLUSION

Based on the above studies, we consider that these data reflect the actions of manufacturers for whom the achievement of regularity and the appropriate length of tools were the most important elements in their production. A large number of backed bladelets made of proximal and distal parts of bladelets confirm that various parts of the blanks were segmented for their production, not only the most regular mesial parts.

We assume that the small proportion of microburins is the result of the rare practice of rejecting them (they could be converted into backed bladelets). The leaving of microburins unprocessed was most likely due to the thickness or the strong plunging of the rejected blanks. Additionally, we can confirm that the proportions of the length and width of the microburins are in line with the parameters of backed bladelet production and this is an argument for connecting them into one production cycle. Further arguments are: the morphological features observed on the butts and the bulbs, and the regularity of the ridges and side edges, which are analogous to those observed on the backed bladelets made of proximal parts. Also, the retouch of some microburins is similar to that observed on backed bladelets.

To sum up, we can conclude that the production of backed bladelets in Ćmielów and Podgrodzie was probably similar to the scheme proposed by Michał Przeździecki (2020). The first stage of the procedure, after selecting the bladelet, was to create a long notch – in the form of a back and then segmentation with the use of striking (Fig. 2). This was usually done along one of the ridges occurring on the bladelet. It seems, based on the knowledge resulting from experiments (*e.g.*, Rankama and Kankaanpää 2011; Sørensen 2017), that manufacturers could use pads and precise strokes for this purpose. There was no need to perform precise notches as in Mesolithic microburin procedures known from the territory of Poland (see *e.g.*, Kozłowski 2009). We can conclude, that during the production process, the manufacturers tried to divide the blanks into parts, that were equal to each other. The standardization of the length facilitated possible repairs during the usage of composite tools. If one or more inserts were damaged, the manufacturer could form and insert them at any time. If each insert was different, the blades would have to be shortened and transformed before each repair. During the last stage of production (after breaking), the inserts were additionally retouched in order to correct their shape.

Finally, we should also attempt to interpret the additional reasons for fractures of backed bladelets, not only those related to intentional segmentation. The distinction between these reasons is an important element in the study of the production of backed bladelets. To sum up, based on the research conducted so far, we can conclude that these tools were broken during their use as hunting weapons. In the study group of backed bladelets, we noticed fractures resulting from their usage (like characteristic impact fractures), which was confirmed by use-wear studies (Pyżewicz 2015a, 2020). Most likely, there are also some fragments that broke due to postdepositional factors. However, detailed experimental and technological studies, including analysis of relationship between length and mode of fragmentation, should be undertaken in the future in order to be able to distinguish different types of genesis of fractures of backed bladelets.

To sum up, we can conclude that backed bladelets were at least partially shaped using the microburin techniques, as evidenced by the studies presented above. Additionally, it should be noted that the characteristic waste products – microburins, were also registered in other inventories from the Magdalenian sites in the Polish territories. Specimens of this type are found in Dzierżysław (Ginter *et al.* 2002; 2005), Wilczyce (Królik 2014) or Klementowice-Kolonia (Wiśniewski T. 2015). In the course of further studies, it would be worth undertaking analogous morphometrical and morphological studies and compere with studies presented above.

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THE TARDENOISIAN CONCEPT IN POLISH MESOLITHIC STUDIES

ABSTRACT

Płonka T. 2022. The Tardenoisian concept in Polish Mesolithic studies. *Sprawozdania Archeologiczne* 74/1, 141-155.

The evolution of the concept of the Tardenoisian in Polish Mesolithic studies visibly falls into three phases, dating approximately to 1900-1970, 1971-1990, 1991-2016. In the first half of the twentieth century the geographical range of the Tardenoisian, known originally from French sites, was extended to areas in Central Europe, Poland included. Although criticised by Polish researchers of the Mesolithic already in the 1960s, this concept continued to appear in the literature until 1970. In the 1960s, 1970s and 1980s the local cultural taxonomy of the Polish Mesolithic was developed, based on meticulous analyses of the archaeological record. Using these sources, some researchers have recognized influences in southwestern Poland of the Western complex of Mesolithic cultures which includes *e.g.*, the Tardenoisian and Beuronian. New material discovered after 1990 confirmed the presence of Beuronian sites in the Polish zone of the Sudeten. The upland and mountainous zone of Central Europe with its great diversity of lithic resources was heavily exploited by communities of this cultural tradition.

Keywords: Mesolithic, Tardenoisian, Beuronian, Sudeten Mesolithic
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INTRODUCTION

The term "Tardenoisian" takes its name from the Tardenois natural region in northern France lying in the departments of Aisne and Marne. The first characteristic artefacts were discovered in 1885 by E. Taté at Coincy-l'Abbaye, in a location known as Sablonnière, in the department of Aisne (Taté 1924). In November of that year, E. Taté notified G. de Mortillet, who after inspecting these materials assigned them to a unit named *le Tardenoisien*. In 1889 at the International Congress of Anthropology and Prehistoric Archaeology, E. Vieille made known his discoveries in this same region which – as it turned out – had preceded the works by Taté, having been made in 1879. Later still, it became known that the earliest finds of microliths had been made in 1868. There is no doubt, however, that the term "Tardenoisien" was coined by G. de Mortillet (1896). The Azilian and the chronologically succeeding Tardenoisian were understood to fill completely the settlement hiatus that supposedly existed in Europe between the Palaeolithic and the Neolithic. The stratigraphic and chronological position of the Tardenoisian was narrowed down as a result of excavations by L. Coulonges at Sauveterre-la-Lémance (Lot-et-Garonne) and by R. Lacan at Cuzoul de Gramat (Lot) in the 1920s and 1930s.

The concept of the Tardenoisian was of major importance for the development of research in the Mesolithic and Late Palaeolithic of Central and Eastern Europe, the territory of present-day Poland included. During different period of the development of archaeology, the Tardenoisian was interpreted in different ways. The evolution of this concept in Polish Mesolithic studies largely coincides with the speculations of Central European archaeologists but nevertheless displays some individual features that are an interesting object for reflection. The present article aims at reviewing the evolution of this concept in the studies of the Polish Mesolithic.

1900-1970

Shortly after the Tardenoisian was recognized, the term was extended to different inventories with microlithic tools known from Western, Central and parts of Eastern Europe. At the same time, in the early years of the twentieth century, when publishing the second portion of prehistoric materials from the Stopnica district, E. Majewski (1904) did not use the term Tardenoisian, despite being familiar with the work of de Mortillet (1896) where this culture unit was defined. Discussing the chronological position of tools found in Stopnica district, Majewski used the general term "Mesolithic" although he himself was inclined to agree that microlithic tools "need not be of an earlier date than the Neolithic" (Majewski 1904, 155, 156). The term "Tardenoisian" entered the Polish language literature for good in the 1920s. L. Kozłowski (1923) in his contribution discussing the Stone Age in eastern Lesser Polish Upland used the concept of a "microlithic Mesolithic" to describe small

Table 1. The communities and cultures of the Western Mesolithic Cycle in Europe

Sauvterrian community	Tardenoisian community	Castelnovian community
Sauvterrian culture Boberg culture Shippea Hill culture	Beuron-Coincy culture Rhine Basin culture	Castelnovian culture Montbani culture Hoëdic culture Cuzoul culture Muge culture

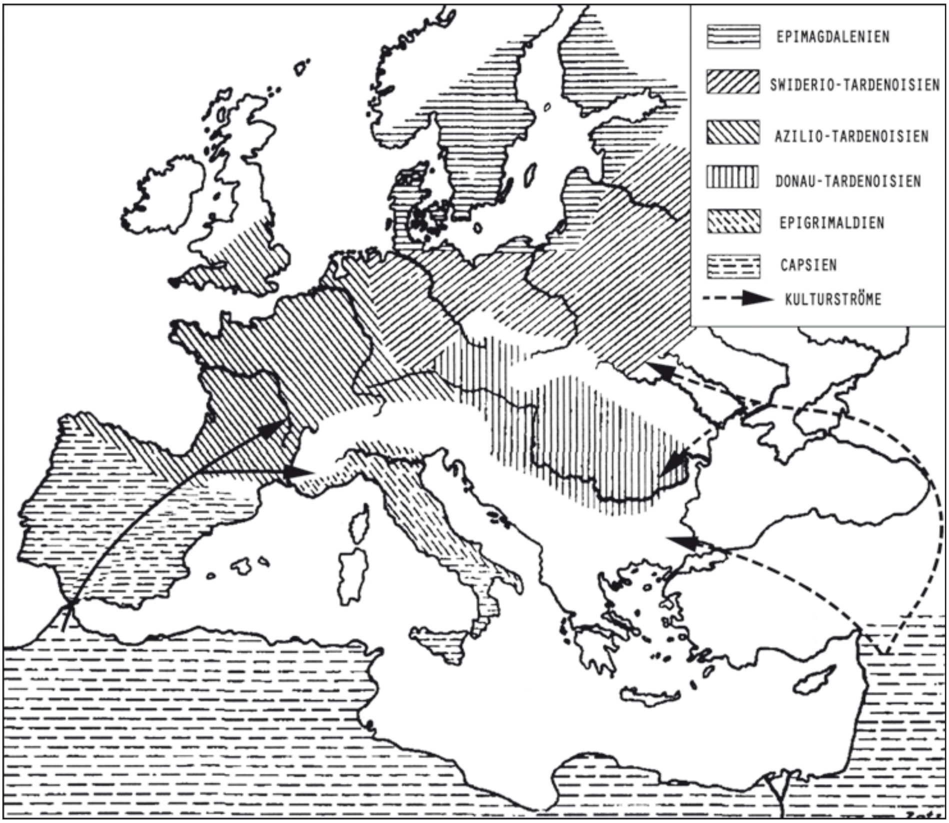

Fig. 1. The Tardenoisian in Europe according to Lothar Zotz (1934, Fig. 6); computer processing by N. Lenkow

tools, often of a geometric shape, apparently introduced to our region from areas in south-western Europe. This term by the same researcher in his earlier studies concerned with the early phases of the Stone Age in Greater Poland (L. Kozłowski 1919) and with the state of research in the Stone Age in Poland (L. Kozłowski 1921, 31-33) – recognizing the "Neolithic microlithic" as its end result. According to L. Kozłowski (1923), this same "microlith" partly belongs to the "Azilian age", but nevertheless for the most part to the "Tardenoisian culture". L. Kozłowski concluded that "our microlithic Mesolithic also belongs to this culture" (L. Kozłowski 1923, 145). However, in the next sentence he goes on to describe the same culture as "early Neolithic". In a chronological table on the following page, he makes a distinction between "Tardenoisian culture" in "Mediterranean countries" and the "microlithic Mesolithic" in the Lesser Polish Upland. Even in this short fragment of Kozłowski's text reveals his dual understanding of the term "microlithic Mesolithic"; on the one hand it is understood as a certain formal and functional assemblage of artefacts found in the Azilian and Tardenoisian cultures, and later, in the "fully fledged Neolithic", but in a different passage it is treated as a chronological notion equivalent to the "Tardenoisian culture" . In the first overview of the Polish Mesolithic, L. Kozłowski (1926) distinguished the presence in sandy areas of Poland of the Tardenoisian culture with western European origins.

A major contribution to the development of the Tardenoisian concept was made by L. Zotz (1931; 1932; 1934) who recognized, next to centres of the Western and the Danubian Tardenoisian indicated by H. Obermaier, a northern Central European centre found in Germany and Poland. In the 1930s, L. Zotz formulated the term of a "Swiderio-Tardenoisian" cultural group which supposedly came into being as the result of the superimposition of Tardenoisian elements over Swiderian ones, in a vast territory extending from Lithuania through Belarus and Ukraine almost as far as the Rhine. Zotz argued that strong cultural currents combined with migrations (Fig. 1) ran on the one hand to Western Europe (by way of Gibraltar), on the other hand, to eastern and Central Europe (through Asia Minor and the Caucasus). The former resulted in the emergence of the Azilo-Tardenoisian, the latter led to the development of the Swiderio-Tardenoisian and the Danubian Tardenoisian. It is extremely interesting that it did not occur to Zotz that artefacts resting on the same level may differ in age.

Zotz argued furthermore that "assemblages" containing side by side Neolithic and Mesolithic elements represent the Neolithic with some residual Tardenoisian features (Zotz 1934). Similarly, B. Klíma assigned the industry from Kylešovský kopec to the Swiderio-Tardenoisian industry and from that time on, Czech researchers classified a larger number of sites in the Czech Massif to the Swiderio-Tardenoisian. This concept was adopted also in Soviet literature of that period (A. Formozov, A. Jabłonskite). In Central Europe, L. Kozłowski, L. Sawicki, K. Jażdżewski, J. Bryk and Z. Szmyt were recognized as the most influential researchers of the "Tardenoisian problem", in Russia this applies to M. Rudynsky.

The perception of the Tardenoisian in the period before World War II is summarized in passages discussing the Mesolithic in the entries contributed by J. Kostrzewski to *Encyklopedia Polska* – Polish Encyclopaedia (1939-1945) and in the volume on the prehistory of Poland published after the War (Kostrzewski 1949). The two texts are quite similar although they differ in some details, and J. Kostrzewski would reiterate his observations about the Tardenoisian in his later contributions (Kostrzewski 1955). Kostrzewski traces the Tardenoisian culture to Africa (as posited by Ed. Vignard), from which region it migrated to the European continent either by way of Gibraltar or through Asia Minor and the Caucasus. Like researchers before him (L. Kozłowski 1926; Clark 1936), J. Kostrzewski argued that the Tardenoisian is to be found almost everywhere in Europe in sandy areas – except for Scandinavia, Eastern Baltic countries and some regions on the Danube. In the pre-1939 territory of Poland, it is noted during the "late Ancylus Lake period", ranging from Lesser Poland to Pomerania, Wilno Land and Lithuania – but only in sandy areas. Kostrzewski (1970, 18) explained the marked preference for dunes by the fact that they were free of vegetation and usually situated near water. In his view, the Polish assemblages were more likely to represent the eastern direction of migration because early Tardenoisian assemblages from our region (pre-1939 Poland) and eastern Germany feature Swiderian tanged points, not noted in western Europe.

Chronologically, the Tardenoisian falls into two groups – early ("Lower Tardenoisian") and late ("Upper Tardenoisian"). Armatures characteristic of this culture are represented in Lower Tardenoisian assemblages by triangles and segments whereas in the Upper Tardenoisian the predominant form are trapezes, burins are no longer in evidence, and a previously unseen form are so-called "pointy scrapers". This culture continues in evidence until the Neolithic, represented also by the Janisławice burial. During the same age, northern Poland was inhabited by another group of people, whose main subsistence strategy was fishing, living near still and flowing waters, who mostly used tools made from antler and bone. These tools have been recorded in the Mazury Lake District, Gdańsk Pomerania and northern area of Greater Poland (Kostrzewski 1949, 26), or according to a different study (Kostrzewski 1939-45, 121) everywhere in Pomerania, northern Mazovia, Vilnius Region and Lithuania. These antler and bone artefacts are reminiscent of the Kunda culture, although axes and batons apparently are related to "types in the Maglemose culture". Kostrzewski's description contains a number of points that, in my view, may be useful to discuss. The first of these follows from the claim that Tardenoisian sites are restricted in their distribution to sandy locations – this leads to the question of where the Kunda and Maglemosian hunters of northern Poland lived – presumably, next to bodies of water where objects of bone and antler made by these people have been found.

The second doubtful point is geographical, since in his post-War study (1939-45), Józef Kostrzewski lists the Vilnius region and Lithuania as areas inhabited both by the Tardenoisian and the Kunda people. To judge from his observations, we can surmise (but cannot be certain) that the former occupied sandy areas, the latter – after all, they were all fishers – waterside sites. However, it is unclear whether in Kostrzewski's view this settlement was synchronous or a diachronous phenomenon.

The third doubt is raised by the cultural inventory of the Tardenoisian people, which does not include objects crafted from antler and bone, except for the single burial at Janisławice, but it is unclear whether J. Kostrzewski treated the elements of this inventory as an exception to the rule. In any event, it did not include fishing tools, so characteristic of the “northern people”. As for the latter, they “almost exclusively” (Kostrzewski 1939-45, 121) used antler and bone tools. However, it is not fully clear how exactly the phrase “almost exclusively” was understood by Kostrzewski. I believe that the Professor had an awareness that lithic tools were also in use (after all something was needed to work antler and bone) but they cannot be linked to objects made of these organic materials. He voiced this view explicitly in his works published in 1955 and 1966, and blamed the absence of lithic artefacts on the level of research – the lack of regular archaeological excavations.

These doubtful points were addressed, with some modified ideas about different peoples, in a volume discussing the prehistory of Pomerania (Kostrzewski 1966, 11-13). During “the Ancylus Lake period” this region was inhabited by peoples of two distinct cultures – Tardenoisian and Maglemosian-Kunda. The former are known primarily from camps on dunes with rich flint inventories, since antler and bone are unlikely to survive there. Finds associated with the latter have been recovered from rivers, lakes and marshland where organic material have a high survival rate whereas lithic artefacts “eluded the attention of casual explorers”. Formerly, the Tardenoisian culture used to be identified mostly with hunters, the latter with fishers, but his view is too one-sided. The sites at Kunda and Maglemose have produced a large number of flints and the grave inventory from Janisławice contained no less than 54 antler and bone objects. Bone and antler tools, contrary to the view of the earlier generation of researchers, were present also on French sites (Barrière 1955; 1956). Thus, the communities of both these cultures practiced gathering, hunting and fishing, with only some prevalence of hunting in the Tardenoisian environment and fishing among the Maglemose-Kunda communities.

Meanwhile, summarizing the state of research on the Tardenoisian, C. Barrière (1955; 1956) found this civilisation is characteristic of western Europe, claiming that the majority of Tardenoisian sites are known from France, and that some Tardenoisian influences are to be seen in Central Europe. In his view, studies of stratified sites prove that the Tardenoisian was preceded by the Sauvterrian. C. Barrière states outright that the Tardenoisian was also familiar with tool forms other than microliths, and with objects made of bone. Furthermore, he argues that there is no need to look for the roots of the Tardenoisian in Africa because microlithic forms and the microburin technique are known from the Upper Palaeolithic and Epipalaeolithic of Western Europe.

The Swiderio-Tardenoisian concept had already come under criticism before the War. In a competent observation made while reviewing the work of C. Engel and W. La Baume, K. Jażdżewski demonstrated that the existence of such a formation cannot be sustained since Swiderian and Tardenoisian materials are evidently chronologically separate (Jażdżewski 1938, 308-309). More criticism and some modifications of the Swiderio-Tardenoisian concept came in the early 1960s, although the author of this criticism, J. K. Kozłowski nevertheless proposed to allocate some assemblages from the former Kraków district to the “Mazovian-Tardenoisian industry” (J. K. Kozłowski 1960, 95). On the other hand, Zotz’s reasoning was criticised firmly by R. Schild and H. Więckowska in their article from 1961 (Schild and Więckowska 1961). Their conclusion was that the speculative culture units are the result of an uncritical analysis of surface finds, containing side by side Late Palaeolithic, Mesolithic and later materials. Addressing the Tardenoisian concept, H. Więckowska (1964, 31) claimed that all too often Mesolithic materials from Europe tend to be classified routinely to the Tardenoisian industry: early (with triangles) or late (with trapezes). While on this subject, she also observed that "the existing synthetic analyses of the Mesolithic are at present untenable". During the investigation of sites in the region of Dębe, north of Warsaw, it turned out that the materials fall outside the established system, proving that the earlier classifications are outdated. H. Więckowska argues that a new analysis of Mesolithic materials can be attempted only using the concept of industries and industry cycles of S. Krukowski. On the other hand, discussions of this sort found their way to the synthetic prehistory of Poland published in mid-1960s (Kostrzewski *et al.* 1965, 50). An opinion is found in this volume that is quite similar to Więckowska's position. This is that while so far a few hundred sites are known from Poland to date, many of them had yielded mixed inventories, their chronology remained undetermined and typological differences between them are considerable. Most of these sites were classified to the Tardenoisian culture, but this cultural taxonomy turns out to be completely useless (*nota bene*, the authors reiterate the incorrect view about the origins of the name "Tardenoisian" deriving it from the site Fère en Tardenois). As a result, in the chapter dedicated to the Mesolithic no cultural taxonomy whatsoever is used, only a description is given of phenomena and material culture of that age. The author of this contribution was presumably W. Chmielewski who was well familiar with the context of the discussion of the cultural divisions of the Mesolithic (J. Kostrzewski wrote of the Tardenoisian culture as late as 1970).

Similarly S.K. Kozłowski considered the existing cultural taxonomy of the Mesolithic to be outdated (S. K. Kozłowski 1965, 151, 152). He argued that the "apparent uniformity" of Mesolithic artefacts from Europe had persuaded Polish researchers to adopt French taxonomic solutions – the inventories would be determined as "Tardenoisian", their chronological determinations dependent on the presence of triangles or trapezes. This was aggravated by incorrect methods used to recover the materials, which resulted in mixing inventories of a different age (which was then used an argument to discredit the value of surface finds in general). At the same time, in a footnote (no. 4 on page 152), the same author was "conditionally" inclined to use the term "Tardenoisian period" as a synonym of the Mesolithic (*cf.* his voice in a discussion at the First Palaeolithic Symposium in Cracow).

What follows from these critical observations is that the Tardenoisian concept had been used routinely as a tool in classifying assemblages with Mesolithic armatures found in Poland, in Central Europe and in parts of Western Europe. Only with the study of the diversity of these tool forms and the parallel development of typological analyses, were culture units, understood to represent specifically local cultural relationships, recognized during the 1950s and 1960s.

1971-1990

The effect of these in-depth studies was a series of synthetic studies of the Mesolithic in Poland, the earliest published in the 1970s and 1980s (S. K. Kozłowski 1972; 1989; Więckowska 1975). Their authors proposed a new cultural taxonomy for the Mesolithic materials from this region, one that corresponds to the local lithic styles. S. K. Kozłowski confined the use of the term "Tardenoisian" to a specific complex of cultures characteristic of Western Europe, in its uplands and foothills, with some peripheral sites in Central Europe (S. K. Kozłowski 1972, 206-213), with the Tardenoisian culture proper found only in the west. In Central Europe, in the region directly bordering on Polish lands, he distinguished Smolín type assemblages, named after a type site in Moravia investigated by K. Valoch (1963). In Central European inventories belonging to the Tardenoisian tradition, the main armature forms would be Tardenoisian points, Komornica truncations, mostly with a base in the proximal part of bladelet, short lanceolate backed points, short isosceles triangles, short segments and asymmetrical trapezes. A form characteristic of these assemblages is also the endscraper – either small and short, circular or other forms. In the view of S. K. Kozłowski (1972, 211, 212, Pl. XLVI: 38-51) Smolín type assemblages found in Poland would include the surface inventory from Potasznia I, Milicz district with Komornica truncations with a base in the proximal part of bladelet, isosceles triangles, an asymmetrical trapeze, a Tardenoisian point or a small Janisławice point as well as some small and short endscrapers (Fig. 2: 1-5). He interpreted these materials as evidence of a sporadic penetration of the region and, as such, not likely to be found in high numbers in

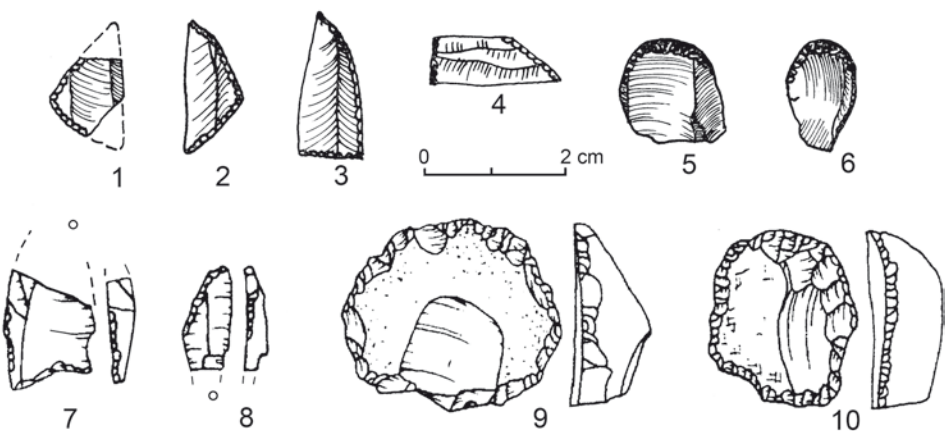

Fig. 2. Stone artefacts from southwestern Poland. 1-5 – Potasznia I; 6-10 – Ratno Dolne 2 (1, 2 – isosceles triangles; 3 – Tardenoisien or Janisławice point; 4 – asymmetric trapeze; 5, 6, 9, 10 – endscrapers; 7 – Tardenoisen point (?); 8 – Komornica truncation with a base in the proximal part of bladelet; 1-7, 9, 10 – erratic flint; 8 – opal). After Bagniewski 1976; Bronowicki 2002; computer processing by N. Lenkow

Poland, "possibly except for the little studied uplands in Lower Silesia (?)" (S. K. Kozłowski 1972, 212). In later studies, the site Potasznia I was allocated to the Beuronian ("the Beuron-Coincy culture"). J. K. Kozłowski and S. K. Kozłowski elaborated a two-stage taxonomy of Mesolithic cultural units in Europe (Tab. 1) in which "the Beuron-Coincy culture" belonged alongside the Rhine Basin culture to the Tardenoisian community of the Western Mesolithic Cycle (J. K. Kozłowski and S. K. Kozłowski 1975, 274; 1977, 245). This cycle grouped cultures that had originated in the Palaeolithic of southwestern Europe. At the end of the 1980s, based on materials then at hand, S. K. Kozłowski ultimately rejected the argument of the existence of sites of this culture in southwestern Poland (S. K. Kozłowski 1989, 189, 190).

In the 1970s and 1980s, no Mesolithic sites were recorded in the Polish Sudeten and their foreland. This situation was thought to reflect the specific preferences of the Mesolithic hunters who avoided hilly and mountainous terrain bordering in Poland on the European Lowland (Rothert 1936; Bagniewski 1987). In his work on the Mesolithic settlement in southwestern Poland, Z. Bagniewski (1987, 9) observed that despite many years of study no Mesolithic sites had been identified in the Sudeten mountains above 250 m a.s.l. But he did not rule out their existence because their remains could have been redeposited and buried by erosion processes, much more intensive in the mountains than in the lowlands.

1991-2016

The late 1980s and 1990s brought intensive archaeological investigations in the Sudeten Mountains and the Sudeten Foreland oriented on discovering evidence of Palaeolithic and Mesolithic occupation (Bronowicki and Kowalski 1990; Płonka 1995; Bobak 1996; Bronowicki 1999a; 1999b; Masojć 2004). This fieldwork revealed the presence of rich Mesolithic settlement in the region, confirmed in any case by a large number of finds known from the Czech part of the Sudeten (Vencl 1978; 1991a; 1991b; 1992; 1996). Material recovered in the Polish part of the Sudeten resembled the "Lowland" Mesolithic inventories known from southwestern Poland, with characteristic microlithic forms, other tool forms and cores (Bagniewski 1987; Bronowicki 1999a; Masojć 2004; Płonka 2007). At the same time, different areas of northeastern Bohemia, in the region of Sopotnice, in the Orlickie Foothills and in the Lusatian Mountains, have produced sites that may be referred to using the term Beuronian, despite the exceedingly rare occurrence of Tardenoisian points (Vencl 1991b; 1992; Svoboda 2003). Next to a large selection of armatures such as isosceles and other triangles, segments, Komornica-type truncations with a base in the proximal part of a bladelet, these sites are characterized by the regular use of local raw materials, with the proportion of Baltic erratic flint in some sites as high as 55-79% (Płonka 2007, tab. 1). In any case, a feature characteristic of these sites is the raw material polymorphism; the lithic

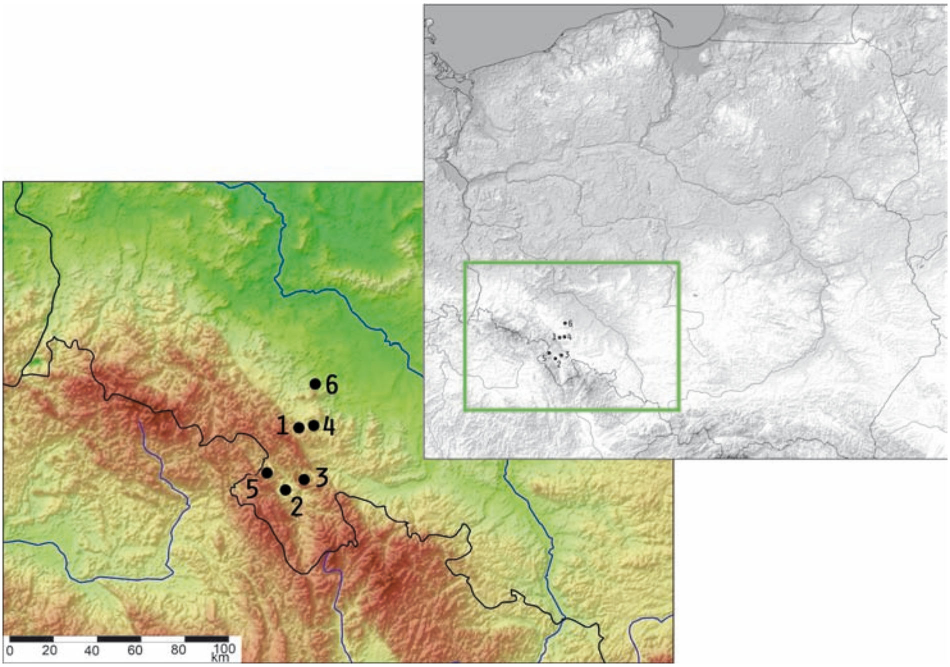

Fig. 3. Beuronian sites and sites with Beuronian elements in southwestern Poland. 1 – Bielawa 12; 2 – Kamieniec 3; 3 – Ławica 8; 4 – Piława Dolna 16; 5 – Ratno Dolne 2; 6 – Ślęża (mountain) 177; computer processing by N. Lenkow

artefacts found in them were made of many different raw materials, some of them sourced over 50 km away. They date to the Boreal and the Atlantic period (Płonka 2007).

In the 1990s and early years of the 21st century, the studies of J. Bronowicki revealed the existence in the Polish Sudeten of sites similar in character (Fig. 3). They delivered some characteristic tool forms like Tardenoisian points (?), round endscrapers and Komornica truncations with a base in the proximal part of bladelet (Fig. 2: 6-10) One of these sites, at Ławica 8 in the gorge on the Nysa Kłodzka river in the Bardzkie Mountains, produced an inventory of several hundred Mesolithic artefacts struck from erratic flint and local siliceous rock, as well as other raw materials (Bronowicki and Bobak 1999; Bronowicki 2000). The Polish sites with Beuronian elements cluster in three regions (Bronowicki 2002; 2008; 2016; Masojć 2016): i./ the gorge on the Nysa Kłodzka in the Bardzkie Mountains; ii./ in the western Ścinawskie Hills in the Kłodzko Basin; iii./ near the Międzylesie Gate in the Kłodzko Basin. Elements of this culture are known also from the Bielawa Basin at the foot of the Sowie Mountains (Masojć 2016). These sites are marked by an impressively rich selection of local rocks used in knapping: diverse types of rock crystal, radiolarites from the Bardzkie Mountains, jasper, opal, chalcedony, agate, lidite, various quartzites and others. In addition to them, the same sites produced finds of lithics originating from areas of Sudeten found today across the border in northeastern Bohemia (assorted spongolites, including spongolites of Ústí nad Orlicí type). Also noted are artefacts struck from raw materials originating from an even more remote area: assorted cherts sourced in Moravia (*e.g.*, Krumlovský les and Olomučany chert), radiolarite of the Szentgál type from northwestern Hungary, Vlára radiolarite from northwestern Slovakia, and the Bečov and Skršín quartzite from northern Bohemia. This confirmed the early tentative conclusions reached by S. K. Kozłowski (1972), reiterated in the 1990s by T. Galiński (1997, 67), about the existence of sites representing the Western complex of Mesolithic cultures in the upland and mountainous regions of southwestern Poland. Also worth noting is that the distribution of this phenomenon in the Polish Sudeten (Fig. 3) tends to reflect the earlier directions of archaeological fieldwork – most likely, the Beuronian is to be found also in other parts of the Sudeten.

At this stage of Mesolithic studies, Beuronian sites were first identified with a definite mountain and upland landscape. Thus, the spread of this cultural phenomenon was associated with this specific geographic environment with a varied hypsometry, substantial microregional diversity, with numerous outcrops of local rock of a varying quality. In many cases (*e.g.*, Hřibojedy) the quality was poor, but regardless of this, the strategy of using local lithic resources was more attractive than sourcing them from more remote sources. Nevertheless, erratic flint continued to play a significant role as a raw material, even if available only from glacial sediments found in the Sudeten Mountains and their foreland.

THE TARDENOISIAN CONCEPT – EVOLUTION OF INTERPRETATIONS

The three periods of perception and use of the term “Tardenoisian” belong to the mainstream of changes in archaeology both worldwide and European. In the first period (1900-1970) the archaeology of the Stone Age identifies phenomena on a global scale. Cultural units distinguished at this time in European Palaeolithic and Mesolithic studies had a very wide geographical range covering much of our continent. The Tardenoisian became a convenient classification tool that included finds with microlithic tools in the type of armatures from western, central and parts of eastern Europe. This global approach was accompanied by ideas on migration that trace the origins of the Tardenoisian to Africa attributing its spread to Europe to movements of foragers. Additionally, the Tardenoisian became the core of the Swiderio-Tardenoisian concept of the evolutionary development of the Late Palaeolithic cultures into Mesolithic ones.

In the 1960s, as local systems of taxonomy and chronology of the Mesolithic were being developed in Central Europe the “Tardenoisian” concept came under criticism, and it was replaced with new cultural units identified through the analysis of local lithic artefacts. Nevertheless, in contributions close to popular science, and in monographs concerned with regional prehistory, the term may be seen to continue in use during this period (Kostrzewski 1966; 1970). At the same time in the literature concerned with the European Mesolithic, the Tardenoisian is regarded as a local phenomenon with a geographical distribution limited to some areas of western Europe (Barrière 1956).

During the next period (1971-1990), the Tardenoisian is redefined in the Polish literature only as an element of a larger complex of Mesolithic cultures (Western Mesolitic Cycle). The geographical extent of the Tardenoisian was made clear, with suggestions made about the impact of these cultures or even physical presence of groups representing them in the territory of Poland (of Smolín type assemblages, Beuron-Coincy culture, Beuronian), supposedly in its southwestern region, especially in the foothills and mountain zones (Sudeten and Sudeten Foreland). Ultimately these conjectures were not confirmed by the archaeological record, which did not corroborate occupation or impact of communities from the Western complex of Mesolithic cultures.

After 1990, intensive archaeological fieldwork in the Polish Sudeten led to the discovery of new materials which may be allocated to the Beuronian, or at least include some artefacts characteristic of this culture. These finds are corroborated by discoveries made in northeastern Bohemia also identified with the Beuronian. This period of reflection about the Tardenoisian concept brings a new understanding of the connection of this settlement with the Central European uplands and mountainous zone, and the model of the raw materials economy largely aimed on the exploitation of local lithic resources, but also on raw materials sourced at a greater distance of more than fifty, even several hundred kilometres.

FINAL REMARKS

While following the interesting phenomenon of the evolution of the Tardenoisian concept in Mesolithic studies in Poland, one may wonder about the possible directions future studies of this subject could take. What needs solving is the matter of the presence of Beuronian sites in other parts of the Polish Sudeten and their range – both their local cultural attribution and chronological range. These problems can be solved partly through investigation of well stratified sites with Beuronian materials that still await discovery. No less interesting is the matter of interactions between the communities of the Western complex of Mesolithic cultures and the hunter-gatherers of the Lowland zone also settled in the Sudeten zone.

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THE ORIGIN OF THE TROUGH RETOUCH IN THE LUBLIN-VOLHYNIAN CULTURE

ABSTRACT

Kadrow S. and Zakościelna A. 2022. The origin of the trough retouch in the Lublin-Volhynian culture. *Sprawozdania Archeologiczne* 74/1, 157-186.

The technique of trough retouch played a key role in the Lublin-Volhynia culture as the most expressive technology of co-shaping the edges of flint tools. An important role is played by the so-called retouched blade-daggers, produced using this retouching technique. They were part of the equipment for the graves of men considered to be members of the local elite. They appeared in a similar context only in the early Eneolithic Skelya culture in the Black Sea steppes and are dated from at least 4500 to 4100 BC. Specimens from the steppes must have been a source and act as a model for imitation in the production of analogous artefacts in the latter culture. The lack of retouched blade-daggers in Trypillia and Malice culture proves that the Lublin-Volhynia culture population took them directly from the Skelya culture. This adaptation took place no later than 4100 BC, when the Lublin-Volhynia culture population already had their own elite, ready to use retouched blade-daggers.

Keywords: trough retouch, Lublin-Volhynia culture, retouched blade-daggers, Black Sea steppes, Skelya culture

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INTRODUCTION

Trough-like retouch is a distinctive method of forming flint tools with flat and semi-flat retouching with long parallel negatives, perpendicular, and most often oblique to the longitudinal axis of the product. It was used to form blade and bifacial tools.

So far, Anna Zakościelna and Jerzy Libera have devoted the most attention to this retouching in Poland (Libera and Zakościelna 2013; Zakościelna and Libera 2014). They defined the classic type of trough retouch. It is flat or semi-flat, very regular, with negatives and micro-negatives situated parallel to each other and perpendicular or oblique to the retouched edge. It covers considerable parts near the edge, sometimes the entire edge, or less frequently the whole surfaces of the tools. It occurs mainly in the Lublin-Volhynian culture (hereafter: L-VC). It is found sporadically in other Eneolithic cultures as evidence of ties with this culture. In later periods, there was no trough retouch of the classic variety (Libera and Zakościelna 2013, 228).

Similar retouching techniques were already present in the Upper Palaeolithic (Solutrean culture and Aurignacian industries) and in the pre-ceramic Neolithic period in Hacilar and Çatal Hüyük in Anatolia. In Europe, the earliest in the Eneolithic context it was found in the Kodjadermen-Gumelniţa-Karanovo VI (hereafter: KGK VI) cultural complex. Occasionally, it was used there to shape bifacial points (Libera and Zakościelna 2013, 218). In the non-classical version, this retouching was used in various cultures of the late Neolithic and early Bronze Age in Scandinavia and in Central and Eastern Europe (Zakościelna and Libera 2014).

It was only in the Cucuteni-Trypillia cultural complex (hereafter: CTCC) that the trough retouching (in its classic version) played an important role, but not as much as in the L-VC. It appeared on the Dniester (Polivaniv Yar, Zalishchiki) in the BI phase of the Trypillia culture (hereafter: TC). In the entire area of the culture in question, the trough retouching became widespread in phase BII (Libera and Zakościelna 2013, 218).

The aim of the article is to explain the genesis and chronology of the appearance of the trough retouch in the L-VC.

THE SPATIAL AND CHRONOLOGICAL RANGE OF THE STUDY

The chronological and spatial scope of the article is determined by the occurrence of mass (non-sporadic) production of flint tools (such as: retouched blades, blade tools, bifacial points), shaped by classic trough retouching.

These tools are recorded at the earliest in the area of the steppe, in the early Eneolithic Skelya culture (hereafter: SC), located between the Dnieper and Siverskyi Donets and the lower Don (Rassamakin 2020, fig. 1), in Suvorovo communities from the same time in the

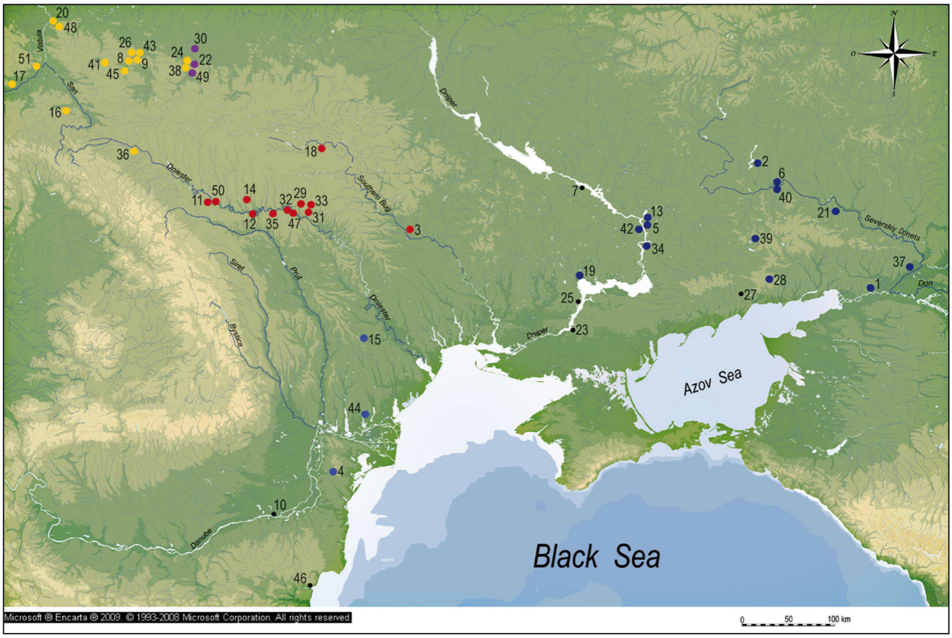

Fig. 1. Map of the most important sites mentioned in the text: 1 – Aksay; 2 – Aleksandriya; 3 – Berezovskaya (Hydroelectric Station); 4 – Casimcea; 5 – Chapli; 6 – Chernikovo Ozero; 7 – Dereivka; 8 – Gozdów; 9 – Gródek; 10 – Gumelnița; 11 – Horodnytsa-Horodyshche; 12 – Hrynchuky; 13 – Igren; 14 – Kadiyvtsi; 15 – Kainar; 16 – Kosina; 17 – Książnice; 18 – Kurylivka; 19 – Kut; 20 – Las Stocki; 21 – Luhansk; 22 – Lyshche; 23 – Lysogorskoe; 24 –Luck; 25 – Mikhailovka; 26 – Moniatycze Kolonia; 27 – Nikolskoe; 28 – Novodanilovka; 29 – Nyzhniy Olchedaev; 30 – Ostriv; 31 – Ozaryntsi; 32 – Ozheve-Ostriv; 33 – Patryntsi; 34 – Petro Svistunovo; 35 – Polivaniv Yar; 36 – Radelichi; 37 – Razdorskoe; 38 – Rovancy; 39 – Semenovka; 40 – Serebryanska; 41 – Sitaniec Wolica; 42 –Strilcha Skelya; 43 – Strzyżów; 44 – Suvorovo; 45 – Tyszowce; 46 – Varna; 47 – Vasylivka; 48 – Wąwolnica; 49 – Yaroslavichi; 50 – Zalishchiki; 51 – Złota; yellow circles – L-VC; violet circles – Rzeszów phase of the MC; red circles – TC; blue circles – Suvorovo type; dark blue circles – SC; small black circles – sites of other cultures
(prepared by Elena Starkova and Maria Juran)

lower Danube area and in the Khvalynsk culture (hereafter: KC) from the lower Volga (Rassamakin 1999, 63, fig. 3.1).

They are dated to the early steppe Eneolithic period 4550 (?) – 4100/4000 BC (Rassamakin 1999, 97, tab. 3.2) or in a slightly newer approach to the period 4750 (?) – 4100 (?) BC (Rassamakin 2004a, 180-182, fig. 125).

Numerous examples of the use of the classic trough retouch in the CTCC in the stages: Cucuteni A and AB2 and Trypillia BI and BII extend the spatial scope of the article by forest and forest-steppe parts of the Boh, Dniester, Prut, Seret and Dnieper river basins in the vicinity of Kyiv (Chernysh 1982, 194-212, map 5). As the above-mentioned phases are dated from about 4550-4100 (BI) to 4100-3800 (BII) BC (Rassamakin 2004a, 180-183, fig. 125), the time span of this article extends by another 300 years to 3800 BC.

The most complete trough retouching in its classic form was used in the L-VC (Zakościelna 1996, 92, 93; tab. I-LV). It occurs from the upper Horyń river to the Wieprz river valley, occurring in the Volhynia Upland, further west on the Nałęczów Plateau, in the Małopolska Upland and in the Rzeszów loess belt, and is significantly diluted in the upper Dniester basin (Zakościelna 1996, 19-26, map 1). In the Małopolska Upland, this culture is dated to the period 4050-3800 BC (Wilk 2018, 486). Due to the relationship with the cultures of eastern and south-eastern Europe, the beginning of this culture in the Volhynia Upland should be moved to 4250 BC.

The spatial scope of the article therefore covers vast areas north and east of the Carpathians, to the northern boundaries of the Małopolska, Lublin and Volhynia Uplands. In the north-east it reaches Kyiv, in the east the lower Don. In the south, the border is the shores of the Azov and Black Seas, as far as the Danube Delta and Dobrogea. Particular attention is focused on the area of Volhynia, the upper Dniester and Siverskyi Donets basins (Fig. 1). The chronological scope is narrowed down to the second half of the 5th millennium BC and the beginnings of the 4th millennium BC.

MATERIALS

Skelya culture

There are rich deposits of high-quality Upper Cretaceous flint raw materials between the Dnieper and Don rivers, where the SC people lived. They occur in concretions of various sizes (from 10 to several dozen cm) and shape (bulky, shallow; *cf*. Kolesnik 2017; 2019). They are relatively easily accessible in the exposures of eroded hills and river valleys, especially in the Bakhmut-Toretsk river basin, the middle Siverskyi Donets, in the Krynka river valley, in some parts of the Miyus and Tuzlov valleys, at the mouth of the Donets and Don and in the middle course of the Oskol River (Fig. 2; Kolesnik 2019, 599-601). There was a “Donetsk flint mining centre” in this area. Anatoliy V. Kolesnik (2019, fig. 1, 604-614) lists six mining and processing regions, the largest of which – with underground mining chambers – was identified in the village of Shirokoe. In all these outcrops, remains of flint mines (pits) and flint processing workshops dating from the Palaeolithic to the Bronze Age have been discovered. On the other hand, the mining of Cretaceous flints in the Donbas area began in Eneolithic, along with the demand for macrolithic blades (Kolesnik 2017, 60; 2019, 610).

In the available literature, details on the macroscopic characteristics of these raw materials are modest. Dorothea S. Tsveybel (1970, 229), publishing the results of research on mining installations in the vicinity of the village of Shirokoe, describes the flint there as grey, smoky, and matt without specifying the size of concretions. Kolesnik (2019, 605) in the Krasnoe mining complex (on one of the right tributaries of the Donets) distinguishes

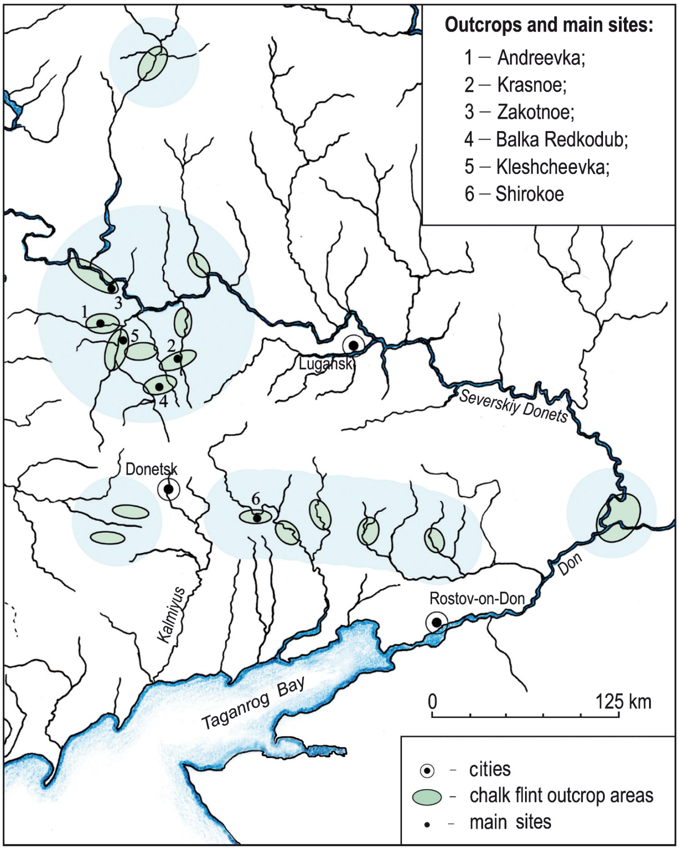

Fig. 2. Map of the Cretaceous flint deposits in Donbas and mining sites (after Kolesnik 2019; prepared by Elena Starkova)

between two types of flints: grey and dark grey glassy and "variegated" with white and brown veins.The latter occurs in the form of large concretions. Glassy grey flint was also located in the Stupka river and in the Dolgaya valley (Kolesnik 2019, 605, 606).

Thus, the SC communities had the comfort of functioning in an environment rich in good flint raw materials.The flint making of this culture is known primarily from burial sites, the few settlements, and hoards of cores and blades. At least a dozen of them are located along the main rivers, *i.e.* the Severskiý Donets and its tributaries, the Don and the Dnieper (Telegin *et al.* 2001, 62; Kolesnik 2012).

Numerous macrolithic blades and retouched blade-daggers as well as triangular points of various sizes shaped with flat retouching come from the graves of the SC. Judging by the drawings, and especially the photos available in some publications (Skakun 2008; Rassamakin 2020), at least some of them are developed with the classic trough retouch, very

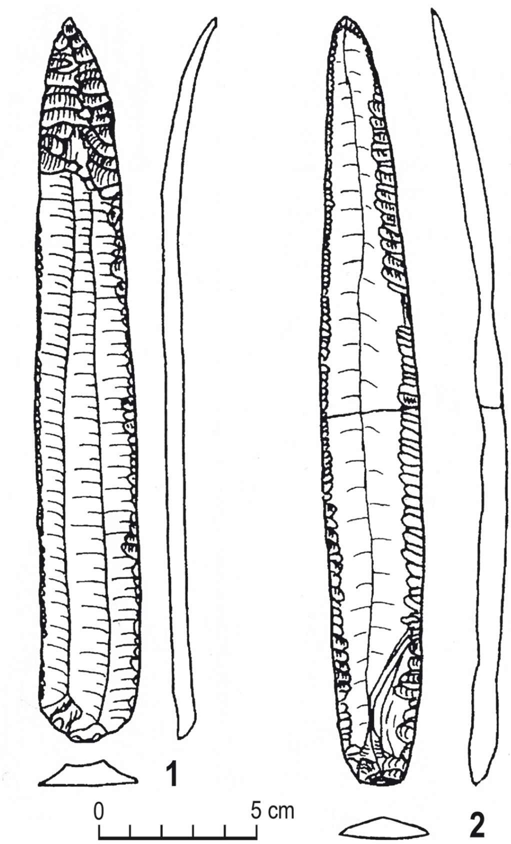

Fig. 3. Skelya culture: 1 – Aksay, group of mounds „Mukhin II", mound 5, grave 9 (obsidian); 2 – Kut, mound 8, grave 7 (flint) (after Rassamakin 2004a; 2004b)

regular. In a few cases, this semi-flat retouch extends far onto the surface of the products and, in contact with the negatives on the other side, completely covers the negative blade surfaces.

The most spectacular examples of long blades, retouched blade-daggers and, at the same time, the most numerous sets of bifacial triangular points, were provided by the complexes of burial group II (dated 4550-4100 BC) from Alexandria (Rassamakin 2004b, Pl. 194, 195; 2020, fig. 10: 2), Igren VIII (tomb 8 – Rassamakin 2020, fig. 15: 4; tomb 10 – Rassamakin 2020, fig. 9: 2 and Rassamakin 2004b, 76, Pl. 252-254, 257), Kut (tomb 8, tomb 7 – Fig. 3: 2; Rassamakin 1999, fig. 3.8: 7; 2004b, Pl. 232: 3, 5), Luhansk (Skakun 2008) and Petro Svistunovo (Bodianskyi 1968; Skakun 2008). Interestingly, one of the longest retouched blade-daggers, from the grave at Aksay "Mukhin II" on the Don, is made of obsidian (Fig. 3: 1; Rassamakin 2004b, Pl. 291: 10).

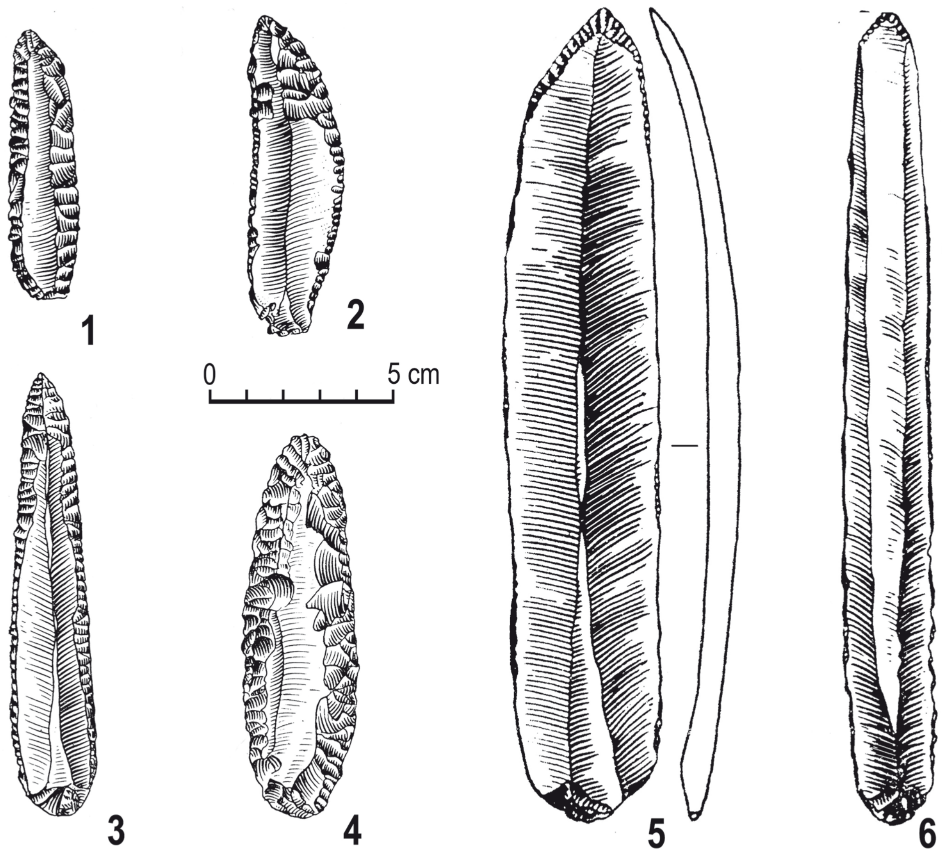

Fig. 4. Skelya culture: 1-5 – Petro Svistunovo (after Bodianskyi 1968)

Some of the graves of burial group II contained numerous flint products. First of all, one should pay attention to two such objects. Sixty years ago, two partially destroyed graves were discovered in Petro Svistunovo in Zaporizhia (Bodianskyi 1968). Exceptional flint equipment was contained in grave 2. Its inventory contained 60 bifacial points of various sizes (Bodianskyi 1968, fig. 4; Rassamakin 2004b, Pl. 235-241), eight axes with a lenticular cross-section (Bodianskyi 1968, fig. 1; 5; Rassamakin 2004b, Pl. 242), 15 blades preserved wholly and in fragments. They include regular blades 16 to 27 cm long (Bodianskyi 1968, fig. 7: 2-4; Rassamakin 2004b, 74-76, Pl. 243: 6-8; 244: 1) and three retouched blade-daggers (Bodianskyi 1968, figs 2: 3, 5; 7: 1; Skakun 2008, figs 9, 10).The latter, as well as all the bifacial points, are formed by regular trough retouching (Fig. 4). Moreover, from the surface of the site and from the destroyed graves, copper bracelets, beads and a copper battle-axe, boar tusk and Cardium shell pendants were collected (Bodianskyi 1968, fig. 3; Rassamakin 2004b, Pl. 233, 234).

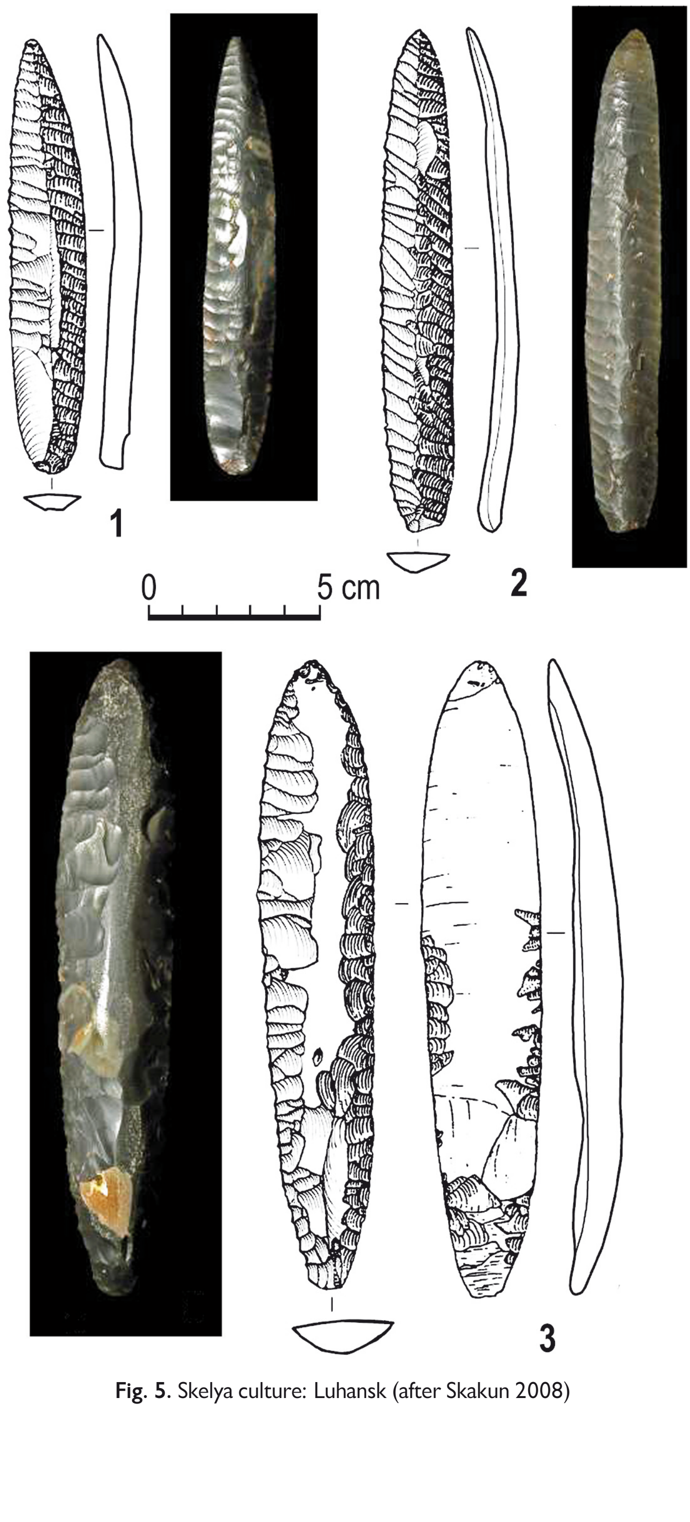

Fig. 5. Skelya culture: Luhansk (after Skakun 2008)

A triple grave explored in 1970 in Luhansk (former Voroshilovgrad) contained a unique set of flint products. The dead were equipped with 33 items made of flint, slate, serpentine, bone and horn (Pislariy *et al.* 1976, 21-25). The flint inventory consisted of 17 macrolithic blades and their fragments. Most of them were located by the skull (8 on the right side – Pislariy *et al.* 1976, figs. 2; 3: 7, 8, 10-15 and 2 on the left side – fig. 4: 1, 2) and around the hips of the skeleton 2, the middle one. In addition, this individual (in the middle) had one long blade in each hand, including one with proximal and distal retouching (Pislariy *et al.* 1976, 22; fig. 4: 6, 7).The individual labelled skeleton 1, was equipped with a single-sided blade with a trough retouch and a retouched blade placed under the skull (Pislariy *et al.* 1976, fig. 3: 1, 3; Skakun 2008, fig. 4: 2; 5: 3), and a dagger formed with the same retouching (Pislariy *et al.* 1976, fig. 3: 3; Skakun 2008, fig. 5: 5; 7: 3), while skeleton 3 had one blade with a retouched tip in his right hand (Skakun 2008, fig. 3: 5).

In 2008, Natalia Skakun published the results of the technological and traseological analysis of 14 flint products from a grave in Luhansk.They are made of three raw materials that differ in colour: honey yellow (Skakun 2008, fig. 4 and: 1, 2, 5, 7-10), striped grey (Skakun 2008, fig 5: 1-3; 6: 3, 4, 6) and black (Skakun 2008, fig. 5: 5-7; f: 2-4). The author of the study does not decide on the origin of the raw materials, although she mentions that they may come from deposits in the Don basin (*cf.* Pislariy *et al.* 1976, 26). Nevertheless, she notes that yellow flint is very similar to the raw materials from Dobrogea known to her from personal inspection, while black – to Volhynian flint. The blades made of honey yellow flint are 15-23 cm long, 2-3.8 cm wide and 0.4-06 cm thick. The two entire blades of striped grey flint measure 19 and 19.2 cm in length, 2.3 cm wide and 0.4 cm thick. On the other hand, retouched blade-daggers made of black flint are 12.5-18 cm long; 2-3.5 cm wide and 0.8-1.3 cm thick.Three retouched blade-daggers of black flint were made with a trough retouch (Skakun 2008, figs. 5: 5-7 and 7: 2-4). In two cases, the negatives are oblique to the axis of symmetry, very regular contact with each other and cover the entire dorsal surface of the blades (Fig. 5: 1, 2; Skakun 2008, fig. 5: 5, 6 and 7: 2, 3). Completely unique is the most massive, retouched blade-dagger, formed by parallel and scaly retouching, partially (in the proximal part?) bifacially, which is also polished on both sides, even smoothed on the upper side (Fig. 5: 3; Skakun 2008, 9, fig. 7: 5; 8).

Skakun notices that the blade products from the Luhansk grave also differ in terms of technology. The researcher is of the opinion that the specimens made of yellow and grey striped raw materials have technological features suggesting their exploitation from the cores by means of enhanced pressure – a lever, and in this respect they have much in common with the products from the KGK VI and Varna complexes studied by her. However, they differ from blade macroliths of the TC, which are – according to her – less regular and more massive, and were obtained by a different technique. She assesses the inventories of graves in Chapli and Petro Svistunovo in a similar manner to the grave goods in Luhansk (Skakun 2008, 7-8).

The retouched blade-daggers from Luhansk made of black flint stand out from all the forms of this type that have been traced in the grave complexes of the early steppe Eneolithic.

This is mainly due to the extremely regular oblique trough retouch, covering almost the entire upper surfaces of two of them. Identically regular retouching is of course known from the sites of the TC BII-C (Figs 6, 7) and the L-VC (Figs 9-12), although it would be difficult to find such perfectly made retouched blade-daggers in them.

Long blades and retouched blade-daggers are rarely part of the equipment of the graves of burial group I, dated only in the period 3800-2900 BC (Rassamakin 2004a, 183, 184, fig. 125). In this monumental work you can find only two such objects discovered in the settlement of Aleksandriya in the Donets basin (Siverskyi Donets). Due to their late chronology, they will not be described in more detail.

The settlements of the SC also produced tools formed by trough retouching. Particular mention should be made of the sites in the Serebryanska and Chernikovo Ozero in the central Siverskyi Donets basin. Despite the low-quality drawings, some of them undoubtedly show retouched blade-daggers made with this technique (Sanzharov *et al.* 2000, figs 15: 9, 10; 20: 10, 11, 13; 31: 8-10, 16?; 34 : 7) and bifacial points (Sanzharov *et al.* 2000, figs 15: 8, 13; 21: 6; 30: 1; 34: 19; 36: 3). These forms are not as spectacular as those found in the graves. They have smaller dimensions. Nevertheless, the retouching technique is identical.

The trough retouching survived in the steppe areas into the Bronze Age. It was used for the production of arrowheads of various sizes and for the final processing of the edges of large points (Razumov 2011, *e.g.*, figs 13, 15: 1-5; 24: 1-6; 26-28).

Trypillia Culture

The trough retouch in the TC inventories appears at the BI (Cucuteni A1-2) stage with the first axes and the progressive macrolithization of the blades. We have the most data from the settlements of Zalishchiki (Vynogradova 1972), Polivaniv Yar (Popova 2003) on the Middle Dnister river and from the recently analysed material from Ozheve-Ostriv (Chernovol and Radomskyi 2015; Radomskyi 2017; 2018). This cluster also includes the settlements of Horodnytsa-Horodyshche, Ozarintsy, Nyzhniy Olchedaev, Patryntsi, Vasylivka, Hrynchuky and Kadiyvtsi, on which the surveys were carried out and materials from the BI stage were obtained (Radomskyi 2018). In the inventories of all the abovementioned sites, although with varying intensity, a parallel retouch was used, related to the trough techque, used for shaping blade tools and, above all, bifacial triangular points.

According to Tatiana Popova (2003), in the oldest settlement layers of Polivaniv Yar, associated with the transition phase from Trypillia A to BI (PJ III1) and with the BI stage (PJ III2), the presence of trough retouch can be noted only on triangular points (Popova 2003, fig. 13). In the third settlement layer (P-J II1), related to the transition from stage BI to BII, this retouching is clearly visible on retouched blades with increased metric parameters. The first flint axes appear then (Popova 2003, fig. 49). In the materials from the next layer (PJ II2) – corresponding to stage BII – trough retouching is the basic technique of

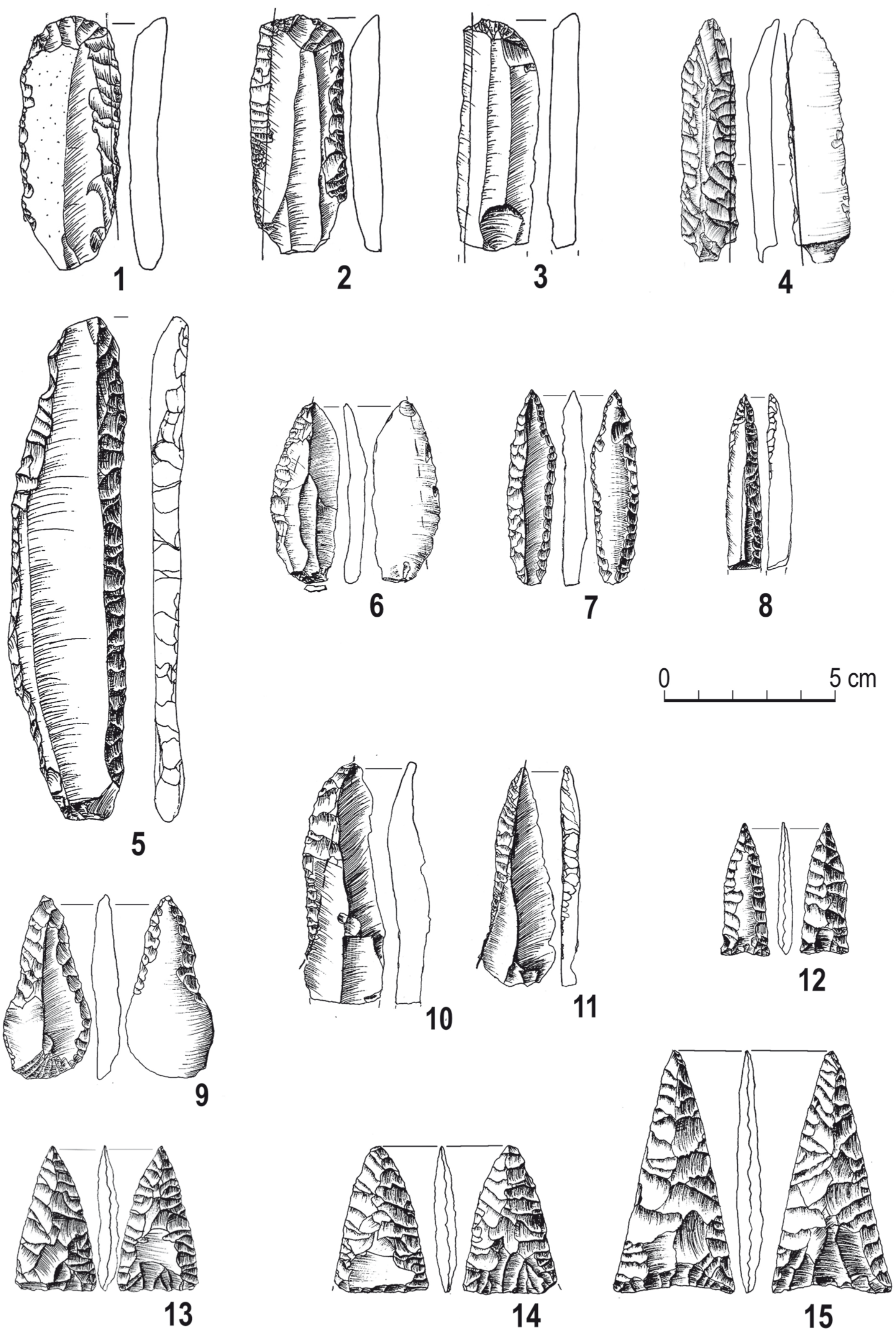

Fig. 6. Trypillia culture, phase BI: 1-5 – Ozaryntsi; 6-15 – Ozheve-Ostriv (after Radomskyi 2015; 2017; Chernovol *et al.* 2021)

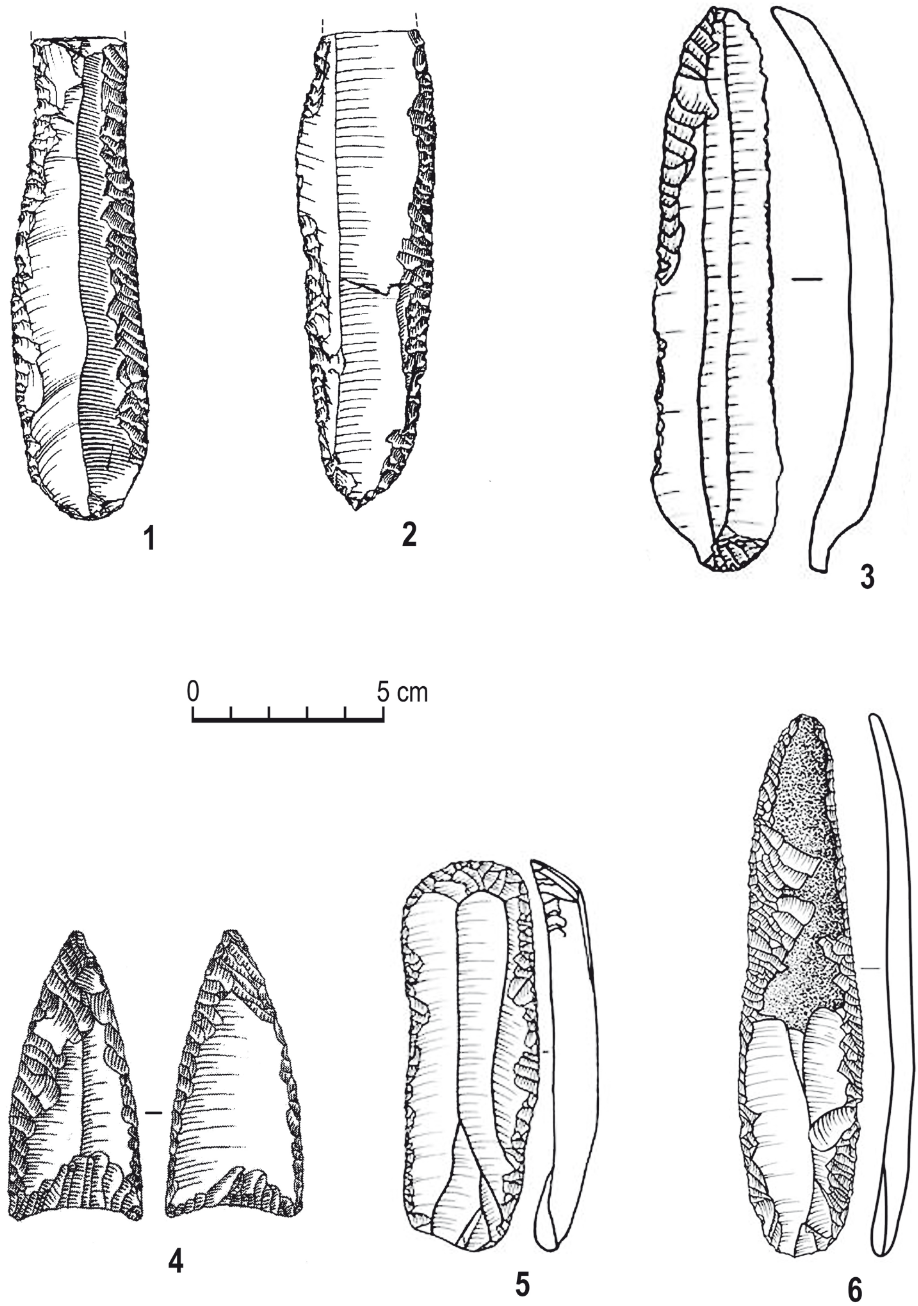

Fig. 7. Trypillia culture, phase BII-CI: 1-4 – Bodaki; 5, 6 – Brînzeni (after Skakun 2004; Terekhina *et al.* 2022)

forming tools, mainly retouched blades, as well as triangular points (Popova 2003, figs 723-5, 7-10, 73: 1, 5-8). It is a similar situation in the youngest layers of the site (P-J I1-2) related to the stage CI and CII (Popova 2003 figs 83: 3-7, 9-13; 85: 3-7, 9).

The early part of the BI (BI-1) stage in the middle Dniester includes the Ozaryntsi and Horodnytsa-Horodyshche settlements (excavated sites) as well as Nyzhniy Olchedaev and Patryntsi (surface materials). In Ozaryntsi, there are double-sided, and one-sided converging blades with a classic trough retouching (Fig. 6: 1-5; Radomskyi 2018, fig. 70: 2, 7, 8, 11, 12), and most of all semi-finished products and ready-made triangular points (Radomskyi 2018 , fig. 72: 4-7), as in Horodnytsa-Horodyshche (Radomskyi 2018, fig. 75: 3, 7).

From the Ozheve-Ostriv settlement, dated to the second half of the Trypole BI stage (BI-2 – Chernovol and Radomskyi 2015, 367; Radomskyi 2018, 3), there were 10,102 artefacts discovered within six houses and in the layers between them. Today this is the most fully analysed flint inventory made of the local Dnister raw material, and documents the complete production cycle, from the cores to the tools.

For forming the edges of the working tools, first of all, small rough and scaly retouching was used, but the retouch called 'parallel' by Radomskyi and the classic trough retouch (0.6% of all retouched tools – Radomskyi 2018, 120) are also recorded.

Among the tools abundantly illustrated by the author, several double-sided, convergent and one-sided retouched blades were made with it (Fig. 6: 6-8, 10, 11; Radomskyi 2018, figs 18: 10; 29: 3, 4; 34: 2; 45: 3; 58: 2; 60: 1; 64: 4, 11, 12), perforators/borers (with bifacial retouching – Fig. 6: 9; Radomskyi 2018, figs 58: 7; 64: 1, 2, 8) and basically all triangular points (Fig. 6: 12-15; Radomskyi 2018, figs 35: 1-5; 36: 1-6, 9, 10; 37: III; 38: IIb, III; 66: 18; 67; 68). The same is true for the remaining settlements of the BI-2 stage on the Middle Dniester, taken into account by Radomskyi: Vasilivka (Radomskyi 2018, figs 82: 4, 7; 85: 1, 3, 5). Attention is drawn to the presence in the assemblage from Kadiyvci Bavka of a massive endscraper and a one-sided retouched blade with a classic trough retouch (Radomskyi 2018, fig. 87: 1, 3).

In the period corresponding to Trypillia BI-BII – Cucuteni AB, parallel retouching similar to trough technique, forming retouched blades and bifacial points, are also recorded in the Southern Bug (Boh) basin (Zaets and Ryzhov 1992, figs 55: 2, 7, 14, 18; 55: 3, 13, 17; 57: 6, 11-17, 19, 20; 58: 3, 7-9, 11-16), between the Dniester and Prut region (Sorokin 1991, 27; figs 6: 7, 11, 16; 12: 8, 10; 16: 1-3, 5-8) and Prut and Seret (Marinescu-Bîlcu and Bolomey 2000, figs 33; 38: 9, 17, 22; 40: 6, 7, 16, 19; 43; 44: 1-12).

At the next stage of development – TC BII – trough retouching is already the basic technique of forming tools in the area of the entire TC range, similarly to stage C (Chernysh 1982, 207; Konoplia 1990, 22-24; Egnovatova 1993, 16, 17). We have at least a few sites from Volhynia and Podolia that have produced rich flint assemblages, including a considerable series of tools with working edges shaped with this retouching. The first place to be mentioned is the production-settlement in Bodaki, situated "on the deposits" of Volhynian flint. Many years of research by Natalia N. Skakun have produced a large series of flint

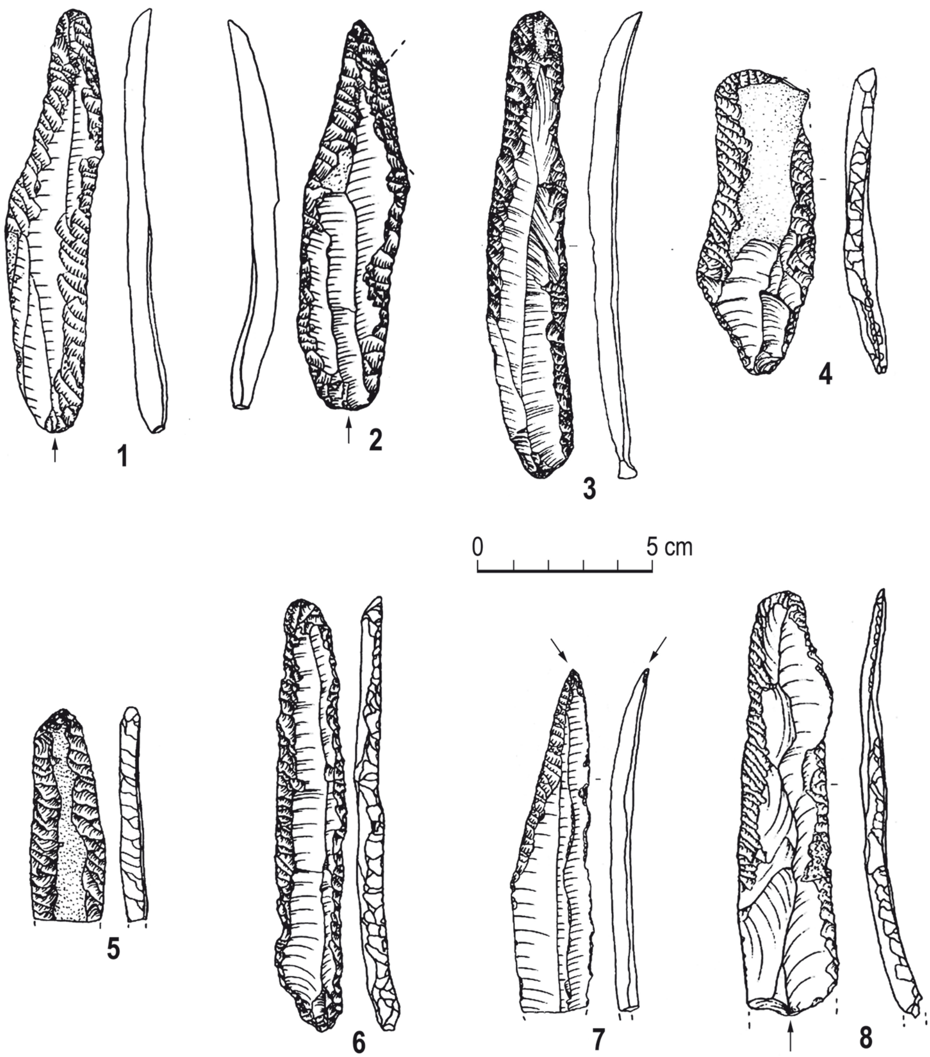

Fig. 8. Trypillia culture, phase BII-CI: Bilcze Złote (after Kadrow *et al.* 2003)

materials, including several dozen cores for macrolithic blades (Skakun 2004, fig. 3), several hundred blades and tools.The massive converging retouched blades are noteworthy (Fig. 7: 1-3; *cf.* Skakun 2004, fig. 5: 2-4; 9: 1, 2; Trekhina *et al.* 2022, figs 2: 2; 3: 4), and triangular points (Fig. 7: 4; Skakun 2004, fig. 11: 1-6; Trekhina *et al.* 2022, fig. 3: 1) formed with trough retouching.

In the middle Dniester basin there is the Bilcze Złote (Ogród and Werteba sites), which were inhabited from the turn of stages/phases BI/BII (Ogród I) through BII (Ogród II) to the middle section of the CI (Ogród III) and Bilcze Złote Werteba I-III, related to the CI/CII phase (Kadrow *et al.* 2003, 62-74; Kadrow 2013). The collection of 276 flint products, analyzed jointly from both sites (Kadrow *et al.* 2003, 101; Trela-Kieferling 2013), is dominated by macrolithic blade tools, mostly formed by trough retouching, mainly one-sided and concurrent double-sided retouched blades ending with endscrapers or claws (Fig. 8; Kadrow *et al.* 2003, figs 40: 1-5, 7, 12; 42: 8, 11, 12; 43: 1, 3-5, 10, 11; 47: 6, 8, 9). Some of them are in the form of retouched blade-daggers (Kadrow *et al.* 2003, 44: 10-12). Most of the endscrapers are made of retouched blade fragments with trough retouching (Kadrow *et al.* 2003, fig. 39: 1-5, 17, 16). The lack of triangular bifacial points is probably the result of the nineteenth-century methods of exploring the sites.

In other territories of the range of the TC, trough retouching was also popular in the BII stage and was used until the end of its development. Retouched blades and triangular points made with this retouch are found in the settlements located between Dniester and Prut (*e.g.,* Brynzeni, Mereşeuca-Cetăţuia III – Terekhina *et al.* 2022, figs 7: 2, 5, 6; 8: 1-3, 5) and Dniester and Southern Bug (including Vladimirovka – Chernysh 1951, figs 20: 8, 11; 22: 1; 23: 2-8, 11, 15; 24: 3, 5 , 6; Voroshilovka and Kurylivka – Gusiev 1995, 166, figs 47: 1, 2; 49: 2, 5, 6; 51: 1; 53: 1-15; Nemirov – Zakostselna 2017: Pl. 5.2: 5; 5.3 : 2, 3-6, 7; 5.4: 1, 2, 4, 6; 5.5: 1, 3, 4; 5.6: 2).

From the graves of stage CII come triangular points and macrolithic retouched blades ending with endscrapers and retouched blade-daggers formed with a retouch similar to a trough one (Sofiyivka, Krasny Khutor – Budziszewski 1995, figs 2: a, c; 3: a-c; 4: a; 5: a-c; 6; a-e; h: i-l).

Rzeszów phase of the Malice culture

From the dozens of sites of the late (Rzeszów) stage of the Malice culture in western Ukraine (Konoplia 1997, 63; Pozikhovskyi 2004, 320) known today, at least a few (not counting surface materials) have provided a significant series of flint materials. Among them are the settlements of Ostriv ur. Popiv Horb, Yaroslavichi ur. Bereg and Lyshche ur. Vygadanka in Volhynia (Konoplia 1990; Zakościelna 1996). The inventories of these settlements were described in detail by Vitaliy Konoplia (1990, 9, 10), and a wide selection of drawings of cores, half-products and tools is published in the work of Anna Zakościelna (1996, Pl. LI-LV). The flintwork utilised the local Volhynian flint. One-platformed blade cores from Yaroslavichi ranged in height from 26 to 153 mm (Zakościelna 1996, Pl. LIII: 1, 2), and in Ostriv – from 73 to 263 mm (Zakościelna 1996, Pl. LI: 1, 2).

The blades are metrically diverse, including macrolithic ones (up to 187 mm in length in Yaroslavichi). In the large collection of tools, retouched blades predominate over burins and endscrapers. The share of truncated blades, perforators and borers as well as triangular points is much smaller. One of the basic techniques for tool formation is trough retouching, especially for forming edges of one-sided, double-sided and tapered retouched

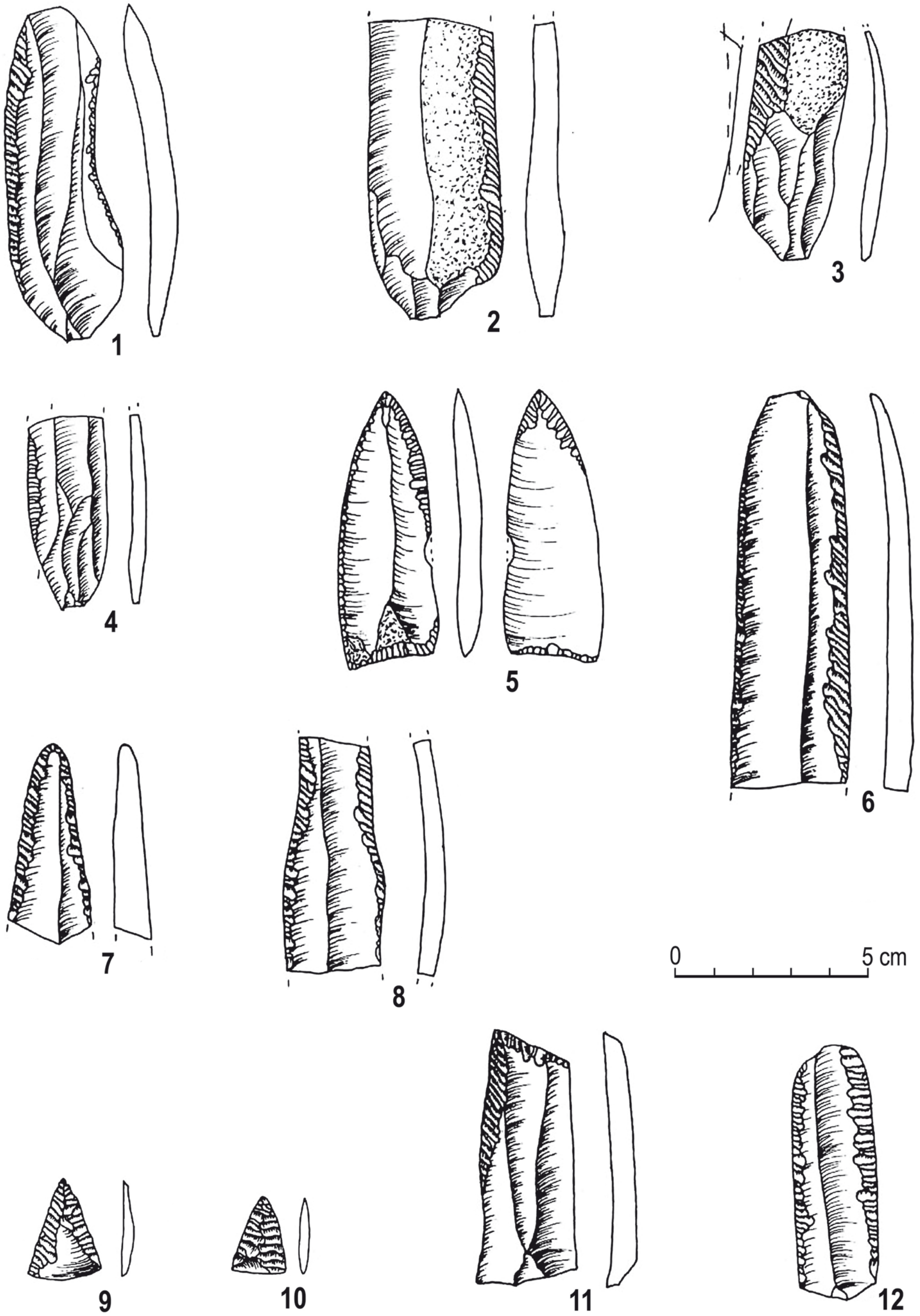

Fig. 9. Malice culture, Rzeszów phase: 1-5 – Ostriv- Popiv Horb; 6-10 – Jaroslavichi-Bereg; 11, 12 – Lyshche-Vygadanka (after Zakościelna 1996)

blades and points (Fig. 9). Konoplia states (1990, 9-10) that this retouching occurs in Ostriv on 27.1% of 'knives' (retouched blades) and 50% of sickle inserts and all blades (Zakościelna 1996, Pl. LII: 2-4, 919, 20). In Lyshch, it appears on 17.7% of 'knives' (retouched blades) and 60% of sickle inserts and all blades (Zakościelna 1996, Pl. LV: 5, 6, 11, 13, 20, 21). It is also present in Yaroslavichi (Zakościelna 1996, Pl. LIV: 1-6, 16-20). There are no retouched blade-daggers in these settlement inventories. Triangular points with a straight or indented base are numerous, they are retouched bifacially, but rarely on the whole surface. Some of them are over 6 cm long (Zakościelna 1996, Pl. LII: 19). One Las Stocki truncated blade was recorded (Fig. 9: 11); Zakościelna 1996, Pl. LV: 6), a form characteristic of L-VC inventories in the western zone of its range (Zakościelna 1996, 61, 92, 93).

Lublin-Volhynia culture

Trough retouching was used to shape working edges of endscrapers and other parts of these tools, the points of massive perforators, some truncated blades, and most of all triangular points and retouched blades (Zakościelna 1996, 56, 60-70, 92, 93). The most complete application of the trough retouch was used in the production of retouched blades (Figs 10-13).

In the inventories of settlements in Wąwolnica, site 6 and Las Stocki, site 7, for which it was possible to make statistics, 23.8% and 36% of all tools, respectively, were made with a trough retouch, and among retouched blades as many as 82.5% and 88.7% (Zakościelna 1996, 92, 93; Libera and Zakościelna 2013, 219). The above statistics prove that the ability to use this retouching technique was common and did not fall within the scope of manufacturing specialization.

The most magnificent and perfectly made tools the so-called retouched blade-daggers – come from L-VC graves (Zakościelna 2008; 2010).The basic characteristics of these products are macrolithic dimensions (length from 154 to 219 mm, with a width of 26-39 mm and a thickness of 7-12 mm), the use of classic through retouching and the use of only Volhynian flint for their production (Zakościelna 2008, 578; 2010, 139, 142). The method of forming retouched blade-daggers is varied. In some cases, a trough retouch only shapes the top and slightly overlaps the side edges (Fig. 12: 2, 3; Zakościelna 2008, fig. 1: 1; 2: 1, 2; 3: 2). In other cases, it shapes one full edge and the other in sections (Figs 12: 1, 4; 13: 3; Zakościelna 2008, figs 2: 4; 3: 1). The processing is rarely almost circumferential (Fig. 13: 1, 2; Zakościelna 2008, fig. 1: 2, 3).

Retouched blade-daggers are part of the grave equipment of a small part of male burials, the richest ones, which are also accompanied by other socially valued items, the so-called prestige artefacts (Zakościelna 2008, 586; 2010, 187-189). They were discovered in exposed places, mainly around the head and on the chest, less often around the waist of buried males (Zakościelna 2008, 583). The second location is particularly significant, as it

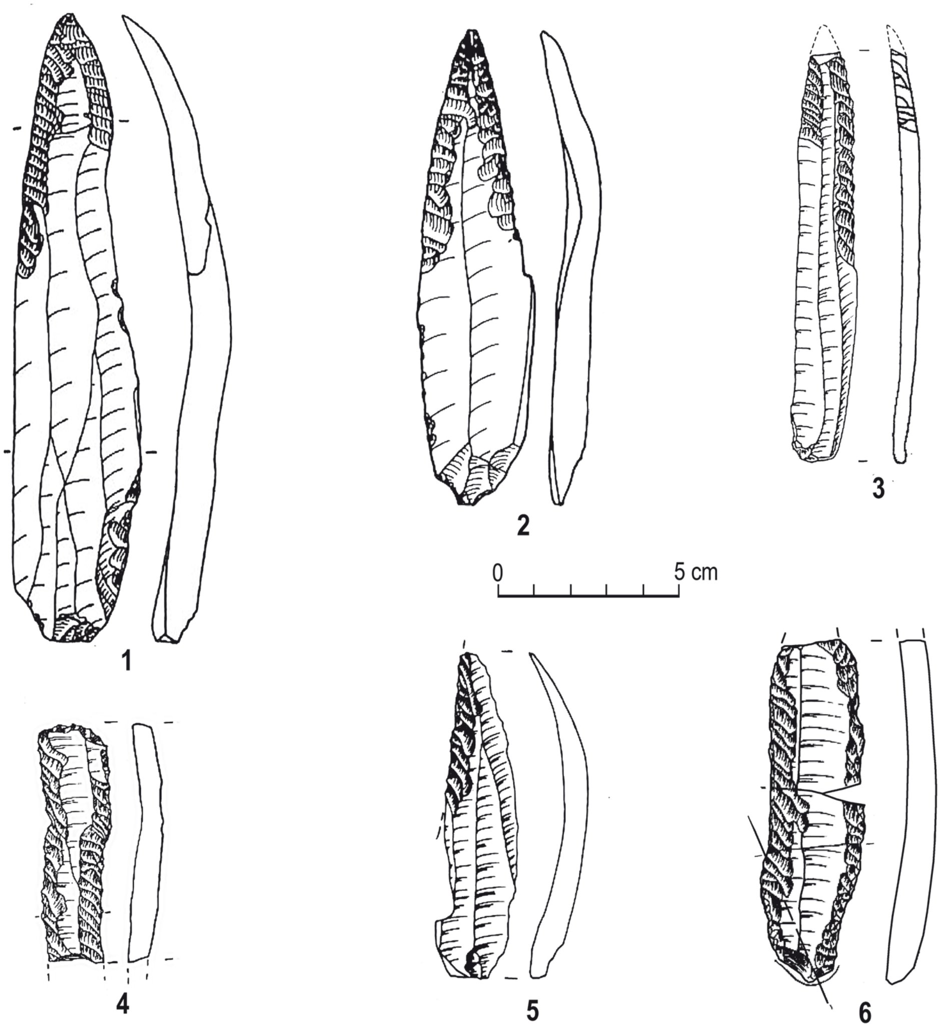

Fig. 10. Lublin-Volhynia culture: 1, 2 – Kosina 35; 3, 4 – Las Stocki 7; 5, 6 – Wąwolnica 6 (after Zakościelna 1996)

informs us that they were worn on the breasts during their lifetime, which meant that they fulfilled important social roles and conveyed messages about the high status of their owners (Wilk 2006, fig. 5; Zakościelna 2008, fig. 5: A). In such a position, retouched blade-daggers were discovered in grave 5 in Książnice 2, grave 1 in Gozdów 1 and grave 2/1987 in Gródek 1C. In the latter case, the man had two retouched blade-daggers on his chest (Zakościelna 2008, fig. 5: A).

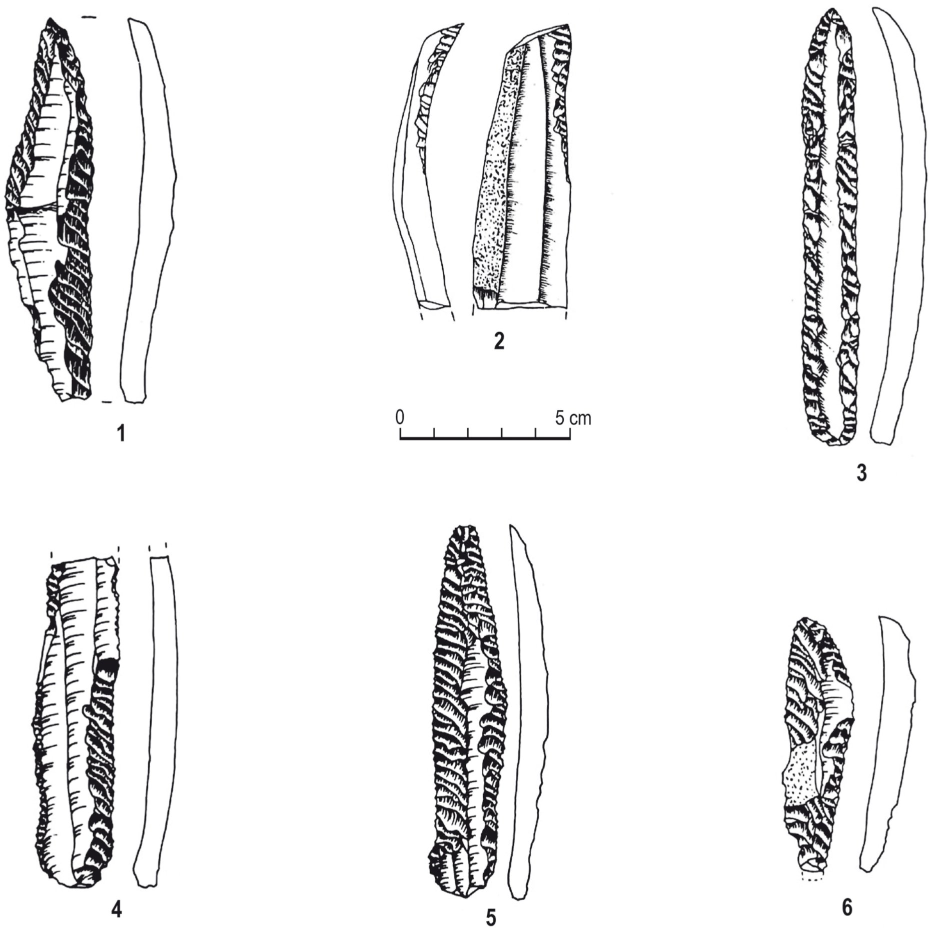

Fig. 11. Lublin-Volhynia culture: 1 – Wąwolnica 6; 2, 3 – Złota „Grodzisko I, II"; 4-6 – Radelichi III „Zastruga" (after Zakościelna 1996)

Triangular points are the second category of L-VC products made exclusively with trough retouching.They come from both settlements (Gródek 1C, Las Stocki – Zakościelna 1996, 66-70, Pl. VI: 3-7; XXII: 19) and graves (Gródek 1C, graves I and VI, Strzyżów 26, graves 2 and 7 , Tyszowce, grave 1, Rovantsy – Zakościelna 2010, Pl. XI: 3, 4l; XVIa: 1; LXIIa: 13; LXVI: 1; LXX: 6-7; LXXXVIII: 6, 7). They were produced from flakes and blades. They have a triangular shape, and differ in the shape of the sides (straight, convex, concave) and bases (straight, convex, concave) and the degree of bifacial treatment, which does not always completely remove the original surfaces (Zakościelna 1996, fig. 9). The triangular points known from L-VC settlements and graves are small. Their height ranges

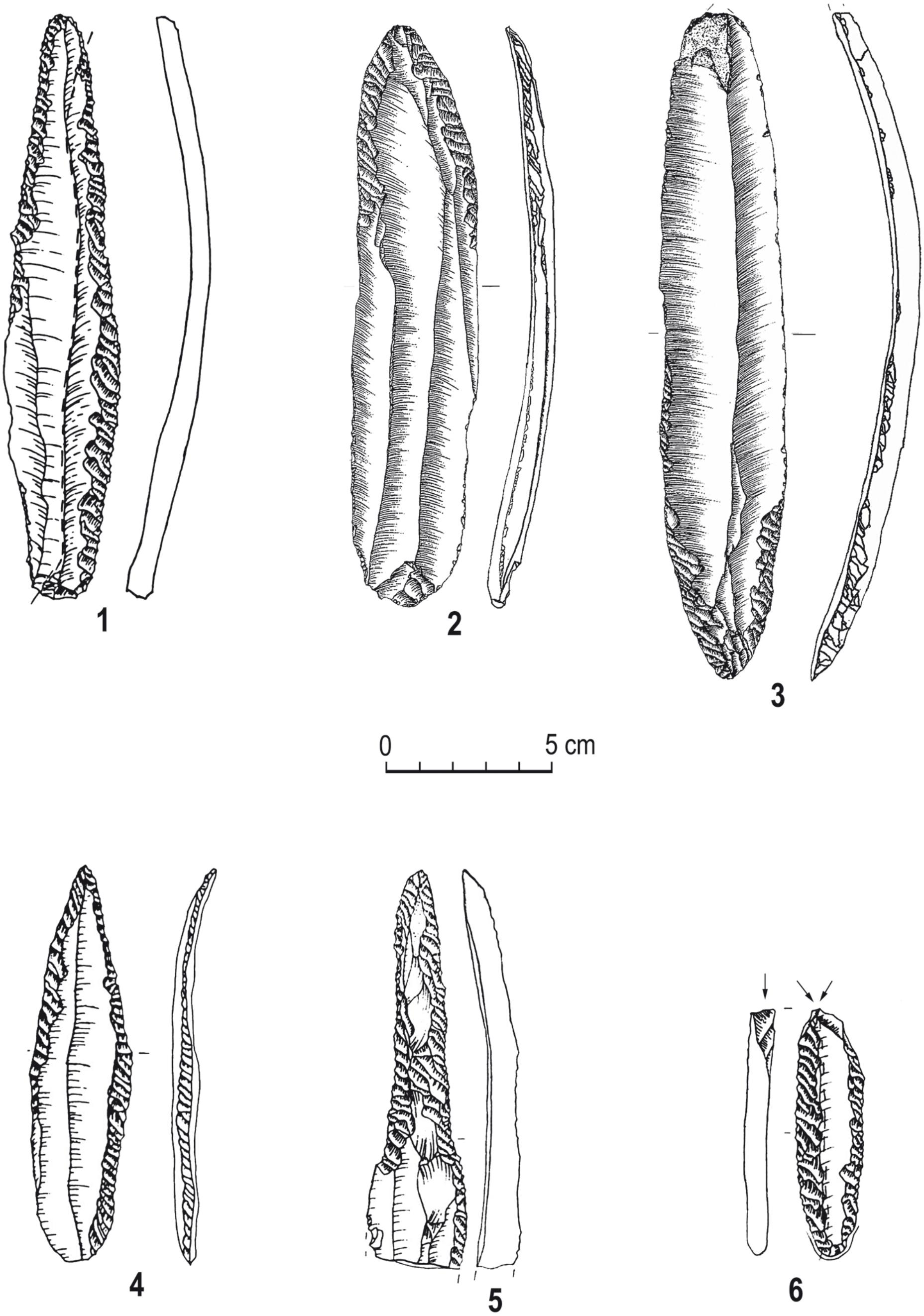

Fig. 12. Lublin-Volhynia culture: 1 – Gródek 1C, grave VI; 2, 3 – Gródek 1C, grave 2/1987; 4 – Moniatycze Kolonia, grave 2; 5-6 – Tyszowce 3, grave 1 (after Taras and Zakościelna 1999; Zakościelna 2010)

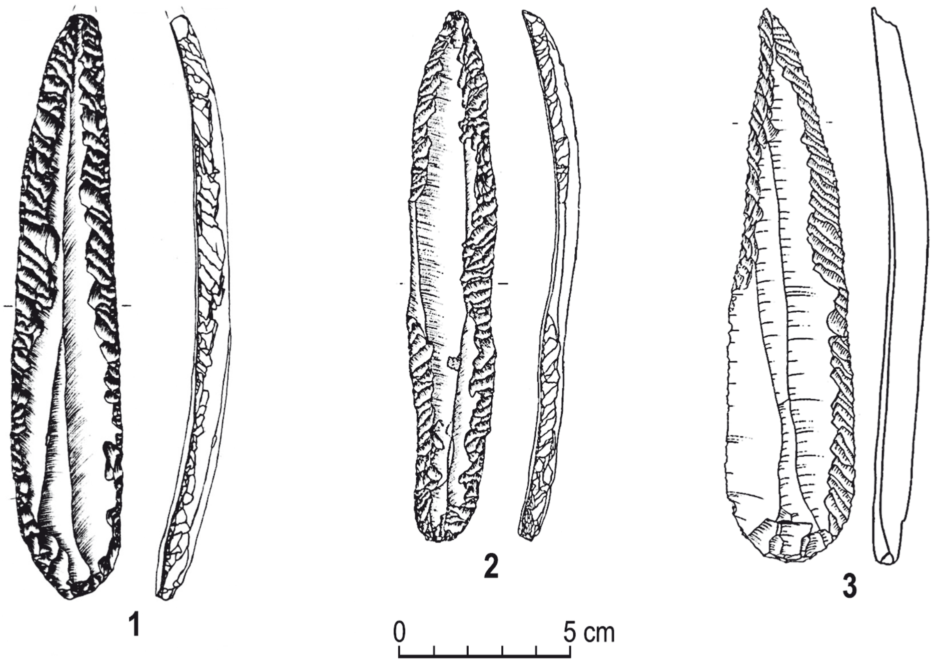

Fig. 13. Lublin-Volhynia culture: 1 – Książnice 2, grave 5; 2 – Sitaniec Wolica 3, grave 1; 3 – Złota „Grodzisko II", grave 101 (after Zakościelna 2006; 2010)

from 14 to 32 mm, and the width of the base ranges from 11 to 29 mm. Most likely, larger specimens were also produced, reaching 60-70 mm in length. However, they are known so far only from destroyed sites (Łuck, ur. Lug – Zakościelna 1996, Pl. XLV: 20) or loose finds (Strzyżów I/II, Gródek 1C – Chmielewski 2008).

Summarizing the issue of the trough retouch in L-VC, we can confidently quote the conclusions of J. Libera and A. Zakościelna, who reviewed the Eneolithic and Bronze Age inventories in Poland and stated (Libera and Zakościelna 2013; 228; *cf*. also: Zakościelna and Libera 2014, 198):

"1. Classic trough retouching... as the ability to form the edges of working tools/weapons we find only in the Lublin-Volhynian culture. It was commonly used in all settlement regions, regardless of the type of flint raw material. It had a universal character, with the help of it not only retouched blades, but also truncated blades and triangular points, as well as some endscrapers, perforators and burins were formed. It is a feature that unifies the image of flint-making of this culture in its entire range, and in Poland it can be treated as a cultural determinant.

2. In other Eneolithic cultures, it is found sporadically and should be interpreted as a manifestation of the relationship with the L-VC (in the case of well-documented finds),

or as evidence of an older settlement of this culture in these sites. In the case of the Funnel-Beaker culture, especially the Małopolska group, relations with the TC in the borderland of these formations also come into play."

DISCUSSION

The oldest products co-shaped by the classic trough retouch in the form of retouched blades (including retouched blade-daggers) and bifacial blades are found in the SC. The literature on the subject presents various views on the genesis, taxonomy, terminology, functioning and the role of steppe cultures in the early Eneolithic. For this reason, we present below a brief overview of the most important positions in this area.

Early Eneolithic on the Pontic and Azov steppes – a brief overview of views

In the well-known approach of Marija Gimbutas (1977), the notion of 'kurgan culture' and the migration of horse warriors from the steppes to the west, the main effect of which was the destruction of 'Old Europe', are of key importance. In the last version of her proposal around 5000 BC on the Volga, the Samara culture appeared. It was followed by the KC (1st half of the 5th millennium BC), and in the middle of the 5th millennium BC, we are dealing with the Yamna culture (hereafter: YC). The Sredny Stog II culture was an archaeological trace of the first migration of this population from the Volga area towards the Dnieper and the Pontic steppes. This happened in the period 4400-4300 BC (Rassamakin 1999, 60; 2020, 27, 28).

In the proposal of N. Y. Merpert (1965), referring to the Gimbutas proposal discussed above, the Sredny Stog II culture was created on the Dnieper on the basis of the local Neolithic culture. Then the discussed culture merged with the YC migrating from the east, creating its specific, local variant on the lower Dnieper (Rassamkin 1999, 60; 2020, 28, 29).

V. N. Danilenko (1974) sees two trajectories of Eneolithic development in the steppes. The first is represented by the development sequence of the early YC, and the second is the lower levels of the Mikhailovka settlement on the Lower Dnieper. The YC was established on the Caspian Sea. The Berezhnovka phase moving westwards contributed to the shift of the Sredny Stog culture to the Dnieper (Danilenko 1974, 85, 86). This combined with pastoral steppe cultures such sites as: Suvorovo, Casimcea, Kainar (on the lower Danube), Petro-Svistunovo and Novodanilovka (on the Dnieper; *cf.* Rassamakin 1999, 60-62; 2020, 28).

D. Y. Telegin (1973) developed a periodization of the Sredny Stog culture, in which he included all groups older than YC from the area between the Don and the Dnieper (including the sites of Lower Mikhailovka, Dereivka and Aleksandriya). However, he excluded sites of the Novodanilovka type from it (Rassamakin 1999, 62; 2020, 29).

Yuriy Rassamakin (1999; 2004a) rejected the current chronological and cultural divisions. He based his basic divisions on the categorization of burials, taking into account the basic features of the funeral rite (Rassamakin 1999, 72, fig. 3.4; 2004a, 23-61, fig. 1; 2020, 30-33). Only the older graves of the second burial group (category/tradition) are related to the early Eneolithic (Rassamakin 2004a, 180-182, fig. 125).

The oldest materials from the steppes between the Dnieper and the Don are associated with the SC. This is dated to the entire early Eneolithic period (4550-4100 BC – Rassamakin 1999, 64, 65, fig. 3.2; 4750-4100 BC – Rassamakin 2004a, 180-182, fig. 125) or generally to the second and third quarter of the 5th millennium BC (Rassamakin 2020, 38-40).

Pottery from the site of Strilcha Skelya (also present in the settlements in Aleksandriya, Razdorskoe, Semenovka) differs from the pottery of the Sredny Stog II culture. The set of artefacts from Skelya contains long blades, triangular points, flat stone axes and stone horse-headed sceptres. Such a typical set of remains from SC graves is repeated at the sites of TC BI – BII, possibly also in BII (Rassamakin 1999, 83). Sredny Stog ceramics refer only to the late phase of SC (Rassamakin 1999, 75-77). On the other hand, the ceramics of SC are identical to the Cucuteni C kitchen ceramics, which occur at the CC A3-A4 – TC BI phase sites (Rassamakin 1999, 77).

The above-mentioned stone remains and ceramics typical of the SC are also found on the sites of CTCC (respectively phase A-B1 and BI-BII). However, there is no Sredny Stog II pottery at all on these sites (Rassamakin 1999, 79).

The Early Eneolithic in the steppes – a model of functioning

The transition from the Neolithic to the Eneolithic in the steppes was conditioned by the appearance of two cultural complexes: KGK VI and CTCC (respectively phase A3-A4 and BI; Rassamakin 1999, 100; 2004a, 180-182). The first of them was a producer, and the second was an intermediary in the transfer of prestigious items to the steppe population (Rassamakin 1999, 124, fig. 3.49: 1). The area above the Lower Danube played a key role in this (Suvorovo complexes and the Cernavoda I culture). In turn, the population of the SC passed them further east to the lower Volga and south-east to the Caucasus foreland (Rassamakin 1999, 100).

At the beginning of the Eneolithic, the first imports of TC BI ceramics appeared in the Neolithic sites on the Dnieper in the forest-steppe zone (Kyiv-Cherkassy culture). They also reached the steppe (Nikolskoe cemetery – ceramics, gold, copper and mace-head) and at the Lysogorskoe cemetery (Spondylus bracelet).

On the other hand, the ceramics of the SC, zoomorphic sceptres, proto-cheek-pieces made of bone, triangular points, flat flint axes and long retouched blades are found in various proportions on the CTCC settlements (respectively in phases A3-A4 and BI; in Berezovskaya Hydroelectric Station – almost all these monuments appeared together; Rassamakin 1999, 102).

Prestige items are being exchanged in the Pontic region at this time. It was a key moment for the steppe communities, tantamount to the beginning of the Eneolithic in this region (Rassamakin 1999, 100).

Imports of prestigious items appeared mainly where the SC was formed. The official zone of elite graves is the region of this culture, where there are also settlements Strilcha Skelya, Aleksandriya, Razdorskoe I – level 4 and 5.

The prestigious objects of the Skelya culture also include retouched blades and bifacial points with trough retouching made of flint and obsidian (Rassamakin 2004a, 207, fig. 137). Among the above-mentioned retouched blades there are also those resembling daggers (*e.g.*, Kut, mound 8, tomb 7 – Rassamakin 1999, 84, fig. 3.18).

In the early Eneolithic, numerous mines and flint workshops operated on the Siverskyi Donets. They produced triangular bifacial points, tetrahedral axes and long blades, known from the graves of the elite. The discussed mines and workshops were part of the prestige item exchange system (Rassamakin 1999, 103, 104).

Pottery of the SC was discovered on TC BI settlements on the Dniester in Polivaniv Yar III and Vasilivka. There were also flint workshops there. They were perhaps inspired by the manufacturers from the Siverskyi Donets region.

Hiatus

In the period 4100(?)-3900/3800 BC, graves of the early horizon of the second (II) burial group (Rassamakin 2004a, 182) disappear in the areas west of the Dnieper. On the Dnieper, the graves of the mentioned burial group belong to the Sredny Stog II culture (Rassamakin 2004a, 206).

This period (hiatus) is respectively synchronized with the phases AB2 and BII of the CTCC (Rassamakin 2004a, 205, fig. 136). It begins with the disappearance of the Gumelniţa culture settlements, which are no longer present in the A4 phase of the CC. This was the result of the crisis in agriculture caused by climate change from 4200 BC (Diachenko 2019, 74-76). Then the system of exchanging prestigious items on the steppes disappears like the entire Skelya culture (Rassamakin 1999, 103).

The increasing drying of the climate in the period 4100-3800 BC led to increasing migration from the middle Dniester basin to the northeast and the formation of giant settlements in the Sieniucha basin between the Southern Bug and the Dnieper (Diachenko 2019, 76). Perhaps the same climatic changes resulted in the colonization of the southern part of the Volhynia Upland at the sources of the Styr and Horyn rivers by the population of the TC of BII phase.

The origin of the trough retouch in L-VC

If there were no retouched blade-daggers shaped by the classic trough retouch in the SC and L-VC cultures, the question of the origin of this retouching in the latter cultures would be obvious.

From the exploitation and production centres of flint on the Siverskyi Donets and from the areas of elite graves located in vast areas to the east of the Dnieper, through the Middle Dnister TC complexes from phase BI, the trough retouch would pass to the population of the MC from the Rzeszów phase, inhabiting the Volhynia Upland in the upper reaches of the river Styr and Horyń or directly to the population of L-CV, born at that time (from about 4250 BC).

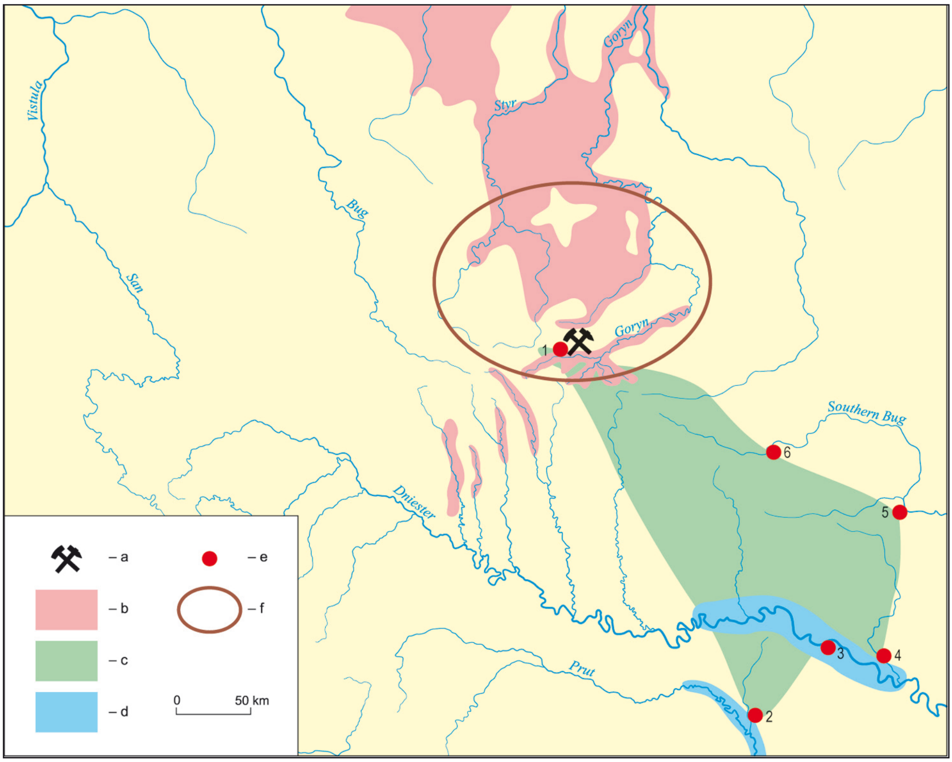

Fig. 14. Schematic map of access to flint raw materials for the population of TC settlements from the BII phase: a – mines of Volhynian flint; b – deposits of Volhynian flint; c – Volhynian flint circulation area between the TC settlements from the BII phase; d – deposits of the Prut and Dniester flint; e – TC sites from the BII phase, where products made of Volhynian flint were found f – Rzeszów Phase of Malice culture. 1 – Bodaki; 2 – Brînzeni VIII; 3 – Mereşseuca-Cetăţuia; 4 – Busha; 5 – Voroshilovka; 6 – Sosny (after Terekhina *et al.* 2022; prepared by Elena Starkova and Maria Juran)

However, retouched blade-daggers are present only in the graves of the SC and L-VC culture elites. So far, they have not been registered in the TC or MC of the Rzeszów phase. As prestigious items, they could only circulate in the communities where these elites functioned. Thus, they had to be transferred directly from the steppe environment to the population of the early stage (postulated only and empirically not yet confirmed) of L-VC, in which the processes of social hierarchy had to reach a certain degree of advancement.

At the same time, the process of transferring to L-CV the skills and practice of trough retouching in the alternative way, *i.e.* through and with the participation of the inhabitants of the Rzeszów phase of the MC, has one serious consequence. It forces us to accept the thesis about the specificity of the settlement agglomeration of the aforementioned cultural unit on the upper Styr and Horyn area, where the above-mentioned process took place. Only the local population of MC adapted blade macrolithization, triangular bifacial points and trough retouching, in contrast to the upper Bug region, Rzeszów-Przemyśl loess area or the Lublin and Sandomierz Uplands.

This specificity was the result of the processes of heterogenization and cultural hybridization, intensifying in certain areas at specific periods of time (cf. Kadrow *et al.* 2021, 154-157). They favored the weakening of cultural boundaries and the generation of new identities and cultural forms (Barker 2005, 293-295). The reason for their intense activity in the described area could be outcrops of Volhynian flint (Fig. 14), an attractive raw material sought, among others by the Polgar communities of the upper Tisza river basin.

CONCLUSIONS

The theses presented above are logical consequences of the time-space relations between important elements of the cultural puzzle in the vast area of eastern Europe between the delta of the Danube in the west and the Don in the east, and between the Black Sea in the south and Volhynia in the north (Fig. 1) in the second half of the 5^{th} millennium BC.

These theses require empirical verification. In the area of the upper Styr and Horyń basin in Volhynia, which is of key importance for the genesis of L-VC, several sites should be selected for excavation in order to obtain sources that will: illuminate the transformation process of MC into L-VC, reveal the co-determining external cultural impulses, allow the construction of their absolute chronolgy, provide samples for the analysis of DNA and stable isotopes to determine the contribution of the populations of various cultural units to its course.

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NEW INSIGHTS INTO THE USE OF "IMPORTED" FLINT RAW MATERIALS IN THE YOUNGER PHASES OF THE FUNNEL BEAKER CULTURE IN THE STAROGARD LAKE DISTRICT

ABSTRACT

Małecka-Kukawka J., Kukawka S. and Adamczak K. 2022. New insights into the use of "imported" flint raw materials in the younger phases of the Funnel Beaker culture in the Starogard Lake District. *Sprawozdania Archeologiczne* 74/1, 187-204.

In recent years, the region of Starogard Lake District in northern Poland has seen a growing interest in the Funnel Beaker culture, including the research on local flintworking, which has fed the discussion on the traffic in "exotic" flint in the younger phases of the Funnel Beaker settlement in the region (3650-3100 calBC). In this study, lithic assemblages from the Starogard Lake District are screened for "imported" flint artefacts to determine the parent rock material used for their production and monitor their frequencies in the local assemblages. By exploring the use-wear analysis results, we also investigate the production and consumption patterns of the local and "imported" flint artefacts from the Chełmno land and the Starogard Lake District. The obtained results were confronted with comparative data from other parts of the Eastern Group and confirming the marginal position of the Eastern Pomerania region in the "exotic" flint trading network during the Funnel Beaker era in Poland.

Keywords: Neolithic, Funnel Beaker culture, Eastern Pomerania, flint, imported flint raw material
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INTRODUCTION

In 2021 fifty years have passed since the publication edited by Janusz Krzysztof Kozłowski: "Z badań nad krzemieniarstwem neolitycznym i eneolitycznym (Referaty i komunikaty przedstawione na sympozjum w Nowej Hucie dn. 10, 11 maja 1971)" (in English: "Studies on the Neolithic and Eneolithic flint industries [Papers and reports presented during the Symposium held in Nowa Huta, 10th-11th May 1971]"). The appearance of this scientific work has generally been considered a significant turning point in the development of studies upon Neolithic flintworking. Both the symposium itself and the publication of research papers from it became seen as: "… an expression of the constitution of the Neolithic flint processing studies as an independent scientific research direction, having at its disposal a separate category of archaeological data, specific research methods, most of which were adopted from the Palaeolithic archaeology, as well as characteristic research goals that expand our knowledge on the New Stone Age…" (Lech 2000, 178). The issues raised at the Symposium represented, without any doubts, a brand-new quality in the lithic industries studies from the New Stone Age on the European scale. This event provided an opportunity to summarise the preliminary stage of studies in this respect and identify research problems, which have not lost their significance until the present, including the issues of acquisition, processing, and distribution of lithic raw materials (Kozłowski 1971, 139-146; Lech 2000, 178). The problems of the obtaining and circulation of siliceous rocks in the Neolithic are also widely studied in European archaeology (from more recent studies, *e.g.*, Kerig, Shennan 2015; Bostyn, Denis 2016).

One of the co-authors of the publication mentioned above, J. K. Kozłowski, stated as follows: "The investigations on interregional contacts in the New Stone Age are mostly based on stylistic premises expressed in forms and decoration of pottery. In fact, 'imported' lithic artefacts can provide more objective and conclusive evidence for interregional contacts than those seen through the influences and imports of 'ceramic' styles" (Kozłowski 1971, 139).

In 2019, while undertaking studies on the distribution of mined raw materials in the FBC eastern group, we concluded: "For nearly 100 years, pottery is the major source, based on which the division into archaeological cultures and their derivatives (phases, groups, stylistics, *etc.*) has been performed, recognised as prehistoric variability in the real culture. This variability of culture, settlement and economic issues, and cultural affiliations of other categories of artefacts have all been considered through the context of pottery. This simplified picture of a common archaeological practice applied in most investigations on the Neolithic and the successive periods (*cf.* Kukawka 1997, 16, 17). In this paper, we would like to attempt to confront the viewpoints based on the observed variability in pottery with the context of co-occurring flint artefacts, which are still, in our opinion, strongly underestimated in compiling publications on the Neolithic Age" (Adamczak, Kukawka and Małecka-

Kukawka 2019, 176). From these, one may conclude that despite a growing interest of archaeologists in the Neolithic flint processing and a significant increase in the number of source data in this respect, the prehistoric fundamentals postulated by J. K. Kozłowski 50 years ago are still valid.

In the paper mentioned above published in 2019, we addressed the issue of "imported" flint artefacts in the younger phases of the FBC eastern group. We also underlined an unequal state of knowledge not only of this particular flint industry, but the Funnel Beaker culture within the extent of its eastern group in general, stressing that along with the increase in the amount of data, we would expect the picture of particular regions to look different than it might have seemed. This especially concerns the region of Eastern Pomerania, which has yielded a substantial flint collection (1364 artefacts) but was entirely excavated at site 9 in Barłożno (Adamczak, Kukawka and Małecka-Kukawka 2019, 177-181).

In 2020 another scientific work was published, namely "Wczesny i środkowy neolit na Pojezierzu Starogardzkim w świetle badań nad dolną Wierzycą i Janką" (in English: "The Early and Middle Neolithic in the Starogard Lake District in the context of investigations carried out along the Wierzyca and Janka Rivers") edited by Olgierd Felczak. This book encompassed the outcomes of analyses on flint materials from the sites Rożental 1, Pelplin Maciejewo 20 and Brody Pomorskie 20 (three zones, discussed separately; Małecka-Kukawka 2020, 227-268; see: fig. 1 and tab. 1). This significant increase in the number of data inspired us to continue our studies upon the distribution issues of "exotic" lithic materials in the younger phases of the FBC eastern group, and confront them with the results presented in 2019.

In the present paper, we have adopted "older and younger FBC" as chronological determinations. They refer to chronology based on pottery variability, supported by radiocarbon dates (for the Chełmno land, *cf*. Kukawka 2010, and the Starogard Lake District, *cf*. Felczak 2020). The older FBC corresponds with ceramic assemblages with no "zig-zag" decoration (conventional phases I-IIIA in the Kuyavian periodisation, according to A. Kośko 1981). While the younger FBC refers to pottery with "zig-zag" motif (from the so-called classical and late Wiórek phase), and other younger assemblages (in general, from the Luboń phase, or containing elements of the Luboń stylistics; conventional phases IIIB-V in the Kuyavian scheme, according to A. Kośko 1981). Based on radiocarbon determinations for the Chełmno land, these two styles of pottery decoration (*i.e.*, with or without "zig-zag" motifs) are separated at *ca*. 3700/3600 calBC (Kukawka 2010). O. Felczak addresses the characteristics of the agglomeration of the FBC settlement in the Starogard Lake District throughout the 4th millennium BC. However, the most comprehensively analysed lithic materials from the Starogard Lake District should be dated to the younger period, that is 3650/3600-3100/3000 calBC, which corresponds with the classical and late Wiórek phase (Felczak 2020a, 95-186; 2020b, 187-195).

RESEARCH DESCRIPTION AND METHODS

This paper is essentially a data supplement to the article published in 2019, the research goal of which can be defined as follows:

> "The non-local ("imported") lithic materials under study occurred naturally within the area occupied at those times by the south-eastern group of the Funnel Beaker culture, or within the extent of the Tripolye Culture (TC) (Volhynian flints), [...] the authors aim at verification whether their contribution varied regionally, and was dependent on the distance of their deposition spots from the FBC south-eastern group settlement region, or their original outcrops. A few hypotheses will be put to the test. In our opinion, hypotheses logically result from the viewpoints based on analyses of pottery. Thus, intense relationships in terms of pottery resemblance with the FBC south-eastern group should correlate with an increased contribution of all, or some at least, raw materials. This is since all of them occurred at the sites in question, though in various proportions, identified as the FBC sites. The process of Eneolithisation incoming from the TC environment (the Mątwy group; Kośko 1981) should have increased the Volhynian flints' contribution. On the other hand, the Eneolithisation associated with the Baden culture (Badenisation process) coming mostly from the west, according to opinions of scholars interested in the Kuyavia region (Przybył 2009, with further references), should be characterised by a decrease in the share of "imported" flints within assemblages uncovered at the sites where this cultural phenomenon was recorded. The situation should be similar concerning intensified relationships with the North-Eastern European Subneolithic (Kukawka 2010, with further references)" (Adamczak *et al.* 2019, 176).

The presentation of new data from the Starogard Lake District given in this paper follows the principles adopted in our article published in 2019: [1] the analyses covered flint assemblages exclusively from the remains of settlements; [2] our calculations excluded charred flints to maintain the analytical comparability; [3] we decided not to divide erratic flints that occur locally in Polish Lowlands into "erratic Baltic flint, variant I" and "Pomeranian flint", which seems to be well justified from the perspective of established research goals. The issue of other factors, of science or beyond-science nature, which could have affected the frequencies of "exotic" materials, was discussed in greater detail in other papers (*cf.* Adamczak *et al.* 2017, 295-308; 2019, 175-189).

DATA FROM THE STAROGARD LAKE DISTRICT AND OTHER REGIONS

Table 1 presents the raw material structure of flint assemblages coming from sites localised in the Starogard Lake Districts. According to the above-mentioned principles, the numbers given in this table differ from those published by Jolanta Małecka-Kukawka in

Table 1. Raw material characteristics of the FBC flint assemblages from the Starogard Lake District

l.p.	site	nb	jp	cz	św	woł	pas	no	N	references
1	Barłożno 9	100	-	+	-	-	-	-	1364	Adamczak *et al.* 2019
2	Brody Pomorskie 20 zone I	94	-	+	1	4	-	1	410	Małecka-Kukawka 2020
3	Brody Pomorskie 20 zone II	97	-	1	1	-	-	-	69	Małecka-Kukawka 2020
4	Brody Pomorskie 20 zone III	95	-	+	1	3	-	1	328	Małecka-Kukawka 2020
5	*Brody Pomorskie 20 zones I-III + outside zones*	*95*	-	+	*1*	*3*	-	*1*	*1008*	Małecka-Kukawka 2020
6	Pelplin Maciejewo 20	95	-	-	1	2	-	1	85	Małecka-Kukawka 2020
7	Rożental 1	99	-	+	-	1	-	-	366	Małecka-Kukawka 2020
8	Bielawki 6	100	-	-	-	-	?	?	2036?	Ostasz 2011

nb – Cretaceous Baltic flint and Pomeranian flint, jp – Jurassic Cracow flint, cz – chocolate flints, św – Świeciechów flint, woł – Volhynian flint, pas – striped flint, no – undetermined flint. Other abbreviations: l.p. – ordinal number, N – number of flint artefacts within the assemblage, ? – a number of artefacts are not certain, + - marginal share of raw material, below 0.5%. The list excludes undetermined flints due to their state of preservation (charring).

2020, resulting from the rejection of charred specimens in our analysis. Table 1 also contains data acquired at the site 6 in Bielawki, com. Pelplin (Ostasz 2011, 45-57). The paper presenting the results of investigations carried out at this site reveals only general information about the flint assemblage associated by the author, Maricn Wąs, with the FBC flint tradition (*cf.* Wąs 2016, 55). Despite missing quantitative and qualitative data (including on the technical and morphological structure), we decided to include this collection into our considerations, since in the context of other flint assemblages, even such general information on the raw material structure would be valuable for the reconstruction of the picture of inflow of "exotic" lithic materials into the Starogard Lake District. The site in Bielawki is a multicultural site, where apart from the predominant FBC pottery ("zig-zag" stylistics), there were identified collections of vessels of other characteristics, associated with the late Linear Band Pottery culture, Subneolithic, Globular Amphora and Corded Ware cultures, as well as cultural units from the beginnings of the Bronze Age (Ostasz 2011). A blade of a polished axe made of striped flint was also discovered, which according to the current state of knowledge, should relate to the Globular Amphora culture.

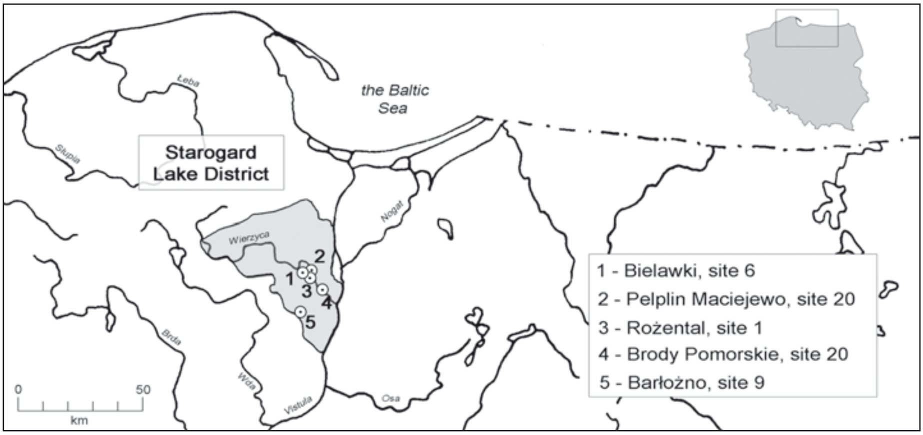

Fig. 1. Map of the Starogard Lake District with the location of FBC sites reported in this study (compiled by K. Adamczak)

Since this paper aims to complement the picture of the distribution of "exotic" lithic materials amongst the communities of the FBC eastern group presented in 2019, we decided to include the related data from other regions and information coming from the Starogard Lake District. In 2019 an article reporting the flint industry in Greater Poland was published (Kabaciński and Sobkowiak-Tabaka 2019, 33-63). However, we decided not to verify the data under analysis with the information presented in this paper for some reasons including, [1] some data from Greater Poland contained within the above-mentioned article comes from papers that we had already discussed in our work of 2019; [2] there is a lack of quantitative information that could be included in our calculations presented in table 2; [3] based on our general evaluation, this new information referring to the structure of raw materials does not verify our previous conclusions (demonstrative, expressed as a percentage).

We have also encountered a typescript of a PhD thesis written by Michał Dobrzyński (2014; online access), which had not been mentioned in our article of 2019. This paper covers the issues of flint processing in the regions of our interest, namely Central Poland and the Gostynin Lake District, and despite the fact that the information presented there would verify the data given in Table 2, in some cases at least, we decided not to include it in our present paper due to the following reasons: [1] the numbers of flint specimens sometimes differ from those given in the source papers; [2] the thesis is not uniform in terms of methodology – some part of collections were analysed once again by the author, whereas the others (obviously, inaccessible to the author) were just quoted from the original literature; [3] in those instances when the author had access to original flint collections published in older articles, his findings in terms of the quantity of assemblages and raw material determinations differed from the conclusions drawn by the first investigators of those assemblages, due to unknown reasons; [4] we are unable to evaluate the competences neither of the authors of the older papers quoted in the above-mentioned thesis, nor its author himself. Therefore, our article will be based on source publications concerning Central Poland and the Gostynin Lake District. The rightness of our decision is supported by the fact that regional indices of "imported" lithic raw materials are not very varied if we compare our findings with those given by M. Dobrzyński (*e.g.*, the general index of "imported" flints for Central Poland is very similar: 5.4% in our analysis, and 5.0% in the above-quoted PhD thesis; see tab. 2).

To sum up, we have gathered information referring to the frequencies of imported lithic materials from 53 sites of the younger phase of the FBC eastern group (Adamczak *et al.* 2019, table 1 – with source literature, fig. 1 – distribution of sites, as well as table 1 and fig. 1 in the text). Since, in some cases, the authors of these analyses distinguished certain settlement zones within the sites, or classified artefacts based on some other principles, the 53 sites as mentioned earlier are represented by 61 assemblages of flint artefacts. In total, the collection in question enclosed almost 17 thousand artefacts (or nearly 19 thousand if we include the site Bielawki 6; comp. the comments in the text), over 1600 of which were determined by the authors of the source analyses as imported (Jurassic, chocolate, Świeciechów, Volhynian and striped flints).

New information on the structure of raw materials in assemblages from the Starogard Lake District has extended our knowledge of the circulation of mined raw materials in the northern zone of the FBC eastern group. According to the approach adopted in our paper of 2019 (*cf.* Adamczak *et al.* 2019, table 2, 181), from the viewpoint of the occurrence of "exotic" materials, the region of Eastern Pomerania seems to have been peripheral, staying beyond the general distribution system legible in the other areas of the FBC settlement in Polish Lowlands. This statement also concerns Greater Poland, where raw materials from southern Poland or Volhynian flints were marginal. These observations confirmed the relevance of the conclusions formulated by Bogdan Balcer fifty years ago, particularly regarding the flint processing model employed by the FBC communities. This model was based on the flow of lithic materials from flint mines through production and workshop sites, ending at settlements and campsites where the FBC tools were used (Balcer 1971, 52-56). Jacek Lech adopted an identical model for interpreting lithic raw materials in the Linear Band Pottery Complex (Lech 1981, 130-174). Having investigated the flint materials from particular analytical categories of this model, the authors concluded as follows: [1] the further from the points of flint extraction and processing, the less number of artefacts made of "exotic" materials is recorded within the general structure of assemblages; [2] there are significant differences in terms of technical and morphological structure between the assemblages from particular categories of the above-mentioned model; [3] starting from the category of flint extraction and processing points, a high percentage of forms coming from the rejuvenation of artefacts is observed, with commonly applied splintering technique in the core reduction process.

In summary of analyses on lithic materials from Eastern Pomerania, it was concluded as follows:

> “The described features of flint processing in the classical FBC phase in the Starogard Lake District correspond well with observations made for lithic materials from other regions of Polish Lowlands […]. Published results of analyses performed for numerous flint assemblages of the Funnel Beaker culture from Polish Lowlands indicate regional differences in terms of quantities, raw material structure […] or abundance of various typological forms; however, in a general view, they all represent a quite coherent model of behaviours associated with acquisition, processing, utilisation and disposition of both, local as well as “imported” flints. This generalised picture of the flint industry recorded at sites enclosed in this paper corresponds well with the flint processing model typical of the classical Wiórek phase of the Funnel Beaker culture in Kuyavia (described by L. Domańska 2013), the application of which can be extended over other regions of the FBC settlement in the zone of the Great River Valleys in Polish Lowlands” (Małecka-Kukawka 2020, 253).

DISCUSSION – SEARCHING FOR A DISTRIBUTION MODEL OF “EXOTIC” LITHIC RAW MATERIALS

Having analysed the data listed in Table 2, we can state that the general model explaining the frequencies of occurrence of mined raw materials has been confirmed: the further from the extraction areas and flint processing and workshop sites, the lower the contribution of artefacts made of “exotic” flints is recorded. As was presented in Table 2, the highest index, accounting for 33.8%, was obtained for the Gostynin Lake District. The lowest was recorded for the Starogard Lake District and Greater Poland (1.8 % and 0.6%, respectively). An exception in this respect is the region of Central Poland. Although it is located within the closest distance from the flint outcrops, when compared with all other agglomerations of the FBC eastern group, it revealed a significantly lower index of “exotic” lithic materials than any other, more remote regions (Fig. 2). Any attempts to explain this phenomenon exceed the scope of the present paper.

From the viewpoint of decades of studies upon Neolithic flintworking, it seems that the confirmation of the relevance of the model of flint processing and distribution as an operational chain under the scheme “mines – flint processing and workshop sites – end-users at settlements” for successive flint assemblages, is not able to extend our knowledge in this respect any further, neither is the well substantiated flint processing model of the classical Wiórek phase. Due to its repetitiveness in all of the regions of the FBC settlement in Polish Lowlands, it has lost its role as a creative, analytical tool. Nevertheless, noteworthy in this respect are the materials from the site 20 in Redecz Krukowy associated with the early FBC phases, mainly due to exceptionally numerous collections of flint artefacts made of chocolate flint, the number of which is multiple times greater than any other recognised assem-

Table 2. Frequencies of “imported” flint materials per particular region of the FBC eastern group during the younger stages (3650-3100 calBC)

region	jp	cz	św	woł	pas	N imp.	N total	% imp.
Gostynin Lake District	3,0	14,4	6,3	7,3	2,9	270	798	**33,8**
Kuyavia S-E	0,6	6,8	10,0	8,0	0,3	319	1242	**25,7**
Kuyavia N-W	0,6	9,5	0,9	2,1	0,4	755	5557	**13,6**
Dorzyń land	-	3,4	2,7	1,4	-	11	146	**7,5**
Central Poland	0,9	2,6	0,7	1,0	0,1	120	2217	**5,4**
Chełmno land	0,2	1,6	2,8	0,1	0,1	60	1276	**4,7**
Greater Poland	0,1	0,5	0,1	0,03	-	18	2791	**0,6**
Starogard Lake District	-	0,21	0,35	1,2	-	50	2823	**1,77**

Abbreviations of types of flints as in table 1; N imp. – number of „imported" flints; N total – total number of flints determined in terms of raw materials; % imp. – index of „imported" flints.
For the Starogard Lake District, data from the site Bielawki 6 were neglected (we do not know how many artefacts should be associated with the Funnel Beaker culture). If we took this data into account, the particular „imported" lithic raw materials indices would be significantly lower.

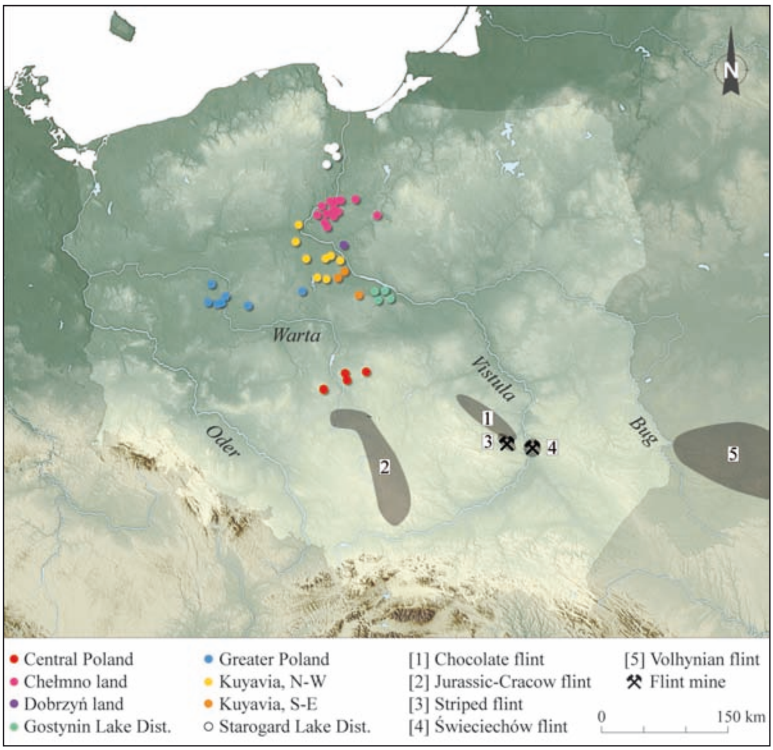

Fig. 2. Settlement agglomerations in particular regions of the FBC eastern group with location of selected flint outcrops and mines (map background: Yarr65/Shutterstock.com; compiled Ł. Kowalski)

blages made of this type of flint known from the FBC sites (Papiernik and Wicha 2018, 313-397). Technical and morphological analyses performed for this material have revealed that in this particular case, ready-to-use artefacts made of chocolate flint were brought to the settlement from the outside; therefore, they cannot be considered as the remains of a processing and workshop site. Whatever their provenance was, this exceptional collection on the scale of the entire FBC eastern group, in terms of its abundance, requires a different interpretation (Papiernik and Wicha 2018, 382, 383).

FUNCTIONAL ASPECTS OF ARTEFACTS MADE OF "EXOTIC" LITHIC MATERIALS – THE USE-WEAR APPROACH

Flint materials from the Starogard Lake District were subject to micro use-wear analysis. This analysis allows obtaining information about the functional application of various forms of artefacts, allowing us to identify similarities and differences between particular flint assemblages. Microscopic observations covered all of the artefacts that were also classified in terms of raw materials and subject to morphological analysis according to the methodological approach adopted for studies on the Neolithic flint material from the Chełmno land (Małecka-Kukawka 2001). Unfortunately, investigations of the function of flint artefacts are not so commonly applied to other regions occupied by the Neolithic communities. Indeed, in the recent dozen or so years, we can observe an increase in the number of micro use-wear elaborations contained within more and more publications.

Nevertheless, they hardly cover the entire assemblages; instead, they focus on only some part, consisting of arbitrarily selected specimens, usually morphological tools, and a subjective choice of more "spectacular" artefacts. Results of such analyses are mostly considered as annexes to the factual content of articles, having no more significant impact on interpretations based on "traditional" approaches (for relevant remarks, see Jankowska 2017, 344, 345). Due to this, it is difficult to perform comparative studies for materials from the regions occupied by the younger FBC communities discussed in this paper. However, we decided that comparing materials, for which micro use-wear analysis was performed based on identical methodological principles, coming from two settlement concentrations located along the Vistula River, may be interesting and can deliver some new data on artefacts made of "imported" lithic materials in the cultural contexts of their utilisation.

For the needs of the issues considered in this paper, we compared the analysis results in the most generalised manner, summing the number of artefacts bearing traces of utilisation within two categories: functional tools made of local and "imported" lithic materials. The results of this analysis are presented in Table 3. For the older FBC phase in the Chełmno land, the contribution of artefacts bearing traces of utilisation made of local lithic materials (considered 100%) amounts to 16.3%. In comparison, the proportion of those made of "imported" flints accounts for 64.8%. For the younger FBC phases, regarding the

Table 3. Frequencies of flint artefacts with use-wear traces in the local and "imported" raw material

Regions and chronology of FBC	Local flints		Imported flints	
	N	T	N	T
Chełmno land Older FBC	619	101 (16,3%)	108	70 (64,8%)
Chełmno land Younger FBC	420	39 (9,3%)	26	18 (69,2%)
Starogard Lake District Younger FBC	1403	81 (5,8%)	49	41 (83,7%)

N – a number of artefacts subject to use-wear analysis; T. – a number of flint artefacts with use-wear traces and their percentage within the given category

Chełmno land and the Starogard Lake District, the percentage of functional tools made of local lithic materials is significantly lower (9.3% and 5.8%, respectively). The contribution of functional tools made of "imported" flints from the Chełmno land is higher and amounts to 69.2%, while for the Starogard Lake District, their proportion reaches up to 83.7%. Having analysed the numbers given in Table 3, one can conclude that the increase in the number of artefacts made of local lithic materials is correlated with the decrease in the percentage of functional specimens with traces of utilisation. This is associated with the differences in activities performed during the flint processing, revealed through analysing the morphological structure of assemblages, mainly focused on categories of flakes and core reduction waste products (*cf.* Małecka-Kukawka 2001, 55-83; 2020). Flint inventories from sites in Eastern Pomerania are much more abundant than those from the Chełmno land. This is most likely due to the local accessibility of lithic materials and their quality. Still, it may also result from the local rules of raw material acquisition, namely bringing to the settlement many poor-quality materials and discarding most of them as useless waste within the settlement boundary. This regional variability in the number of assemblages made of local lithic materials might have been affected by the manner of inventorying flint materials during excavations (for more details, see Małecka-Kukawka 2020, 228). Moreover, we should stress a legible difference in the number of artefacts bearing traces of utilisation made of "imported" lithic materials. For the assemblages from the Starogard Lake District, this index is nearly 15% higher when compared with the collections from the Chełmno land (83.7% vs 69.2%, respectively).

A great abundance of flint assemblages from the Starogard Lake District, resulting from local accessibility of raw materials, might have affected the results of investigations on the contribution of "imported" flints (Table 2) and the index of artefacts bearing traces of utilisation. To minimise the risk of distortion of the functional picture of the collections under study, due to the local conditions in terms of lithic material accessibility and the manners of discarding waste products, we decided to present the contribution of artefacts

Table 4. Flint artefacts with use-wear traces (100%) are given in basic categories of raw materials

Regions and chronology of FBC	Local flints	Imported flint
Chełmno land Older FBC	59%	41%
Chełmno land Younger FBC	**68%**	**32%**
Starogard Lake District Younger FBC	**66%**	**34%**

bearing traces of utilisation, considered as 100%, divided into two major categories – local and "exotic" flints (see Tab. 4). These results turned out to be most surprising. Having analysed the numbers given in Table 2, one can conclude that the proportion of "imported" flints in the Chełmno land (taking into account all of the collections under study) is nearly thrice as high as their proportion in the Starogard Lake District (in a ratio of 2.6 to 1). From the viewpoint of micro use-wear analysis, a conclusion may be drawn that the younger FBC phase frequencies of local and "imported" flints bearing traces of utilisation are almost identical (Tab. 4). Since the data presented in this paper comes from merely two regions of the FBC settlement areas, we refrain from stating decisively whether all that was said above was just a coincidence or rather an observation of a crucial interpretative significance. At this point, we would tend to opt for the latter option. Despite some essential differences in frequencies of "imported" raw materials between the assemblages from the Chełmno land and the Starogard Lake District, their functional utilisation was nearly identical. It should also be stressed that from the perspective of micro use-wear analysis, in both of these regions, two-thirds of all tools with traces of utilisation were made of local lithic materials. In contrast, only one third was made of "exotic" flints.

THE PHENOMENON OF DISTRIBUTION OF "EXOTIC" LITHIC RAW MATERIALS – ANTHROPOLOGICAL APPROACH

In the line of our findings from 2019, complemented with the new data from the Starogard Lake District, we can conclude that each of the regions of the FBC settlement has its own cultural (anthropological) expression (Adamczak, Kukawka and Małecka-Kukawka, 2019, 182, 183). We agree with Andrzej Piotr Kowalski, who claims that "(…) the phenomenon of culture does not consist of sets of objects exclusively; instead, it is determined by a certain composition of values constituting the status of these objects in the context of a particular society" (Kowalski 2014, 34).

Revealed in archaeological investigations, differences in the contribution of artefacts made of "exotic" materials have strengthened our hypothesis of territorial communities

Table 5. Frequencies of „imported" raw materials in the total number of flint artefacts per particular region of the FBC settlement (the given order of areas is consistent with the distance from the outcrops of flints in southern Poland)

regions	jp	cz	św	woł	pas	N imp. (100%)	% imp
Central Poland	18	48	13	20	1	120	5,4
Gostynin Lake District	9	43	19	21	9	270	33,8
Kuyavia S-E	2	27	39	31	1	319	25,7
Kuyavia N-W	4	**70**	**7**	16	3	755	13,6
Chełmno land	3	33	**60**	**2**	1	60	4,7
Starogard Lake District	0	12	20	**68**	0	50	1,8
Greater Poland	11	72	11	6	0	18	0,6
Dobrzyń land	0	45	36	18	0	11	7,5

Abbreviations of types of flints as in table 1. N imp. – number of „imported" flints; % imp – index of imported flints in entire colection. The internal frame stands for the regions with at least 50 "imported" flints evidenced. The other two regions showing a single flint artefact share at 6% and 9%, respectively, were excluded from further considerations. The numbers in bold are marked to draw the reader's special attention.

with different beliefs and cultural behaviours, including manners of acquisition and utilisation of artefacts made of lithic materials.

To display these regional differences, we compared data referring to the intensity of "imported" flints, where the proportion of particular types of flints was confronted with the total number of "imported" flint materials, considered 100% (Tab. 5). This comparison should be taken as one of the possible results since we are aware that any new data may verify these determinations. This mainly concerns the regions of Greater Poland and the Dobrzyń land, where, at this point, a single artefact constitutes 6% and 9%, respectively. The state of current knowledge impact on the distribution of raw materials (and others) has been evidenced distinctly in our elaboration of materials from the Starogard Lake District.

In Table 5, we have listed the percentage of particular "imported" materials within the overall number of artefacts (the sum of all specimens made of "exotic" flints, considered as 100%) per particular region. The last column (excluding the data from Central Poland, which was explained in the introduction) confirms the above-described model, namely, the further from the flint outcrops, the smaller number of "exotic" materials within the structure of flint assemblages. We also stressed the role of micro use-wear analysis and its possibilities in verifying this model, providing that only the artefacts bearing traces of utilisation were taken into account. In Table 5, we have marked in bold the percentages of particular extra local lithic materials in three regions: northern Kuyavia, the Chełmno land and the Starogard Lake District. The indices of particular "exotic" flints vary in these regions: for northern Kuyavia, the highest is the contribution of chocolate flint (70%), for the Chełmno land – Świeciechów flint (60%), and for the Starogard Lake District – Volhynian flint (68%).

While making an attempt to understand the phenomenon of distribution of raw materials, we cannot neglect the importance of the location of distinguished territorial communities (obviously, keeping in mind that the proposed division is only stipulated, constructed for the needs of this paper, and based on the current state of knowledge), which is strictly associated with the distance from the outcrops of "exotic" flints, their potential, direct or indirect, accessibility, and finally relations of certain human groups with their neighbours. These relationships, clearly legible thanks to the results of analyses of pottery and flint assemblages (made of "exotic" materials, in particular), shaped the regional and interregional connections that formed specific communities, changeable throughout time and space, of various degrees of cultural affinity.

Apart from other factors discussed in the introductory part of this paper, complex systems of distribution could have affected the recorded variability in the structure of flint assemblages coming from particular sites. In this respect, one should consider the duration of the FBC eastern group development. During this period, lasting for several hundreds of years, the individual (social) relationships with the neighbours or more remote groups of people could have got closer or, on the contrary, might have diminished in time. This must have affected the scale of the inflow of foreign artefacts, potentially desirable, though unequally accessible, depending on time and space. We can also point out another reason for the individualism mentioned above. Directions of the inflow of "exotic" materials were undoubtedly more complex than the suggested "routes" running along both banks of the Vistula River. In this case, we refer to interregional migration mentioned in the literature (*e.g.* to the Chełmno land). This movement could have disturbed these interregional relationships and consequently affected short-term, at least, changes in human associations, resulting in an "atypical" inflow of "exotic" flints (brought by immigrants themselves or obtained as an effect of their connections with their motherlands).

A constant interest in "exotic" flints and their continuous inflow to the FBC communities in Polish Lowlands evidence a permanent relationship with settlements located in the south-east and in the south. The basis of these relationships should be sought in the gift-giving obligation with the system of goods exchange, distinctive for the early farming communities (including those of the Funnel Beaker culture), which characterises most aptly the very essence of distribution of artefacts made of "exotic" lithic materials (*cf.* Mauss, 1973; Burszta 2005, 18-24; Kowalski 2005, 25-33; Lech 1981; Małecka-Kukawka 2001).

These interconnections were not disturbed either during the Baden era in the region (Badenisation process of the FBC) or through the contacts with the Subneolithic hunter-gatherer-fishers (Subneolithisation process of the FBC) that are clearly evidenced by the ceramic assemblages and further supported by the data in Table 5. Investigations of flint assemblages open different cultural views on the Neolithic societies whilst challenging the supremacy of ceramic evidence in archaeological research. After all, both these categories of artefacts were left in the same place by the same group of people.

CONCLUSIONS

1. In general, in the younger phases of the FBC eastern group development, the most commonly encountered imported raw materials were chocolate, and less frequently, Świeciechów flints. Striped and Cracow Jurassic flints played a marginal role in this cultural context.

2. The index of contribution of imported raw materials, computed in relation to the entire flint collection, indicates that the further from their outcrops, the smaller their proportion was. Exceptional in this respect is the region of Central Poland, situated within the closest distance from the outcrops of Jurassic, chocolate, Świeciechów and striped flints. This may be due to the location of this region outside of the main distribution routes. It is also possible that the traces of settlement in this region come from a short period of expansion of the FBC eastern group to the south, when the intensity of inflow of imported goods within this cultural unit decreased. Other potential interpretations of this phenomenon cannot be excluded either (see point 6).

3. Currently distinguished regions significantly differ one from another in terms of frequencies of particular foreign raw materials. This indicates an actual regionalisation of local FBC communities and diversified valorisation of raw materials within these units.

4. Technical and utilitarian qualities of "exotic" raw materials were exploited and highly appreciated. However, these qualities might not have been the major reason for acquisition of those flints. This hypothesis is supported by the following observations: lack of foreign raw materials in some post-settlement structures, predominance of utilised tools made of local flints, and a fact that *ca.* 20-30% of all specimens made of imported materials bear no traces of utilisation.

5. Acquisition of "exotic" lithic raw materials was an effect of more complex connections and relationships between particular human groups, exceeding beyond the utilitarian aspect. This conclusion is consistent with the contemporary opinions on the Neolithic culture in general. Valorisation of these raw materials' foreign (exotic) nature might have not been associated with their utilitarian value at all, *i.e.* raw material management needs.

6. Surprising results were obtained thanks to comparing the functional structure of flints coming from two regions, namely the Starogard Lake District and the Chełmno land. In both of these regions *ca.* 70% of tools bearing traces of utilisation were made of local raw materials, while only 30% represented imported flints. Nevertheless, within the group of artefacts made of local flints, considered 100%, functional tools constituted only 6-9%, while amongst the specimens representing the "exotic" raw materials (again, considered 100%) functional tools enclosed as much as 70-80% of all artefacts. Noteworthy is a significant overrepresentation of "exotic" flints (with traces of utilisation) in reference to their contribution within the entire flint collections (discussed in point 2). This prompts us to a deeper reflection upon the manner of evaluation of the scale of inflow of imported flints

based on the analysis of assemblages coming from post-settlement waste deposits. Due to the lack of more reliable data obtained from micro use-wear analysis performed for all flint artefacts coming from a particular site (usually it covers only selected specimens), we are not able to compare our findings with other regions of the FBC settlement.

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MICRO-REGIONAL VARIANTS OF THE FLINT KNAPPING TRADITIONS IN THE LATE NEOLITHIC FROM THE PERSPECTIVE OF PROKOPIAK'S MOUNT

ABSTRACT

Domańska L. 2022. Micro-regional variants of the flint knapping traditions in the Late Neolithic from the perspective of Prokopiak's Mount. *Sprawozdania Archeologiczne* 74/1, 205-220.

The distinctive sandy structure of Prokopiak's Mount in Opatowice stands out from the surrounding black soils of the Kujawy Upland, and therefore attracted the interest among the Late Neolithic communities of the region. A program of comprehensive archaeological research was conducted here in 1985-1998, eleven sites were investigated and the materials obtained from five of them were published. These sites all produced rich flint assemblages. Three of these assemblages, being relatively homogeneous, (Opatowice 33, 36 and 42), were selected for research on the formation of local traditions of flint production in the Late Neolithic in Kujawy. The presented assemblages cover the entire chronological span from 3650 BC to 2600 BC. And chronologically correspond to the classic Wiórek horizon (Opatowice 33), the Luboń-Radziejów horizon (Opatowice 42) and the classic GAC horizon (Opatowice 36).

Keywords: Kujawy, Late Neolithic, lithic analysis
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Prokopiak's Mount in Opatowice, Radziejów commune in Kuyavian-Pomeranian Voivodeship is part of the range of Radziejów Hills. Due to its sandy structure, it is a vividly distinctive element against the surrounding black soils of the Kujawy Upland. This particular feature aroused keen interest among the Late Neolithic communities. That interest resulted in numerous, often multiphase, sites dated to that period. They testify to the extensive economic use of the Mount in the Late Neolithic (Szmyt 2013).

The area of the Mount was included in the program of comprehensive archaeological research conducted in the years 1985-1998 (Kośko and Szmyt 1993). The field work was carried out at eleven sites and the materials obtained from five of them were published (Kośko and Szmyt 2006; 2007; 2007a; 2014; 2015).

All the mentioned sites provided rich flint assemblages (Domańska 2013). The following three of them, being relatively homogeneous, were selected for the research on the formation of local traditions of flint production in the Late Neolithic in Kujawy: Opatowice 33, 36 and 42.

THE SITES

Opatowice 33

Traces of the TRB population settlement prevail at the site. The beginnings of it date back to around 3650 BC. The shape of the oldest settlement is very poorly readable due to the subsequent acts of devastation. Far more data was provided by the later settlement, which was established after 3400 BC. Two farmsteads are dated to this period, one of which was almost entirely explored. The vast majority of the artefacts discovered at the site are associated with the younger phase of the TRB settlement (Kośko and Szmyt 2006; Szmyt 2013).

A few single GAC finds can also be linked with the Late Neolithic (Kośko and Szmyt 2006). Three multi-platform flake cores, single flakes, splintered pieces and a burin were recorded in a small concentration of pottery representing that culture. They were all made of Baltic flint.

A small group of several items which are not related to the Late Neolithic may be assigned to the Mesolithic. They are represented by, among other things, four microliths.

Taking into account the above observations, the assemblage of 277 flint artefacts from Opatowice 33 can be considered relatively homogeneous and the vast majority of it can be associated with the classic Wiórek horizon of the TRB (Domańska 2013).

The dominant raw material discovered at the site was Baltic flint. 155 specimens of this material were registered, and its percentage share in the structure of the analysed assemblage was 55.9%. The second place in terms of quantity is taken by chocolate flint with 90 specimens singled out, which constitutes 32.5% of all the found artefacts. Among

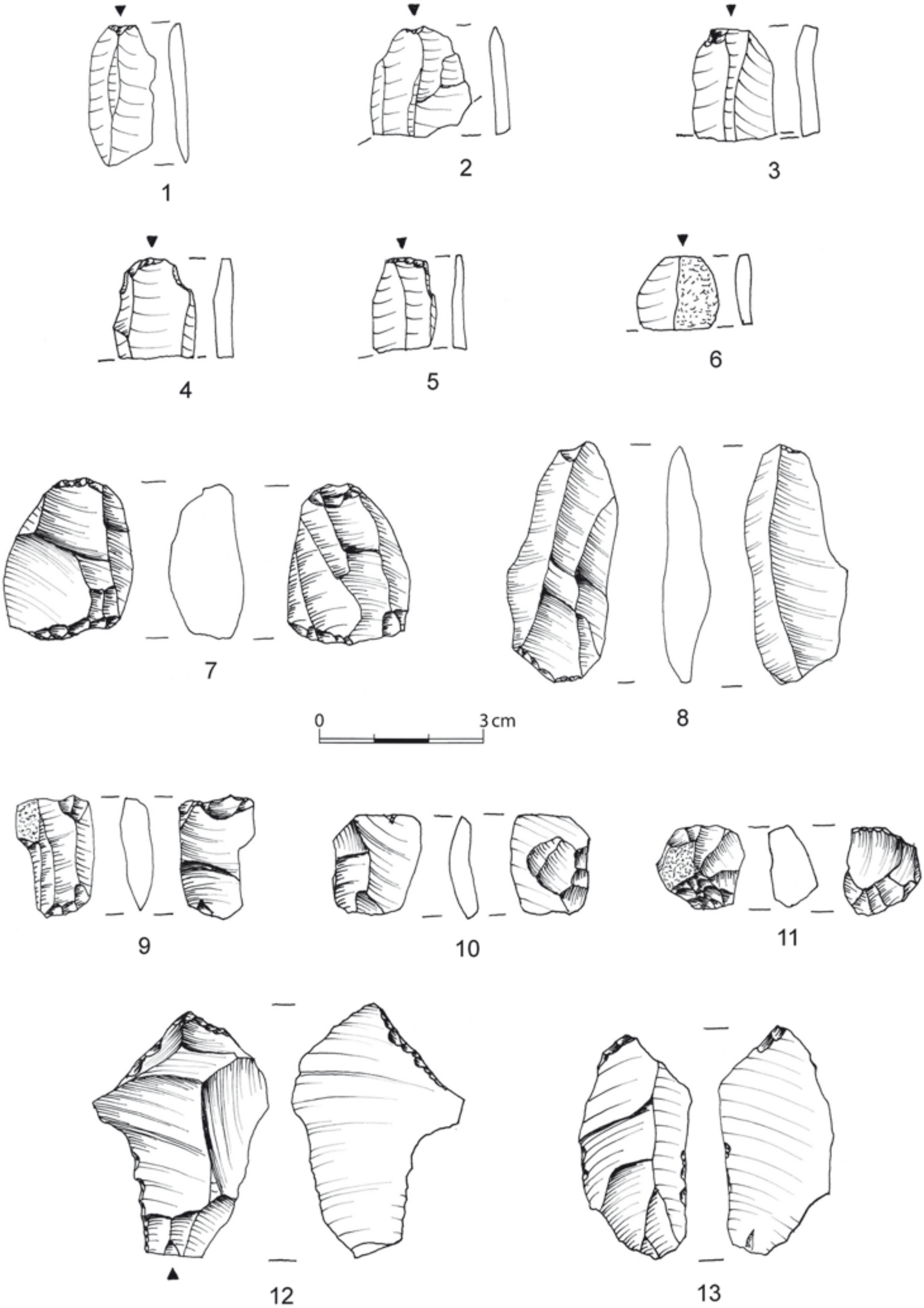

Fig. 1. Opatowice 33, Radziejów Kujawski community. Blades (1-6), splintered pieces (7-11), borers (12-13)

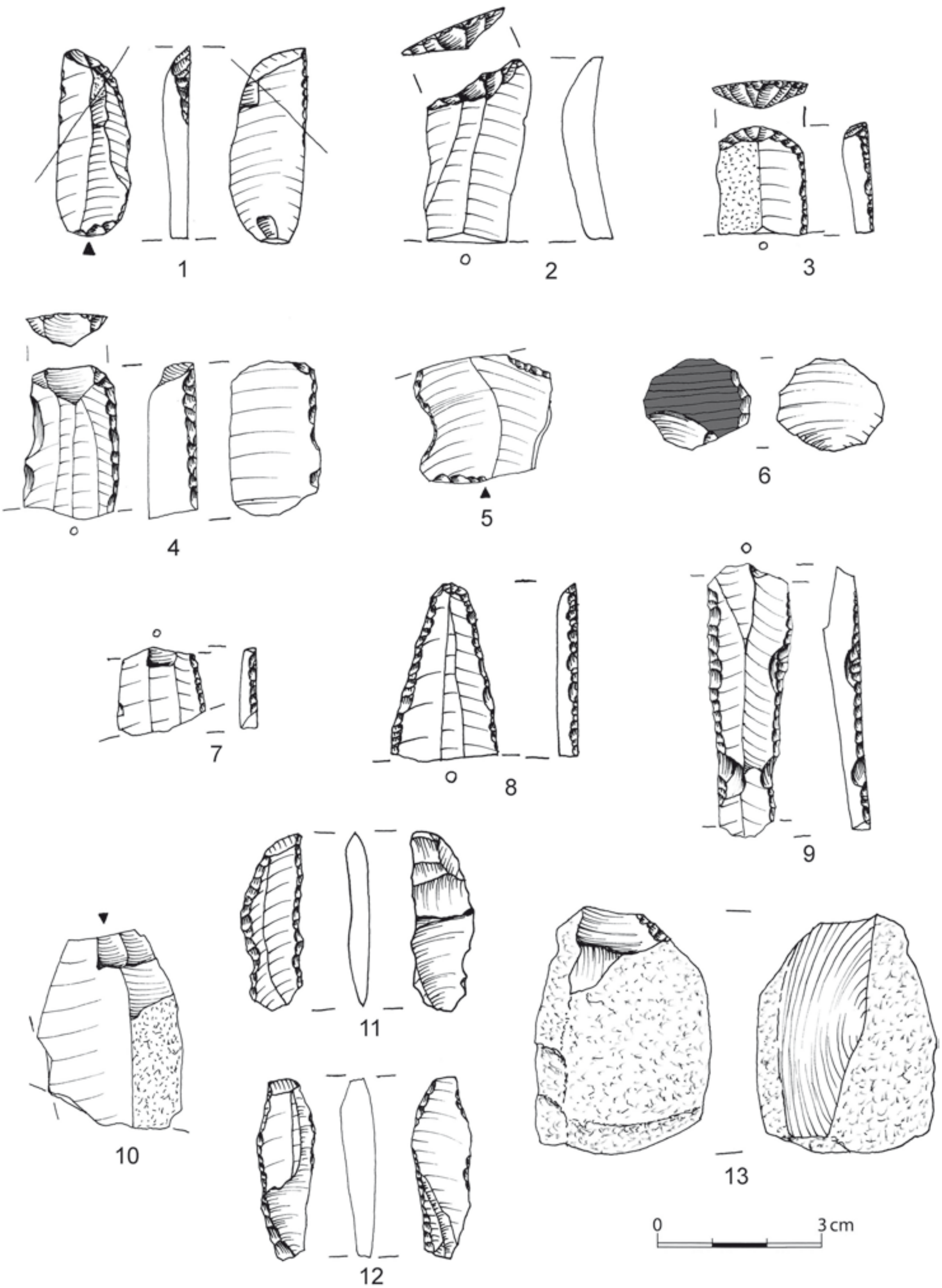

Fig. 2. Opatowice 33, Radziejów Kujawski community. Truncated blade (1), endscrapers (2-4), retouched flake (5), flake from polished axe (6), micro-retouched blade (7), blade with continuous retouch (8), retouched blade (9), blade (10), splintered pieces retouched (11-13)

other southern raw materials, one specimen of Volhynian flint and one specimen made of Świeciechów flint were recorded. This assemblage is complemented by 30 specimens of intensely burnt flint.

Most of the products are technologically connected with two techniques of exploitation: flaking and splintering. The quantitatively dominant group are products of the splintering technique, 21 splintered pieces (Fig. 1: 7-11) and 60 splintered piece flakes were recorded. Their share was 29.2% of the total assemblage. The group of flake exploitation products included eight cores and 57 flakes (23.4% of the whole assemblage).

The group of blade exploitation included two microlithic cores and 32 blades (12.3% of the whole assemblage). The aforementioned cores and blades with widths ranging from 5 to 9 mm can be associated with the Mesolithic. The assumption that Mesolithic hunters were present at the site is also confirmed by the discovered microliths (a triangle, a trapeze, a rhombus and a fragment of a truncated blade). The blades, which range from 11 to 17 mm in width, can be linked to the settlement of the TRB population (Fig. 1: 1-6). Most of the analysed blades were made of chocolate flint.

The group of tools included 28 specimens. A flake from polished axe made from chocolate flint was also distinguished.

The tool group can be divided into three subgroups. The first subgroup consists of tools which are, most likely, unrelated to the TRB. They include four microliths and a burin recorded in the GAC pottery concentration.

Among the remaining 23 specimens, eight conventional tools were discovered: three endscrapers (Fig. 2: 2-4), two borers, one truncated blade (Fig. 2: 1), one blade with continuous retouch (Fig. 2: 8), one projectile point. The blade with continuous retouch is the only product made of Volhynian flint discovered at the analysed site. It belongs to the category of convergent pieces.

The group of atypical tools consists of 15 pieces and prevails in the discussed assemblage. The atypical tools were divided into groups according to the type of blank from which they were made, i.e. blade tools – eight pieces, flake tools – four pieces and splintered-based tools – three pieces. The majority of them are products made of Baltic flint – eight pieces, six are made of chocolate flint, and one piece is intensely burned. The retouched pieces and pieces with use retouch constitute the most numerous part among atypical tools (Fig. 2: 5, 7, 9, 11-13).

Opatowice 36

At the site Opatowice 36, traces of a TRB settlement dating from 3700-3500 BC and clearly dominant remains of the GAC population settlement from 2900-2600 BC were recorded (Kośko and Szmyt 2015). The collection of artefacts related to the exploitation and use of flint, obtained in the course of archaeological research, includes 1,369 pieces (Domańska 2013; 2015).

The dominant raw material in the assemblage from Opatowice 36 is the local Baltic flint. Its share is 85.5% of the total material (1,169 pieces) whereas the products made of exotic flint are of marginal importance in terms of quantity. Among them, there is chocolate flint, from which 109 specimens (8%) were made. The remaining species are present in trace quantities; these include: 10 artefacts made of Świeciechów flint, nine from banded flint and seven of Volhynian flint.

Most of the recorded pieces are technologically related to two techniques of exploitation: splintering and flaking. In addition to the blade tools, only 14 other pieces are products of blade exploitation.

The group which definitely prevails in terms of quantity are the products of the splintering technique. Together, they constitute nearly half of the assemblage (almost 49%). The characterised assemblage consists of: splintered piece flakes – which are the most numerous artefacts in the entire assemblage (533 pieces, *i.e.*, 38.8% of the total assemblage) and splintered pieces (139 pieces, *i.e.*, 10.1% of the total assemblage). The percentage contribution of this group increases even more after taking into account the tools made of splintered piece flakes.

The distinguished group of flake exploitation includes mainly flakes (243 items). Only one flake core is genetically linked to this group. Overall, this group accounts for c. 18% of the total assemblage. The group of blade exploitation, which consists of 13 blades and one blade core, accounts for only 1% of the total assemblage.

A significant part of the assemblage – comparable to the number of flakes – are the pieces classified as chunks (19.3%); this category consists of burned chunks and chunks with flake negatives. Micro-debitage in the form of chips (*i.e.* flakes smaller than 5 mm) comprises just over 2.3% of the entire assemblage (31 pieces).

The presented assemblage also contained a group of polished axes (one piece) and flakes removed from axes (18 flakes) – they were singled out to a separate group.

A total of 124 tools were recorded, which made up 9.1% of the whole assemblage. The group was divided into two subgroups. The first one is composed of conventional tools. The other group consists of atypical tools, i.e. flakes and blades with traces of use in the form of the utility retouching and use gloss.

The group of conventional tools is composed of 30 pieces, among which two types quantitatively prevail: endscrapers (19 pieces) and truncated blades (eight pieces). In addition, two projectile points and one convergent blade with continuous retouch were registered. The latter piece should be associated with traces of settlement of the TRB population from the period 3700-3500 BC (Domańska 2015).

The remaining part is made up of atypical tools, which are quantitatively dominant – with 94 pieces distinguished (75.9% of all the tools). These pieces were grouped into three subsets according to the type of blank used. The most numerous are the pieces made of blades (54 pieces in total). This group includes 43 blades with use retouch, four retouched blades and seven micro-retouched blades. The share of the atypical flake tools is perceptibly

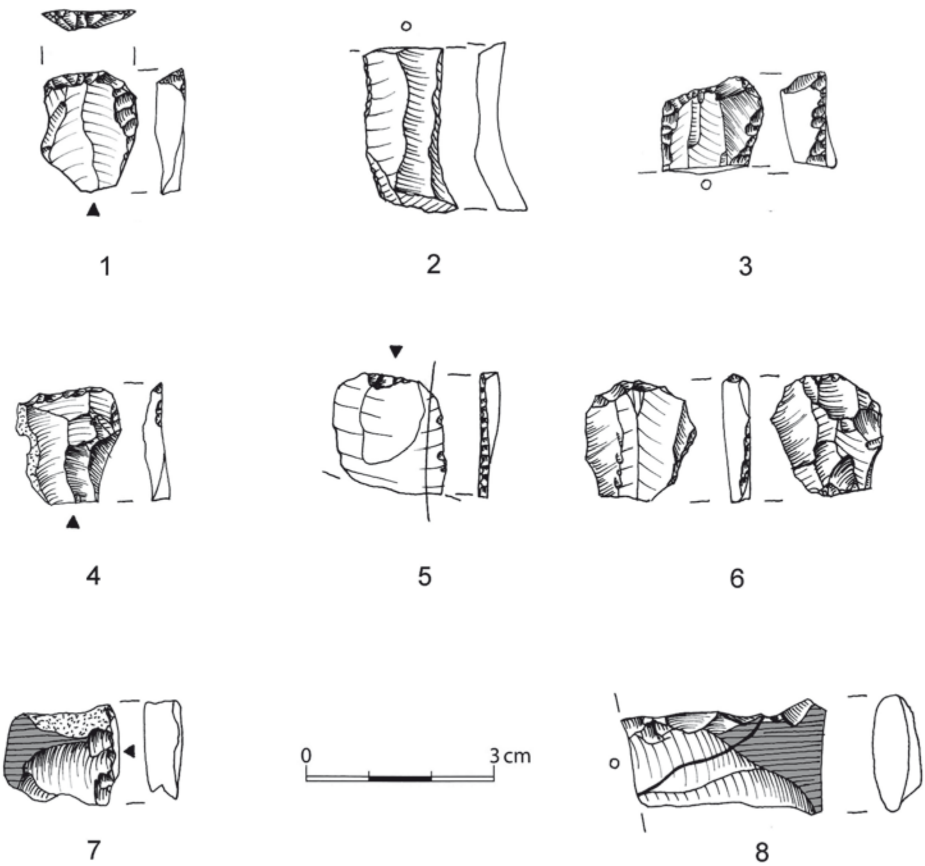

Fig. 3. Opatowice 36, Radziejów Kujawski community. Flint artefacts from the concentration of GAC pottery: Endscraper (1), blade with use retouch (2), retouched flakes (3-4), flake with polish on the lateral edge (5), splinterd piece (6), flakes from axes (7-8)

lower. Among them, the following were distinguished: flakes with use retouch (15 pieces), retouched and micro-retouched pieces (20 in total). The collection of atypical tools is supplemented by pieces that are technologically connected with the splintering technique. Only five splintered-based tools were identified in the assemblage.

In the central part of the site a concentration of GAC pottery and flint artefacts was registered; it is related to the alleged house of this population (Kośko and Szmyt 2015). A total of 161 flint products were recorded in the above-mentioned concentration (Fig. 3).

The vast majority of them were made of Baltic flint: 137 pieces – which accounts for 85.1% of all the products. There were also 12 pieces made of chocolate flint (7.5% of the collection), one piece made of banded flint (0.6%) and 11 intensely burned flint pieces (6.8%).

The most numerous group are products of the splintering technique, which includes 31 splintered pieces and 41 splintered piece flakes, which together constitute 44.7% of the entire collection. The next most common are: chunks – 44 examples (27.3%), flakes – 34 (21.1%), tools – seven items (4.4%) and four flakes removed from axes (2.5%). The group of tools includes two endscrapers (Fig. 3: 1), one blade with use retouch (Fig. 3: 2), two retouched flakes (Fig. 3: 3, 4), one micro-retouched flake and one flake with polish on the lateral edge (Fig. 3: 5).

A comparative analysis of the flint pieces from the above-described cluster recorded in the central part of the site as well as the entire assemblage confirms the far-reaching similarities linking the two assemblages. This observation seems to be just another piece of evidence of the relationship between the vast majority of the flint assemblage and the settlement of the GAC population at the presented site.

Opatowice 42

During the excavations conducted at the Opatowice 42 site, a particularly large collection of the TRB pottery was obtained. On its basis, several phases of settlement of the site occupied by the TRB communities were identified. The artefacts representing the respective phases co-occurred in almost the entire excavated area, but in some parts of the site they formed relatively homogeneous systems (Kośko and Szmyt 2007a; Szmyt 2013).

A house (feature 21) and 'yard' (trenches surrounding the house) seems to be one of such systems. It functioned (most probably) in the period between 3350 and 3100 BC. The vast majority of ceramic and lithic artefacts discovered at the site come from its context (Kośko and Szmyt 2007a).

The excavation of the site provided 473 flint products (Domańska 2007a). Of these, 62 were recorded in the aforementioned house (Feature 21) and 139 pieces were recorded on the surface of the postulated 'yard'.

CHARACTERISTIC OF THE ASSEMBLAGE FROM FEATURE 21 (HOUSE)

A total of 62 artefacts were recorded in Feature 21. The prevailing raw material in this assemblage is Baltic flint. Its share is 75.8% of the total material (47 pieces). On the other hand, the products made of flint which, from the perspective of this site, can be classified as exotic, are in vast minority. Seven pieces of chocolate flint (11.3% of the total structure of the assemblage), a fragment of an axe made of banded flint and a tool made of Volhynian flint were identified. Also, six intensely burned pieces (9.7% of the whole assemblage) were recorded.

The majority of the products from this feature are technologically connected with the splintering technique of exploitation. 12 splintered pieces and 13 splintered piece flakes

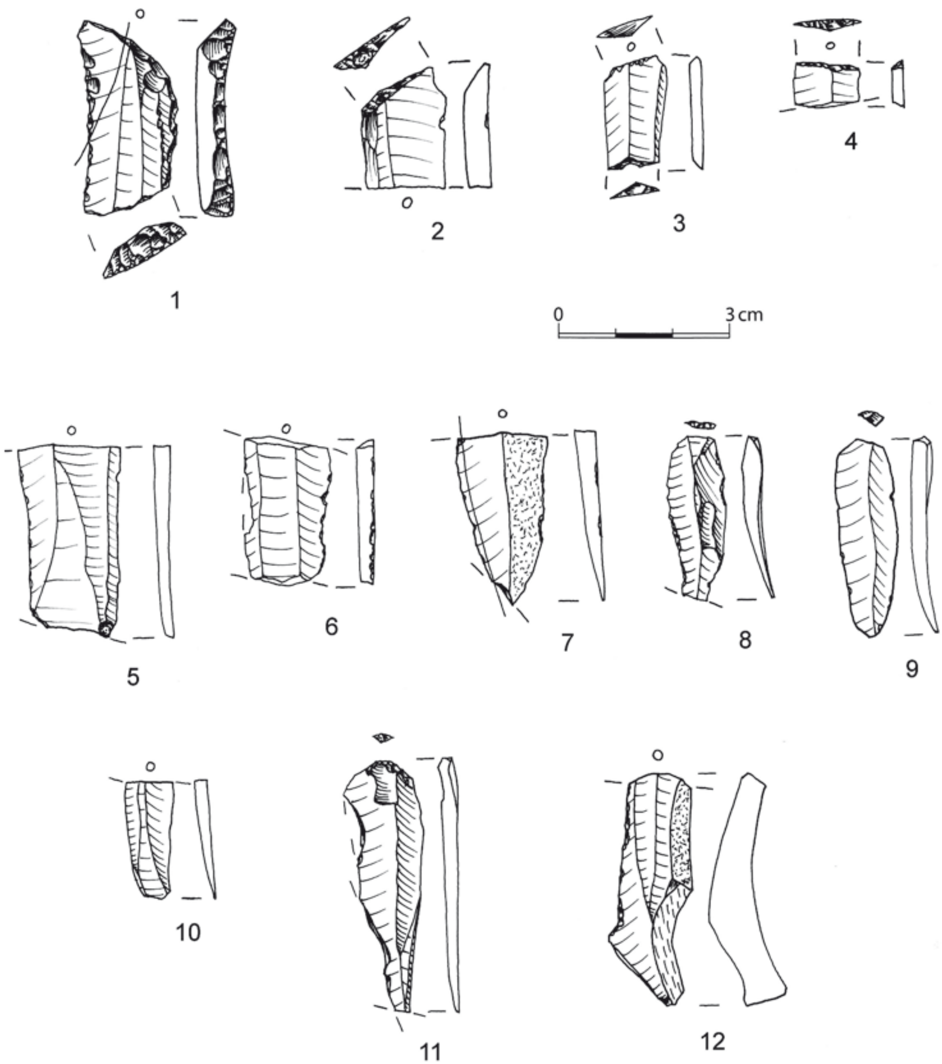

Fig. 4. Opatowice 42, Radziejów Kujawski community. Flint artefacts from Feature 21: Truncated blades (1-4), blades with use retouch (5-9), blades (10-11), micro-retouched blade (12)

were recorded. Collectively, they represent 40.3% of the whole assemblage. The groups of products of the flake and blade exploitation show a similar quantitative share in the quantitative and qualitative structure of the analysed materials. The assemblage yielded five flakes and four blades.

Tools are the dominant group among the artefacts derived from the house, 16 specimens were recorded, which constitutes 25.8% of the entire assemblage structure. Of these, four were made of chocolate flint, one of Volhynian flint and nine of Baltic flint. In the case of two pieces, the high degree of burning precluded the possibility of identifying the raw material.

The group of tools was divided into two subgroups: conventional tools and atypical tools. The latter subgroup prevailed. A separate group is composed of flakes from axes.

Only four specimens (truncated blades) were included in the first group (Fig. 4: 1-4). Among them, two double truncated blades and two single pieces were discovered. It should be noted, however, that single truncated blades are just fragments, and their classification may be incorrect. Three truncated blades were made of Baltic flint, and one was an intensely burned piece. Only one truncated blade has clear polish arranged diagonally to the axis of the blank.

The group of atypical tools consisted of 12 specimens. They included one micro-retouched blade (Fig. 4: 12), five blades with use retouch (Fig. 4: 5-9), one retouched flake, three flakes with use retouch, one retouched splintered piece and one splintered piece flake with use retouch. Tools made of Baltic flint prevail (six), but there were also four tools made of chocolate flint, one from Volhynian flint and one is an intensely burned piece.

CHARACTERISTIC OF THE ASSEMBLAGE FROM THE TRENCHES SURROUNDING THE HOUSE ('YARD')

A total of 139 artefacts were recorded in the area of the house's 'yard'. The ones made of Baltic flint were by far the most numerous pieces in the assemblage, 115 specimens were identified, which accounts for 82.8% of the total assemblage structure. Southern raw materials constitute a total of 12.9% of the raw material structure of the presented assemblage. The most numerous among them were products made of chocolate flint (16 pieces) but also some products made of Volhynian and Świeciechów flint (one piece of each) were recorded. Only 4.3% of the raw material structure of the assemblage consisted of burned pieces.

The assemblage generally consist of products classified into eight categories. Most of them are technologically related to the splintering technique. Negative chunks made of Baltic flint (33.8% of the total structure of the assemblage) are very numerous in the assemblage. Also, three chips were identified, two of which were made of chocolate flint.

The group of products of the splintering technique includes 22 splintered pieces and 36 splintered piece flakes. They constitute 41.9% of the entire assemblage. Except for one splintered piece made of Świeciechów flint and one burned piece, the remaining splintered pieces were made of Baltic flint. Bipolar bifacial pieces dominate among them. The analysed assemblage included six flakes (4.3% of all the materials) and five blades (3.6% of the assemblage) (Fig. 5: 12-13).

There were 18 specimens classifiable as tools, which constitutes 12.9% of the total assemblage. Two flakes removed from polished axes were singled out for as a separate group, one of which is made of Baltic flint and the other is a burned specimen.

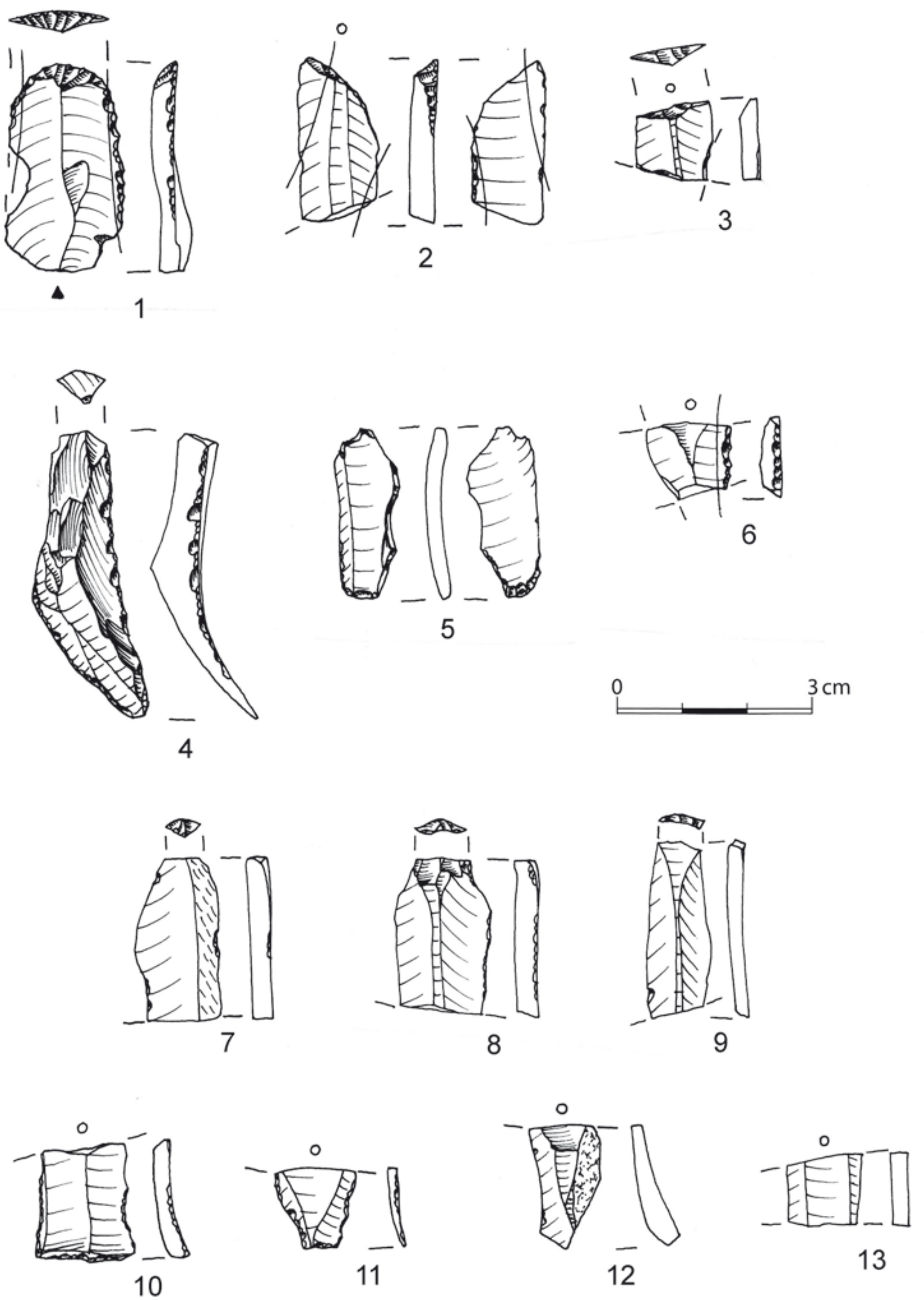

Fig. 5. Opatowice 42, Radziejów Kujawski community. Flint artetacts from the trenches surrounding the house ('yard'): endscraper (1), truncated blades (2-3), retouched blades (4, 6), micro-retouched blades (5, 10-11), blades with use retouch (7-9), blades (12-13)

The group of tools was divided into two subgroups: conventional tools and atypical tools. The first subgroup included three specimens, and the other – 15 tools.

The first subgroup was composed of one endscraper (Fig. 5: 1) and two truncated blades (Fig. 5: 2, 3). The distinguished endscraper was made of Baltic flint; it is a unilateral retouched blade, arcuate with unilateral retouch and bilateral polish. The group of truncated blades included a double piece made of Baltic flint and a fragment of a truncated blade made of chocolate flint.

The group of atypical tools contains retouched blades (Fig. 5: 4, 6), micro-retouched blades (Fig. 5: 5, 10, 11), blades with use retouch (Fig. 5: 7-9), retouched flake, micro-retouched flakes and retouched splintered flakes. In the discussed group of tools, blades dominate (eight pieces); there are also five splintered tools and two other tools made on splintered piece flakes. Tools made of Baltic flint (seven pieces) are slightly more numerous; there are also six pieces made of chocolate flint, one of Volhynian flint and one intensely burned piece.

A COMPARATIVE ANALYSIS OF THE ASSEMBLAGES

The presented assemblages chronologically correspond to the classic Wiórek horizon (Opatowice 33), the Luboń-Radziejów horizon (Opatowice 42) and the classic GAC horizon (phases IIb-IIIa). They cover the entire chronological span from 3650 BC to 2600 BC (Kośko and Szmyt 2006; 2007a; 2015). Their comparison leads to several conclusions:

1. The major raw material in all three sites is the local Baltic flint; the level of its use varies as follows: Opatowice 33 – 55.9%, Opatowice 42: house – 75.8%, 'yard' – 82.8%, Opatowice 36 – the share of the raw material in all materials is – 85.5%, for a separated cluster inside the alleged GAC house – 85.1%.

2. In the group of southern raw materials, chocolate flint occurs most abundantly. For Opatowice 33, the ratio of this raw material is 32.5%. Chocolate flint is also dominant in the group of imports in the house assemblage and in the trenches surrounding Feature 21 (house) at the site Opatowice 42 (11.3% and 11.5%, respectively). The share of chocolate flint calculated for the entire assemblage from Opatowice 36 is 8% and for the alleged GAC house – 7.5%.

3. The assemblages from Opatowice 36 and 42 are composed mainly of splintered pieces. For Opatowice 42, the indexes for this group are as follows: house (Feature 21) – 40.3%, trenches around the house ('yard') – 41.9%, while in the case of materials from Opatowice 36 the indexes for the group are as follows: for the entire assemblage – 48.9%, inside the alleged GAC house – 44.7%. A slightly different situation was recorded for the site Opatowice 33. The group of products of the splintering technique does not exceed 30% of the assemblage.

4. The quantitative share of the group of flakes in the presented assemblages is different. The highest index for this group is achieved in the materials from Opatowice 33 where it

amounts to 23.4% of all products and is close to the quantitative share index in this assemblage of splintered piece and splintered piece flakes. For the site Opatowice 36, the quantitative share index of the group of products of flake exploitation is 18% of the total assemblage – for the GAC ceramic cluster in the central part of the site it is 21.1%. Only five flakes were recorded in the house at the site Opatowice 42, and the trenches surrounding the house – six pieces were recorded.

5. In all three sites, blades which were not transformed into tools were rare finds and occurred as follows: Opatowice 33 – 19 pieces of chocolate flint; Opatowice 36 – 10 blades made of Baltic flint and three blades of chocolate flint; Opatowice 42 – four blades were recorded in the house (two made of chocolate flint and two of Baltic flint) and in the trenches surrounding the house – five pieces (one made of chocolate flint, one of Baltic flint and three intensely burned pieces). It should be emphasized, though, that the group of products made of chocolate flint derived from the presented site did not contain any technical forms, which would indicate that the blade exploitation was performed locally.

6. Atypical tools strongly prevail in the analysed assemblages. At the site Opatowice 33, they account for over 53% of all tools, while at the remaining sites their percentage varies between 75% and 83%. The presented group of tools is dominated by blade pieces, while blades with use retouch and micro-retouched blades predominate.

7. The group of conventional tools is dominated by endscrapers and truncated blades: Opatowice 33 – three endscrapers and one truncated blade; Opatowice 36 – 19 endscrapers and eight truncated blades were recorded at the site, while two endscrapers were discovered within the cluster of flints inside the alleged GAC house; Opatowice 42 – four truncated blades were identified inside the house and on the surface of the 'yard' – one endscraper and two truncated blades.

CONCLUSIONS

The above comparison clearly shows a far-reaching convergence between the analysed assemblages in terms of their quantitative and qualitative structures. This is mainly confirmed thanks to the analysis of the flint materials from Opatowice 36 and 42. These groups are characterised by similar indexes in terms of the raw material structure (quantitative indexes for Baltic flint range from 75 to 85%, and for chocolate flint: 7.5-11%). At both sites, the groups of products of the splintering technique are clearly dominant (40-50%), and in the group of tools – atypical tools prevail with a quantitative share in this group of products ranging between 75 and 83%.

The assemblage from Opatowice 33 differs slightly from the other two presented groups. The most important difference is marked by an occurrence in these materials of convergent retouched blades made of Volhynian flint. They comprise quite a characteristic element of the classic Wiórek assemblages in Kujawy, however, they were not recorded in the context of Luboń-Radziejów materials (Domańska 2013; 2016). The presented assemblage is also distinguished by a relatively high quantitative index for specimens of chocolate flint (32.5% of the total raw material structure) and a similar quantitative share of the products of the splintering technique as well as the classical methods of core exploitation.

It should be emphasized that the perceived differences are purely quantitative. No significant qualitative differences related to the technology or the general structure of the tool group were noted. This observation comes as a surprise, taking into account the 'ceramic' cultural attributes of the individual assemblages.

Very complex systems of sources have been recorded at the presented sites related to the asynchronous occupation episodes of the late Neolithic population (Kośko and Szmyt 2006; 2007a; 2015). This fact calls for a certain degree of caution in formulating explicit opinions. The observed similarities between the methods of flint production of the classic Wiórek, the Luboń-Radziejów and the Globular Amphora populations at sites Opatowice 33, 36 and 42 cannot be interpreted only as a source-related issue resulting from the mixed nature of the flint assemblages recorded at the presented sites. Therefore, it appears that the idea of the possibility of continuation of the previously developed models of making flint tools by subsequent Late Neolithic communities should be allowed (Domańska 2016).

This may be indicated by the results of the comparative analyses of two GAC flint assemblages from Kujawy, which come from the following sites: Kołuda Wielka 13 and Opatowice 36. The first group is dated to phase IIa, the other – to phase IIb-IIIa (Szmyt 2013; Kośko and Szmyt 2015).

The collection of artefacts obtained at the site Kołuda Wielka 13 consists of 99 pieces (Domańska and Wąs 2021). The local Baltic flint is clearly the dominant material at the site. Its share is 75.8% of all materials. Chocolate flint takes second place in terms of quantity – 17.2%. The products of the splintering technique are definitely the dominant group – 47.5% of the entire assemblage. In turn, 16 specimens were included in the group of products of flake exploitation, which accounts for 16.2% of the total assemblage. There were no products found at the site that could be associated with blade exploitation. Indirectly, only a fragment of a truncated blade and a fragment of a tool with use gloss bear some characteristics of blade debitage. The group of tools includes 21 specimens, 17 of which are atypical pieces.

As a result of comparing this assemblage to the materials from Opatowice 36, it needs to be reiterated that the discovered differences are only quantitative. No significant qualitative differences related to the technology or the general structure of the group of tools were recorded. Both collections of flints contain elements that testify to their local, simple production focused on immediate needs. These materials also contain remnants of bigger tools, such as axes and products made of chocolate flint. Importantly, the said artefacts were not produced locally but their occurrence at the sites was a result of interregional contacts.

Interesting conclusions also arise from the comparison between the flint materials from site Opatowice 42 and the flint assemblage from site Mrowino 3 located in Greater Poland, representing the TRB Luboń phase (Szmyt 2018). The vast majority of products from the latter site (98.2% of all the pieces) were made of local Baltic flint. The raw material used at the site was excellent quality – the average concretion measured 20 cm. It was most probably derived from the area of the Warta River gorge near Poznań. The quality of the raw material seems to be related to the dominance of the classical methods of core exploitation as the products of this technique represent 82.7% of the total assemblage (Kabaciński and Winiarska-Kabacińska 2018). To compare – in the assemblage from Opatowice 42, the group of products of the splintering technique dominates, and the size of products in this group does not exceed 3 cm. This difference between the analysed assemblages of the TRB Luboń phase is most likely due to the type of the raw material available. Thus the inhabitants of the settlement in Opatowice used small lumps of low-quality flint.

In summary, the flint industry of the Late Neolithic communities in the area of Prokopiak's Mount is an example of specific local solutions focused on the current needs. The production was intended to satisfy utilitarian exigency. Therefore, it was based on simple manufacturing operations that did not require any complicated procedures.

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K-TYPE FLINT IN FINAL ENEOLITHIC LESSER POLAND

ABSTRACT

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Studies of artefacts from Corded Ware culture graves in western Lesser Poland have demonstrated that raw materials originating from the eastern Świętokrzyskie region take a leading role: Świeciechów flint (for the production of axes), and chocolate flint (for making flake and blade tools). New data obtained through the study of settlement sites in the vicinity of Kraków have highlighted the significant role of another hitherto little-noticed raw material: K-type flint (otherwise known as the Wielka Wieś type). This raw material was used mainly for the production of core tools. Workshops producing axes from this flint were discovered on the right bank of the Vistula River in the area between Kraków-Bieżanow and Zakrzów. Tools made from K-type flint appear in Final Eneolithic graves north of Kraków as well, and another production centre is known from this region, near Ojców. The provenance of the raw materials used in the vicinity of Ojców and in the Kraków-Bieżanów – Zakrzów area remains undetermined. Hypothetically, two deposits with different locations were used.

In light of new discoveries made during large-scale rescue research projects, the raw material preferences in Final Eneolithic Lesser Poland seem more complex than previously believed, and they varied from micro-region to micro-region.

Keywords: Final Eneolithic, Corded Ware culture, Lesser Poland, flint production, raw material
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1. INTRODUCTION

Until recently, research on the flint industry of the Corded Ware culture (CWC) communities in Lesser Poland relied primarily on materials from funerary contexts (*e.g.,* Balcer 1983, 226-233). The subject was also addressed in general studies of the Final Eneolithic (*e.g.,* Machnik 1966; Włodarczak 2006). Of the excavated flint mining sites, only the finds from the chocolate flint mine at Polany Kolonia II have been linked to the CWC (Schild *et al.* 1977), and data on settlement sites were almost completely missing. Consequently, the picture of flint-working appeared incomplete. It was justified to assume that what was deposited in graves were selected categories of artefacts that did not represent a full spectrum, and that there may have been selection in terms of raw material as well (*e.g.,* Gancarski and Valde-Nowak 2011). It has also sometimes been assumed that grave furnishings included objects with ritual functions, but not necessarily related to daily activities (*e.g.,* Osipowicz 2022). At the same time, the relatively rich grave inventories suggestively indicated the leading typological and technological features of the Final Eneolithic CWC flint industry, as well as the patterns of raw material supply. The assemblages from Lesser Poland highlight a tendency, characteristic of the 3rd millennium BC, towards attaching supra-utilitarian value to flint raw materials, manifested in the long-distance distribution of selected flint types (Włodarczak 2017, 315, 316). In particular, raw materials were selectively chosen for the production of core tools (axes) and knife inserts (including the cha-racteristic 'flame-shaped knives' – Valde-Nowak 2000). In the case of the Kraków-Sandomierz group of the CWC (*i.e.*, materials from sites located primarily in the Lesser Poland Upland), two raw materials were of particular importance: Świeciechów flint for the production of axes, and chocolate flint for the production of knives and (less frequently) arrowheads (Balcer 1983, 227). Such a preference was also documented in the loess areas of western Lesser Poland (the Kraków region), *i.e.,* in the vicinity of rich and varied Jurassic flint deposits, which nevertheless do not occur in grave inventories on the expected scale. Even in this area, there is an observed tendency to furnish the deceased with flint objects from the Świętokrzyskie region.

Already in the 21st century, numerous open-area rescue excavations conducted in various regions of Lesser Poland have resulted in the discovery of important materials linked to the CWC. Firstly, unique flint assemblages have been obtained from settlement sites and flint workshops, particularly in western Lesser Poland (Włodarczak 2013). Secondly, CWC materials have been discovered in areas previously less well recognised, such as the Wieliczka-Bochnia region (*e.g.*, Jarosz *et al.* 2010) and the south-eastern part of the Sandomierz Basin (Machnik 2011). In areas that are better recognised as well, studies have covered micro-regions from which no rich collections of Final Eneolithic finds were previously known. These discoveries make it possible to verify previous findings concerning CWC flint-working in Lesser Poland.

One of the results of the new research in western Lesser Poland is the recognition of a greater significance of what is known as 'Cretaceous flint of type K' than previously

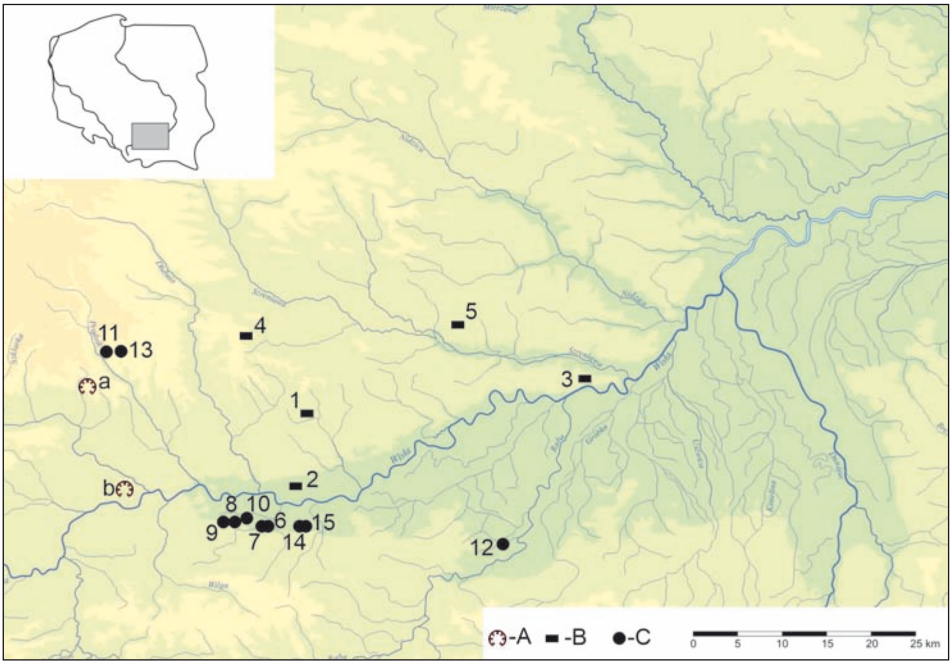

Fig. 1. Main outcrops of K-type flint and the Final Eneolithic sites mentioned in text.
A – outcrops of K-flint: a – Ujazd, b – Kraków, Sikornik Hill; B – Final Eneolithic graves with axes made of K-flint (1 – Kocmyrzów, site 17; 2 – Kraków-Pleszów, site 17; 3 – Książnice Wielkie, site 1; 4 – Polanowice, site 4; 5 – Teresin); C – Final Eneolithic settlement sites (6 – Kokotów, site 13; 7 – Kokotów, site 20; 8 – Kraków-Bieżanów, site 8; 9 – Kraków-Bieżanów, site 15; 10 – Kraków-Bieżanów, site 33; 11 – Ojców, site 12 ; 12 – Proszówki, site 10; 13 – Smardzowice; 14 – Zakrzów, site 1; 15 – Zakrzów, site 13).
Prepared by P. Włodarczak

thought (Kaczanowska and Kozłowski 1976, 207, 208). This raw material had been exploited from the Middle Eneolithic onwards, as evidenced by its presence in the Funnel Beaker culture settlements in the Kraków area (*e.g.,* Wilczyński 2011, 522). It also appears in the materials of the Baden culture (Late Eneolithic). However, a marked increase in its importance comes only in the Final Eneolithic period (after *c.* 2900 BC), when it began to be used primarily for the manufacture of tetrahedral axes. In the Kraków region, its importance in the production of core tools remained high into the Early Bronze Age, as noted as early as the 1970s in the context of materials from the site complex at Iwanowice (Kopacz 1976). The new large-scale rescue research mentioned above has uncovered assemblages with a high proportion of K-type flint at Final Eneolithic settlement sites from the southwestern fringes of the Sandomierz Basin (Wieliczka-Gdów Plateau). These discoveries change the picture of the flint industry of the Lesser Poland CWC, indicating a greater micro-regional diversity than previously thought (Fig. 1). One of the differentiating factors was raw material preference, particularly regarding the production of core tools.

2. K-TYPE FLINT

In categorizing the varieties of flints from the Kraków region, Małgorzata Kaczanowska and Janusz Krzysztof Kozłowski distinguished a group of 'striated flints with light and dark stripes, admittedly relatively rarely used by prehistoric man, and Cretaceous flints' (Kaczanowska and Kozłowski 1976, 207, 208). They called this group the 'K variety' and distinguished two variants. The detailed characteristics of this group, both in terms of geological age and sites of occurrence, have not yet been clarified to the present day (see Lech 1980, 199, 200). Kaczanowska and Kozłowski indicated the presence of K-type flints in the basins of the Prądnik River (above all: in the vicinity of Wielka Wieś and Witkowice) and the Dłubnia River, *e.g.*, in the vicinity of Michałowice (Fig. 1; Kaczanowska and Kozłowski 1976, 209, fig. 1). The most spectacular outcrops were located in Wielka Wieś and in neighbouring Ujazd (Matyszkiewicz and Kochman 2020; Kochman *et al.* 2020), hence this flint was sometimes referred to as 'Wielka Wieś flint' (Přichystal 2009, 95). Macroscopic methods cannot precisely identify the place where this type of raw material was exploited (Matyszkiewicz and Kochman 2020). For the discussion of the distribution of K-type flint at Final Eneolithic sites, presented below, it is important to note its occurrence also at the quarry on Sikornik Hill (Sowiniec Range), within southern Kraków (Matyszkiewicz and Kochman 2020, fig. 3: b). Indeed, it is quite likely that flint from this zone was used in the workshops known from such sites as Kraków-Bieżanów, Kokotów or Zakrzów (the south-western margin of the Sandomierz Basin).

In geological terminology, K-type raw material is referred to as bedded chert, and its age is referred to the Oxfordian/Kimmeridgian stages, *i.e.*, the Late Jurassic epoch (*e.g.*, Matyszkiewicz and Kochman 2020). The geological systematics of Jurassic flints presents a complex issue, one going beyond the scope of this paper.

3. CWC CAMP SITES AND FLINT WORKSHOPS IN THE WIELICZKA-BOCHNIA REGION

The important role of K-type flint in the production of Final Eneolithic core tools was determined by discoveries made during archaeological research preceding the construction of the A4 motorway between Kraków and Bochnia, when numerous finds related to the Corded Ware culture were uncovered (Włodarczak 2013) along with even richer traces of Early Bronze Age occupation (for a summary: Górski and Jarosz 2015). K-flint artefacts, mainly associated with the manufacture of core tools, were discovered at most sites. Their larger collections published so far come from site 33 in Kraków-Bieżanów (Jarosz *et al.* 2010; 2012) and from site 20 in Kokotów, Wieliczka commune (Czerniak *et al.* 2015). At the latter site, the artefacts from the K-type flint of interest here are referred to as 'Jurassic flint of type X' and are in many cases erroneously linked to the settlement of the Funnel

Fig. 2. Axes of K-type flint from Kokotów, site 20.
After Czerniak *et al.* 2015. Photo by M. Wąs

Beaker culture (Czerniak *et al.* 2015, 27 ff.). The abundant collection of tetrahedral axes from Kokotów makes it possible to unequivocally link most of these artefacts (if not all) to the Final Eneolithic industry, despite the doubts expressed by the authors of the study (Czerniak *et al.* 2015, 28, 29). Indeed, these artefacts have good analogies in CWC grave inventories from Lesser Poland (Fig. 2). The flint artefacts from Kokotów were accompanied by a small number of pottery fragments (Czerniak *et al.* 2015, 18, figs 1-3) with characteristics of the older phase of CWC development.

Fig. 3. Kraków-Bieżanów, site 33. Examples of flakes (K-type flint). Photo by E. Włodarczak

From site 33 in Kraków-Bieżanów comes a collection of 192 flakes of K-type flint, representing the remains of a Final Eneolithic workshop producing tetrahedral axes (Fig. 3). In addition to these, a set of tools made from this raw material was found there, including tetrahedral axes themselves (Figs 4-6; Jarosz *et al.* 2010, 18-20, figs 7-9). In typological and stylistic terms, they fit the CWC standards. In addition to flint artefacts, the site also produced fragments of ceramic vessels from the older phase of this culture (Jarosz *et al.* 2010, 12, 13, figs 3-5). Similar but less numerous finds of K-type flint axes, as well as production waste, are also known from nearby sites, including Kraków-Bieżanów sites 8 and 15, as well as site 13 in Kokotów (unpublished research by the Kraków Team for Archaeological Supervision of Motorway Construction).

By analogy with the above-mentioned sites at Kokotów and Kraków-Bieżanów, the tetrahedral axe workshop from site 13 at Zakrzów, Niepołomice commune, a large part of which consists of K-type flint waste, should also be dated to the Final Eneolithic (Nowak 2015). In addition, numerous stray finds of tetrahedral and dihedral axes made from this type of raw material are known from the complex of sites near Zakrzów. A sizable collection of them, coming mainly from pre-war surveys (*e.g.,* Czapkiewicz 1910; 1930), is held in the Archaeological Museum in Kraków, and individual artefacts can also be found in the collection of the Cracow Saltworks Museum in Wieliczka (Fraś and Lajs 2015, 299, photo

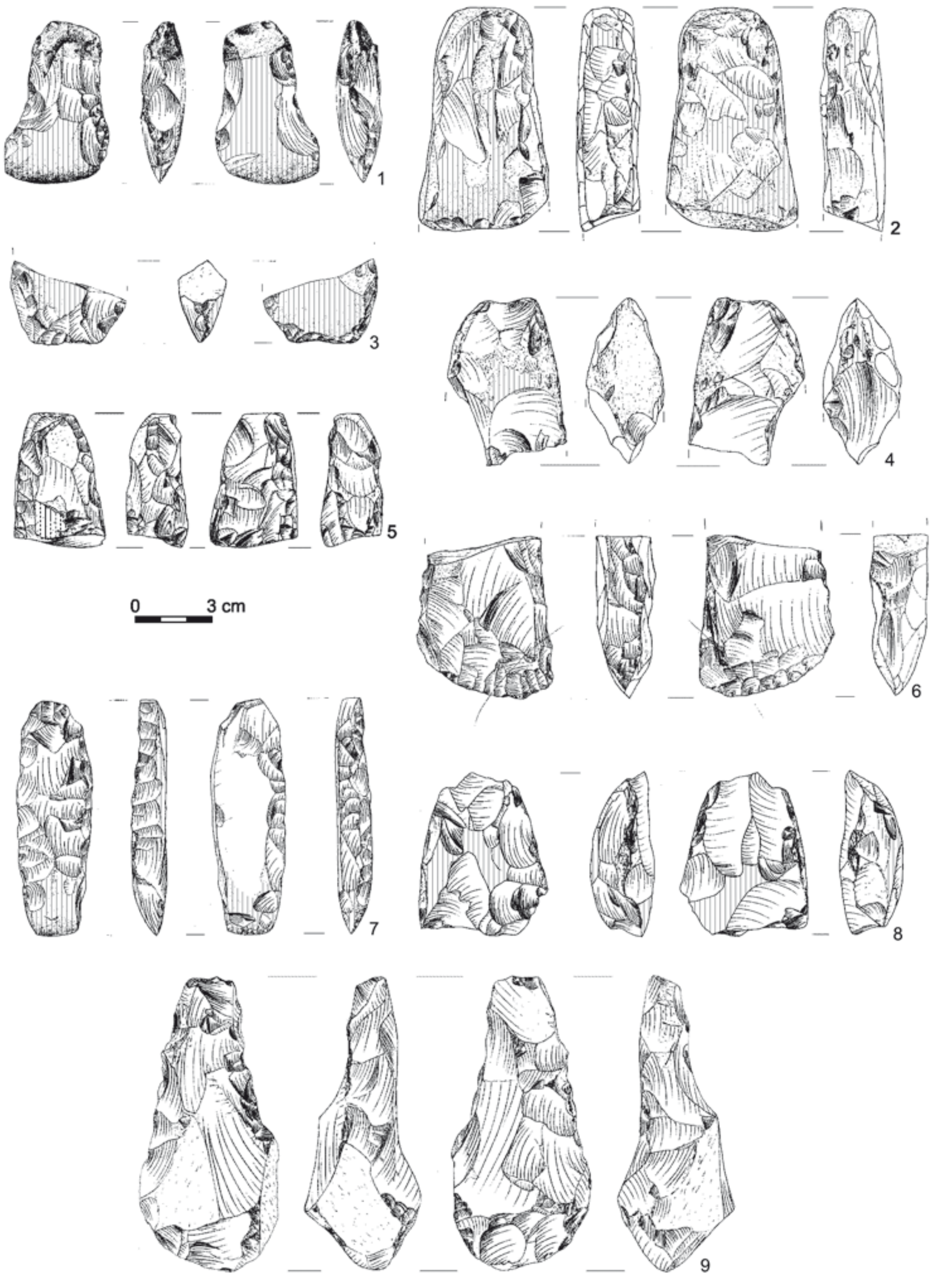

Fig. 4. Core tools from Kraków-Bieżanów, site 33 (K-type flint). After Jarosz *et al.* 2010. Illustrated by A. Kukułka

Fig. 5. Kraków-Bieżanów, site 33. Axes made from K-type flint. Photo by E. Włodarczak

Fig. 6. Kraków-Bieżanów, site 33. Axe made from K-type flint. Photo by E. Włodarczak

25; 325, photo 38 *et al.*). This justifies a suggestion that a production centre existed on the right bank of the Vistula in the vicinity of Kraków, and that it specialised in the manufacture of tetrahedral core tools from K-type flint. This situation is thus analogous to that in the vicinity of Ojców. What remains unknown in the case of the finds from the Kraków-Bieżanów-Zakrzów zone is the provenance of the K-type raw material. One possibility is that it originated from the Sowiniec Range, as perhaps indicated by its similarity to flints from Sikornik Hill. This is, however, only conjecture and an indication of a promising direction for future raw material studies.

Artefacts made of Cretaceous flint of type K have been found at a number of sites rescue-excavated prior to the construction of the A4 motorway in the south-western part of the Sandomierz Basin. Their range towards the east reaches the vicinity of Bochnia (*e.g.,* Proszówki, Bochnia commune, site 10). A significant percentage of these sites are connected with the settlement of the older or younger phase of the Mierzanowice culture. Less evident there are forms connected with the Final Eneolithic settlement, and this is due to a small number of finds reliably identified with the CWC.

4. K-TYPE FLINT IN FINAL ENEOLITHIC BURIAL ASSEMBLAGES IN THE LOESS UPLANDS OF WESTERN LESSER POLAND

CWC graves from the Lesser Poland Uplands often contain axes, and they occur in burials of men, women, and children alike (Włodarczak 2006, 71). Axes made from Lower Turonian flints from the eastern edge of the Świętokrzyskie Mountains, above all Świeciechów flint, predominate (Balcer 1983, 227; Budziszewski and Włodarczak 2011, 60, fig. 7). What is striking in grave inventories from western Lesser Poland is the absence of core tools made from typical varieties of Jurassic Kraków flint, and only incidental presence of chocolate flint, whereas axes from flints described as types G and K are present (according to Kaczanowska and Kozłowski 1976). Visually, these are often similar artefacts made of beige, banded rock and, as a result, type K raw material has sometimes been erroneously identified as 'Jurassic flint of type G' in the past. Five axes made of K-type flint are known from CWC grave inventories in western Lesser Poland (Table 1), and all these finds come from sites located in the Kraków zone (up to the Szreniawa valley in the north). Their typological diversity is noteworthy: each specimen represents a different type (division according to Budziszewski and Włodarczak 2011, 58, fig. 4). They include two axes that are the leading forms for the Lesser Poland inventories of the younger phase of the CWC (*i.e.,* for the Kraków-Sandomierz group): a flat axe (Teresin – Fig. 7: 1) and a thick axe (Kocmyrzów, grave 3 – Fig. 7: 2). These finds emphasise the importance of K-type flint in the production of core tools in the western Lesser Poland zone. The fact objects made from this flint were placed to graves demonstrates its significant ceremonial rank. Indeed, when we look at the funerary ritual of the CWC from the perspective of flint inventories, a clear

Table 1. Axes made of K-type flint found in CWC graves in Lesser Poland

Locality, commune, site number	Grave number	Type (after Budziszewski, Włodarczak 2011)	Literature
Kocmyrzów, Comm. Kocmyrzów-Luborzyca, site 17	3	GS	Unpublished (research by K. Tunia)
Kraków-Pleszów, site 17	1058	BM	Górski and Włodarczak 2000
Książnice Wielkie, Comm. Koszyce, site 1	5/II	DM	Machnik 1964
Polanowice, Comm. Słomniki, site 4	4	MD	Prokopowicz 1966
Teresin, Comm. Proszowice	-	PS	Machnik 1962

raw material selection becomes evident. In the graves of the Kraków-Sandomierz group, one can notice the custom of placing axes made of opaque, dull, 'chert-like' raw materials, grey or beige in colour, next to the deceased. In addition to the most important tools made from Lower Turonian flint (mainly from Świeciechów raw material), there are also products made from flint types G and K, as well as from banded flint. On the other hand, axes made from chocolate or Volhynian flint are only incidentally found in funerary contexts, although the use of the former is confirmed by finds from mining sites (Schild *et al.* 1977).

The known graves with axes made from K-type flint have all been found in close proximity to the deposits of this raw material known from the Dłubnia, Prądnik and Kluczwoda valleys (including Ujazd near Wielka Wieś). Also noteworthy is the presence of workshop materials associated with the production of tetrahedral core tools at "Kopcowa Góra", *i.e.*, site 12 in Ojców (Trela 1998). These finds have been linked to the Baden culture on the basis of an assessment of typological features (Trela 1998, 35), and also due to the presence of pottery from this period at the site (Rook 1980, 68, Pl. 17). However, the Final Eneolithic lithic industry includes a tradition which refers to the previous period (Late Eneolithic) manifested, among others, by the production of axes characteristic of the Globular Amphora culture and the Baden culture (Budziszewski and Włodarczak 2011, 59, 60). These recent discoveries clearly indicate a spike in interest in K-type flint at the end of the Eneolithic and the beginning of the Bronze Age. Hence, it seems quite likely that at least some of the traces of core tool manufacture from "Kopcowa Góra" are actually related to the communities of the Corded Ware culture. Numerous stray finds of axes from Smardzowice, Skała commune, close to Ojców, also reveal features characteristic of this period (materials from the Archaeological Museum in Kraków, kindly indicated by Ms Barbara Drobniewicz). All these materials point to the existence of a production centre for core tools in the vicinity of Ojców, using raw materials from the valleys of the Dłubnia, Prądnik and Kluczwoda Rivers.

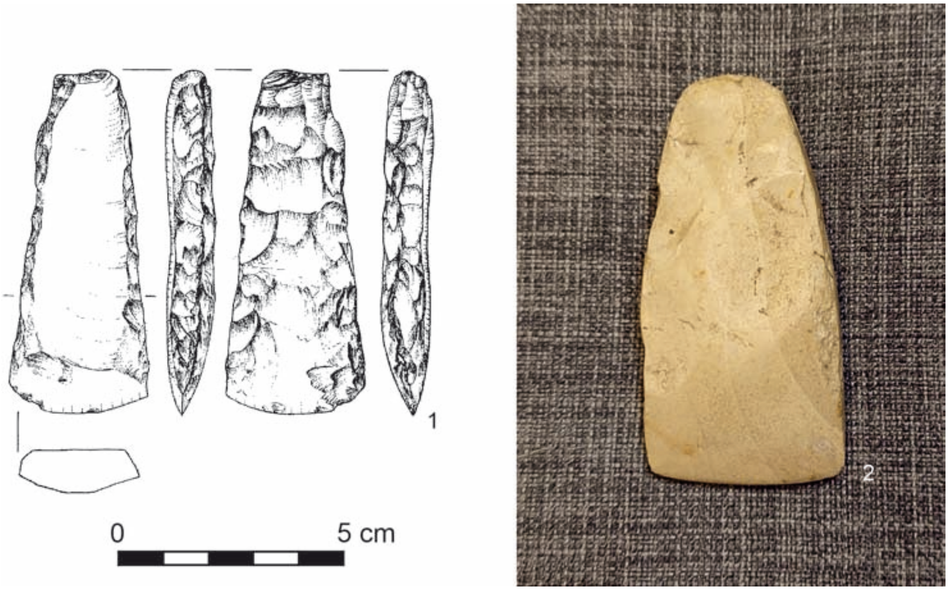

Fig. 7. Axes made of K-type flint from the Final Eneolithic graves.
1 – Teresin, Proszowice district (illustrated by E. Osipowa); 2 – Kocmyrzów, grave 3 (photo by E. Włodarczak)

So far, no grave with a K-type axe has been discovered north of the Szreniawa valley. However, research carried out in recent years on cemeteries in the Miechów Upland and the northern part of the Proszowice Plateau has uncovered relatively numerous graves with axes made from Jurassic flint of type G, which were found in Bronocice, Giebułtów and Smroków, among other places (materials from unpublished research by various authors). This, in turn, indicates that the significance of G-type flint in the manufacture of Final Eneolithic core tools in the northern part of the western Lesser Poland loess upland was greater than previously assumed. The better investigation of individual micro-regions reveals greater diversity in raw materials used for the production of the leading tools of the western Lesser Poland CWC. This revision does not negate the importance of interregional import of selected raw materials, a phenomenon characteristic of the economy of Final Eneolithic communities of the 3rd millennium BC.

5. CONCLUSIONS

The use of K-type flint was in the past often associated with the flint-industry of the Baden culture, not least on the basis of interpretations of the materials from Kopcowa Góra in Ojców (*e.g.,* Trela 1998; Nowak 2015). However, discoveries in the last 20 years have clearly demonstrated a surge of interest in this raw material in the Final Eneolithic and Early Bronze Age periods. Unlike the flints from the margins of the Świętokrzyskie Mountains, the K-type raw material played a significant role only in the Kraków region, both in the loess uplands of western Lesser Poland and in the south-western part of the Sandomierz Basin (in the Vistula Plain and the Wieliczka-Gdów Plateau). It was used almost exclusively for the production of axes, mainly tetrahedral specimens in the case of the CWC.

At present, two centres of production of Final Eneolithic core tools from K-type flint are known: (1) in the vicinity of Ojców and (2) in the zone between Kraków-Bieżanow and Zakrzów on the right bank of the Vistula River. The word 'centres' in this case should be understood as accumulations of traces of flint production, as opposed to centres appearing in the Early Bronze Age specialising in large-scale production of specific artefacts. That the same raw material deposits could have been exploited in both zones is questionable. At the present stage of research it is impossible to determine the exact place of origin of Jurassic and Cretaceous Kraków flints discovered at archaeological sites (Matyszkiewicz and Kochman 2020). An interesting point to note is the possibility that the Final Eneolithic and Early Bronze Age workshops from the right bank of the Vistula River used raw material from the Sowiniec Range (now within the boundaries of Kraków).

The discoveries associated with the use of K-type flint in western Lesser Poland contribute to a series of new studies aiming to refine the picture of the CWC flintknapping. New possibilities in this respect are the result of the acquisition of a considerable body of evidence from the numerous large-scale rescue excavations carried out in recent years, mainly those preceding motorway construction. Thanks to these sources, it has become possible to demonstrate the micro-regional specificity of some areas of Lesser Poland, discernible, among other things, in raw material diversity. This diversity concerns first of all the preference for the production of core tools, one of the important categories of flint products (sometimes regarded as "insignia"). In the southern part of western Lesser Poland, on the border with the Carpathian forelands, the local character is defined by the use of selected types of Kraków flint (above all: K-type flint) for the production of tetrahedral axes.

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OBVIOUS NON-OBVIOUSNESS. BIFACIAL SICKLES OF BANDED FLINT

ABSTRACT

Migal W. 2022. Obvious non-obviousness. Bifacial sickles of banded flint. *Sprawozdania Archeologiczne* 74/1, 237-246.

The article presents results of refittings of two half-products of bifacial sickles made from banded flint. These items are typical for the Mierzanowice culture but usually had been made from different kind of raw material. Banded flint was extracted in the Borownia mine and used mainly for the production of bifacial axes. Nine kilometers away from site is Ożarów where production was focused on sickles made from Turonian flint. Banded flint is very difficult to work with and is unlikely to be suitable for the production of thin bifaces. To deal with that and make more elaborate product such as sickles, the flintknappers in Borownia used only a certain part of raw material just underneath the cortex layer. Although the presented sickles seem to by something extraordinary when it comes to selection of raw material they don't contradict the relation between the physical properties of flints and the types of tools known from Mierzanowice culture.

Keywords: Early Bronze Age, Mierzanowice culture, flint technology, bifacial sickles, banded flint, refitting flint

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INTRODUCTION

In 2022, over twenty years have passed since Jerzy Libera published a work summarizing the knowledge related to the production of bifacial forms in Poland and Western Ukraine (Libera 2001). Although some interesting works related to the topic have been published since then (*e.g.*, Czebreszuk and Kozłowska-Skoczka 2008; Frieman and Ericsen ed. 2015), most of the conclusions from Jerzy Libera's work still hold. When assessing the current situation, it can be stated that there is a return to an interest in the issues of Early Bronze Age bifacial production studies. An example is both the monograph devoted to the mines and workshops of bifacial sickles in Ożarów (Brzeziński 2020) and the publication of site in Czerniczyn (Hyrchała 2017).

In recent years, the mines in Borownia have been subjected to several reconnaissance investigations (*cf.* Mieszkowski *et al.* 2014; Lech 2020; *cf.* Budziszewski 1980). An extremely important project was to clarify the chronology of banded flint mining in the area of the site. The goals, history and assumptions of these studies have recently been exhaustively presented by Jacek Lech (2020). These works, subordinated to the tasks related to entering the mines in Borownia into the UNESCO World Heritage List, had various goals.

Fig. 1. Borownia. The flint workshop in Trench I.
This is the location of the production of axe blades. In the lower part of the picture, the filling of the mining shaft with limestone rubble is visible. In the upper part of the picture is a cross section of the mining heap with a layer of flint waste. Among the waste here, the two refitted sickles were found. Photo by E. Marek

First of all, it was about specifying the chronology of flint exploitation and the cultural attribution of the workshop remains. The result of the research was the determination of the exploitation period as having taken place between 2300 and 1600/1500 BCE), *i.e.,* for the duration of the Mierzanowice culture (Lech 2020, 226-228). At present, it seems that the entire area of the exploitation field was related to the activity of the Mierzanowice population. However an episode related to the Funnel Beaker Culture, the traces of which were found in the fields surrounding the mines (Lech 2020, 231; Zalewski and Borkowski 1996), should not be ruled out.

The opportunity to write the following text was the rescue excavations carried out in the summer of 2020 by the company “Arkadia”, and related to the renovation of the local road 0678T in Ruda Kościelna, Ćmielów commune, turning it into an asphalt-surfaced road. This passed almost crosswise through the complex of mines called in the archaeological literature “Borownia mine” (AZP 84-70/18). Without going into the discussions related to the purposefulness and circumstances of archaeological research, suffice to say that at present the flint collection obtained by researchers are being studied by the writer of these words.

According to the research program, the trench was 60 meters long and 5 meters wide marked out linearly along the district road (Marek and Wasowski 2020). It cut across the entire mining field. The remains of at least six mines and adjacent flint workshops were exposed. Two mining features related to the extraction of banded flint were partially examined. In addition, the remains of two more mining shafts and at least three flint workshops were uncovered and explored (Fig. 1). In one of the flint workshops located under the limestone heaps (section W14 workshop 1, Marek and Wąsowski 2020), the two items that are the subject of this analysis were found. In total, about 6,200 artefacts were acquired, including 407 half-products of axes. These materials are currently being analyzed.

ARTEFACTS

The results from previous research have shown that in the Małopolska Upland there was a clear connection between the type of tools found in burials of the Mierzanowice culture and the raw material from which they were made (Bąbel 2013a, 122, 123). Sickles were most often made of Ożarów flint, axe blades of banded flint, and heart-shaped arrow points of chocolate flint. In some graves (Bąbel 2013b), single tools made of chocolate (sickle) and Świeciechów (axe) flint were found. Nevertheless, the correlation between raw material and tool types is conspicuous. Each of these varieties of raw material seems predisposed to produce a particular type of tool:

– Flint from Ożarów appeared in large nodules, from which massive flakes could be easily detached and then process into bifacial sickles. This flint was homogeneous and cleavable, which facilitated the processing of a skilled craftsman (Brzeziński 2020).

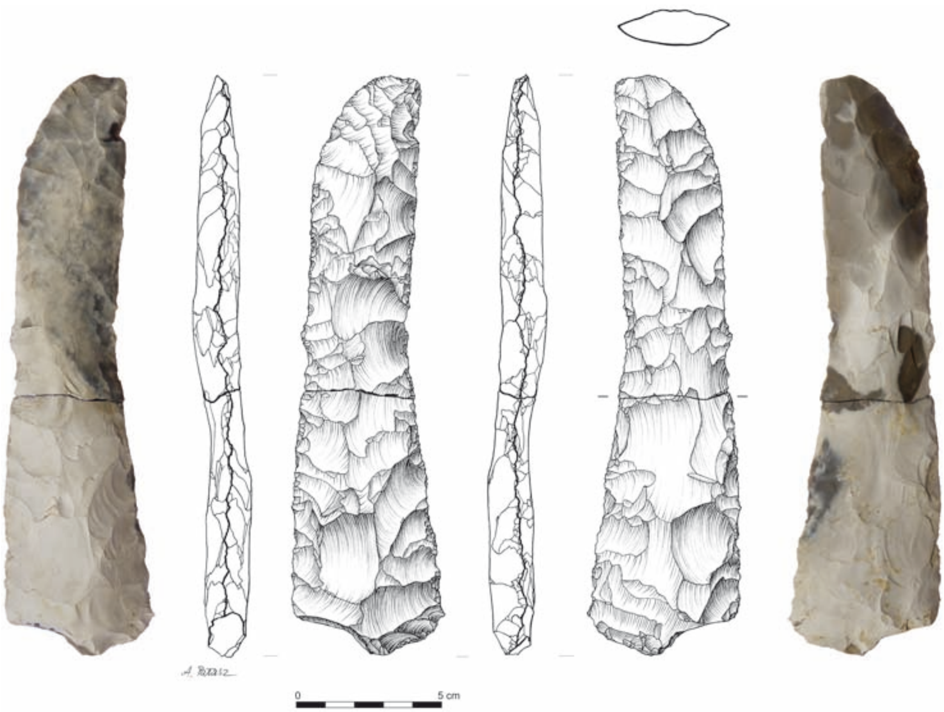

Fig. 2. Borownia. Refitting of almost finished sickle of banded flint.
The form was broken during the final thinning of the item as the result of a mistake.
Illustrated by A. Pałasz

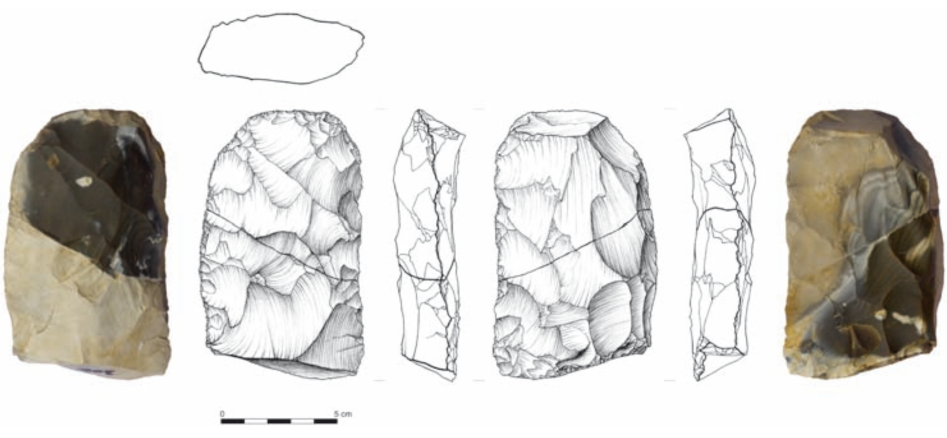

Fig. 3. Borownia. Refitting of a broken sickle preform of banded flint.
On one of the faces, the inner part of the flint with no bands was removed. Illustrated by A. Pałasz

– Chocolate flint, present in smaller chunks or larger, but cracked concretions, due to its excellent cleavage and fine crystals, was perfect for making tools with sharp edges, such as blade knives or arrowheads.

– Banded flint, very difficult to split, seemed to be ideal for making axes resistant to cracks during use (Budziszewski 1991; Bąbel 2013a; 2013b).

The presented short text is devoted to considerations on two refittings of bifacial sickles.

The old collection from Borownia that was obtained from the surface during the interwar period consists of advanced half-products of various bifacial axes. These forms date to the Early Bronze Age and are associated with the Mierzanowice culture (Budziszewski and Michniak 1983). There are also known bifacial (or semi-triangular in cross-section) mining tools called pickaxes (Krakowska 1996). So far, no mention has been made of the remains of the making of bifacial sickles from banded flint. Meanwhile, in both cases described below, we are without doubt dealing with half-products of just such tools. Both of them were found in the workshop within the layer of waste products where most of other preforms are bifacial axes known to us from the graves of the Mierzanowice culture. The first type were massive, quite thick specimens with a cushion-like cross-section and an ellipse-like shape (see Bąbel 2013b, fig. 56). The second type were flat smaller axes that divide into ellipsoidal and sub-triangular ones (Bąbel 2013b, fig. 122, 245).

The first of the items presented here is a bifacial sickle consisting of two parts. Its dimensions: length 198.7 mm, width at the base 50.8 mm, and at the top 34.1 mm (Fig. 2). This gives a thickness to width ratio of 1: 3.5 in the lower part and 1: 2 in the upper part. This specimen is half transversely cracked, shows advanced treatment and is almost completely finished. It is covered with careful, surface retouching and has no natural and cortical areas. The shape of the half-product resembles a similar one, known from the cemeteries in Mierzanowice and Wojciechowice (Serwatka 2020). The analysed form was damaged during the process of final thinning of the surface with larger flakes. This is well shown in the illustration. The flintknapper started to work from the base with three flakes, now visible in the form of negatives. During the next stage, the specimen broke and was abandoned in this condition on the site. Observing the profile of the half-product, we can easily see its "helical" shape, which has not been improved. This specimen can definitely be classified as a product of the Mierzanowice culture (Libera 2001, 57; Bąbel 2013b).

The second refitting is a damaged semi-finished sickle from an earlier processing stage. It was possible to find only two elements forming the apex fragment (Fig. 3). This specimen can be distinguished from the half-products of axes from the same workshop, despite the rather preliminary stage of processing. This is mainly evidenced by the asymmetry of the specimen, typical for the Mierzanowice sickles, already visible in the early stages of shaping (Grużdź 2020). Although many of the early bronze axes have an asymmetrical shape, their edges are never concave, as is the case with sickle half-products known to us, for example, from the workshops in Ożarów (*cf.* Bąbel 2013b; Grużdź 2020). Judging by the nature of the fracture surfaces, the specimen was damaged by a phenomenon known as “end shock”. It’s a wrong hit, too close to one of the endings. As a result, it causes a strong vibration that sometimes separates the specimen into several parts - as we can see in the above case (Flintknapping Vocabulary 2022). The specimen has a length of 108.1 mm and a width of 61.4 to 72.6 mm. With a thickness of 22.7 mm, this gives a thickness to width ratio of about 1:3.

RAW MATERIAL AND PROCESSING TECHNIQUE

Both analyzed sickles were made of flint extracted from the mines in Borownia. The nature of this raw material differs significantly from that known to us from Krzemionki or from the modern quarries in Śródborze. The features of banded flints from various exposures and exploitation sites have been quite well described in the literature by Michniak and Budziszewski (1986). It is worth mentioning at this point that the authors, rightly observed the specific nature of the raw material from Borownia. The features that are visible at first glance are:

– a light beige subcortical part up to 15 millimeters thick much thicker than in the case of other banded flints, (Fig. 4), which is easy to work with,

– bands in the form of thick, twisted, non-parallel streaks (Fig. 4), more resistant and hard to work with during reduction

– core made of non-banded homogeneous material, as it turns out, occupying even 70% of the volume (Fig. 4), which is very hard to knap.

These features correspond to the physical properties that determine the susceptibility to processing with flint techniques (Migal 2020). The non-banded core of the nodule is extremely difficult to process and its deliberate reduction is visible in the materials from the workshop. This was done in such a way that in the half-products of large axes, the mass from the non-banded flint was residual, preferably located in the near-cutting edge part (Michniak and Budziszewski 1986). This provided the additional advantage of greater fracture resistance of the finished product (an axe blade or a mining pickaxe). This effect was also noticed earlier by Michniak and Budziszewski. Although the most common part of flint to work with was banded part. It was achieved by knapping large flakes that were later shaped into small axes.

From the above description of production in flint workshops, an internally contradictory picture emerges. The raw material from Borownia appears to be extremely difficult to process (and it is indeed so) due to the high content of a non-banded, homogeneous, pale concretion core. At the same time, to make bifacial, slender sickles with a rather thin cross-section and good proportions, a flint with different properties was needed. It had to be homogeneous and easily cleavable (brittle). Thus, the dark, banded layer was too hard to produce thinner and slender bifacial products.

Fig. 4. Borownia. Two varieties of flint from the mine.
The first variant (on the bottom of picture) was flint with no banded core and with a thick grey layer below the cortex – the first sickle preform was produced from this kind of raw material. The second variant (upper part of the picture) has a lot of grey bands that are difficult to knap – the second sickle was produced from this kind of material. Illustrated by A. Pałasz

When we look at both half-products, we can easily see that the first sickle is made entirely of a subcortical, light-beige layer surrounding the concretion. On the other hand, the second – from the subcortex and dark banded parts, intensively reduced on one of the surfaces so that only the part from the more cleavable subcortex was subjected to further processing. The reduction of bifacial tools from less cleavable raw material is quite obvious. Working in this way, the craftsman wanted to deal with the raw material that could be processed as best as possible. There was no such need in the workshops in Ożarów, known to us, where bifacial sickles were made – there was a homogeneous flint of good quality (Grużdź 2020).

In the workshop from which the objects in question come, an interesting way of getting rid of fragments difficult for further processing was used in the production of axes. In the first phase of processing the cushion axe, large flakes reducing the non-banded mass were knapped from both ends of the specimen. At this stage, we usually cannot yet determine where the working edge was planned. Such a procedure was not used in the case of the sickles from Ożarów (Grużdź 2020). The second of the specimens (despite its initial processing stage) also shows that the reduction of the form was performed from both edges to both sides, as in the workshops in Ożarów. This fact seems to confirm that the second item is a sickle half-product. An interesting technological observation is that the first of the sickles does not have places well prepared with smaller flakes and grinding places for applying force (Migal 2020). Perhaps this is why it was difficult for flintknappers of the Mierzanowice culture to achieve ready-made products with a high ratio of thickness to width. This appears later, for example, in the case of Czerniczyn-Torczyn daggers (Libera 2001), where this ratio reaches 1:8.

CONCLUSIONS AND DISCUSSION

The presence of sickle half-products in the workshops discovered in Borownia is a big surprise. The general picture of the flint-making of the Mierzanowice culture shows the preferences of raw material related to the production of individual flint tools. Axes were usually made of banded flint, arrowheads and flake knives were made of chocolate flint, and sickles were made of Ożarów flint (Budziszewski 1991).

Half-products of 407 axes come from the examined bifacial axe workshop. The two refittings of sickles are therefore an interesting example of mining and processing habits. They show that:

1. Both the exploitation of banded flint in Borownia and Ożarów were carried out by the same group of specialized miners – flintknappers,

2. They were very well versed in the physical properties of the raw materials, choosing the appropriate varieties and even parts of one nodule for different processing purposes; easily cleavable subcortex for sickles and less cleavable for axes,

3. They used a flexible strategy when it comes to choosing the target form. That is, they were ready to change manufacturing decisions according to the properties of the raw material.

4. The sickles left the workshops in ready form. This is evidenced by the damage to one of the products in the last phase of thinning.

5. Edges and striking platforms were not as well prepared as in later bifacial products, for example, Czerniczyn-Torczyn type daggers. Therefore, the sickles were more thick in cross-section.

I hope that the further studies of the material from Borownia will bring further interesting results related to the processing of flint in the Early Bronze Age in Poland. The presence of banded flint sickles together with half-products of bifacial axes contradicts the notion of so-called "assortment specialization". It is a hypothesis that assumes a very narrow specialization of the flintknappers groups limited to the type of product and the raw material from which it was made (Bąbel 2013a, 122-123 and 227).

The discovery of two bifacial sickles in the axe workshops of Borownia does not change the image of Early Bronze Age flint-making in Małopolska. It is only an interesting aspect of production process. It also shows the way the raw material was perceived by flint workers of the Mierzanowice culture. It proves that both the tool types – sickles and axes were made by the same craftsmen. The relationships between the raw materials and the types of tools visible in the funerary complexes depended on the physical properties of individual types of flints. Therefore, there was probably no monopoly on access to the flint outcrops within that time period.

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MODERN FLINT MINING LANDSCAPES AND FLINT KNAPPING EVIDENCE FROM THE KRAKÓW GUNFLINT PRODUCTION CENTRE – WHAT WE KNOW FROM LIDAR AND FIELD SURVEY

ABSTRACT

Szubski M., Niebylski J., Grużdź W., Jakubczak M. and Budziszewski J. 2022. Modern flint mining landscapes and flint knapping evidence from the Kraków Gunflint Production Centre – What we know from LiDAR and field survey. *Sprawozdania Archeologiczne* 74/1, 247-268.

We know that on the Polish territories that belonged to Austrian and Russian Empires, from the second part of the 18th till the 19th centuries, gunflint workshops were operating. One of the workshop centres were situated in the Kraków region (southern Poland) and others were located in the regions of Ivano-Frankivsk (Ukraine, former Austrian monarchy) and Kremenets (Ukraine, former Russian monarchy). The number of workshops, the quantity of products and their export gave them significance on a European scale. We used several methods to preliminary investigate the area near Kraków using LiDAR and field verification. We analysis three modern flint mines in this region – Zelków, Karniowice and Mników which have preserved anthropogenic relief and well-preserved flint workshops on the surface. Flints obtained during field verification (studies included a sets of cores and technological blanks) were analyzed. Our efforts allowed us to attempt to recreate the chaîne opératoire for Polish gunflint workshops as well to determine differences between particular sites.

Keywords: conflict archaeology, flint mining, gunflints, Lesser Poland, modern period
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INTRODUCTION

When the archaeological scientific community was crystallising in Kraków in the mid-19th century (Chochorowski 2015; Woźny and Dzięgielewski 2017 (2018); Woźny 2018), gunflint workshops near the city were still functioning. In the archives of the Archaeological Museum in Kraków, there is a note about them from 1871 by Józef Łepkowski, and the Museum's collection includes a collection of flint products from Zelków, Kraków district (Łepkowski 1871). However, for many decades, they did not attract any more interest from archaeologists. It was only in 1964 that Bolesław Ginter and Stanisław Kowalski published their short study on the production of gunflints and their importance for the cognition of prehistoric flint-knapping (Ginter and Kowalski 1964). That publication did not bring about the revival of interest in the subject and the information on modern flint mines in Zelków remained an open secret exclusively for the Kraków community of Stone Age researchers for the following decades. A similar fate befell the modern flint mine in Mników, Kraków district, which was discovered by Krzysztof Sobczyk during the excavations conducted in Brzoskwinia, yet was not published either. Information on the modern mining of Jurassic flints from the vicinity of Kraków was ignored even in monographic studies devoted to it (Kaczanowska and Kozłowski 1976). The precise location of the site from Zelków was published only thanks to the surface research of Jacek Lech's team conducted in the Prądnik basin and in the neighbouring areas in the years 1976-1980 (Lech *et al.* 1984, 235, 236). However, fieldwalking conducted in the framework of the research project known as the Polish Archaeological Record (Polish name: Archeologiczne Zdjęcie Polski – AZP) conducted a decade later by Jacek Górski and Mirosław Zając, which was archived on the Archaeological Site Record Sheet (Polish abbreviation: KEZA) and accompanying documentation as Site 1 in Żelków (region number: 100-55, site 94), signalled again problems with the precise determination of the boundaries of the site and the need for carrying out comprehensive research there. Concurrently, publications appearing in foreign literature emphasised the importance of gunflint production from the vicinity of Kraków (Slotta 1981, 351, 352; Cheben and Struhár 1999).

In the Kraków community, only Anna Dagnan-Ginter (Dagnan-Ginter *et al.* 1992) and Bolesław Ginter (2009; 2015) consistently published further materials related to modern flint production. In more recent times, Jerzy Libera from the Maria Curie-Skłodowska University in Lublin has also become interested in gunflints (*e.g.*, 2014; 2015; Mączyński and Libera 2015), which resulted, among other things, in Marek Lalak's master's thesis (2006). In the international environment, the organization of an informal research group devoted to gunflint production by Torben Bjarke Ballin (2013) brought a significant revival of work on this issue. During their visit to Poland in April 2013, Austrian researchers, Gerhard Trnka and Michael Brandl, drew attention to the need for intensifying the research carried out on the gunflint production centre near Kraków (Fig. 1).

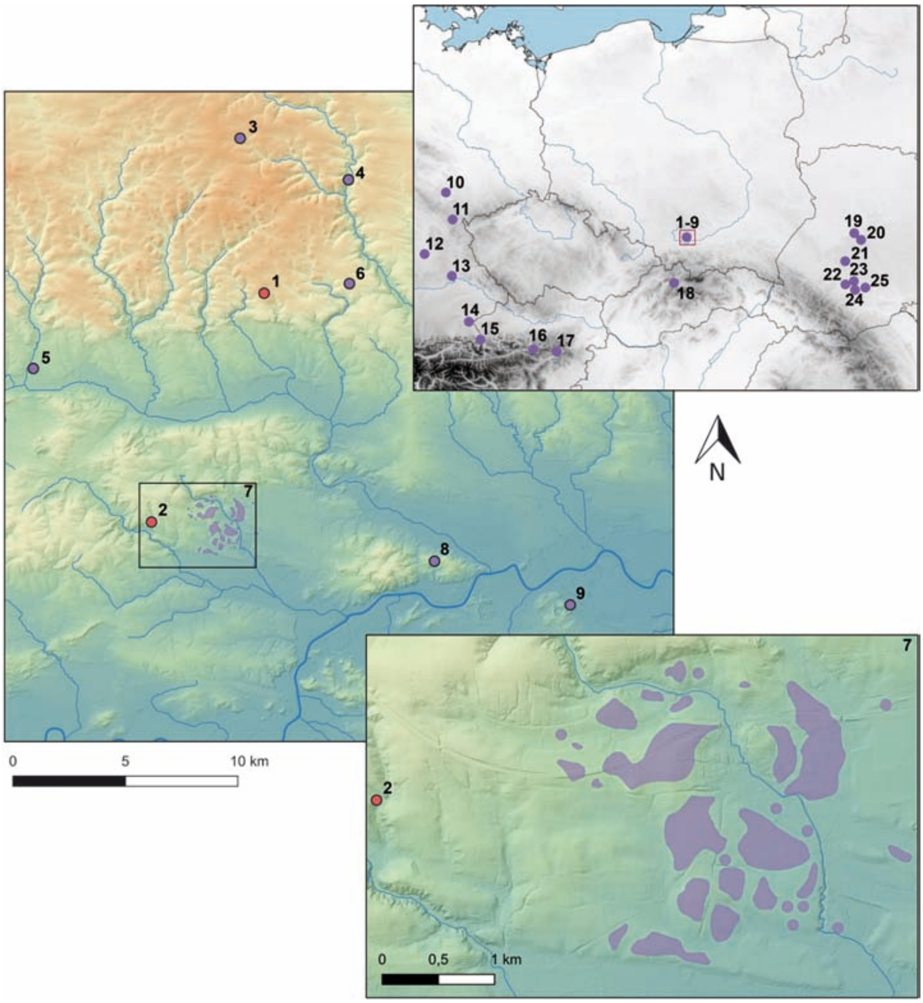

Fig. 1. Upper – location of gunflint production sites in Central Europe; middle – location of gunflint production sites in the area of the Kraków Gunflint Production Centre; lower – the area of sites related to gunflint production, discovered during the AZP research project in the region of Morawica. Key: 1 – Karniowice and Zelków flint mines and the Bolechowice, Karniowice and Zelków workshops (Poland), 2 – Mników flint mine (Poland), 3 – Sąspów workshop (Poland), 4 – Ojców workshop (Poland), 5 – Dębnik and Paczółtowice (Krzeszowice) workshops and flint mine (Poland), 6 – Duża Cave in Mączne Skały (Wielka Wieś) workshop (Poland), 7 – Aleksandrowice, Chrosna and Mników workshops and the Morawica workshop and flint mine (Poland), 8 – Kraków-Zwierzyniec workshop (Poland), 9 – Kraków-Podgórze flint mine (Poland), 10 – Wiederau (Rochlitz) agate mine (Germany), 11 – Schneeberg workshop (Germany), 12 – Nuremberg workshop (Germany), 13 – Burglengenfeld workshop and flint mine (Germany), 14 – Halsbach agate mine (Germany), 15 – Glasenbach workshop (Austria), 16 – Seewiesen flint mine (Austria), 17 – Gams bei Hieflau flint mine (Austria), 18 – Bešeňová workshop (Slovakia), 19 – Sapaniv workshop and flint mine (Ukraine), 20 – Kremenets workshop (Ukraine), 21 – Berezhany workshop (Ukraine), 22 – Nyzhniv workshop and flint mine (Ukraine), 23 – Mariyampil flint mine (Ukraine), 24 – Nezvysko workshop (Ukraine), 25 – Dolyna flint mine (Ukraine). Map projected by J. Niebylski, drawn by M. Jakubczak

The Warsaw community had already been working for two years on the use of airborne laser scanning for the identification of sites related to the exploitation of flint (Budziszewski *et al.* 2019). Thus, when the ISOK (IT system for protection against extraordinary hazards) scans of the neighbourhood of Kraków were made available, the area of interest also included the remains of the modern flint mining from that region. The analyses of the digital terrain model were supplemented with fieldwork surveys in the forest between Zelków and Karniowice in March and December 2014, and the outcomes of those works were presented at the international symposia in Barcelona in 2015 (Budziszewski *et al.* 2015) and Spiennes in 2016 (Budziszewski *et al.* 2019). At the same time, work on gunflint in the region near Kraków was started by Jakub Niebylski, who in 2013-2014 was preparing a pro-seminar and then a master's thesis at the Institute of Archaeology of the Jagiellonian University in Kraków (Niebylski 2017b). Therefore, it was decided to join efforts by conducting another series of field surveys in the Karniowice forest and Mników in the spring of 2017. The results of those works were summarized by organizing a session "Gunflints: production, distribution and use" with researchers from Austria and Belgium, as part of the 23rd Annual Meeting of the European Association of Archaeologists, held in Maastricht in 2017 (*e.g.*, Jakubczak *et al.* 2017; Niebylski 2017a), whereas their Polish abstract was presented a few weeks later at the conference "Jurassic Flint in prehistory" in Kraków. Independent research on materials from Zelków from the collection of the Archaeological Museum in Kraków was carried out in 2016 by the team of Dagmara Werra (Werra *et al.* 2019). In 2018-2021, the work was continued by Jakub Niebylski as a research task "Galician gunflint production centres", carried out as part of the scientific plan of the Institute of Archaeology and Ethnology, Polish Academy of Sciences.

GUNFLINTS AND THE HISTORICAL BACKGROUND OF THEIR USAGE

A gunflint is a fragment of flint, or another rock or mineral of appropriate hardness, processed suitably by splitting or grinding. It allows a spark to be struck after hitting or rubbing it against a steel frizzen, which is an element of a firearm lock, and thus ignites the material on its pan (Niebylski 2018a, 61). It was mounted in the flintlock of hand firearms, in order to strike sparks igniting the charge of fine black powder placed on the pan, transferring the flame through the touch hole to the barrel, enabling the combustion of the main propellant charge (coarse black powder) in the barrel, the increased pressure of the combustion products of which expelled a projectile (Fig. 2: C; Niebylski 2018a, 61). They were made of lead, and in the absence of regulatory wraps, fragments of leather, a flattened lead bullet, paper from a cartridge and birch wood were also used as packing (Badzińska 2016, 18; Krajewski 2017, 339; Niebylski 2018a, 61).

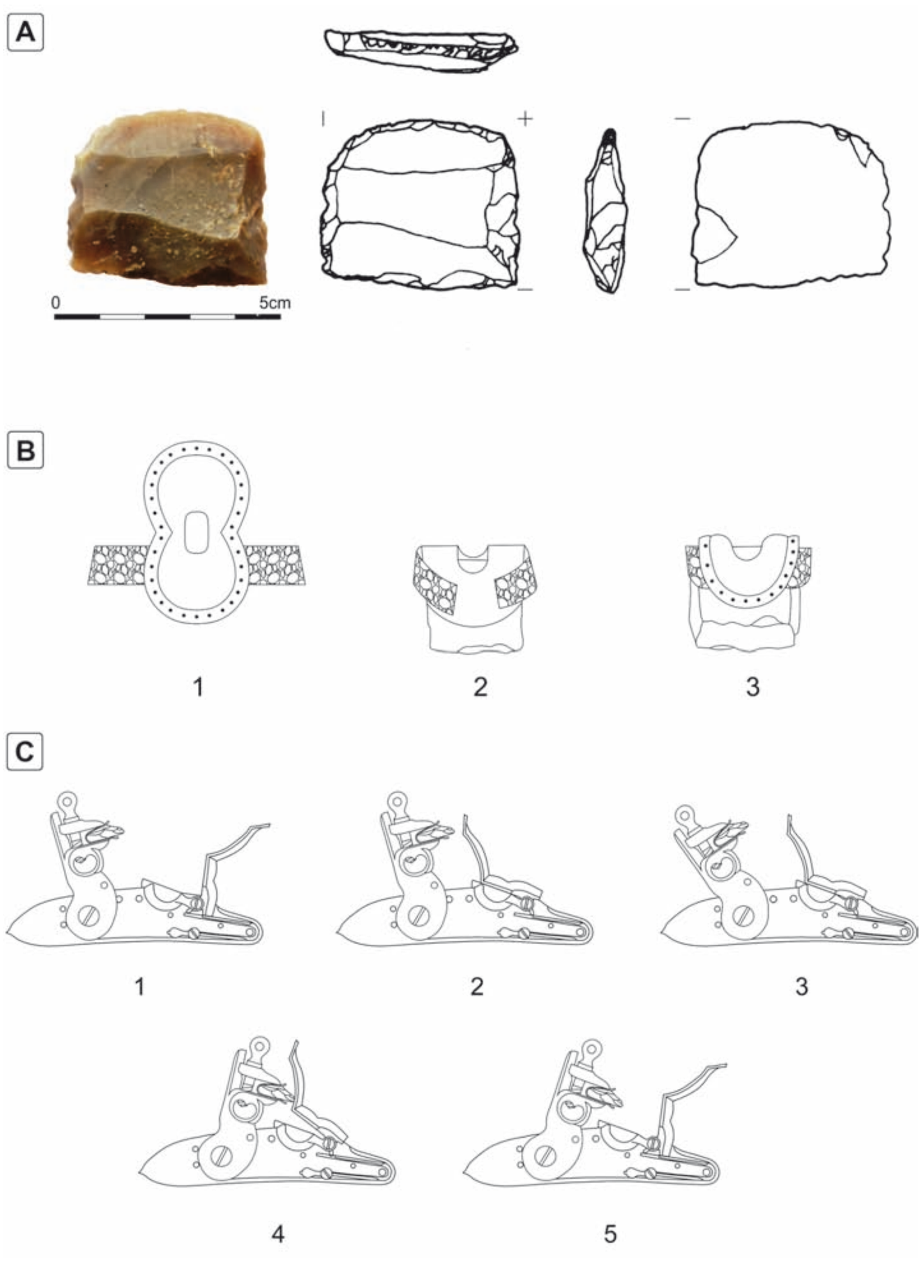

Fig 2. A – Gunflint found during excavation at Rabin Beer Meisels street in Kraków. Photo and drawn by J. Niebylski. B – a lead gunflint wrap and how to properly assemble it. 1. The unfolded wrap, 2. the lower surface of the gunflint with the mounted wrap, 3. the upper surface of the gunflint with the mounted wrap. After Maciejewski 1980, 138. C – The principle of operation (1-5) of the flintlock. Designed by J. Niebylski, drawn by K. Rosińska-Balik

Gunflints were initially made on flakes, and in the course of time, they began to be made on broken blades. The production of gunflints with the use of a newer technique was carried out by the splitting method – in the British and French tradition, and by grinding – in the German tradition (Skertchly 1879, 41-64; Witthoft 1970, 33, 34, 36, 37, 43, 46; Brandl 2013, 139-143; von Kaiser 2013). In Galicia, for the needs of the Austrian Empire's army, gunflints were made in accordance with the French tradition, and in horizontal projection, they were similar to the shape of a horseshoe (Niebylski 2018a, 69). They were different in size in order to optimally match the size of the lock of the weapon – the width of both the pan and frizzen, as well as the distance between their axes and the barrel. Russian gunflints have a cross-section more similar to a trapezoid (Brandl and Niebylski 2019).

The flintlock was used until the end of the first half of the 19th century, when it was replaced with a percussion lock as a result of rearming the armies with a new weapon (Maciejewski 1980, 13; Niebylski 2018a, 57, 71). Gunflints were stored as military reserves for a while, and then that stock was disposed of. The evidence of such activities are the deposits of discarded gunflints discovered at the Neugebäude Castle in Vienna, the Zamość Fortress, the Modlin Fortress, and the Olomouc Fortress (Penz and Trnka 2004; Libera 2014; 2015, 218, 219; Brandl and Niebylski 2019). After rearming the armies of Western and Central European countries, the weapon using the gunflint lock was still used for civilian purposes, mainly hunting and recreation, as well as being exported to other countries, whose armies were armed with inferior firearms (Barandiarán 1974, 196-197; Slotta 1981, 359; de Latour 2009, 76).

After firearms using a flint lock for ignition had become popular in the 17th century, gunflints were produced individually by their users and were not standardized. A metal hammer was utilised to form them (Brandl 2013, 139). In France, such production was certified in 1643 in the Meusnes area (Loir-et-Cher dep.), while in England in 1686, in the Brandon region (Suffolk County), yet it was not carried out continuously (Skertchly 1879, 3; Witthoft 1970, 43; Weiner 2012, 969).

More or less at the onset of the 1740s, the method of producing gunflints formed from broken blades became popular in the Meusnes region (Witthoft 1970, 34, 36; Weiner 2012, 969). The military specimens had one striking edge and a horseshoe shape provided by retouching three tangent edges. At that time, the share of production intended for the civil market and export was significant (Brandl 2013, 139, 143). That method was adopted around the beginning of the 1790s in the Brandon area (Weiner 2012, 969). Those gunflints had one impact edge, and the remaining edges were formed into a rectangular shape at the stage of breaking the semi-finished product. Contrary to the situation in France, English gunflints were produced exclusively for the needs of their own army (Brandl 2013, 142, 143).

Before 1790, Austria ordered 10 million gunflints a year in France, the cost of which was 20,000 florins (Raymond and Roth 1809, 96, 157; von Keess 1824, 621). Due to the need for becoming independent from importing that strategic product, the Archduke of

Austria, Joseph II Habsburg, issued an appeal on September 10, 1787, in which he promised to transfer a prize of 100 ducats to a person who would find suitable flint outcrops in the country and set up a gunflint factory, as well as additional gratification of 200 ducats for maintaining production (Vollständige… 1789, 450; Hacquet 1792, 63). This was realised in 1787 in Nyzhniv (Ivano-Frankivsk Oblast) in today's Ukraine, where traces of mining have been preserved until now (Brandl *et al.* 2019, 38). In 1788, a total of 200,000 gunflints were produced, 40-50,000 of which were sold to the civil market (Hacquet 1792, 58).

Shortly after the establishment of the centre in Nyzhniv, more factories were opened in that area, as well as in the Kraków region. They form two clusters – the Kraków Gunflint Production Centre near Kraków (Kraków district) and the Ivano-Frankivks Gunflint Production Centre (Ivano-Frankivsk and Ternopil Oblasts), where gunflints for the needs of the Habsburg Monarchy were produced (Fig. 1; Niebylski 2017a, 323; 2018b, 48-49; Budziszewski *et al.* 2019, 40). The third source of gunflint production for the needs of Habsburg armies was the region of Verona (Veneto region) in Italy (Brandl 2013, 148-156).

The region of gunflint production near Ivano-Frankivsk includes, among others, such places related to the production of gunflints as: Berezhany, Dolyna, Mariyampil, Nezvysko and Nyzhniv (Niebylski 2018a, 70, 72). Close ties between these localities are noticeable. The production from Berezhany was moved in 1803 to the factory in Nyzhniv due to unfavourable climatic conditions (Hacquet 1806). Until 1817, the workshop in Nyzhniv had been supplied from the raw material extraction site in Mariyampil (von Thielen 1827, 177).

In the Kraków region, the following places are associated with producing gunflints: Aleksandrowice, Bolechowice, Chrosna, Dębnik, Karniowice, Kraków-Podgórze, Kraków-Zwierzyniec, Krzeszowice, the Duża Cave in Mączne Skały, Mników, Morawica, Ojców, Paczółtowice, Sąspów, Wielka Wieś and Zelków (Kolberg 1871, 40; Dryja 2005, 68; Ginter 2009, 346; 2015, 288; Niebylski 2018a, 67, 68). Only some of them are mentioned in written sources, while others are known thanks to archaeological data. Among the ones that were mentioned in the historical sources were some gunflint production in Kraków-Zwierzyniec – "between Kraków and Bielany" (Kołaczkowski 1888, 519; Schnür-Pepłowski 1896, 127), Kraków-Podgórze (Hacquet 1792, 40, 41, 61; 1796, 79, 80; 1806, 5, 6, 16; Raymond and Roth 1809, 157; von Keess 1824, 492), Krzeszowice (Bredetzky 1811, 416; von Hoyer 1831, 204, 205; Kolberg 1871, 40) and Morawica (von Oeynhausen 1822, 266-267; Umiński 1879, 7). It is Morawica, indeed, that appears to have been a large centre of gunflint production, well accessible archaeologically. The following villages around it: Aleksandrowice, Chrosna, Mników and also Morawica have produced numerous surface discoveries of gunflint production waste, which, however, should be referred to the centre in Morawica (Fig. 1; Niebylski 2018a, 67-68). In addition, the flint mine in Mników was probably the raw material base for that workshop. On the other hand, the following places: Bolechowice, Karniowice, the Duża Cave in Mączne Skały, Ojców, Sąspów and Wielka Wieś form a distinct cluster near Zelków, where gunflints were produced in home workshops. The villages of Dębnik and Paczółtowice, where home workshops could be found as well, are located quite close to Krzeszowice; therefore, they should probably be referred to the factory mentioned in the sources, the operation of which in 1811 has been confirmed (Bredetzky 1811, 416; von Hoyer 1831, 204-205; Kolberg 1871, 40).

Among these sites, the places of the extraction of the raw material are the mining fields visible in the terrain and located in Mników, Karniowice and Zelków (Jakubczak *et al.* 2017, 324; Niebylski 2018a, 67, 68; Budziszewski *et al.* 2019, 17). The sources also mention a flint mine located in the mountains in the Morawica region, where there were 2-3 slightly recessed shafts, from which the raw material was extracted for the needs of that workshop (von Oeynhausen 1822, 266, 267). Most likely, this information is related to the mining field in Mników.

In the case of some sites, the names of their managers are known. The workshop in Kraków-Zwierzyniec was established by the mining counsellor Wampe and the postmaster Reichendorfer from Wieliczka (Kołaczkowski 1888, 519). Moreover, in 1811, Wampe owned a workshop in Krzeszowice (Bredetzky 1811, 62). Another owner of the workshop in Kraków-Zwierzyniec is also known. It was Sperling, a German colonist and the owner of a nearby lime kiln, as well as the coal mine in Jaworzno, Jaworzno district (Bredetzky 1811, 62). It is highly likely that the gunflint production in other sites was accompanied by the lime industry that required significant amounts of excavated limestone material, which is a waste material in the process of extracting flint. In the light of reports, fire was used in the workshop in Krzeszowice, which perhaps should be interpreted as a working lime kiln. As stated in the note by Józef Łepkowski drawn up in 1871, the flints processed at that time in Zelków were collected by carters from Morawica (Łepkowski 1871). Perhaps those workshops were to certain extent related to each other.

The production of flint items other than gunflints is also certified in this gunflint production centre. What has been confirmed in some of them is manufacturing flints for fire strikers, a large number of which was found at the site in Aleksandrowice, as well as in the Duża Cave in Mączne Skały, Mników and Zelków (Ginter and Kowalski 1964, 84; Dagnan-Ginter *et al.* 1992, 15; Ginter 2015, 290, 292-295).

In the factory in Kraków-Zwierzyniec, the employees were four boys aged 8 to 16 (Bredetzky 1811, 241, 242). For comparison purposes, in the workshop in Berezhany, the number of the workers ranged from 50 to 80, while in Nyzhniv there were 33 employees (Schnür-Pepłowski 1896, 127; Brandl 2013, 255). Their number was related to a significant amount of gunflint production. Before 1827, two million gunflints were produced annually in Nyzhniv, while production in 1844 was 1.5 million (von Thielen 1827, 358; Brandl 2013, 256). From the Kraków Gunflint Production Centre, not only were surplus products exported to the neighbouring regions (Cheben and Struhár 1999), but also in the case of Morawica to China, Japan and America, whereas gunflints from Krzeszowice were exported to Turkey (Kolberg 1871, 40; Umiński 1879, 7). In Poland, a merchant Jan Franciszek Fiszer (1773-1815), whose shop was located in Kraków at Rynek Główny 44 also traded in gunflints (Wawel Louis 1977, 90).

The end of manufacture in the Kraków Gunflint Production Centre was a kind of slow phasing out. This was related to the lack of demand for gunflints for military purposes, after arming the army with weapon with a percussion lock, which no longer required a gunflint. Gunflint-makers, however, still produced them for the civil market for some time, while in the last period of the workshop's operation, the production of flints for fire strikers was probably significant. The workshop in Zelków was operating the longest, and production there ceased around 1880 (Ginter and Kowalski 1964, 84). The centre in Morawica was functioning before 1822, at least until 1879 (von Oeynhausen 1822, 266-267; Umiński 1879, 7). The workshop in Kraków-Podgórze was still in operation in 1871, when production in Dębnik and Paczółtowice had already been finished, and at that time its traces were waste heaps near gunflint-makers' households that had still not been removed (Kolberg 1871, 40).

DETECTION AND VERIFICATION METHODS

Thanks to the dissemination and the possibility of almost cost-free acquisition of data from airborne laser scanning, extensive prospection of forested areas has become possible, including re-analysis of the already discovered and studied sites (*e.g.* Budziszewski and Wysocki 2012; Budziszewski and Grabowski 2014; Banaszek 2015). The airborne laser scanning data used for this work were obtained as part of the ISOK project. Initially, this program assumed aerial scanning of the valleys of the main Polish rivers, but over time, its area was enlarged and at present, it covers the entire country. The data on the analyzed area were obtained in standard I that provides cloud density at the level of at least 4 points/m^2 (Kurczyński and Bakuła 2013). Light Detection and Ranging (abbreviation: LiDAR) has already shown its significant usefulness in the search for and the analysis of flint mining sites (Jakubczak 2012; Radziszewska 2015; Szubski 2016; Budziszewski *et al.* 2018; 2019; Sudoł-Procyk *et al.* 2018).

The acquired point cloud was reclassified with the use of the *Axelsson* algorithm in the LAStools software. The proper execution of this operation allows for a significant increase in the number of points classified as lying on the ground. In certain situations, the default classification used in the ISOK program leads to the complete erasure of archaeological features from the Digital Terrain Model (DTM), as, for instance, in the case of the megalithic cemetery in Wietrzychowo, Nidzica district (Kiarszys and Szalast 2014, 281, 282). Hence the need for reclassifying the point cloud, especially when analyzing objects poorly preserved in the terrain, such as the relics of the prehistoric (and modern) flint mining.

The topic of preparing appropriate visualizations has already been discussed in the literature several times. Nevertheless, it is worth mentioning once again that the selection of appropriate filters and settings is crucial in order to obtain as much information as possible, and the LiDAR data can be visualised in many more ways than a shaded terrain model and its coloured version with the use of hypsometry (*cf.* Kokalj and Hesse 2017; Kiarszys and Banaszek 2017). The mine profile is a specific type of the manifestation of an archaeological site, and thus, it requires a special approach towards its visualisation. Due to the fact that the principles of operation and the capabilities of particular visualisations have frequently been widely described (*e.g.*, Kokalj and Hesse 2017), below we will present only their parameters. In the case of Karniowice, the best outcomes were obtained thanks to applying *Local Dominance* (radius: min. 10, max. 15; observer height: 1.6 m; histogram stretch: 0.85-1.2 m). For the site in Zelków, where the profile has been better preserved, the radius was lowered to 5-10, and the height of the observer was set to the default 1.7 m. The set in Mników is located on a relatively steep slope, therefore, the *Local Dominance* visualisation could not be used in this case. The best results were provided by Sky View Factor (search radius 16) and shading from 16 directions (*multi-hillshading*), the angle of incidence of light is 35 degrees.

The microtopography of the flint mine in Zelków

The mining field covers the area of approx. 1.5 ha and it has an irregular shape (Fig. 3: D). It is now entirely covered with forest. There are no visible signs of agricultural or forestry cultivation. The deep remains of cavities and distinctive waste heaps confirm its good state of preservation. The largest shaft hollows have a diameter of about 10 m, and the difference between the bottom of the hollow in relation to the top of its heap reaches up to 2 m.

Attention should be paid to the correlation of the LiDAR data with the Austrian cadastral map from the end of the 19^{th} century (1896). After overlaying the map on the digital terrain model, it is clearly visible that some of the boundaries of the mining field coincide with the boundaries of the plots (Fig. 4), especially the eastern and south-western borders (the border of plots 226 and 228). This relationship with the cadastral boundaries clearly shows that the mining field was exploited in modern times. Referring to the French traditions, which were probably modelled on the exploitation of flint in the 18th century, those plots were leased by the owners of gunflint factories (Emy 1978, 55-57; Jamnik 1993, 31; Brandl 2013, 138). The very good preservation of the remains of the mine is further evidence of the modern origins of its profile.

The microtopography of the flint mines in Karniowice

The complex in Karniowice consists of at least three mining fields with a varied mine relief (Fig. 3). The northernmost zone (A) has an area of approx. 0.4 ha, and is covered with earthworks of a poorly visible profile (type 1 – marked in green on the map), some shaft hollows are noticeable, yet it is not feasible to analyse them in more detail. In this area, there are slight traces of forest ploughing, which certainly contributed to the destruction of the earthworks.

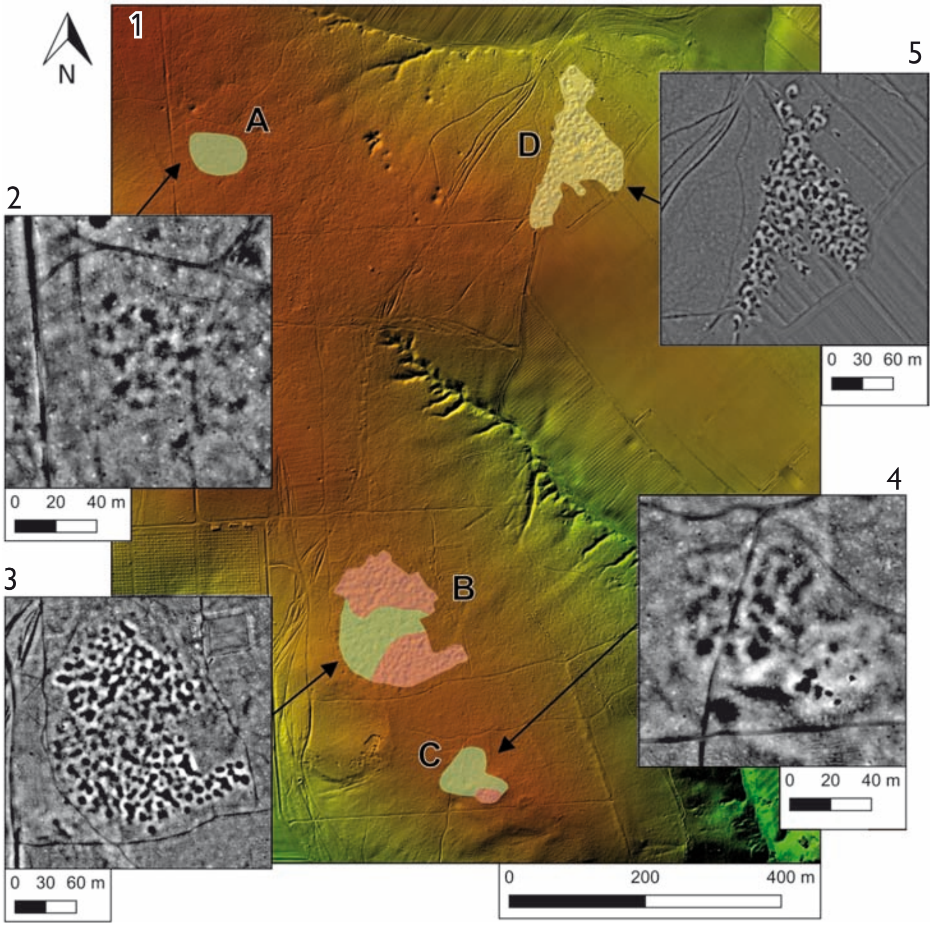

Fig. 3. Mining fields in Karniowice (A, B, C) and Zelków (D).
Visualisations: Hillshading (1) and Local Dominance (2, 3, 4, 5). Drawn by M. Jakubczak

The central mining field (B) has an area of 2.4 ha, approximately 0.5 ha of which is covered in the central part with a more delicate relief similar to that in field A. The remaining part of the mining field is covered with a much more distinct relief (type 2 – marked in red on the map) and it consists of large (max. 8-9 m) and distinct hollows surrounded by waste heaps. The difference in the topography may result from discrepancies in the type of flint exploitation related to the use of the site in various periods, but also from the state of preservation. Although there are no visible traces of forest or agricultural ploughing, it cannot be excluded that that part of the field was partially destroyed in one way or another. In addition, it ought to be mentioned that some of the shafts, particularly in the southern part, seem to be arranged in lines, which suggests an organized exploitation.

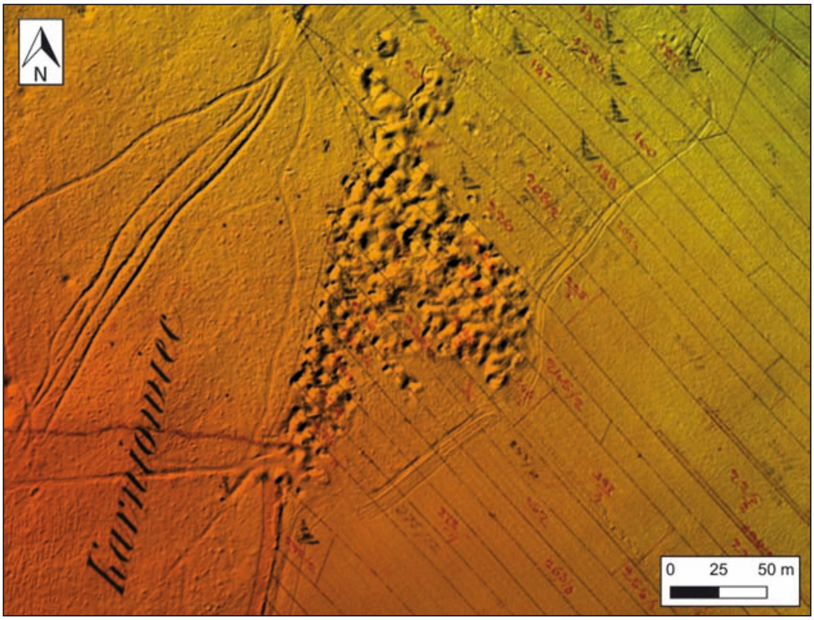

Fig. 4. Hillshaded DTM of the Zelków mining field, with overlapped 19th century cadastral map from 1896. Drawn by M. Jakubczak

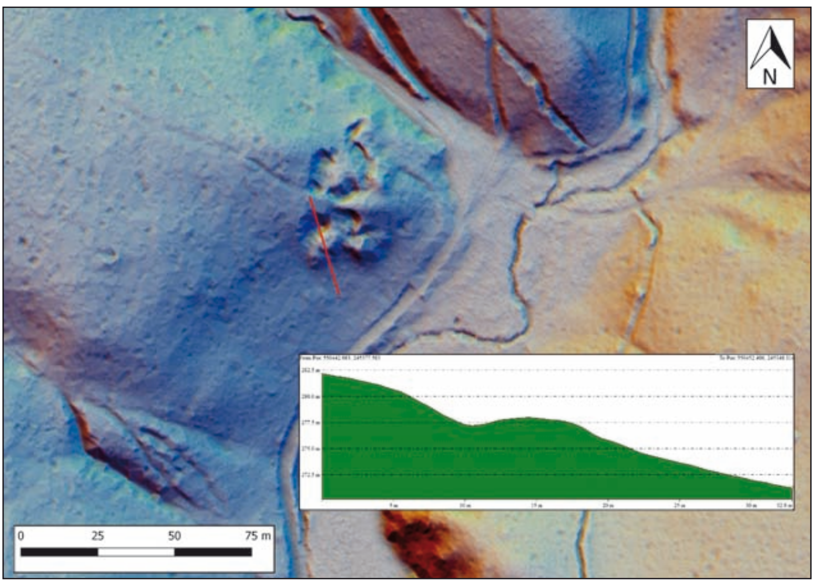

Fig. 5. Multi-hillshading of the Mników mine with a cross section of one of the shafts. Drawn by M. Jakubczak

The southern mining field (C) with an area of about 0.5 ha has mainly a type 1 profile, similar to field A, with the exception of a few shafts in its southern part. The largest of the shafts has a diameter of about 7 m. What is visible are the waste heaps. Also here, as in the case of field B, these discrepancies may result from both a divergent type of exploitation and the state of preservation.

The microtopography of the flint mine in Mników

The mining field in Mników is located on the western slope, about 15 meters above the bottom of the Półrzeczka Gorge (Fig. 5). It consists of seven clearly visible hollows. Each of them has a heap on the side of the valley. Exploitation was carried out with the use of the quarry method, digging into the side of the slope, while the excavated material was thrown towards the slope. The small size of the site proves that the raw material was used for a short time at that point.

FIELD VERIFICATION

In the case of the airborne laser scanning method, due to possible errors in the DTM point cloud classification, the verification of all features documented by remote sensing is absolutely necessary (Holata and Plzák 2018, 33, 34). Verification is particularly vital in the case of flint mining research, as a similar profile may arise due to divergent anthropogenic or natural activities (Budziszewski *et al*. 2018, 217, 218). For this reason, the revealed features were subjected to field verification, during which the sites were measured with a handheld GPS (Global Positioning System) receiver, whereas a small sample of flint material was collected from the surface – the collected material mainly consisted of distinctive core forms and chip residues. So far, no regular surface tests aimed at obtaining a statistically significant sample of flint products have been carried out on these sites.

FLINT MATERIAL

Due to the numerous sources of the periods when they were produced, the technology of producing gunflints is well understood from the point of view of individual links in the *chain of operations*. The evidence comes from both written sources and the tradition that has survived in some parts of Europe practically to the present day. In order to represent the materials from the sites in Mników, Zelków and Karniowice, a sample of flints from the surface was collected, mainly cores and occasionally non-characteristic waste, such as flakes and blades. The technological analysis was focused on two aspects of gunflint making. First, the features of the technique were presented. Then, an attempt was made to describe

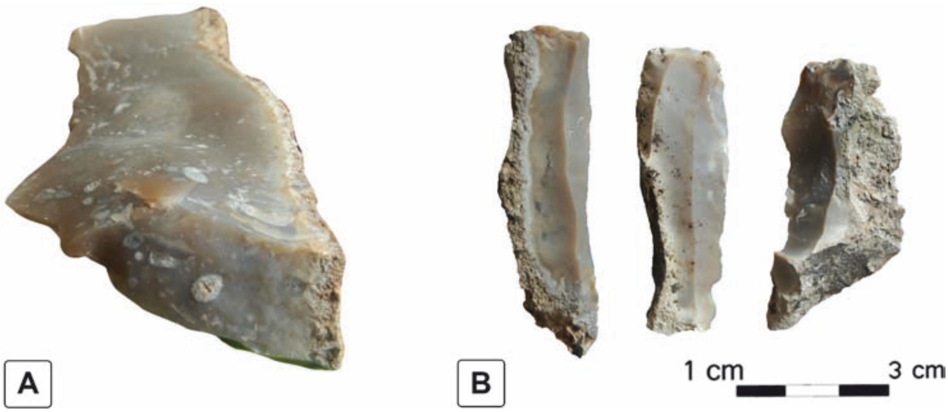

Fig 6. Blades from Zelków mining site. A – The specimen shows a large, massive butt and a well-distinguished hertz cone on the bulb characteristic for hard hammer percussion. B – Specimens with cortical side. Photo by M. Szubski

knapping methods at individual sites analysed in the study – in the context of the way in which the cores were prepared and exploited.

In accordance with the state of our scientific knowledge, the gunflint making industries are the only technologies in Poland utilising steel tooling in flint production. These tools, specialized hammers, due to their hardness, left characteristic technological traces on the fragments of flint that were split off with them. The individual features listed below may appear on products and waste from other archaeological contexts, but the coexistence of most of them in the collection is a solid indication that we are dealing with modern gunflint manufacturing. Additionally, it should be emphasised that it is better to interpret the majority of technological tracess from flakes and blades rather than from core forms that are frequently worn out and do not represent the middle stages of production. Gunflint production in the analysed collections is characterised by the following features: a flaking angle for obtaining blades usually around 60-80°, pronounced bulb with "ring crack" marking the point of percussion or even "errailure scar", mostly plain butts that are wide and thick, when we compare them to the rest of the blade (Fig. 6: A) and the distal parts of the blades are usually curved. Some blades obtained from the site are characterized by the presence of the cortical surface along one of the sides (Fig. 6: B). All of them fulfil the presented morphological criteria proving the use of a steel hammer.

Flint-making methods used for the production of gunflints in the researched assemblages can be broadly divided into two groups. The first one is related to the exploitation of blades and flake material registered at the sites in Zelków and Mników. The blades were obtained from single-platform cores, prepared with one blow and most probably not rejuvenated if not needed in later stages of production. The flakes of forms in this group do not show any traces of preparation, so it should be assumed that the block was "opened" with

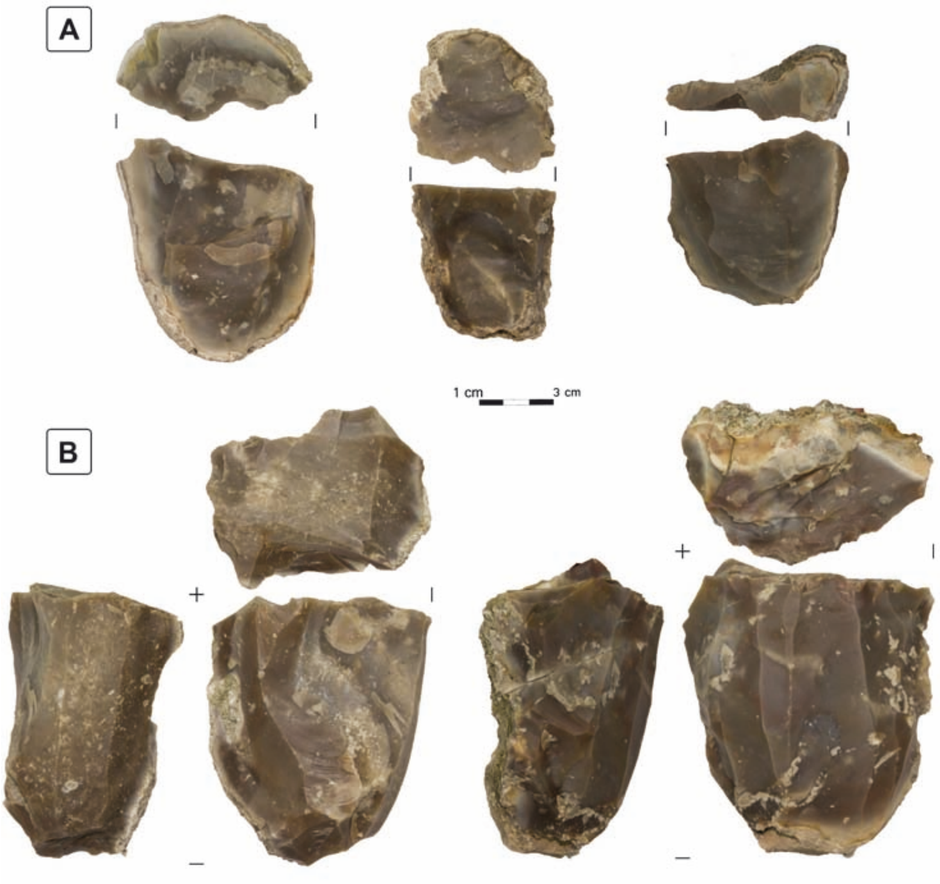

Fig. 7. Methods of obtaining blades.
A – Zelków mining site. Flint cores from described method I of obtaining blades. B – Karniowice mining site. Blade cores from described method II of obtaining blades. Photo by M. Szubski

a series of cortex blades and flakes. The coring angle on the analysed cores is sharp. The negatives on a flake are rather irregular, often with a flake morphology rather than a blade, which was arguably a desirable aim of gunflint production (Fig. 7: A).

The second core category was recorded in Karniowice (Fig. 7: B). The obtained cores are characterised by a sub-conical shape, with rejuvenated platforms and traces of negatives with a much more regular course, which makes them similar to Neolithic blade technologies (Dzieduszycka-Machnikowa and Lech 1976). On the basis of the morphology of the negatives, it can be assumed that the cores were made with the use of two techniques: hard hammer – possibly including rock hammers, and tools made of softer raw materials that could not be precisely specified. On the basis of these conclusions, several hypotheses can be formulated. The first one concerns a specific kind of palimpsest – the 19th century gunflint makers picked up from the outcrop area and processed Neolithic cores. The second assumes connections with the *chain of operations* of Neolithic manufacturers who, in the last stages of production, processed blade cores with the use of hard hammers. That could be related to the learning process – the cores were provided to younger adepts who, for instance, learned to process them. Moreover, it could be linked with other cultural processes within those communities.

CONCLUSIONS

The preliminary research carried out allows us to conclude that the mines in Mników and Zelków are associated only with modern gunflint production. On the other hand, the complex of sites in Karniowice probably documents modern mining activity on sites used for the same purpose in prehistoric times. One of the key conclusions from the research to date on modern traces of flint mining is the uniqueness of the degree of their preservation, which should be properly conserved. Until recently, those sites had only roughly-prepared KEZAL sheets and the awareness of their location and chronology among Polish archaeologists was low.

In order to start comprehensive research on modern flint mining in the area of the Kraków Gunflint Production Centre, the following activities should be taken into consideration:

1. It is necessary to continue the research on the surface relief at the sites in Zelków and Karniowice to be able to separate the remains of the prehistoric and modern mining activities. We know from the experience of the research on the prehistoric mining field in Borownia (Radziszewska 2015; Budziszewski *et al.* 2019) that more precise scans than those performed within the ISOK project are required for this. The analysis of the profile should be supplemented with geophysical surveys, the most appropriate of which today seems to be Ground Penetrating Radar (GPR);

2. The detailed surface surveys on the mines are necessary after obtaining a precise DTM of the terrain, as well as field surveys in the vicinity of the sites in Zelków and Karniowice in accordance with the suggestions included in the AZP study. Such research will allow the identification and dating of individual workshops scattered near the mining fields;

3. It is necessary to collect and process the flint materials obtained so far from the sites of gunflint provenance, as well as conduct further technological analyzes that may shed light on the problem of the diversity of mine relief type observed by us (whether it results from chronological, technical, or another differentiation). Therefore, it is crucial to better understand the flint techniques used by historic knappers. At first sight, the question of distinguishing the prehistoric and modern techniques of flint processing with blade technology seems to be obvious. The analyzes of the material obtained from the area of the

mine, where we can find them in parallel (*e.g.*, Karniowice) demonstrate, however, that this is not such a trivial issue;

4. The identification of three regions related to the Kraków Gunflint Production Centre gives rise to the need for building a canon of physicochemical analyzes that would allow for the differentiation of products from particular regions. Such research has already been initiated (Brandl and Niebylski 2019; Werra *et al*. 2019), and with the increasing number of flint assemblages, including ready-made gunflints, it should be standardized and continued;

5. It is necessary to initiate the historical research on the problem of gunflint production at the end of the Kingdom of Poland and its evolution in the following centuries. In particular, the issues of the ownership of individual mines and plots, as well as potential locations of home workshops reached by the half-products, probably obtained from the mine.

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FIELD SURVEY AND MATERIALS

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EASTERN PERIPHERY OF THE MAGDALENIAN WORLD. WIERZAWICE 31 HUNTING CAMPSITE (SE POLAND)

ABSTRACT

Bobak D., Łanczont M., Nowak A., Mroczek P., Połtowicz-Bobak M. and Standzikowski K. 2022. Eastern periphery of the Magdalenian world. Wierzawice 31 hunting campsite (SE Poland). *Sprawozdania Archeologiczne* 74/1, 269-297.

Wierzawice 31 site is one of the easternmost Magdalenian sites, situated in the south-eastern corner of the Kolbuszowa Plateau surrounded, to the east, by the broad San River valley and, on the south, by the sub-Carpathian ice-marginal valley. This archaeological site lies in an area with surface deposits developed as periglacial stratified silty-sandy sediments about 10 m thick, adjoined in the NW by an isolated patch of loess of the island type. The lithic artefacts occur in a small area of about 40 sqm, with the main concentration of artefacts centred around the focus. Almost 70% of the tools are hunting weapon elements. Both technology and tool typology are typical for Magdalenian assemblages. Absolute dating (^{14}C and TL) indicates a very young, Allerød age for the site. The raw materials used indicate connections with the northern part of the Sandomierz Upland. Imports of "Volhynian flint" suggest possible contacts with areas beyond the limits of the Magdalenian range.

Keywords: Late Palaeolithic, stone hearth, loess island, slope processes, Sandomierz Basin, Allerød
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INTRODUCTION

The development of settlement and cultural characteristics of people of the Magdalenian in the eastern part of Central Europe are a subject of interest of researchers dealing with late phase of the Upper Palaeolithic and the early phase of the Late Palaeolithic. Their research has resulted in various studies, including synthetic monographs published in recent years (Połtowicz-Bobak 2013; Maier 2015). Magdalenian territories extending from the eastern part of Germany, to Bohemia and Moravia and eastern Poland represent a complex cultural pattern that, in its essence, is homogeneous in terms of settlement structure, material culture, and economic strategies.

The territories of south-eastern Poland lie at the eastern border of the Magdalenian oecumene. It seems that, in this area, the territory controlled by Magdalenian hunters extended to the San River, going beyond it only to a small extent. Alongside the site in Klementowice on the Nałęczów Plateau (Wiśniewski *et al.* 2012; Wiśniewski 2015), these are the easternmost areas inhabited or used by Magdalenian communities. Only a few Magdalenian sites are known in this area, including the campsite in Wierzawice (Fig. 1: A). A few of them, concentrated in the central part of the Sandomierz Basin, in a small part of its subregion known as the Kolbuszowa Plateau, and located at a considerable distance from other sites discovered in southern Poland so far, feature traces of short-term campsites of small groups of hunters, their chronological position being towards the end of Magdalenian settlement in Europe. These sites, namely Grodzisko Dolne (Lubelczyk 1997; Czopek 2003; Połtowicz 2004; Bobak and Połtowicz-Bobak 2011), Łąka 11-16 (Połtowicz-Bobak *et al.* 2014), and Wierzawice (Bobak *et al.* 2010; 2017), are the main subject of this paper. They are located in an area with various surface deposits, which led us to compare the palaeoenvironment of their surroundings.

LOCATION OF THE SITE

The Wierzawice 31 site is situated in the south-eastern corner of the Kolbuszowa Plateau surrounded, to the east, by the broad San River valley and, on the south, by the sub-Carpathian ice-marginal valley, at present partially used by the Wisłok river (Fig. 1: A, C). This archaeological site lies in an area with surface deposits developed as periglacial stratified silty-sandy sediments about 10 m thick (Wieczorek 2006), adjoined in the NW by an isolated patch of loess of the island type (Fig. 1: A). The boundary between these two sediment types is quite distinct in the terrain (Fig. 1: B-C). The first type is linked with denudation relief and landforms such as residual hills and long slopes dissected by systems of denudation valleys. On the other hand, the area where loess occurs features a varied, deeply dissected erosion-denudation relief with well-developed systems of various types of dry valley forms and anthropogenic gullies. These forms disappear at the boundary of the periglacial rhythmite.

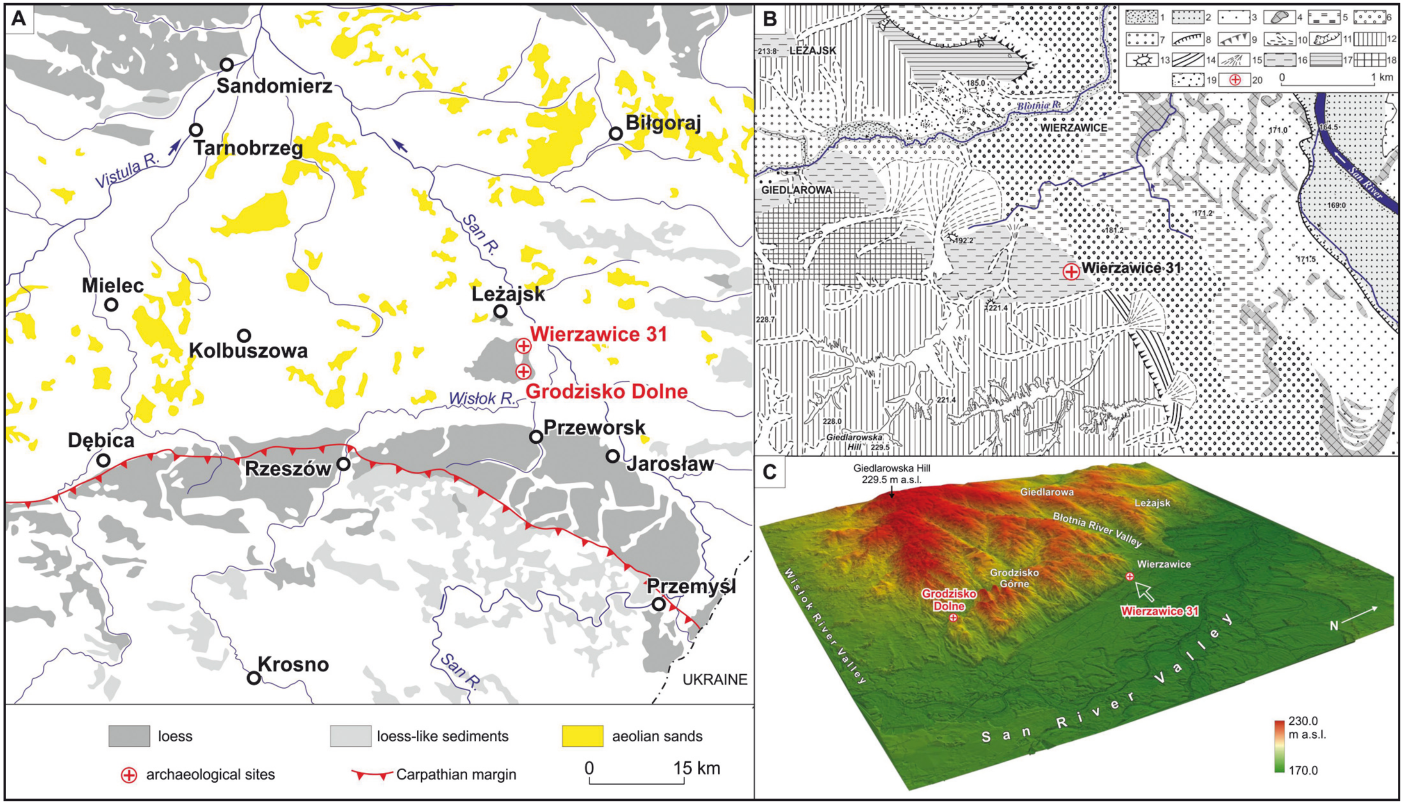

Fig. 1. Location of the discussed archaeological sites against the background: A) distribution of loess and sand covers in Poland SE, based on Marks *et al.* (2006); B) geomorphological sketch based on Łanczont *et al*. (2015, modified); C) digital elevation model. Description of signatures marked on the geomorphological map: Holocene: 1 – river valley bottom and terrace 1.5-2 m; 2 – terrace 3-6 m, 3 – terrace 5-8 m; 4 – abandoned meander; 5 – plains of peat and organic-mineral accumulation. Pleistocene terraces: 6 – lower, 8-13 m, 7 – middle, 12-17 m. 8 – edges and erosion undercuts of younger terrace; 9 – higher erosion edges; 10 – erosional-denudation valleys; 11 –loess and loess-like covers; 13 – erosion remnant; 14 – flat-topped bottom of slope; 15 – alluvial fans; 16 – fluvioglacial plain; 17 – kame terrace; 18 – morainic plateau; 19 – aeolian sandy plain; 20 – site. Illustrated by M. Łanczont and P. Mroczek

The Wierzawice 31 site lies at 188 m a.s.l., in the lower part of the eastern spur of a local hill (culminating at 221.4 m a.s.l.) which forms part of a fragmented glaciofluvial plain extending in the vicinity of a residual moraine dating back to the Sanian glaciation. The foot of a long, gentle hillside, with a gradient of 1.8-2.5° and an E and NE exposure (Hołub *et al.* 2017) is bordered by an 8-13 m high erosion-accumulation terrace, correlated with the Vistulian, and forming an elongated 1-1.5 km wide strip in the Wierzawice area (Wieczorek 2006). Its erosional edge was formed by large palaeomeanders that developed in the Late Glacial (Starkel 2001; Szumański 1986). A few levels of erosion-denudation and accumulation low terraces (5-8 m, 3-6, 1-3 m above the present channel of the San river lying at 165 m a.s.l.) can be discerned in the Holocene bottom of the San valley (Fig. 1: B, C).

The site was discovered by S. Czopek from the Institute of Archaeology of the University of Rzeszów in 2009. In the same year, S. Tokarczyk carried out surveys that led to the identification of Magdalenian materials. During systematic investigations conducted in 2009-2012 by the authors of this paper, a perfectly preserved campsite, interpreted as a short-term hunters' campsite inhabited just once, was discovered (Bobak *et al.* 2010; 2017).

SURFACE DEPOSITS IN THE AREA OF THE WIERZAWICE 31 SITE

The surface sediments with a distinct stratification, investigated to the depth of 2.7 m (Figs 2; 3: A) are carbonate-free sandy silts although a few laminae represent other lithological varieties. The sediment profile consists of three units. The upper unit (from 0.25 to 0.6 m thick) is a degraded (truncated) present soil built of clayey sand and sandy clay where the stratification became illegible due to the impact of pedogenetic processes. The middle unit (about 0.4 m thick), with a predominance of the silt fraction, is a zone of ball-and-pillow structures just over 10 cm in diameter, their primary characteristic being grain-size segregation, interpreted as a result of the secondary selection of material, probably determined by cryogenic processes (Bobak *et al.* 2017). The lower unit (its top part lying at depths ranging from 0.45 to 1.0 m) is a rhythmite consisting of laminae of varying thickness, from 2-5 cm to 10-15 cm, with wavy lamination. The laminae are built of sand of various colours as well as clayey and silty sand with a distinct grain-size segregation; at a greater depth, they transition into yellowish-grey loose quartz sand with individual gravel grains (Fig. 3A). The top part of the lower unit (about 0.1 m thick) is characterised by partially illegible sedimentary structures, slight enrichment with humus (by up to 0.15%), and higher levels of Fe_2O_3 (by up to 1.6-1.8%) in comparison with the present soil, as well as traces of pedofauna activity. These characteristics would indicate initial pedogenesis (weathering horizon). Stone artefacts occurred in that layer (Fig. 2).

Thermoluminescence (TL) and optically stimulated luminescence (OSL) dating results conducted at the Lublin laboratory for the sequences of sediments, analysed in 2010-2011 and 2014, indicate that the series under study formed between the Upper Pleniglacial of

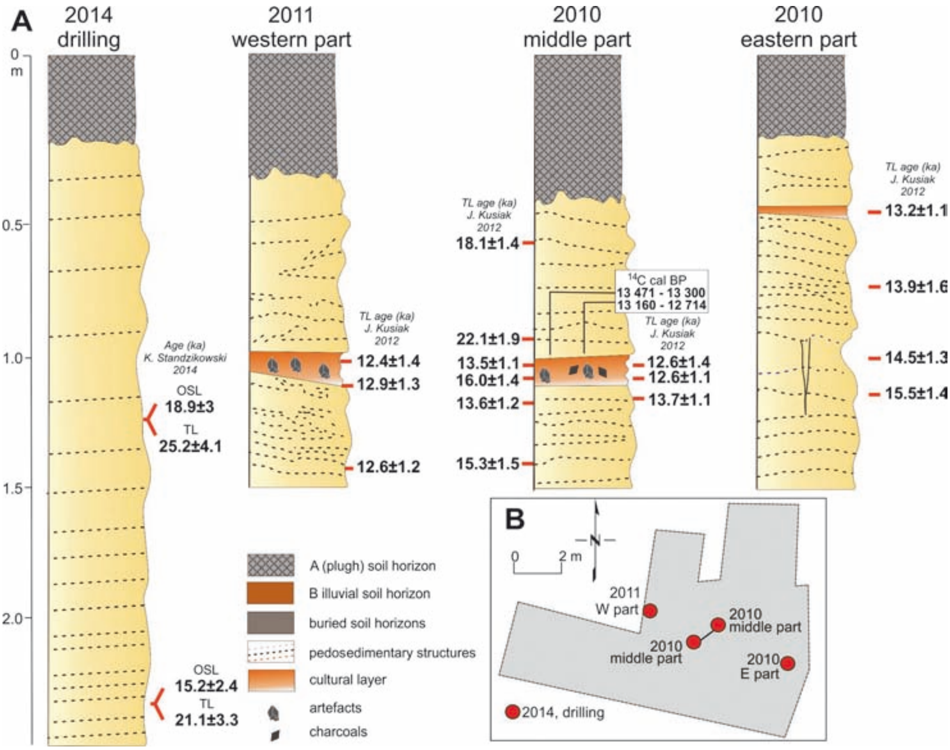

Fig. 2. Lithological development of selected sedimentary sequences in the Wierzawice 31 site after Bobak *et al.* (2017, modified). A – lithology and results of dating; B – excavation plan. Illustrated by M. Łanczont and P. Mroczek

the Vistulian and the Late Glacial. The oldest TL dates obtained for the test drilling carried out in 2011 are 25.2±4.1 ka (depth 1.25 m) and 21.1±3.3 ka (2.5 m). In addition, the following OSL ages were obtained for the same samples: 18.9±3.0 ka and 15.2±2.4 ka.

The following TL dates were obtained in two series for samples from the cultural horizon: samples from 2010 are in the timeframe from 12.6±1.1 to 16.0±1.4 ka, the two dates obtained in 2011 were 12.4±1.4 ka and 12.9±1.3 ka (Fig. 2).

The sediments on which the initial soil horizon with the cultural layer developed formed in a cold, periodically humid periglacial climate as a result of the interaction of various slope processes (slope wash, mudflow, solifluction) and, undoubtedly, aeolian processes. Their accumulation was favoured by the simple, slightly convex and divergent shape of the slope with a relatively low gradient and eastern exposure. The sedimentation of slope deposits was probably quite fast and on a mass scale, and their source was located nearby (upper parts of the slope), hence inversions and a high divergence of parallel TL and OSL dates occur. The short-term exposure of the grains to sunlight was sufficient for

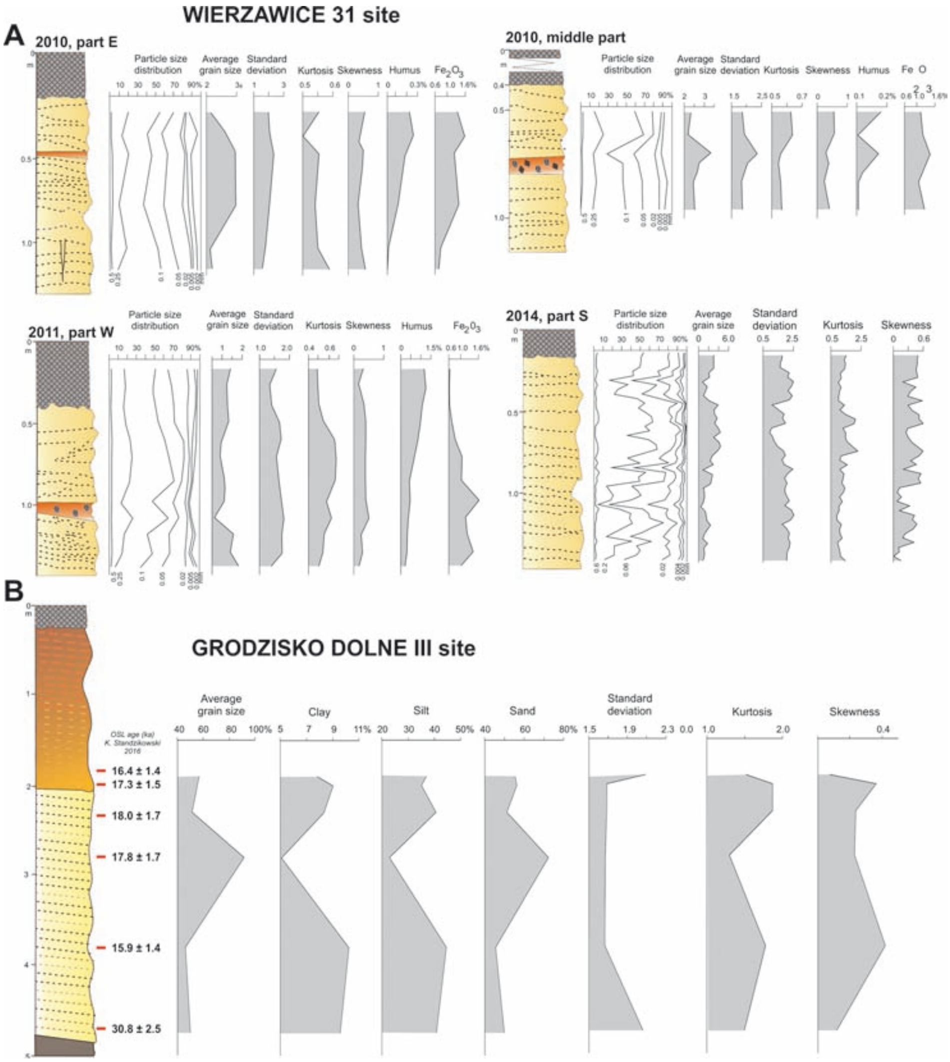

Fig. 3. Results of physicochemical analyses of selected sediment sequences from the Wierzawice 31 site (A) after Bobak *et al.* (2017, modified) and granulometric characteristics and OSL age of a sediment sequences Grodzisko Dolne III site (B). Explanations of signatures in Fig. 2. Granulometric indices calculated according to Folk and Ward (1957). Illustrated by M. Łanczont and P. Mroczek

the total reduction of previously accumulated energy in grains tested by means of the OSL method but was insufficient in the case of the TL method.

A rather poorly developed weathering and soil horizon with a cultural layer formed during a period of land surface stabilisation during a break in slope sedimentation.

THE LOESS ISLAND IN THE VICINITY OF GRODZISKO DOLNE

The loess island on which the site in Grodzisko is situated and neighbouring the Wierzawice 31 site is formed by typical carbonate loess (46-70% silt fraction content), locally sandy, and associated with the Vistulian period (Alexandrowicz 2014). The loess is quite thick, from 10 to 15 m. Interstadial fossil soils or sediments occur within the loess cover (Laskowska-Wysoczańska 1971; Wójcik 1999). A malacological analysis was conducted to reconstruct the accumulation environment of the loess in exposures in the vicinity of Grodzisko Dolne (Alexandrowicz 2014). In the part of the sequence the age of which corresponds to the stratified periglacial sediments in Wierzawice, the *Pupilla* fauna association mainly occurs, indicating a continental polar climate, and dry, cold steppe-type habitats, as well as a period of intense loess accumulation that started *circa* 22.0±2.8 ka. The altered climate conditions and the slower loess sedimentation rate led to the development of *Succinella* fauna that predominates in the "aeolian-deluvial" loess (younger from the loess at Grodzisko Dolne) the sedimentation of which began *circa* 18.0±2.8 ka (Wójcik 1999). This association indicates the more humid conditions of a cold climate (Alexandrowicz 1999; 2014). Having an inhibitory impact on the intensity of aeolian processes and erosion processes, these conditions probably led to the loess being locally covered by stratified periglacial slope sediments. This is indicated by the sequence of sediments found in another loess exposure located nearby (Grodzisko Dolne III – N50°10'26''; E22°28'17.5'') with quite a shallow but stratigraphically varied profile (>5 m) where laminated silty carbonate sand (Fig. 3: B) dated to 18.0 ka is covered by a top series of carbonate-free slope sediments dated to 17.3 ka and 16.4 ka, analogous to those in Wierzawice (Table 1). The

Table 1. Results of the OSL dating of the Grodzisko Dolne III site

Sample (depth) [m]	**No Lab. LUB**	^{40}**K** [Bq/kg]	^{226}**Ra** [Bq/kg]	^{228}**Th** [Bq/kg]	**Dose rate** d_r [Gy/ka]	**Equivalent dose** d_e [Gy]	**OSL age** [ka]
OSL 1 (1.90)	**6435**	373±7	24.1±2.0	30.2±1.0	2.26 ± 0.18	36.97± 1.15	**16.4 ± 1.4**
OSL 2 (2.00)	**6436**	341±7	26.6±2.0	24.6±0.9	2.12 ± 0.17	36.65 ± 1.28	**17.3 ± 1.5**
OSL 3 (2.30)	**6437**	365±9	19.6±2.1	29.2±0.9	2.12 ± 0.19	38.23 ± 1.09	**18.0 ± 1.7**
OSL 4 (2.80)	**6438**	279±7	26.0±2.1	24.8±1.0	1.91 ± 0.17	33.90 ± 0.99	**17.8 ± 1.7**
OSL 5 (3.80)	**6439**	388±9	35.4±2.7	36.9±1.2	2.63 ± 0.21	41.88 ± 1.37	**15.9 ± 1.4**
OSL 6 (4.75)	**6440**	336±8	29.9±1.9	25.0±1.0	2.13 ± 0.16	65.69 ± 1.70	**30.8 ± 2.5**

key characteristics of the sediment sequence from Grodzisko Dolne III is the rapidly changing share of the particular main fractions, very poor sorting, high values of skewness and curtosis (Fig. 3: B). Such characteristics indicate short-distance transport of the mixed local material, occurring mainly as a result of aeolian and slope processes. The distinct mixing of local material is evidenced by the considerably younger age of the OSL sample (15.9 ka), originating from the depth of 3.8 m.

The two profiles of Grodzisko Dolne and the Wierzawice profile presented here show a high variation of sediments and sedimentation processes within a small area at the same time. The similar time of the accumulation of loess and stratified periglacial slope sediments indicates the strong influence of local conditions (fossil relief and its orientation in relation to loess-forming winds as well as the geology of the bedrock – shallow outcrops of older Pleistocene sediments susceptible to erosion) on the kind of sedimentation processes (Bobak *et al.* 2017). With the change of the climate conditions in the final phase of the Pleniglacial, *circa* 16.0 ka ago, there occurred a certain spatial homogenisation of the formation of surface deposits by slope processes (slope wash and solifluction) in the SE part of the Kolbuszowa Plateau. These processes paused during the Allerød when a group of Magdalenian hunters appeared in the Wierzawice area.

VEGETATION IN THE ALLERØD AND POST-ALLERØD PERIOD

The vegetation of the Wierzawice area during the late-Glacial warming was reconstructed based on the published palaeobotanical data. The distribution of plant communities was reconstructed taking into account the local determinants of relief such as absolute elevation, slope gradient and exposure, insolation conditions, hydrologic regime, bedrock lithology (Hołub *et al.* 2016, further literature ibid.). In the Allerød optimum, dense pine, birch and larch forests predominated in the environs of Wierzawice, with clusters of willow shrubs and ferns and patches of rich steppe. *Heliophyta* grew in very sunny places, while *Selaginella selaginoides* in wet places. The climate of the Allerød optimum was temperate cool, and periodically more dry. During the younger phase of the Allerød, open park birch and pine forests occurred only in sheltered places. The plateaus and slopes were covered mainly by steppe with Artemisia, and patches of moss tundra. Willow shrubs grew in wet places near morphological edges, and sedge, horsetail, and ferns grew on peatland. Towards the end of the Allerød, tundra patches with dwarf birch were predominant.

The sparse tundra-steppe vegetation and the climate cooling of the Younger Dryas resulted in the local re-initiation of slope processes in susceptible locations, *e.g.* in Wierzawice. This led to the covering over of the soil that incorporated the cultural layer and the resultant protection of the site and its artefacts against erosion.

ARCHAEOLOGICAL MATERIAL

The complex consists of ~3,500 lithics (Table 2). No artefacts made of organic material and no faunal remains have been found. The preserved artefacts include stones, some of which are part of a structure identified and interpreted as a hearth. Some stones are fragments of sandstone plates. Traces of hematite also occur in the form of small grains or, more often, dust stains. Individual tools were also covered by concentrations of such dust mixed with sediment.

A vast majority of the artefacts were located *in situ*. Some artefacts, particularly small chips, were obtained while sieving sediments. Since, for objective reasons, it was impossible to sieve during the investigations in 2010 when the main part of the site was explored, it can be assumed that some chips have been lost.

An area covering almost 40 square metres was investigated in the course of fieldwork (Fig. 4). A vast majority of artefacts lay within a limited space up to 5 square metres, in a few small and compact concentrations. Most of these concentrations are associated with the hearth. More dispersed artefacts, rarely forming legible concentrations, are located beyond the hearth. However, one can notice certain correlations that make it possible to formulate hypotheses concerning the spatial planning of the campsite. What is more, in the case of this small and not particularly rich campsite, the analysis can be easier and more legible than in the case of sites which are a palimpsest created by repeated settlement activity at the same site (Ginter and Połtowicz-Bobak 2020).

The assemblage contains all categories of artefacts: 20 cores (less than 0.5%), 103 tools (*circa* 3%), and a total of 3,000 blades, flakes and chips. A vast majority of them have a three-dimensional location within the site's stratigraphy, although some originate from the arable horizon and sediment sieving.

Table 2. General structure of lithic artefacts from Wierzawice 31 site

Category of artefacts		Number
Cores		20
Blades, flakes, debris		~3400
tools		103
	Endscrapers	3
	Burins	18
	Perforators	1
	Microliths	65, after refitting – 58
	Truncated blade	4
	Combined tools	1
	Others	11

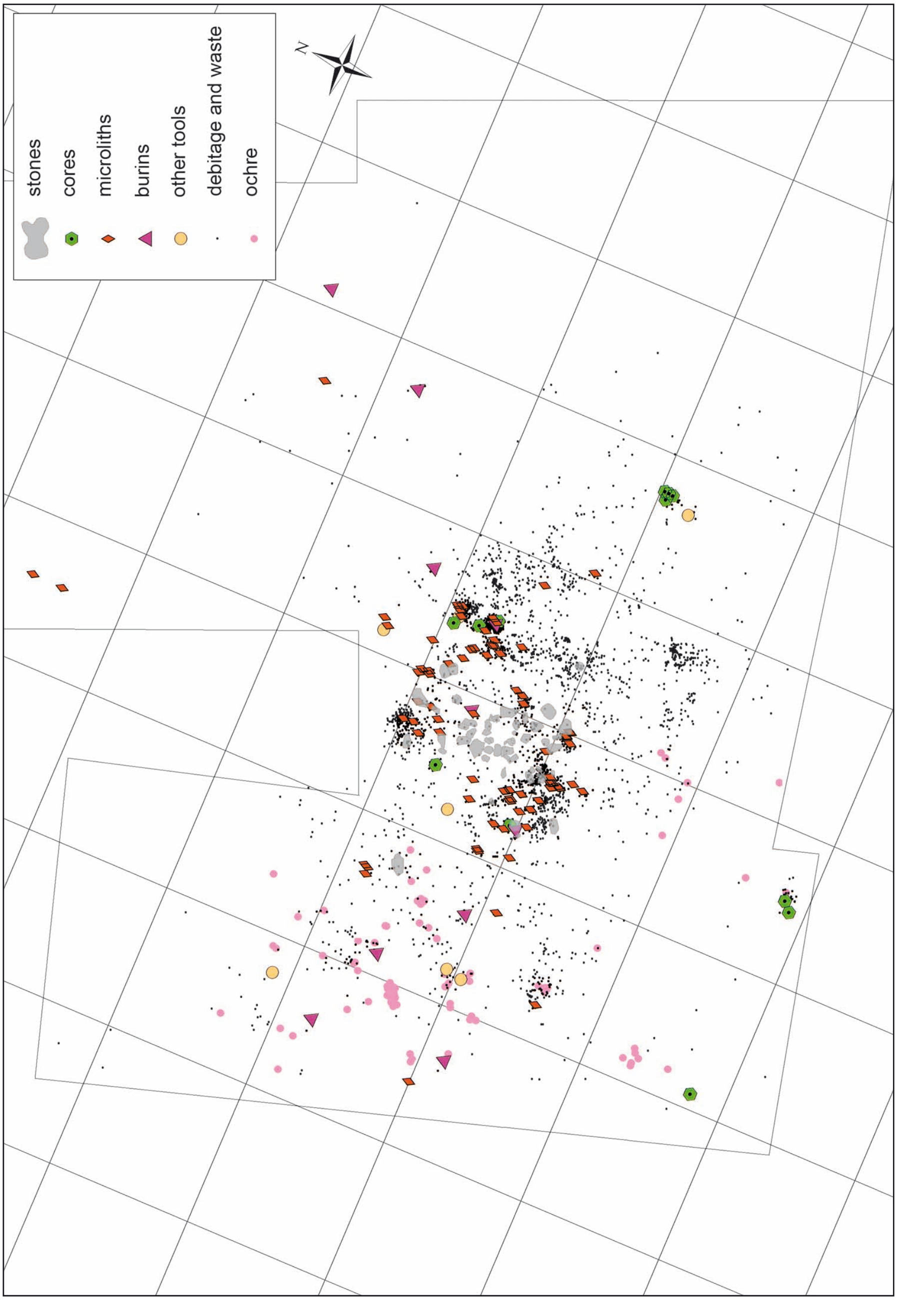

Fig. 4. Wierzawice, site 31. Planigraphy of the finds. Illustrated by D. Bobak

RAW MATERIAL

The stone artefacts were made of basically three flint species: erratic flint (the most prevalent, with a share of more than 40%), chocolate flint (about 20%) and Świeciechów flint (more than 5%).

Among these three dominant species, only erratic flint has local origin as it occurs in the Middle Pleistocene glacial till forming the main part of the Quaternary cover of the Kolbuszowa Plateau. The other two kinds originate from areas located about 100 km north of the site. The Świeciechów and chocolate flint probably originate from more than one place. A few artefacts, including cores, have smooth, unworked surfaces, which suggests that they could have been made from fragments found in secondary deposits, or that they could have been lying on the surface over a longer period. It seems that some of them originate directly from the sources.

Other raw materials occur in small amounts. Besides Jurassic flint, present in the form of a few items, a few flint specimens of a probably eastern origin, described as "Volhynian flint", are worthy of attention. This arbitrary term is applied to raw materials whose outcrops are located east of the present-day boundaries of the Magdalenian, without determining whether these are Volhynian or Transdnistrian materials. One small core seems to have been made of this material. This fact is quite significant, however, because it provides evidence of some contacts between the Magdalenian communities and areas located further east, beyond the territories they inhabited. We do not know what the nature of these contacts was (exchange between groups? penetration of areas located further east?). After the verification of the raw materials, the earlier claim of the presence of Carpathian Bircza flint at the site should be called into question (*cf*. Bobak *et al*. 2017).

The imports of the key raw materials used at the site are identified by the very clear direction along the north-south axis, linking territories of SE Poland with the northern part of the Sandomierz Basin and the Świętkorzyskie Mountains region. Magdalenian sites, including rich and repeatedly inhabited campsites of the basic type, are known in these areas (Połtowicz 2006; Połtowicz-Bobak 2012; 2020; Schild 2014).

TECHNOLOGY

In the assemblage, 20 cores (Figs 5, 6, 7: 1, 2, 4) have been identified, 17 of which have been described (the remaining three were inaccessible). Most of them were discarded in residual condition (13 artefacts), usually reduced to a high degree. There is also a small number of forms discarded in the middle of the reduction phase even though usually damaged by the hinge formed during the core reduction. One core was discarded in its early phase of reduction although also in this case it resulted from damage to the knapping surface due to mistakes in processing. The absence of initial products, combined with a small

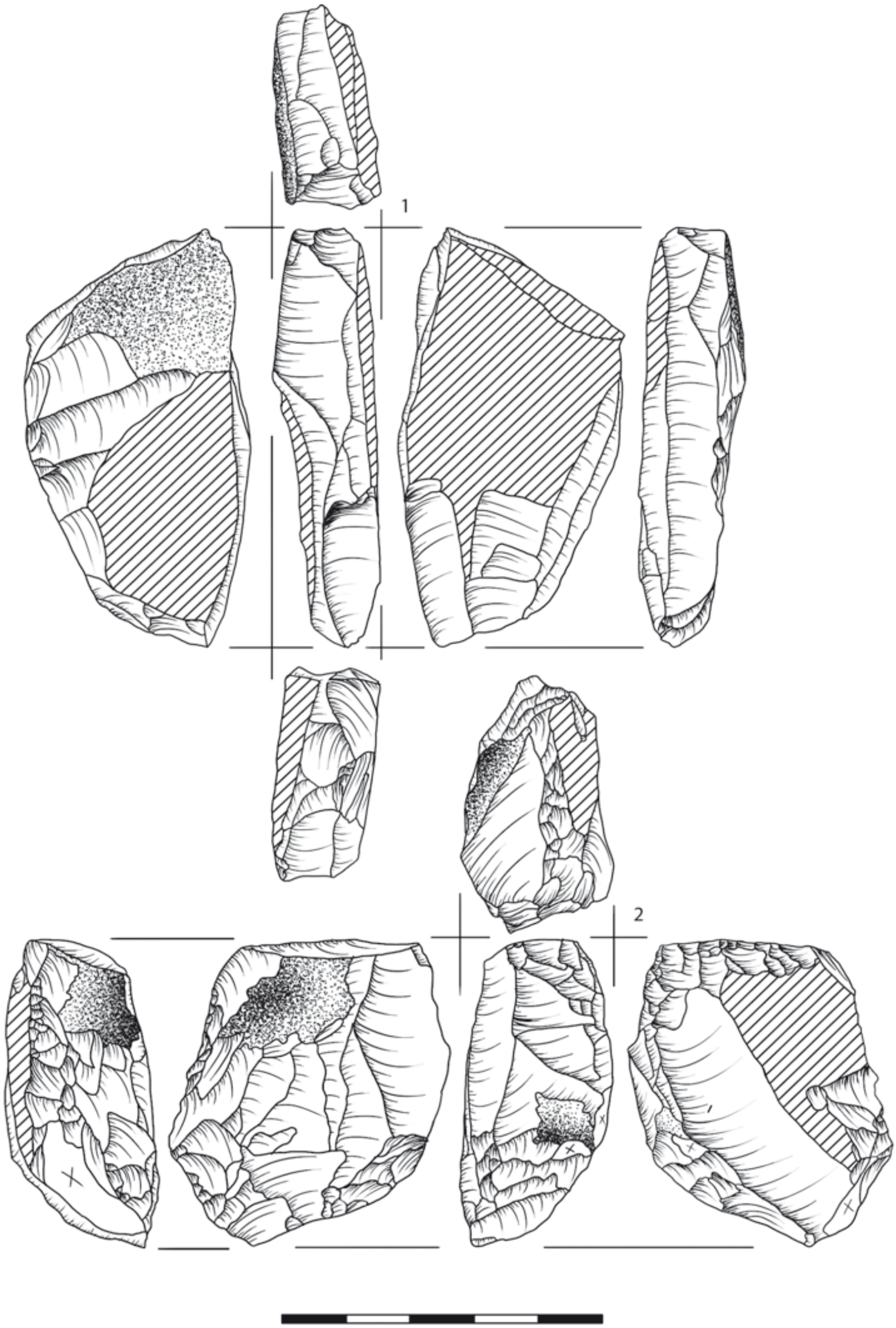

Fig. 5. Wierzawice, site 31. Cores. Illustrated by A. Nowak

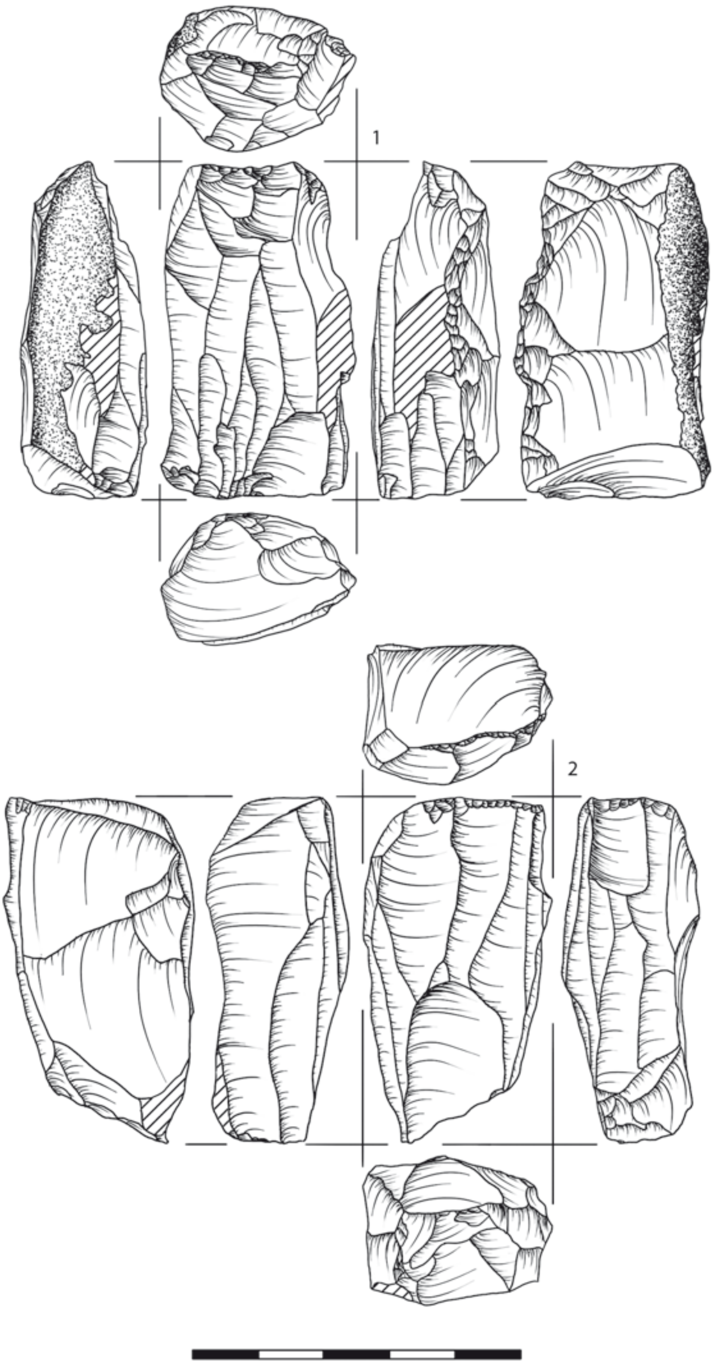

Fig. 6. Wierzawice, site 31. Cores. Illustrated by A. Nowak

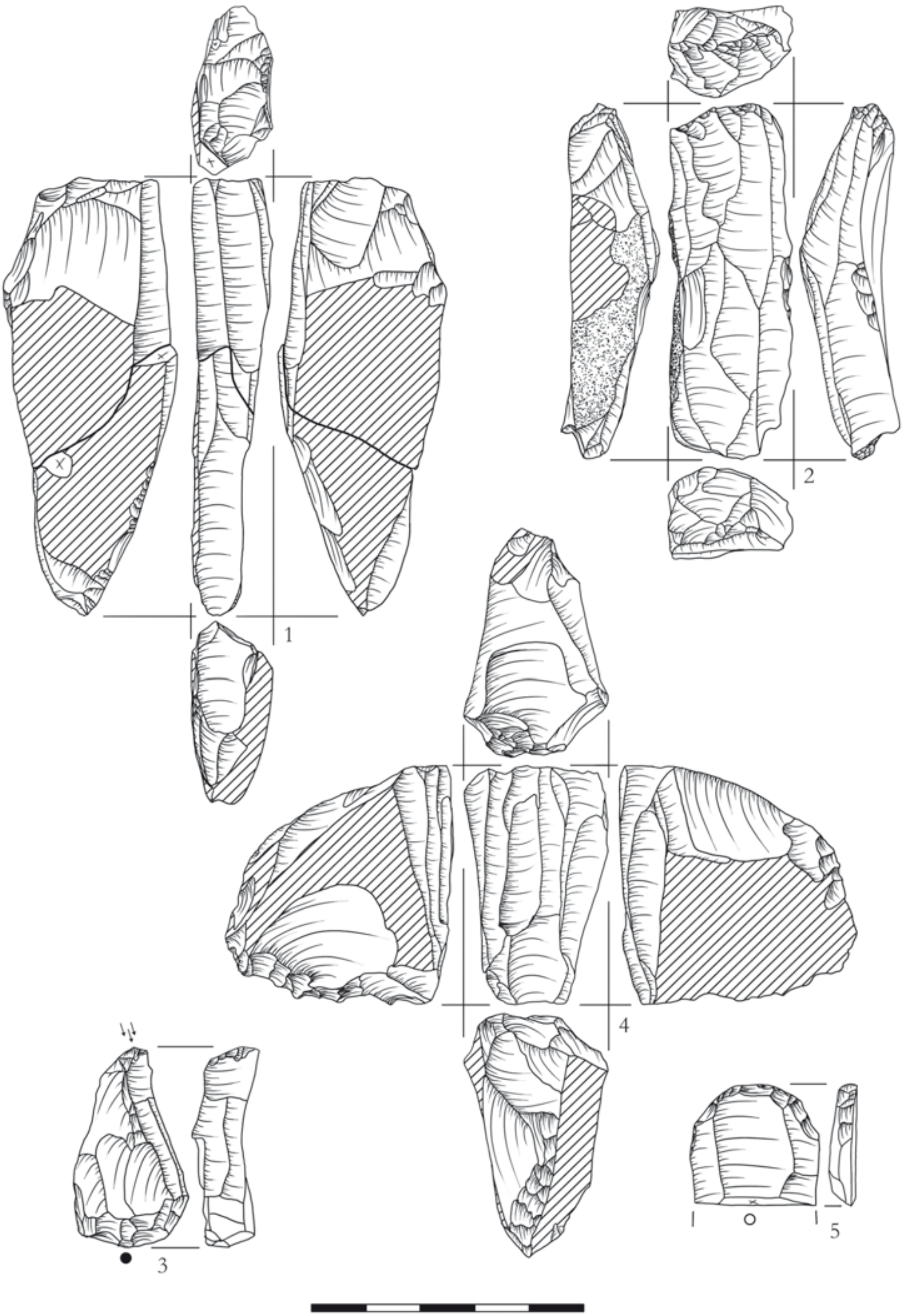

Fig. 7. Wierzawice, site 31. 1, 2, 4 – cores; 3 – burin; 4 – end-scraper. Illustrated by A. Nowak

share of *éclat d'amorçage* forms and forms with a large amount of cortex as well as waste from the early phases of core preparation, indicates that the cores were most probably brought to the site already in the form of initially worked pieces or pre-cores, prepared outside the site. At the same time, the strong reduction of the cores and presence of characteristic technical forms indicate an intensive reduction combined with repairs. A definite majority of items do not bear traces of faceting, which, however, is also a result of the high degree of their reduction. The items on which traces have been preserved provide evidence of faceting by creating lateral and, rarely, posterior crested ridges. A vast majority of the backs are flat, natural or partially formed by flake negatives scars. Similarly, pieces of cortex are often visible on the sides. The striking platforms were faceted, shaped, sometimes renewed. In one case, there is an edge platform (one of the platforms of a double-platform core). In the case of double-platform cores, there may be different combinations without a clear domination of any. On the other hand, traces of faceting of platform edges are very rare, which most probably results from the residual state of preservation of the cores.

A similar number of cores with a narrow and broad knapping surface can be observed. Double-platform cores were reduced by means of a series of blows from each side. In most cases, no dominance of either platform can be observed.

The preserved cores are usually small: the largest one is 80.14 mm long, including the refitted plunged blade; the smallest one is 29.79 mm long. The length of most cores ranges from 44 to 65 mm (10 artefacts).

The cores in the assemblage are almost exclusively blade cores (11 items), from which narrow, sometimes very narrow blades (and sometimes bladelets) were obtained. Only two cores can be classified as bladelet cores although it seems that originally they were blade cores as well. There are no classic, small bladelet cores known from most Magdalenian sites. One item has been described as a bladelet/flake core, one as a blade/flake core, and one as a flake core. One core has not been classified because it was burnt to a high degree.

The distribution of the raw materials used is quite striking. The three main species of flint – chocolate, Świeciechów and erratic – are represented in nearly the same proportions: five chocolate flint and five Świeciechów items, and four erratic flint items. They are accompanied by two cores probably made of Volhynian flint. Both of them are small blade cores; one was made without precision and bears no trace of platform edge faceting. Another item, burnt to a high degree, has not been identified. A white discolouration of the surface suggests that it is most probably erratic flint (Bobak *et al.* 2008).

Double-platform cores are the dominant category (10 items against three single-platform cores and four with a changed orientation) with shared knapping surfaces, both narrow and broad, with neither surface being clearly dominant. Knapping surfaces rarely encompassed the side or sides of a core. The knapping of both platforms usually occurred in a series starting from both of them (nine artefacts). An alternating knapping of both platforms is visible in only two cases. A question thus arises about how many of the cores identified as double-platform could have actually been cores with a changed orientation.

Their intentionally double-platform structure is suggested by the fact that in most cases, these platforms are equal; a distinct dominance of one of them is visible in just two cases.

The cores were intensively reduced by means of typical repairs such as regeneration and rejuvenation of the platforms, platform edge faceting, or forming secondary crested ridges. In most cases, hinges or badly damaged edges of the platforms are visible on the knapping surfaces. This damage was frequently the reason for discarding an item and, in a few cases, changing the orientation.

One splintered piece and eight splintered flakes have been identified.

In the debitage group, more than 700 blades along with bladelets and more than 1,000 flakes were identified; other items are unidentified fragments, pieces, technical forms (nearly 60) and numerous chips. Some chips and small flakes were obtained through sieving. It is worth noting that the number of blades is only slightly higher than the number of flakes. There are very few *éclat d'amorçage* products and artefacts with the cortex percentage greater than 50%, while artefacts devoid of cortex account for more than 55%. These characteristics indicate that the initial working took place outside the site, which confirms the conclusions based on the analysis of the cores. The faceted butts are more numerous than the flat ones (44% and 28% respectively). The characteristics of proximal parts indicates the use of soft-hammer percussion. The occurrence of *en éperon* butts has been documented. The unidirectional pattern of the negative scars that is clearly predominant on the upper surfaces of blades and flakes (nearly 90%) and contradicts the clearly confirmed double-platform structure of the cores should be linked with the serial reduction of the cores.

TOOLS

The composition of the tool group is very characteristic. Backed blades and bladelets (Figs. 8: 5-16; 9) are the most prevalent, accounting for more than 65% of all tools (65 items, *i.e.* 68%; after refitting – 58 items). Burins, the second largest group, are much less numerous (Figs. 7: 3; 8: 1-4), with a total of 18 items (18%). The other tools include a small number of truncated blades (four items), end-scrapers (three items) (Fig. 7: 5), retouched blades and flakes (seven items), and a few examples of serrated tools, borers, combined tools (scraper + burin), and three fragments of unspecified tools.

The most numerous category of tools, i.e. backed blades and bladelets, consists of several varieties, differing with regard to the number and location of retouched edges, and kinds of retouch (Figs. 8: 5-16; 9).

Ordinary backed bladelets, accounting for more than 50% of all backed pieces, are the most numerous. Another, much less numerous group consists of backed pieces with a retouch of the other edge (slightly above 20%), including a few items with a semi-steep retouch to the lower surface, accompanied by a small number of backed pieces with a re-

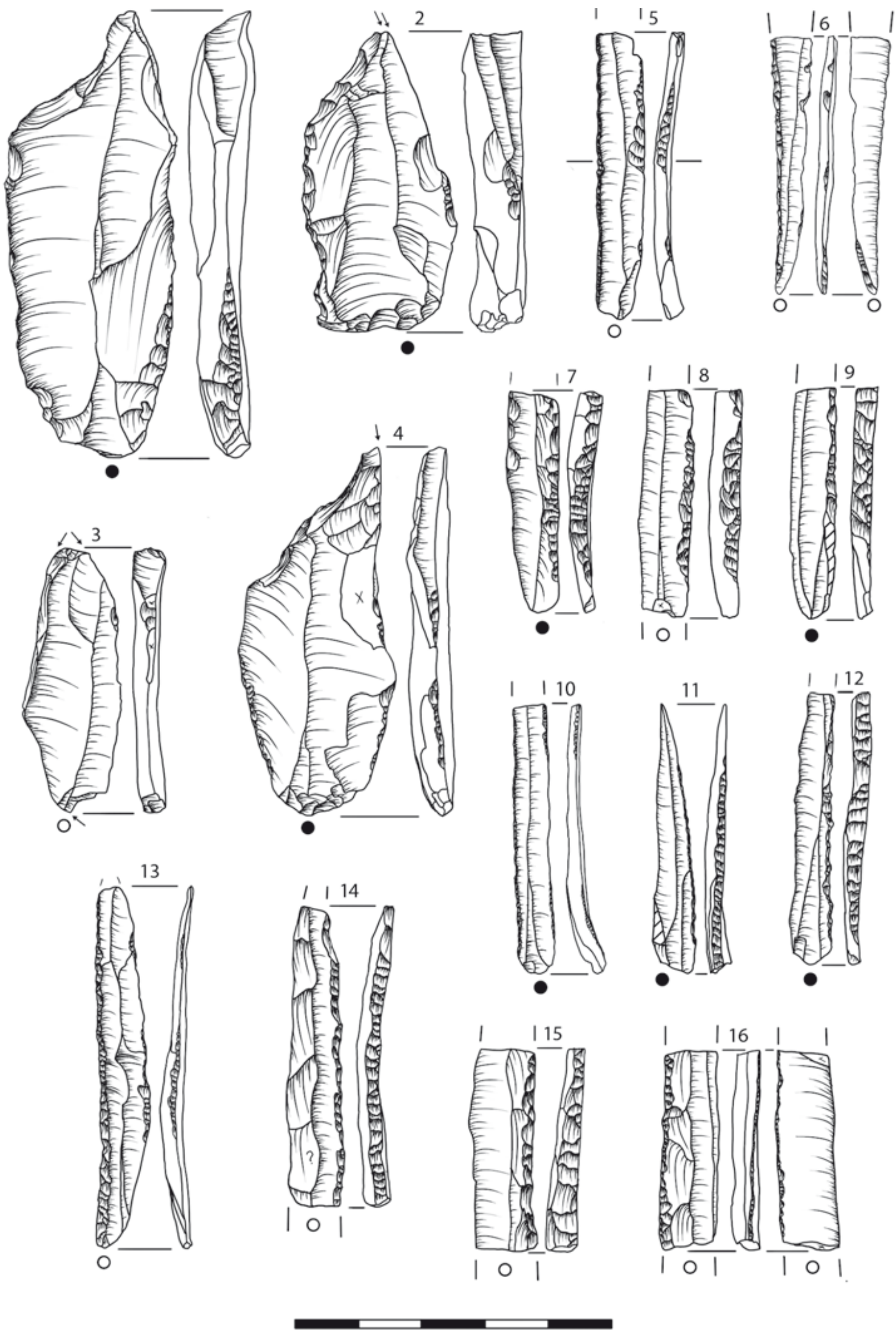

Fig. 8. Wierzawice, site 31. Tools: 1-4 burins; 5-16 backed pieces. Illustrated by A. Nowak

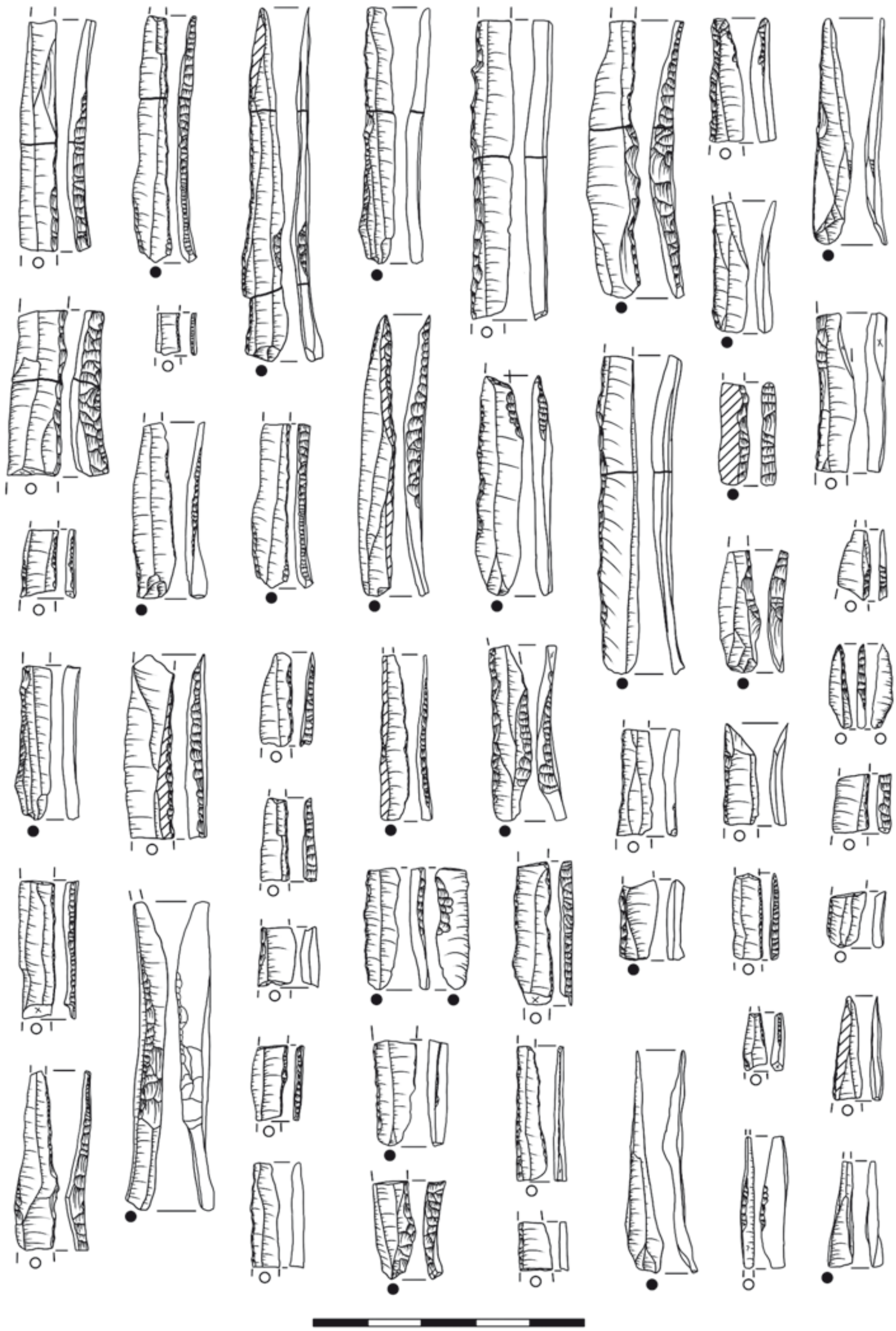

Fig. 9. Wierzawice, site 31. Tools – backed pieces. Illustrated by A. Nowak

touch of the shorter edge and an alternating retouch. There are no rectangles or backed blades with an arched back. The retouches are quite varied: steep or semi-steep, from thick to thin, exclusively unidirectional (from the lower to the upper surface). This diversity of retouch may also result from the fact that the backed blades and bladelets preserved in the assemblage represent different phases of production that was taking place on site, in the immediate vicinity of the hearth. This is indicated by refitting. Backed pieces were made on bladelets and long narrow blades that were intentionally broken – both before and after retouching a back. It seems that repairing and preparing of new hunting weapons were among the most important actions carried out during a short stay at the Wierzawice campsite. Some of the preserved artefacts do not show any traces of wear (Bobak *et al.* 2017).

Burins are the second most numerous category of tools although they are much less numerous than the backed blades and bladelets. Burins on truncations with straight or oblique truncations are predominant in this category (Fig. 7: 3). A group of burins of the Lacan type is particularly worthy of attention: four whole artefacts and three fragments of truncations were identified and can probably be linked to this type of tools. At least two (and perhaps three) burins of the Lacan type were made from blades struck off the same erratic flint core (Fig. 8: 1-2, 4).

Types other than burins on truncations are represented by just two dihedral burins (one doubled) and a burin on a truncation coupled with a dihedral one (Fig. 8: 3).

The truncations of truncated blades are analogous to the truncations of Lacan-type burins, which can raise the question whether these may be fragments of other burins of this type. Due to the characteristic way of creating Lacan-type burins, where the burin blow is followed by the truncation, it can be assumed that these are indeed truncated blades.

A small number of end-scrapers form another group. Among them, one small artefact with a simple scraping surface is worthy of special attention. It was made from a shortened blade (Fig. 7: 5). This form is interesting because it is the only example of a tool having features characteristic of assemblages linked to the youngest phases of the Magdalenian or Epimagdalenian, as is the case, for example, in the highest Magdalenian layers in the Kůlna Cave in Moravia (Valoch 1988). The other end-scrapers are ordinary blade forms.

Given the tool set observed in the assemblage, there is a relatively large number of retouched blades and flakes, i.e. uncharacteristic forms, undoubtedly created *ad hoc* to perform specific, usually short-lasting actions.

It is worth noting that other forms characteristic of the Magdalenian, particularly borers, combined tools and splintered pieces, are practically not represented in the assemblage.

The tools forming the assemblage are thus dominated by one group, *i.e.* backed blades and bladelets, commonly interpreted as pieces of weaponry, in this case, hunting weaponry. Burins, almost exclusively burins on truncations, form another, less numerous group. This composition is very characteristic.

Microscope observation of the tools confirms that the backed blades and bladelets were used as insets in hunting weapons. Many of the investigated artefacts show traces of use, including the characteristic impact signs, while other backed pieces and some burins show clear traces of the processing of organic materials, which indicates the processing of the carcasses of hunted animals. A zone in the western part of the campsite is perhaps a remnant of such a place, as suggested by the stains of hematite dust and lumps of dye discovered there (Bobak *et al.* 2017). A few artefacts were found whose edges were covered with hematite dust. A relatively large number of burins as well as backed pieces, though distinctly less numerous than in the central part of the campsite, were also found in that zone.

Other tools are represented by a small number of artefacts; no traces of wear were found on the investigated examples of debitage (*ibid.*). Some backed blades and bladelets bear traces of wear or impact, but there is a large number of backed pieces devoid of such traces. This group includes artefacts that were certainly produced at the site. Backed pieces and refitted pieces sometimes show different stages and the method of production.

THE SPATIAL AND FUNCTIONAL ARRANGEMENT OF THE SITE

Wierzawice 31 is an example of a small, short-term hunting camp site inhabited most probably over a short period of time by a small group of Magdalenian hunters. Its central point is a very well-preserved stone hearth, surrounded by concentrations of flint artefacts and other stones (Figs. 4; 10).

The hearth is built of granite pebbles and sandstone slabs which form a legible oval structure measuring 95 × 60 cm (the outer circumference). The main traces of burning are pieces of charcoal, highly washed out and mixed with sediments. A small number of burnt flints, mainly small flakes and chips, were found within the structure and in its immediate vicinity. Some stones forming part of the structure also bear traces of the impact of fire. It is worth noting that these traces mainly occur on the lower parts of the stones. No burning traces were found in the sediments. The hearth is not sunk into the ground. The observations conducted indicate similarities between the Wierzawice hearth and other Magdalenian sites where hearth-covering stone structures occur, *e.g.* at Monruz or Champréveyres in Switzerland (Bullinger *et al.* 2006, see for further literature; Leesch *et al.* 2010).

The presence of stones is very clearly limited to the zone of the hearth and its immediate vicinity. Outside the oval structure, the stones are within one metre and co-occur with flint concentrations (Figs 11, 12). These are typically sandstone slabs, some of which are broken pieces of one slab. It is not clear whether they were linked with the hearth structure or whether they had a different function (pads? seating?). Traces of wear visible on some slabs suggest that at least some of them were used for a different purpose, not as structural elements of the hearths or possibly other structures. However, there is a lack of evidence to identify traces of a residential structure at the site. No permanent structures (*e.g.* post-holes) that could be linked to a shelter structure were found, and the pattern of lithic artefacts does not indicate that either.

Fig. 10. Wierzawice, site 31. Hearth remains during excavations. Photo by D. Bobak

Fig. 11. Wierzawice, site 31. Concentration of artefacts. Photo by D. Bobak

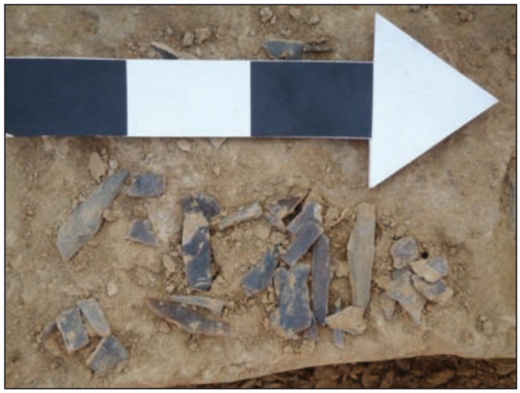

Fig 12. Wierzawice, site 31. Concentration of artefacts. Photo by D. Bobak

A considerable amount of information on the site's spatial and functional arrangement can be obtained from the observation of the distribution of lithic artefacts (Fig. 4). What can be clearly seen is the close connection of the backed blades and bladelets with the hearth. Most of the backed blades and bladelets occur around the hearth. What is more, many of them form small but dense concentrations of backed pieces, some of which can be refitted. There is no doubt that it was a place where hunting weapons were produced and repaired. A small number of cores also occur in the vicinity of the hearth: two lying separately, another three – concentrated, closely linked with the accompanying backed blades and bladelets. These cores are almost exclusively residual blade (often narrow blade) cores or bladelet cores; they are accompanied by blades and production debris. The other cores lie at a greater distance, about two metres from the concentration of cores around the hearth. Two concentrations can be observed here: one in the eastern part, the other in the southern part, on the periphery of the campsite. These two concentrations of cores seem to indicate places of raw material working and debitage production, *i.e.* something like small workshops. The cores lying by the hearth, among backed pieces and numerous pieces of debitage, should be linked with the production of backed blades and bladelets.

Individual tools and pieces of debitage or waste scattered along the boundary should be interpreted as products that were lost or moved there by accident.

The western part of the site also merits attention. The numerous traces of hematite occurring there, whether in the form of grains or dust stains in the sediments, certainly mark a boundary of an activity – probably related to organic material processing (animal carcasses or hides?), which could be confirmed by the relatively numerous burins in this part of the site. Traces of ochre suggesting this kind of activity occur only in one part of the site, but it is worth noting that they are less than two metres away from the hearth, *i.e.* in the immediate vicinity of the camp's centre around which the life of the inhabitants revolved. Such distinct zones of organic material processing are also known from other, larger Magdalenian sites where organic matter processing zones are located at the periphery of camp sites (Julien 1984; 1989; Julien *et al.* 1988). In the case of Wierzawice, we can identify such a separate zone although it is not located at the periphery. This results from the small size of the camp site and, above all, from its role of a short-term hunting campsite where activities were limited to the preparation and repair of weapons and, as seems likely, flaying the killed animals. This purpose of the site is evidenced by the absence of domestic tools, alongside the arguments mentioned above.

SETTLEMENT CHRONOLOGY OF THE SITE

Two radiocarbon dates (Poz-36901: 11,560±40 uncal BP and Poz-41200: 11,080±130 uncal BP) as well as the series of TL and OSL dates mentioned above were obtained at the Wierzawice site (Fig. 2). These dates enable a preliminary determination of the chronology of settlement activity at this site. The calibrated radiocarbon dates are in the range from 13,470 BP to 12,710 BP (with a significance level of 95%). The TL dates obtained from the settlement layer indicate quite a broad timeframe encompassing the end of the Pleniglacial and the entire Late Glacial period.

In order to determine the time of the site's functioning with greater precision, an attempt was made to model that period by means of Bayesian age modelling, carried out using OxCal ver. 4.3 software (Bronk Ramsey 2009a). The IntCal13 calibration curve was used (Reimer *et al.* 2013). All dates (^{14}C and TL) from the cultural layer and the TL date from the eastern profile from 2010 were used to build the model (Figs 2; 13). The profile was selected because the sequence of the greatest number (3) of pre-settlement dates for which a stratigraphic account can be reconstructed originates from this profile. The date 16,000±1,400 BP was excluded from the cultural layer dates as an evident outlier (which was also confirmed by the outlier analysis, cf. Bronk Ramsey 2009b). In consequence, the period preceding Magdalenian settlement was determined by three TLdates, and the duration of settlement was determined by two ^{14}C dates and six TL dates. The objective of the modelling was to establish the broadest possible timeframes in which the Magdalenian settlement episode may have occurred.

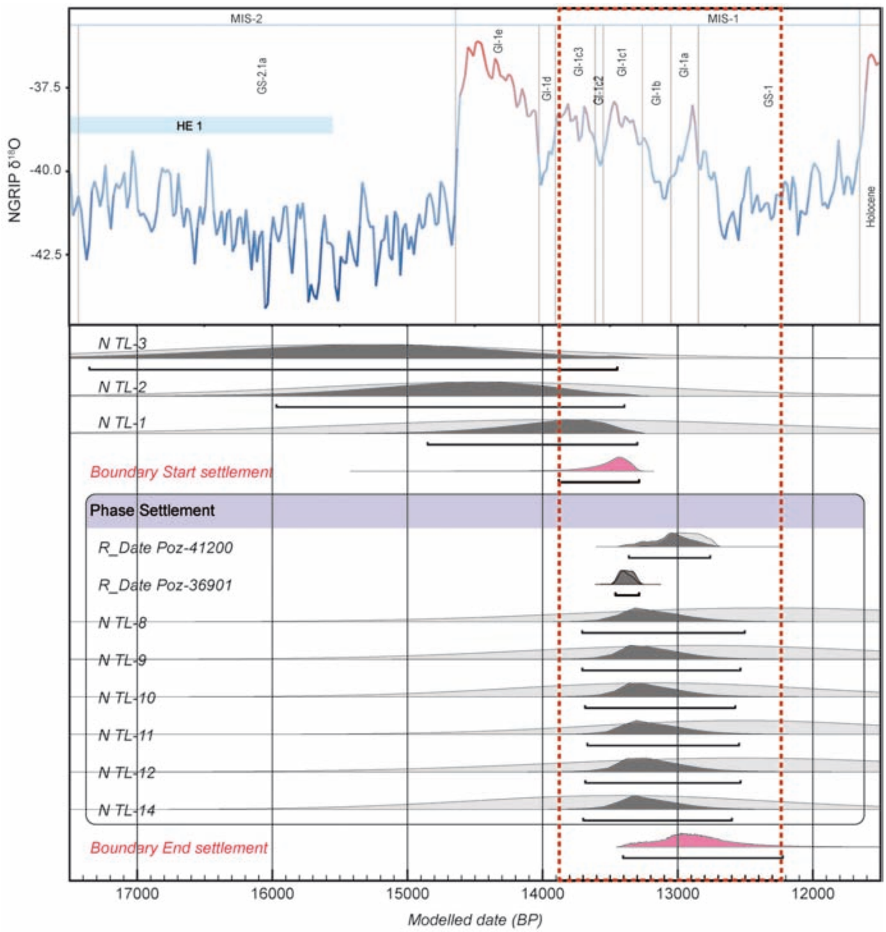

Fig. 13. Bayesian modelling of the site chronology. Illustrated by D. Bobak

The modelling result is shown in Fig. 13. The information obtained makes it possible to date the earliest possible beginning of settlement at the study site to the period between 13,880 BP and 13,290 BP, and the end of settlement to the period between 13,400 and 12,220 BP, *i.e.* from the start of GI-1c3 to the first half of GS-1. According to the sedimentological survey, the cultural layer at the site should be linked with a pause in slope sedimentation and the resulting stabilisation of the terrain, during which a poorly developed weathering/soil horizon formed. This allows us to limit the upper time limit to the period before or to the very beginning of the last Dryas.

Such a young age may give rise to some doubts and questions about the possible errors in absolute dating. In this case, errors may result mainly from the contamination of samples leading to younger dates. It may be the case with radiocarbon dates, but it is another matter with TL dates. Such dates can become younger only during sediment bleaching, which occurred long after the deposition of the layer. In the case of dates originating from below the settlement layer, such a possibility can be ruled out; the spatial distribution of the artefacts shows that they were covered by an intact layer of Magdalenian settlement. Thus, there is no physical possibility of the bleaching of grains from layers located below the layer containing remnants of the Magdalenian campsite that would produce a measurement that would yield an age younger than the settlement.

Similarly, it is not possible to obtain younger dates from the settlement layer. The processes that would cause the above would also have to have disrupted the preserved spatial arrangement of the campsite, which is not the case, as we know. Therefore, it seems that the obtained ^{14}C dates as well as the TL ones should be regarded as reliable.

DISCUSSION AND SUMMARY

The characteristics of the assemblage as well as the distribution of the settlement remains indicate that the Wierzawice site should be interpreted as a short-term camp site, probably inhabited by a small group of hunters. It is one of the very few Magdalenian sites in south-eastern Poland (Fig. 14) represented exclusively by poor sites, most probably

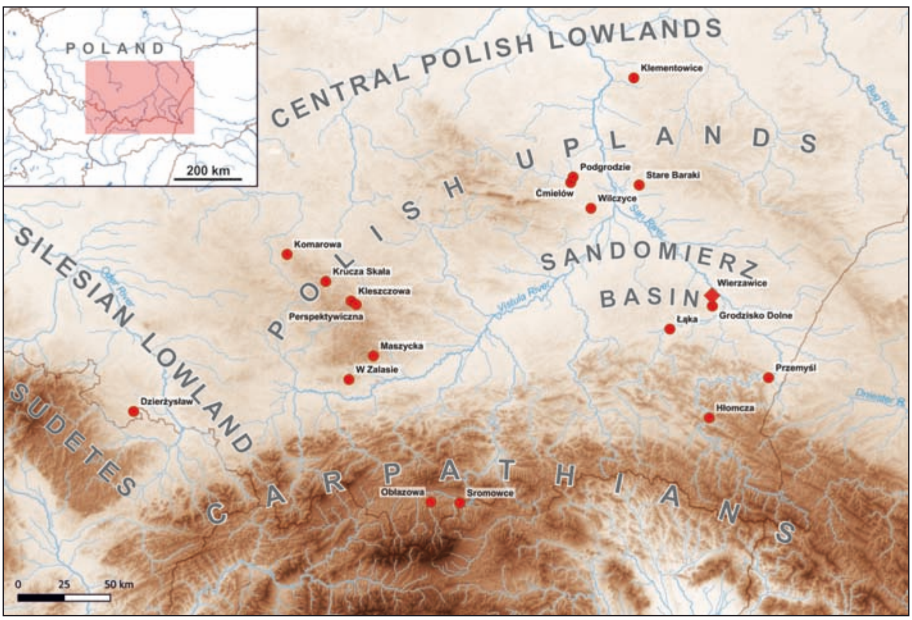

Fig. 14. Magdalenian sites in Southern Poland mentioned in text. Illustrated by D. Bobak

documenting short-term stays, (Łanczont *et al.* 2002; Połtowicz-Bobak 2012; 2013; Połtowicz-Bobak *et al.* 2014) and probably one workshop on the new discovered site in Stare Baraki (Wiśniewski 2020). The Wierzawice site is the richest and best preserved site known in this area (Bobak *et al.* 2017).

Grodzisko Dolne and Łąka, located on the Kolbuszowa Plateau, are the closest sites to Wierzawice. They were dated to the warm periods of the Late Glacial: the Allerød in the case of Grodzisko Dolne and Wierzawice (Połtowicz 2006; Bobak *et al.* 2010; 2017; Bobak and Połtowicz-Bobak 2013; Połtowicz-Bobak 2013), and the second half of the Bølling/beginning of the Allerød in the case of the Ůŕka site (Połtowicz-Bobak *et al.* 2014). It should be stressed that absolute dates obtained with physical methods are available only for the Wierzawice site. The materials from Grodzisko Dolne form a very poor assemblage (40 items) that includes two cores and a few tools: end-scrapers, burins, borers, and backed pieces including arched backed blades (Czopek 1999; Połtowicz 2006). Its chronological position, linked with the Allerød, based on typological premises, is not certain.

The Łąka site features a small assemblage of nearly 200 artefacts, including four cores, one pre-core and 38 tools, including a large series of end-scrapers, burins, and borers; there are no backed blades or bladelets (Połtowicz-Bobak *et al.* 2014).

The materials from the Łąka and Grodzisko Dolne sites include end-scrapers with an almost 1: 1 length to width ratio, often associated with assemblages of such a young age. Only one such artefact can be found at Wierzawice. However, at Grodzisko and, above all, at Łąka, these artefacts are accompanied by tools made from regular, long blades. The Łąka assemblage contains classic Magdalenian blade cores.

It is also worth noting that artefacts in all of these three assemblages were made from a whole range of different materials, among which chocolate, erratic and Świeciechów flint predominates – proportionally more numerous at Wierzawice and less numerous at Łąka. The share of Jurassic flint is higher at Łąka. The percentage share of raw materials at Grodzisko Dolne is more difficult to estimate due to the small size of the assemblage. A few flint artefacts of probably eastern origin ("Volhynian" flint) have been found at Grodzisko Dolne and Wierzawice, and a limno-quartzite originating from the south (Slovakia?) has been discovered at Łąka. These imports may be an important piece of evidence indicating the possible directions of contacts maintained by the Magdalenian communities.

All these sites, similarly to the other Magdalenian sites in this part of Poland, are remnants of small campsites inhabited for short periods. The Wierzawice campsite is the most legible, obviously: its layout and assemblage composition allow for an unequivocal interpretation. In the case of the Łąka site, it was probably a campsite, probably inhabited for a short time as well, but rather of a domestic type, which is indicated primarily by the composition of the assemblage, with a predominance of domestic tools and absence of weapons (backed blades and bladelets). The Grodzisko Dolne site, due to the small number and fragmentary character of its assemblage, cannot be defined in functional terms. The Hłomcza site in the Carpathians is also a short-term campsite of a domestic type (Łanczont *et al.* 2002), probably older than the sites from the Kolbuszowa Plateau discussed here. However, although the above-mentioned sites in the region did not function at the same time, it seems that within a broader timeframe, they are linked with the phase of a certain stabilisation of the land surface and homogenisation of environment conditions in the Kolbuszowa Plateau, where intensive aeolian and slope processes occurred simultaneously in the broadly defined pre-Allerød period.

The territories of south-eastern Poland definitely constitute the eastern borderland of the Magdalenian. Nonetheless, it seems that the area was an integral part of the territories inhabited and used by Magdalenian hunters and strongly linked with the settlement centre on the northern part of the Sandomierz Upland (Połtowicz-Bobak 2020). Perhaps the peripheral character of settlement can explain such a young age of the Wierzawice site and perhaps some of the neighbouring sites as well. Perhaps this area offered favourable conditions for the Magdalenian traditions to survive further into the Allerød Interstadial, when areas lying further west were already within the range of the ABP technocomplex traditions (also present in the territory of the present-day Rzeszów region) (Bobak and Połtowicz-Bobak 2011). This very young age is definitely one of the most interesting problems related to the eastern borderland of the Magdalenian.

The question of contacts with areas east of the present-day borders of Poland remains open. One cannot rule out that the line of the San river, surely an important transport route but also demarcating the eastern boundaries of the Magdalenian, will turn out not to have been an impassable border but just another barrier crossed by the carriers of Magdalenian, or at least its tradition.

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TECHNOLOGICAL STUDY OF THE LITHIC MATERIALS FROM THE SITE WOŁKUSZ 3 IN NE POLAND. THE CONCEPT OF THE PREFERENTIAL BLADES' PRODUCTION

ABSTRACT

Przeździecki M. and Szymczak K. 2022. Technological study of the lithic materials from the site Wołkusz 3 in NE Poland. The concept of the preferential blades' production. *Sprawozdania Archeologiczne* 74/1, 299-323.

The article aims to present the results of the technological analysis of the lithic artefacts from the site Wołkusz 3. This comprises a detailed characterisation of one of the two reconstructed flint knapping strategies described as the concept of preferential blades. The Wolkushian culture inventory consisting of almost 3000 pieces was subjected to the analyses. The collection includes the debitage products – cores, flakes and blades, as well as the products of debitage modification – retouched tools and the spalls connected with the process of their production and repairing. The conclusions are based on refitting studies supported by the analyses of the relief of negatives and the morphological attributes.

Keywords: Late Palaeolithic, tanged points complex, Volkushian culture, lithic technological analysis, Wołkusz site no. 3
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INTRODUCTION

The present article is the continuation of the technological characterisation of the lithic artefacts from Site 3 at Wołkusz Lipsk n/Biebrzą commune, Augustów county, podlaskie voivodship, initiated in vol. 64 of Archeologia Polski (Przeździecki 2019). So far, it comprised the detailed discussion on the first of the two technological strategies reconstructed on the basis of this assemblage, namely the concept of the preferential production of points. Here we are going to present the second technological strategy, defined as the concept of preferential production of blades.

The fundamental aim of our discussion – undertaken in both our texts – is answering the question concerning whether the distinctiveness of the Wolkushian culture inventories (Szymczak 1995, 13, 30-40; 1999) described on the basis of their typological structure and the morphology of the retouched tool forms, is also reflected in the applied technologies, *i.e.* in specific features of the debitage and cores. Demonstrating such a correlation would have be fundamental importance in the discussion that has gone on for a long time on the taxonomic classification, definition, and often the validity of differentiating the prehistoric units.

The above-mentioned controversies originate from the syncretic character of the Wolkushian culture inventories, containing the retouched tools traditionally associated with the various TPC (Tanged Point Complex) units. Mainly, this concerns the concomitance of at least two categories of tanged points, *i.e.* those with flat retouch on the ventral face of the tang, that is Świdry and Chwalibogowice types, and those with the retouch exclusively on the dorsal face of the tang, that is finer items of Ahrensburg type, and more massive ones of Bromme type (Taute 1968, 10-13, Abb. 1). The described coincidence, especially when other reliable typological premises are lacking, raises natural doubts as to the homogeneity of such assemblages (Sulgostowska 1989). The alternative suggestion for explaining the phenomenon of simultaneous appearance of the tanged points of various types was given by M. Kobusiewicz (2009). He believes that some types of tools, such as points of Lyngby type, because of their universal functional character, may occur at the same time in the inventories belonging to various taxonomical units. On the other hand, the lately published results of the morphometric analyses of the tanged points from Western and Eastern Europe generally seem to discredit the use of this category of points as cultural indicators (Ivanovaite *et al.* 2019).

The authors think that the doubts mentioned above could be resolved by a detailed technological characterisation of these assemblages. The benefits from such an approach would be as follows:

a. introducing new arguments to the discussion on the Wolkushian culture, which would evaluate the typological criteria on the basis of which the whole unit was differentiated;

b. incorporation of the mass material (debitage, cores, and spalls), to the analyses, which thus far were rather ignored;

c. the possibility to formulate a new type of conclusions concerning the activities connected with flint knapping; they could be examined on the different levels: specific, *e.g.*, individual decisions taken by the flint knappers on a particular site, or more general, *e.g.*, the technological tradition expressed by the permanent replication of the certain technological standards (methods and techniques) by the larger social groups;

d. the comparison of the obtained results with the technological picture of the other TPC cultural units (*e.g.*, Dziewanowski 2006; 2012).

The first step to undertake the investigation in this direction is the detailed analysis of the reference inventory. The conclusions drawn on this stage are going to constitute the starting point to the wider comparative analyses and search for possible analogies. The specificity of the technological investigation which demands the detailed and time consuming analyses, in this case excludes any other procedure.

MATERIALS AND METHODS

We have chosen the assemblage from the site Wołkusz 3 as the reference inventory for three reasons:

a. the presence of a representative set of the retouched tool forms, recognized as distinctive for the Wolkushian culture (Szymczak 1995, 13, 14, 30-36), in that number the rich series of the massive tanged points without the flat retouch on the ventral face of the tang;

b. the presence of a representative set of cores, debitage products, and the spalls, *i.e.* the components which allow the technological observations to be performed;

c. the assemblage belongs to the not too numerous group of the Wolkushian inventories gained in course of the systematic, well documented excavation.

The article concentrates on the analyses of the core refittings. The choice of this category of artefacts was dictated by the following reasons:

a. the information recorded in the core reduction process is the most complete representation of the debitage process;

b. core refittings combine different categories of products, coming from different stages/phases of their implementation;

c. conclusions resulting from the analysis of core refittings provide a context for research on non- refitting artefacts.

Application of this method allowed the identification of the sequence of operations (the succession of detaching), and, what is especially important, the rating of their cause-and-effect relations (Cziesla 1990, 9-45). The important part of the investigation was also the analysis of the morphological details, and the scar pattern analyses (*e.g.*, Bar-Yosef and Van Peer 2009). This gave insight into the individual and cultural choices of the makers/flintknappers. The complementary application of these methods made it possible to reconstruct the process of debitage together with the connection of the technological operations constituting it with the set of morphological attributes of their material correlates.

The concept of the preferential blades' production was identified in the context of 10 refitting blocks. They reflect two varieties of its realization – single striking platform (blocks W3B2, W3B3, W3B21, W3B31), and double striking platform (blocks W3B8, W3B11, W3B17, W3B20, W3B25, W3B198). Both concepts were characterized in detailed individually exemplified by the case studies of blocks W3B2 and W3B8. The most important conclusions obtained in course of this analysis, the technological (*e.g.*, identified links of operation chain), as well as the morphological ones (the set of distinctive features), served to construct tables making it possible to compare also the results of the examination of the remaining refitting blocks (Tables 1, 2). This provided the basis for the synthesis of data and the formulation of general conclusions about the debitage process carried out on the site and the morphological parameters of the products. The summary of the research presents the reconstructions of the idealized model of the chain of operations.

The concept of the preferential method was first described in the late Palaeolithic context by Witold Migal (2007). In his research, he linked the shape of the blades, but above all, the arrangement of the negatives on the upper side of the points (Bromme type) with the scar pattern on the flaking surface on the cores. Since then, elements of this theory have been used, inter alia, in analysis lithic technology of the Swiderian (Dziewanowski 2006ł 2012) and Volkushian (Przeździecki 2019) assemblages.

RESULTS

The concept of the preferential blade production in single striking platform variant. Case study – block W3B2

Block W3B2 of dimensions 112/36/75 mm consists of nine pieces. It represents a strongly exploited single striking platform core (el. 1), 7 technical spalls – 3 flakes (el. 2, 3, 6), 2 crested blades (el. 4, 5), and 3 blades (e. 7-9) (Fig. 1). It illustrates the process of reduction of a single striking platform core with the narrow, rectangular flaking surface situated on the narrower side of the flint nodule, and the unworked, cortical surfaces of the remaining sides and back.

The initial stage of the treatment of block W3B2 was named 'stage 0'. It is represented by a series of percussions aiming to give a nodule its primary core shape. This operation is manifested by a group of the relatively fine, hollow negatives (1-6), which are the effect of the removing of the natural knobbs, a characteristic feature for the nodules of the cetaceous flint of the north-eastern variety.

The second stage is the initial preparation comprising the zone of future striking surface, and then the striking platform. In case of the flaking surface the process was realized in the course of two succeeding operations.

Table 1. Technological operations (knapping stages) identified during the analysis of the refitted cores from the site Wołkusz 3. Note that the second column shows the dominant order of occurrence of the technological treatments or phases. However, in a few cases this order may be changed, so it is important to follow the numbering of negatives (n) and elements (e). The symbol 'x' indicates that a given type of operation did not occur in the reconstructed process or was not identified, *e.g.* due to the low completeness of the block

stage	treatment/phase	**W3B2** Fig. 1	**W3B3** Fig. 3	**W3B21** Fig. 4	**W3B31** Fig. 5	**W3B8** Fig. 2	**W3B25** Fig. 9	**W3B17** Fig. 7	**W3B11** Fig. 6	**W3B20** Fig. 8	**W3B198** Fig. 10
0	regularization	n.1-6	x	x	x	x	x	n.1-5, e.2, 3	n.1	-	x
1	sides preparation	x	x	x	x	x	x	x	-	n.1, 10	x
	back preparation	x	x	x	x	x	x	x	n.2, 3	n.2-9, e.2	x
	exposure of the upper striking platform level I	e.3	n.1-4	n.1		n.1	n.1	n.4	n.4, 5	n.17-21, e.6, 7	x
	exposure of the lower striking platform level I	x	x	x	x	e.2	n.2, 3	n.8	n.6	n.12-16, e.3, 4	x
	configuration of the future striking surface	n.7-10, e.2	n.5-8	-	-	n.3-8	n.4, 5	n.6, 7	-	n.11, 23-29, e.8	x
	exposure of the striking surface	n.11-13, e.4, 5	n.9,10	n.3-8	n.1	n.9-12, e.3-6	n.6-8	n.10-18	n.7, 8	n.31, 32	x
	exposure of the upper striking platform level II	e. 6	x	x	x	x	x	x	x	x	x
2	isolation of the preferential blade	n.14, 15	n.11-15	n.4-6	n. 2, 3	n.11-13, e.5,6	n.9, 10	n.19-21, e.5	n.9, 10	n.30, e.9, n.33-36	n.1
	execution of the preferential blade	n.16, 17	n.16, e.2, 3	e.2, n. 9	n. 4	n.14, e.7	n.11, 12	n. 22	n.11, e.2	n.37, 38	n.2
	isolation of the preferential blade	x	x	x	n.5, 7	x	x	n.23, 24	-	x	n.3, 4
	execution of the preferential blade	x	x	x	e.2	x	x	n.25	-	x	n.5
	isolation of the preferential blade	x	x	x	n.8	x	x		-	x	
	execution of the preferential blade	x	x	x	n.9	x	x	x	-	x	
3	serial debitage	n.18-20, e.7	n. 17-20	x	-	n.15-17, e.8, 9	x	x	n.12-16	x	n.6, 7
	exposure of the lower striking platform level II	x	x	x	x	n.18-20	n.13	x	x	e.5	n.9-12
	exposure of the striking surface on the side of the core	n.21, 22	x	x	x	x	n.14, 15	n.26, e.6	n.17	x	n.8, e.2, 3

Table. 2. Group of morphological attributes identified during the analysis of the refittings cores from the site Wołkusz 3. Roman numerals mark the levels of the striking platform and subsequent stages of the evolution of the striking surface. The symbol 'x' indicates that the given morphological feature is not present in the block

Block number	Striking platform			Internal angle between striking platform and striking surface	Striking surface	Sides	Back
	Configuration	Type of surface	Direction of detaching		Horizontal convexity /shape	Type of surface	Type of surface
W3B2	x	I single-negative II single-negative	I from the striking surface II from the striking surface	I 90°- 80° II 90°- 80°	I triangular II flat III double-walled	cortical	cortical
W3B3	x	multi-negative	multidirectional	80°- 70°	I triangular II double-walled	cortical and negative	cortical
W3B21	x	single-negative	from the striking surface	80°- 70°	I triangular II flat	cortical and negative	negative
W3B31	x	I single-negative II single-negative	from the striking surface	80°- 70°	trapezoidal	cortical and negative	cortical
W3B8	I paralel II angular	I single-negative / upper/ I multi-negative / lower/ II multi-negative / lower/	I from the striking surface / upper/ I from the side /lower/ II from the side /lower/	I 80°- 70° /upper/ I 80°- 70° /lower/ II 90°- 80° /lower/	I trapezoidal II flat	cortical and negative	cortical

W3B25	I parallel II angular	I single-negative / upper/ I multi-negative / lower/	I from the striking surface / upper/ I from the side /lower/	I 70°- 60° /upper/ I 90°- 80° /lower/ II 80°- 70° /lower/	I triangular II flat III double-walled	cortical and negative	cortical
W3B17	angular	I single-negative / upper/ I single-negative / lower/ II single-negative / lower/	I from the side /upper/ I from the striking surface / lower/ II from the striking surface / lower/	I 70°- 60° /upper/ I 70°- 60° /lower/ II 70°- 60° /lower/	I flat II double-walled	negative	negative
W3B11	parallel	I single-negative / upper/ I multi-negative / lower/	I from the striking surface / upper/ I multidirectional /lower/	80°- 70° /upper/ 90°- 80° /lower/	I triangular II flat III double-walled	cortical and negative	cortical
W3B20	parallel	I multi-negative / upper/ II single-negative / upper/ I single-negative / lower/ II single-negative / lower/	I from the striking surface / upper/ I from the striking surface / lower/	I 80°- 70° /upper/ II 90°- 80° /upper/ I 80°- 70° /lower II 90°- 80° /lower/	trapezoidal	cortical and negative	negative
W3B198	parallel	I multi-negative / upper/ I single-negative / lower/	I from the striking surface / upper/ I from the striking surface / lower/	I 80°- 70° /upper/ I 90°- 80° /lower/	trapezoidal	negative	cortical

Fig. 1. Block W3B2: single striking platform variant.
Black – cortex; hatched area – thermally damaged surface; red numbers – refitted pieces; black numbers – negatives of removals; arrows – direction of percussion

The first group of these operations, *i.e*. the bifacial shaping of the crested edge (marking the future striking surface), on the narrower side of the nodule, is documented by the negatives Nos. 7-10, and the relatively massive cortical flake (el. 2). This flake, in spite of the function connected strictly with the flaking surface formation, played also a significant role in the procedure of the shaping of the striking platform. It consisted of creating within the limits of the striking surface, or one of the core's sides, the base (a single negative) which would allow the execution of a single, precise blow removing the basal flake and thus forming the a regularly flat, relatively broad striking platform. While analyzing the process of shaping of the crested edge, it is worth mentioning the ad hoc use of the base of the core as the place for a single trimming blow (n. 10). Interesting is that, despite the favorable parameters which potentially would allow the adaptation of the base of the core to play the role of the alternative, opposite striking platform, this possibility was never made use of, and the reduction process was carried on all the time only from one striking platform.

The second phase of the preparation consisted of the exposure of the flaking surface by knapping a series of technical blades. This is illustrated by the refitting of two crested blades (el. 4, 5), and a sequence of negatives Nos. 11-15. They were removed in a way (arrangement and succession) which determined the general cut out of the planned preferential form on the flaking surface (n. 15). The phase of exposing the flaking surface was preceded by knapping a single flake (el. 3), which formed a regular striking platform on the wider end of the nodule (level I).

The end of the operations connected with the core's preparation was marked by the procedure of the shaping of the striking platform (level II). The blow removing a flake (el. 6) was executed somewhat from the left side of the precore/core, slantwise in relation to the axis of the future striking platform which allowed the knapper to obtain an even, uniform platform encompassing the full contour of the core.

The next stage of the core reduction was the detaching of regular blades proper. It is defined by two stages of its generation: predetermination, and the execution of the preferential forms (n. 17). The aim of the first group of the operations mentioned above was the extraction from the contour of the flaking surface the cut out of the future preferential blade. This effect was obtained by the separation along its future edges of the semicortex blades (n. 14, 15), and crested blades (el. 4, 5). The process of generating the preferential form is being closed by the stage of the execution of a blade (n. 16, 17). It seems that in case of the analyzed core the same operation could have been repeated at least twice.

In the third stage, the knapping process changed dramatically. As long as during the stage of the blade detachment proper (stage 2) the effective area of the flaking surface was limited to the narrower side of the core, during the third stage the exploitation axis was moved in the direction of the side plane of the core (n. 18-22). This operation ensured keeping the proper convexity of the striking surface, and detaching the blades without cortex, which would be not possible in the case of holding on to the previous setup of a core, *i.e.*, with the flaking surface limited only to the narrower side of a nodule. As a result of this operation, at the junction of the previous front and side of the core, a "corner" was shaped, creating optimal conditions for the separation of the blades. Of course, the morphological changes correlate with the change in the blades generation concept, *i.e.,* the start of a serial debitage.

In the final phase of the stage 3, the process of core reduction became broken down because of the subsequent mistakes committed by the flint knapper. This is illustrated by a series of hinged negatives (n. 19-22), which are the traces of unsuccessful execution of serial forms. Even though the knapper tried to repair the core, his efforts made the situation worse and worse, leading to him finishing attempts at its further exploitation and to discard it as an already useless piece. These operation are illustrated by the refittings (el. 7-9), and negatives (21-23).

The conducted analysis allows us to draw the following conclusions:

a. Block W3B2 represents almost complete record of the sequence of operations connected with the reduction of a core;

b. The exploitation was carried on with the use of exclusively one striking platform;

c. The main technological axis is defined by a concept of the production of the preferential blades with the parallel run of the edges in their proximal and mesial segments, but converging rapidly in their distal parts, creating in that way a regular sharp pointed tip;

d. The effectiveness of such a process was limited to just one or two predetermined forms meeting the morphological demands described above; Furthermore, a numerous group of (predetermining) technical waste forms was generated.

e. The indirect evidence that the described preferential forms met the expected morphometric standards is a lack of these elements in the refitted block.

The main links of the operation chain reconstructed in course of the analysis of block W3B2 are defined by three groups of operations designating the succeeding stages of reduction.

Stage 0 was giving the nodule more regular shape, which enfolds a series of blows leading to the removal of the knobby or finger shaped protuberances characteristic of the nodules of the cretaceous flint of north-eastern variety (Szymczak 1992).

Stage 1 was just a preparation limited to the zone of future striking platform and future striking surface. Within this stage we have distinguished:

a. the phase of configuration of the future flaking surface – which resulted in forming a bifacial crest on the narrower side of the nodule;

b. the phase of exploitation of the flaking surface – which started with the detaching of a series of crested blades, and the blades next to the crested blades to form a narrow flaking surface with parallel blade negatives and the isolated zone ready to detach the preferential form from it.

The operation which divides those two phases was preparing the striking platform (level I) where as the base for a final blow, the surface of one of the crested blades' negatives was used. The finale of the stage of primary preparation was marked by the detaching of the rejuvenation blade defining ultimately the level (II) and the parameters of the core.

Stage 2 was the process of detaching blades, and consists of:

a. a phase of predetermination of the preferential blades (configuration phase) consisting in the isolation on the flaking surface of the outline of the planned form. It was achieved by the detachment from both sides of the flaking surface the blades next to the crested blades, or subcortical blades.

b. phase of execution of the preferential blades which were the primal aim of the core's processing.

Stage 3 is described as the serial debitage and is defined by the process of the gradual broadening of the flaking surface in the direction of one of the raw sides of a core. As a result, the flaking surface has a specific, two-sided form where one side covers the surface of the primal striking surface, while the second – a fragment of the core's side. The blades are detached from the corner formed in that way.

The concept of preferential blades' production in the double striking platform variant. Case study of block W3B8

Block W3B8 of the dimensions 96/37/69 mm (Fig. 2) presents the refitting of eleven elements representing a nearly complete record of the reduction of the core (el. 1) with a narrow, well prepared striking surface, and flat, cortical or natural (patinated) surfaces of the sides and back.

The first of the reconstructed stages is the primary preparation including two phases. The first one was limited just to forming the upper striking platform (level I) (n.1) with

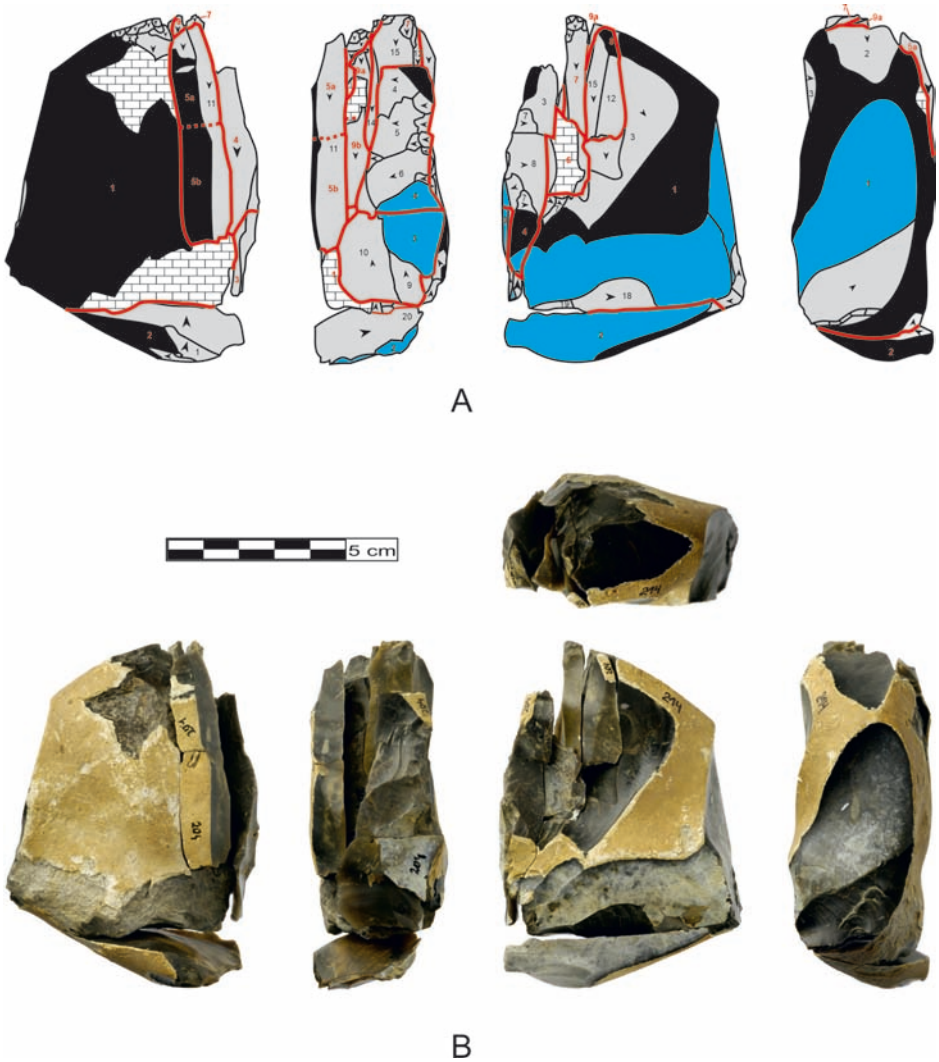

Fig. 2. Block W3B8: double striking platform variant. Black – cortex; blue – patinated surface, hatched area – thermally damaged surface; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion; red line – plane connection (negative object to positive object); red dotted line – connection fractures (broken pieces)

a single blow directed from the side of striking surface, and the lower striking platform with a blow from the core's side (level I) (e. 2) where as a base the surface of the especially designed negative (2) was used. It is worth emphasizing that the analogous operation was reconstructed in the case of the refitting W3B2. The second stage is determined by the operation of preparing the striking surface, and consists of:

a. the phase of configuration of the future striking surface, *i.e.* the bifacial crested edge (n. 3-8) on the narrower side of the nodule;

b. the phase of exposing of the striking surface, from which a series of crested blades (n. 9, 10; e, 4), the blades next to crested blades (e. 3, n. 11, 12), and subcortical blades (e. 5a, b) was detached.

It should be mentioned that the phase of exposing the flaking surface in its initial moment was realized based on the parallel exploitation of both opposite striking platforms. Nonetheless, together with the continuation of the reduction process, the role of the lower striking platform gradually diminished, till the moment when in the terminal phase of the preparation the whole set of operations connected with the process of exposing the flaking surface was taken over exclusively by the upper striking platform.

The second stage of the reduction of block W3B8 is defined by the process of generating the preferential blades (n. 11-14, e. 7, 9a, b). As in the case of block W3B2, it has a two phase course. The phase of configuration is illustrated by the detachment of two predetermining forms (e. 5a, b, 6) which resulted in forming in the central part of the flaking surface a clearly separated zone of isolation of the preferential blades (n. 14).

In the third stage, the concept of blades generating was being modified and takes a character of the serial exploitation, *i.e.* where the execution of one form (e. 7) was integrated with operation of configuration of the next one (n. 15-17, e. 8, 9a, b). This process was carried out within the existing striking surface. In this aspect it differs from the stage of terminal blades' detachment reconstructed in the context of block W3B8. Yet, the common element for both variants is the way of the blows' localization, making it possible to isolate a certain part of the flaking surface restricting the place of the execution of the next blade.

Core reduction ends with the correction of the lower striking platform (level II) (n. 18-20). Most likely this was done to use it to remove the hinges on the striking surface.

Summarizing the information gained in the course of the analysis of block W3B8, special attention should be paid to the following facts:

a. The high degree of the core's reconstruction makes it possible to characterize in detail the process of its reduction.

b. It provides an example of realizing the single striking platform intention of reduction but based on the double striking platform architecture of the core. From this perspective, the property of having two opposite striking platforms has a purely formal character. In the technological context the exploitation process bears all the attributes of the single striking platform concept. The active using of the lower striking platform was connected exclusively with the most initial stage of the striking surface's preparation, and was limited to just 3-4 blows; the remaining part of the reconstructed technical operations was realized on the base of the upper striking platform. This is reflected in the unidirectional arrangement of the negatives on the striking surface, as well as in the refittings of the detached blades.

c. The main technological axis is being defined by the concept of the production of the preferential blades, *i.e.* the forms with parallel edges in their proximal and mesial parts, but converging rapidly in the distal part creating a sharp, pointed tip.

d. The effectiveness of these operations was limited to gaining 2-3 preferential forms. In addition, a few pieces of technical waste forms were also generated.

The individual links of the operation chain which were reconstructed in course of the analyses could be generalized in the following stages:

Stage 1 – initial preparation, comprising:

a. the exposure of the upper and lower striking platform performed in the single-phase variant,

b. preparation of the flaking surface performed in two-phase variant.

Stage 2 – the blades' detaching proper, comprising the two-phase process of predetermination and execution of the preferential forms;

Stage 3 – terminal blades' detachment based on the serial debitage concept.

DISCUSSION

The results of the conducted analysis of the cores point to a number of the multilevel similarities in the manner of their reduction. The analogous features are:

a. The aim of debitage which was the gaining of the single preferential blades, *i.e.* the massive forms of rectangular shapes and with parallel side edges and internegative scars, together with the relatively wide apices.

b. The process of core reduction (the method), which means a strictly defined sequence of technical operations (Table 1).

c. Morphological parameters of the negative and positive forms (Bradley and Giria 1996), in other words – the effects and products of debitage (Table 2).

The fundamental axis of the discussed strategy was determined by the quest of the proper isolation (convexity) of the blade on the striking surface, and preservation of the parallel run of its side edges. In technological aspect this was the superior aim determining the character of the certain technical operations, as well as the morphometric parameters of the core. The conducted analysis have shown that the effect of isolation could be obtained in three different ways:

a. by exposing on both sides of the flaking surface a pair of deep and wide negatives which resulted in shaping in the central part of the well pronounced hump, *e.g.* W3B20 (Fig. 8), W3B21 (Fig. 4), W3B31 (Fig. 5), W3B198 (Fig. 10), W3B13 (Fig. 11:1);

b. by the gradual separation of the isolation zone with the help of knapping off a number of fine blades and bladelets *e.g.* W3B2 (Fig. 1), W3B26 (Fig. 11: 3);

c. by moving the field of the flaking surface towards the side of the core, in a way that shaped it into a two sided form (double-walled), and in such a situation, the blade was

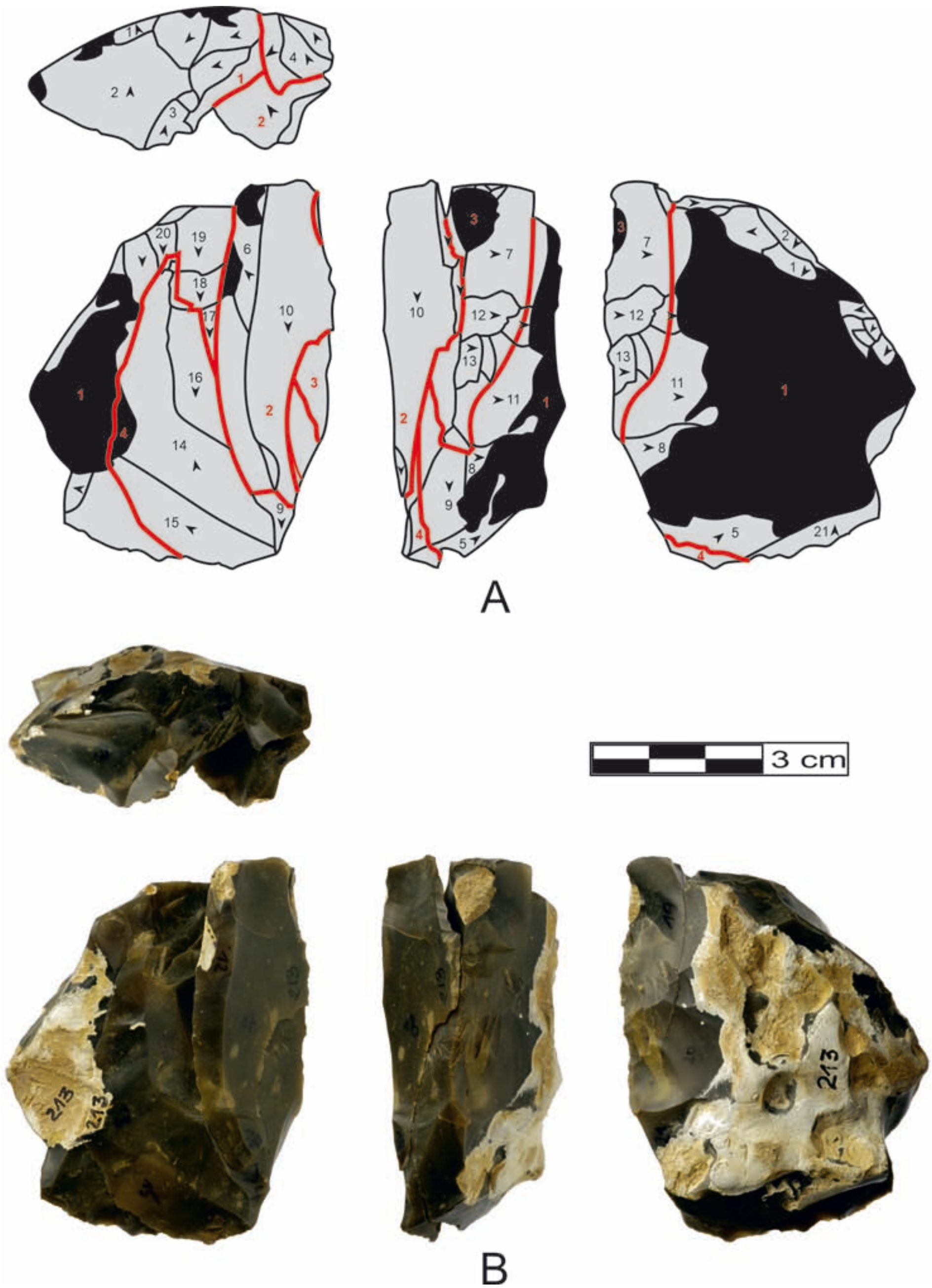

Fig. 3. Block W3B3: single striking platform variant. Black – cortex; red numbers – refitted pieces; red line – plane connection of the pieces (negative to positive); red dotted line – connection fractures (broken pieces); black numbers – order of removals; arrows – direction of percussion

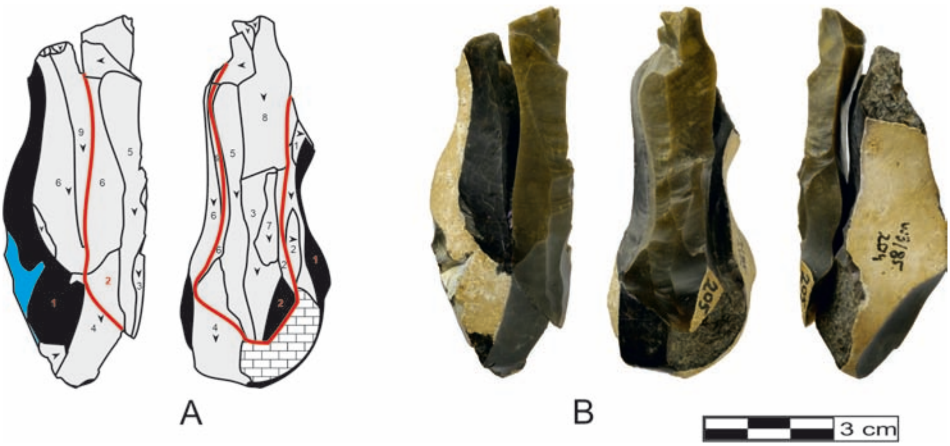

Fig. 4. Block W3B21: single striking platform variant. Black – cortex; blue – patinated surface; hatched area – thermally damaged surface; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion

detached along the corner which was created in the course of this operation. This is perfectly illustrated by blocks W3B11 (Fig. 6), W3B17 (Fig. 7), W3B25 (Fig. 9) and W3B29 (Fig. 11: 2).

The procedures described above undoubtedly have the character of predetermining operations that allow controlling the parameters such as thickness, width, and the course of the side edges of the planned blade. This would mean that the debitage products that were generated in the course of realizing this could be divided to the technical (predetermining) forms, and the preferential (predetermined) ones. This division reflects directly the two subsequent stages connected with the process of generating a preferential form, *i.e.* the phase of isolating the side edges (Fig. 12: 1D, 2B), and the phase of execution (Fig. 12: 2A, C). It should be noted that the convexity shaping process often took place at the stage of flaking surface preparation (exposure phase) (Table 1).

The earliest stage (Fig. 12: 2) of detaching blades was connected with the procedure of generating the preferential form based on the operation of exposition and drawing back of the sides of the flaking surface by detaching massive crested or semicortex blades along both its edges (Figs 4, 5, 8, 11: 1, 3, 4). At that moment, all the operations connected with the process of detachment of blades were strictly limited to the exact striking surface, *i.e.* the zone that was already shaped during the stage of the primary preparation. In another variant, the process of isolating the preferential form was realized by knapping off a series of fine, highly morphologically differentiated blades or bladelets.

In the third stage (Fig. 12: 3), the stadial debitage procedure breaks down in favour of serial debitage. This is related to the loss of the horizontal convexity of the flaking surface

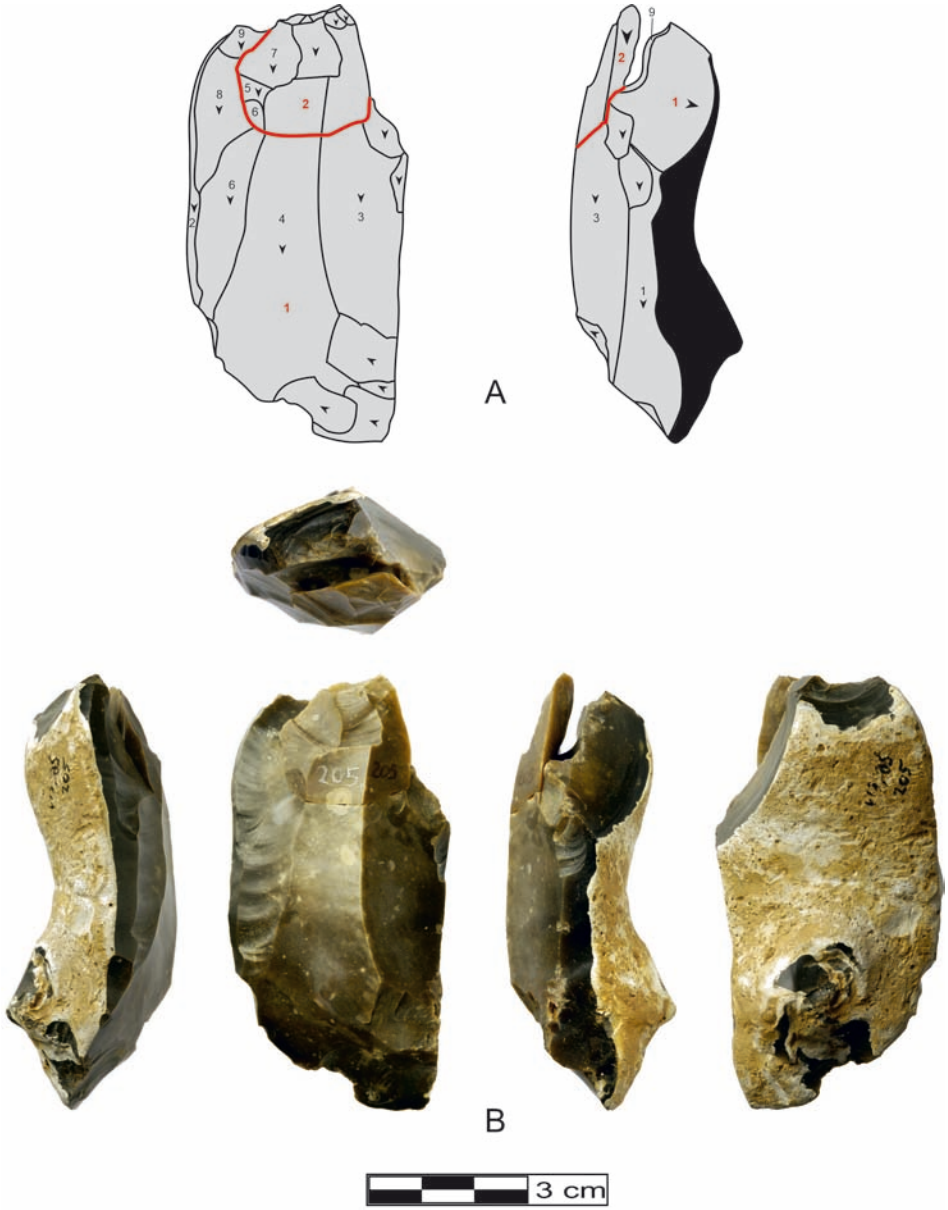

Fig. 5. Block W3B31: single striking platform variant. Black – cortex; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion

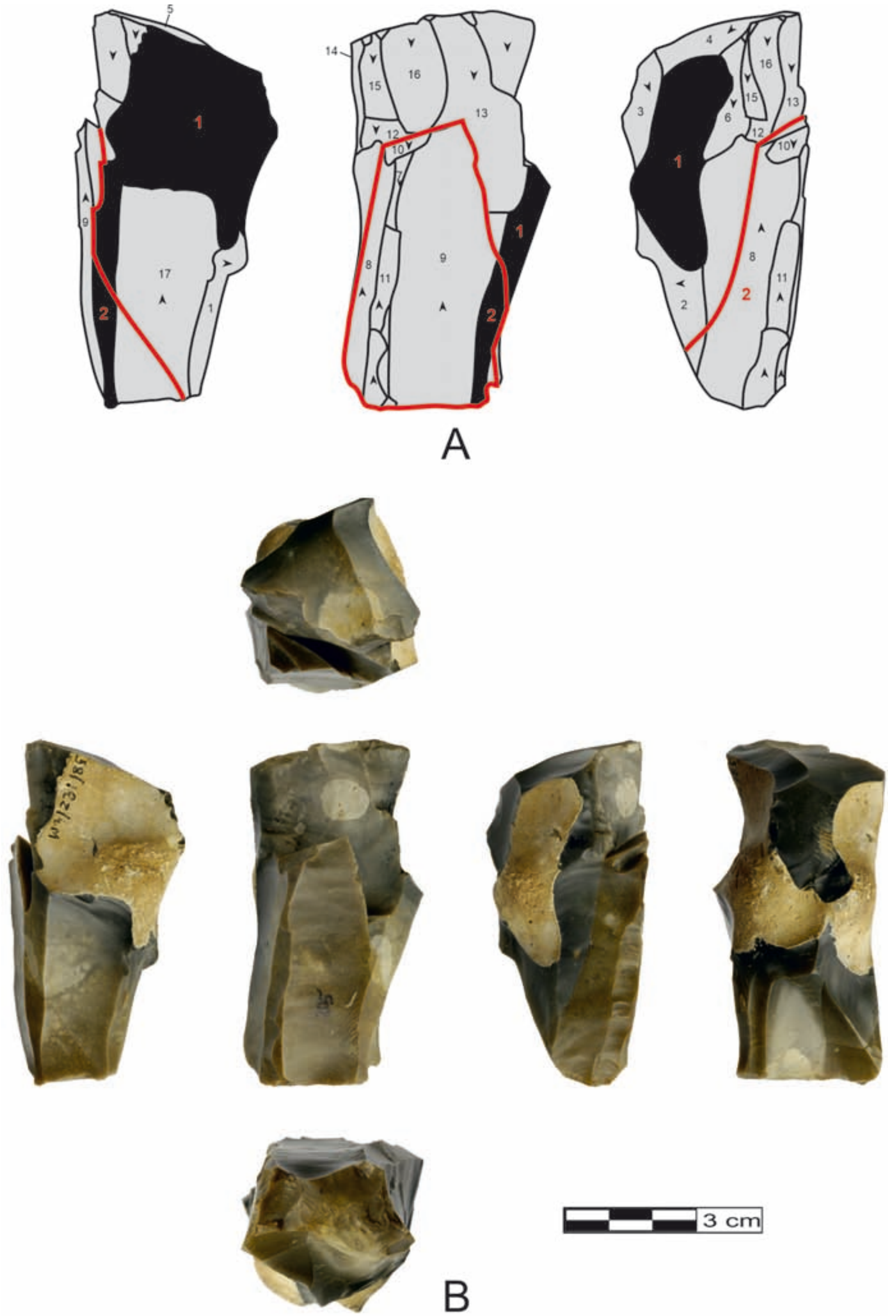

Fig. 6. Block W3B11: double striking platform variant. Black – cortex; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion

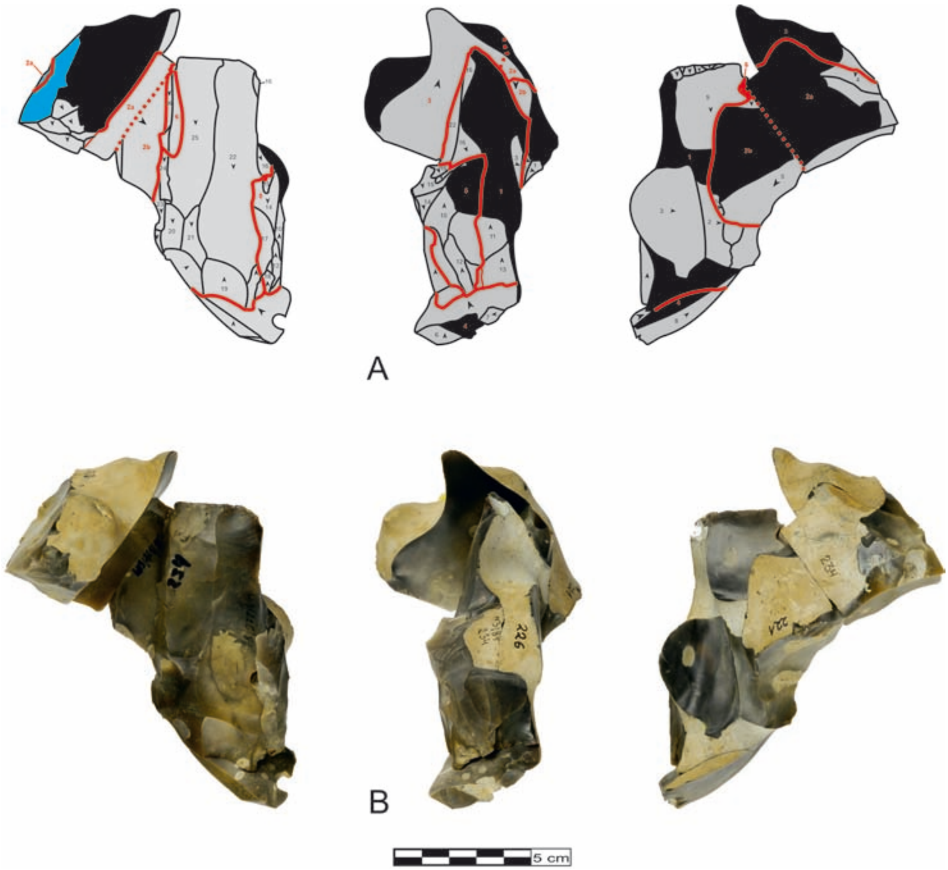

Fig. 7. Block W3B17: double striking platform variant. Black – cortex; blue – patinated surface; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion; red line – plane connection (ventral and dorsal sides); red dotted line – connection fractures (broken pieces)

that until then had a triangular or trapezoidal shape. This impasse was solved by shifting the flaking surface to one of the sides of the core. The result of this operation is the characteristic form of 'the new one'. Serial blades were detached along the corner (Figs 6, 7, 9, 11: 2).

Summing up the results of the study on the refits, it should not be missed that the process of the proper blades' detachment was preceded by one or two separate phases. The first, described as regularization of the raw material (Fig. 12: 0), is illustrated by the deep negatives of the oval outline which are the effect of knocking off the finger like or knobby protrusions. It seems that the 'planes' obtained in that way could also serve as the basal surfaces to execute the most initial blows of the preparation character.

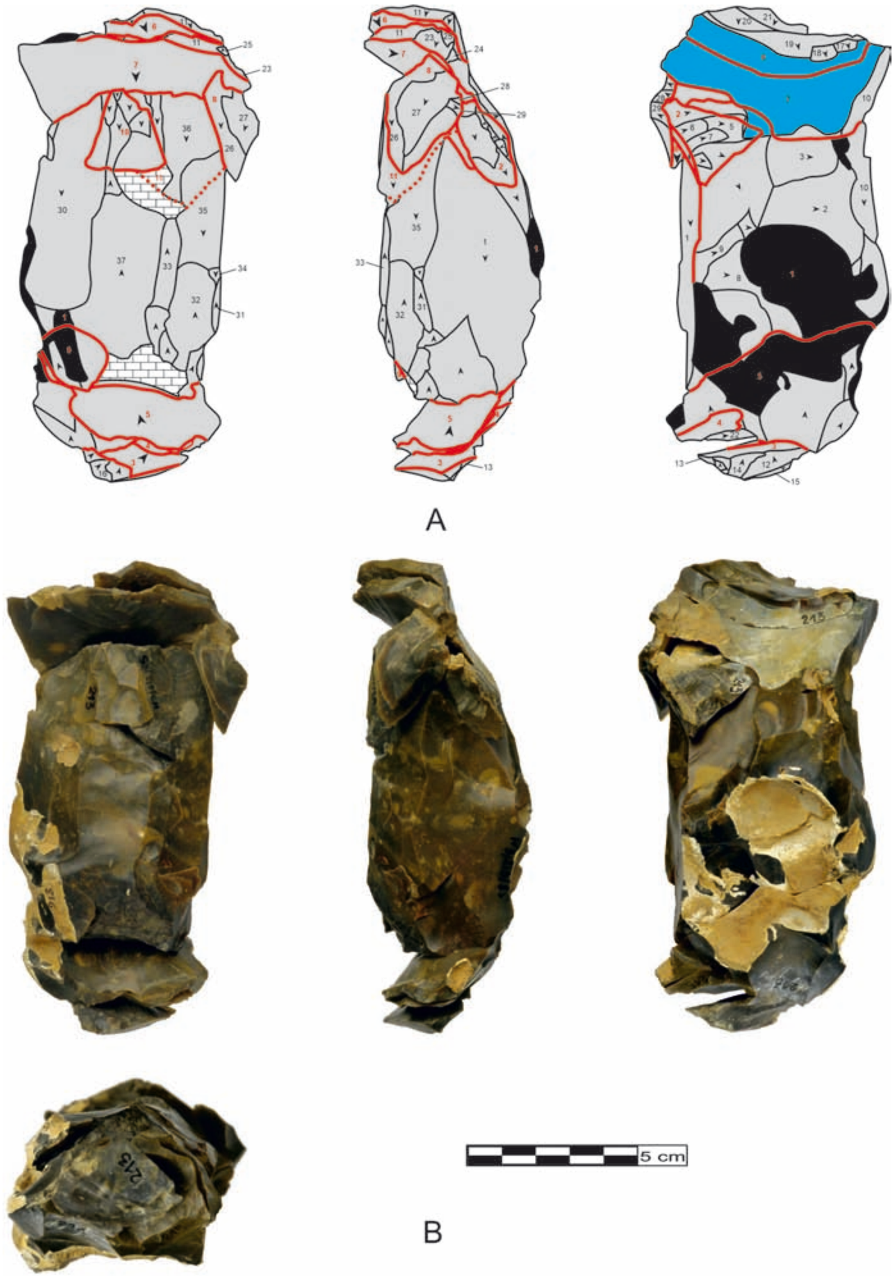

Fig. 8. Block W3B20: double striking platform variant. Black – cortex; blue – patinated surface; hatched area – thermally damaged surface; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion; red line – plane connection (negative object to positive object); red dotted line – connection fractures (broken pieces)

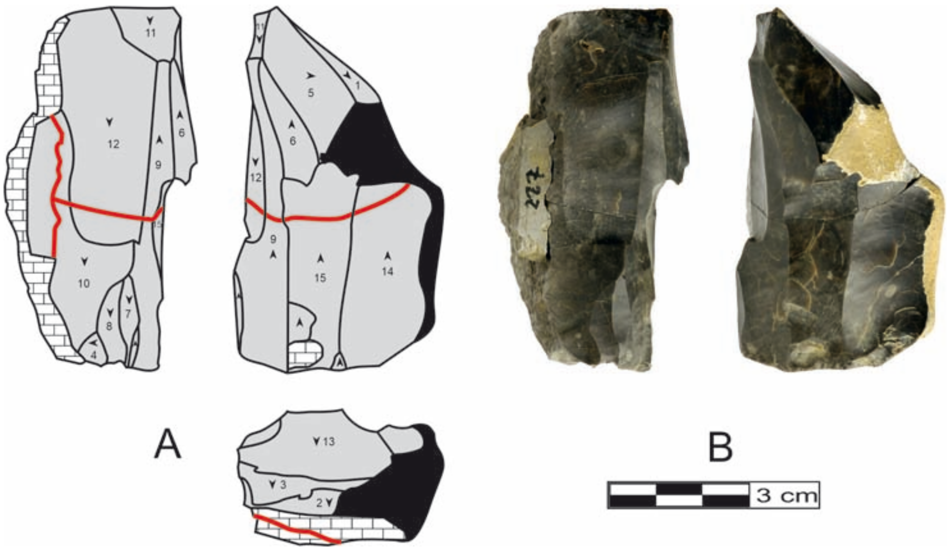

Fig. 9. Block W3B25: double striking platform variant. Black – cortex; hatched area – thermally damaged surface; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion

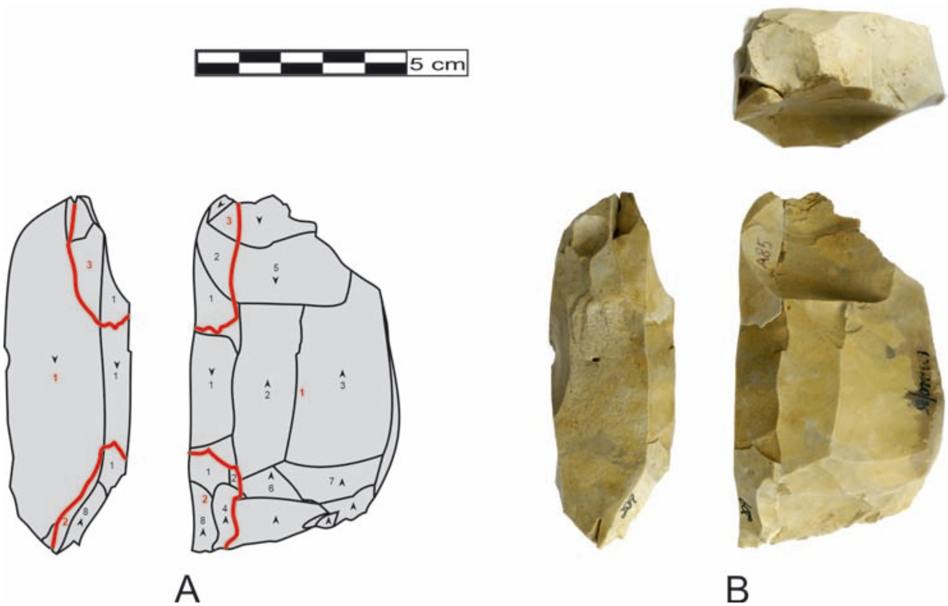

Fig. 10. Block W3B198: double striking platform variant. Black – cortex; red numbers – refitted pieces; black numbers – order of removals; arrows – direction of percussion

Fig. 11. Selected examples of refittings from the site Wołkusz 3: 1. Block W3B13 – double striking platform variant; 2. Block W3B26 – double striking platform variant; 3. Block W3B29 – double striking platform variant; 4. Block W3B170 – refittings of massive blades (cortex- and semicortex)

The second (Fig. 12: 1) is the initial preparation of the core. Even though it was realized with the use of the relatively simple means, and being spatially limited to the zones of (future) striking platform (s) and (future) striking surfaces, it is characterized by the presence of specific operations that analysis of all the blocks showed were being repeated. The first group of these operations is determined by the two-phase process of the preparation of the striking platform consisting of:

a. Operation of shaping of the bifacial crested edge (future striking surface) compassing the whole, or only a fragment of future flaking surface (Fig. 1: A) As the second of these

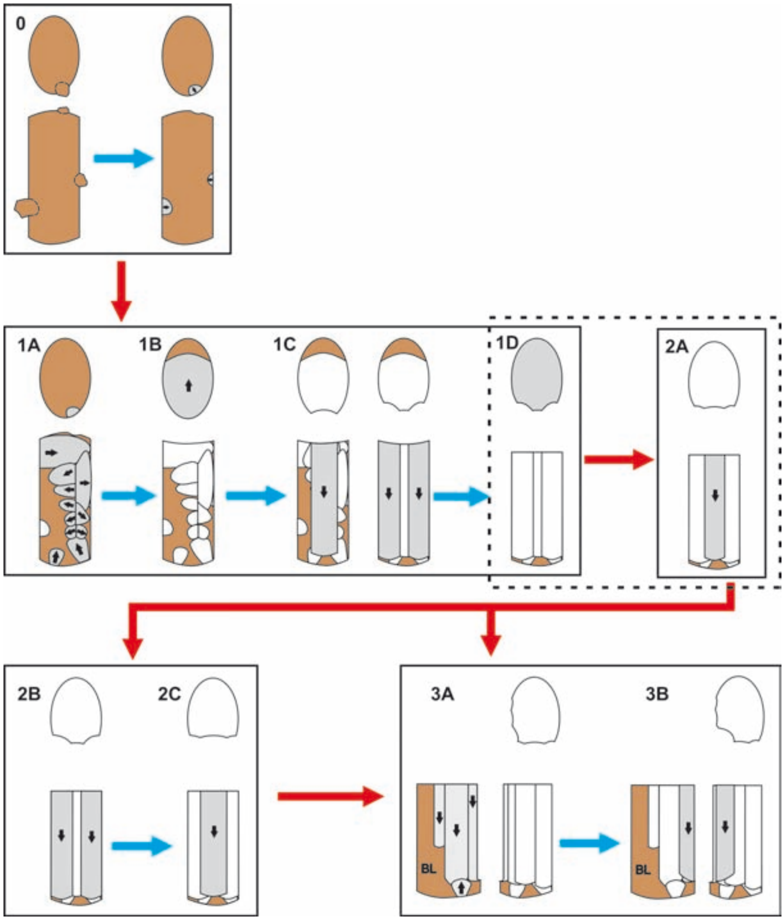

Fig. 12. Idealized scheme of the realization of the concept of the preferential blades' production: Stage 0 – regularization. Stage 1 – preparation of the striking platforms, flaking surface and optionally also side/s/ or back of the core: 1A configuration of the future striking surface; 1B exposing of the striking platform (level I); 1C exposing of the striking surface, optionally integrated with the isolation of the side edges of the preferential blade; 1D exposing the striking platform (level II). Stage 2 – the proper blades' detachment: 2A the phase of executing the first preferential blade; 2B the phase of isolating the side edges of the subsequent blade; 2C the phase of executing the second preferential blade. Stage 3 – the serial debitage detaching (the flaking surface takes a two sided-form)

variants is concerned, the exposure of the remaining part of the flaking surface was realized by the detaching of the series of cortical and subcortical technical forms.

b. Operation of removing the crested blades, and the blades next to crested blades (Fig. 1: C), often already at that point resulting in forming in the central part of the flaking surface the zone of isolating of the preferential form (Fig. 1: D).

The element to separate these two phases was an operation of forming the future striking platform (Fig. 1: B). A surface of one of the negatives after detaching a crested blade served as the base for the final blow. In that way, the optimal conditions to execute the successful blow forming the plane of the striking platform were attained. The last phase of the preparation was usually determined by the operation of detaching the basal technical flake which defines the final level of the striking platform.

The groups of technological operations discussed above find their reflection in the certain ensemble of the morphometric attributes of the products of debitage, in that number the core forms, which are the most interesting for us (Table 2). However, it should be underlined that these attributes are not equally readable which is due to the fact that the concept of preferential blades' production in the Wołkusz 3 site was realized in three different variants with the use of flint nodules of various dimensions, shapes and quality (*e.g.*, nodules strongly cryogenically cracked), and by two different flint knappers representing different level of skills.

In spite of the factors mentioned above make it difficult to define a universal recipe of the core treatment, yet a group of features exists the coexistence of which could be linked with the described technological strategy. These are:

a. Distinctive for the initial phase of the blades' detachment (stage 2), the trapezoidal horizontal convexity of the striking surface, with the clearly distinguished in its central part, of the zone of isolation of the preferential blade, together with the winged back side negatives (Fig. 12: 2). In the terminal stage of blades' detaching the flaking surface becomes flat and sometimes becomes collapsed when it takes a two-sided form (stage 3) (Fig. 12: 3)

b. The dominating, unidirectional, always parallel arrangement of the negatives on the striking surface.

c. The relatively small (usually 3-4) number of the negatives; instead, they are wide and relatively deep, and their length is equal, or only a bit shorter than, the whole length of the striking surface.

d. The back, together with the cortical sides, basically not bearing traces of preparation; the eventual protrusion is regulated by the single blows of *ad hoc* character.

CONCLUSIONS

Based on the technological analysis of the material from the site Wołkusz 3, two different, though linked by a common denominator of technological strategies. were recognized:

a. The one already described in an earlier paper (Przeździecki 2019), that is the concept of the preferential points' production, *i.e.* of single, relatively massive forms of a strictly determined (laurel leaf shaped) form, localized along the axis of symmetry, sharp tip, wedge like profile, and relatively short proportions;

b. The main subject of this article – the concept of the preferential blades' production, *i.e.* slim, though quite massive (thick and wide) forms of the more less rectangular shape.

Their common denominator, which at the same time is the cardinal attribute of the technological characteristics of the inventory, was the idea of the isolation of the cut out of the planned preferential forms (blades or points) on the area of the striking surface. In the case of both concepts, the process of generating the preferential form had a strictly determined multistage (two – or four phase) course with the clear division into:

a. the predetermining group of operations; and

b. the final operation described as the execution of the half product.

What is especially important, the reconstructed sequences of the operations could be connected with the certain set of morphological attributes of the cores and the debitage products.

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PEDANTRY IN THE PALAEOLITHIC? THE STORY OF TWO SMALL SWIDERIAN PITS FROM CHEŁMNO-DOBRZYŃ LAKELAND

ABSTRACT

Osipowicz G., Orłowska J. and Kuriga J. 2022. Pedantry in the Palaeolithic? The story of two small Swiderian pits from Chełmno-Dobrzyń Lakeland. *Sprawozdania Archeologiczne* 74/1, 325-344.

The article presents a multifaceted analysis of two collections of flint products from Late Palaeolithic pits discovered during the excavations of sites Ludowice 6 (Ryńsk commune), and Paliwodzizna 29 (Golub-Dobrzyń commune). Both sites are located in the Chełmno-Dobrzyń Lake District in central Poland. The research included raw material analysis, technological and morphological analysis, studies using the refitting method, and use-wear analysis. As a result of the conducted study, it was shown that both features are most likely a remnant of refuse pits in the type of so-called waste heaps, but their detailed functional origins are different.

Keywords: Late Palaeolithic, waste heaps, Poland, Paliwodzizna, Ludowice, flint
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1. INTRODUCTION

One of the fundamental goals of contemporary Stone Age archaeology is an attempt to interpret the functions and spatial organization of prehistoric camps (*cf*. Fiedorczuk 2006, 13-17; Osipowicz 2017, 9-11 – further literature there). Studies on this issue have been conducted since the 1960s and have roots primarily in British analytical archaeology and the American "New Archaeology". They were focused on two main research issues: (1) understanding the rules governing the deposition of artefacts at sites (Yellen 1977; Binford 1978; 1983) and (2) modelling the function and mobility patterns of prehistoric communities (mainly hunter-gatherers) and the purpose of their camps (Binford 1977; 1979; 1980).

The research conducted for this article is on the border of both of these analytical trends. It take up the problem of the probable function of interesting and relatively rare cultural features occurring at sites dating back to the Late Palaeolithic. These structures are sometimes referred to as the so-called waste heaps, *i.e.*, sites for the secondary disposal of garbage collected from other camp areas (*cf*. Schiffer 1976, 30; Fiedorczuk 2006, 131). Usually, they are pits with a diameter not exceeding one metre, containing many pieces of waste flint. In Poland, they have been identified at such Late Palaeolithic sites as Rydno IV / 57, Skarżysko-Kamienna comm. (Schild 1967), Poznań-Starołęka 1 and Kocierz 3, Płoty comm. (Galiński 1987, 1999; Kobusiewicz, 1999, 45-46), Rydno XI / 59, Skarżysko-Kamienna comm., Całowanie, Karczew comm. (Fiedorczuk 2006,), Trzebca II / 64 and Gojść III, Nowa Brzeźnica comm. (Ginter 1974, 54). They also occur at German sites, *e.g.*, in Borneck-West near Ahrensburg (Rust 1958) or Groitzsch, distr. Leipzig (Hanitzsch 1961).

Recently, two features of this type have been identified in the Chełmno-Dobrzyń Lake District in central Poland. The first one was discovered during the excavation of the site Ludowice 6, Ryńsk comm., and the second one on the site Paliwodzizna 29, Golub-Dobrzyń comm. The purpose of this article is a multifaceted analysis of collections of flint products from these features, verifying the concept of the typical refuse origin of this type of structures. Solving this problem may be necessary for understanding the rules governing the waste management economy in the late glacial hunter-gatherer camps, which is one of the critical elements of the studies of their internal organization and function.

2. MATERIAL

The Ludowice 6 site is located in the central part of the Chełmno Lakeland (Fig. 1), on the slope of a hill with a maximum height of 100 m.a.s.l. It is placed in the contact zone of the sander and a large kettle hole, currently filled with the biogenic sediments, which are remnants of the Late Glacial and Early Holocene lake (Osipowicz 2017a, 40).

The site was discovered during surveys carried out in 1985. Excavations started here in 2009 and were conducted over five seasons. From 2011 to 2014, they were carried out as

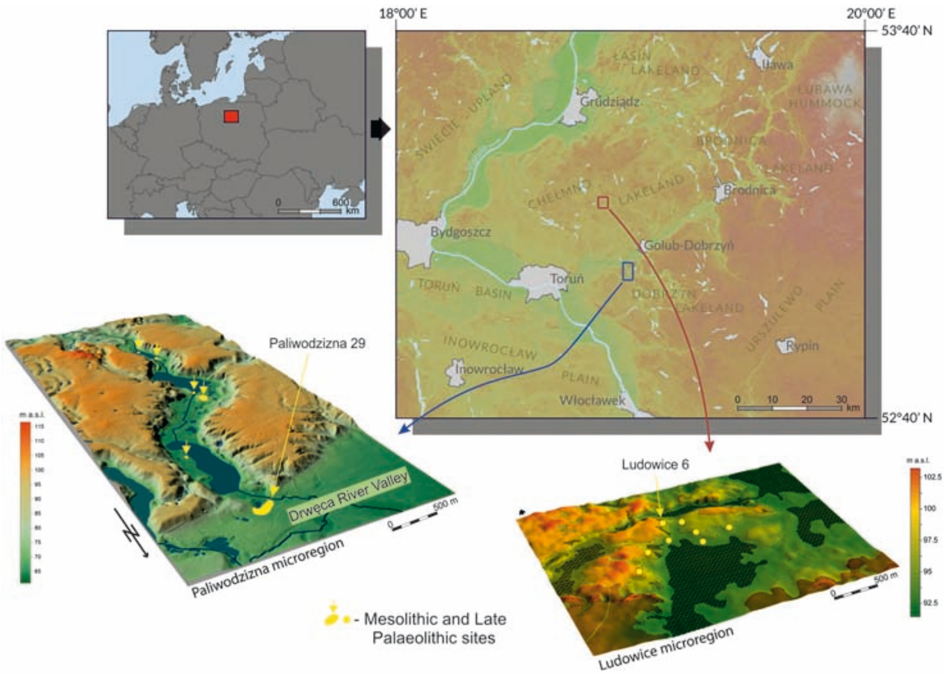

Fig. 1. Location of the sites Ludowice 6 and Paliwodzizna 29

part of the project of the National Science Centre in Kraków (NCN), entitled *Mesolithic communities of the Chełmno-Dobrzyń Lakeland. A settlement enclave in Ludowice, commune Wąbrzeźno* (project no. N N109 226140). They covered an area of 756 m², resulting in discovery of nine sedimentary layers and 30 cultural features. The group of collected artefacts included: 13,630 flint specimens, 733 products made of other stone materials, 240 bones, and a few wooden items. The vast majority of the artefacts are related to the Late Mesolithic settlement and come from the area of two large habitats from this period, located in the western and central part of the excavations area (*cf.* Fig. 2). The results of detailed studies of these sources have already been partly published (including, Osipowicz *et al.* 2014; Osipowicz 2015, 2017a, b, 2019).

The third small concentration of prehistoric artefacts was discovered in the eastern part of the site, in the vicinity of the shore of the former lake. It is related to the Late Palaeolithic settlement of the Swiderian culture and is the first of two collections of flint products analysed for this study. The cluster consists of a small flint scatter associated with the pit (Feature no. 30) – a deposit of flint artefacts (Fig. 2). Due to the weather conditions prevailing during the excavations, the result of which was the immediate drying of the explored layers and the characteristics of the soil cover at the site, it was impossible to define the boundaries and outline of the filling of this feature. However, its possible appearance

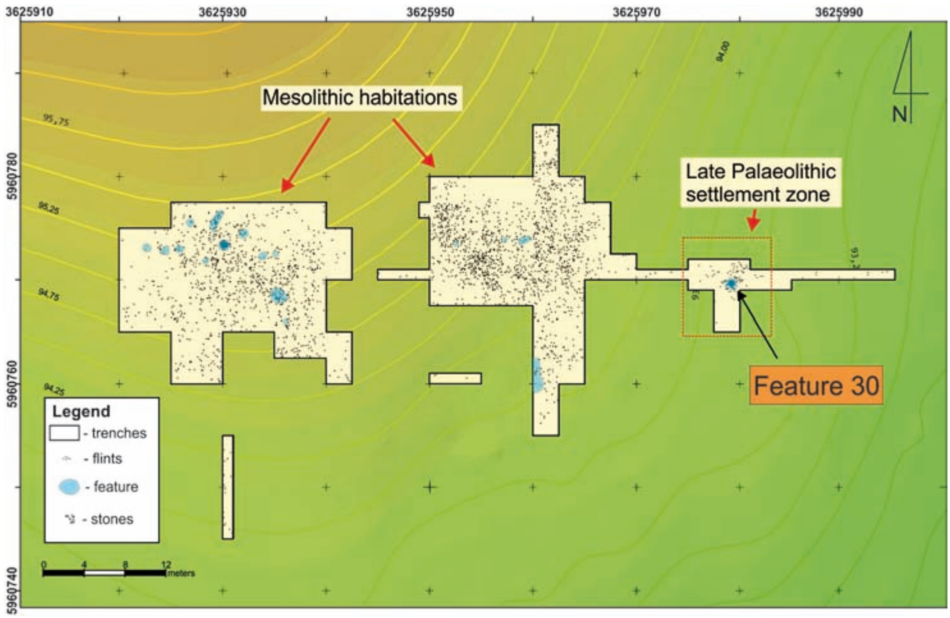

Fig. 2. Ludowice, Site 6. Location of the Feature no. 30

can be inferred from the artefact distribution, which suggests that it was a pit with a diameter of about 60 cm (Fig. 3: B), a depth of 15 cm, and a trough-shaped cross-section (Fig. 3: C). Overall, the concentration of Palaeolithic material included 344 flint products, 171 of which come from Feature no. 30.

Site Paliwodzizna 29 is located in the Drwęca River Valley, which separate Dobrzyń and Chełmno Lakelands (Fig. 1; *cf.* Solon *et al.* 2018). It lies on a flat-topped morphological ridge situated in a place where the subglacial valley of Lake Grodno and Lake Plebanka becomes the valley of the Drwęca River (*cf.* Osipowicz *et al.* 2022). It is one of the few Stone Age sites in the area subjected to archaeological research as part of the NCN project entitled: *Mesolithic communities of the Chełmno-Dobrzyń Lakeland – daily life, mobility, external contacts and relationships with the environment* (project no. 2016/23/B/HS3/00689).

The site's excavations have been underway since 2016 and have not been completed yet. During the first five years of their duration, a total area of 468.62 m² was excavated – 429.62 m² located in the sand (dry) part of the site and 39 m² in a wet part – in the shore zone of the prehistoric bay of the Lake Grodno (Fig. 4: A). As a result of the conducted work, an exceptionally rich assemblage of archaeological material was identified, which indicates that this place was used many times during prehistory. However, most of them are remnants of a multi-phase and functionally diversified Mesolithic settlement. The results of the first studies on these sources have already been published (*cf.* Osipowicz 2021; Osipowicz *et al.* 2022).

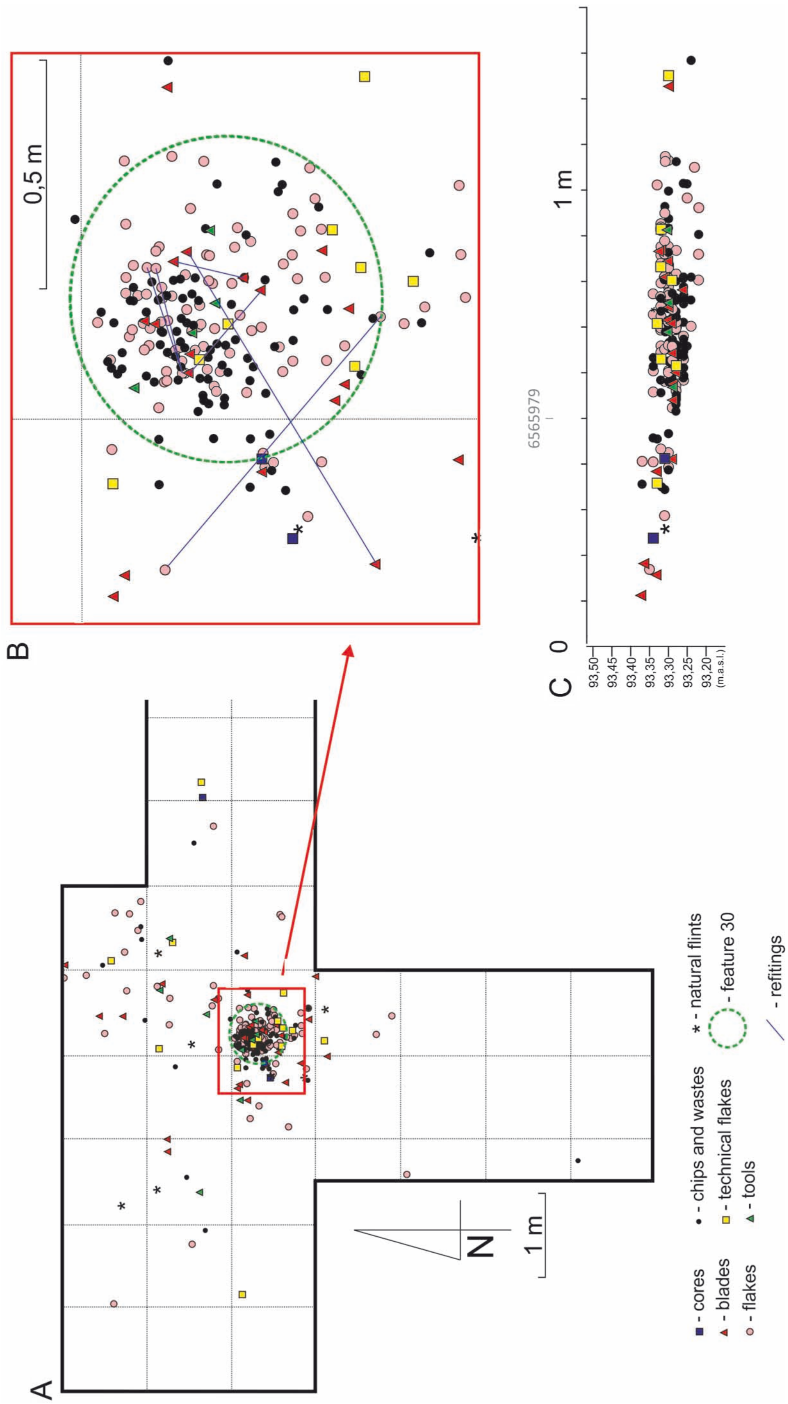

Fig. 3. Ludowice, Site 6. Distribution of the artefacts within the Late Palaeolithic flint scatter (A) and Feature no. 30 (B, C)

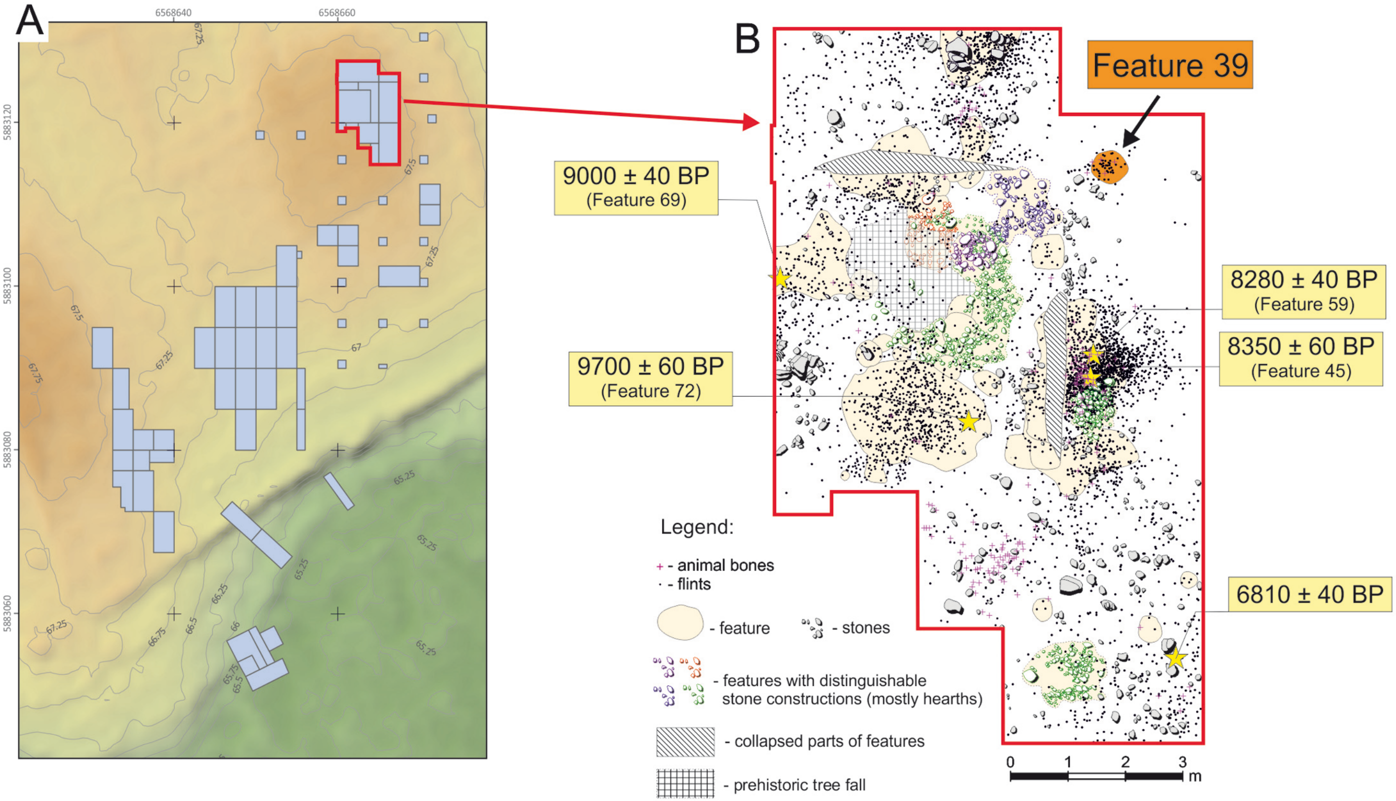

Fig. 4. Paliwodzizna, Site 29. Location (A) and details (B) of the Feature no. 39

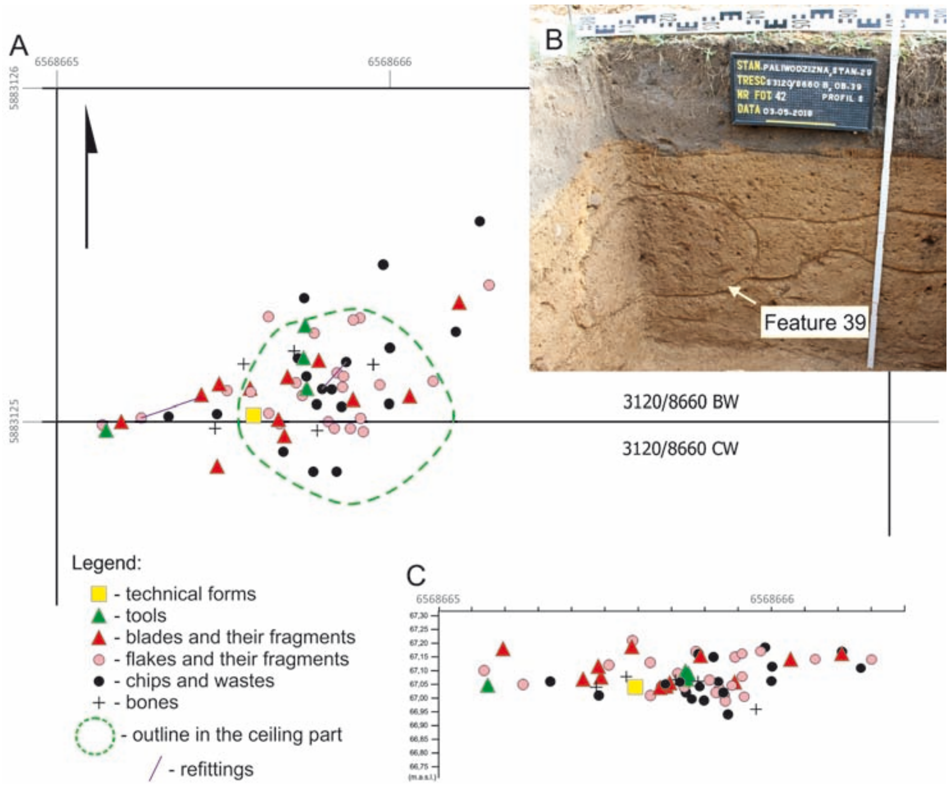

Fig. 5. Paliwodzizna, Site 29. Feature no. 39: Distribution of the flint artefacts in the horizontal (A) and vertical (C) planes. B – profiles south and west in the test trench no S3120/8660B

One of the most interesting concentrations of Early Holocene material was identified in the northern part of the area covered by the excavation, at the top of a small hill with an essentially circumferential exposure (Fig. 4: A). In addition to the undoubtedly unique sources related to the settlement of the Mesolithic hunter-gatherers (to whom independent studies will be devoted), a small refuse pit was discovered here, containing material of the Late Palaeolithic Swiderian culture (Feature no. 39 – Fig. 4: B). This structure occurred on the border of two standard excavation trenches and a test trench, making it difficult to distinguish and explore it. The outline of the feature was observed to a greater extent only in its upper parts (Fig. 5: A), and a fragmentary cross-section was documented in the corner of one of the excavation trenches (Fig. 5: B). In general, it can be stated that it was an oval-shaped pit with a diameter of about 60 cm and a depth of about 30 cm. From its filling, 59 flint products were collected, which comprise the second collection analysed for this study.

3. METHODS

The collections of flint products included in the study were subjected to raw material, technological, morphological, and use-wear analyses.

The technological and morphological analysis of flint materials was conducted based on the dynamic classification method (Schild *et al.* 1975, 12) and supplemented with studies using the refitting method (Schild *et al.* 1975, 38; Cziesla 1990; Fiedorczuk 2006). The analysis of the collection from Ludowice was made difficult by covering the artefacts with a matte "peat" patina, which in some cases even made it impossible to observe the flake ripples. This fact, combined with the significant fragmentation of products from this collection, meant that quite a few of the items in the assemblage, even relatively well-preserved specimens, were classified as undefined forms due to classification doubts. These factors probably also influenced the small number of identified blades from double platform cores. On the other hand, such a characteristic patination of the Late Palaeolithic artefacts allowed easy distinction from individual Mesolithic products occurring in their context, which are not covered with patina.

All flint finds were subjected to traceological analysis. Its initial stages were conducted using a Nikon SMZ-2T microscope and a Nikon SMZ-745T microscope with a Delta Pix Invenio 6EIII camera, the latter was used to make the microphotograph presented in Fig. 8A.

A Zeiss-Axiotech microscope-computer set with an Axiocam 105 camera was used to analyze polishes readable on artefacts from the Ludowice 6 site. The products from the site in Paliwodzizna were analyzed using a Zeiss Axioscope 5 Vario microscope with an Axiocam 208 camera. Micrographs shown in Fig. 8B-E were also taken using it. Before the use-wear analysis, the artefacts were cleaned with pure ethanol (C_2H_5OH).

The applied traceological terminology was based on the concept system existing in the subject literature (HoHo Committee 1979, 133-135; Vaughan 1985, 10-13, Glossary, p. VII; van Gijn 1989, 16-20; Juel Jensen 1994, 20-27; Korobkova 1999: 17-21; Osipowicz 2010, 24-35), which was adapted to the needs and requirements of the conducted analysis. The comparative material used was a collection of experimental tools that presently comprises about 500 specimens, located in the NCU Institute of Archaeology in Toruń.

4. RESULTS

4.1. Raw material analysis

All artefacts included in both analysed collections were made of Baltic-erratic flint. Specimens from Ludowice come from core exploitation of raw material with uniform characteristics, perhaps even one nodule. In the case of Paliwodzizna, many different types of erratic flint were processed. Individual artefacts from Ludowice probably show signs of slight overheating, and 12 specimens from the collection in Paliwodzizna (20.3%) are heavily burned.

4.2. Technological and morphological analysis

4.2.1. LUDOWICE, SITE 6

Both sets were analysed independently to interpret the morphological structure of the collection of flint products from Feature no. 30 and the registration of differences in this respect between it and the flint scatter constituting its context.

Flint scatter (without Feature no. 30)

All technological groups are represented in the set, although there is a small number of morphological tools and a relatively large share of technical forms (Tab. 1, 2). Additionally, three natural nodules of erratic flint with a diameter of about 5 cm were discovered in the area of the flint scatter, which were not included in the tables.

Group I (preparation, and early stages of core processing) included 5.2% of the products. They are four crested blades (Fig. 6: 1), two semi-crested blades (Fig. 6: 2), and three cortex flakes.

In group II (reduction of flakes), which accounts for 27.2% of the collection, flakes removed from single platform cores dominate (53.2% of products). However, specimens coming from cores with a changed orientation are only slightly less numerous (38.3% of products in the group). In the end flakes associated with the processing of double platform cores are singular.

The structure of the III technological group (reduction of blades – 13.3% of the collection) is similar to some extent. Specimens knapped from single platform cores also predominate in this case (65.3% of products), and blades removed from double platform cores

Table 1. General morphological structure of the analysed collections of flint products

	Ludowice 6 (without feature no. 30)	% in the set	Ludowice 6 Feature no. 30	% in the set	Paliwodzizna 29 Feature no. 39	% in the set
Cores	5	2.9	-	-	-	-
Blades and their fragments	28	16.2	11	6.4	11	18.6
Flakes, wastes, chips	125	72.2	151	88.3	40	67.8
Tools	4	2.3	3	1.8	7	11.9
Technical forms	11	6.4	6	3.5	1	1.7
Total	173	100	171	100	59	100

Table 2. Ludowice, site 6. Technological structure of flint products (without feature no. 30)

Product categories	Total	%
Group I preparation, and early stages of core processing (5.2% of the set)		
Cortex flakes	3	33.3
Crested blades	4	44.4
Semi crested blades	2	22.3
Total	9	100
Group II flakes' reduction (27.2% of the set)		
Flakes from the single platform cores	25	53.2
Flakes from the double platform cores	4	8.5
Flakes from the changed orientation cores	18	38.3
Total	47	100
Group III blades' reduction (13.3% of the set)		
Changed orientation cores	1	4.3
Cortex blades	1	4.3
Blades from the single platform cores	15	65.3
Double platform cores	1	4.3
Blades from the double platform cores	5	21.8
Total	23	100
Group IV repairs (2.9% of the set)		
Secondary crested blades	1	20
Rejuvenation flakes	2	40
Platform rejuvenation flakes	1	20
Overpassed blades from the single platform cores	1	20
Total	5	100
Group V indeterminate specimens, chipping debris and retouch (49.1% of the set)		
Indeterminate cores and their fragments	3	3.5
Indeterminate blades and their fragments	7	8.2
Indeterminate flakes and their fragments	19	22.3
Chips	31	36.6
Wastes	25	29.4
Totam	85	100
Group VI tools and characteristic wastes from their production (2.3% of the set)		
Tools	3	75
Burin spalls	1	25
Total	4	100
All groups total	173	100

are the second most numerous type of product. However, blades of the second category are three times less numerous than products of the first one. The group also includes a heavily reduced double platform core with the prepared striking platforms and its back part (Fig. 6: 3), a blade core with the orientation changed several times, where apart from the "main" flaking surface, the side and back of the specimen were also reduced (Fig. 6: 4), and a cortex blade.

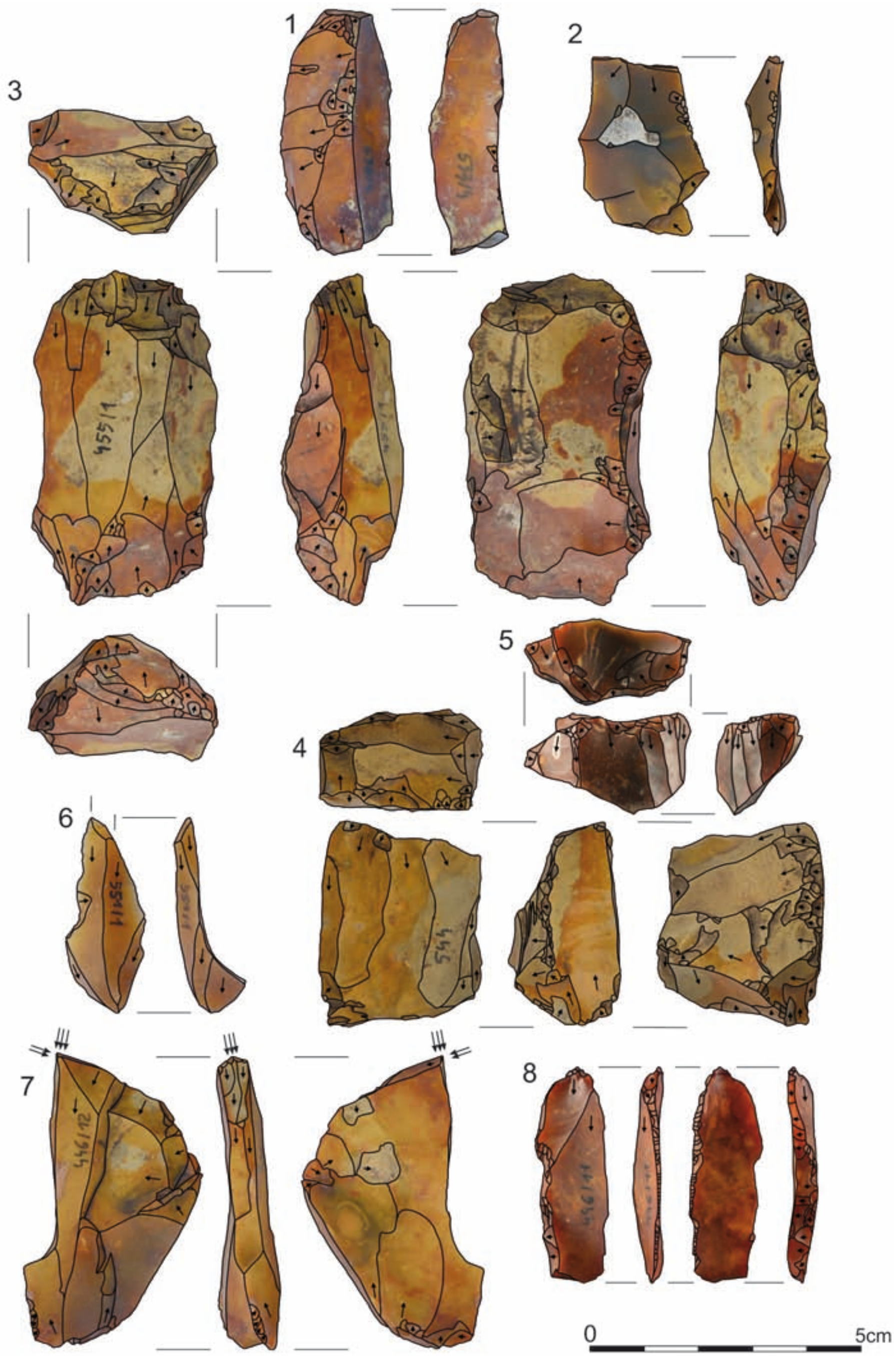

Fig. 6. Ludowice, Site 6. Selection of flint materials

The next group (IV – repairs) is represented by five forms: a secondary crested blade, two rejuvenation flakes (Fig. 6: 5), a platform rejuvenation flake, and a broken overpassed blade from a single platform core (Fig. 6: 6).

As it constitutes 49.1% of the set, group V (indeterminate specimens, chipping debris, and retouch) is the most numerous in the collection. It is dominated by chips, waste, and undefined flakes and their fragments (respectively: 36.6%, 29.4%, and 22.3% of products in the group).

The collection includes four tool forms (group VI). In addition to a small burin spall, a multiple flake dihedral burin (Fig. 6: 7), a heavily damaged single blow burin, and a semi crested blade retouched on the ventral face (Fig. 6: 8) were included. The first of the mentioned burins was most probably reutilized (in the Mesolithic?), as evidenced by the second series of burin spall scars that removes the patina characteristic for Palaeolithic products from this part of the site (Fig. 8: A).

Table 3. Ludowice, site 6, feature no. 30. Technological structure of flint products

Product categories	Total	%
Group I preparation, and early stages of core processing (5.2% of the set)		
Cortex flakes	5	55.5
Crested blades	4	44.5
Total	9	100
Group II flakes' reduction (17.5% of the set)		
Flakes from the single platform cores	19	63.3
Flakes from the changed orientation cores	11	36.7
Total	30	100
Group III blades' reduction (4.7% of the set)		
Blades from the single platform cores	4	50
Blades from the double platform cores	3	37.5
Blades from the changed orientation cores	1	12.5
Total	8	100
Group IV repairs (1.2% of the set)		
Rejuvenation flakes	2	100
Total	2	100
Group V indeterminate specimens, chipping debris and retouch (69.7% of the set)		
Indeterminate blades and their fragments	3	2.5
Indeterminate flakes and their fragments	26	21.8
Chips	60	50.4
Wastes	30	25.3
Total	119	100
Group VI tools and characteristic wastes from their production (1.7% of the set)		
Tools	1	33.4
Burin spalls	2	66.6
Total	3	100
All groups total	171	100

Feature no. 30

In the collection from Feature no. 30, waste material (flakes, waste, and chips) is dominant, accounting for almost 90% of the assemblage. Other categories of artefacts are represented to a small extent (Tabs 1, 3).

Group I (preparation, and early stages of core processing), accounting for 5.2% of the set, included four crested blades (Fig. 7: 1-3) and five cortical flakes. Group II (reduction of flakes) consists mainly of specimens removed from single platform cores (17.5 % of the products), while the remaining come from cores with orientation changed. Products connected with the reduction stage of blades constitute only 4.7% of the described assemblage. Four of the identified blades ware removed from single platform cores, three from double platform cores, and one from a changed orientation core. Group IV (repairs) consists of 2 rejuvenation flakes (Fig. 7: 4, 5). Among the tools (group VI), apart from two small burin spalls, a single burin on an overpassed blade from an opposed platform core is distinguished (Fig. 7: 6). Group V constituting 69.7% of the analysed collection (indeterminate specimens, chipping debris, and retouch), consists mainly of chips (50.4%), next to which, in similar amounts, there were indefinite flakes and waste (21.8% and 25.3% respectively).

The results of research using the refitting method

As a result of the conducted attempts of refitting the analysed material, six small blocks were obtained. One of them is a thermally cracked flake, while the others are refittings from the breaks group (Cziesla 1990, 9-10). These are: the only single blow burin mentioned above (Fig. 7: 6), three blocks of broken blades (Fig. 7: 7-9), and one broken flake (Fig. 7: 10). Although the results of these studies are not spectacular, the refittings between the flint scatter and the deposit were recorded, confirming their homogeneity.

4.2.2. PALIWODZIZNA, SITE 29, FEATURE NO. 39

The morphological structure of the assemblage is presented in Tables 1 and 4. Only one cortical flake was included in group I (preparation, and early stages of core processing). In groups II (reduction of flakes – 20.3% of the collection) and III (reduction of blades – 10.2%), specimens removed from single platform cores are dominant. There was only one blade removed from a double platform core and one flake with a changed orientation in the assemblage. The repairs group (IV) is represented by a fragment of a secondary crested blade (Fig. 7: 11).

As in the case of Feature no. 30 from the site in Ludowice, the most numerous is the group V (indeterminate specimens, chipping debris, and retouch), which constitutes 54.2% of the collection. It consists mainly of chips, waste, and flakes (respectively 37.5%, 25%, and 21.9% of the group), although fragments of undefined blades are also relatively numerous in this case.

Among the tools (group VI), apart from a large burin spall (Fig. 7: 12), there were also included: a multiple single blow burin on a flake (Fig. 7: 18), a Swiderian tanged point with

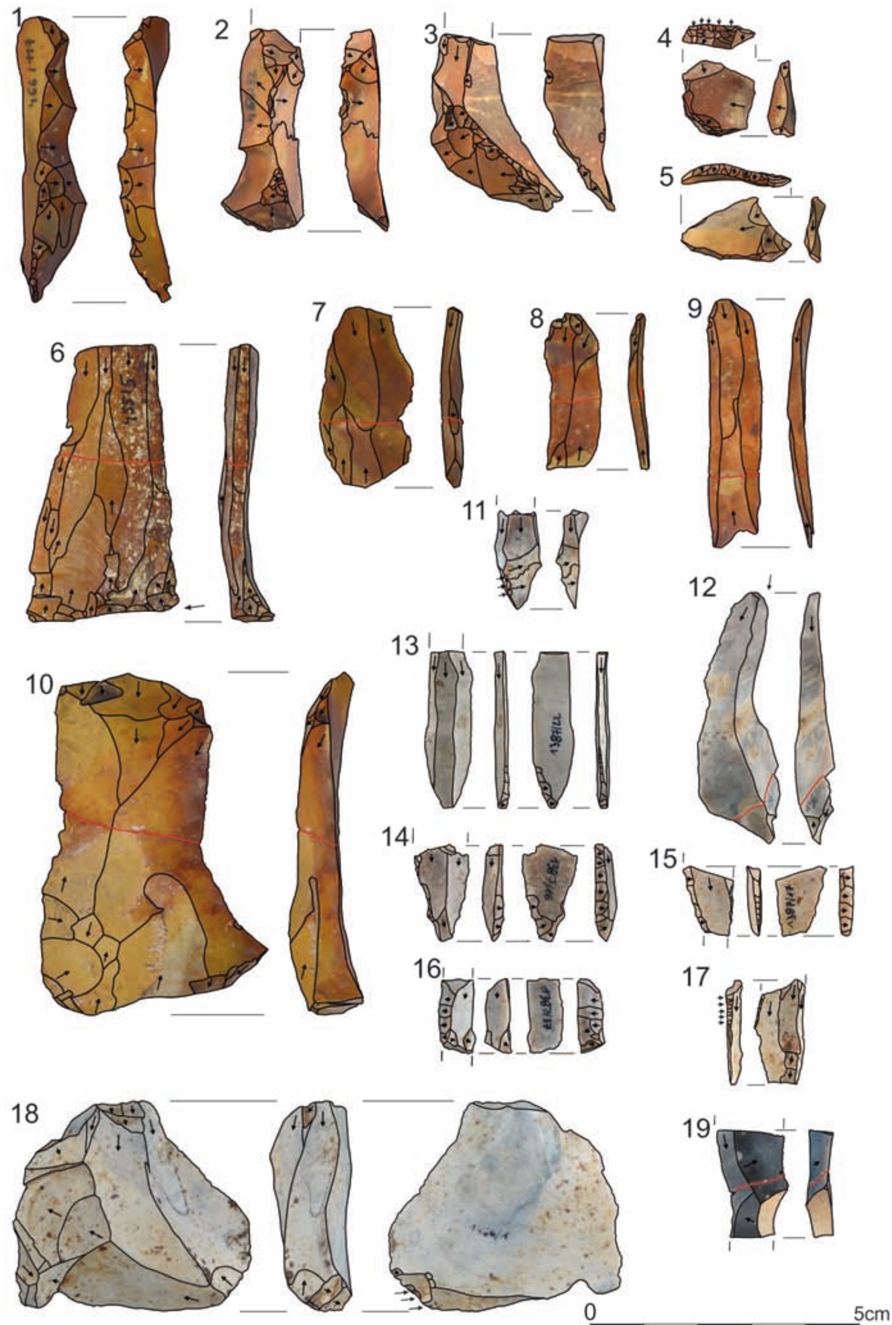

Fig. 7. Ludowice, Site 6. (1-10) and Paliwodzizna, Site 29, Feature no. 39 (11-19). Selection of flint materials

Table 4. Paliwodzizna, site 29, feature no. 39. Technological structure of flint products

Product categories	**Total**	**%**
Group I preparation, and early stages of core processing (1.7% of the set)		
Cortex flakes	1	100
Total	1	100
Group II flakes' reduction (20.3% of the set)		
Flakes from the single platform cores	11	91.6
Flakes from the changed orientation cores	1	8.4
Total	12	100
Group III blades' reduction (10.2% of the set)		
Blades from the single platform cores	5	83.3
Blades from the double platform cores	1	16.7
Total	6	100
Group IV repairs (1.7% of the set)		
Secondary crested blades	1	100
Total	1	100
Group V indeterminate specimens, chipping debris and retouch (54.2% of the set)		
Indeterminate blades and their fragments	5	15.6
Indeterminate flakes and their fragments	7	21.9
Chips	12	37.5
Wastes	8	25
Total	32	100
Group VI tools and characteristic wastes from their production (11.9% of the set)		
Tools	6	85.7
Burin spalls	1	14.3
Total	7	100
All groups total	59	100

a broken tip (Fig. 7: 13), a tang part of the analogous point (Fig. 7: 14) and three fragments of retouched blades (probably a kind of backed pieces – Fig. 7: 15-17).

The results of research using the refitting method

As a result of attempts of refitting of flint material from Feature no. 39 in Paliwodzizna, two blocks of the breaks group were obtained. The first is the burin spall mentioned above, which had a broken distal end (Fig. 7: 12), and the second is the middle part of the blade, possibly semi crested blade, broken into two parts (Fig. 7: 19).

4.3. Use-wear analysis

Microscopic research of flint products from the Ludowice collection led to identifying only one item bearing clearly legible traces of use. It is a multiple dihedral burin discovered outside of Feature no. 30 (Fig. 6: 7). On the sides of its working edge, created as a result of

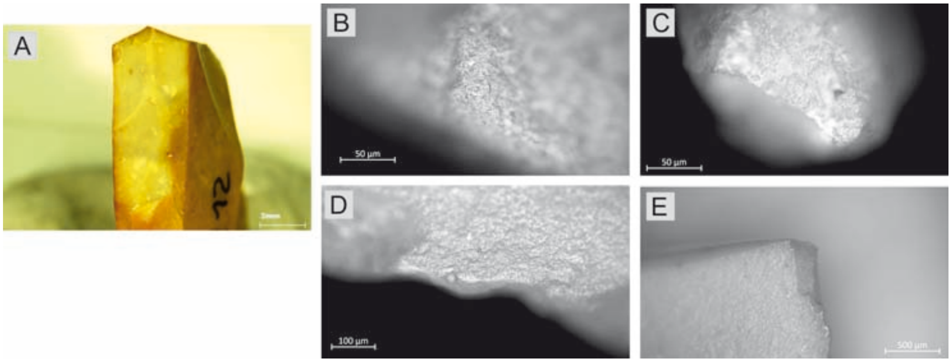

Fig. 8. The example of use-wear traces observed on burin from Ludowice (A-C) and Swiderian tanged point from Paliwodzizna (D-E)

the original (patinated) burin blows (on the ventral and dorsal face of the tool), polish with a domed topography and smooth texture was observed, clearly rounding to both the upper parts of the flint microrelief and the working edge itself (Fig. 8: B). Polish with similar characteristics (but linear) is also visible on a small fragment of the surface of the primary burin blows made on the side of the flake (Fig. 8: C). The negatives of the secondary burin blows made here, which removed the "palaeolithic patina" show no signs of use. The specimen was probably used for carving in wood or (possibly) antler.

In the collection from Site 39 in Paliwodzizna, four specimens with probable traces of use were identified. However, only in the case of one of them, was damage caused by usage clearly legible and it was possible to confirm its use with high probability. This specimen is a broken Swiderian tanged point (Fig. 7: 13). An irregular use retouch is visible on both faces of its side edges. It is built from the singular feather terminated scars. Next to it, a bright abrasive polish with flat topography and smooth texture is present (Fig. 8: D). The fracture visible at the tool's tip is a typical bending fracture with the microburin spalls (Fig. 8: E). The described traces of use indicate that the product was used as an arrowhead.

The remaining artefacts with probable use-wear are preserved in small fragments or bear poorly developed traces, which makes further functional interpretations impossible.

DISCUSSION

The results of the analyses to which flint products from both analysed pits were subjected seem to confirm that they are typically refuse structures, probably of the "waste heaps" type. According to the definition of this type of feature, the morphological structure of both included collections is dominated by waste material. There are no blades or flakes useful in terms of tools visible here. In both cases, studies using the refitting method showed the absence of blocks from the core exploitation process, which indicates that the flint material deposited in the features could have been collected from a larger area and/or could be the result of several acts of knapping (or one more complex activity of this type).

However, the two analysed collections are also quite different. Feature no. 30 from Ludowice appeared in the context of a flint scatter, with which it is homogeneous and probably functionally connected. However, the morphological and functional structure of these two sets is different. In addition to waste material, both contain technical forms, but the flint scatter also includes cores and an artefact used as a tool, which are missing in Feature no. 30. The functional relations between the two structures seem therefore to be quite clear. The flint scatter should be considered as a place of short-term flint knapping and occasional processing of organic raw materials (type OEA; *cf*. Osipowicz 2017a, 32; 2017b). Feature no. 30 is a refuse pit in which the waste from flint knapping carried out within the flint scatter (and possibly in other places) has been deposited. In the opinion of the manufacturer, these materials were unsuitable for further processing or tool use, and the flint products that met these criteria were taken outside the camp.

The characteristics of Feature no. 39 from Paliwodzizna and the collection of artefacts found in it are different. First of all, this feature occurred without the context of a flint scatter or other Late Palaeolithic structures, which perfectly fits the definition of waste heaps (*e.g.*, Binford 1978, 346, 347; Stapert 1989, 7). The material collected from its filling is not as abundant as in Ludowice, but it seems to be much more diverse. As shown by the results of use-wear analysis, it contains a statistically significant amount of used (or probably used) forms and a relatively large number of burnt flints. These products are also preserved in small fragments, confirming their waste nature. Taking all of this into account and considering the general technological structure of the collection of flint products from the feature, it can be concluded that it is not a remnant of flint processing only, as was the case with Ludowice. It was most likely created as a result of "cleaning" the usable space of the residential structure (a hut with a hearth or an open hearth – hence the burning of some artefacts), where the core exploitation process was repeatedly carried out (the collection includes products from various types of erratic material), but also other economic activities were performed. The high fragmentation of this material indicates that it was subjected to quite a long period of trampling, which also supports the above suggestions. This type of waste pit has already been written about in the context of Late Palaeolithic materials (Fiedorczuk 2006, 131).

CONCLUSIONS

In summary, both the pits producing the material analysed here were were most likely features in the type of waste heaps. In the case of the observed discrepancies between them, it should be clearly emphasized that the genesis of this type of structure may be much more complicated than it currently seems. Many issues remain unclear already in the case of the analysed pits. Why waste, flakes, and even chips were deposited in Feature no. 30 in Ludowice, but not the cores or the burin dropped at a short distance from it? What is the origin of such a selection in "cleaning" the surroundings? Why was such highly fragmented material collected in Paliwodzizna, and why was it deposited in an independent pit? Was this only due to the kind of "pedantry" of camp users (as stated in the title of the article) or maybe from something more? The literature on the subject sometimes mentions the ritual profile of such features (Rust 1958, 68; Schild 1967, 201). The filling of the Ludowice pit was identical to the layers constituting its context. Still, in the case of the feature from Paliwodzizna, it had a little different, slightly pinkish colour. This could indicate the presence of ochre in the feature, but no samples were taken to confirm this by chemical analysis. Undoubtedly, the final solution to the problem of Late Palaeolithic waste heaps requires further research. Of critical importance to this problem may be the use-wear analysis of flint products derived from such features and multifaceted and interdisciplinary studies of their fillings. These issues should be considered as the main research postulates in this regard for the near future.

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MINING FIELD „DĄBRÓWKA-I". NEOLITHIC JURASSIC FLINT MINE WITH VESTIGIALLY PRESERVED MINE RELIEF

ABSTRACT

Jakubczak M., Budziszewski J., Leloch M., Gryczewska N., Szeliga M. and Kot M. 2022. Mining field „Dąbrówka-I". Neolithic Jurassic flint mine with vestigially preserved mine relief. *Sprawozdania Archeologiczne* 74/1, 345-372.

Neolithic flint mines are well-studied in the Kraków-Częstochowa Upland. However their spatial structure and diachronic history is still poorly understood especially due to the poor preservation of the mine relief on the surface. The paper presents results of ALS data analyses conducted on the Dąbrówka-I site which is the first Prehistoric flint mine in the region that has been studied recently on the basis of the surface relief. LiDAR analyses combined with technological analyses of collected cores gave us grounds to identify two phases of flint mining at the site dated to Lengyel-Polgar cycle and Late Bronze Age-Early Iron Age. The obtained results show the extent to which a multiproxy non-destructive approach may give ground for in depth studies of flint mines.

Keywords: Prehistoric flint mining, Kraków-Częstochowa Upland, LiDAR data analysis, knapping technology, Lengyel-Polgar cycle

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INTRODUCTION

The southern part of the Kraków-Czestochowa Upland is widely recognised for the presence of prehistoric flint mines. Due to the long-lasting archaeological research in this area, a major phase of flint mining in the region can be connected with the Lengyel-Polgar cycle, *e.g.* on such sites as Sąspów or Bębło (Dzieduszycka-Machnikowa and Lech 1976; Lech 1980c, 1980d). Thanks to the increasing availability and significant reduction in the cost of airborne laser scanning (LiDAR), extensive prospecting of forested areas has become possible, including reanalysis of flint mines already excavated or surveyed (Budziszewski and Wysocki 2012; Czebreszuk *et al.* 2013; Budziszewski and Grabowski 2014; Jakubczak and Szubski 2015; Banaszek 2015; Budziszewski *et al.* 2019). The results show that the Neolithic flint mines in the region, even those where there already is a lot of information from archaeological investigations, are not preserved in the landscape. One of the very few exceptions is the Dąbrówka-I flint mine which was found and preliminarily studied by Jacek Lech (1980a).

The scope of the paper is to study the structure of the Dąbrówka-I flint mine, based on the LiDAR visualisation and the chronology of the site based on technological analyses of collected cores.

Dąbrówka I

The headland that rises above the Prądnik River valley at the level of Dąbrówka hamlet is entirely covered with forest (Fig. 1: C). This is probably how it looked throughout most of its history. It is similar to today's appearance on the Habsburg topographic map made in 1801-1804 by Colonel Anton Mayer von Heldensfeld (Fig. 1: A). According to Jacek Lech, attempts were made to farm here for several decades between 1864 and 1915 (Lech 1980a, 613; 1981, 51). However, the scale of this activity was probably not very large, as it is not included in any of the several Austrian and Russian 19th-century mappings at a scale of 1:100000. Only the New Topographic Map of Western Russia at a scale of 1:84000, published in 1914, attests to the deforestation of the northern part of the headland (Fig. 1: B).

This area is built up by Upper Jurassic limestones with flints. They are covered by Paleogene red and brown clay loams formed during karst weathering of the limestone. In many places, these clays contain rich concentrations of drusy flint nodules – so-called "krzemieńce" (Lech 1980b, 200-202, fig. 2a-b; 1981, fig. 4). They were usually exploited by prehistoric miners. They are covered by quaternary loess layers of various thicknesses.

The "Dąbrówka I" mining field was discovered in the spring of 1973 by Jacek Lech and the forester J. Glanowski (Lech 1980a, 613). The site was visible in the field in the form of heaps of flint consisting of more massive flint materials collected from ploughed land

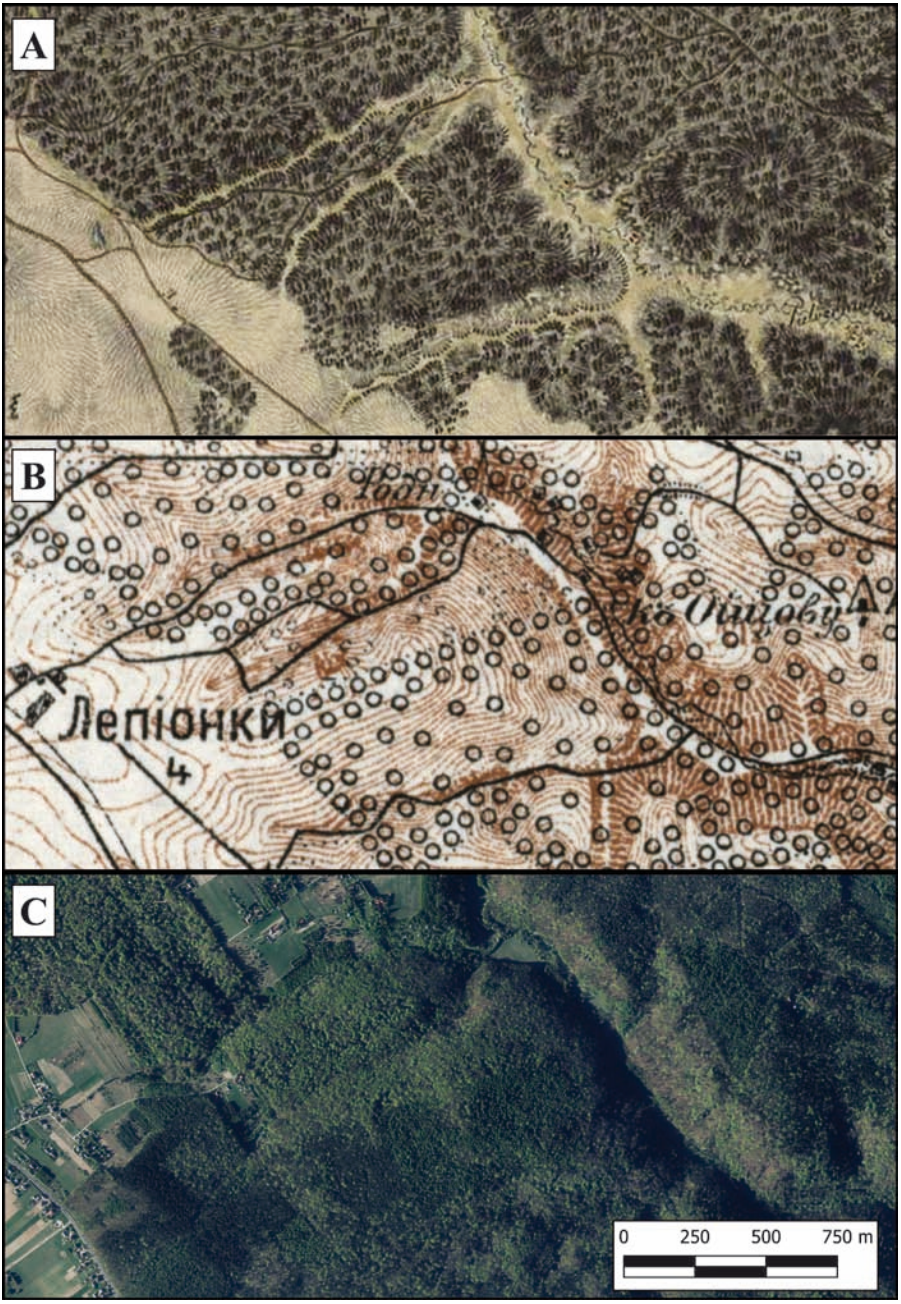

Fig. 1. A – Map prepared in 1801-1804 under the direction of Colonel Anton Mayer von Heldensfeld; B – New Topographic Map of Western Russia from 1914; C – Current aerial photography, after geoportal.gov.pl

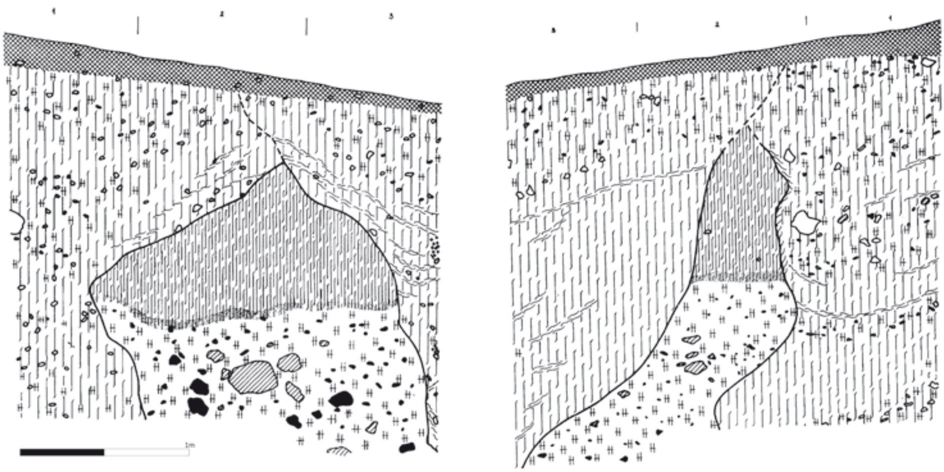

Fig. 2. Two opposing cross-sections of the 1974 test pits by J. Lech at the Dąbrówka-I site, showing the outlines of two shafts (Lech 1980a, Fig. 628)

during the agricultural use of the land and deposited on baulks between the fields (Lech 1981, 78). These allowed for the obtaining of a rich collection of blade cores (Lech 1980a, fig. 627, 1-4, fig. 629, 1, 3-4) and stone hammers (Lech 1980a, fig. 629, 2). These materials were technologically homogeneous and have analogies in the inventories from the mining fields at Sąspów and Bębło. This allowed them to be associated with the Lengyel-Polgar cycle (Lech 1980a, 615; 1981, 78). However, the forest overgrowing the site made it impossible to determine its size (Lech 1981, 51).

In autumn 1974, Jacek Lech together with Andrzej Leligdowicz and Zdzisław Skrok opened a 1 × 3 m test pit at the site (Lech *et al.* 1975). Unfortunately, the pit could not be fully explored. It was excavated to a depth of 2.3/2.4 m. The pit revealed fillings of two stratigraphically-related exploitation shafts (Fig. 2). Their fillings consisted of weathered clay with flints and loess. Relatively numerous nodules of limestone in one of the shafts and a discovery of a flint pick in the backfill (Lech 1980a, fig. 627, 5) suggest that the exploitation may have reached the top of the Jurassic limestone (Lech *et al.* 1975; 1980a, 613, 615; 1981, 76, 77).

The material from the research conducted at the site have never been fully published. However, it was mentioned in several studies of various types (*e.g.*, Lech *et al.* 1984, 233). At the beginning of the 1990s, the site was included in the Polish Archaeological Record (in Polish: AZP) system. It was then given the number AZP 99-55/107. It turned out that the site is currently located in Sąspów village and was described as the 21st site in this locality.

MATERIAL AND METHODS

LiDAR data analysis

LiDAR (Light Detection and Ranging) is a system of several interconnected devices-starting with an emitter that generates a laser beam, a system that distributes it over the scanned surface and a detector that records reflection of the laser beam, linked to a precise GPS system that determines the position of the scanner. Knowing the position of the plane, the speed of wave propagation and the angle at which the laser beam was sent, the algorithm is able to calculate with high accuracy points where subsequent reflections occurred and record them in a spatial coordinate system. This allows a cloud of all points recorded by the scanner to be obtained (Kurczyński 2014, 59, 60). The next step is point cloud classification, which is one of the most crucial elements of data processing. The data are divided into a number of classes, the most important for archeology is class 2 – points lying on the ground. Classification errors may lead to deterioration in quality of the digital terrain model (DTM) or even generation of false objects (Kiarszys and Szalast 2014).

For this study, data were obtained from the ISOK (IT System for the Country's Protection Against Extreme Hazards) project. This program initially assumed carrying out aerial scanning of the valleys of the main Polish rivers, but during the duration of the project, the area was increased and currently covers the whole country. Data for the analysed region were acquired in standard I, which provides a cloud density of at least 4 pts/sqm (Kurczyński and Bakuła 2013). The obtained point cloud was reclassified using the Axelsson algorithm in LAStools software. Proper execution of this operation allowed for a significant increase in the number of points classified as lying on the ground.

For further analysis, a digital terrain model of TIN (Triangulated Irregular Network) type was prepared. This is a vector model where the terrain surface is represented by a grid of triangles, with each vertex having an assigned attribute (Szypuła 2010, 116). The great advantage of this type of model is its high accuracy in representing complex terrain relief. It also gives the possibility to identify places where the quality of the model decreases.

Visualization of data is a crucial step during the processing of the digital terrain model and remote sensing of archaeological sites preserved in terrain relief. The change of the direction from which the model is illuminated allows to see terrain forms invisible at other angles. For example, linear structures that are arranged along the direction of illumination will be much less visible than when illuminated from the side (Devereux *et al.* 2005). In recent years, different ways and parameters of visualisation have become one of the most important issues in methodological discussion of the use of LiDAR in archaeology (Devereux *et al.* 2008), and the number of visualisations continues to grow (Yokoyama *et al.* 2002; Humme *et al.* 2006; Hesse 2010; Challis *et al.* 2011; Kokalj *et al.* 2011). It should be noted that each visualisation provides various capabilities and is suitable for remote sensing and analysis of different types of sites. For example, PCA (Principal Component

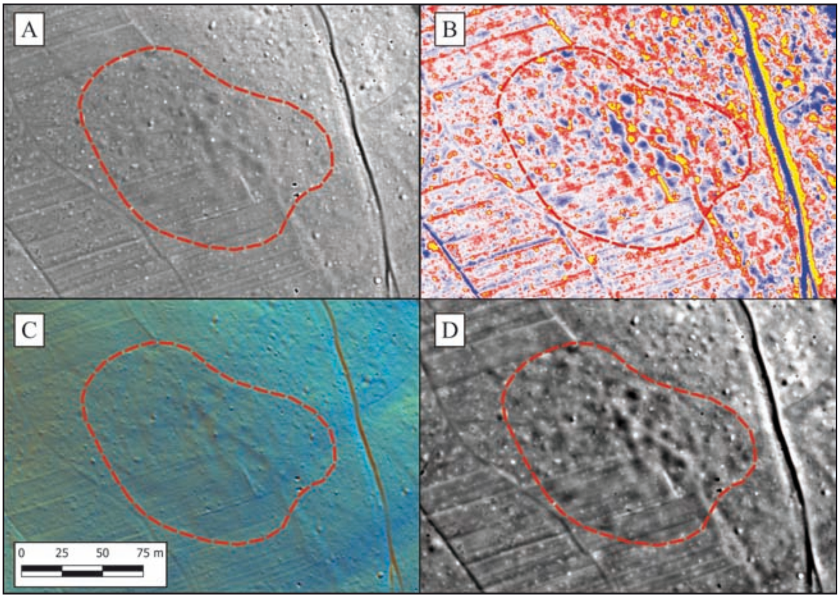

Fig. 3. DTM visualizations of the mining field; A – MSII (radius: 1-2, number of scales: 8, histogram: 1.3-1.6); B – CC_LRM (radius: 10, histogram: -0.2 – 0.15); C – Multi-Hillshading (illumination from 16 directions, h: 20); D – LD (radius: 5-10, observer height: 1.7; histogram: 0.85-1.2)

Analysis) performs better in analysing ridge and furrow than celtic fields (Kokalj and Hesse 2017,35). Visualisations and their parameters should be appropriate for the type of analysed site and local terrain relief (Kokalj and Hesse 2017, 34, 35). It is also possible to merge visualisations, the combinations of which often produce interesting results, especially for more complex or very poorly preserved features. Hillshading of the DTM, slope analysis, principal component analysis, local relief model, sky-view factor, openness, local dominance, accessibility, cumulative visibility, and multi-scale integral invariants should be considered basic visualisations.

Airborne laser scanning has already demonstrated its usefulness in remote sensing of mining fields (Budziszewski *et al.* 2018, 2019; Sudoł-Procyk *et al.* 2018) and in their analysis (Jakubczak 2012; Radziszewska 2015; Szubski 2016).

The Dąbrówka-I mining field is an excellent example of resuming the research of a site using modern methods. Thanks to the use of airborne laser scanning, it was possible to observe the remains of the preserved relief of mining field (Fig. 3). However, it is worth noting that it is very subtle. The following visualisations were prepared for detailed analysis: local relief model, multi-scale integral invariants, trend removal and local dominance. The latter is usually not applied in areas with significant slopes, but in this case, its application became most reasonable after some modifications. The best results were obtained using the local relief model with radius set to 10 meters and local dominance, where radius was also 10 meters, and observer height was 16 meters, the histogram was stretched between 0.85 and 1.2.

The analysis of the mining field surface also showed the dangers of over-interpretation of the data. After preparing the DTM and visualising it, the field surface showed lines running almost along the east-west axis, deceptively resembling ploughing traces. However, after closer analysis of the data, it seems that these should be interpreted as being due to a slight shift in the alignment of flight rows. This topic has been discussed more than once in the literature (Crutchley and Crow 2009, 27; Doneus and Briese 2011, 64; Banaszek 2015, 117). In this case, it is an issue that remains not without influence on the interpretation of the whole site because ploughing on the mining field significantly changes its relief.

Stone assemblage analyses

A significant amount of flint artefacts can be found on the surface of the site, in addition to the delicately delineated pit relief. The material is scattered throughout the site, but it is found in larger concentrations in some places. The material uncovered is mainly debitage from the processing of flint nodules. In order to analyse the chronology of the site and verify its contemporaneous character, it was decided to collect 16 core forms found scattered on the surface of the site.

Cores were subjected to morphometric and scar pattern analyses. In the former case, a set of 16 basic metric and descriptive features were analysed. Scar pattern analysis, on the other hand, was directed primarily at determining the interrelationship of the chronology of the individual negative reflections visible on the core in order to reconstruct a fragment, visible on the tool surface, of the chain of operations (Pastoors and Schäfer 1999; Pastoors *et al.* 2015; Richter 1997; 2001). Seven core forms bearing traces of primary knapping and initial orientation of the nodule in the direction of core formation were included in this analysis. Comparison of the results of the two analyses makes it possible to determine a reproducible pattern of processing of the core forms and to observe, each time, certain aberrations resulting from the specific nature of the raw material.

RESULTS

LiDAR data analysis

Based on LiDAR data, the size of the Dąbrówka-I mining field can be estimated to be about 1.30 ha. The minefield area is located on the valley border and the slope descending towards the Sąspów valley (Fig. 4). The relief of the mining field area is diversified, and it can be divided into three parts (Fig. 5).

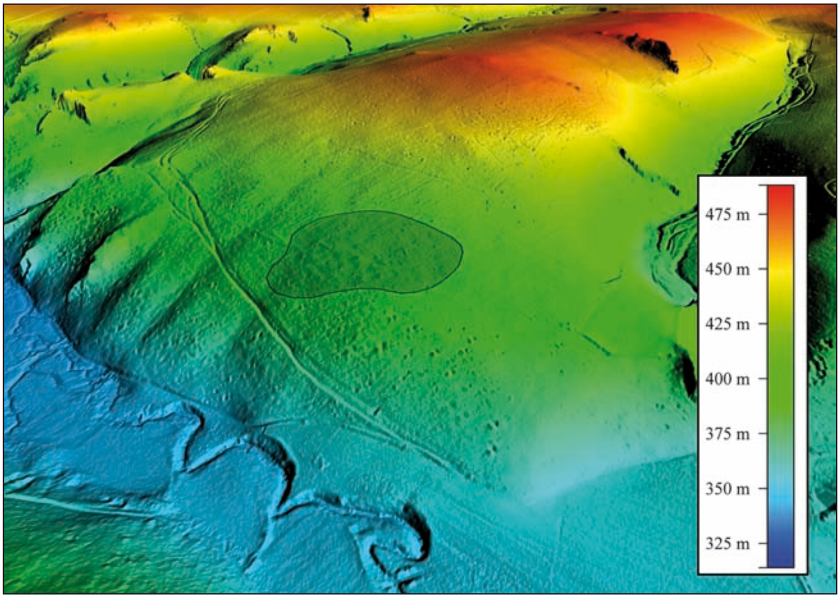

Fig. 4. 3D model with the site area marked, based on the digital terrain model. View from the north-eastern side

Part A is probably the original surface of the mine field associated with its use in the Neolithic period. It is covered by a scatter of irregularly shaped hollows, and it is impossible to indicate the remnants of mining objects or shaft heaps. Most likely, this type of relief covered the entire mine area. Part B covers an area of about 0.18 ha and is located in the central part of the minefield. The remains of mining hollows can be discerned using the local dominance visualisation. At least eleven shafts can be seen. They have spoil heaps, usually on the northeast side in line with the slope. This type of quarry-like mining has its analogues in the striped flint mining field "Skałecznica Duża" (Jakubczak 2012, 32), Mników (Budziszewski *et al.* 2019) and at the Rybniki-"Krzemianka" site (Zalewski 2000, 262). However, in the case of Dąbrówka I, the relief of the site is much more subtle. The depressions have a diameter of up to 7 m and a depth of up to 20 cm, so they are hardly visible in terrain. It is most likely that this part is related to the younger exploitation of the mining field and levels the remains of a Neolithic mine.

Part C located in the eastern part of the mining field consisting of at least four depressions with no visible spoil heaps. It is difficult to say whether these should be connected with part A or B of the mining field or represent another third episode of its use.

In the southern part, there is an area of about 0.37 ha, which was partly levelled by ploughing (Fig. 6). The shape and layout of the field indicate that it is a trace of modern plough cultivation. Baulks separating individual plots are visible, and flint material can be

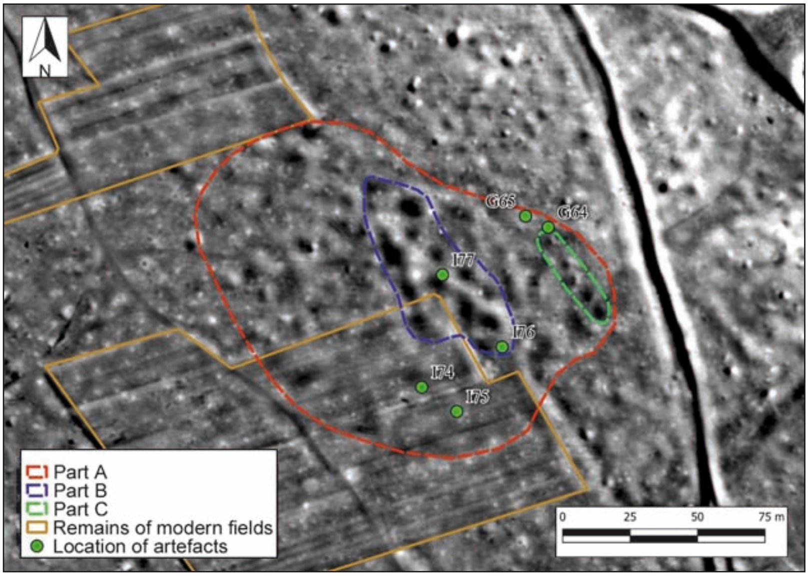

Fig. 5. Interpretation of the pit relief at the site, including the location of the flint cores described in the paper

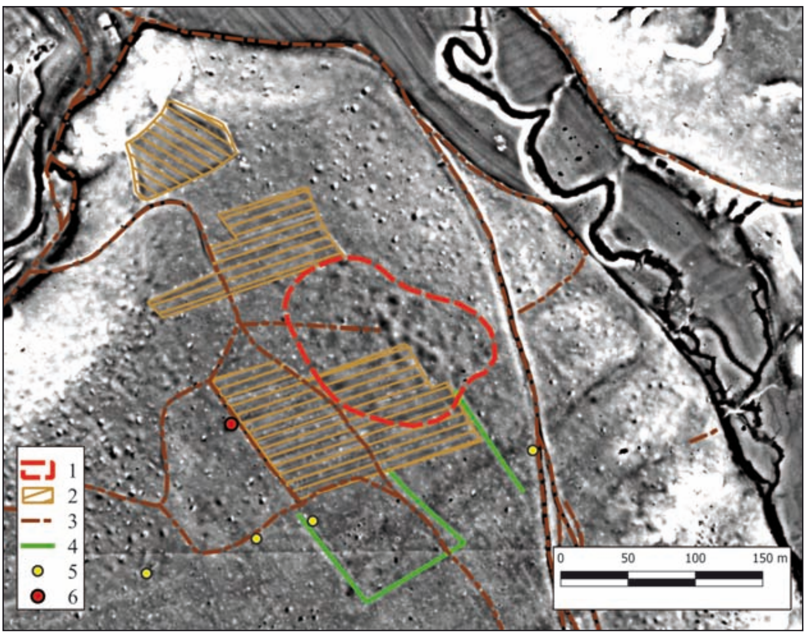

Fig. 6. Interpretation of the landscape in the vicinity of the site.
1 – mining field area; 2 – remains of modern agricultural fields; 3 – traces of roads and road indentations; 4 – remains of old baulks; 5 – boundary mounds; 6 – charcoal pile

seen accumulating on them. During the land use, farmers probably threw the larger forms onto the baulks so that they would not interfere with cultivation. The field division is consistent with the current land records. The age of the forest at this site based on the Forest Data Bank is estimated at a minimum of 70 years, indicating that the episode of cultivation of this area was short. This is supported by the fact that mining relief is still visible at this site.

Flint assemblage

The preliminary analysis of the flint material indicated that the core forms were abandoned at the site at various stages of their reduction. The collected assemblage lack only fully exploited cores. The obtained forms can be divided into three groups.

The first group consists of irregular nodules or chunks of raw material with negatives of single removals, difficult to unambiguously interpret. This group is represented by two specimens not exceeding 13 cm in size. Such may be accidental or connected with testing the raw material.

The second group consists of the pre-cores, represented by seven specimens (Fig. 7). They have partially or fully formed ridges, usually on the narrower side. Three of them are almost entirely covered with cortex. The others are either partially cortical, covered partly with natural, patinated surfaces or completely decorticated. They show a high degree of variation in their size and weight, ranging from 7.6 to 15.5 cm in length, 4.5 to 12.7 cm in width, and 6.9 to 11.7 cm in thickness, with weights ranging from 351.8 to 2031.7 g. It seems that the primary reason for abandoning most of them was internal cracks (*e.g.* Fig. 7, G69), or the impossibility of forming/correcting the core angle, making it impossible to remove blades. Only a single preform (Fig. 7, I76c) with a bilateral ridge forming the apical part and the knapping surface, located within the narrower side of the nodule (Fig. 7), deviates from this. It has a striking platform formed by a single removal, inclined to the flaking surface at an acute angle. The core was abandoned for an unspecifiable reason.

The last group consists of cores abandoned at an initial or advanced stage of the exploitation, also represented by a total of seven specimens (Figs. 8-14). They manifest varying sizes, including heights ranging from 6 to 13 cm, widths ranging from 7 to 10 cm, thicknesses ranging from 6 to 10.6 cm, and weights oscillating from 261.7 g to 1039.8 g. The vast majority of the cores have circular striking platforms (five specimens) located on the narrower sides of the nodule (four specimens). All cores in their initial form were single-platform forms, and in the case of three of them, there were also remnants of a change in orientation (Fig. 8). The remains of primary flaking can be seen on the analysed forms, analogous to those observed within the pre-cores. Apart from remnants of crest formation or ridges in the apical parts, most of the collected specimens also show clear traces of core preparation on their back, including the formation of single- or double-sided ridges covering part or even all of their length (Figs 9, 10). Only one of the analysed specimens has the back of the core left unprepared (Fig. 11).

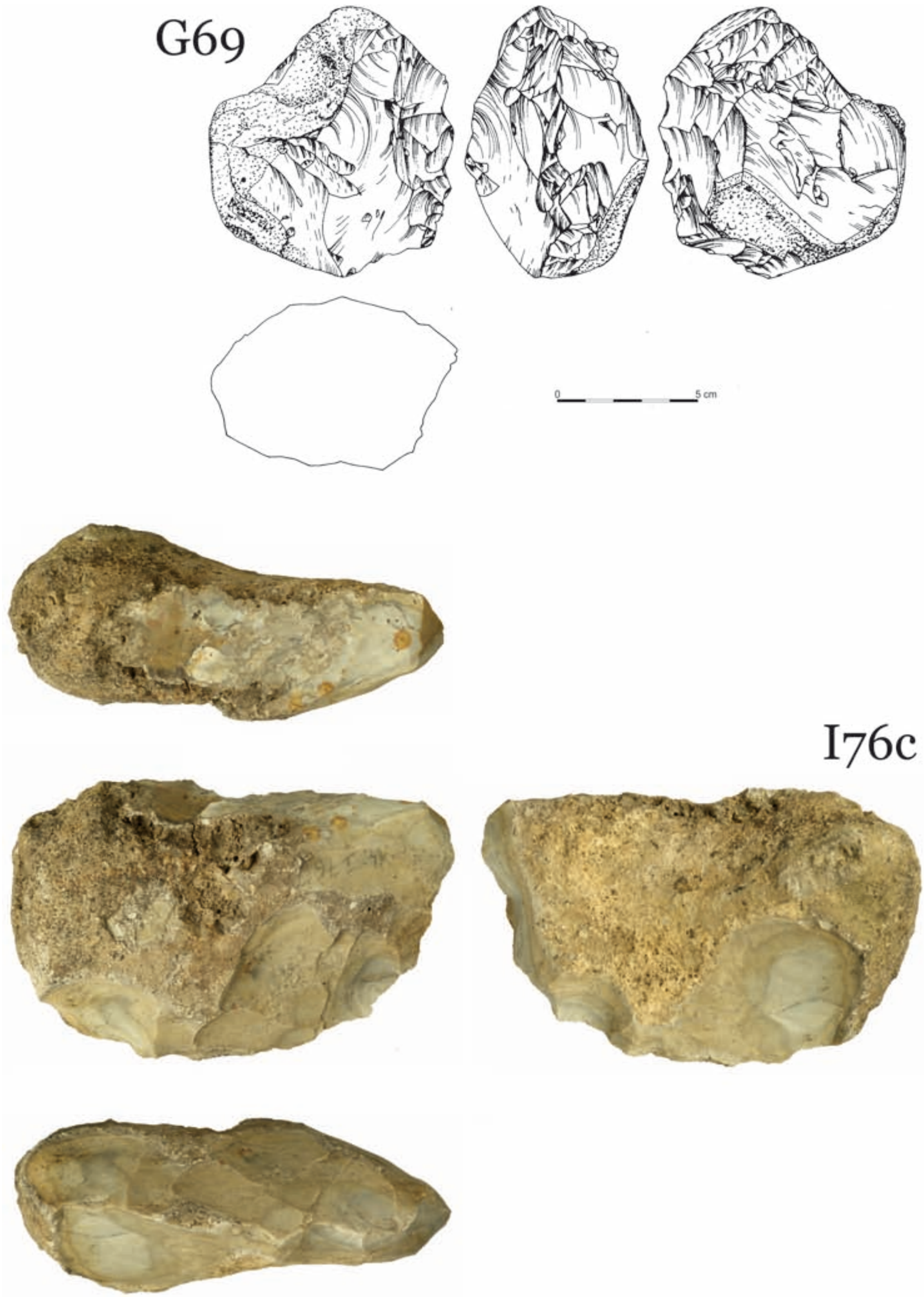

Fig. 7. Initial cores found on the surface
(drawn by Ewa Jurzysta; photo: Natalia Gryczewska)

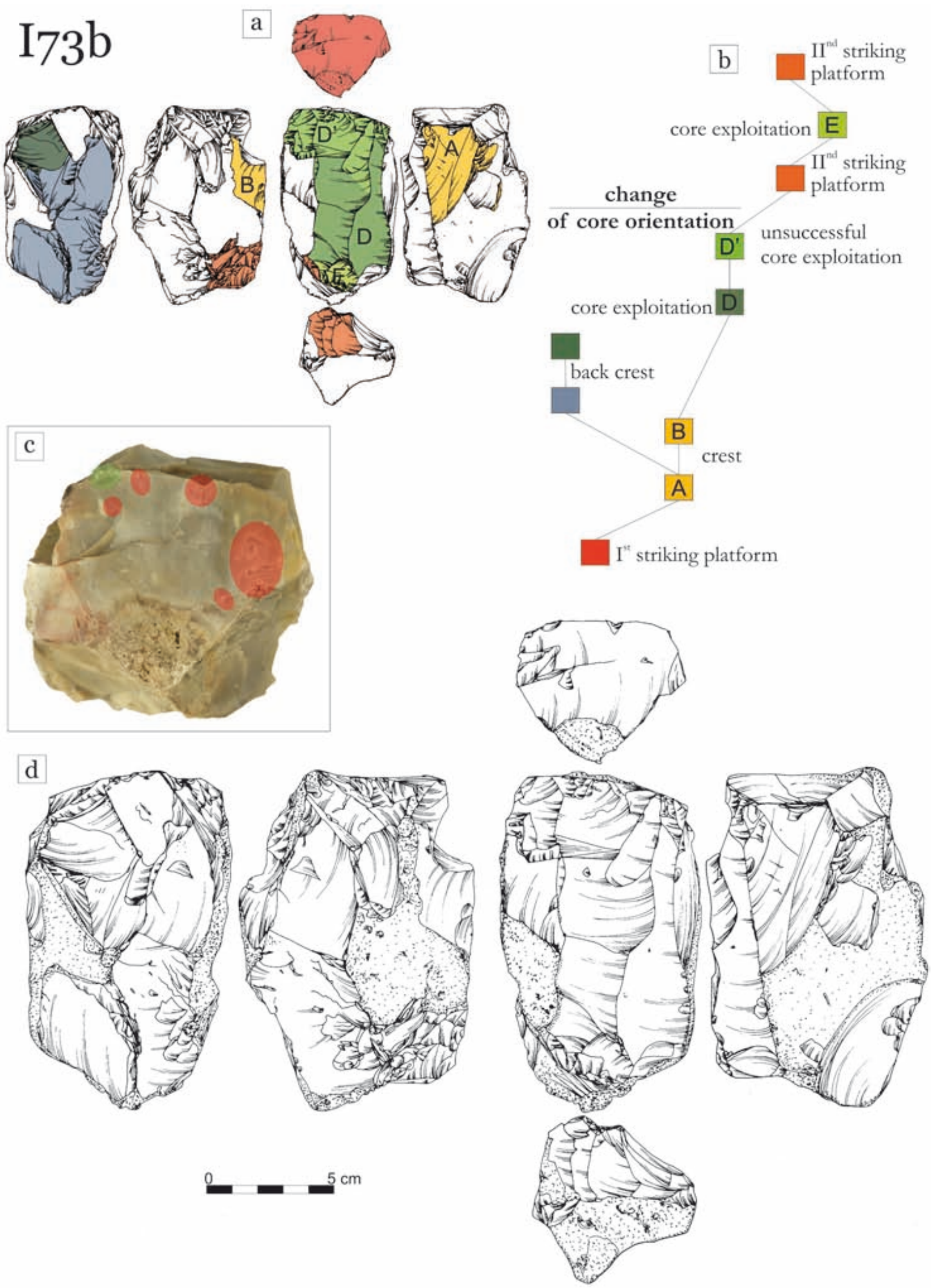

Fig. 8. Scar pattern analysis of the core.
A – visualisation of the analysis results; B – graph showing mutual chronological relations of particular knapping sequences; C – drawing of the artefact (drawn by Ewa Jurzysta, Małgorzata Kot)

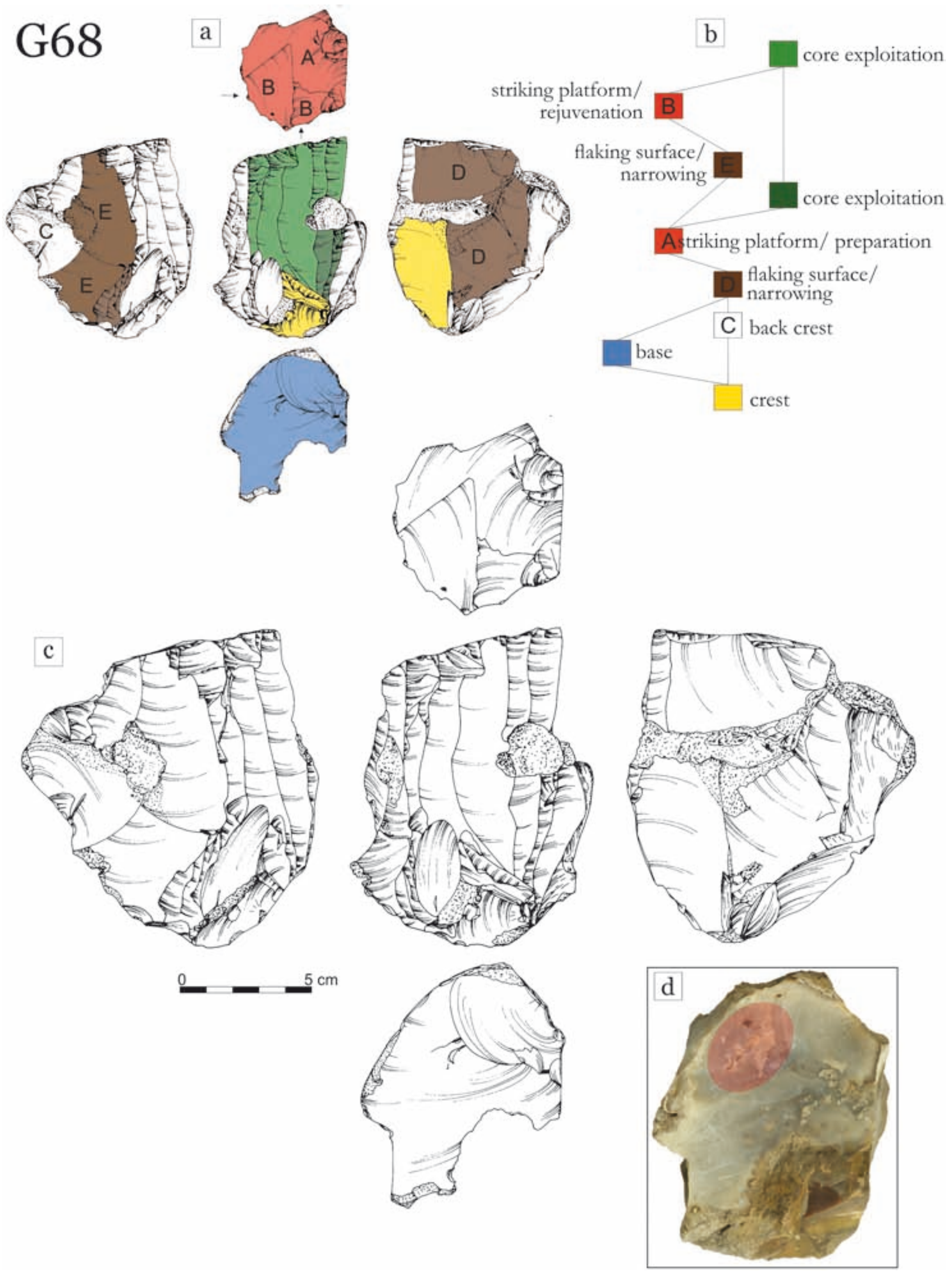

Fig. 9. Scar pattern analysis of the core.
A – visualisation of the analysis results; B – graph showing mutual chronological relationships of particular knapping sequences; C – drawing of the artefact; D – crushes visible on the base of the core
(drawn by: Ewa Jurzysta, Małgorzata Kot; photo: Natalia Gryczewska)

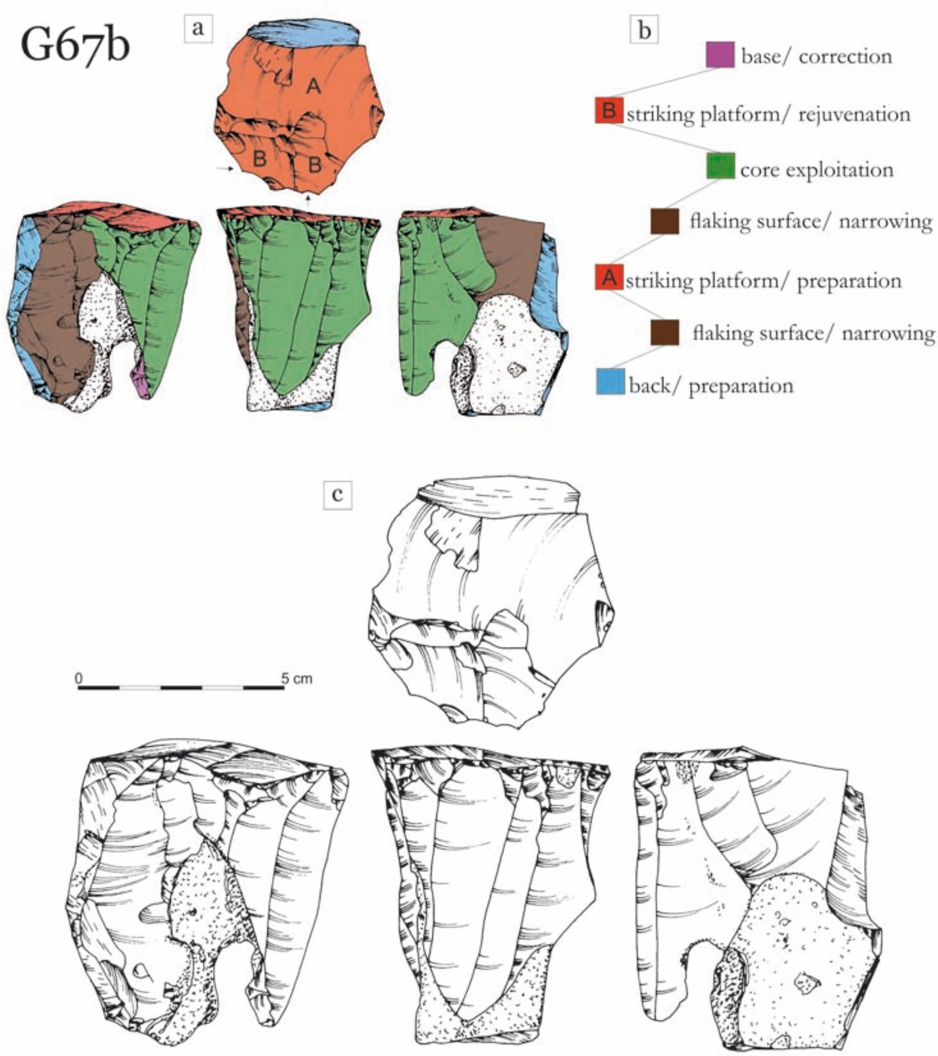

Fig. 10. Scar pattern analysis of the core.
A – visualisation of the analysis results; B – graph showing mutual chronological relationships of particular knapping sequences; C – drawing of the artefact (drawn by Ewa Jurzysta)

The values of core angles of the discussed cores show a small range of variation, oscillating each time around a right angle (80-90°). The planes of the initial striking platforms were formed by a single removal from one of the sides (Figs 9, 10). Throughout the core exploitation, they were successively rejuvenated with finer removals from the side of the flaking surfaces or sides of the cores allowing correction of the core angle (Figs 9, 10). In addition, the surface of one specimen (Fig. 12) retained traces of a secondary crest formed to cap the flaking surface and extend the blade exploitation to the left side of the core (Fig. 11). The analysis of the length of the blade negatives preserved within the flaking surfaces of individual cores indicates that blades 6.5-10 cm long and 2.0-3.3 cm wide were obtained in the last phase of their exploitation.

The flint raw material exploited at the site occurs in various-sized nodules with spherical shapes, covered by a thin (2-4 mm) cortex with a rough texture. The individual concretions have a lot of internal cavities and irregularities, which could have been exploited by their users during the processing (Fig. 10), but more often were a significant impediment to the full and effective exploitation of the cores (Fig. 9). The raw material is highly fractured internally, which appears to have been the main reason for the widespread abandonment of cores during exploitation. Of the collected specimens, only one core (Fig. 10) showed no signs of internal cracking and was abandoned due to its high degree of exploitation. Reduction of all other cores was abandoned due to an error occurring at some stage of exploitation, resulting from internal cracking of the nodule.

The average height of the analysed cores is 10 cm, which indicates a specific metric preference in the selection of flint nodules for production. At the same time, pieces up to 7 cm in length could also be found at the site. This confirms the exploitation of forms with a slightly smaller initial size, allowing the production of shorter and narrower blades (Fig. 10). It also corresponds with the length of the prepared flaking surface of the pre-core (Fig. 7).

The analysis of scar patterns has shown that six out of seven analysed cores were exploited according to a similar technological scheme, based on three primary stages of core preparation, preceding the phase of blade exploitation. As far as it can be determined based on this type of analysis, these stages followed a specific order, from which, however, some deviations occurred. The first stage was forming the sharp edge of a double-sided ridge, covering the initial flaking surface and the top and/or back of the designed core. This ridge was used as a crest for further processing. With one exception (Fig. 7, I76c), it was made within the longest edge of the nodule. The next stage was to form the initial striking platform by removal of one or a series of large flakes at one end of the oblong nodule. The striking platforms of the cores analysed are inclined at approximately right angles to the striking surfaces. The only exception is core I76a (Fig. 14), which will be characterised separately later.

After the preparation of the striking platform, and before the further blade exploitation, the third stage of core preparation was executed; namely, the flaking surface narrowing by series of blades/flakes removed from both sides of the preform, either transverse or longitudinal to the axis of the future core. This aimed to regulate the sides of the cores and reduce the width of the future flaking surfaces by removing the cortex and the natural unevenness of the nodule. Only after such preparation of the sides of the flaking surfaces, the main exploitation of the cores and obtaining blades was commenced. The traces of striking platform rejuvenation in the place of the planned removal of the next blade, by correcting the angle of coring using small flakes, were preserved on three forms (Figs 8-10).

They indicate that the platform edge was prepared each time in the place selected for the future strike, not its whole length. The edges do not bear traces of intensive abrasion. There are also no traces of reduction in the area of the striking platform lines. In general, a tendency toward sequential action is evident with blade exploitation. Major core repair was undertaken only after several blades had been removed, and core angle correction became necessary. Repair of cores was the same as their initial preparation, but the stage of crest forming was usually omitted. First, the repair procedures were undertaken in the striking platform areas, involving the removal of several tiny flakes derived from the side of the flaking surfaces and especially the sides of the cores (Figs 9, 10). The next step in the repair was to reshape the sides of the core. After these steps, it proceeded to its exploitation again.

The three cores show remnants of a change in their initial orientation, made when it was impossible to continue the blade exploitation and repair a functioning or prepared flaking surface.

An example of a change in orientation is the form of core I73b (Fig. 8), in which internal cracking and the very high hinges formed at the first blade removal prevented further exploitation. The reorientation consisted of using the already prepared crest and creating a striking platform at its opposite end. Unfortunately, here too, internal cracks stopped exploitation already at the stage of narrowing the future flaking platform. This core is also interesting because of an error that occurred during blade exploitation. The removed blade did not wholly separate from the core, but its outline is visible on the surface. A further two hinged removals have partially fallen out from underneath it, further highlighting it on the nodule (Fig. 8). In this case, we can observe the only example of a very thorough preparation of the area for the blade impact. It was connected with a strenuous attempt to separate it from the nodule. The future impact point was isolated on the flaking surface by a series of small flakes on both sides of the blade, but there are no traces of preparation of the striking platform, which remained plan. There are distinct crush marks at the point of failed impact (Fig. 8: c). In addition, there is a series of crushes near the point of force application, presumably created by flaking with a hard hammer to deflect the unchipped blade visible on the flaking surface. The final blow occurred in the centre of the striking platform in the line of the internal crack line visible on the platform surface, which provided a chance for complete removal of the flaking surface and its renewal. The impact left a circular mark on the platform and a grid of radially spreading resulting cracks (Fig. 8: c), testifying to its strength.

An interesting example of an attempt to bypass an internal crack is core I73a (Fig. 11), with a lateral crest. The crest was not removed during blade exploitation due to the internal crack adjacent to it along the entire body. The flaking surface was therefore moved to the side of the core. After it had become too flattened, an attempt was made to radically shorten the core by removing several thick flakes from the striking platform. The core was shortened by about 1/3 of its height, but the cracking along the initial crest remained visible.

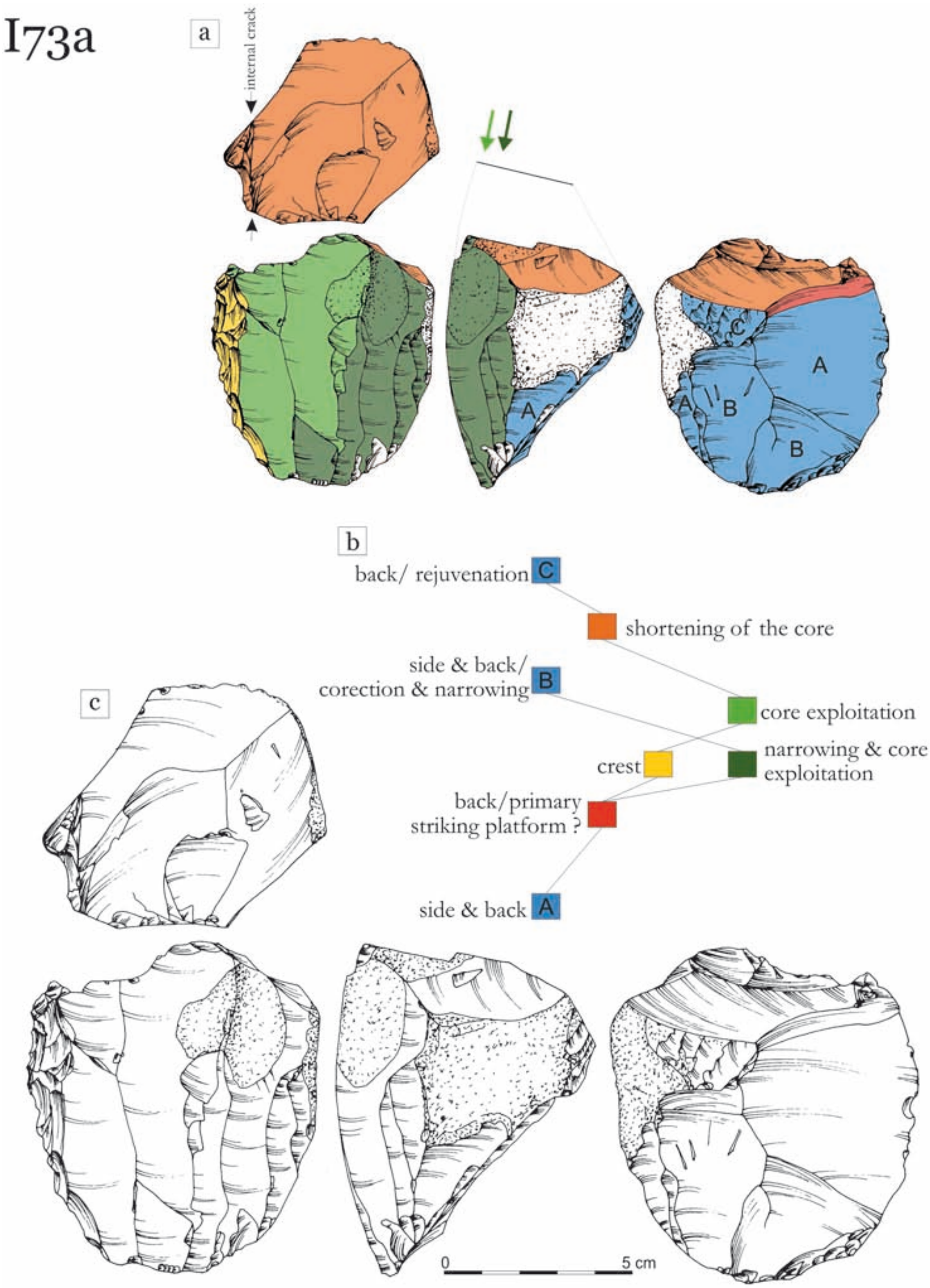

Fig. 11. Scar pattern analysis of the core.
A – visualisation of the analysis results; B – graph showing mutual chronological relations of particular knapping sequences; C – drawing of the artefact (drawn by Ewa Jurzysta)

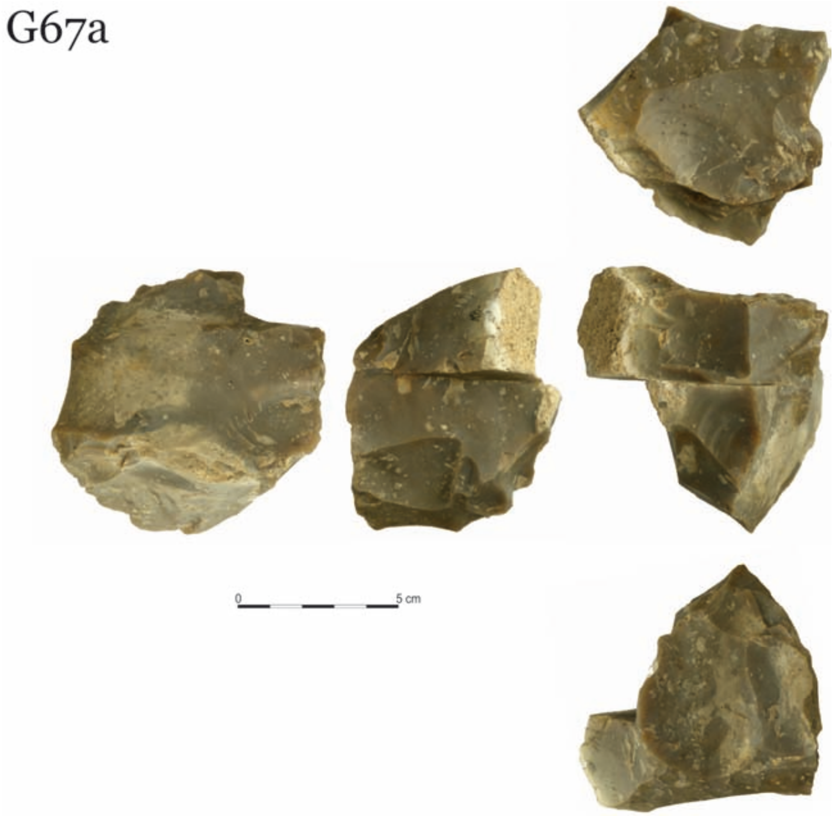

Fig. 12. Core with changed orientation (photo: Natalia Gryczewska)

The crack caused the series of hinges at the striking platform. At this point, the core was abandoned without attempting to use the newly prepared flaking surface.

The right angle of core reduction, accurate preparation of the striking platform before the individual blades removal, traces of well pronounces bulbs visible at the scars of previous blade removals, and their regular edge delineation indicates the use of the indirect percussion.

Finally, it is worth noting the Hertzian cones visible on the surface of the striking platforms, which are traces of unsuccessful impacts. These Hertzian cones were formed at the last stage of the core's life when the flaking surface required radical rejuvenation. They appeared during the attempt to detach massive blades/flakes with the use of a hard hammer. Unsuccessful rejuvenation ended in reorientation or abandonment of the core. In the case of core G68 (Fig. 9), the crushes are visible on the core base formed by a single removal. The crush marks are located far enough away from the edge that it is difficult to see any evidence of attempts to remove flakes/blades. These marks may be the result of leaning the core against a hard surface. Impacts brought out on the striking platform may have

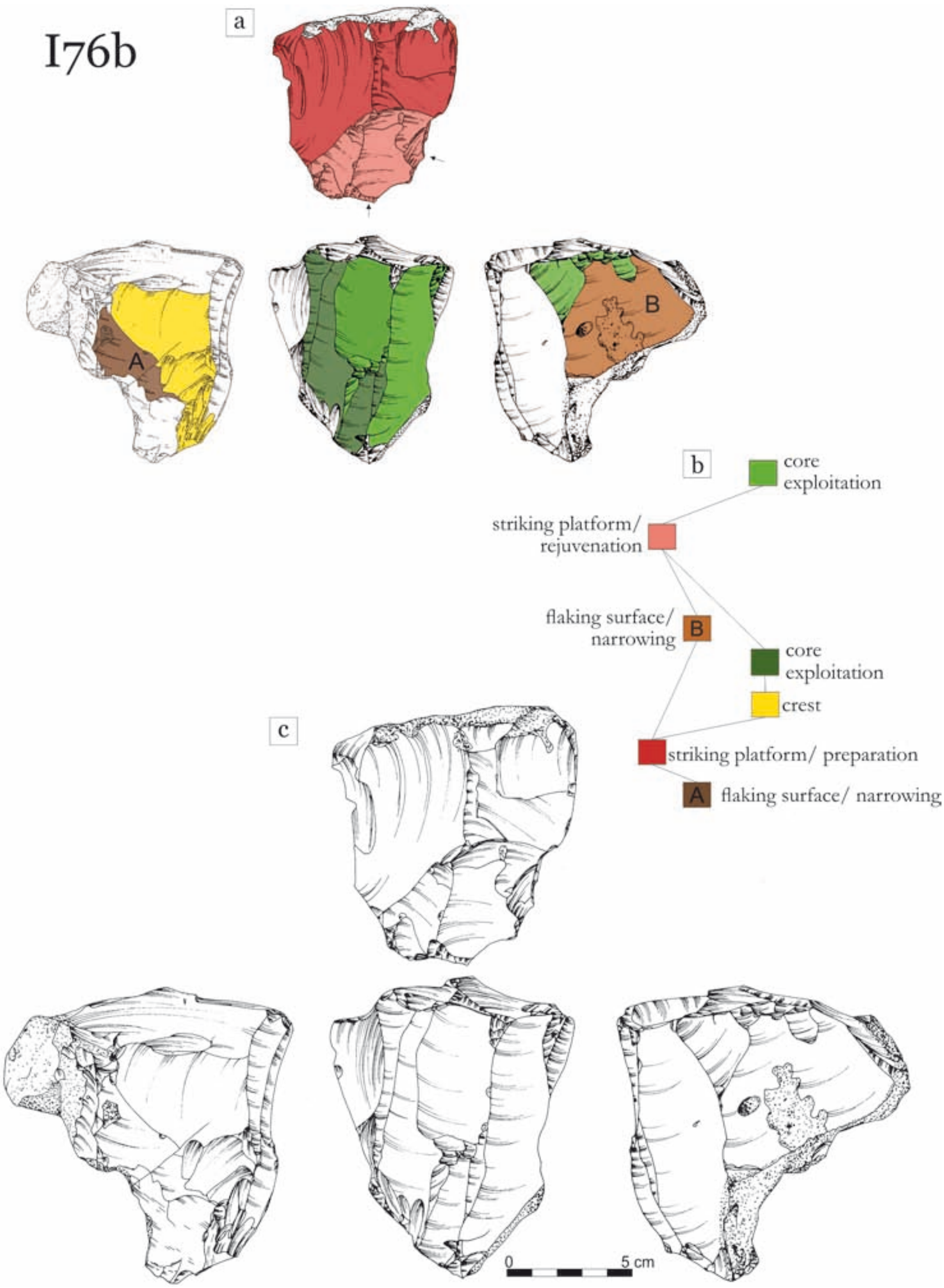

Fig. 13. Scar pattern analysis of the core.
A – visualisation of the analysis results; B – graph showing mutual chronological relationships of particular knapping sequences; C – drawing of the artefact (drawn by Ewa Jurzysta)

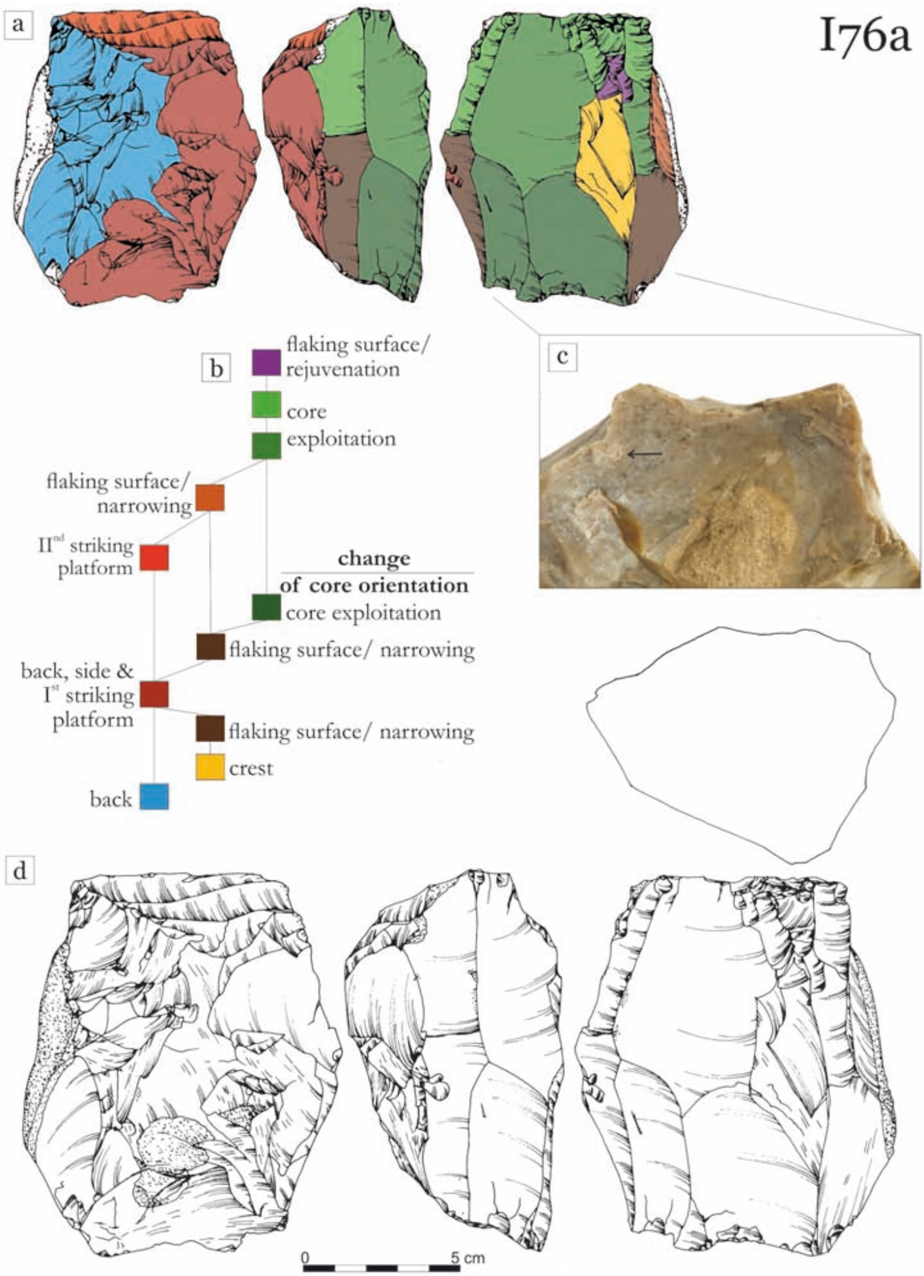

Fig. 14. Scar pattern analysis of the core. A – visualisation of the results of the analysis; B – graph showing mutual chronological relationships of particular knapping sequences; C – drawing of the artefact; D – course of the edge of one of the striking platforms and visible hard hammer impact points (drawn by Ewa Jurzysta, Małgorzata Kot; photo: Natalia Gryczewska)

caused the transfer of force and the formation of crush marks from the underside of the core. However, these conclusions should be verified by traseological analysis. The literature indicates that immobilising the cores using an anvil enables the detachment of straighter blades (Budziszewski and Grużdź 2013, 168).

Only core I76a (Fig. 14) does not fit in the consistent core structure described above. It has two striking platforms. One of them forms a right angle with the flat flaking surface located on the broader side of the nodule. While the other is inclined at an angle of 50°. Such a knapping angle is not found in other cores. In addition, at the initial stage of core reduction, a long crest was prepared at the back of the core. The crest smoothly transitions into removals which form both striking platforms. Such a pattern of striking platform preparation is not similar to the way they are prepared in other cores. After preparing the back of the core along with the striking platforms, the exploitation of the core started with slightly narrowing it and then removing two big flakes from the striking platform of a sharp core angle. Both flakes had prominent butts with an almost triangular shape in the cross-section, which can be observed in the form of deep, triangular notches on the edge of the striking platform.

After these two wide, rectangular flakes, the exploitation was transferred to the second striking platform. One very wide flake was removed at this stage. Then after an attempt to move exploitation to the other side of the flaking surface and after it had narrowed, a series of hinges halted further exploitation of the core.

At this point, it should be emphasised that the flint raw material exploited in the Dąbrówka-I mine was of poor quality and bore numerous internal cracks, which made blade exploitation difficult and prevented the acquisition of a long series of regular blades. We may assume that this was a reason for conducting not only the nodules testing, preform preparation at the site, but also core exploitation and blade production. The small number of blades extracted from each nodule probably made it more economical to transport the finished selected blades from the site than to haul the pre-cores, which could later prove to be suitable for production of only a few blades. It is possible that better quality nodules and pre-cores, without internal cracks, were taken out from the site as a whole, but this can only be confirmed after a detailed debitage analysis.

DISCUSSION

Despite the small series of collected and analysed preforms and cores, the obtained results distinguish two independent episodes of exploitation of the Dąbrówka-I flint mine. The quantitatively dominating group are artefacts connected with blade-production characteristic for the Neolithic, represented by 15 specimens in total, including eight pre-cores and seven cores abandoned at different stages of exploitation. These forms constitute a collection standardised in technological and conceptual terms, reflecting uniform preferences in raw material selection and a repetitive scheme of technical solutions applied during the adaptation of their surfaces for blade production. The uniform character of the collection is also supported by very similar morphometry of the obtained blade blanks. It is visible in the negatives of blade scars preserved on cores and similar values of the core angle oscillating in the 80-90° range each time, indicating the use of the indirect percussion technique for blade exploitation. The commonly observed narrowing of the cores by reducing the side of the core and striving for their rectangular shape in the longitudinal section may also indicate the necessity to immobilise the cores during the use of the indirect percussion technique.

The analysed materials also show strong morphometric correspondences with blade cores recovered at the site during earlier work conducted by Jacek Lech and associated with the "Lengyel-Polgar complex" (Lech 1980a, figs 627, 629). Of particular note is the analogous orientation of cores by locating the flaking surface on the narrow side of the nodule (Lech 1980a, fig. 627, 4 and fig. 629, 3) or narrowing the flaking surface (Lech 1980a, fig. 627, 3 and fig. 629, 4). The near-right angle of coring is also analogous, as are the rejuvenation removals at the striking platform. One of the cores presented by J. Lech (1980a, fig. 629, 1) furthermore bears traces of reorientation, analogous to the forms described above (Fig. 12). These concordances indicate at least the partial chronological contemporaneity and cultural homogeneity of the majority of artefacts collected to date from the surface of the Dąbrówka-I mining field.

The cited technological and metric properties of the presented pre-cores and cores fit very clearly into the pattern of blade production of younger, post-linear Danubian communities developing during the 5th millennium BC. At the same time, they find numerous and very close analogues among such dated assemblage recovered from the nearby, well-studied mines of the Jurassic-Cracow flint in Bębło (Lech 1980d) and Sąspów (Dzieduszycka-Machnikowa and Lech 1976; Lech 1980c, 619). Particularly numerous and apparent similarities to the forms from "Dąbrówka-I" can be seen in the case of the richest and best-studied inventory from the flint mine in Sąspów. They manifest themselves very clearly at the level of formal and metric criteria of selecting flint nodules used for further core reduction. Analogies can also be seen in the orientation of exploitation itself and the location within them of the basic core surfaces, *i.e.* the striking platform and flaking surface, and the closely related scope of adaptation of natural surfaces for the further blade exploitation. It is confirmed by analogous preparation of narrow-flaking surface cores with the use of a crest (Dzieduszycka-Machnikowa and Lech 1976, 117). Clear analogies are also visible during blade exploitation itself, initiated at the flaking surface located on the narrower side of the nodule and sometimes – with the progress of exploitation – undergoing an extension to one of the sides of the core, leading to its flattening (I73a; see Fig. 11). This knapping scheme was commonly used in Sąspów (Dzieduszycka-Machnikowa and J. Lech 1976, 118). Along with other techno-morphometric similarities, it may argue for a similar chronological and cultural position of the presented materials from the Dąbrówka-I flint mine.

The features mentioned above justify the identification of the most intensive phase of exploitation of the Dąbrówka-I mining field with the post-linear groups, including most probably the Pleszów and/or Modlnica groups of the Lengyel-Polgar cycle (Dzieduszycka-Machnikowa and Lech 1976, 151; Lech 1981, 185). The radiocarbon dates obtained for the flint mine in Sąspów (Lech 1980c, 619) do not exclude the possibility of exploitation of the Dąbrówka-I mine also by the communities of the older Lengyel cultural groups or the Malice culture. Intensive penetration of the area by communities of these cultural groups is documented among others by numerous cave sites associated with seasonal stays of human groups (*e.g.*, Kamieńska 1973, 72-74, 100-102; Rook 1980), including intensive processing of local flint (*cf.* Lech 1981, 109-115). High activity of the Malice culture community within the Jurassic-Cracow flint outcrops is also indicated by the rich inventories discovered in recent years at the open-air sites at Modlnica and Targowisko. The narrow- and broad-flaking surface blade cores from these sites, abandoned at various stages of exploitation (Wilczyński 2011, tables I-V, 2014, tables 8-16), show relatively high similarity to some of the cores (Figs. 9-11) and pre-cores (Fig. 7) from "Dąbrówka-I". The mining activity of these communities is also indirectly indicated by the presence of tools in the type of picks (Wilczyński 2014, Pl. 21: 6, 7).

The presence of a second, later phase of mine utilisation is indicated by the presence of core I76c (Fig. 14). Both the morphology of its striking platforms and the morphometric features of the debitage are characteristic for the hard hammer technique. Also, the different structures of the core, the different core angle, the exploitation of two opposite striking platforms, and the location of the flaking surface on the broader side of the nodule, point to its different chronology from other specimens collected from the mine surface. In the materials published by J. Lech, there are no forms analogous to this core.

The mentioned morpho-technical attributes of the discussed core show certain analogies to the so-called "declining knapping traditions", characteristic for the Bronze Age and early Iron Age (Kopacz and Valde-Nowak 1987; Libera 2005). They find morphological analogues among flint materials, including cores known from sites of the Mierzanowice culture near Kraków (*e.g.*, Kopacz 1976; Wilczyński 2011; Stefański 2015), the Trzciniecka culture (Budziszewski 1998), and finally the Lusatian culture (*e.g.*, Kruk 1994; Trela-Kieferling 2013; Wilczyński 2015). Such a cultural classification of the mentioned core in question may be indicated primarily by the remnants of the para-blade, 'Clactonian-type' technique of core exploitation, characteristic for the Lusatian flint production (*e.g.*, Libera 2005, table 1). However, it should be noted that the presence of two striking platforms and the presence of core preparation sequences is unusual in this context. Before assigning a more detailed cultural affiliation to the discussed core, we should wait until a more numerous collection of cores of similar technological features is gathered.

The analysis of LiDAR data also suggests at least two stages of mining field utilization. The only core that can be associated with the later exploitation horizon of the site was found in zone B, which is characterised by a less eroded pit relief.

Our results suggest that the Dąbrówka-I mining field has at least two mining horizons: the first, more intensive one, is connected with the Neolithic period and the second one, covering a smaller area and is connected with the Late Bronze Age/Early Iron Age. Neolithic cores found throughout the site indicate that mining related to the later horizon was carried out within an area already exploited in the Neolithic period.

Acknowledgements

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A SPECIFIC OBSIDIAN WORKPLACE AT THE MALICE CULTURE SETTLEMENT IN KRACZKOWA 31, PODKARPACKIE VOIVODSHIP (SOUTHEASTERN POLAND)

ABSTRACT

Dębiec M. and Pelisiak A. 2022. A specific obsidian workplace at the Malice culture settlement in Kraczkowa 31, Podkarpackie Voivodship (southeastern Poland). *Sprawozdania Archeologiczne* 74/1, 373-387.

This paper presents a knapped assemblage from the Malice culture settlement at Kraczkowa, site 31. Obsidian artefacts dominate in this inventory. The typological structure of obsidian items (small numbers of cores, flakes and blades, and numerous various chips) indicates the existence of a specific workshop where processing of this material occurred.

Keywords: Linear Pottery culture, obsidian, flint knapping, raw material
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INTRODUCTION

In southern, central, and middle-eastern Europe, from the Palaeolithic to Bronze Age periods, obsidian was one of the most important lithic raw materials used for tool production. It was obtained from natural sources located on Mediterranean islands and in central

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and south-eastern Europe and the Near East, and pieces of raw material and various products were distributed widely over long distances, up to hundreds of kilometers from the sources. Obsidian management, and in its context, regional and interregional contacts and a variety of interactions in the Neolithic and Bronze Age in various parts of Europe, have long been the subject of interest of a large group of researchers (*e.g.,* Kaczanowska and Lech 1977; Kulczycka-Leciejewiczowa 1979; Torrence 1986; Bacskay *et al.* 1987; Kaczanowska, Kozłowski 1997; Carter 1998; Szeliga 2007; 2021; Kozłowski *et al.* 2014; Milić 2016; Trykot 2017; Moutsiou 2019; Szeliga and Zakościelna 2019; Szeliga *et al.* 2021). Moreover, in recent decades, such studies, in particular concerning the characteristic features of raw material from individual sources and extraction sites, have found strong support from effective analytical tools in the form of modern physicochemical methods (Williams, Nandris 1977; Williams-Thorpe *et al.* 1984; Hughes and Werra 2014; Milić 2014; Bonsall *et al.* 2017; Orange *et al.* 2017; Riebe 2019; Dillian 2020; Kaminská 2021; Werra *et al.* 2021, further literature there).

Neolithic communities from central Europe used obsidian primarily, or even exclusively, from sources in present-day Slovakia (Carpathian 1), Hungary (Carpathian 2), and Ukraine (Carpathian 3) (for example Szeliga 2009; 2021). Its influx into Neolithic communities that settled the area north of the Carpathians is significantly noticeable in the young Želiezovce phase of the Linienbandkeramik (LBK), and the importation of obsidian was also important to the Malice culture living in this area (*e.g.,* Kaczanowska 1985; 1987; 2001; Sobkowiak-Tabaka 2018; Kadrow *et al.* 2021; Szeliga 2021). On the LBK sites in southern and south-eastern Poland, and in Volhynia, obsidian artefacts are commonly registered but in varying numbers, from one to several hundred items on individual sites (*e.g.,* Aksamit 1971; Milisauskas 1983; 1986; Kadrow 1990a; Szeliga 2009; Valde-Nowak 2009; Czopek *et al.* 2014; Dębiec *et al.* 2014; Wilczyński 2014a; Dębiec *et al.* 2015; Kabaciński *et al.* 2015; Dębiec *et al.* 2021; Kadrow *et al.* 2021; Pelisiak 2021; Szeliga *et al.* 2019; 2021). It should be stressed that among these inventories there is a clear typological differentiation, which may suggest complex patterns of importation and distribution of obsidian raw material, cores, sources, and tools (Raczak 2017). Obsidian is frequently registered in chipped assemblages of the Malice Culture. In these inventories their numbers vary significantly as well (Kadrow 1990a; 1990b; Mitura 2004; Czerniak *et al.* 2005; Górski *et al.* 2005; Dębiec 2005; Szeliga 2007; 2021; Wilczyński 2010a; 2011; 2018; Bobak and Połtowicz-Bobak 2013; Wilczyński *et al.* 2015), and in some cases the group of obsidian artefacts exceeds 100 items (*e.g.,* Ćmielów site 2: 140 artefacts constitute 4.12% of the whole knapped assemblage of the Malice culture discovered at this site; Michalak-Ścibior 1994). Among the Malice culture sites, the assemblage from Targowisko site 11 is distinguished by the numerous and typologically diverse obsidian assemblage: 585 obsidian artefacts, including 69 cores, 209 flakes, 263 blades, two retouched tools, and 42 chips and chunks. Especially significant is the large group of finds from Feature 2925, consisting of 15 cores, 49 blades and 27 flakes (Wilczyński 2010b; 2014b; Grabowska and Zastawny

2014). In the group of known knapped inventories of the Malice culture, the assemblage discovered in pit 1 in Kraczkowa site 31, Podkarpackie province is also important in many respects.

SITE AND METHODS

The Kraczkowa 31 site is located on the Loess Carpathian Foreland of south-eastern Poland (Fig. 1). It is situated on the eastern slope of a small tributary valley of the Sawa River in the right part of the Wisłok River catchment. It was discovered in 1986 by Wojciech Blajer as a result of surface surveys conducted within the Archaeological Record of Poland Project. Rescue excavations on this site were carried out in November 2021, covering an area of 738 m² (Fig. 2). Only one Malice culture feature was discovered. It was registered exactly below a 40-cm-thick plough layer in this part of the site. The upper part of the pit was destroyed by modern agricultural activity. The shape was oval, about 160 × 170 cm in diameter, and semi-rectangular in profile with a maximum depth of the preserved part of 35 cm (Fig. 3).

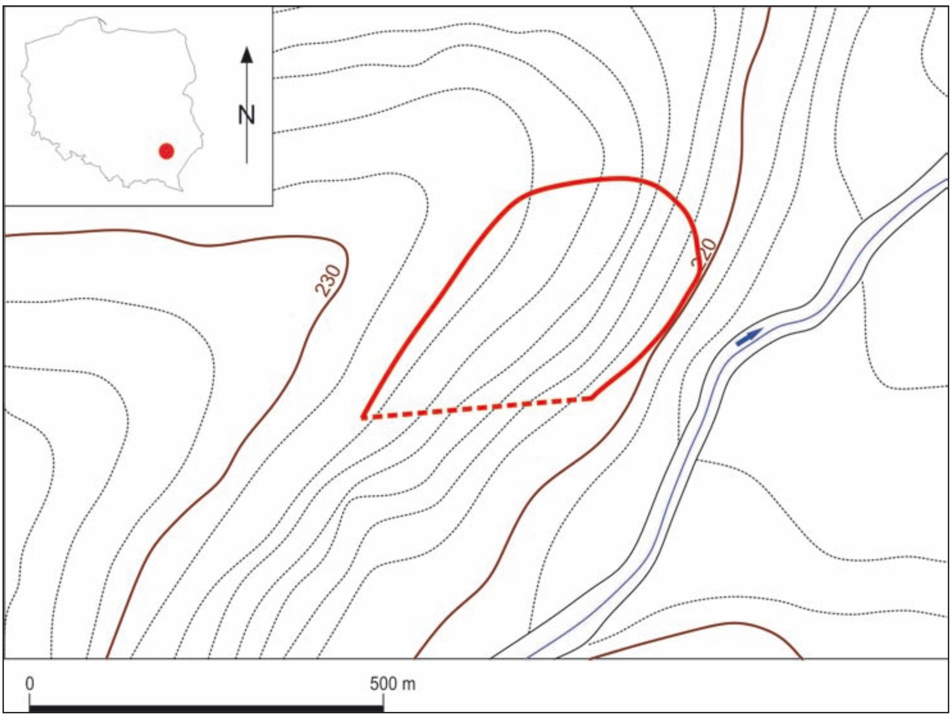

Fig. 1. Kraczkowa 31. Location of the site

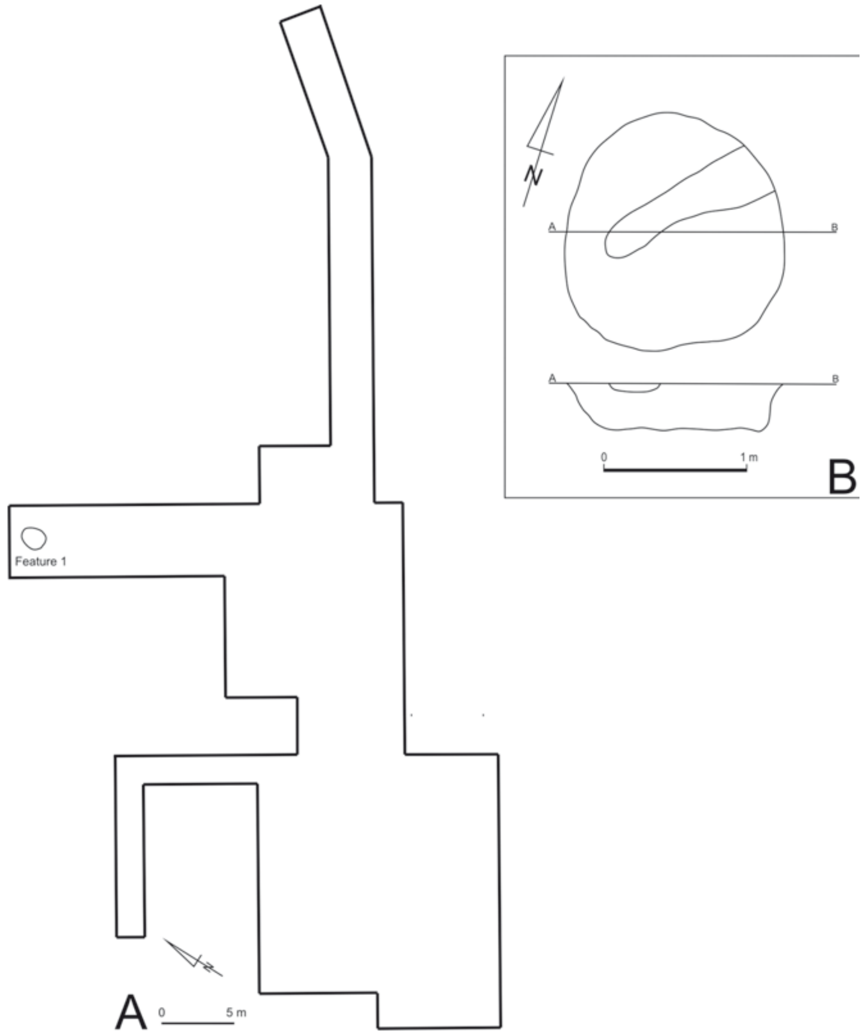

Fig. 2. Kraczkowa 31. Plan of excavated area (A) and Feature 1 (B)

Already at the initial stage of the exploration of this feature, a significant number of small, knapped artefacts were noted. This observation was the basis for the decision to explore this feature in detail. Part of the filling (110 liters) was excavated and flotated under laboratory conditions (in the W. Szafer Institute of Botany of the Polish Academy of Sciences in Cracow) using two sieves with a diameter of 1.2 mm for the coarse fraction and 0.5 mm for the light fraction. The flotation was performed by Maciej Dębiec (Institute of Archeology, University of Rzeszów) and Magdalena Moskal-del Hoyo (Institute of Botany, Polish Academy of Science). As a result, archaeobotanical remains and knapped artefacts were recovered. After drying, the flotated material was rescreened and some very small obsidian chips (less than 1 mm in diameter) were also found.

ARCHAEOLOGICAL EVIDENCE

From Feature no 1 in Kraczkowa, 570 archaeological artifacts were recovered, including 36 fragments of pottery (Fig. 4), three pieces of burnt clay, and 531 knapped artefacts. The plant remains have not yet been investigated. The relative chronology of the feature was established on the basis of the discovered pottery.

The pottery fragments discovered during excavation of the pit were heavily fragmented. It was possible to reconstruct just one type of vessel: a pear-shaped pot with stroked ornaments (Fig. 3: 1). Besides that, two fragments of rims of unknown types of vessels were observed (Fig. 3: 3), one with an additional knob (Fig. 3: 2). Furthermore, a fragment of a body with a small knob was registered (Fig. 3: 4). In addition to this, a few fragments of undecorated Malice pottery were recovered. A fragment of a pear-shaped vessel with stroked ornaments allows us to date the materials from Kraczkowa to the classical phase Ib of the Malice culture (Kadrow 2006).

The knapped assemblage discovered in Feature 1 consists of 531 artefacts: one made from siliceous marl, six from dark chocolate flint, one made from striped chocolate flint, and 523 made from obsidian.

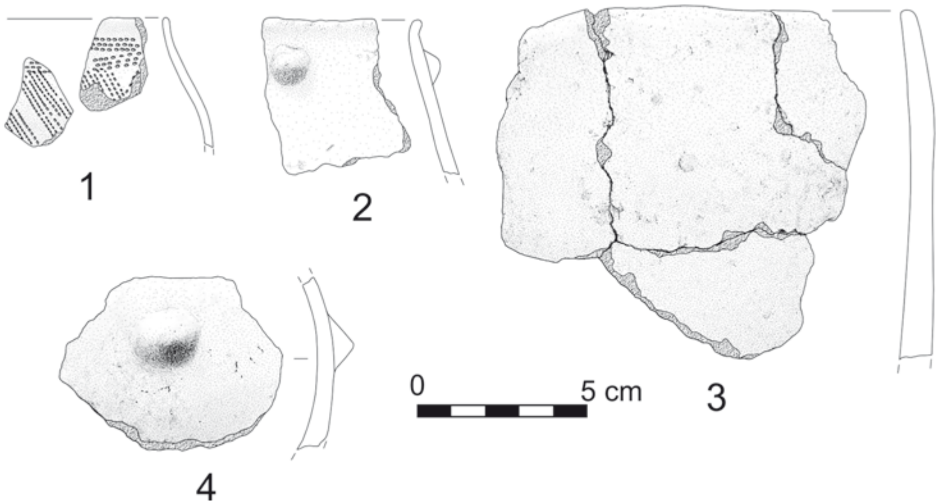

Fig. 3. Kraczkowa 31. Pottery fragments from Feature 1 (drawn by A. B. Bardetskyi)

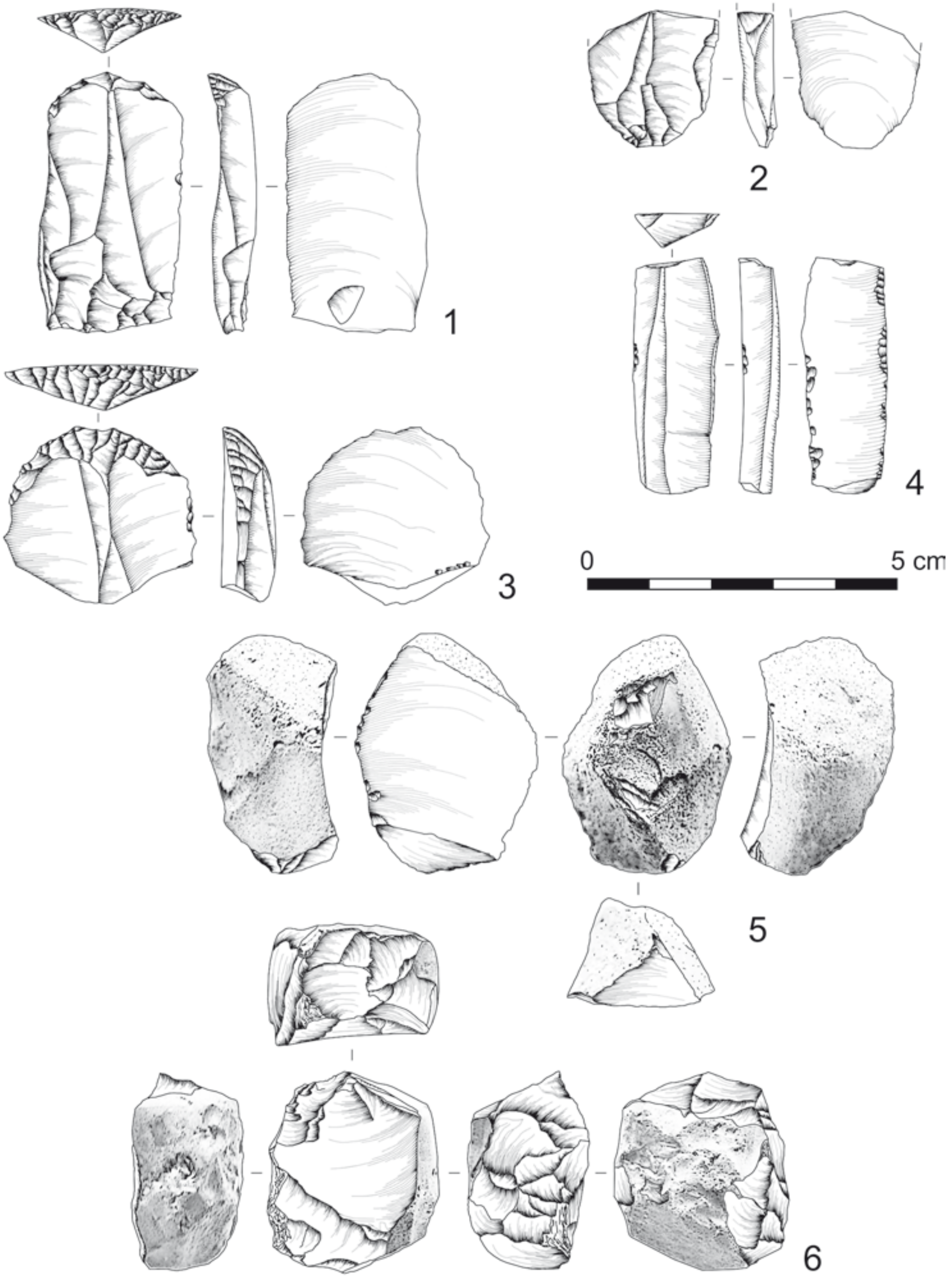

Fig. 4. Kraczkowa 31.
Flint (1-4) and obsidian (5-6) from Feature 1 (drawn by A. B. Bardetskyi)

Siliceous marl

Only one fragment of a flake from the polished part of an axe was discovered.

Dark chocolate flint

Six artefacts were found: one end-scraper made from a regular and curved blade from a single-platform blade core with a rounded semi-steep front, dimensions: length 42 mm, width 23 mm, thickness 6 mm (Fig. 4: 1); one proximal fragment of a regular blade from a single-platform blade core with an edge-like butt and distinct bulb, dimensions of the preserved fragment: length 22 mm, width 21 mm, thickness 4 mm (Fig. 4: 2); one mesial part or regular blade from a single-platform blade core. One edge with micro-retouch and glossy polishing on the ventral side, dimensions: length 38 mm, width 14 mm, thickness 5 mm (Fig. 4: 4); one fragment of flake with a cortical edge. As well, two chips were recorded.

Dark and striped chocolate flint

One fragment of an end-scraper was discovered; it is made from a regular and curved blade from a single platform blade core, rounded and semi-steep front partly covered sides of the blade, both sides regularly retouched on the ventral face, dimensions: length 28 mm, width 31 mm, thickness 6 mm (Fig. 4: 3).

Obsidian

Obsidian artefacts constitute the largest group of knapped artefacts discovered in the Kraczkowa 31 settlement pit. It consists of 523 artefacts.

Pieces of raw material

Only one partly cortical piece of raw material with flake scars, dimension 26 mm, and one cortical piece of obsidian with negative of one flake, dimension 38 mm (Fig. 4: 5).

Single-platform blade cores

One extremely exploited single platform blade core, with cortical base, sides, and back, platform prepared and rejuvenated by flakes detached from the edge of the flaking surface; in the last stage of exploitation flakes and blades of up to 15 mm were detached (Fig. 4: 6).

Fragments of undefined flakes

One small fragment of an undefined flake with a cortical edge, and one small fragment of an undefined flake were recorded.

Wholly cortical flakes

Only one, specimen of a wholly cortical flake, curved in profile, was discovered; length 30 mm, width 23 mm, thickness 5 mm; it has an edge like a cortical butt and a distinct bulb.

Blade fragments

One small fragment of a blade from a single-platform blade core, and two small fragments of microblades were registered.

Unidirectional flakes

Seven unidirectional flakes (flakes bearing on a ventral face unidirectional negatives of flake/flakes detached according to the detachment of the flake) were recorded (characteristics in Table 1); six specimens are preserved whole and one in the distal part, two are

Table 1. Kraczkowa 31, Pit No 1. Obsidian flakes.
A – unidirectional flakes, B – multidirectional flakes, C – <50% cortical, D – 50-100% cortical, E – length (mm); F – width (mm), G – thickness (mm); H – straight, I – curved, J – edge like butt; K – plane butt; L – cortical butt; M – distinct bulb, N – diffuse bulb, O – cortical edge, P – complete, R – distal part.; S – proximal part

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S
			1	30	23	5		1	1		1	1			1		
1			1	25	13	5		1	1			1			1		
1			1	25	13	5		1	1			1			1		
1				19	16	4		1	1			1			1		
1				16	16	2		1	1			1			1		
1		1		23	14	4		1	1				1	1	1		
1				19	18	2		1								1	
1				15	21	4		1			1	1			1		
	1			25	23	4		1	1							1	
	1			13	18	3		1	1			1			1		
	1			11	16	4		1	1			1			1		
	1			16	12	4		1	1			1			1		
	1			16	30	12		1								1	
	1			25	27	7	1			1			1				1
	1			22	22	6	1		1			1			1		

partly cortical, one has a cortical edge. Their lengths varied from 15 to 25 mm (average 20.29 mm), the widths from 13 to 21 mm (average 15.9 mm), thicknesses from 2 to 5 mm (average 3.71 mm); they are curved in profile, five have an edge-like butt, one butt is cortical; five have a distinct bulb and one has a diffuse bulb.

Multidirectional flakes

Seven multidirectional flakes (flakes bearing on a ventral face multidirectional negatives of flakes detached from various directions according to and not according to detachment of the flake) were found in Kraczkowa 31 (characteristics in Table 1); four specimens are preserved whole and three in fragments; their lengths varied from 11 to 25 mm (average 18.29 mm), width from 12 to 30 mm (average 21.14 mm), thickness from 2 to 7 mm (average 4.29 mm); two are straight and five are curved in profile; five have an edge-like butt, one butt is flat, four specimens bear a distinct bulb, one diffuse bulb.

Chips

The chips are smaller than 15 mm in diameter. This category of artefacts (504 items) has been divided into three groups (characteristics in Table 2): < 5 mm in diameter, 5-10 mm

Table 2. Kraczkowa 31, feature 1. Characteristics of obsidian chips

Category of chips	Number
<5 mm in diameter total number	**396**
<5 mm in diameter; of them > 50% cortical items	6
<5 mm in diameter; of them <50% cortical items	28
6-10 mm in diameter total number	**104**
6-10 mm in diameter of them >50% cortical items	3
6-10 mm in diameter of them <50% cortical items	8
11-15 mm in diameter	**4**
11-15 mm in diameter of them >50% cortical items	1
11-15 mm in diameter of them <50% cortical items	1
TOTAL	**504**

in diameter, 11-15 mm in diameter. Aside from 10 chips (one <5 mm in diameter, three – 5-10 mm in diameter and six – 11-15 mm in diameter, two of them are cortical) all the obsidian chips were found as a result of flotation.

DISCUSSION

The differentiation of the quantity and typological composition of obsidian materials discovered at the LBK sites located on the eastern part of the eastern Polish Carpathian Foreland (Rzeszów-Przemyśl loess upland) was the basis for a reliable hypothesis of the various functions and roles played by the settlements of the LBK communities in terms of obtaining, distributing, processing, and using of this raw material in this region. Due to their typological differentiation, it is possible to distinguish four groups of obsidian inventories discovered on the LBK sites: (1) containing pieces of raw material, cores, flakes, blades and retouched tools, (2) without pieces of raw material, (3) without pieces of raw material and cores, (4) containing only tools and/or unretouched blades and flakes, which also would have been used as tools.

This grouping was the starting point for an attempt of reconstruction of the chains of distribution of obsidian raw material and artefacts (Raczak 2017). In the case of Malice culture sites, differentiation of assemblages with respect to typological composition and quantity of obsidian items is also evident. Moreover, with respect to the obsidian assemblage from Targowisko 11, the processing which took place on this site was suggested (*cf.* Wilczyński 2014b). The materials of this culture from Kraczkowa 31 are also related to obsidian processing. However, compared to Targowisko 11 or other Malice culture inventories, very few specimens made of other siliceous raw materials were found in the pit at the Kraczkowa 31 site. Only seven artefacts were made of chocolate flint. This is not surprising, because chocolate flint was commonly used by the Malice culture communities settling the Sandomierz Upland, as well as the loess zone in south-eastern Poland. Artefacts made of chocolate flint constitute a characteristic group in the raw material structure of the knapped assemblages there. Furthermore, blade end-scrapers are one of the typical tools at all excavated Malice culture settlement sites located in these regions (Kadrow 1990a; 1990b; Mitura 2004; Dębiec 2005; Szeliga 2007; 2009; Dębiec and Pelisiak 2008; Bobak and Połtowicz 2013; Wilczyński 2018).

The obsidian part of this assemblage contains 523 items: one core, one blade fragment, 16 flakes, one piece of raw material, and 504 chips. Considering the large number of different chips, the lack of cores (only one used-up specimen) and tools, and the presence of only a few flakes and blades in this obsidian assemblage are all significant. There are many possible interpretations of this state. First, the typological composition of obsidian materials recorded in this pit suggests the processing of pieces of raw material was performed in this place, possibly the preparation of cores and/or retouched tools, with all or almost all of the processed material taken out of the pit or even out of the settlement at Kraczkowa 31. Therefore, it would be the first, recognized, specific place of obsidian processing of Malice Culture people in eastern Subcarpathia, and considering the different composition of the obsidian inventory from Targowisko 11, it would also be the first such workshop associated with the population of the Malice culture north of the Carpathians.

On the other hand, it is justified to ask to what extent the uniqueness of the obsidian inventory at Kraczkowa site 31 (a large number of chips) is a derivative of a very thorough exploration (flotation) of a large part of the pit filling, and whether using the same exploration method (flotation) when examining other sites of this culture, the chips would not constitute a quantitatively significant typological component there as well. Such a possibility should be taken into account, although with the current state of knowledge and archaeological data it remains a matter of guesswork. It should be emphasized, however, that the workshop's character, despite the specific nature of the object, also includes the absence of, or very small numbers of, other categories of obsidian artefacts, which credibly confirms the hypothesis that they were removed from the pit and used elsewhere, perhaps even in another settlement.

FINAL REMARKS

The obsidian assemblage from feature 1 of the Malice culture from Kraczkowa site 31 follows the rules of obsidian distribution, combined with extensive networks of regional and interregional contacts covering the communities of the fifth millennium BC on both sides of the Carpathians. No chocolate flint chips were discovered in the analyzed pit (only seven specimens were recorded), which proves that only obsidian was processed there.

The question remains: to what extent are the large amounts of small obsidian waste and the workshop character of the object connected with the very detailed exploration of its filling? Geomagnetic prospections and excavations are planned for the site of Kraczkowa 31. Their aim will be to define the settlement context of the analyzed feature and answer the question of whether there were other places of the processing of obsidian and/or other siliceous raw materials. It is worth mentioning that also in Kraczkowa, a site of the Linear Pottery Culture yielded numerous obsidian finds (Milisauskas 1986, 170, 171).

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KAMIANETS-PODILSKYI (TATARYSKY) IN THE MIDDLE TRYPILLIA FLINT NETWORKS OF FOREST-STEPPE UKRAINE

ABSTRACT

Sobkowiak-Tabaka I., Kufel-Diakowska B. and Diachenko A. 2022. Kamianets-Podilskyi (Tatarysky) in the Middle Trypillia flint networks of Forest-Steppe Ukraine. *Sprawozdania Archeologiczne* 74/1, 389-409.

The paper presents the results of technological, typological, raw material and use-wear analyses of stone assemblage from the Kamianets-Podilskyi (Tatarysky) site, dated to 3950-3900 BC (the late Trypillia BII). The assemblage is presented against a broad comparative background of sites from Forest-Steppe Ukraine. Flint processing focused on blades production, intended subsequently for the making of tools, produced of good quality raw material (mainly of Turonian Age). However, preferences in the use of raw material changed, depending on the region and the site.

Keywords: Western Trypillia culture, Volhynian flint, flint assemblage, use-wear analysis, flint networks
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INTRODUCTION

Trans-regional networks of transportation and distribution of raw materials and semi-fabricates have been discussed in archaeology for decades. Besides raw materials *per se*, such long-distance connections transported knowledge, ideas and traditions. In numerous cases, materials and information flow through the networks resulted in transmission of innovation packages. For instance, ceramic styles were passed along with the copper tools or ornaments. In the case of Cucuteni-Trypillia cultural complex (5000-3000/2950 BC), and especially its Trypillia components, Eastern Trypillia and Western Trypillia cultures (Ryzhov 2021; Tsvek 2006), long-distance networks of raw material transportation are evident from the distribution of Volhynian (Turonian Age) flint. The ongoing work of Natalia Skakun and co-authors (2018; see also Spinei 2019) on the flint, extraction, processing and distribution over the wide areas is a significant step towards understanding of the Cucuteni-Trypillia contact networks, while closer analysis of the results is possible through the introduction of the available evidence into scientific circulation.

This paper discusses the assemblage of flint tools from the excavations in Kamianets-Podilskyi (Tatarysky), the late Trypillia BII site in the Middle Dniester region (Fig. 1). This site, dated to 3950-3900 BC is chronologically similar to the well-known settlement of

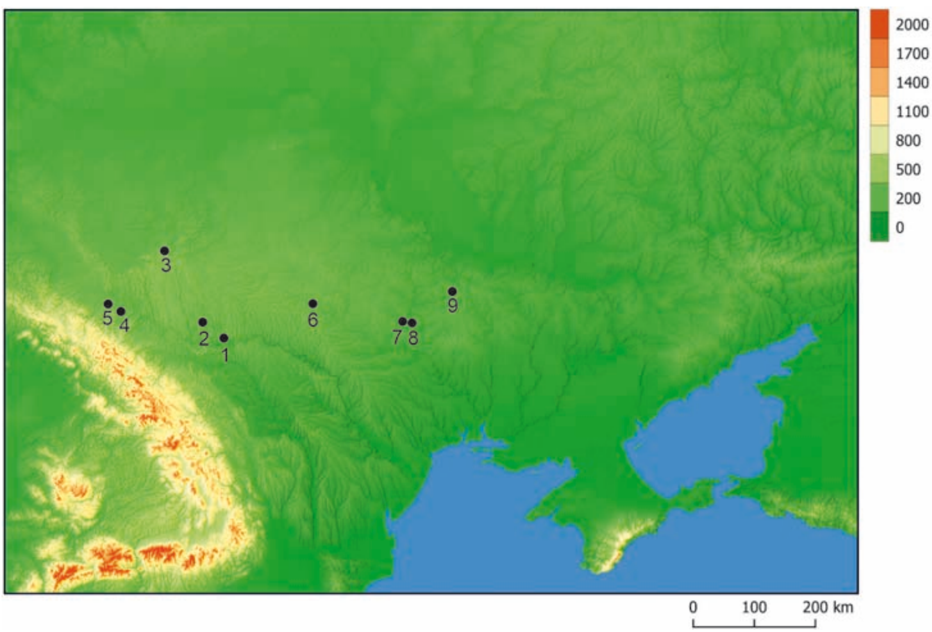

Fig. 1. Location of Trypillia BII sites considered in this study. 1 – Kamianets-Podilskyi (Tatarysky), 2 – Verteba, 3 – Bodaky, 4 – Cherniatyn, 5 – Vikrotoriv, 6 – Voroshylivka, 7 – Nebelivka, 8 – Volodymyrivka, 9 – Andriyivka (Drawing by M. Stróżyk, I. Sobkowiak-Tabaka)

Bodaky, the inhabitants of which probably specialized in flint processing. Both sites are attributed to the Mereşeuca group of the Western Trypillia culture (Diachenko and Sobkowiak-Tabaka 2021; *cf*. Ryzhov 2003; Tkachuk 2019). Here we present the technological and typological characteristics of data associated with the house remains known as "Trypillia ploshchadka" (Diachenko *et al*. 2021) and the area around the pottery kilns (Diachenko and Sobkowiak-Tabaka 2020). Further on, we discuss the results of use-ware analysis, and remind the reader of the several issues of interpreting flint assemblages in the context of early farmers' subsistence strategies.

1. LITHICS

In the course of archaeological excavations carried out on the site in 2019-2021, almost 100 flint and stone artefacts were unearthed. Most of them were discovered in Ploschadka 1 (72 flint items, two made of quartzite, three made of sandstone), while 21 artefacts occurred also near the pottery kilns. The technological characterization of the materials is based on the dynamic typology concept of R. Schild *et al*. (1975, 12, 13) and the typological analysis uses the characteristics of particular groups of tools defined by B. Balcer (1983, 197-207).

1.1. Material from the pottery kilns

Debitage

The assemblage obtained from the area of the pottery kilns excavated on the site consisted of nine pieces of debitage, 10 tools and two nodules of raw material. To the first category of artefacts belong: two cortical flakes (28 × 22 × 7 mm and 79 × 67 × 21 mm); five flakes from single platform cores (from 21 × 29 × 4 mm to 39 × 22 × 4 mm), a fragment of blade from a single platform core and a chunk.

Tools

In the group of tools were two endscrapers, two truncations, one perforator, two arrowheads, one retouched blade and one retouched flake, plus one undetermined fragment of tool.

The **endscrapers** are made of flakes from single platform cores and have similar dimensions (40 × 27 × 8 mm and 44 × 32 × 13 mm). In the first example, the tool's end is oblique, high and step. The right edge is denticulated retouched and on the left one the retouch is tiny). In the second case, the working edge is asymmetrically rounded, medium high and medium step (Fig. 2: 10).

The **truncations** are made of flakes from single platform cores and have very similar dimensions (51 × 28 × 10 mm – Fig. 2: 9 and 54 × 24 × 7 mm – Fig. 3: 10), made of flakes

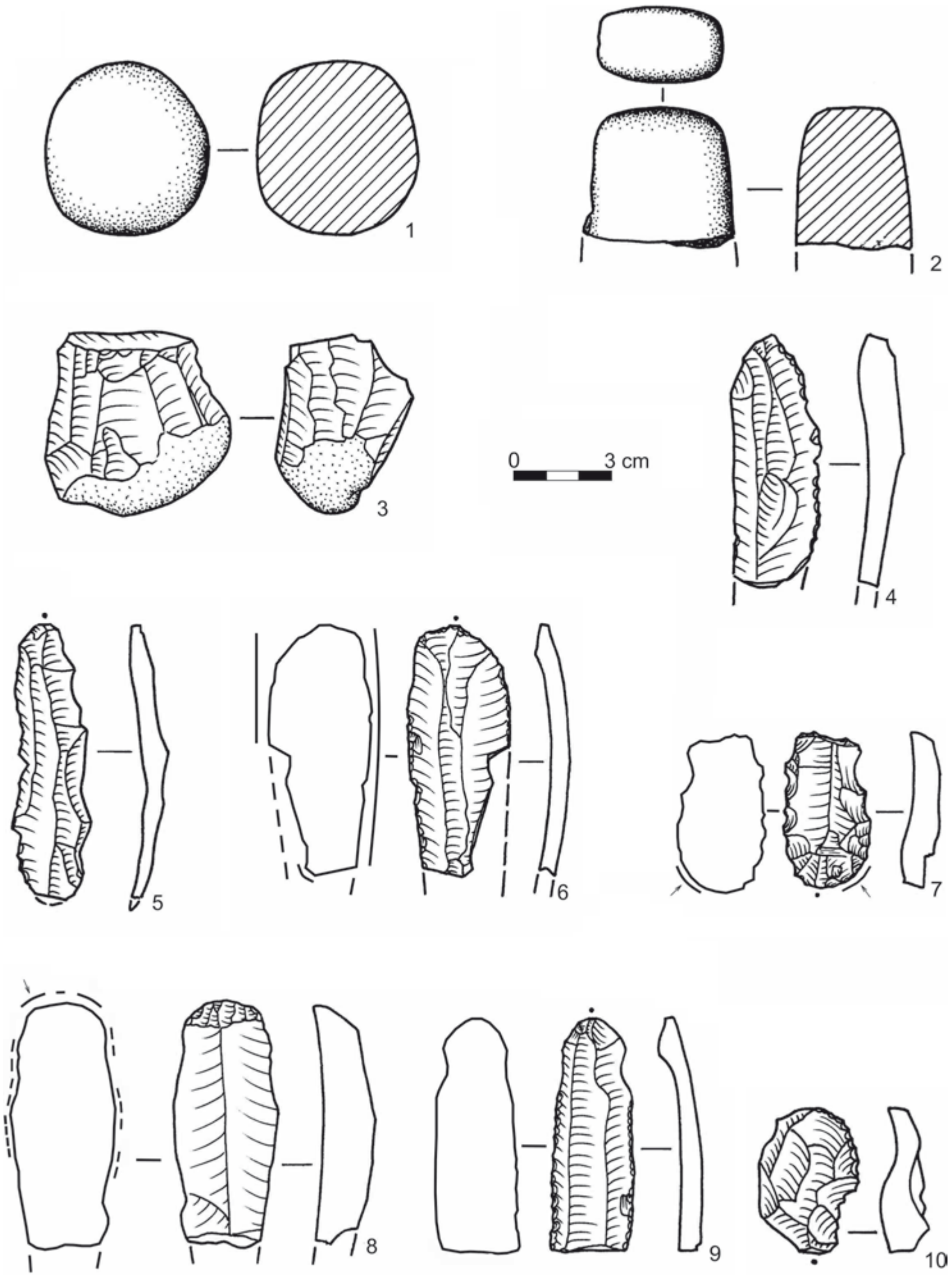

Fig. 2. Kamianets-Podilskyi (Tatarysky).
1, 3-10 – flint artefacts; 2 – fragment of artefact made of sandstone. Line – traces of use, discontinuous line – contact traces, arrow – use direction
(Drawing D. Kushtan, B. Kufel-Diakowska, I. Sobkowiak-Tabaka)

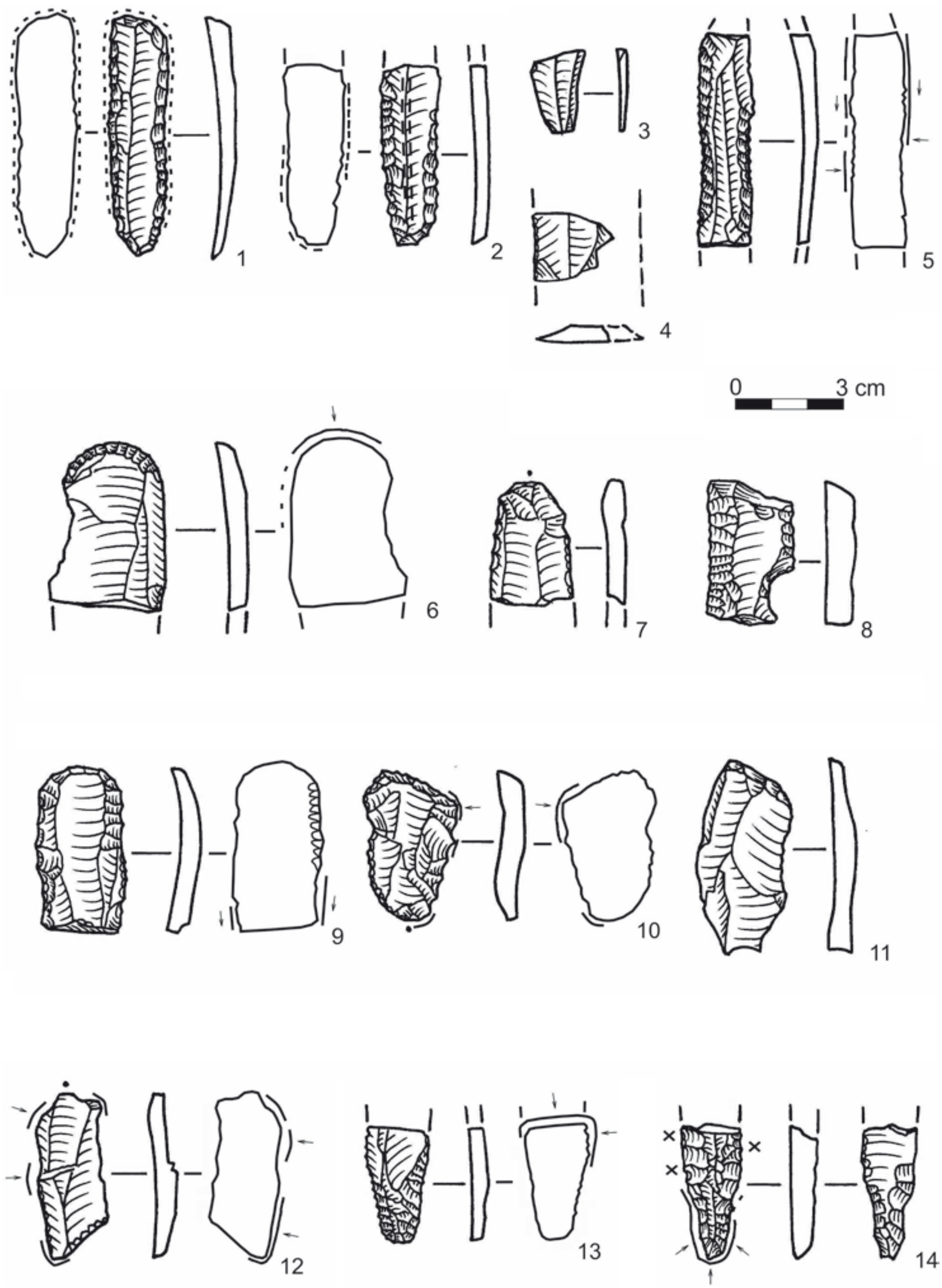

Fig. 3. Kamianets-Podilskyi (Tatarysky). Flint artefacts.
Line – traces of use, discontinuous line – contact traces; arrow – use direction; cross – hafting
(Drawing D. Kushtan, B. Kufel-Diakowska, I. Sobkowiak-Tabaka)

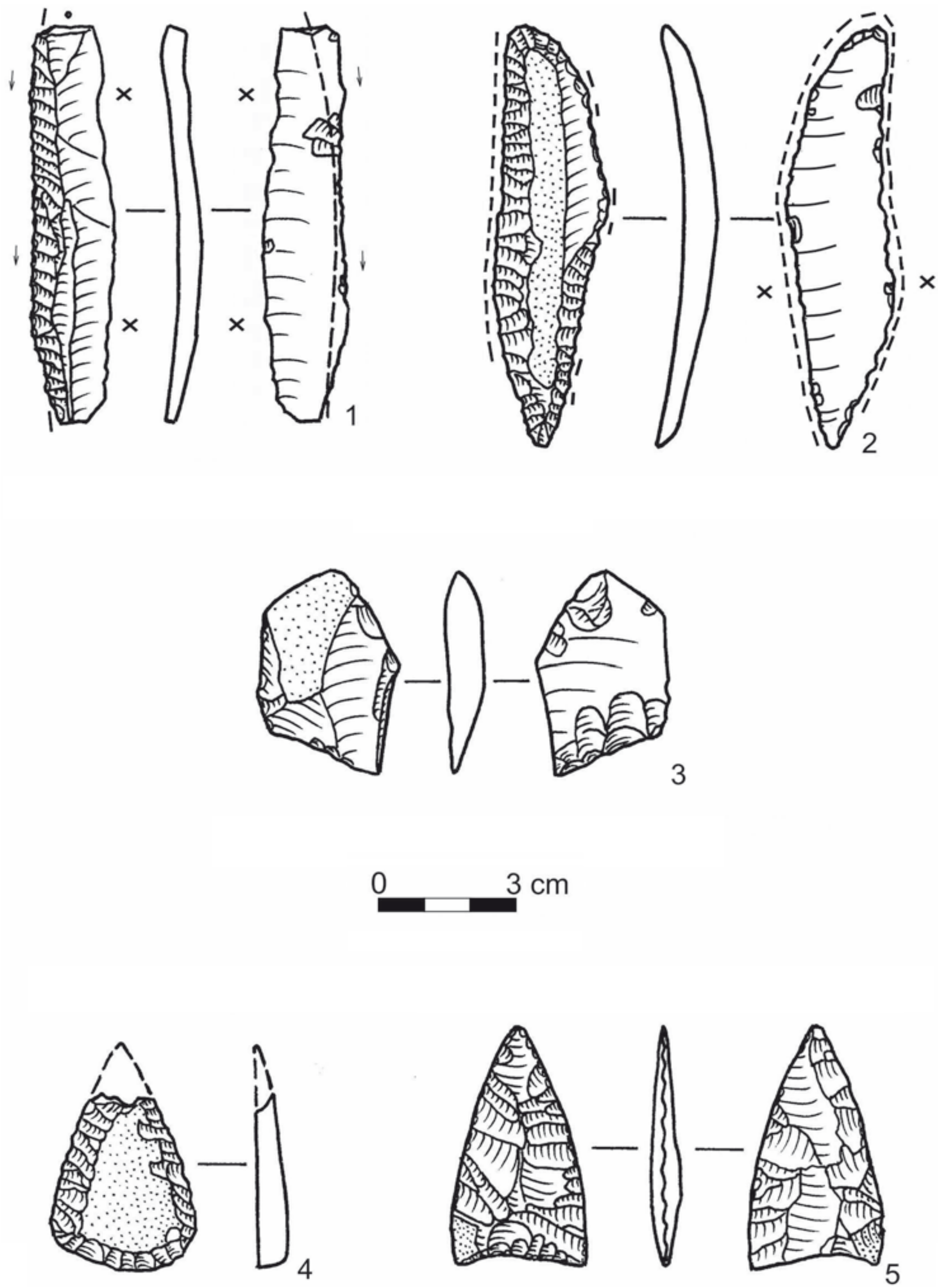

Fig. 4. Kamianets-Podilskyi (Tatarysky). Flint artefacts.
Discontinuous line – contact traces; arrow – use direction; cross – hafting
(Drawing D. Kushtan, B. Kufel-Diakowska, I. Sobkowiak-Tabaka)

from single platform cores. Both tools have oblique truncations, formed in the proximal and distal part of the flakes. In case of the smaller truncation, both edges of tool are retouched.

A fragment of a *perforator* (Fig. 3: 13) was made probably of a blade from single platform core. Both edges of the tool are retouched.

In the group of *arrowheads* two types occur. The first one, with broken tip measures 37 × 32 × 7 mm. The base of the tool is symmetrically rounded and the ventral surface is covered by the cortex (Fig. 4: 4). The second one (51 × 30 × 6 mm – Fig. 4: 5), bifacial, has a concave base and slightly chiselled tip.

Among the group of tools from the area of the pottery kilns is also a fragment of partially retouched cortical flake, and two fragments of partially retouched blades (Fig. 3: 3, 7).

Nodules

The first nodule of raw material measures 80 × 48 × 36 mm, the second one is a fragment of a nodule, covered by a thin cortex.

Almost all artefacts were made of Volhynian flint. The exceptions were one nodule, one truncation, one endscraper and one retouched flake made of local flint plus one truncation made of quartzite.

1.2. Material from Ploschadka 1

In the excavations of Ploschadka 1, 77 flint and stone artefacts were discovered: 50 items of debitage, one core, 26 tools and one tool (hammerstone) related to production of lithic artefacts (Table 1).

There were nine items belonging to the group of finds related to core preparation, initial core trimming and early stage of core processing – one cortical flake made of local flint and eight trimming flakes (two broken), made of Volhynian flint. The smallest one measures 27 × 38 × 10 mm, and the largest one measures 65 × 44 × 9 mm. There are five smooth butts, one faceted one and two of undetermined type.

The group related to flake exploitation is rather large and consists of 15 items (six broken). The dimensions of the smallest one is 27 × 23 × 5 mm, and the largest one is 52 × 46 × 10 mm. Ten butts are smooth, one is dihedral and one is undetermined. Six of the flakes were made of Volhynian flint, three of local flint, three of sandstone and three were burnt.

The group related to blade exploitation contains 16 artefacts – one single platform core for blades and 15 blades from single platform cores. The core measures 54 × 57 × 40 mm. The platform is smooth, and the striking angle is 80°; the back and bottom of the core is covered by the cortex (Fig. 2: 3). Within blades only two of them whole, measuring 49 × 20 × 5 mm and 52 × 25 × 8 mm. Among the fragments of blades three are proximal parts, four central and six distal. There are seven smooth butts and one of undetermined of type. Six blades are made of Volhynian flints, four of local flint, one of quartzite and four are burnt.

Table 1. Kamianets-Podilskyi (Tatarysky). List of artefacts

Technological groups (Schild *et al.* 1975)	**Pottery kilns (Excavation Site I)**	***Ploschadka* (Excavation Site II)**
I – Core preparation, initial core trimming and early stage of core processing		
1. Cortex flakes	2	1
7. Trimming flakes	-	8
II – Exploitation of flakes		
2. Flakes from single platform cores	5	16
III – Exploitation of blades		
1. Single platform cores for blades	-	1
2. Blades from single platform cores	-	15
IV – Reparation		
1. Platform rejuvenation flake	-	1
V – Undetermined artefacts, waste from core exploitation and retouching		
2. Undetermined flakes	1	1
4. Chips	-	3
5. Chunks	1	5
VI – Tools and characteristic waste from tool production		
1.Tools made from blanks struck of by classic coring technique	**10**	**25**
endscrapers on flakes	2	
endscrapers on blades	-	3
truncations	2	2
perforators	1	1
arrowheads	2	-
partially retouched flakes	1	2
partially retouched blades	2	12
retouched blades	-	3
axes or stone shaft-hole axes	-	1
Undetermined tool		1
VII – Tools of lithic chipped production		
1. Hamerstones	-	1
VII – Raw material		
1. Flint nodules	2	-
Total	**21**	**77**

Within the group of reparation, one platform rejuvenation flake was found, measuring 43 × 35 × 11 mm, made of local flint.

The group of undetermined artefacts, flaking and retouching wastes consists of nine artefacts: one undetermined flake made of local flint, three chips (two made of local flint and one burnt) and five chunks (two made of local flint and three burnt).

Tools

The category of tools is the largest group found within the Ploschadka 1. In total, 26 artefacts were discovered.

Endscrapers

The category of endscrapers contains three broken tools, made of rather large blades. The largest one measures (81) × 34 × 15 mm (Fig. 2: 8) and the smallest one measures (46) × 31 × 6 mm (Fig. 3: 5). All working edges are symmetrically rounded, high or medium high, and steep or semi-steep. In two cases, both edges of the endscrapers are retouched (Fig. 2: 8, 3: 8).

Truncations

Within the assemblage of tools, two truncations occurred. The first one, measures 43 × 31 × 9 mm. The truncation is transverse and concave, made by abrupt retouch on the dorsal side of the tool (Fig. 4.3), resembling the scaled technique. The dimensions of the second one are 46 × 19 × 6 mm. Its truncation is transverse and oblique (Fig. 3: 11).

Perforators

Only one, badly damaged, artefact was discovered.

Partially retouched flakes

Two fragments of retouched flake were registered.

Partially retouched blades

The group of partially retouched blades is the most numerous of the categories of tools and contains 12 items. Only one tool is whole and measures 84 × 25 × 8 mm (Fig. 2: 5). The other artefacts are broken. Within broken exemplars, five proximal parts (Fig. 2: 6, 9; 3: 2, 6), four central ones (Fig. 3: 4) and two distal ones (Fig. 2: 4) were registered. The blades were rather large and wide (retained dimensions some of them are (77) × 27 × 8 mm, (78) × 28 × 12 mm, 82 × 34 × 7 mm). Retouch occurs on fragments of right or left edges (sometimes on both of them) and is, in most cases, abrupt and invasive.

Retouched blades

This category of tools contains three artefacts. The smallest one, measures 66 × 16 × 5 mm, and its edges were retouched by high and abrupt retouch (Fig. 3: 1). The dimensions of the second one are 87 × 19 × 5 mm. The left edge of the tool is retouched by trough-like retouch, and on the dorsal side traces of polishing are visible (Fig. 4: 1). The largest one measures 92 × 23 × 8 mm. All edges of the tool were retouched by quite massive retouch, apart from a fragment of the right edge, where the retouch was smaller. The ventral side of the artefact is covered by cortex (Fig. 4: 2).

Chopping tools

The only example of an axe or a stone shaft-hole axe, made of sandstone, is broken (Fig. 2: 2).

Undetermined tools

Only one undermined tool was registered (Fig. 3: 12).

Tools related to production of lithic artefacts

In the assemblage one round hammerstone, measuring 52 × 52 × 54 mm, occurred. The artefact is burnt, and nearly the entire surface is covered by the cortex (Fig. 2: 1).

1.2.1. ANALYSIS OF THE FLINT MATERIAL

The assemblage of artefacts from the pottery kilns area is quite random due to the features being located on a steep slope and it cannot be ruled out that they got here as a result of post-depositional processes. Therefore, we limited our analysis of flint processing to a discussion of the material from Ploschadka 1, representing a rather homogeneous assemblage.

1.2.1.1. Raw material

The analyzed assemblage from Ploschadka 1 was made mostly from Volhynian flint (35 artefacts – c. 56% of the whole collection). The colour of the flint is dark grey or black. In the siliceous mass of several items, grey spots or bands are visible and some artefacts are covered by a thin white cortex. Nineteen artefacts were made from local flint (c. 25% of the whole collection), three from sandstone (c. 4% of the whole collection), two from quartzite (c. 3% of the whole collection), and 18 artefacts are burnt (some of them very heavily, as a result of which small fragments – chips – fell off the products). It is worth mentioning that 14 of the 25 flint tools were made of Volhynian flint, mainly long and wide retouched blades.

Only one core was recorded in the assemblage from Ploschadka 1, measuring 54 × 57 × 40 mm. However, taking into account the length of some retouched blades (87 and 92 mm) we assume that the cores may have been up to 15 cm long. Based on the presence of items from the group representing core preparation, initial core trimming and early stage of core processing that were made mostly from Volhynian flint (seven out of the nine items of this group), it is very likely that the raw material processing took place in the other parts of the site. However, obtaining blanks for tool-making from somewhere else cannot be completely ruled out. Certainly, the Volhynian raw material was used very rationally at this site, as evidenced by the re-using of some tools made from this raw material.

1.2.1.2. Knapping technique

Raw material processing at the site was based on classic tool reduction. No artefact was discovered that had been made by the splintering technique, viewed by some archeologists as evidence of absence of good quality of raw material (Deckers 1982).

Based on the presence of the core, and observation of the debitage and blanks for tools, we can assume that the classic core reduction technique was applied to single platform cores.

The lithic production at the site was focused both on flake and blade blanks; this is confirmed, on the one hand, by the presence of artefacts from the group of exploitation of flakes and some tools made on flakes and, on the other hand, by tools made mostly on blades.

Debitage was performed by application of the soft percussion technique, which may be assumed by the hammerstone found at the site and characteristic cylindrical "scars" (Pelegrin 2000, fig.3), present on the percussion bulbs of several artefacts.

1.2.1.3. Tool production

Within the analyzed collection were 26 tools, which is almost 34% of the assemblage from Ploschadka 1. The most numerous category of the tools are partially retouched and retouched blades (15 items). They are tools of rather considerable size, with a length exceeding in some cases 92 mm or 87 mm (the broken item). The lateral edges of this type of tool are shaped with continuous or partial retouch – abrupt and invasive. They were mainly used for scraping/cutting hide, soft material processing and cutting cereals (one case).

A less numerous group of tools is represented by endscrapes (three broken artefacts), made on blades and truncations (two artefacts), made on flakes. Among the other tools are: a perforator, a partially retouched flake, a fragment of an axe or a stone shaft-hole axe and an undetermined tool. Some of these tools display traces of use (see below).

2. USE-WEAR ANALYSES

Fifteen flint artefacts were selected for use-wear analyses. The collection included three specimens from the Excavation-Site I (endscraper, truncation and perforator) and 12 specimens from Ploschadka 1 (three endscrapers, a truncation, seven retouched blades and an undetermined tool fragment) (Table 2).

2.1. Methods

Microscopic observations were carried out at the Laboratory of Archaeometry and Archaeological Conservation, Institute of Archaeology, University of Wrocław, with the use of the standard optical microscopes: an Olympus SZX9 stereomicroscope (×6.3–114) for recording fractures and scars and a Nikon ECLIPSE LV100 metallographic microscope (×50–500) for analysing polish. Prior to microscopic observations, the artefacts were cleaned in an ultrasonic tank (2 minutes bath in water).

2.2. Results

Traces of use were recorded on almost all of the analysed tools, beside one retouched blade. Most of the flint artefacts display polish from contact with soft materials: of animal (eight specimens), or vegetal origin (two specimens), and three where the nature of the material remains undetermined. Only one tool examined had been used for working hard materials.

Seven tools had been used for scraping hide (Fig. 2: 7-8; 3: 5-6, 10, 12-13). This group includes different types of retouched tools: three endscrapers, two truncations, a retouched blade and undetermined tool fragment (perforator or retouched blade). The working edges are also diverse: distal retouched (two), proximal retouched (one), lateral unretouched (two), lateral retouched (two) and edge of breakage (one). All working edges display well-developed hide-working traces. They are highly rounded, covered by greasy polish of cratered topography located on the very edge and one of the aspects near the edge. Polish is accompanied by infrequent filled-in striations and single black scratches (Fig. 5: 1-2). A retouched blade shows traces of mixed directionality, both perpendicular and parallel, resembling "polish 10", which suggests that this tool was used for a scraping and cutting activity. The group of hide-working tools complements a proximal fragment of perforator, with very well-developed traces located around the tip (Fig. 3: 14; 7: 3).

Traces of cutting cereals are recorded only on a single specimen, which is a completely preserved, long retouched blade (Fig. 4: 1). The artefact displays quite well-developed sickle gloss on the left lateral side covered by regular, laminar retouch. The edge is highly rounded. Reflected, bright polish is located along the whole edge, covering also the bulb. Traces run parallel to the main axis. Linear traces, such as striations are scarce, but depressions of different size, including comet-shaped pits are numerous. The retouch negatives are not completely filled with polish (Fig. 5: 4). Some accidental scars have removed portions of sickle gloss. The opposite side shows slight edge rounding and generic polish near the very edge, which are very common characteristics of hafting traces of long parallel Neolithic sickle inserts (*e.g.*, TRB, Baden culture).

Plant or wood polish is preserved on small portions of left and right edges of an endscraper (Fig. 3: 9). Due to subsequent edge retouch, use polish is intersected by negatives and the cutting edges are sharp. They are covered by fairly invasive, irregular bright polish of domed topography that shows clear directionality – parallel to the main axis (Fig. 5: 5). Other parts of lateral sides as well as retouched distal edge (the endscraper's cutting edge) do not show any traces of use.

Three long blades with all the edges covered by parallel retouch display continuous traces similar to each other (Fig. 3: 1-2; 4: 2). These are edge rounding and polish from contact with

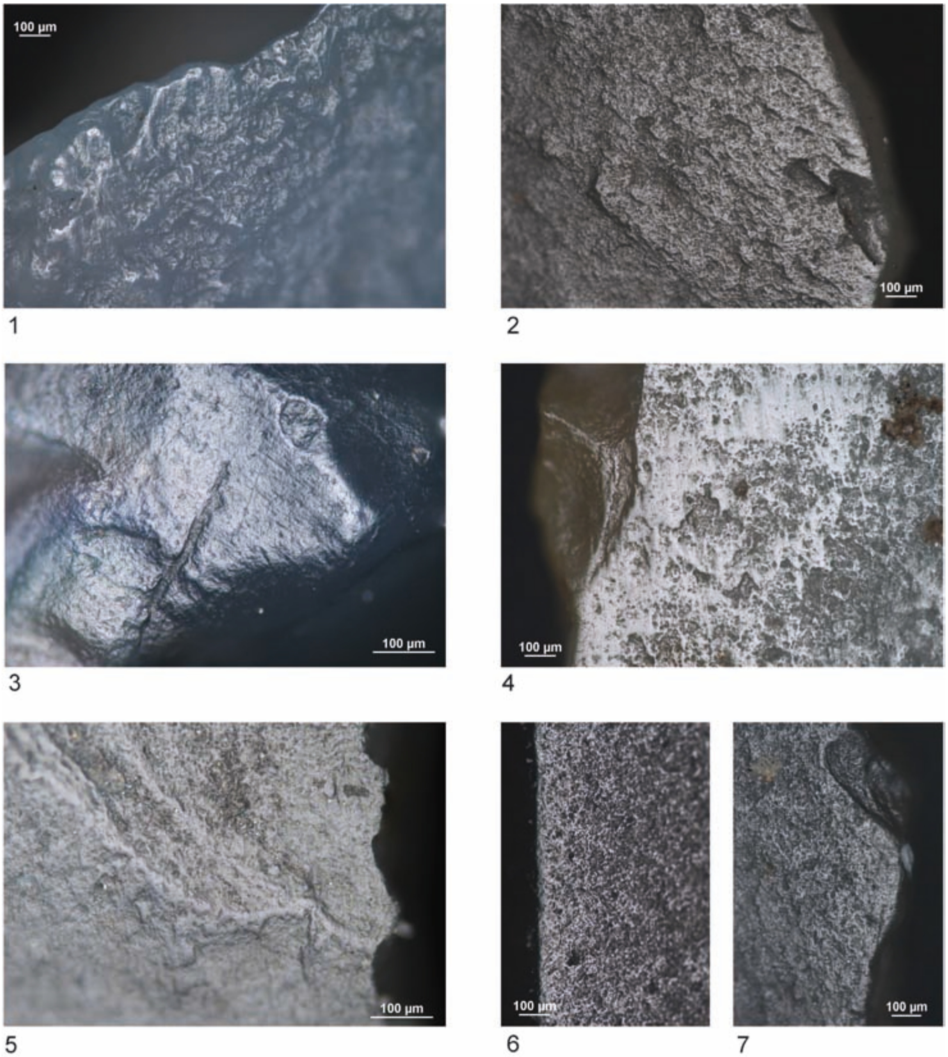

Fig. 5. Kamianets-Podilskyi (Tatarysky).
Traces of use on flint tools: 1-2 – scraping hide; 3 – perforating hide; 4 – working plant or wood; 5 – cutting cereals; 6, 7 – traces on long retouched blades (Photo B. Kufel-Diakowska)

soft material, sometimes accompanied by tiny scratches of mixed directionality. In one case gloss is visible also on the dorsal ridge (Fig. 5: 6, 7). On the other example, hafting traces are preserved on the bulb part of a tool. Tools might have played the role of universal knives or daggers, kept in a sheath made from organic materials (see examples of the European Late Neolithic and Bronze Age: Wilk and Kufel-Diakowska 2016; Sudoł-Procyk *et al.* 2017).

Table 2. Kamianets-Podilskyi (Tatarysky). Results of the use-wear analysis of selected flints

No.	Inv. No./ Excavation Site No.	Tool category	Preservation	Activity/ working material	Figure
1	1/I	truncation	complete	scraping/hide	
2	2/I	endscraper	complete	scraping ?/hide	
3	14/I	perforator	proximal part	piercing/hide	5:3
4	28/II	undetermined tools fragment	proximal part	scraping/hide	
5	48/II	retouched blade	distal part	contact/soft material	5:6
6	62/II	endscraper	distal part	scraping/hide	5:1
7	81/II	retouched blade	proximal part	no traces	
8	82/II	truncation	complete	scraping/hide	5:2
9	85/II	endscraper	complete	cutting/plant or wood	5:5
10	86/II	retouched blade	mesial part	scraping and cutting/ hide	
11	87/II	retouched blade	proximal part	undetermined/hard material	
12	89/II	retouched blade	complete	contact/soft material	
13	90/II	retouched blade	complete	contact/soft material	5:7
14	91/II	retouched blade	complete	cutting/cereals	5:4
15	93/II	endscraper	distal part	scraping/hide	

Traces of contact with a hard material were recorded on a fragment of retouched blade (Fig. 2: 6). The distal part and a portion of left lateral side of a blade were broken off. The right and preserved portion of a left cutting edge are abraded and thickened, with generic polish displayed on the very edge, as well as step, irregular scars on both aspects. The tool was used for undetermined transverse activity (or was deliberately damaged?).

Despite the small size of the analysed collection of flint tools, some remarks can be made based on the recorded traces of use. First of all, the tools displayed well-developed microtraces, which means that they mostly had a relatively long use-life. In the group of used tools, we can distinguish complete formal flint tools. They are retouched blades with traces of contact with soft materials or with traces of cutting cereals. These tools, which played a role as knives or daggers, or sickle inserts, were hafted and indented for long usage. There are also other formal hafted or hand-held tools: (complete?) endscrapers used for scraping hide and a fragment of perforator. Apart from tools produced for an intended function, there are also smaller truncations and fragments of retouched tools. Probably some of them could have been recycled fragments of re-used long retouched blades (deliberately broken?). The production of long blades as the main products of Trypillia BII flint knapping is confirmed at the Bodaky site with lithic workshops (Skakun *et al.* 2018). In the case of the smaller specimens from Kamianets-Podilskyi (Tatarysky), the traces of use are located on random edges (bulb edge, edge of breakage). They also represent different types of retouch which is not as regular and invasive as in case of the complete specimens. This meant that there is rather a weak relationship between the type of a tool and its function, because flint blades were recycled, modified into other forms. This is well documented by a group of tools used for scraping hide.

3. DISCUSSION

A comparison of the flint production at the Kamianets-Podilskyi (Tatarysky) settlement with other known assemblages from Trypillia BII sites is difficult because of the regional differences and various function of features, from which the flint artefacts come (Pichkur 2019; Pichkur and Shidlovskiy 2005).

At the Nebelivka megasite (Fig. 1), contemporary with our site, only c. 150 lithic artefacts were found within the surface of the excavated area, houses, mega-structure, test-pits and large pit in the Sondazh 1, made from Volhynian flint (almost half of the lithics), or deriving from local procurement probably in Korobchyno quarry and rock crystal. However, the authors noted two modes of flint processing. The first one, based on local flint or chert, focuses on satisfying the immediate need of the members of the house, and the other one, based on imported Volhynian flint, is used for preparing blades by flint-knapping experts (Kiosak *et al.* 2020, 352-367). Almost a half of the assemblage contains retouched items, which is very characteristic for Trypillia BII-C sites (Sorokin 1991). The typical tools of the Nebelivka megasite contain retouched blades, mainly medial parts with semi-abrupt retouches along with a single or both edges; some of them served as knives or perforators. There are also a few projectile points (Kiosak *et al.* 2020, 366).

Andriyivka is the other site dated to stage BII, slightly earlier than Nebelivka (Diachenko *et al.* 2020; Ryzhov 2015), where 181 flint items were found (Fig. 1). Within this assemblage, two cores, 30 items of debitage and as many as 141 tools occurred. The most numerous category of the tool is again retouched blades (38 items), mainly knife-shaped ones with regular or partial retouch. The next largest group of tools are endscrapers (30 items), made on flakes and blades, and scraping tools (four items) The following are: retouched flakes (23 items), notched scrapers (22 items), sickle inserts (18 items), perforators (three items), cutting tools (three items), chisel-like tools (two items), polished axe and arrowheads (two points). Almost all flint artefacts were made of local raw material, procured in the Velyka Vys river basin but there also some tools made of good quality flint of Turonian age, close to the Volhynian one (Pichkur 2012). However, the latter kind of flint was available locally, near Korobchyno village, in the area of the Velyka Vys river, where complexes of flint extraction are evident (Tsvek and Movchan 1997). The second category of raw material was used to make retouched blades. According to the author, this fact might indicate the need to review the hypothesis, concerning the presence of Volhynian flint in this region (Pichkur 2012).

A similar assemblage to Andriyivka, in terms of raw material and range of tools, was found during surveys at the Volodymyrivka site (Fig. 1). Among 121 items, made mostly of local raw material from the banks of the Syniukha River and sporadically of Volhynian flint, 65 tools occurred. The group of tools contains retouched blades (14 items) and flakes (21 items), endscrapers (four items), perforators (four items), sickle insets (three items), arrowheads and others in less quantity (Hofmann *et al.* 2019).

From the area of the Middle Buh, the site Voroshylivka is worth mentioning (Fig. 1). Next to the Ploschadka 4, a flint workshop was located (Gusev 1995, Fig. 45). Most of 568 artefacts were made of Volhynian and "Upper Dniester" flint (in the author's terminology). Tools, made both on flakes and blades, are characterized by abrupt retouch. The most frequent groups of tools are endscrapers and retouched blades. Burins, borers, perforators and arrowheads also occurred, however in smaller quantities (Gusev 1995, 172-187).

The only known Trypillia settlement, specialized in flint extraction and located in Volhynia area is Bodaky (Fig. 1). Activities there ranged from the production of semi-fabricates to the manufacturing of large finished blades and tools. Those products were then distributed over different Trypillia areas and territory of neighboring cultural units (Skakun 2005; Skakun *et al.* 2018). Bodaky is considered to be a settlement that is synchronous (Diachenko and Sobkowiak-Tabaka 2021) or slightly earlier (Tkachuk 2019) than Kamianets-Podilskyi (Tatarysky).

Moving on to the western Podillia region, three settlements with flint assemblages, related to the Trypillia BII, are known. In the case of the first one, Verteba, due to the 19th century date of the site's investigation, and its collector's character (as well as later Western Trypillia layers there), we cannot analyze this inventory in a detailed way. However, it is worth highlighting the specific features of the flint processing of Middle Trypillia such as a large amount of retouched blades (including those with trough-like retouch) in the category of tools, endscrapers of blades, perforators and truncations (Kadrow *et al.* 2003, 101).

At the Viktoriv I site (Fig. 1), from the area of the remains of houses (268m^2), were retrieved c. 3500 stone artefacts, made of Volhynian flint (the Podillia variety of Turonian flint according to Konoplja 1998). The assemblage consist of 17 cores, c. 1800 items of debitage and a large amount of tools, includingretouched flakes and blades, saws, endscrapers, scrapers, burins, perforators, arrowheads and grinding stones (Konoplja 2005).

The last settlement from this region is called Cherniatyn quarry (Fig. 1). From the house and the trench, 415 flint artefacts were registered, made of Volhynian flint (the Podillia variation of Turonian flint according to Konoplja 1998). Within the assemblage were seven quite large cores, 221 flakes and 32 blades, and tool such as 63 retouched blades, 26 endscrapers, 12 burins, four perforators, two borers, three truncations, 14 notches, five axes and others (Konoplja 2015, 388-399).

4. CONCLUSIONS

Based on the short characteristic of a few flint assemblages from the sites, related to the Middle Trypillia in the area of forest-steppe Ukraine, we can assume that flint processing focused on the production of blades intended subsequently for the making of tools. The dominant types of tools were retouched blades (sometimes partially retouched), endscrapers and perforators.

Preferences in the use of raw material changed, depending on the region and the site. On many of these sites, local, non-Volhynian raw material predominated, with tools, mainly retouched blades, being made from better quality raw materials – local or imported Volhynian flint. Exceptions are represented by Bodaky, a number of Podillian sites and settlements in Volhynia (Pichkur and Shidlovskiy 2005).

The territory encompassing Volhynian flint outcrops, with the exception of Eastern Volhynia, was settled by the populations of the Malice culture during the time period of our interest (Kadrow 2013; Kadrow and Zakościelna 2000). It is worth highlighting that a fragment of a kitchen vessel found near the kilns at Tatarysky, was produced using WTC pottery-making techniques, but with ornamentation influenced by Malice traditions (Diachenko and Sobkowiak-Tabaka 2021). A few other sherds representative of Malice influences are known from surface collections at the site (Levinzon 2018; 2019). In this context, we must mention that also the ceramic assemblage of Bodaky displays strong influences from the Malice culture (Skakun and Starkova 2003; Tkachuk 2008) fitting a broader context of mutual influences between Malice, Lublin-Volhynian and Trypillia pottery styles (*e.g.*, Kadrow 2013; Starkova and Zakościelna 2018; Zakościelna 2010). Taking into account these influences, we assume the import of Turonian age flint from Southern Volhynia to Kamianets-Podilskiy (Tatarysky). It is also likely that influences in ceramic styles were disseminated throughout the WTC along with the spread of semifabricates and tools made of Volhynian flint.

The assemblage of finds from Ploschadka 1 in Kamianets-Podilskyi (Tatarysky) does not include any single spindle whorl, while a collection of spindle whorls comes from multiple surveys at this site (Levinzon 2018; 2019). At first glance, this fact finds a correlation with the results of use-ware analysis indicating leather and skin processing as a predominant function of artefacts, and might suggest a certain economic specialization of the inhabitants of this house. However, tools related to farming would not be necessarily deposited within a settlement, and especially within a house. In case of access to raw material, such tools would rather remain in the fields after being broken (Zbenovich 1989). It is worth mentioning that two artefacts with traces of so called sickle gloss were registered within surveys in the 1990s and 2000s (Radomskyi *et al.* 2021).

Also, as pointed out by Nikolova and Pashkevych (2003), ethnographic evidence from Caucasus, Middle Asia and the mountains of South-Eastern Asia suggests that hulled wheat, which was mostly grown by Trypillia populations, is cultivated and harvested using wooden tools. The latter are still used in Georgia and known as “shamkvi”, “shankvi” or “shnakvi”. Therefore, the results of the analysis of tools assemblages most probably underestimates the proportion of agriculture in Tripolye economies in general (Pashkevych, Videiko 2006), and activities of the House 1 inhabitants in Kamianets-Podilskyi (Tatarysky) in particular.

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Anna Zakościelna[1]

PREPARED/ABANDONED/SYMBOLIC? – A MONUMENTAL GRAVE OF THE FUNNEL BEAKER CULTURE FROM SITE 3 IN STRZESZKOWICE DUŻE, LUBLIN DISTRICT

ABSTRACT

Zakościelna A. 2022. Prepared/abandoned/symbolic? – a monumental grave of the Funnel Beaker culture from Site 3 in Strzeszkowice Duże, Lublin District. *Sprawozdania Archeologiczne* 74/1, 411-431.

Remains of a monumental structure linked with the Funnel Beaker culture were discovered in Strzeszkowice Duże (Lublin District, Poland) during a rescue excavation carried out prior to investment works (building expressway S19 from Lublin to Kraśnik). The structure did not contain any burial chamber or burial. In one of ditches forming the outline of the construction, there was a hoard of nine artefacts made of Świeciechów flint.

Keywords: Funnel Beaker culture, monumental structure, long flint blades, Świeciechów flint, hoard
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INTRODUCTION

Site 3 in Strzeszkowice Duże (AZP – Polish Archaeological Record 79-80/7; φ 51°09'15.1" N; λ 22°24'27,0" E) – located in Niedrzwica Duża Commune, Lublin District – occupies the southern slope of the Ciemięga River valley (tributary of the Bystrzyca), in the eastern part of the Bełżyce Plateau (314.13) – mesoregion of the Lublin Upland (Solon *et al.* 2018, 170, 171).

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Fig. 1. Strzeszkowice Duże, Site 3. Location of the site on a map, scale 1:10 000.
Base maps: https://maps-for-free.com and https://www.geoportal.gov.pl/. Graphic design by P. Mączyński

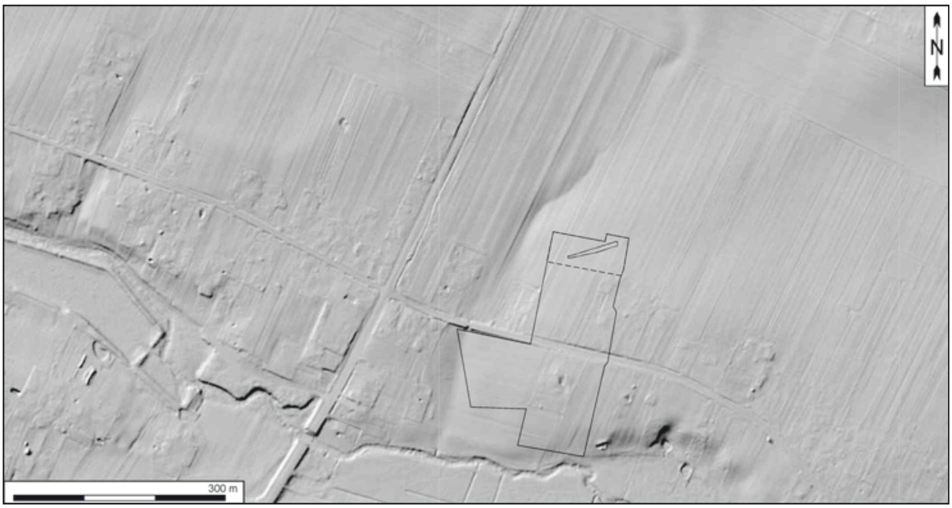

Fig. 2. Strzeszkowice Duże, Site 3. Digital model of the terrain with the marked monumental structure.
Source: https://www.geoportal.gov.pl/. Graphic design by P. Mączyński

The district road 'Bełżyce-Krężnica Jara-Lublin' (West – East) runs from the west to the east, more or less through the middle of the area of the site, the edges of which are delineated with the dispersion of the surface material (Figs 1; 2).

The rescue excavation – preceding the construction of expressway S19 'Lublin-Kraśnik' and led by Józef Niedźwiedź – was carried out in autumn 2019, covering the area of 335.8 ares, which overlapped with the territory intended to be affected by earthmoving during the road construction. This work resulted in finding 667 artefacts – having different functions and cultural attributions – indicating several stages of use of the site (Fig. 3). The

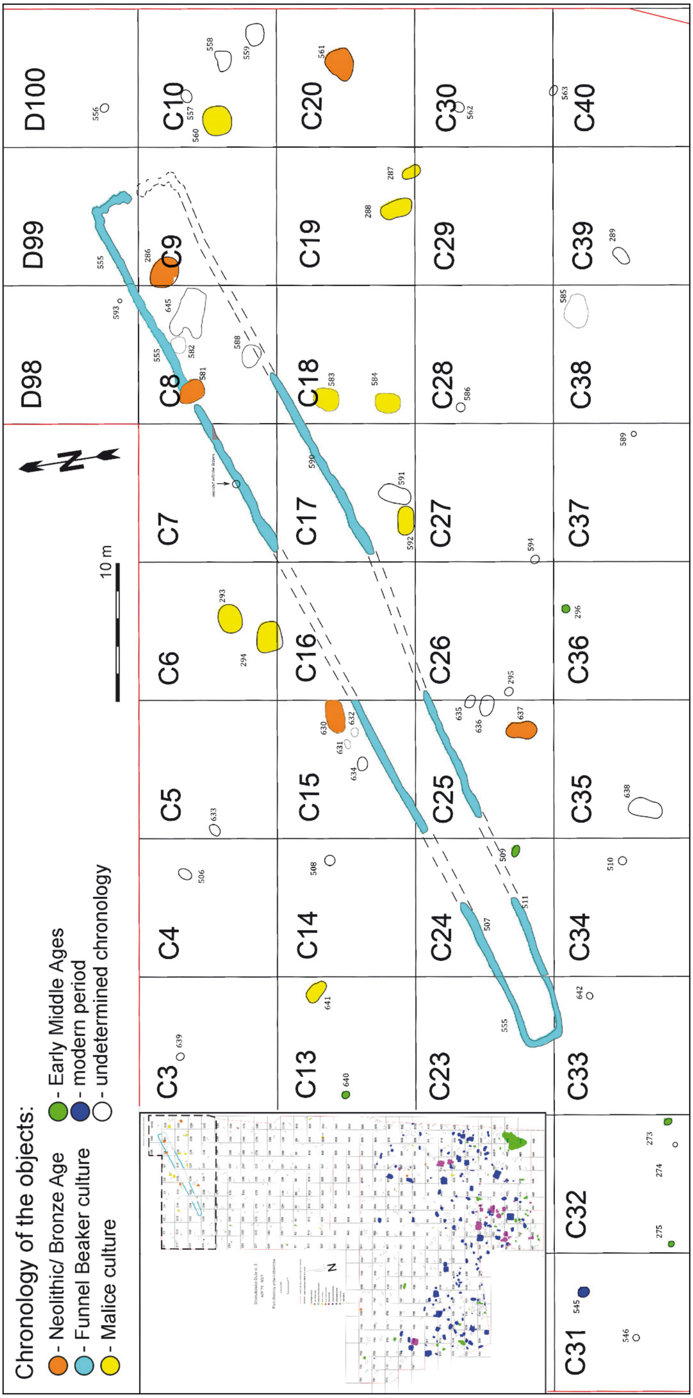

Fig. 3. Strzeszkowice Duże, site 3. Plan of the discovered features. After E. Niedźwiedź, J. Niedźwiedź 2020. Graphic design by P. Mączyński

earliest one is associated with the Malice culture, to which 17 settlement features were attributed. Eight features were generally dated to the Neolithic/Bronze Age based on the technological features of fragmented, non-diagnostic pottery; the monumental structure – which at the stage of the surface survey had been documented as four ditch segments – was attributed to the Funnel Beaker culture. Four features were attributed to the Mierzanowice culture, and one to the Lusatian culture. The bulk of the discovered features (163) were associated with the early Middle Ages (9^{th}-12^{th} centuries AD); there were also settlement remains from the late Middle Ages and Modern Period (Niedźwiedź and Niedźwiedź 2020, 25, 80, 81).

MONUMENTAL STRUCTURE

The structure discussed in this paper is located near the northern and north-eastern edges of the researched area (φ 51°09'18.6" N; λ 22°24'1,25" E). In the excavation documentation, it is marked with number 555 (initially, the successively discovered parts of the ditch had been marked with numbers 507, 511, 555, 590). The feature is located on the eastern slope of an oval elevation having an all-round exposition and descending into a small hollow that enters the valley of the Ciemięga River (Figs 1; 2). The tomb was recorded as six shallow, segmented foundation ditches arranged in the form of a tall trapezoid oriented from the east to the west (with the deviation of c. 10° towards the southwest-northeast. In several places (*e.g.*, near the front of the construction, in the central part and by the narrow side) the outlines were not preserved or it was impossible to record them due to the exceptionally unfavourable conditions. The structure was 69 m long, its front (eastern) side was 7 m wide, whereas the narrow (western) part had a width of 3 m. In the – partially reconstructed – front side, there was a gap (c. 1.0-1.2 m wide) (Figs 3; 4). The highest part of the foundation ditch, which marked the ground floor of the construction, was recorded directly under the topsoil, at a depth of 26-28 cm by the front side – located near the top part of the elevation, 27-30 cm in the central part and 28-32 cm by the narrow side, on the slope of the elevation. The width of the ditch was 50-70 cm, its depth varied from 54-58 cm in the eastern part to 50-70 cm in the western section. Its profile was semi-oval or nearly rectangular. The ditch was filled with lixiviated, horizontally stratified loess having a light grey colour, which was alternately light grey and rusty in places (Fig. 4).

During the exploration, no post holes were found near the foundation ditch or inside the structure. Still, according to the archaeologist excavating the site, the exceptional drought affecting the region during the research considerably influenced the observation conditions, and even moistening the soil did not prove helpful (Niedźwiedź and Niedźwiedź 2020, 30). In one section of the southern ditch (feature 590), in its highest part, three medium-sized cobbles were discovered. The fill of the ditch lacked archaeological material – except one non-diagnostic pottery sherd and a cluster of nine Świeciechów flint blade

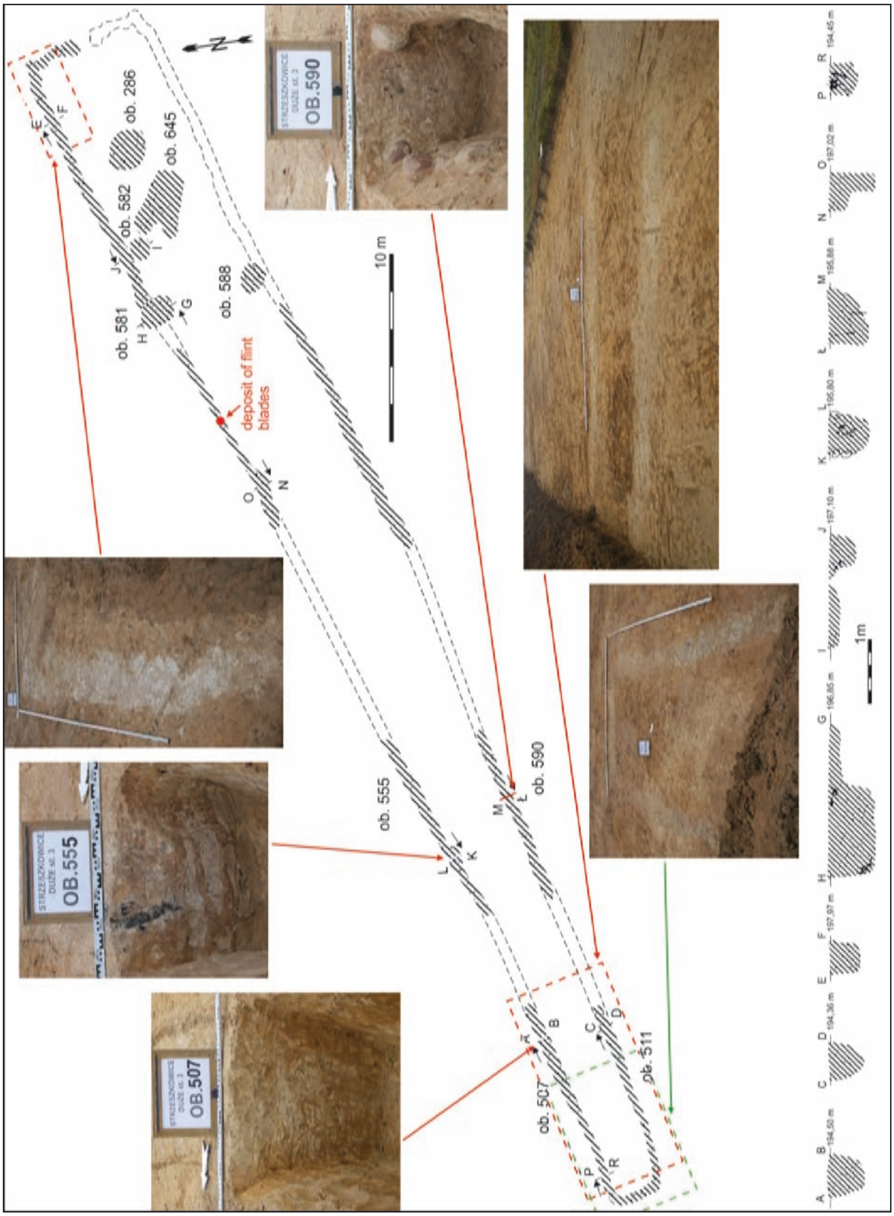

Fig. 4. Strzeszkowice Duże, site 3. Plan of the monumental structure. After E. Niedźwiedź, J. Niedźwiedź 2020. Graphic design by P. Mączyński

Fig. 5. Strzeszkowice Duże, site 3. Hoard of blades. Photo by T. Wiśniewski

artefacts discovered in the northern ditch, around 22 m from the north-eastern corner of the front side (Fig. 4).

The space encircled with the ditch did not yield any burial pits or burials attributed to the Funnel Beaker culture. There were no features or movable material of this archaeological culture near the structure or elsewhere in the researched area (Fig. 3). Opposite to the entrance, around 4 m from the front side of the monumental structure, there was a vast, shallow pit (feature No. 286, dimensions: 174 × 185 × 20 cm), whose fill contained one flint artefact. A similar, deeper pit (No. 581) – disturbing the northern ditch – was located 14 m from the north-eastern corner. It also contained a single flint artefact. Both features were broadly dated to the Neolithic. Near the front side of the structure, there were three other features lacking cultural materials and whose cultural and chronological attribution remains unknown (Nos. 582, 645, 588). Feature 582 was slightly disturbed by the ditch, thus it must come from some earlier time. Still, it is impossible to determine with precision the relation between feature No. 588 and the ditch (it was impossible to record the outline of the latter in this place) (Figs 3, 4).

Near the monumental structure, there were recorded five settlement features – containing single flint artefacts as well as single pottery sherds and generally dated to the Neolithic/Bronze Age – and nine features associated with the Malice culture. They were clustered near the front side of the structure, to the south of the southern ditch (Nos. 287, 288, 560, 583, 584, 592), two were located just by the northern ditch, more or less in its middle (293, 294) and another one (641) was found not much more than 11 metres north of the tail. The monumental structure did not disrupt any of the features attributed to this culture (Fig. 3).

As mentioned before, in the fill of the northern ditch – located around 22 m from the north-eastern corner – there was a cluster of nine macrolithic blade forms made of Świeciechów flint, which were without any doubt artefacts made by Funnel Beaker people (Fig. 5). Originally, they might have been kept in some sort of a container or wrapped in cloth. On the surfaces of most of them, there were dark brown, irregular spots having different sizes, which possibly had been caused by the decomposition of such a container/wrapping (Samples of the residue for identification test were taken in the Analytical Laboratory of the Department of Chemistry, Maria Curie-Skłodowska University in Lublin).

COMPOSITION OF THE FLINT ARTEFACTS

1. Blade, trapezoidal in cross-section, with the slightly damaged tip, broken post excavation. Flat butt, with multiple negative scars, faceted; negative scars left by platform edge trimming; moderately prominent bulb, almost invisible in the blade profile, with a scar and vast chipping; parallel lateral edges gradually converging into the pointed tip; several series of minute chipping; in the distal part of the left edge, there is regular single-series retouch on the dorsal surface; in the proximal part of the right edge, there is a retouched notch (?) on the ventral surface; bent in the mesial part; dimensions: 230 × 44 × 15 mm; metric category: 96 (Dzieduszycka-Machnikowa and Lech 1976, 31-33, 162); bend height: 14; weight: 155.6 g (Fig. 6: 1).

2. Blade, lengthwise cortical on one side, triangular/trapezoidal in cross-section, having a fragment bearing scars left by the trimming the core apex; broken four times post excavation; chipped in the places of the fractures. Gabled butt with multiple negative scars; abraded butt edge; negative scars left by platform edge trimming; moderately prominent bulb, partly removed – the right edge of the proximal part is formed with flat alternating denticulated retouch; parallel lateral edges gradually converging into the pointed tip; strongly bent in the mesial part; dimensions: 226 × 47 × 10 mm; metric category: 105; bend height: 22 mm, weight 102.0 g (Fig. 6: 2).

3. Blade showing part of the preparation of the crest, partly lengthwise cortical, triangular in cross-section. Gabled butt bearing two negative scars; abraded butt edge; negative scars left by platform edge trimming; lip below the butt; moderately prominent bulb with no visible cone; parallel lateral edges, gradually converging into the pointed tip; on the ventral surface of the right edge, there is segmental abrupt edge retouch and flat conchoidal retouch; dihedral burin, formed on the tip with three or four blows, three of which are flat and thin down the ventral surface of the tip; bent in the mesial part; dimensions: 227 × 38 × 14 mm; metric category: 86; bend height: 17 mm; weight: 112.6 g (Fig. 7: 1).

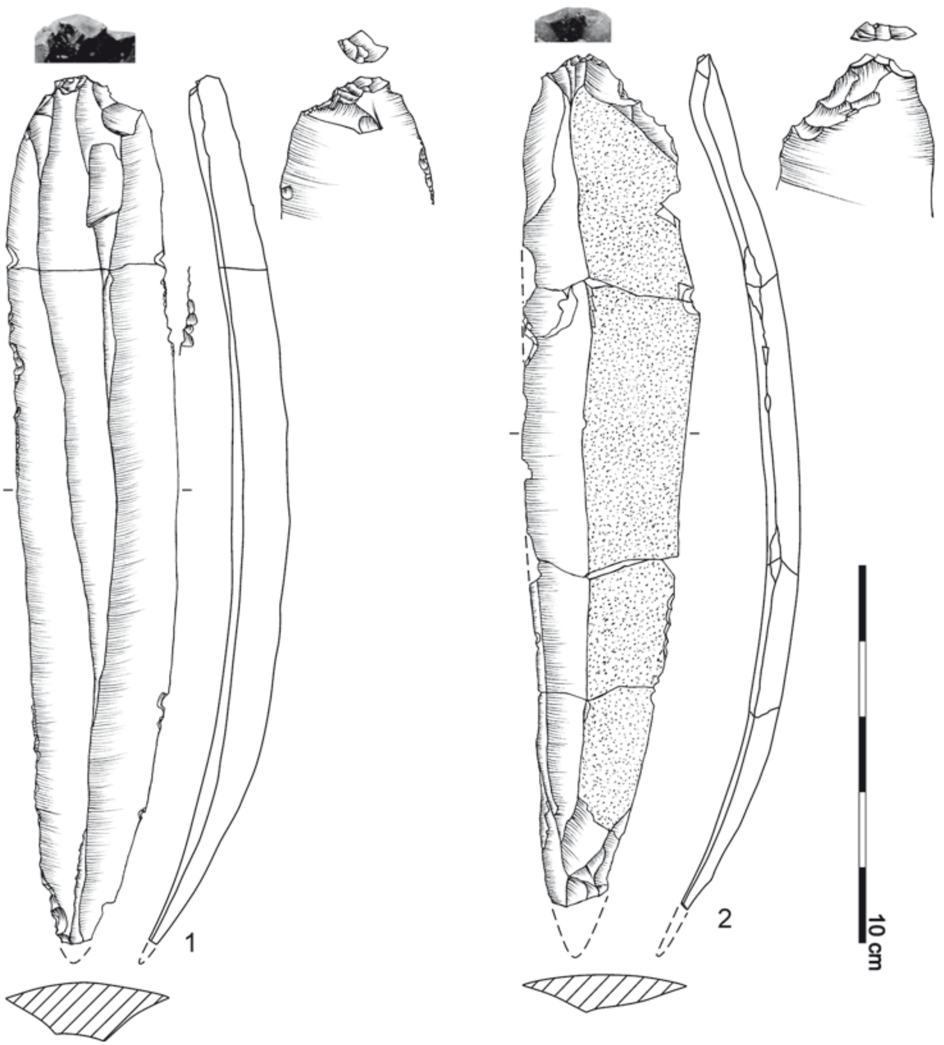

Fig. 6. Strzeszkowice Duże, site 3. Blades from the hoard.
Drawings by J. Libera. Photos by T. Wiśniewski. Graphic design by P. Mączyński

4. Blade with negative scars on the dorsal surface, triangular cross-section, broken post excavation. Gabled butt bearing multiple negative scars, faceted; negative scars left by platform edge trimming; lip below the butt; moderately prominent bulb without visible cone; not very regular lateral edges converging into the pointed tip; in the distal part, on both edges, there are two notches – located almost opposite to each other – formed with abrupt retouch; on the tip, there is a simple burin formed with two blows on the right edge;

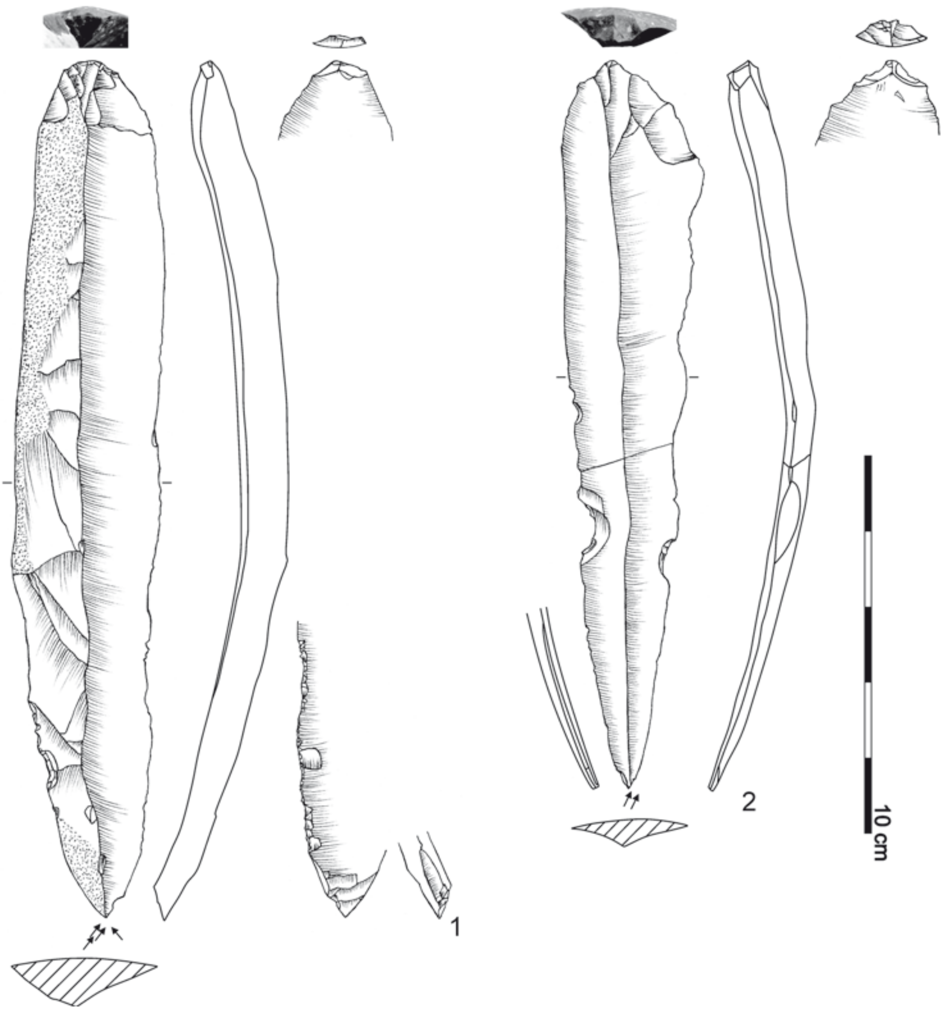

Fig. 7. Strzeszkowice Duże, site 3. Blades from the hoard.
Drawings by J. Libera. Photos by T. Wiśniewski. Graphic design by P. Mączyński

micro-retouch on the left edge; considerable bend in the mesial portion; dimensions: 193 × 38 × 10 mm; metric category: 85; bend height: 19 mm; weight 50.0 g (Fig. 7: 2).

5. Retouched blade with a triangular/trapezoidal cross-section; not very regular conchoidal retouch in the proximal part covering up to ⅓ of the length; in the remaining parts, there is minute alternating edge retouch; on the ventral surface of the right side, there is flat, double-series retouch in the mesial part; edge butt, abraded; negative scars left by

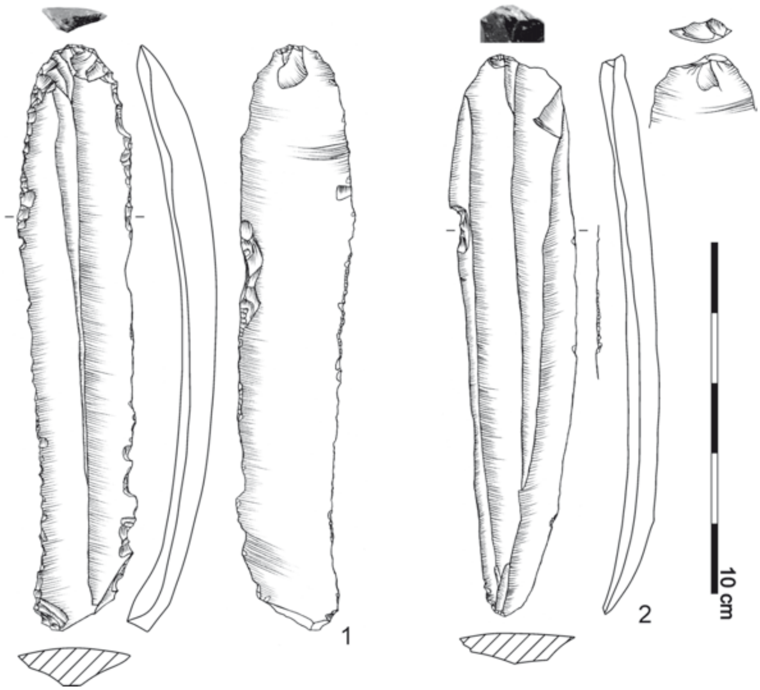

Fig. 8. Strzeszkowice Duże, site 3. Blades from the hoard.
Drawings by J. Libera. Photos by T. Wiśniewski. Graphic design by P. Mączyński

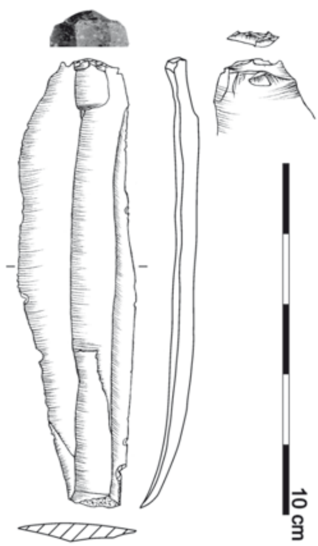

Fig. 9. Strzeszkowice Duże, site 3. Blade from the hoard.
Drawing by J. Libera. Photo by T. Wiśniewski. Graphic design by P. Mączyński

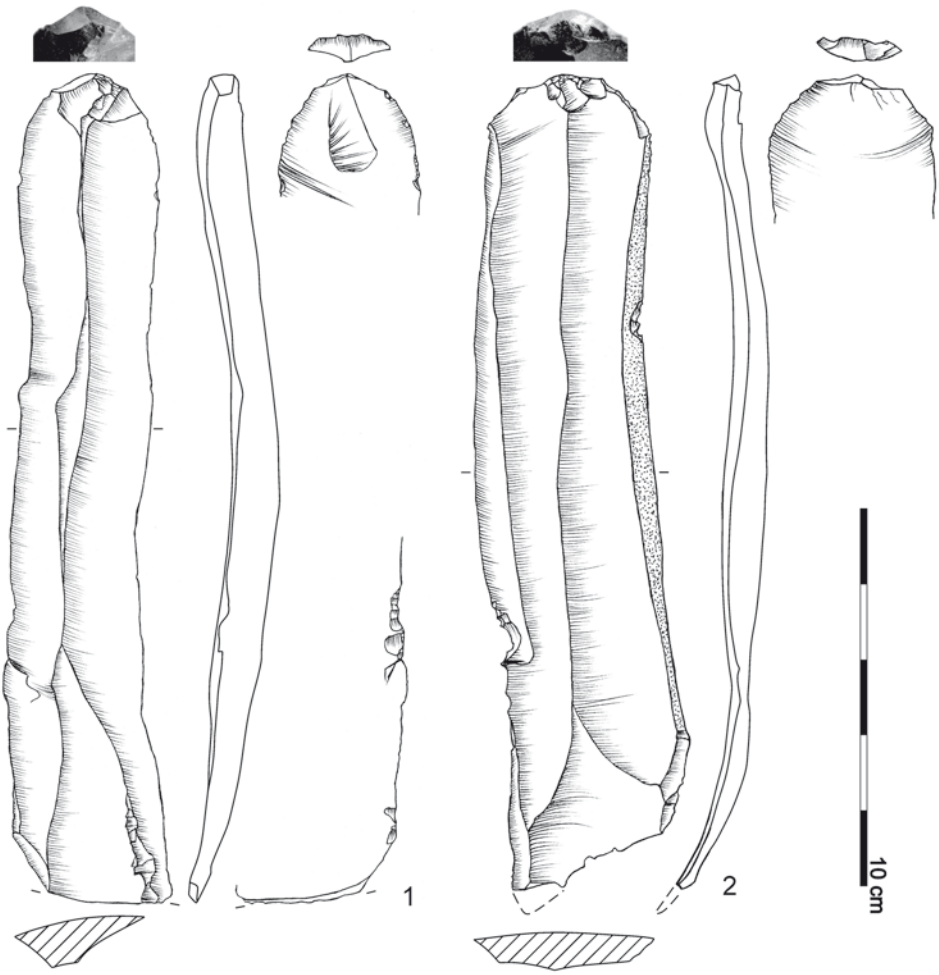

Fig. 10. Strzeszkowice Duże, site 3. Blades from the hoard.
Drawings by J. Libera. Photos by T. Wiśniewski. Graphic design by P. Mączyński

platform edge trimming; moderately prominent bulb with a scar and considerable chipping; parallel lateral edges, natural surface tip, diagonal to the axis; the edges of the tip, especially the lower edge, are rounded and slightly glossed; bent in the mesial part; dimensions: 167 × 33 × 12 mm; metric category: 75; bend height: 15 mm; weight 58.9 g (Fig. 8: 1).

6. Blade with negative scars on the dorsal surface and a polygonal cross-section. Butt bearing multiple negative scars, faceted, with negative scars left by platform edge trimming; moderately prominent bulb with a scar and chipping; parallel lateral edges gradually converging into the pointed tip, whose dorsal surface is covered with minute retouch; minute

retouch on the ventral surface, in the central part of the right edge; in the proximal part, on the left edge, there is a notch formed with semi-flat retouch; bend near the tip; dimensions: 1 60 × 34 × 9 mm; metric category 75; bend height 10 mm; weight 52.7 g (Fig. 8: 2).

7. Blade with negative scars on the dorsal surface and a trapezoidal/polygonal cross-section. Gabled butt bearing two negative scars, faceted; negative scars left by platform edge trimming, moderately prominent bulb with scars and chipping; parallel lateral edges, linear tip, perpendicular to the axis, with vestigial traces of cortex; very minute retouch and a notch on the right edge, near the tip; bend near the tip; dimensions: 128 × 33 × 6 mm; metric category 74; bend height 8 mm; weight 26.1 g (Fig. 9).

8. Blade with negative scars on the dorsal surface with a triangular/trapezoidal cross-section. Gabled butt bearing two negative scars, abraded butt edge, negative scars left by platform edge trimming; lip below the butt; moderately prominent bulb with a scar and vast chipping; parallel, not very regular lateral edges; flat segmented retouch on the ventral surface of the right edge; tip perpendicular to the axis, broken; opposing negative scar – in the distal part – formed during the preparation of the core apex; mesial bend; dimensions: 220 × 39 × 13 mm; metric category: 86; bend height: 12 mm; weight: 111.2 g; can be refitted with blade No. 5 (Fig. 10: 1).

9. Blade, lengthwise cortical on one side with a polygonal cross-section. Gabled butt with multiple negative scars, abraded butt edge, negative scars left by platform edge trimming; lip below the butt; distinctly arched bulb with a slight scar; parallel lateral edges; the left edge is chipped in the distal part; the right is slightly glossed, especially on its ventral surface; opposing negative scar in the distal part formed during the preparation of the core apex; linear tip, diagonal to the axis, slightly broken; distal bend; dimensions: 216 × 48 × 10 mm; metric category: 105; bend height: 11 mm; weight: 116.2 g; can be refitted with blade No. 4 (Fig. 10: 2).

TECHNOLOGICAL AND MORPHOLOGICAL ANALYSIS

Besides the chipped fractures of two specimens- which resulted from careless exploitation – the blades are preserved in a very good condition and are not covered with patina.

All the blades were made of Świeciechów flint. Macroscopic features of this raw material allow us to select two artefact groups. The first set is composed of seven specimens (Fig. 5: 1-7) made of dark grey flint, which is saturated to a considerable degree with white-grey dots and spots whose diameters vary from 0.5 to 3 mm (but those reaching the upper limit are very rare). The intense spotting makes the flint surfaces somewhat abrasive. Two specimens included in this group have partly preserved, very thin and soft cortex. The other set consists of two artefacts made of grey flint covered with a modest number of white-grey spots whose diameters vary from 0.5 to 1 mm; the cortex preserved on one of these blades is also very thin and soft (Fig. 5: 8-9).

The surfaces of all the artefacts are also covered with the previously-mentioned dark brown, irregular spots of unknown origin. Their number is relatively small on the specimens included in the first group and considerable on both artefacts from the second set (Fig. 5).

The above-presented division – due to the macroscopic features of the raw material used – also has a bearing on the morphologies of the artefacts. Most of the blades included in the first group are very regular, with lateral edges generally parallel to each other (and to ridges between negative scars), that gradually converge into pointed tips. Particular specimens have their mass somewhat evenly distributed. The most massive ones (Figs 6: 1; 7: 1) are the thickest in the medial portion, which indicates that the flaking surface was considerably convex. The next two most bulky artefacts are the thickest in the proximal portion, becoming gradually thinner towards the distal end (Figs 6: 2; 7: 2). The mass of the retouched blade is similarly distributed, but the oblique distal portion – which removed some part of the natural surface of the core apex – is relatively thick (Fig. 8: 1). All the blades are bent in the profile. Six specimens are incurved in the mesial part, and the heights of the curvature vary from 14 to 22 mm. In the remaining three, the bends occur in the apical section and their heights range from 8 to 11 mm (Table 1).

The dorsal surfaces of five specimens included in this group completely lack cortex (with the exception of the shortest blade, which has its vestigial remains on the tip) and have between two and four negative scars left by blades previously detached from the core. The remaining two specimens have one side covered with lengthwise thin and smooth cortex. The percussion ripples on the ventral surfaces are clearly visible only in the butt-conoid parts and faintly on the curved tips. They do not occur on other parts of the artefacts. The cross-sections of the blades are triangular (two specimens), trapezoidal (one specimen), triangular-trapezoidal (two specimens) and trapezoidal-polygonal (two specimens). Two blades from this set can be refitted (Figs 5: 1, 2; 6: 1, 2).

The morphologies of the two refitting blades included in the second raw material group (Figs 5: 8, 9; 10: 1, 2) are considerably different from the rest. Although their edges are parallel, they are not very regular, whereas the tips are linear, perpendicular to the axis. Their morphologies are not the same, despite the fact that the blades can be refitted. The specimen with cortex preserved virtually along the entire length of the right side (Fig. 10: 2) is the thickest in the proximal and mesial parts, curved in the middle and having the polygonal cross-section. The mass of the other blade – having only negative scars on its dorsal surface – is cumulated in its mesial part. It is also bent in the middle. The cross-section of this artefact is triangular-trapezoidal (Fig. 10: 1).

Although the blades representing the two raw material groups have different morphologies, their technological features are considerably similar. In their proximal parts, they all have traces of procedures performed on the platform (platform edge) prior to the detachment of the blades: faceting (Figs 6: 1; 7: 2; 8: 3; 9), abrading (Figs 6: 2; 7: 1; 8: 1; 10: 1, 2) and trimming it (all). In the front view, the butts are gabled, with two or multiple negative

Table 1. Strzeszkowice, site 3. Morphometric characteristics of blades from the hoard (M – mesial bend; D – distal bend)

No.	Débitage taxon	Length (mm)	Width	Thickness	Metric category	Height of the bend (mm)	Weight (grammes)	Cross-section	Remarks	Fig.
1	Blade with negative scars on the dorsal surface	230	44	15	96	14 – M	155.6	trapezoidal	Broken post excavation, refits with No. 2	Fig. 6: 1
2	Blade with one lengthwise cortical side	226	47	10	105	22 – M	102.0	triangular/ trapezoidal	Broken post excavation in four places, refits with No. 1	Fig. 6: 2
3	Secondary crested blade with one lengthwise cortical side	227	38	14	86	17 – M	112.6	triangular		Fig. 7: 1
4	Blade with negative scars on the dorsal surface	193	38	10	85	19 – M	50.0	triangular	Broken post excavation	Fig. 7: 2
5	Retouched blade with negative scars on the dorsal surface	167	33	12	75	15 – M	58.9	triangular/ trapezoidal		Fig.8: 1
6	Blade with negative scars on the dorsal surface	160	34	9	75	10 – D	52.7	polygonal		Fig. 8: 2
7	Blade with negative scars on the dorsal surface	128	33	6	74	8 – D	26.1	trapezoidal/ polygonal		Fig. 9
8	Blade with negative scars on the dorsal surface	220	39	13	86	12 – M	111.2	triangular/ trapezoidal	Refits with No. 9	Fig. 10: 1
9	Blade with one lengthwise cortical side	216	48	10	105	11 – M	116.2	polygonal	Refits with No. 8	Fig. 10: 2
	minimum	**128**	**33**	**6**			**26.1**			
	maximum	**230**	**48**	**15**			**155.6**			
	average	**196.33**	**39.33**	**11**			**87.2**			
	standard deviation	**36.94**	**5.79**	**2.78**			**41.9**			
	total weight						**785.3**			

scars (seven specimens – Figs 6: 2; 7: 1-2; 8: 2; 9; 10: 1-2), one is an edge butt (Fig. 8: 1), whereas another was flat (Fig. 6: 1), although not for certain, since the right part of the butt is damaged (post-excavation damage?). There is micro-crushing on some of them, albeit there are no fractures. In most specimens, core-forming procedures preceding the detachment of the blades led to selecting the point of force application on the platform. The angles between the butt and the dorsal surface are c. 80° or more or less perpendicular. Eight blades have moderately prominent bulbs, in some cases almost invisible in the profile (Figs 6: 1; 7: 2; 8: 1; 9), usually with a scar and chipping (Figs 6: 1; 8: 1-2; 9; 10: 1) or only with the former (No. 9), whereas three specimens lack both features (Fig. 10: 2). One artefact has a short, distinctly arched bulb (Fig. 10: 2). Most of the artefacts have a lip below the butt.

The blades included in both raw material groups are macrolithic. Their lengths vary from 128 to 230 mm and widths from 33 to 48 mm, whereas their thickness ranges from 6 to 15 mm. They represent the following metric categories: 70 (three specimens), 80 (three specimens), 90 (one specimen) and 100 (two specimens). Only one artefact was included in class four (No. 7 – the shortest) and the remaining specimens belong to classes five and six – they are also relatively thin, which indicates that they were slender forms (Dzieduszycka-Machnikowa and Lech 1976, 31-33). The weights of particular specimens vary from 26.1 to 155.6 g. The whole collection weights 785.3 g (Table 1).

TECHNIQUE OF FLINT PRODUCTION

As mentioned before, the macroscopic features of the raw material used allow us do select two categories of the blades belonging to the discussed set. The technological style of the specimens included in the first group indicates that three of them (Figs 5: 1-3; 6: 1, 2; 7: 1) were detached from the same core having a convex platform and at least one prepared side. Still, they come from a relatively early stage of core exploitation. Two specimens were detached during the process of expanding the flaking surface to the sides: the fragmentary blade showing part of the preparation of the crest with preserved cortex (Figs 5: 3; 7: 1) and the blade with one lengthwise cortical side (Figs 5: 2; 6: 2), which refits with the blade whose dorsal surface is covered solely with negative scars (Figs 5: 1, 2; 6: 1, 2). It is still possible that the two next blades (Figs 5: 4, 6; 7: 2; 8: 2) were also detached from the same core, but at later stages of its exploitation, when it was considerably shorter. Still, it is impossible to verify the correctness of this assumption. Although the same raw material was used in the production of two other specimens (Figs 5: 5, 7; 8: 1; 9), they were detached from a different core (or cores), which is indicated by the differently shaped tip of the retouched blade and the vestigial traces of cortex on the shortest blade.

The two blades included in the second raw material group can be refitted, so they certainly come from one core (Figs 5: 8-9; 10: 1, 2).

All the blades from this collection have preserved distinct technological features that allow us to have a closer look at the methods of detaching them from the cores. These are two techniques, well documented in prehistoric materials, experimentally tested and comprehensively discussed in the archaeological literature: indirect percussion and lever pressure (*e.g.*, Giria 1997, 68-75; Migal 2002, 264; 2006, 391-396; Pelegrin 2006, 39-47; 2012a, 17-21; Budziszewski and Grużdź 2013, 167-169; Mączyński *et al.* 2019, 211-214). It is also possible that a variation of the latter – crutch pressure technique –was employed. It required tool makers to use some strength. They used a handle (crutch) pressed down with force or body weight (Balcer 1983, fig. 1: d; Migal 2002, 258; Manolakakis 2008, fig. 1; Pelegrin 2012b, fig. 18.8). During the Eneolithic, these methods – especially the lever pressure technique – were mastered. In some parts of Europe, they were used in order to produce long and very long blades, whereby the employment of the lever pressure method made it possible to detach specimens longer than 30 or even 40 cm (Manolakakis 2005, *e.g.*, Pl. 95: 1-2; 106: 1-2; 108: 1). On the other hand, the indirect percussion technique would be used to produce less regular – in the terms of the outline of their lateral edges and mass distribution – blades reaching up to 30 cm in length (Migal 2003, 61; Pelegrin 2006, 42, fig. 2). Many archaeologists point out that certain technological features of specimens obtained with the use the two methods are similar. This resemblance is caused by such factors as core shape (convex or flat flaking surface), manner of stabilising the core during the exploitation, point of force application on the platform (flat or convex – where meet two negative scars formed during core preparation), type of punch (antler, copper), type of lever end (made of antler or copper – Migal 2002, 258; 2006, 391-395; Pelegrin 2006, 39-47; 2012a, 18-20). Among long blades discovered across Europe, western Asia and the Middle East, the most numerous are artefacts detached with the use of lever pressure, where the end of the lever was made of antler or copper. Such blades were produced in workshops located close to the outcrops of raw materials having good quality and adequately large chunks (Pelegrin 2012a, *passim*).

Besides the length and regular character of blades, the most important marks of employing the lever pressure technique and linked with the preparation of the active part of the platform prior to detaching blades are: size and shape of the butt, presence or absence of a lip below the butt, size and shape of the percussion bulb, as well as micro-traces on the butt and bulb indicating the type of lever used. The butts of the blades from the hoard discovered in Strzeszkowice Duże 3 have traces indicating that they were detached by applying pressure to the core with a lever having an end made of deer antler – this fact is mainly indicated by the gabled butts that correspond to the delicate lips, whereas flat butts lack circular fractures or cracks in the shape of circle segments left by copper tips (harder than those made of antler) (Pelegrin 2012, figs. 18.18; 19.19). This fact corresponds to the conclusions and experiments of Witold Migal (2006, 391-396) and Jacques Pelegrin (2012a). The latter analysed a group of blades made of Świeciechów flint and attributed to the Funnel Beaker culture. Next, he experimentally reproduced them using different techniques. As a result, he came to the conclusion that the micro-traces present on the butts of the macrolithic blades analysed by him and attributed to this culture are typical of the pressure technique with the use of an antler lever (Pelegrin 2012a, 23-26).

DISCUSSION

The feature discovered at Site 3 in Strzeszkowice Duże is a tomb of Niedźwiedź type, subtype A, defined by Seweryn Rzepecki, who has dedicated a separate paper to these constructions (Rzepecki 2011). According to him, the distinctive feature of such unchambered tombs was 'the presence of foundation ditches delineating the ground level (or only its part) of a monumental construction. Lack of 'large stone' structures is also an important diagnostic aspect' (Rzepecki 2011, 13). Such tombs were quite widespread across the territories occupied by the Funnel Beaker culture. They were built by the populations of all its territorial groups and – against all appearances – they were not the most popular in areas lacking the 'large stone' material (Rzepecki 2011, 82). In most cases, the foundation ditches of such constructions contained holes left by posts supporting their walls, and – possibly – roofs (as their existence is uncertain). There are also features where no such post holes were recorded, *e.g.*, in Lublin-Sławinek 2 (*e.g.*, Jastrzębski and Ślusarska 1985, 194, fig. 3) or Szczytna 6 (Król *et al.* 2014, 64, 65).

Monumental constructions of the Funnel Beaker culture that do not contain any bodies occur rarely, but not exceptionally seldom. Every new discovery of this type compels us to answer the question concerning the functions (Wierzbicki 2006) of such constructions, especially in cases when they lack burial chambers or burials. This is the case of Strzeszkowice Duże 3. It is difficult to consider features 286 or 645 – which are located opposite the entrance – as the remains of the burial pit. The former could not play this role due to its almost circular shape, whereas the latter – because of its orientation, which is inconsistent with the general layout of the construction (Figs 3, 4). The examination of the tomb itself, as well as of its near and far surroundings, did not result in finding movable materials – especially pottery – that could be considered as having been left by the builders. Besides the form of the construction, only the hoard of the macrolithic flint tools directly indicates that the structure should be linked with the Funnel Beaker culture.

The monumental construction is located on the western slope of an oval elevation having an all-round exposition and descending to a currently dry valley stretching towards the valley of the Ciemięga River, and at the same time on the area adjacent to the northern and eastern limits of the excavation trench. We cannot rule out the possibility that the discovered tomb marks the western boundary of a greater cemetery, which spreads east of it – on the top part of the elevation (Fig. 1). An attempt to verify this hypothesis with the use of LiDAR imaging gave a negative result (Fig. 2), which does not mean that it has provided us with a conclusive answer. In order to verify this, it would be necessary to conduct a geomagnetic survey, or at least a test excavation.

The simplest answer to the question concerning the function of the discussed construction is contained in the title, but – for obvious reasons – a question mark was used in it. We can imagine that the local Funnel Baker community made a collective effort to build a monumental tomb, but – for unknown reasons – the people changed their mind regarding its intended function. We also cannot rule out the possibility that its function was symbolic.

The custom of depositing different flint hoards in the stone linings of monumental tombs is characteristic especially of the Łupawa group of the Funnel Beaker culture. The deposits were composed of both vessels and raw materials or flint artefacts (Jankowska 1975, 32; Weber 1983, 60, 61, Tables XV, XX). This phenomenon occurs very rarely across the territories of the south-eastern group of the Funnel Beaker culture. Among the several dozen previously researched megalithic graves, such hoards, including blades and blade tools, were discovered in Malice Kościelne and Pawłów (Bargieł and Florek 2005, 25, fig. 9; 2006a, 368; 2006b, 389, fig. 9). The necropolis in Malice Kościelne, Site 1 – where five hoards of blades deposited in the stone linings of both tombs discovered – is exceptional in this respect (Bargieł and Florek 2006a, 368, fig. 11; Libera and Zakościelna 2006, 163).

Deposits composed of flint artefacts – but not of vessels – must be linked with some general idea prevalent across the south-eastern group. There, aquatic hoards associated with the Funnel Beaker culture most often include flint artefacts, mainly long blades (Kaflińska 2004; Florek and Zakościelna 2003; Libera and Zakościelna 2010), whereas votive gifts composed of vessels (common for the eastern group) occur seldom (Bargieł and Kącki 1989).

The composition of the set found in the ditch forming the ground level of the monumental structure in Straszkowice Duże 3 should be treated as a reference to the tradition prevalent across the Polish Lowland, just as the occasional use of chocolate flint in non-economic activities or placing, usually single, granite stones among the limestone chunks used in the construction of burial chambers or tomb linings (also *e.g.*, in Pawłów, Karmanowice, graves 35 and 37 – J. Nogaj-Chachaj 1990, 13, or in Słonowice – oral information by K. Tunia). The presence of cobbles discovered at Strzeszkowice Duże 3, in one of the sections of the southern ditch (feature 590 – Fig. 4) is probably a form of relating to these traditions.

CONCLUSION

The construction discovered at the site of Strzeszkowice Duże 3 is another tomb linked with the settlement cluster of the Funnel Beaker culture from the western part of the Lublin Upland. At the same time, it is the only structure of this kind that did not have a funerary function and contained a deposit of flint artefacts. For this reason, it makes an interesting contribution to the study of the funerary rites prevalent in the south-eastern group of the Funnel Beaker culture.

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TWO FLINT AXES FROM SADŁOWICE, OPATÓW DISTRICT, ŚWIĘTOKRZYSKIE VOIVODESHIP: CONTRIBUTION TO THE RESEARCH OF THE GLOBULAR AMPHORA SETTLEMENT IN THE SANDOMIERZ UPLAND

ABSTRACT

Bajka M. and Florek M. 2022. Two flint axes from Sadłowice, Opatów District, Świętokrzyskie Voivodeship: Contribution to the research of the Globular Amphora settlement in the Sandomierz Upland. *Sprawozdania Archeologiczne* 74/1, 433-440.

Two axes made of striped flint were discovered in Sadłowice (Opatów District), located in the central part of the Sandomierz Upland, by the Opatówka River. One of them is exceptionally large. These artefacts probably come from a damaged grave (or graves) attributed to the Globular Amphora culture.

Keywords: Globular Amphora culture, axes, striped flint, cemetery, Sandomierz Upland
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In 2015, the Sandomierz representation of the Voivodeship Heritage Protection Office in Kielce was notified that an inhabitant of the village of Studzianki (Opatów District, Świętokrzyskie Voivodeship) was in possession of two flint axes. They had been possibly found during field works (after ploughing). It is not known precisely when it happened, but most probably around 2010 or even earlier. The discovery was made within the limits of

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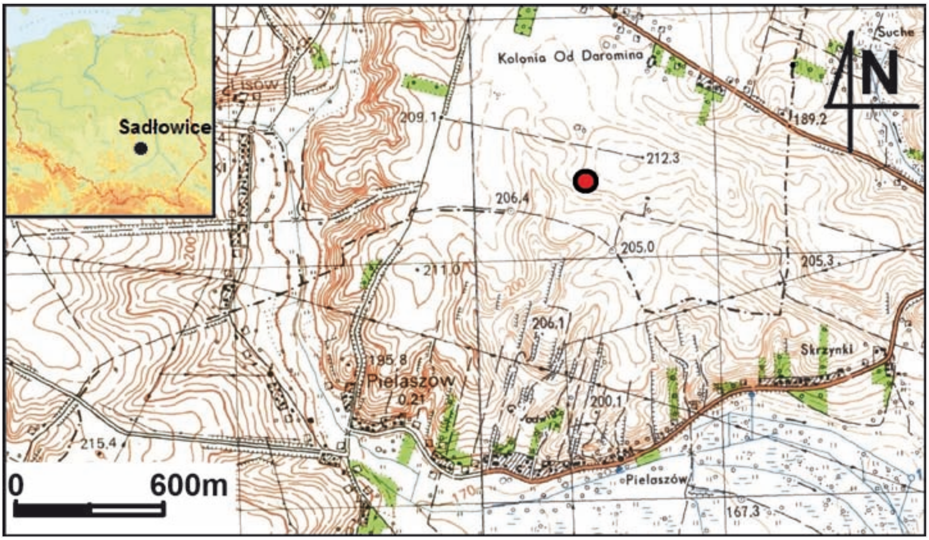

Fig. 1. Sadłowice, site 34. Discovery site of the axes. Topographic map 1:25 000; sec. 144.44; Główny Urząd Geodezji i Kartografii, Warszawa 1978. Prepared by M. Florek

the nearby village of Sadłowice, on one of two neighbouring plots of land: ID Nos. 451 and 452 (Fig. 1).

The site of the discovery is located in the central part of the Sandomierz Upland, near the highest point of a local upland hummock elevated over 40 metres above the level of the Opatówka River valley, on its northern bank. About 100 metres north of the site, there is a small, closed depression, which is sometimes flooded (so-called – "wymok").

According to information provided by the owner of the field, the ploughed axes were found one next to the other, at a distance of several metres. Large, flat stones were also ploughed up near the place of the discovery. Some of them were deposited on the ridge separating the fields, which was confirmed during the inspection of the site in 2015. No archaeological artefacts had been found there before (this statement also applies to the surface survey conducted within the framework of the Polish Archaeological Record in the year 2000). The place of the discovery was marked as Sadłowice Site 34 (AZP 87-72/242) and was probably a Globular Amphora cemetery.

Description of the axes:

Axe I (Fig. 2) – flat axe made of striped flint; its shape is regular and each surface is symmetrical; quadrilateral cross-section; trapezoidal in the horizontal view, with the strongly broadened blade; wedge-shaped in the side view, with slightly convex front surfaces; horizontal, almost flat butt, slightly arched, polished in places; polished and burnished on the entire surface; on one of the front surfaces, there are traces of diagonal

Fig. 2. Sadłowice, site 34. Axe I. Prepared by M. Bajka

abrasions, recently made as a result of strong pressure applied with a metal tool (plough?); minute chipping on the blade; traces of unpolished, single scars left by blows visible on the upper part of the tool, near the butt; dimensions: length 23.3 cm, width 9.6 cm, thickness 2.8 cm, weight 815 g.

Axe II (Fig. 3) – axe made of striped flint, quadrilateral cross-section, rectangular in the horizontal view, slightly narrowing towards the butt, somewhat lenticular in the side view; slightly arched butt, horizontal, partly polished; polished and burnished on the entire surface, less thoroughly on the side surfaces; side of the blade is damaged (chipped); single unpolished scars left by blows on all the surfaces; dimensions: length 15.8 cm, width 4.6 cm, thickness 3.0 cm; weight: 365 g.

The shape and the method of finishing the axes by polishing and burnishing their whole surfaces as well as the used raw material (striped flint) indicate that both artefacts should

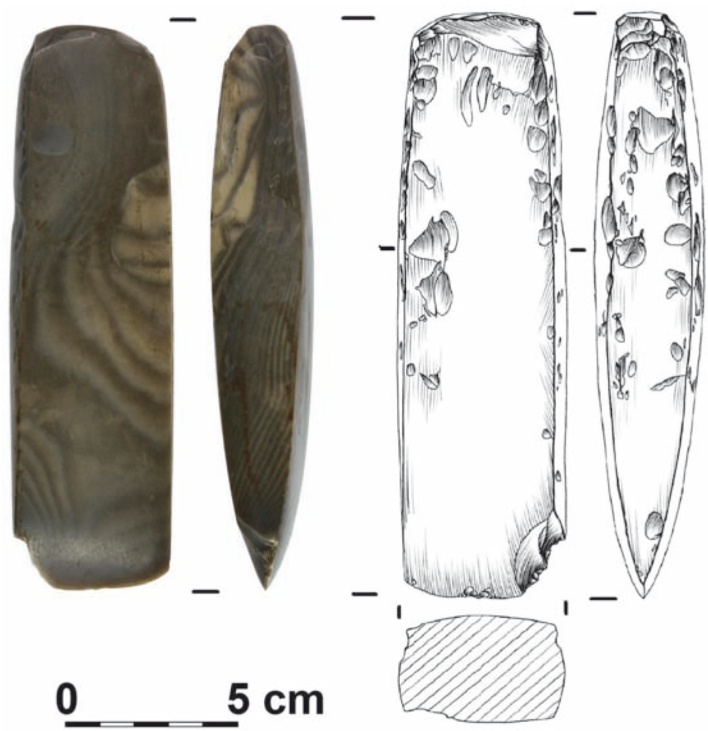

Fig. 3. Sadłowice, site 34. Axe II. Prepared by M. Bajka

be associated with the Globular Amphora culture (Nosek 1967, 234; Balcer 1983, 209; *cf.* also Libera 2009, 169-178). Axe I is a flat form with a trapezoidal shape (outline) of the front surfaces, which is typical of the Globular Amphora culture. On the other hand, axe II, having the quadrilateral cross-section and nearly parallel side surfaces, is the so-called "thick axe" according to the nomenclature by J. Budziszewski (*cf.* Budziszewski and Grużdź 2013, 169).

The exceptionally large size of axe I is noteworthy. Its length (23.3 cm) allows us to include it in the group of the most sizeable axes attributed to the Globular Amphora culture. Other artefacts of this type associated with the same archaeological culture and having similar, although more modest sizes (all trapezoidal in the horizontal view and made of striped flint) were discovered in the following localities: Klementowice (Puławy District, Lublin Voivodeship): a loose find from Site 5, length 20.5 cm (Uzarowiczowa 1968, 217-223, fig. 5: f) and an axe from Grave 1 on Site 47, having the length of 19 cm (Nogaj-Chachaj 1996, 25-29, fig. 3); Huta Dzierążyńska (Tomaszów Lubelski District, Lublin Voivodeship): a loose find, length of 17 cm (Niedźwiedź *et al.* 2013, fig. 60: 1); Opole Lubelskie (Lublin

Voivodeship): a loose find, length of 19.2 cm (Nogaj-Chachaj and Stasiak 1997, 256-259, fig. 2). An axe of a similar size (length of 21.4 cm), but of uncertain cultural affiliation (Globular Amphora or Trypillian culture), made of Volhynian flint, was also discovered in Zwięczyca (Rzeszów District, Subcarpathian Voivodeship) (Kadrow 1989, 7, 8, fig. 1). Nevertheless, the lengths of Globular Amphora axes vary between 5 and 20 cm, but they are usually not particularly large specimens, having the average length of about 11 cm (Balcer 1983, 209; Libera 2009, 169).

None of the two axes has any traces of use, and the minor damage to their surfaces is mechanical and results from post deposition processes. This fact indicates that they come from a damaged grave or graves (*cf*. Balcer 1983, 209). The possibility that the place of the discussed discovery is the site of a Globular Amphora cemetery is indicated by the presence of numerous stones on the surface (including regular sandstone slabs, which were probably construction elements of damaged graves). Also the location of the site (the highest part of the vast upland hummock elevated over the valley of the Opatówka River), typical of the Globular Amphora cemeteries from the Sandomierz Upland, indicates that they are probably artefacts from a grave (or graves) attributed to the mentioned archaeological culture.

So far (as of the end of 2020), 189 Globular Amphora sites, including 36 defined as certain or alleged Globular Amphora cemeteries, or possibly single graves, have been recorded (Fig. 4). If the two axes indeed come from a damaged grave (or graves), of which there is every indication, this would mean that this is the 37th cemetery of the discussed culture from this territory.

The presented numbers certainly do not reflect the actual state of the Globular Amphora settlement in the Sandomierz Upland, which was attested by discoveries made in 2021 (*e.g*., finding previously unknown archaeological sites attributed to this culture – in seemingly thoroughly researched areas – during the construction of the Ostrowiec Świętokrzyski – Sandomierz pipeline). On the other hand, it is not likely that future discoveries will considerably change the map of the distribution of the Globular Amphora culture settlement in this area charted based on previously recognised sites.

The settlement of the Globular Amphora culture in the Sandomierz Upland appears to be connected with the valleys of the Vistula and Kamienna and – to a lesser extent – with the valley of the Gorzyczanka River. Still, of the greatest importance was the valley of the Opatówka (Kowalewska-Marszałek 2019, fig. 1: b). The cemeteries and single graves of the Globular Amphora culture – as well as settlements located in their vicinities – were established near the edges of these valleys and those of their small tributaries (*e.g*., by such minor rivers as the Przepaść, Polanówka and Gierczanka), on promontories and elevations overlooking them. Sites located at greater distances from these valleys are usually traces of settlement left either by small, short-lived camps or by certain forms of economic exploitation of this area. Most probably, particularly important was the valley of the Opatówka River, playing the role of an axis of the Sandomierz Upland, connecting the valley of the

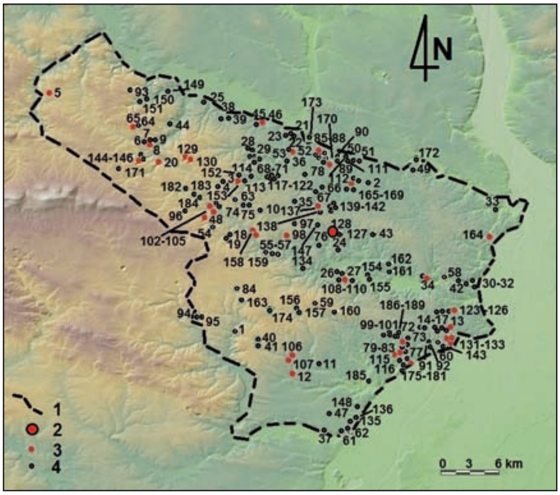

Fig. 4. Sites of the Globular Amphora culture from the Sandomierz Upland. Compiled on the basis of information from the provincial register of archaeological monuments. Prepared by M. Florek. Map key: 1 – border of the Sandomierz Upland; 2 – Sadłowice, site 34; 3 – cemetery, grave; 4 – settlement, settlement trace

1. Beradź 1, community Klimontów; 2. Bidziny 7, community Wojciechowice; 3. Bogusławice 12, community Sadowie; 4. Bogusławice 14, community Sadowie; 5. Boleszyn 2, community Waśniów; 6. Broniszowice 6, community Bodzechów; 7. Broniszowice 10, community Bodzechów; 8. Broniszowice 12, community Bodzechów; 9. Broniszowice 19, community Bodzechów; 10. Brzezie 17, community Opatów; 11. Bystrojowice 9, community Samborzec; 12. Byszów 22, community Klimontów; 13. Chwałki 1, community Obrazów; 14. Chwałki 6, community Obrazów; 15. Chwałki 17, community Obrazów; 16. Chwałki 21, community Obrazów; 17. Chwałki 26, community Obrazów; 18. Czerników Karski 3, community Opatów; 19. Czerników Karski 5, community Opatów; 20. Czerwona Góra 3, community Sadowie; 21. Ćmielów 1, community Ćmielów; 22. Ćmielów 33, community Ćmielów; 23. Ćmielów – Przepaść 9, community Ćmielów; 24. Daromin 45, community Wilczyce; 25. Denkówek 5, community Bodzechów; 26. Dobrocice 16, community Wilczyce; 27. Dobrocice 17, community Wilczyce; 28. Drzenkowice 27, community Ćmielów; 29. Drzenkowice 31, community Ćmielów; 30. Dwikozy 3, community Dwikozy; 31. Dwikozy 14, community Dwikozy; 32. Dwikozy 19, community Dwikozy; 33. Dziurów 19, community Zawichost; 34. Gałkowice-Ocin 15, community Wilczyce; 35. Gierczyce 10, community Wojciechowice; 36. Glinka 3, community Ćmielów; 37. Gnieszowice 55, community Koprzywnica; 38. Goździelin 4, community Bodzechów; 39. Goździelin 8, community Bodzechów; 40. Goźlice 56, community Klimontów; 41. Goźlice 60, community Klimontów; 42. Góry Wysokie 14, community Dwikozy; 43. Grochocice 6, community Ożarów; 44. Gromadzice 25, community Bodzechów; 45. Grójec 5, community Ćmielów; 46. Grójec 24, community Ćmielów; 47, Jachimowice 3, community Samborzec; 48. Jałowęsy 28, community Opatów; 49. Jankowice 4, community Ożarów; 50. Jasice 23, community Wojciechowice; 51. Jasice 26, community Wojciechowice; 52. Jastków 3, community Ćmielów; 53. Jastków 24, community Ćmielów; 54. Jurkowice 5, community Opatów; 55. Karwów 22, community Opatów; 56. Karwów 24, community Opatów; 57. Karwów 28, community Opatów; 58. Kichary Nowe 2, community Dwikozy; 59. Kleczanów 1-2, community Obrazów; 60. Kobierniki 5, community Samborzec; 61. Koprzywnica 22, community Koprzywnica; 62. Koprzywnica 26, community Koprzywnica; 63. Kornacice 39, community Opatów; 64. Kosowice 3, community Bodzechów; 65. Kosowice 12, community Bodzechów; 66. Koszyce 2, community Wojciechowice; 67. Koszyce 4, community Wojciechowice; 68, Krzczonowice 52, community Ćmielów; 69. Krzczonowice 54, community Ćmielów; 70. Krzczonowice 63, community Ćmielów; 71. Krzczonowice 69, community Ćmielów; 72. Lenarczyce 11, community Obrazów; 73. Lenarczyce 26, community Obrazów; 74. Lipowa 1, community Opatów; 75. Lipowa 2, community Opatów; 76. Lisów 31, Wojciechowice; 77. Łojowice 3, community Samborzec; 78. Łukawka 6, community Wojciechowice;

Vistula with the Świętokrzyskie Mountains (Holy Cross Mountains). There are 16 cemeteries (more than a third of the total number of the known necropolises attributed to the Globular Amphora culture) located along this watercourse. A smaller number of such sites are distributed along the Vistula, but they include a local cluster near the place where the

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79. Malice 1, community Obrazów; 80. Malice 6, community Obrazów; 81. Malice 8, community Obrazów; 82. Malice 19, community Obrazów; 83. Malice 20, community Obrazów; 84. Malżyn 10, community Lipnik; 85. Mierzanowice 1, community Wojciechowice; 86. Mierzanowice 3, community Wojciechowice; 87. Mierzanowice 4, community Wojciechowice; 88. Mierzanowice 5, community Wojciechowice; 89. Mikułowice 6, community Wojciechowice; 90. Mikułowice 35, community Wojciechowice; 91. Milczany 13, community Samborzec; 92. Milczany 29, community Samborzec; 93. Mychów Kolonia 38, community Bodzechów; 94. Mydłów 38, community Iwaniska; 95. Mydłów 51, community Iwaniska; 96. Niemienice 16, community Sadowie; 97. Nikisiałka Duża 4, community Opatów; 98. Nikisiałka Mała 44, community Opatów; 99. Obrazów 1, community Obrazów; 100. Obrazów 2, community Obrazów; 101. Obrazów 3, community Obrazów; 102. Opatów 6, community Opatów; 103. Opatów 17, community Opatów; 104. Opatów 61, community Opatów; 105. Opatów 62, community Opatów; 106. Ossolin 2, community Klimontów; 107. Ossolin 42, community Klimontów; 108. Pęczyny 1, community Wilczyce; 109. Pęczyny 9, community Wilczyce; 110. Pęczyny 10, Wilczyce; 111. Podgajcze 1, community Wojciechowice; 112. Podgajcze 5, community Wojciechowice; 113. Podole 4, community Opatów; 114. Podole 29, community Opatów; 115. Polanów 1 (Złota-Gajowizna), community Samborzec; 116. Polanów 6, community Samborzec; 117. Przeuszyn 1, community Ćmielów; 118. Przeuszyn 2, community Ćmielów; 119. Przeuszyn 5, community Ćmielów; 120. Przeuszyn 9, community Ćmielów; 121. Przeuszyn 13, community Ćmielów; 122. Przeuszyn 37, community Ćmielów; 123. Rzeczyca Mokra 1, community Dwikozy; 124. Rzeczyca Mokra 2, community Dwikozy; 125. Rzeczyca Mokra 5, community Dwikozy; 126. Rzeczyca Mokra 13, community Dwikozy; 127. Sadłowice 17, community Wojciechowice; 128. Sadłowice 34, community Wojciechowice; 129. Sadowie 3, community Sadowie; 130. Sadowie 23, community Sadowie; 131. Sandomierz 43, community Sandomierz; 132. Sandomierz 44, community Sandomierz; 133. Sandomierz 78, community Sandomierz; 134. Słabuszewice 46, community Lipnik; 135. Sośniczany 6, community Koprzywnica; 136. Sośniczany 33, community Koprzywnica; 137. Stodoły 1, community Wojciechowice; 138. Stodoły 11, community Wojciechowice; 139. Stodoły Kolonia 3, community Wojciechowice; 140. Stodoły Kolonia 6, community Wojciechowice; 141. Stodoły Kolonia 7, community Wojciechowice; 142. Stodoły Kolonia 52, community Wojciechowice; 143. Strochcice 3, community Samborzec; 144. Stryczowice 4, community Waśniów; 145. Stryczowice 7, community Waśniów; 146. Stryczowice 63, community Waśniów; 147. Studzianki 10, community Lipnik; 148. Szewce 2, community Samborzec; 149. Szewna 14, gm. Bodzechów – osada; 150. Szwarszowice 15, community Bodzechów; 151. Szwarszowice 29, community Bodzechów; 152. Trębanów 1, community Ćmielów; 153. Trębanów 2, community Ćmielów; 154. Tułkowice 14, community Wilczyce; 155. Tułkowice 35, community Wilczyce; 156. Usarzów 51, community Lipnik; 157. Usarzów 55, community Lipnik; 158. Wąworków 1, community Opatów; 159. Wąworków 3, community Opatów; 160. Węgrce Panieńskie 18, community Obrazów; 161. Wilczyce 10, community Wilczyce; 162. Wilczyce 64, community Wilczyce; 163. Wilkowice 6, community Klimontów; 164. Winiary 3, community Dwikozy; 165. Wojciechowice 1, community Wojciechowice; 166. Wojciechowice 4, community Wojciechowice; 167. Wojciechowice 6, community Wojciechowice; 168, Wojciechowice 8, community Wojciechowice; 169. Wojciechowice 20, community Wojciechowice; 170. Wojnowice 4, community Wojciechowice; 171. Worowice 6, community Waśniów; 172. Wólka Chrapanowska 7, community Ożarów; 173. Wólka Wojnowska 32, community Ćmielów; 174. Zdanów 19, community Obrazów; 175. Złota 2, community Samborzec; 176. Złota 3, community Samborzec; 177. Złota 38, community Samborzec; 178. Złota 45, community Samborzec; 179. Złota 62, community Samborzec; 180. Złota 68, community Samborzec; 181. Złota 72, community Samborzec; 182. Zochcin 35, community Sadowie; 183. Zochcinek 13, community Opatów; 184. Zochcinek 17, community Opatów; 185. Żuków 2, community Samborzec; 186. Żurawica 4, community Samborzec; 187. Żurawica 5, community Samborzec; 188. Żurawica 7, community Samborzec; 189. Żurawica 8, community Samborzec

river meets the Polanówka – its minor tributary – in the vicinity of Złota. The third major settlement cluster attributed to the Globular Amphora culture and including cemeteries is linked with the valleys of the Kamienna and its small tributaries like the Gierczanka and Przepaść. Its establishment must have been considerably influenced by the access to the nearby deposits of striped flint in the territory of the Iłża Piedmont.

The noticeably scattered character of the Globular Amphora settlement – or even its lack – in the northwestern part of the Sandomierz Upland – where only one cemetery has been found (Boleszyn, Waśniów community), but without a single recorded settlement or settlement trace – is probably the result of the poor state of research of this territory. Still, the fact that the northeastern part of the Sandomierz Upland lacks any settlement remains that could be attributed to the Globular Amphora culture is puzzling, since this area was previously densely settled by the people of the Funnel Beaker culture (Kowalewska-Marszałek 2019, fig. 1).

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FLINT PRODUCTS FROM A GLOBULAR AMPHORA CULTURE GRAVE IN STEFANKOWICE-KOLONIA, HRUBIESZÓW DISTRICT, SITE 33 IN THE LIGHT OF THE LATEST CONSIDERATIONS

ABSTRACT

Mączyński P. 2022. Flint products from a Globular Amphora culture grave in Stefankowice-Kolonia, Hrubieszów District, site 33 in the light of the latest considerations. *Sprawozdania Archeologiczne* 74/1, 441-457.

The aim of this article is to present further considerations on the technological and functional aspects of flint tools produced by the community of the Globular Amphora culture. These reflections are based on discoveries made in a cist grave from site 33 in Stefankowice-Kolonia (southeastern Poland). During the exploration of the funerary feature, a skeleton was found. It belonged to a man in the Maturus age. The body was accompanied by an abundant set of flint products composed of five blades and three axes (including one half-product). These artefacts were subjected to a technological analysis aimed at determining the techniques employed in the production of the blades and core tools. The analysis was complemented with microscopic examination performed in order to determine the functions of the discovered items.

Keywords: Globular Amphora culture, flint blade, axes, use-wear analysis, technology
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INTRODUCTION

Artefacts made of siliceous rocks represent a group of grave goods frequently found in the materials of the Globular Amphora culture (hereinafter referred to as the GAC). Due to their unique character, they have been presented in numerous publications whose authors discuss their typologies as well as their technological aspects (Michniak and Budziszewski 1986, 214; Borkowski and Migal 1996; Migal and Sałaciński 1996; Sałaciński and Migal 1997; Migal 2006; Budziszewski and Grużdź 2013). Also the functions of such flint artefacts have been discussed many times in archaeological literature. Materials from settlements as well as those from funerary features have been microscopically examined. Unfortunately, despite the relatively large number of such publications, they usually represent analyses performed on small collections (Pyżewicz 2013; Osipowicz *et al.* 2014; Pyżewicz *et al.* 2016; Winiarska-Kabacińska 2017a; 2017b; Mączyński 2018; Boroń and Winiarska-Kabacińska 2021). No attempt to present a summary paper has been made so far. The study of flint materials found in the grave from site 33 in Stefankowice-Kolonia should be considered as a contribution to the debate on the production and importance of flint tools in the society known as the GAC.

LOCATION OF THE SITE AND BURIAL

Site 33 from Stefankowice-Kolonia is located on the loess hills of the Horodło Ridge (Solon *et al.* 2018). A place near the edge of the gentle S-E slope of a small watercourse was chosen for the burial (Fig. 1).

The site was discovered in 1986, during autumn works conducted in a field belonging to J. Baraniuk. Shallowly buried boulders were discovered when ploughing the field. Removing one of them resulted in revealing the burial chamber. Subsequent field research did not lead to discovering other features.

The body was laid in an oval stone cist, of dimensions 2.0 × 1.4 m and oriented E-W. It was buried 30 cm below the present ground level. Over ten granite blocks of different sizes were used in the construction of its side walls. They were additionally sealed from the outside with smaller cobbles. The whole structure was covered with two large erratic blocks. As in the case of the walls, they were also packed around with smaller stones (Fig. 2).

The individual buried inside was a man of about 40 years old (*Maturus* age). He was buried laid on the right side, with strongly flexed legs and his head pointing to the east. A rich set of grave gifts was found near the body. Unfortunately, we do not know the precise original locations of particular flints accompanying the body. Near the skull, there was a flint axe. Some other artefacts – two axes, four flint blades and a bone chisel – were discovered behind his back. The last flint object – a bladelet – was accompanied by three fragments of bone adornments (T-shaped pendants) found among the chest bones. Another ornament – a circular amber plate – was located below the upper epiphysis of the left tibia. There were also two vessels deposited in the grave, behind the head of the buried man (Ścibior *et al*. 1991, 84-86; Bronicki 2016b, 190-195).

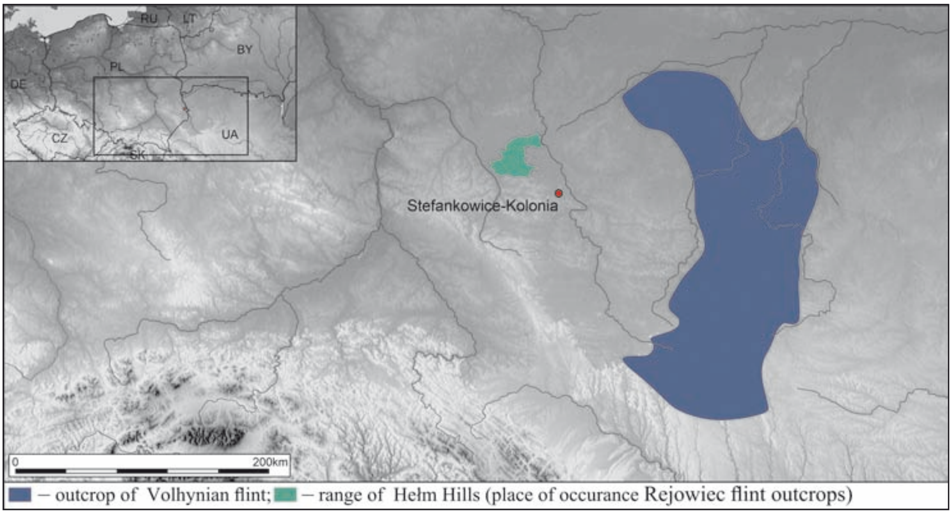

Fig. 1. Location of Stefankowice-Kolonia, Hrubieszów District, site 33, and outcrops of Rejowiec flint and Volhynian flint (after Petrougne 1995, fig. 1; Libera *et al*. 2014; base map: https://maps-for-free.com). Prepared by P. Mączyński

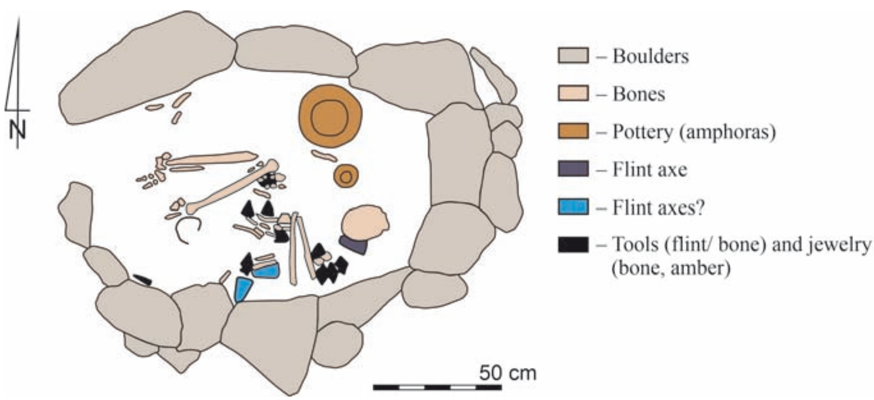

Fig. 2. Stefankowice-Kolonia, Hrubieszów District, site 33. Plan of the Globular Amphora culture grave. Prepared by P. Mączyński, after Ścibior *et al.* 1991

REVIEW OF THE MATERIALS

1. Partial secondary crested blade having an irregular outline. Cortical surfaces preserved only on a fragment of the right side. Irregular lateral edges; profile curved in the mesial part. Faceted butt, moderately prominent bulb with a scar; dimensions: 66 × 14 × 5 mm; weight: 4.5 g. Raw material: Cretaceous flint (Fig. 4: 1).

2. Blade with negative scars on the dorsal surface; triangular cross-section. Lateral edges parallel in places; profile curved in the mesial part. Butt bearing negative scars; platform edge slightly trimmed; prominent bulb with a visible scar; dimensions: 73 × 12 × 3 mm; weight: 2.7 g. Raw material: Cretaceous flint (Fig. 4: 2).

3. Blade; trapezoidal cross-section; cortical surfaces preserved only on the distal end. Irregular lateral edges, profile curved in the mesial part. Faceted butt; platform edge slightly trimmed; prominent bulb with a visible scar; dimensions: 70 × 17 × 4 mm; height of the bend: 4 mm; weight: 5.9 g. Raw material: Cretaceous flint (Fig. 4: 3).

Fig. 3. Stefankowice-Kolonia, Hrubieszów District, site 33. 1 – flint axe half-product; 2, 3 – flint axes. Photo by P. Mączyński

4. Chunky blade; trapezoidal cross-section; cortical surfaces preserved only on a small section of the right side. Irregular lateral edges; profile curved in the mesial part. Faceted butt; platform edge slightly trimmed; prominent bulb with a visible scar; dimensions: 48 × 20 × 4 mm; weight: 3.3 g. Raw material: Cretaceous flint (Fig. 4: 4).

5. Blade with negative scars on the dorsal surface; triangular-trapezoidal cross section; with the broken distal part. Edges parallel on the whole length; straight in the profile. Butt bearing a single negative scar; moderately prominent bulb with a visible scar; scars of

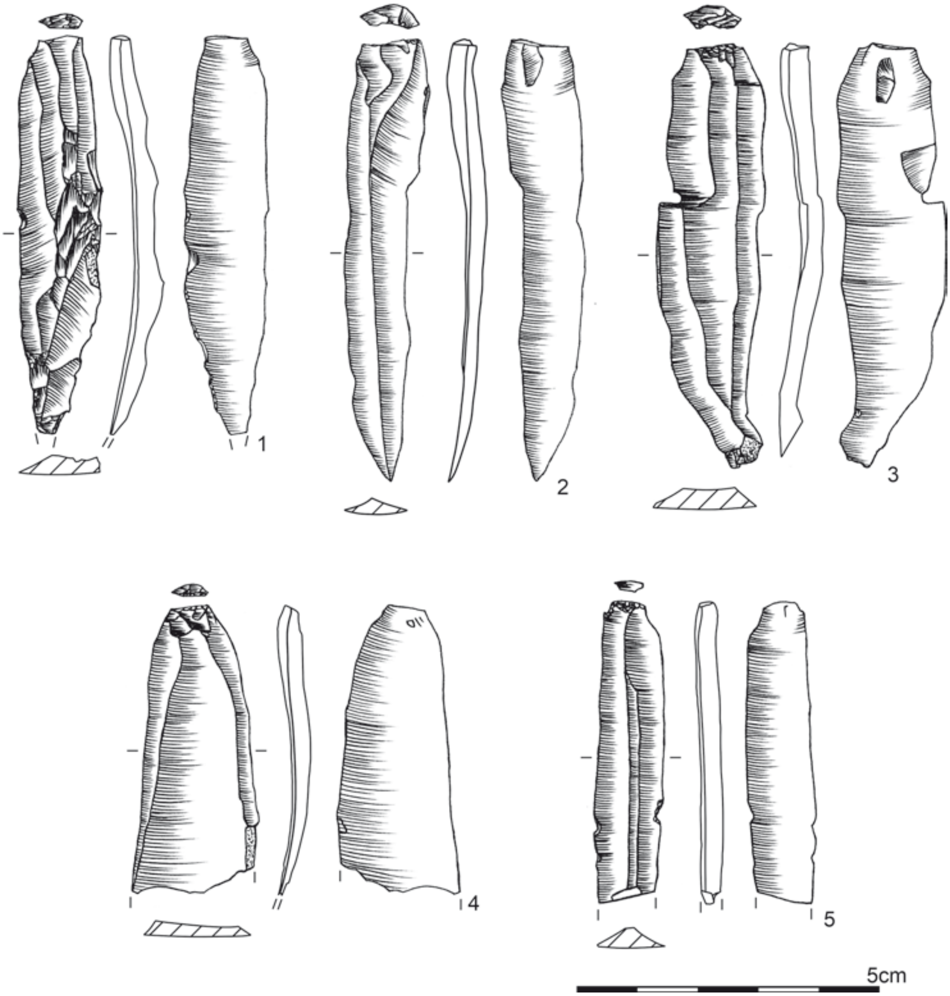

Fig. 4. Stefankowice-Kolonia, Hrubieszów District, site 33. Flint blades.
Drawing by P. Mączyński

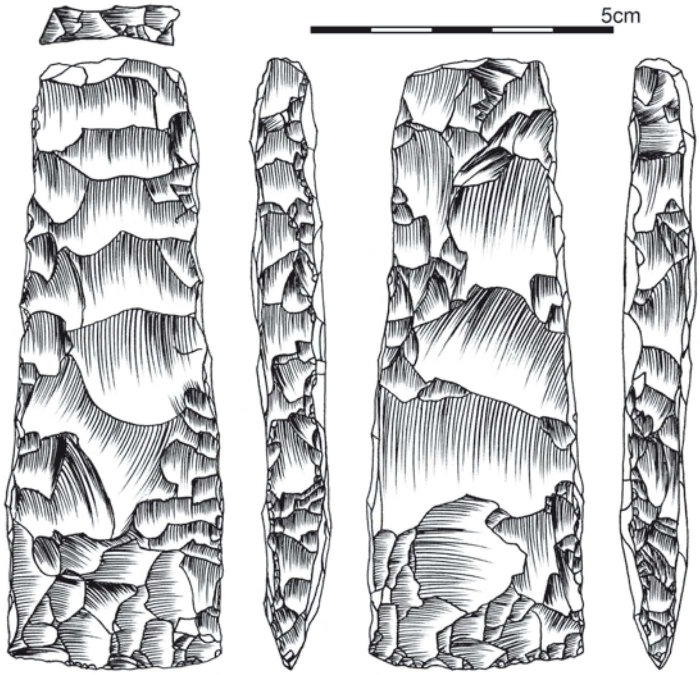

Fig. 5. Stefankowice-Kolonia, Hrubieszów District, site 33.
Four-edged axe half-product. Drawing by P. Mączyński

platform edge trimming; dimensions: 50 × 11 × 4 mm; weight: 2.4 g. Raw material: Cretaceous flint (Fig. 4: 5).

6. Axe half-product, trapezoidal in the face view; no surfaces processed by abrasion; chisel-shaped in the longitudinal section; almost rectangular in the cross-section; slightly arched cutting edge; almost rectangular butt. Height-thickness ratio: 8/1. Dimensions: 104 × 37 × 12 mm; weight: 71 g. Raw material: Cretaceous flint (Fig. 3: 1; 5).

7. Axe; trapezoidal in the face view. Processed by abrasion on *ca*. 70-80% of the surface; chisel-shaped in the longitudinal section; in the cross-section resembling a rectangle with strongly convex sides; slightly arched cutting edge with visible damage; rectangular butt, not polished. Height-thickness ratio: 6/1. Dimensions: 120 × 52 × 22 mm; weight 205 mm. Raw material: Cretaceous flint (Figs 3: 2; 6:1).

8. Axe; trapezoidal in the face view. Processed by abrasion on *ca*. 90% of the surface; chisel-shaped in the longitudinal section; in the cross-section resembling a rectangle with slightly convex sides; slightly arched cutting edge; almost rectangular butt, not polished. Height-thickness ratio: 9/1. Dimensions: 78 × 28 × 8 mm; weight 23 g. Raw material: Cretaceous flint (Figs 3: 3; 7: 1).

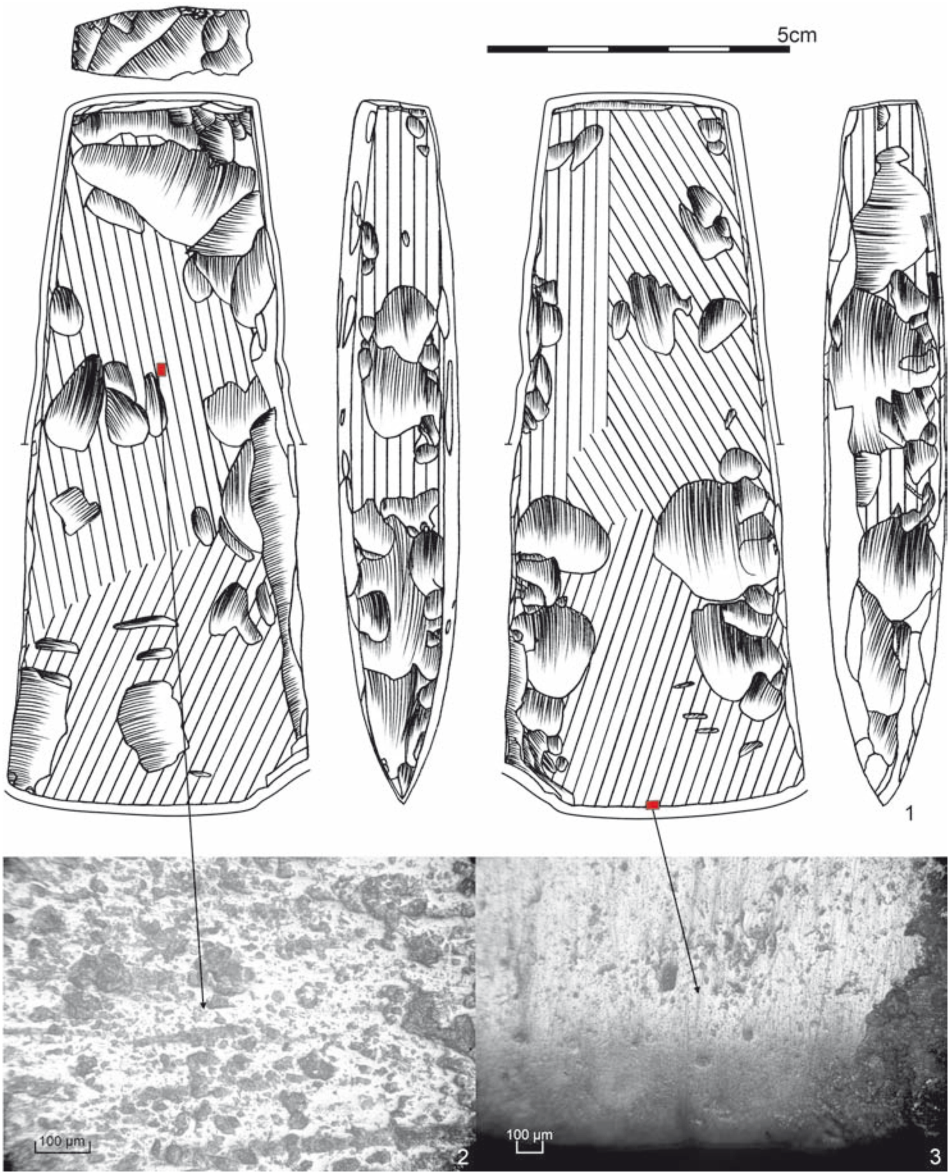

Fig. 6. Stefankowice-Kolonia, Hrubieszów District, site 33.
1 – four-edged axe; 2 – traces of sharpening; 3 – hafting traces.
Drawing and photo by P. Mączyński

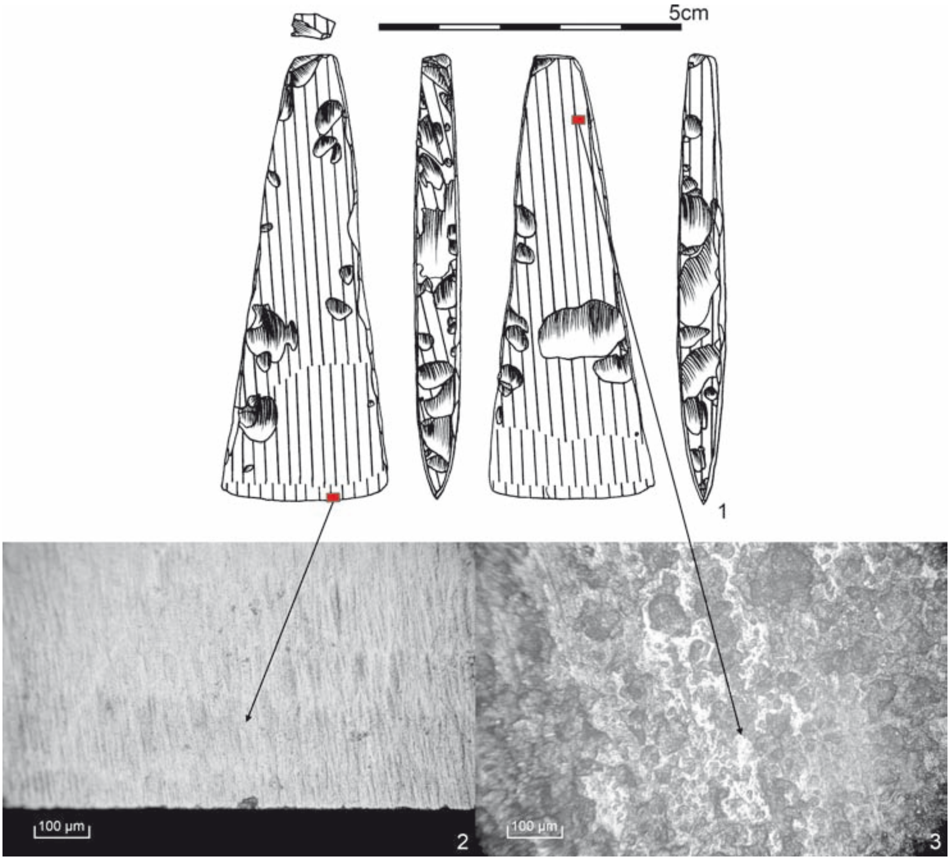

Fig. 7. Stefankowice-Kolonia, Hrubieszów District, site 33.
1 – four-edged axe; 2 – hafting traces; 3 – use-wear traces – wood working.
Drawing and photo by P. Mączyński

METHODS

Examination for identifying use-wear patterns was conducted with the use of two types of microscopes. At the first stage of the research, a stereoscopic Carl Zeiss Discovery v8 microscope – allowing magnifications from 10× to 80× – was employed. When performing this analysis, magnifications of up to 50× were used. The next phase consisted of observing the surfaces of the analysed artefacts under a metallographic Meiji Techno MC-50T microscope, which allowed us to obtain the actual magnifications of 50×/100×/200×/500×. In this case, magnifications of up to 200x were used.

The research of the technology employed in the production of the blades and axes was mainly based on the observation of their general morphologies. The microscopes were used only occasionally. They were used to observe the butts of the blades. This procedure sometimes proves useful when identifying raw materials used in the production of hammerstones or punches that came in contact with stone surfaces. On the other hand, during the analysis of the axes the microscopes were employed to observe their surfaces processed by abrasion in order to distinguish different cut types.

The types of flints used in the production of particular tools were determined with the use of macroscopic methods that take into account their colours, structures and presence or absence of inclusions.

RAW MATERIAL ANALYSIS

Before presenting the flint artefacts deposited in the grave, it is necessary to discuss the provenance of the raw materials used in their production. The colours of the blades are rather diverse. Generally speaking, they were made of dark navy blue or grey flint with many turbidities and brighter discolorations (Fig. 3).

The axe (half-product) that was not processed by abrasion was made of a matt flint concretion (Fig. 3: 1; 5). On its upper face, it has a creamy grey colour with slightly brighter discolorations. In the middle part, the colour of the raw material is completely different (dark grey turning into brown). Also the second specimen is two-coloured. It is black-and-grey near the cutting edge and butt, whereas the middle part of the artefact is ash-grey with visible darker discolorations (Figs 3: 3; 7: 1). The third axe was made of ash-grey flint having a heterogeneous colour (Figs 3: 2; 6: 1).

It is particularly difficult to determine without any doubt the provenance of the raw material used, which is caused by the fact that different flint varieties – whose colours resemble those of the artefacts discovered in the grave from Stefankowice-Kolonia – were located within the range of the distribution of GAC materials. About 40 km to the north-east, in the Chełm Hills, there are the outcrops of Rejowiec flint in post-glacial deposits formed during the Riss glaciation (Rejniewicz 1985, 10, 13; Libera *et al.* 2014, 60; 2016, 154-155; see also Bronicki 2016a). On the other hand, the colours of the discussed artefacts – especially of the axes – are similar to those of raw materials (Volhynian flint) occurring in the Volhynian-Podolian Upland, which are located about 100 km from the site in question (Petrougne 1995, fig. 1; *cf.* Zakościelna 1996, 16). It is worth mentioning that the author of the previous paper consecrated to this funerary collection, A. Bronicki, mentioned that all the axes and four blades were made of Volhynian flint (Fig. 4: 1, 3-5). On the other hand, the last blade (Fig. 4: 2) was described as made of Transnistrian flint (2016b, 195).

Due to these uncertainties and insufficient degree of knowledge of the various varieties of the raw materials from the Volhynian-Podolian Upland, the question of the provenance of the materials used in the production of the reviewed artefacts remains unanswered.

MORPHOLOGICAL AND TECHNOLOGICAL ANALYSIS OF THE BLADES

The question of determining the methods employed during the production of flint artefacts has been tackled many times in the archaeological literature (Inizan *et al*. 1999, 78, 79; Sørensen 2006). Some of these papers discussed specifically GAC materials (Migal and Sałaciński 1996; Budziszewski and Gróżdź 2013, 167, 168). It is usually difficult to reconstruct techniques used in core exploitation destined to produce blades, thus such attempts are often not very accurate. This results from the fact that debitage morphologies are caused by different factors. The most important of them include the type of flint used, the shape of the processed core and its orientation. The manual dexterity and skills of knappers as well as the shapes and sizes of tools used by them should be also taken into account. All these variables mean that blades produced with the use of different methods can have similar technological and stylistic features (Budziszewski and Gróżdź 2013; Grużdź 2017, 150).

The discussed set consists of five blades and three flint axes (includes one half-product). Although the blades are slightly more numerous than the axes, their joint mass is much smaller and amounts to less than 19 g. The axes weigh together as much as 300 g.

Although attempts at refitting (see: Tomaszewski 1986, 240, 241) were made in order to obtain further information, it was found that these forms cannot be refitted, although the colours of several items indicate that they were struck from the same nodule. The microscopic observation of the blade butts did not result in distinguishing traces that would indicate the type of raw material used in the production of the tools employed in detaching the blades. An attempt to identify the technique employed in the core exploitation was based on the general character of the blade morphologies. Three specimens are relatively thin and slender, with a curve in the mesial part (Fig. 4: 1-3). What is more, their lateral edges and ridges are irregular. These features indicate that indirect percussion was employed in their production. The same technique was probably used to detach another blade – which was by contrast chunky (Fig. 4: 4).

Several morphological features distinguish the last of the artefacts (Fig. 4: 5) from the previously-described forms. This blade has straight and parallel lateral edges and ridges. Its profile is straight. These features indicate that it was detached with the use of the pressure technique (*cf*. Sørensen 2006, fig. 5).

The above-presented observations indicate that the blades deposited in the grave were produced with the use of several methods. Still, we need to bear in mind that an expert knapper having access to good quality material was able to employ the direct percussion technique in order to produce blades with straight edges. The weak point of the presented analysis is the size of the collection. Examining a larger group of artefacts having similar features would certainly increase the value of the obtained results.

MORPHOLOGICAL AND TECHNOLOGICAL ANALYSIS OF THE FLINT AXES

The production of tetrahedral axes made of striped flint has been discussed several times in the archaeological literature. Stress was put on researching the methods of flaking them into shape and polishing (Borkowski and Migal 1996; Migal and Sałaciński 1996; Sałaciński and Migal 1997; Budziszewski and Grużdź 2013). Usually, archaeologists distinguish several production stages – like choosing adequate raw material, testing it and chipping the artefacts into desired shape. In the first stages, artisans probably employed the hard hammerstone technique. The methods of indirect percussion and pressure were used only at the end of the production process in order to process flint with greater precision (Budziszewski and Grużdź 2013, 170).

The set of axes from Stefankowice-Kolonia includes one specimen that was not processed by abrasion, which gives us deeper insight into the methods of shaping the surfaces of core tools. This artefact was made with precision and is probably a product shaped by knapping. On the axe, there are negative scars associated with two phases of flint processing. The initial scars were formed when giving it an overall shape. These are vast scars whose arrangement indicates that both faces and sides were formed with blows directed towards the centre. In many cases, they go across the entire width of the sides. Surfaces located by the cutting edge are an exception here, because they were shaped with blows from the front. Most probably, indirect percussion was employed during this phase of flint processing. The last stage of knapping the axe into shape consisted in forming minute negative scars correcting the side margins and the cutting edge. They are visible only in certain sections. Here, the knapper might have used both the indirect percussion and pressure techniques (*cf*. Budziszewski and Grużdź 2013, 170).

The last stage of every axe production was processing it by abrasion, which gave such artefacts their final shape. Two methods were employed then. An axe might have been processed when held directly in the hand or in a specially made device. The latter considerably accelerated the process. Using each of the two methods results in leaving different types of traces, thus it is possible to identify to a certain extent the techniques employed (Madsen 1984; Pyżewicz *et al*. 2016, 311, 312). Still, we need to bear in mind that the entire process of abrading an axe might have consisted of several phases involving processing it in the hand as well as with the use of a special device.

Usually, traces present on processed surfaces make it possible to determine the relative granulometry of the abrasive plate used as well as the direction of abrading and – as mentioned before – the technique employed.

In the description of the surfaces processed by abrasion, it was decided to use the division presented by W. Borkowski and W. Migal (1996), who – based on microscopic observations – defined three categories of axe surfaces formed with the use of different methods:

Grinding – smooth surfaces accompanied by straight scratches, which appear to be white against dark background;

Polishing (fine grinding) – smooth surfaces without thick scratches - sometimes their fragments are visible; at times, there are fine and thin scratches having a different character; such surfaces are usually glossed;

Edge sharpening – smooth, shiny surfaces without scratches (Borkowski and Migal 1996, 48).

Such activities were performed on both abraded axes. In the case of the larger specimen (Figs 3: 2; 6: 1, 3), it was impossible to observe the lower face (near the cutting edge) due to very distinct use-wear patterns that had completely blurred the traces of processing by abrasion. On the other hand, the state of processing recorded on the upper face and on the sides allowed us to include it in the first category. There are also polished surfaces in certain places. What is interesting is that the scratches formed on the axe indicate that it was abraded at different angles, which probably means that they were created during processing the artefact when held in hand.

The whole surface of the other axe was observed (Figs 3: 3; 7: 1, 2), as it lacks use-wear patterns on its cutting edge. On the upper face, there are traces of grinding which give way – gradually and towards the cutting edge – to patterns left by polishing. Near and on the cutting edge, there are marks of sharpening. As in the previous case, the character of the surface indicates that the artefact was processed by abrasion without the use of a special device.

RESULTS OF THE FUNCTIONAL OBSERVATION

All the artefacts were subjected to microscopic examination. The analyses conducted on the blades indicated that their edges are not covered with use-wear patterns (Fig. 4). What is interesting is that the edges are very well preserved. Only in some sections is there micro-retouch, which should be interpreted as incidental and undesired damage. Due to the absence of use-wear patterns, as well as to the very good general state of preservation of the edges, it is worth considering whether these artefacts were specially made to be deposited in the grave.

More interesting are the results of the analyses conducted on the flint axes. The first specimen – not processed by abrasion - is not covered with use-wear patterns, which confirms the assumption that this is an unfinished artefact (Fig. 5). On the other two axes, there are traces indicating that they served as tools.

The larger specimen (Fig. 6: 1) has a pale bright gloss with a dome-crater topography near the cutting edge (Fig. 6: 3). This pattern is accompanied by bright scratches arranged perpendicular to the cutting edge, which are interpreted as a result of processing soft wood.

What is more, traces in the form of a bright gloss – having a dome topography – are present in some places of the upper face of the tool. They indicate that the axe was hafted in a wooden handle (Fig. 6: 2). Most probably, these parts were more susceptible to abrasion from the handle when the axe was used.

The use-wear patterns on the second specimen are much less distinct (Fig. 7: 1). On the upper face, there is a bright gloss having a dome topography (Fig. 7: 3) which should be interpreted as indicating the use of hafting (?). What is important is that the cutting edge of the axe is not covered with use-wear patterns, thus it appears that it was sharpened by abrading anew the part located near the edge (Fig. 7: 2). It is possible that this activity was performed shortly before depositing the artefact in the grave, which might be indicated by the lack of damage on the cutting edge (minute negative scars or chipping).

DISCUSSION

It is worth considering what can be said about the discussed collection in regard to other GAC assemblages. We should also think about the character of the flint artefacts deposited in other graves. Unfortunately, there is only a modest body of information from Polish territories. Blade tools have been relatively seldom analysed. Among materials discovered at sepulchral sites, the most abundant are those from site 3 in Koszyce, Proszowice District. A total of 39 flint blades and seven core forms – found during the exploration of a collective grave discovered at this site – were subjected to an analysis. According to K. Pyżewicz – the author of the research – the group of blades included ten specimens covered with use-wear patterns. The activities performed with these artefacts include cutting plants, dismembering animal carcases and hide processing (Pyżewicz 2013, 180-182). In this context, we should mention a retouched blade discovered in a monumental grave from Kierzkowo, Żnin District. Its unretouched side was also used as a sickle insert (Winiarska-Kabacińska 2017b, 174, Fig. 1: b).

Flint axes have been much less frequently subjected to functional analyses. Besides the mentioned site in Koszyce, such artefacts come from the following sites: Kowal, Włocławek District, site 14; Ludwinowo, Włocławek District, site 3; Puławy-Włostowice, Puławy District, site 3; Żelice, Wągrowiec District; Wągrowiec, Wągrowiec District (Osipowicz *et al.* 2014, 97; Pyżewicz *et al.* 2016, 331, 332; Winiarska-Kabacińska 2017a, 564; Mączyński 2018, 350). There is a total of sixteen flint axes from the above-listed sites that have been subjected to analyses aimed at determining their functions. These artefacts can be divided into several groups:

– items with traces created when performing certain activities – usually wood working;
– items with use-wear patterns in the form of traces left by hafting;
– items without traces left by hafting or performing activities.

In the analysed material, tools without traces left by work are prevalent. It is possible that at least in some cases their edges were processed by abrasion again before they were deposited in graves.

To sum up the results of the analyses conducted on the funerary materials from the above-mentioned sites, we can state that the custom of endowing buried people with sets of full value artefacts, not damaged by prolonged use was followed by the GAC community. These are half-products, semi-raw materials and functional tools that had been used to a minimal extent or were not used at all.

CONCLUSION

The obtained results of the functional analyses indicate that people burying the man in the grave from Stefankowice-Kolonia endowed him with a set of practically unused flint tools without use-wear traces (Fig. 4: 1-5; 5). The massive, chunky axe, on the surface of which there are distinct patterns formed as a result of working wood, is an exception here (Fig. 6: 1). Common sense tells us that this artefact, due to its confirmed use history, was probably deposited together with a handle.

The recorded custom of burying people with sets of undamaged tools appears to be typical of the GAC community. The statement applies to all grave inventories subjected to use-wear analyses.

Problems with identifying the flint varieties used in the production of the tools were an obstacle in analysing the material. This issue appears to be somewhat complex. Still, this fact results from the considerable number of flint deposits to which the GAC society had access. It is also important that raw materials distributed throughout the eastern zone of the GAC – across the Volhynian-Podolian Upland - are not sufficiently known. On the other hand, this state of affairs is also caused by the internal diversity of nodules and visual similarities between materials yielded by different deposits.

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THE FUNERAL RITE OF THE MIERZANOWICE CULTURE IN THE VISTULA AND SAN RIVER BASINS – GRAVES FROM ROZBÓRZ, PRZEWORSK DISTRICT

ABSTRACT

Jarosz P., Mazurek M. and Szczepanek A. 2022. The Funeral rite of the Mierzanowice Culture in the Vistula and San river basins – graves from Rozbórz, Przeworsk district. *Sprawozdania Archeologiczne* 74/1, 459-484.

The article describes a small cemetery of the Mierzanowice culture discovered at site 42 in Rozbórz, Przeworsk district, Podkarpackie Voivodship. The necropolis analysed is an example of the diversity of funeral rituals in the area between the Vistula and San rivers in the early Bronze Age. The analysis of the graves' inventories enabled them to be connected with at least two phases of the cemetery's utilisation. They can be synchronized with the early (features 668, 1891, 1978, 3141) and classical or late (1834, 2003, 2005) phases of the Mierzanowice culture. The strontium isotopes analyses performed on two individuals indicate that they spent their childhood in the area of the Rzeszów Foothills.

Keywords: Early Bronze Age, funeral ritual, strontium isotopes analyses, Rzeszów Foothills
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1. INTRODUCTION

Thanks to the latest excavations in the large area of the Vistula and San rivers basin, the settlement of the Mierzanowice culture is relatively well known (*e.g.,* Przybyła and Blajer 2008, map 1, 2; Machnik 2011; Górski and Jarosz 2015; Jarosz *et al.* 2018; Jarosz and Mazurek 2020; Madej and Valde-Nowak 2020). However, it should be noted that the significant number of settlement sites known contrasts with the small number of graves. Until the beginning of the current century, only the burial located in the mound of the Corded Ware culture in Jawczyce, Wieliczka district (Zoll-Adamikowa and Niżnik 1963; Jarosz 2021) and a grave from Orliska Sokolnickie, Tarnobrzeg district (Czopek *et al.* 1993) were known. In the following years, single graves were recorded in Średnia, Przemyśl district (Jarosz 2002; 2021) and Lipnik, Przeworsk district (Kaflińska 2001). The next discoveries come from excavations that preceded the construction of the A-4 motorway in several places in Małopolska and Podkarpackie Voivodeships which increased the number of known graves associated with the Mierzanowice culture (Czerniak *et al.* 2006; Józwiak and Rosen 2006; Jarosz 2017; Rybicka *et al.* 2017). One such site is a small cluster of sepulchral features discovered at site 42 in Rozbórz, Przeworsk district, in the Podkarpackie Voivodship (Jarosz *et al.* 2013).

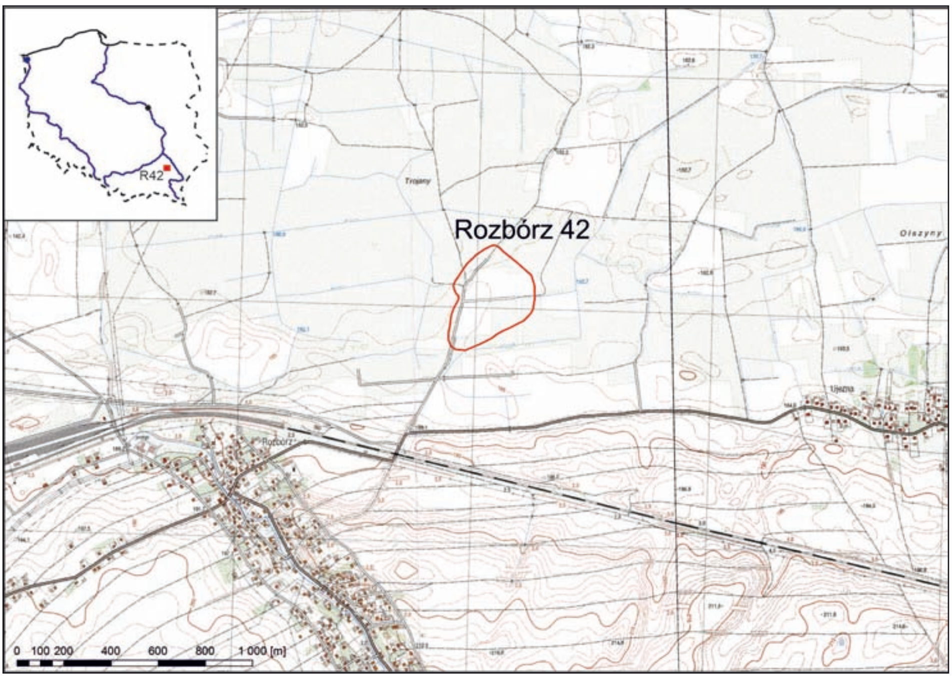

Fig. 1. Location of site 42 in Rozbórz, Przeworsk district. Prepared by M. Mazurek

The site is located on the southern edge of the Sub-Carpathian Ice Marginal Valley, at the junction with the loess of the Rzeszów Foothills (Fig. 1; Solon *et al.* 2018). It was discovered in 2008 during surface survey along the corridor of the planned A4 highway (Sznajdrowska 2013). In 2010, excavations were carried out over an area of 626.19 ares. As a consequence, settlements of the Linear Pottery, Malice, Trzciniec and Lusatian cultures

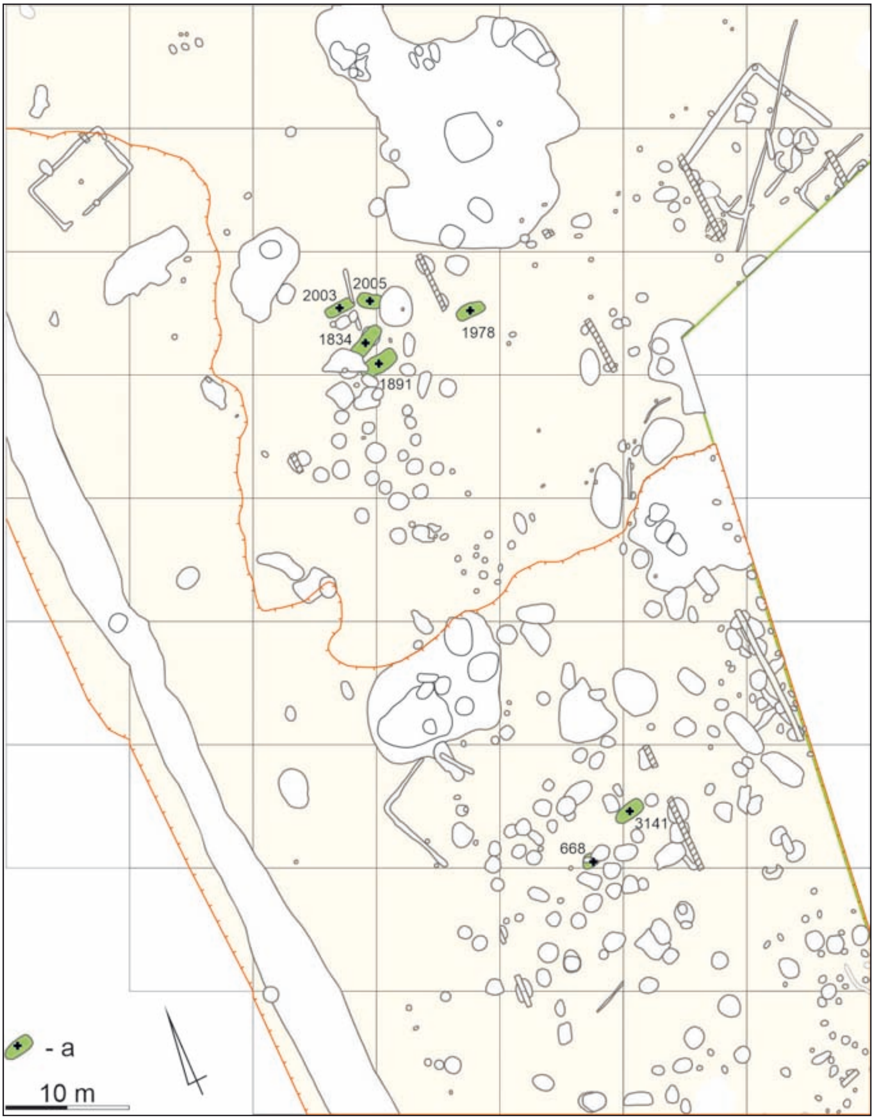

Fig. 2. Rozbórz, Przeworsk district, site 42. Spatial distribution of graves of the Mierzanowice culture. a – grave. Prepared by P. Jarosz and M. Mazurek

were discovered, as well as graves of the Malice, Globular Amphora, Corded Ware and Mierzanowice cultures (Mazurek and Okoński 2013). The excavated area is 182-184 m above sea level. This area is mainly covered with clay and loam soils. Only in the southern part, at the highest point of the site (about 184 m above sea level), there is a small patch of sand, probably a relic of a blown dune. On the west and north-west sides, the area slopes gently toward a vast, marshy valley with peat layers, which are cut by small watercourses with a southerly course, flowing into the Wisłok River.

The article deals with graves that can date to the early Bronze Age and associated with the settlement of the Mierzanowice culture population. Seven features (nos 668, 1834, 1891, 1978, 2003, 2005 and 3141) are located on the highest part of the alluvial cone formed within the wide bottom of the river valley (Figs 1, 2). In the context of the funeral rituals of this culture, it is a significant and small necropolis, which is an example of the diversity of sepulchral rite in the area between the Vistula and San rivers in the early Bronze Age. It should be recalled that during investigations carried out before the construction of the highway, burials had been discovered in settlement features in the area of Rzeszów Foothills (*e.g.*, Dobkowice, Jarosław district, sites 35 and 37; Jarosz *et al.* 2018).

2. DESCRIPTION OF GRAVES AND THEIR EQUIPMENT

Feature 668

Only the western part of the grave was preserved, the rest was destroyed by a Lusatian Culture pit (feature 411). Based on the preserved part of the grave, it can be stated that it was oriented along the W-E axis (Fig. 3: 1). Its recorded length was about 160 cm and a width of 125 cm. The depth of the feature was approximately 20 cm from the level of discovery (*i.e.*, after removal of the topsoil by the excavators) and the bottom was flat (Fig. 3: 2). The skeleton was not preserved. The grave equipment consisted of a cup and a retouched flake.

Inventory of the grave:

1. A cup with an S-shaped profile, decorated in the upper part with four bands of double impressions of a Z-twisted cord (Fig. 3: 3). Below are vertical stamp impressions, grouped in fours. The handle of the vessel is undecorated, wide and tapered where its upper part joins the vessel body. The exterior colour of the vessel ranges from grey to black and the interior is grey. Both surfaces are damaged, rough, and uneven. There is a fine sand and gravel admixture in the clay. The dimensions of the vessel: height – 76 mm, spout diameter – 88 mm, belly diameter – 91 mm, bottom diameter – 41 mm, handle width – 14 mm, wall thickness – 4 mm, cord imprint thickness – 1.5 mm

2. A cortex flake of Volhynian flint with almost circumferential marginal retouch on the upper side – sidescraper (Fig. 3: 4). Dimensions: 40 × 26 × 6 mm.

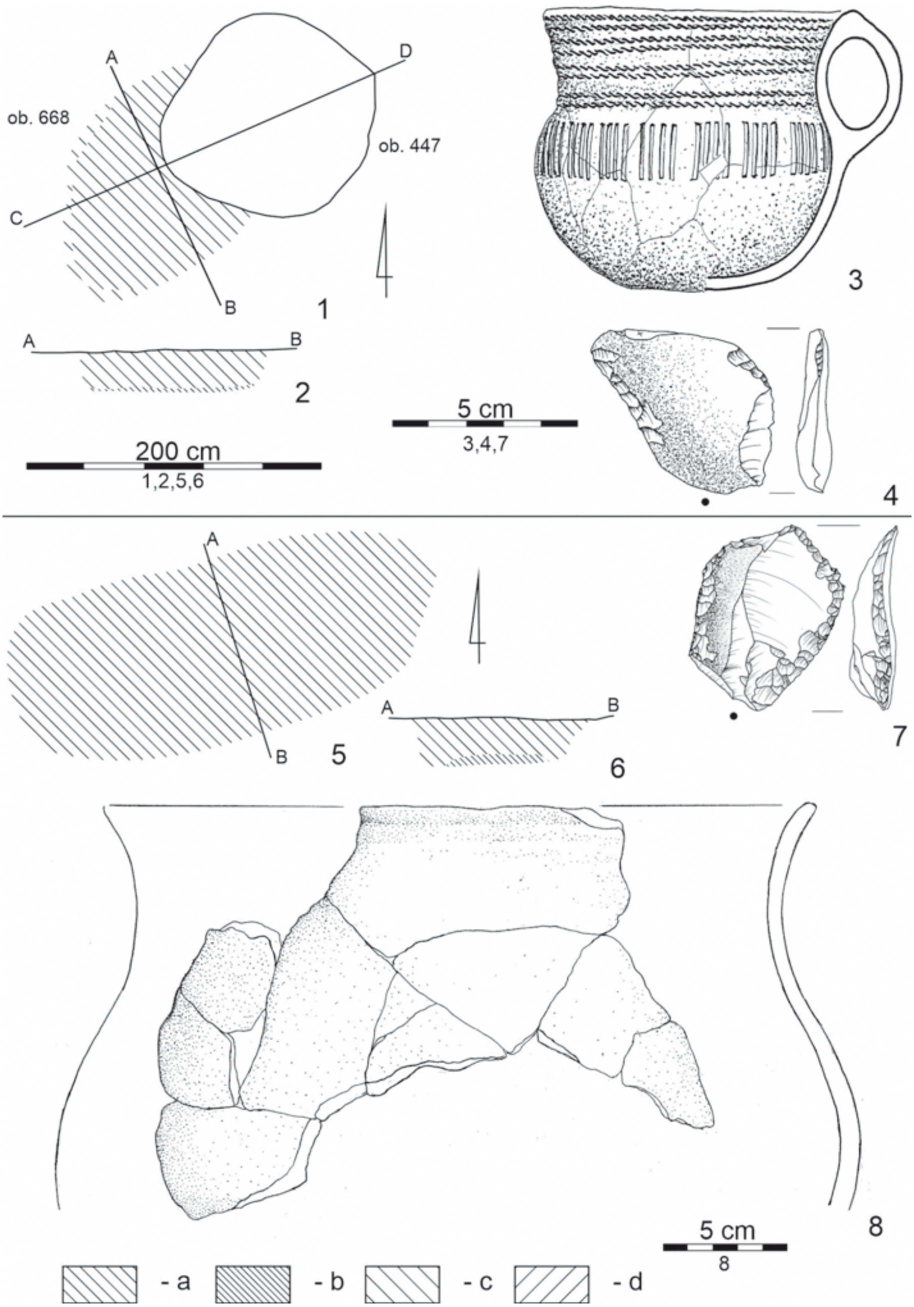

Fig. 3. Rozbórz, Przeworsk district, site 42. Feature 668: horizontal view (1) and vertical section (2); 3, 4 – grave goods. Feature 1891: horizontal view (5) and vertical section (6); 7, 8 – grave goods. a – dark brown; b – black; c – light brown; d – brown. Drawn by P. Jarosz, A. Nowak, J. Ożóg, J. Tarchała

Feature 1834

At the discovery level, the grave pit had an oval shape with the preserved dimensions of 300 × 120 cm, its longer axis was oriented SW – NE (Fig. 3: 5). The flat bottom of the feature was about 30 cm from the level of the discovery (Fig. 3: 6). The skeleton has not survived. The equipment of the deceased consisted of a pot of which only the upper part was preserved and a retouched flake. The feature crossed a deeper grave no. 2006, in which an individual of the Corded Ware culture was buried.

Inventory of the grave:

1. The upper part of the pot with a sigma-shaped profile (Fig. 3: 8). The exterior colour of the vessel ranges from dark brown to black and the interior is dark grey. Both surfaces rough and even. There is a fine admixture of crushed stone, sand and mica in the clay. The dimensions of the vessel: spout diameter – 290 mm, belly diameter – 330 mm, wall thickness – 6 mm.

2. Partly cortical flake of Volhynian flint, with almost circumferential marginal retouching on the upper side – sidescraper (Fig. 3: 7). Dimensions: 40 × 30 × 9 mm.

Feature 1891

The burial pit at the discovery level had an oval shape measuring 330 × 120 cm, the filling was homogeneous, and the longer axis was oriented along the W-E line (Fig. 4: 1). The feature was about 40 cm deep and the bottom was flat (Fig. 4: 2). The skeleton, very poorly preserved, belonged to a man aged 25 to 35. The burial equipment was located in the central part of the pit and consisted of a wrist guard made of marl, two retouched flakes, and a copper bracelet. In the filling of the feature, fragments of Globular Amphora culture vessels and a burned flint chip were also found.

Inventory of the grave:

1. Chip flake made of Volhynian flint (Fig. 4: 5) with one retouched edge on the upper side (inset). Dimensions: 66 × 32 × 5 mm, weight – 10.77 g.

2. A flake of Volhynian flint with partially preserved cortex (Fig. 4: 6) with retouching of the longer edge (inset). Dimensions: 72 × 45 × 14 mm, weight – 34.3 g.

3. Wrist guard made of silica marl (Fig. 4: 3, 3a). Rectangular shape with curved longer edges and four holes, located close to the corners of the artefact. Holes drilled from both sides. Dimensions: length – 59 mm, width – 20-27 mm, thickness – 7 mm, hole diameter – 3 mm, weight – 12.58 g.

4. Open bracelet made of copper wire with a circular cross section (Figs. 4: 4, 4a). The ends are thin and sharp. Dimensions: diameter approx. 60 mm, wire diameter 3-5 mm, weight 13.19 g.

Anthropological analysis

Only fragments of the skeleton have been preserved: crowns of poorly worn permanent molars of the maxilla: right M1 and left M2, single bones of the wrist, and fragments of massive diaphyses and epiphyses of long bones.

Age: *Adultus* (25-35 years), sex: male

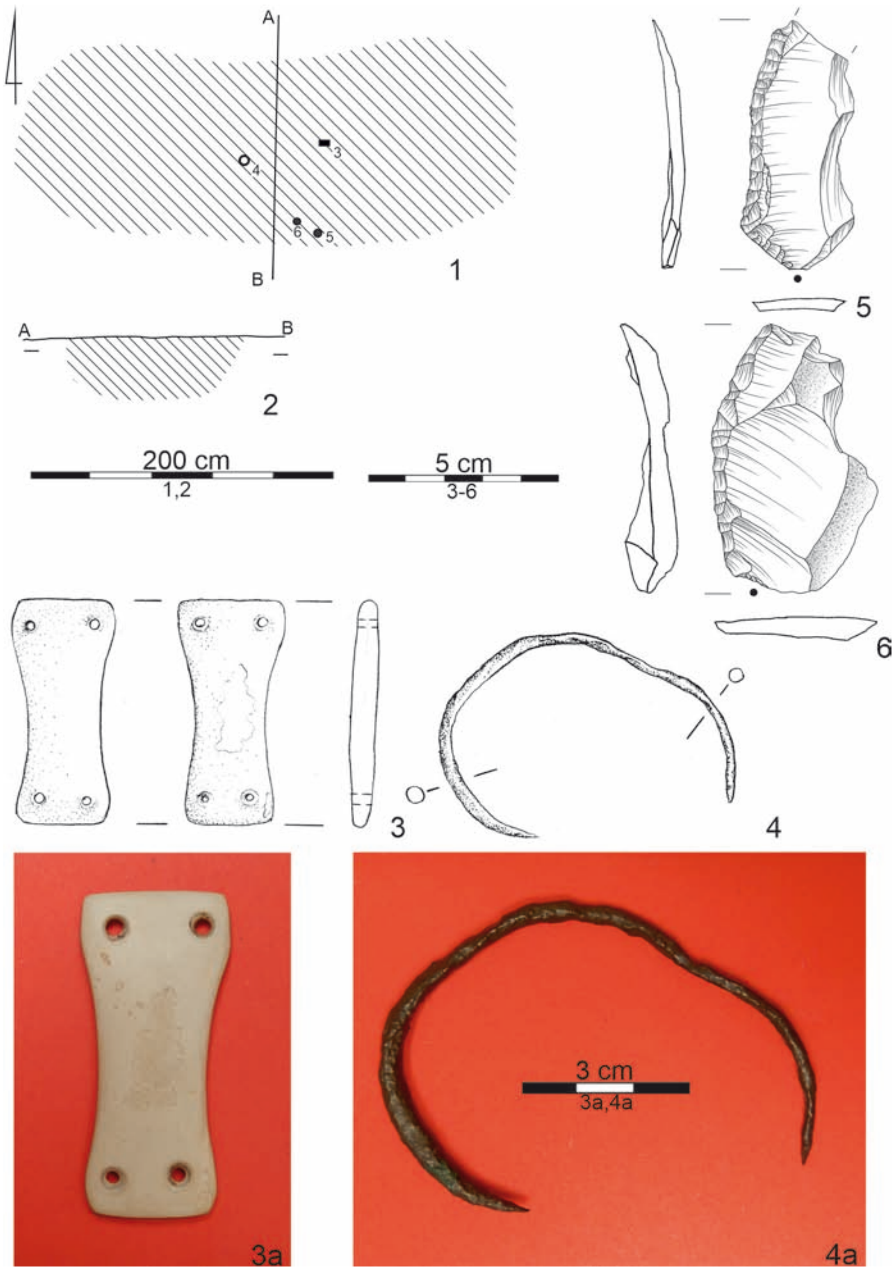

Fig. 4. Rozbórz, Przeworsk district, site 42.
Feature 1891: horizontal view (1) and vertical section (2); 3-6 – grave goods.
Drawn by P. Jarosz, A. Nowak, J. Ożóg. Photo by P. Jarosz

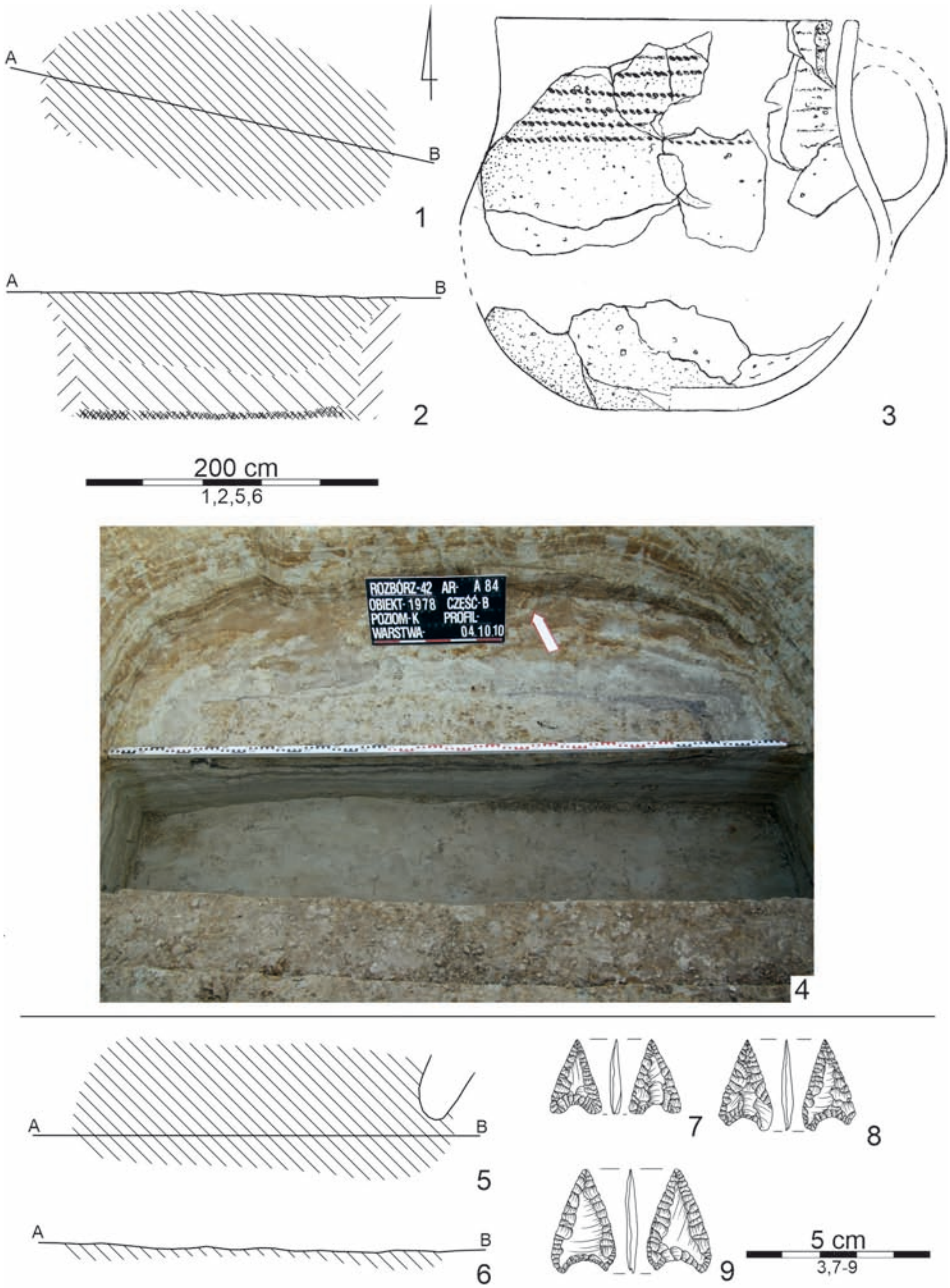

Fig. 5. Rozbórz, Przeworsk district, site 42. Feature 1978: horizontal view (1, 4) and vertical section (2); 3 – grave goods. Feature 2003: horizontal view (5) and vertical section (6); 7-9 – grave goods. Drawn by P. Jarosz, A. Nowak, A. Mazurek. Photo by M. Mazurek

Feature 1978

At the discovery level, the feature had an oval shape with preserved dimensions of 250 × 115 cm; the longer axis was oriented along the W-E line (Fig. 5: 1). In its vertical cross-section, the pit resembled a rectangle with a flat bottom approximately 90 cm deep (Fig. 5: 2). The skeleton was not preserved. In the bottom part, traces of an internal wooden structure were recorded (Fig. 5: 4). The burial equipment consisted of a cup and was located at the bottom of the grave.

Inventory of the grave:

1. A damaged cup with an S-shaped profile decorated on the neck with seven imprints of a Z-twisted cord (Fig. 5: 3). The handle of the vessel is undecorated, wide, and tapered with the upper part placed below the spout and the lower in the upper part of the body. The outer colour of the vessel is brown and dark brown, and inside and at the edge it is grey. Both surfaces are rough and uneven. In the clay, there is an admixture of white and pink crushed stone. The bottom is not separated; it is flat. Dimensions of the vessel: reconstructed height – 110 mm, spout diameter – 96 mm, belly diameter – 116 mm, bottom diameter – 47 mm, handle width – 22 mm, wall thickness – 4.5 mm, cord imprint thickness – 1.5 mm

Feature 2003

At the discovery level, the feature had an oval shape with preserved dimensions of 260 × 90 cm, and its longer axis was oriented along the W-E line (Fig. 5: 5). The pit is shallow, about 15 cm thick, with an uneven bottom (Fig. 5: 6). The skeleton was not preserved. The burial equipment was placed in the central part of the pit and consisted of three flint arrowheads. In the filling of the feature, a small fragment of a retouched blade and a chip of Świeciechów flint were also found, these can be associated with the Neolithic settlement at the site, there were also fragments of vessels from the Globular Amphora culture, and the mouth of the vessel in the technology of the late phase of the Mierzanowice culture.

Inventory of the grave:

1. A symmetrical arrowhead made of Volhynian flint with a contour similar to an isosceles triangle. Straight side edges, wide wings, trapezoidal notch (Fig. 5: 7). Formed by a flat-surface retouch on a flake. Dimensions: length – 21 mm, width – 14 mm, thickness – 3 mm; weight – 0.7 g.

2. A slender symmetrical arrowhead made of Volhynian flint, with an outline resembling an isosceles triangle, with straight side edges, and the base slightly concave with pointed wings (Fig. 5: 8). Formed by a flat-surface retouch on a flake. Dimensions: length – 26 mm, width – 15 mm, thickness – 3 mm; weight – 0.8 g.

3. A slender, symmetrical arrowhead made of Volhynian flint, with an outline similar to an isosceles triangle, with slightly convex side edges ending with subtly arched wings. The base with a sharply arched notch (Fig. 5: 9). Formed by a flat-surface retouch on a flake. Dimensions: length – 29 mm, width – 18 mm, thickness – 2 mm; weight – 1.15 g.

Feature 2005

At the discovery level, the feature had an oval shape with preserved dimensions of 240 × 110 cm, the longer axis was oriented along the NW – SE line (Fig. 6: 1). The pit was shallow with a thickness of about 25 cm, and the bottom was uneven (Fig. 6: 2). The skeleton of an individual aged 25 to 35 years, of indeterminate sex, was in very bad condition. The deceased was folded in a slightly contracted position on the right side with his head on the SE, his face turned to N. The right arm was straightened along the body, most probably slightly directed toward the pelvis, the left arm was folded over the pelvis, and the legs slightly contracted (Fig. 6: 1, 3). No equipment was found in the grave. In the filling of the pit, a ceramic sherd was found, made with a technology typical for the late phase of the Mierzanowice culture. The surface of the vessel fragment is uneven and rough; the outer part is orange and the inner part black. The clay contains a mineral admixture of sand, fine pink and white crushed stone and mica.

Anthropological analysis

The skeletal bones are poorly preserved; permanent teeth and small fragments of long bone diaphyses and epiphyses.

M3				P1							P1		M1		M3
M3	M2	M1				I2									M3

Age: *Adultus* (25-35 years), sex: undetermined.

Feature 3141

At the discovery level, the feature had a rectangular shape with rounded corners measuring 240 × 120 cm, the longer axis was oriented along the W – E line (Fig. 6: 4). In the vertical section, the pit resembled a rectangular with a flat bottom located at a depth of about 110 cm (Figs 6: 5; 7: 1). In the bottom part, traces of an internal wooden structure were recorded. A male aged 20 to 30 years lay at the bottom, which was approximately 110 cm below the top of the pit (Figs 6: 6; 7: 2). The skeleton was poorly preserved, but its layout was readable. The deceased was folded on his right side with his head facing west. The upper limbs are very bent at the elbow and hands to the head. The right upper limb of the deceased was bent at the elbow joint and his hand was at the face, while the left arm, also bent at the elbow, was at the level of the deceased's chest. The lower extremities were bent at the hip joint at the right angle and at the knee joint strongly bent, forming an acute angle. The burial equipment consisted of six beads made of bone discovered in the area of the ribs.

Inventory of the grave:

1. Six animal bone beads with a circular outline (Fig. 6: 7). Flat, biconical, or boat-shaped in cross-section. Dimensions: the diameter of the monument – 10-14 mm, the diameter of the hole – 4-5 mm, height – 3-8 mm.

Anthropological analysis

The skeleton is almost complete, but significantly damaged. The cranial vault of the long skull of medium structure was reconstructed (g-op: 180 mm; eu-eu: approximately 130 mm), and all preserved sections of the sutures are open. The mastoid processes of the temporal bones are wide and long, the superciliary arches at the frontal bone are marked, and the squama of the occipital bone is sculpted. The right mastoid process and the petrous

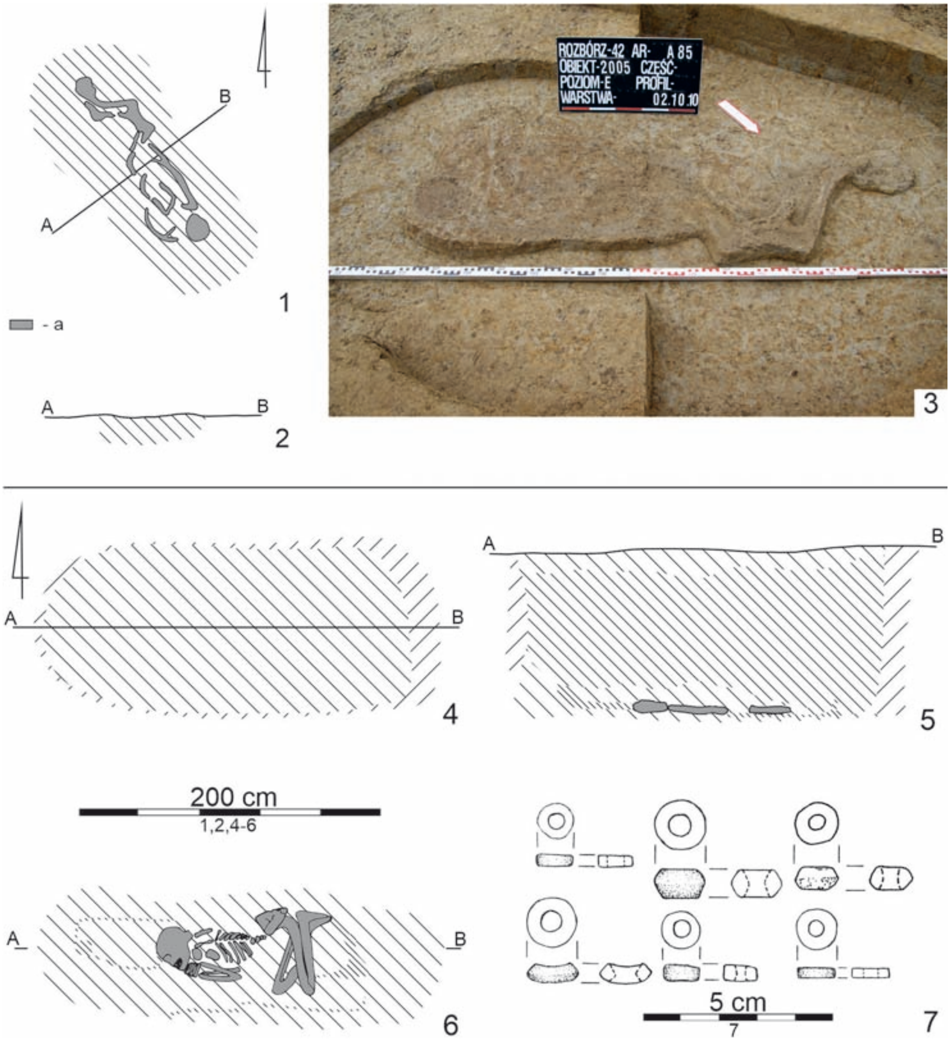

Fig. 6. Rozbórz, Przeworsk district, site 42.
Feature 2005: horizontal view (1, 3) and vertical section (2). Feature 3141: horizontal view (4, 6) and vertical section (5); 7 – grave goods. a – human bones. Drawn by P. Jarosz, M. Mazurek, J. Ożóg

part of the temporal bone show significant bone tissue overgrowth in the form of inflammatory lesions related to the pathology of the middle ear. Permanent teeth are poorly worn:

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

The bones of the postcranial skeleton are very massive. There are fragments of vertebrae and ribs, as well as damaged bone fragments from the upper and lower limbs.

Age: *Adultus* (20-30 years), sex: male

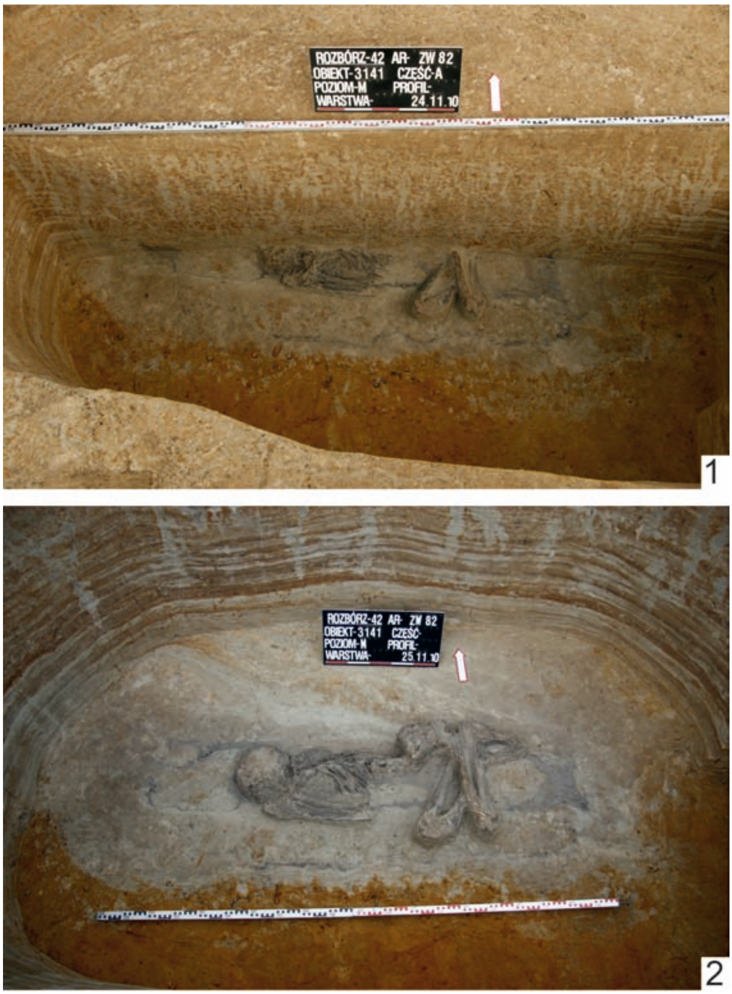

Fig. 7. Rozbórz, Przeworsk district, site 42. Feature 3141: vertical section (1) and horizontal view (2). Photo by M. Mazurek

3. ANALYSIS

The graves discovered at the site occupied the highest part of the area and were gathered into two groups (Fig. 2). The first cluster consisted of five graves – 1834, 1891, 1978, 2003, 2005; they were located in an area of 15 × 7 m. The other two graves, 668 and 3141, were located approximately 40 m south of the first group. Two of the discovered graves had a stratigraphic relationship with other features. Grave 688, was intersected by feature 411 dated to the Lusatian culture (Figs 2; 3: 1), which destroyed its eastern part, while feature 1834 cut a grave of the Corded Ware culture no. 2006 (Fig. 2).

3.1. Chronology of graves

The relative chronology of the graves was determined on the basis of their inventories. Due to the poor preservation of the bones, which caused a low collagen content, it was not possible to obtain radiocarbon dating for the burials. Funerary equipment was found in six features – graves 668, 1834, 1891, 1978, 2003, 3141, only one did not contain any gifts – 2005, and its dating can be indirectly based on the material found in its filling. Three burial inventories included vessels (688, 1834, 1978), four of them flint artefacts (668, 1834, 1891, 2003), and in one case, a copper ornament, a stone wrist guard (1891), and bone beads (3141) were found.

The small cup found in feature 668 was decorated at the neck with four double Z-twisted cord imprints, below which, on the belly, four vertical stamp impressions were located (Fig. 3: 1). The form of the vessel refers to type B2 according to S. Kadrow and J. Machnik (1997, fig. 72). Neck ornamentation in the form of horizontal Z-twisted cord impressions is common at the vessels of the early phase of the Mierzanowice culture (Kadrow and Machnik 1997, fig. 4, 8, 10; Jarosz and Mazurek 2020) and less frequently in the proto-Mierzanowice phase (Kadrow and Machnik 1997, 18, fig. 3: 7). Vertical ornamentation on the belly of the vessel also appears in the early stages of this unit's development. However, the arrangement in the form of grouped impressions of the stamp should be considered as very rare. A similar decoration consisting of three to five imprints was found on the jug from the settlement pit 112 in Dobkowice, site 37 (Jarosz *et al.* 2018, 81, tab. 10: 2) and on the amphora (?) from Sietesz, Przeworsk district (Madej 1999, 52, fig. 8: k). Grouped three imprints, but made of cord, are visible on the belly of a cup from grave 89 in Mierzanowice (Bąbel 2013, 124, fig. 159: 1), and on a cup from grave 6 in Torczyn in the Łuck region where four long, vertical incisions were grouped (Fitzke 1975, 56, fig. 5: b). The decoration of vessels consisting of horizontal and vertical elements, usually made with the use of double impressions of a cord, occurs on the ceramic of the early phase of the Mierzanowice culture (Kadrow and Machnik 1997, figs 4, 5) and consequently the cup decorated with a slightly different technique should be dated to this phase.

A cup, similar to Kadrow and Machnik's (1997) type A4 or C (Fig. 5: 3) was discovered in feature 1978. The vessel is decorated around the neck with seven loosely placed horizontal imprints of a Z-twisted cord. Such ornamentation appears on cups in the early phase of the Mierzanowice culture (Kadrow and Machnik 1997, 38). Along with the vertical impressions, such decoration is visible, for example, on a vessel from grave 79 in Żerniki Górne, Busko-Zdrój district (Kempisty 1978, 142, fig. 186: 1) and in the cemetery in Veselé, Piešťany district, grave 5 and 17 (Budinský-Krička 1965, 101, 102, Taf. V: 4, VI: 11) and Ulwówek, Sokal district (Kadrow and Machnik 1997, fig. 142, 59: 10).

Grave no. 1981 can also be associated with the early phase of the Mierzanowice culture (Fig. 4). The burial equipment included a wrist guard made of silica marl (Figs 4: 3; 3a). The long sides of the item are concave, and the corners have four holes drilled from the top and bottom. Its shape can be assigned to type E according to the classification of E. Sangmeister (1974, abb. 8). Similar finds are known from south-east Poland in the graves of the Mierzanowice culture, at Kraków-Nowa Huta-Mogiła, site 53, grave 11/63 (Hachulska-Ledwos 1967, 91), Święcice, Miechów district, grave 3 (Prokopowicz 1964, 404, 405, fig. 5-8) and Kietrz, Głubczyce district, site D, grave 102 (Łęczycki 1983, 69, fig. 2: 4). The artefacts from these sites were made of slate, and have a rectangular outline with slightly curved edges and four holes at the corners. These wrist guards can be classified as type C according to E. Sangmeister. Similar finds were found in the Małopolska Upland in the grave of the Bell Beaker culture in Samborzec, grave III and Beradź, grave 5 both Sandomierz district (Budziszewski and Włodarczak 2010, fig. VI: 7). In the latter case, the radiocarbon chronology is 3790±35 BP (Poz-101084), after calibration referring to 2286-2146 BC (1σ; Jarosz *et al.* 2020, fig. 3: B) and can be associated with the beginnings of the Mierzanowice culture. Type C is typical for the Bell Beaker culture in the Moravian area (Budziszewski and Włodarczak 2010). The artefact of grave 11/63 from Kraków-Nowa Huta-Mogiła, site 53 (Hachulska-Ledwos 1967), is rectangular in shape with two openings at opposite corners. Graves containing wrist guards associated with the Mierzanowice culture and the Bell Beaker culture were known from the areas west of the Vistula. Only the site in Rozbórz is located east of the Vistula river, and the item discovered there is at the same time the easternmost find of this type in the Mierzanowice culture.

A copper bracelet with thinned ends was also discovered in the feature 1891 (Fig. 4: 4, 4a). The presence of copper bracelets in the features of the early phase of the Mierzanowice culture is a rare phenomenon; known examples come from the areas of south-eastern Poland, for example, damaged bracelets from the grave 13/63 from Kraków-Nowa Huta-Mogiła, site 53 (Hachulska-Ledwos 1967, 91), Mierzanowice, grave 84 (Bąbel 2013, fig. 159: 3) and Jakuszowice, Kazimierza Wielka district, site 2 (Jarosz and Szczepanek 2019, 284, fig. 4: 3). This find is not a chronological indicator.

Grave 3141, in which bone beads were discovered, can be cautiously associated with the early phase of the development of the Mierzanowice culture (Fig. 6: 7). They were usually placed in the vicinity of the deceased's chest. Ornaments of this type were found in the above-mentioned grave 89 in Mierzanowice (Bąbel 2013, fig. 159: 3), but also in a late phase grave of the Mierzanowice culture in Świniary Stare, Sandomierz district (Krausowie 1971, Pl. 4). Therefore, it is not an item that allows for certain dating. These ornaments are much more common in early phase graves, *e.g.*, Mirocin, Przeworsk district, site 27, feature 271 (Jarosz and Mazurek 2020, Pl. 25: 1), Łubcze, Tomaszów Lubelski district, site 37, grave 1 (Machnik *et al.* 2009, 102, fig. 74: 3), Jakuszowice, site 2 (Jarosz and Szczepanek 2019, 283, fig. 2, 3). The way in which the deceased was situated with strongly contracted legs indicates its early Mierzanowice chronology.

In feature 1834, an S-profiled pot was discovered, only the upper part of which is preserved (Fig. 3: 8). This grave may be associated with the younger phase of the Mierzanowice culture. It is difficult to define its type clearly, but the composition of the admixture and the method of forming the vessel allow one to associate this pot with the late phase of the Mierzanowice culture. Undecorated pots are a rare element of grave inventories. Such examples are known mainly from the cemetery in Szarbia, Kazimierza Wielka district, including graves 2/III, 4/III, 5/V, 10/5 (Baczyńska 1994, tables II: B1; III: B3; VII: 4; IX: 2).

Another grave for which it is difficult to determine the chronology is grave 2005, in which the skeleton is contracted on the right side and knees slightly bent was discovered in a shallow pit (Fig. 6: 1, 3). The dating of this feature can only be determined indirectly, based on the fragments of potsherds found in its filling, technologically similar to the pot found in the grave in 1834. The way of placing the deceased with slightly bent legs also refers to the ritual of the classic and late phase of the Mierzanowice culture. Analogous arrangements of the deceased are known from single graves from the cemeteries of the Mierzanowice culture, *e.g.*, Krzewica, Tomaszów Lubelski district (Gurba 1960, 16, fig. 1), Pieczeniegi, Miechów district (Krauss 1968, fig. 2, 3), Iwanowice, Kraków district, site Babia Góra (Kadrow and Machnikowie 1992), dating to the later phases of this unit development.

It is hard to clearly define the chronological position of feature 2003. In this grave, three Volhynian flint arrowheads were found (Fig. 5: 7-9). The proportions of the slender artefact with a shallow, arched, or trapezoidal niche refer to type III of the Mierzanowice culture arrowhead classification (Borkowski 1987, fig. 20). Such finds are not a chronological indicator. In the materials of this culture, they are found in the early phases of development, when they appear together, for example, with cups decorated with zone ornaments – *e.g.*, Kraków-Nowa Huta, site Kopiec Wandy, grave 11/63 (Hachulska-Ledwos 1967, 90, 91, Pl. I), Starachowice-Wierzbnik, grave 16 (Sawicka 1922-1924, 296-302, figs 1-3), Żerniki Górne, grave 79 (Kempisty 1978, fig. 186). They were also found in the ensembles dated to the classical and late phases of the Mierzanowice culture – Żerniki Górne, grave 19 (Kempisty 1978, fig. 151), Mierzanowice, Opatów district, graves 9 and 11 (Bąbel 2013, figs 33, 34). Volynian flint is a typical raw material in the production of flint tools associated with the Mierzanowice culture at sites located east of the Vistula, *e.g.*, in the graves at Sokal Ridge (Libera 2009) and in the settlements in the Rzeszów Foothills (Jarosz *et al.* 2018; Jarosz and Mazurek 2020). However, it is not often used for the production of arrowheads at Mierzanowice culture sites located in the Małopolska Upland (Borkowski 1987, 161).

It should be emphasized that other tools from the remaining graves at the site in Rozbórz were made of cretaceous Volhynian raw material. In features 668 (Fig. 3: 4) and 1834 (Fig. 3: 7), sidescrapers were found. Such forms are typical for early Bronze Age industries (Włodarczak *et al.* 2011, 335). In feature 1891 (Fig. 4: 5, 6), knife-shaped forms made on flakes of Volhynian flint were found. Such artefacts are found both at the cemeteries of the Mierzanowice culture (Kempisty 1978, 144, fig. 190: 2), and in the Bell Beaker ones (Kopacz *et al.* 2009, Pl. 24:13; Budziszewski and Włodarczak 2010, Pl. XV: III-12).

3.2. Elements of the funeral rite

The analysis of the grave goods indicates at least two phases of the cemetery's utilisation, which can be synchronized with the early (features 668, 1891, 1978, 3141) and classical or late (1834, 2003, 2005) phases of the Mierzanowice culture. Graves that can be dated to the early phase were located in the northern (1891, 1978) and southern (668, 3141) groups. On the other hand, classical or late graves occurred only in the northern groups (1834, 2003, 2005; Fig. 2). All of them have an oval shape and rectangular vertical section with a flat bottom. The size of the burial pits varied and ranged from 320 × 130 cm – feature 1891 (Fig. 4: 1) to 240 × 110 cm – feature 1978 (Fig. 5: 1). Their depth also varied from very shallow pits with depth 20-30 cm – features: 1834 (Fig. 3: 6), 1891 (Fig. 4: 2), to a depth of about 110 cm – feature 3141 (Figs 6: 5; 7: 2). The fillings of the burial pits indicated a single event after the funeral rites had been completed. In the central part of the pit of features 1978 (Fig. 5: 4) and 3141 (Figs 6: 6; 7), associated with the early phase of the Mierzanowice culture, traces of an internal wooden structure, most probably in the form of a log, have been recognised. It is typical for the graves of the Mierzanowice culture and they were found, for example, on sites between the Vistula and San rivers in Zagórze, site 2 (Jarosz 2017), Łysokanie, site 8 – graves 5 and 6 (Józwiak and Rosen 2006, 539, figs 5, 6) and Targowisko, site 14 and 15 – feature 882 (Czerniak *et al.* 2006, fig. 19), all Wieliczka district. Similar constructions are also known from the Małopolska Upland, for example, graves from Mierzanowice (Bąbel 2013, fig. 38), Żerniki Górne (Kempisty 1978, fig. 157) and located further east in the Dniester basin, from Byków near Drohobycz (Czopek *et al.* 2016, 195-207).

The longer axis of the graves from the early phase of the Mierzanowice culture at the site in Rozbórz was oriented along the lines of W-E (2), SW-NE (1) and NW-SE (1). In the proto- and early phases of this culture, the orientation of the burial pits located in area between the Vistula and San rivers is varied. At the cemetery in Łysokanie, site 8, most of the features were oriented along the NE-SW axis (Józwiak and Rosen 2006, 538). In the Małopolska Upland, burials dated to the proto- and early phases in Modlnica, Kraków district, site 5, they were oriented along the N-S, NE-SW and SW-NE axes, in Żerniki

Górne mainly along the W-E axis (Kempisty 1978, 109-149; Włodarczak 1998, fig. 9; 2011). At Sokal Ridge grave 1 from Łubcze, site 37 that was dug into mound 1 was oriented along the N-S line (Machnik *et al.* 2009).

Similarly to the graves of the early phase, burials dated to the classical or late phases were oriented. Analogical differentiation was observed at site 6 in Szczytna, Jarosław district, where the graves were placed near the destroyed mound I (Hozer *et al.* 2017, 104, fig. 51). Such variation in orientation is also found at cemeteries from the Małopolska Upland, *e.g.* Iwanowice, site Babia Góra (Kadrow and Machnikowie 1992, 14-46), Szarbia, Kazimierza Wielka district (Baczyńska 1994), where location of the pit is related to the sex of the buried.

The preservation of the human remains in the graves in 2005 and 3141 allowed for reconstruction of the arrangement of the remains of the deceased (Figs 6: 1, 6; 7: 2), which in the context of the generally advanced destruction of bones in the graves of the Mierzanowice culture in this region is exceptional. Well-preserved human remains found in intentionally placed graves are known from Jawczyce, site 1, burial mound 2, grave 2 (Zoll-Adamikowa and Niżnik 1963; Jarosz 2021), Mirocin, site 27, feature 271 (Jarosz and Mazurek 2020, 51, photo 9) and Skołoszów, Jarosław district, site 7, feature 750 (Rybicka *et al.* 2017, 138, fig 27). In other cases, the skeletons, due to the shallow depth of the burial pit or the acidic reaction of the soil, are not preserved. Such is the situation at Bochnia Submontane Region (Targowisko, Łysokanie, Zagórze). Again, the situation is similar in most of the graves in the Rzeszów Foothills (including Szczytna, site 6; Lipnik; Mirocin, site 27, grave 214) and the neighbouring areas of the Carpathian Foothills (*e.g.,* Średnia, site 3, grave 2).

The male buried in feature 3141 (Fig. 6: 2; 7), was placed along the W-E line, on the right side, in a strongly contracted position, with his head facing W and his face facing S. The hands were folded around the chest and head of the buried and the legs were bent sharply. Burials oriented this way, with skeletons resting on the right side, are typical for male graves in the early phase of the Mierzanowice culture development. Examples of such bu-rials are known from Żerniki Górne, site 1, graves: 52, 59, 79, 96 (Kempisty 1978) and Mierzanowice, site 1, grave 89 (Bąbel 2013).

In the case of the grave of a later chronology, no. 2005, the young male lay contracted on the right side, with his head to the SE (Fig. 6: 6). The layout on the right side, as in the early phase, is reserved for male burials. However, the orientation toward the east with deviations towards the N and S is typical for female graves in the late phase (Kadrow and Machnikowie 1992, 69, fig. 34).

The location of the grave goods in relation to the skeleton could be observed in grave 2003, where the flint arrowheads were located probably in the central part of the burial, because during anthropological analysis they were found by the hip of the deceased. Bone beads were found in the chest zone of a male buried in grave 3141 (they were discovered between costae during their cleaning in laboratory). In feature 668, the equipment, a cup and a sidescraper, were found in the preserved western part of the grave. In the central part of the pit in the burial 1891 there was a wrist guard and a copper bracelet. To the south of them were laid two flint tools (Fig. 4: 1). The skeleton was partially preserved, which does not allow for the precise location of the finds in relation to the body of the deceased. One can only assume that the copper ornament and the wrist guard were probably placed on the forearms. The flint artefacts were placed on the side of the deceased. Such an interpretation is possible due to the arrangement of find by the remains discovered in the grave from Kietrz (Łęczycki 1983, fig. 2). The wrist guard was located in the central part of the burial pit, in the place of the forearm bones. An anthropological analysis of the remains from Kietrz allowed us to determine that they belonged to a male (Miśkiewicz 1983) folded on his right side with strongly crouched legs.

In all the graves discussed, with preserved bones, there were adult individuals buried and two of them were male. However, in grave 2005, the deceased was buried on his right side, which is also typical for this sex. Burials containing the remains of males laid on the right side dominate in the early phases of the Mierzanowice culture (*e.g.*, Żerniki Górne; Kempisty 1978, tab. 47; Włodarczak 1998, 171). Only one grave containing the remains of a female deposited on the left side is known from Mirocin, site 27, feature 271 in the Rzeszów Foothills (Fig. 8: 4; Jarosz and Mazurek 2020, 51, photo 9; Szczepanek 2020, 204-207).

As in the early phases, in the classical and late stages in the San-Vistula region, the number of graves is extremely modest. Only two graves from Jawczyce and Skołoszów are known, where a male and a female were placed, respectively, on the right side and in an unidentified arrangement (Fig. 8: 5). The graves of this phase form small groups. Similar, small clusters are found near the Corded Ware culture mounds at Sokal Ridge; *e.g.*, Lubcze, site 25, mound 3 and the site 38, Mound 1 (Machnik *et al.* 2009, 80, 108-115). This contrasts with the area of the Małopolska Upland, where large cemeteries have been discovered and the rule of placing males on the right side and females on the left side is observed, *e.g.* Iwanowice, site Babia Góra (Kadrow and Machnikowie 1992), Szarbia (Baczyńska 1994), Mierzanowice (Bąbel 2013).

In addition to typical graves, the differentiation of the funeral customs of the Mierzanowice culture population between the Vistula and San rivers is manifested by the presence of burials in settlements in pits (Fig. 8: 1-3). At settlement sites associated with the early phase of the Mierzanowice culture, single skeletons were found, for example, in Mirocin, site 24, feature 16 (Fig. 8: 1). In a settlement pit, the burial of a young female lying on her right side with a skull of a *Bos taurus* was discovered (Jarosz and Mazurek 2020). Other cases are known from Dobkowice, site 39, feature 54, upper level of the pit (Jarosz *et al.* 2018, 103; table 27: 1) and Skołoszów, site 7, feature 256 (Rybicka *et al.* 2017, 119, fig. 8: B). There are also examples of more than one individual in settlement pit *e.g.*, three – Dobkowice, site 37, feature 13 (Jarosz *et al.* 2018, 73; table 5: 1). Collective burials may also be of a partial nature, *e.g.* in Dobkowice, site 39; feature 54, bottom level (Fig. 8: 3; Jarosz *et al.* 2018, 103; table 27: 2), but it is difficult to determine whether it was a deliberate intention

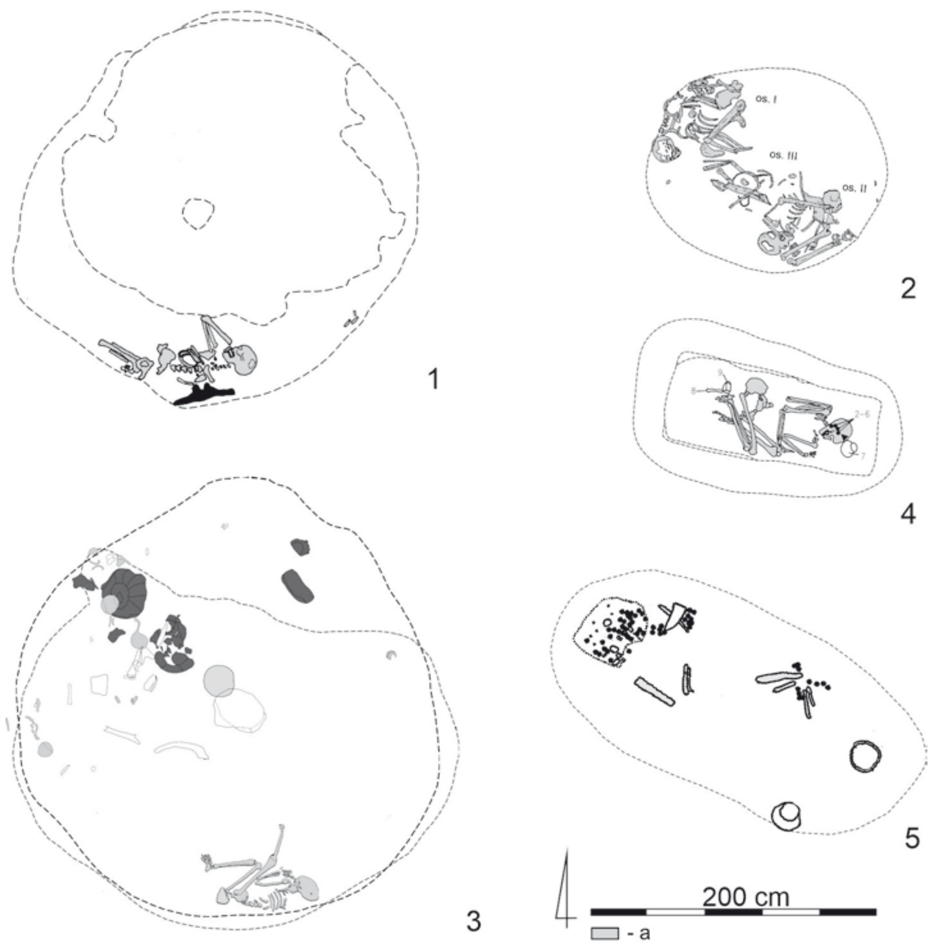

Fig. 8. Selected features with human remains in Rzeszów Foothills.
1 – Mirocin, site 24, feat. 16; 2 – Dobkowice, site 37, feat. 13; 3 – Dobkowice, site 39, feat. 54; 4 – Mirocin, site 27, feat. 271; Skołoszów, site 7, feat. 750; a – human bones. Prepared by P. Jarosz

or the result of the fragmentation of the burial related to the natural slow process of filling the feature, *e.g.* Dobkowice, site 37, feature 120 (Jarosz *et al.* 2018, 59-61, photo 20; 86, table 13: 2, 3; Szczepanek 2018, 124). Similarly in settlements associated with the classical and late phases, burials in pits were discovered in Skołoszów, site 7, features 355, 658 (Rybicka *et al.* 2017, 119, fig. 8: B; 128, table 2) and Ożańsk, Jarosław district, site 13 (Kadrow 2013, 124).

In addition, it was observed that in settlement pits in the region between the Vistula and San rivers, during the whole development of the Mierzanowice culture, children and females were buried as a complete body or part of it; however, partial burial may be the result of taphonomic processes. There are no clear examples of adult male burials (see Rybicka *et al.* 2017; Jarosz *et al.* 2018; Szczepanek 2018; 2020; Jarosz and Mazurek 2020). Analogous pits containing individuals of the same age categories were discovered on sites in the Małopolska Upland, for example in Wilczyce, Sandomierz district, site 10, feature 4 (Jarosz *et al.* 2020), Sandomierz-Kruków, Sandomierz district (Wróbel 1985), Iwanowice, site Babia Góra, feature 5 (Kadrow and Makowicz-Poliszot 2000, 260).

3.3. Individuals of the Mierzanowice culture in light of strontium isotope analyses

The analyses of strontium isotopes for the burials in graves 1891 and 3141 were obtained at the Isotope Laboratory of the University of Adam Mickiewicz in Poznań (Bełka *et al.* 2018). The aim of the research was to establish the origin of the analysed individuals (Price *et al.* 1998; Alt *et al.* 2014). The strontium isotope signatures are presented in Table 1 and Figure 6.

The interpretation of the results obtained for the population of the Mierzanowice culture from the Rzeszów Foothills is presented in detail in the monograph which describes the sites of this culture in Dobkowice and Mirocin (Bełka *et al.* 2018; Szczepanek 2020).

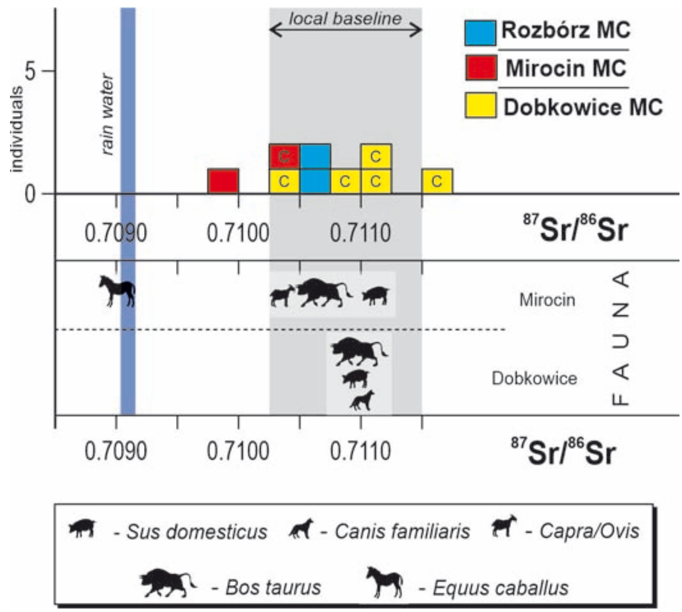

Fig. 9. Strontium isotopic signatures ($^{87}Sr/^{86}Sr$) of enamel from human and animal teeth at sites of the Mierzanowice culture from Rzeszów Foothills. Prepared by A. Szczepanek

Table 1. Results of strontium isotope analyses of human remains from Site 42 in Rozbórz, Przeworsk district

Site	Feature	Age (years)	Sex	Sample	$^{87}Sr/^{86}Sr$
Rozbórz 42	1891	25-35	M	upper right M1	0,710580±09
Rozbórz 42	3141	20-30	M	lower M2	0,710725±13
				upper left M1	0,710595±12

Subsequent analyses allowed the compilation of isotope signatures from features 1891 and 3141 with people of the Mierzanowice culture buried in graves and settlement pits located in the Rzeszów Foothills in the context of results obtained for animal teeth (according to Bełka *et al.* 2018; Szczepanek 2020).

The comparison of the attained data allows us to confirm earlier conclusions concerning the settlement model of the Mierzanowice culture communities and to indicate the area of Rzeszów Foothills as a place where they spent their childhood (Fig. 9).

5. CONCLUSIONS

The discovery of graves of individuals of the Mierzanowice culture in Rozbórz has enriched the small number of such features known in the region between the Vistula and San rivers. Due to their small number, it is difficult to present a synthetic description of funeral customs. There are, however, some tendencies visible, especially in the choice of a place to lay the dead. It was found that typical graves containing individual burials were located outside of settlements at different distances from them. This situation was recorded, for example, at site 27 in Mirocin, where the graves associated with the early phase of the culture were located far from the settlement features of this phase (Jarosz and Mazurek 2020, 74, fig. 48). Similar remarks were made in the case of graves and settlement pits in the late phase of the Mierzanowice culture located at the same elevation at site 6 in Szczytna (Hozer *et al.* 2017). Sometimes the graves, as in Rozbórz, form small groups, *e.g.*, Łysokanie and Targowisko. The second possibility for placing the dead was settlement pits, with a trapezoidal vertical cross-section, which do not differ from typical settlement features. Such structures are known from the above mentioned Dobkowice, Mirocin (early phase), Skołoszów and Ożańsk (late phase).

The described diversity of the interment rite, especially in the early phase, reflects the complexity of funeral phenomena known in the other areas of the upper Vistula, Bug, and Dniester basins, as well as the wider Central European context. The customs of placing the dead (children and females) or parts of their bodies in settlement pits are visible in the Únětice culture (Gralak 2009; Knipper *et al.* 2016). The demonstrated diversity of the funeral rite requires further investigation, especially a genetic study, allowing for the identification of interregional connections of these culture communities. In this context, the analysed graves from Rozbórz create an important study of cultural phenomena present in the early Bronze Age.

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FLINT SICKLES FROM GRAVES OF THE STRZYŻÓW CULTURE IN THE LIGHT OF USE-WEAR ANALYSIS

ABSTRACT

Hyrchała A., Pyżewicz K. and Bartecki B. 2022. Flint sickles from graves of the Strzyżów culture in the light of use-wear analysis. *Sprawozdania Archeologiczne* 74/1, 485-499.

The presented article aims to interpret the function of selected flint sickles from the Early Bronze Age. For this purpose, we made a use-wear analysis of 13 sickles coming from the cemeteries of the Strzyżów culture in south-east Poland: Rogalin, site 15, Hrubieszów-Podgórze, site 1, Hrebenne, sites 10 and 31, and Świerszczów, site 5 (Hrubieszów district, Lublin province). All analyzed sickles were made of Volhynian flint and represent the sub-triangular type. As a result, we can conclude that analyzed tools were used mostly for harvesting cereals or other siliceous plants. They were placed in hafts made of hard organic materials, combined with hide/plant. Conducted studies also revealed that these objects, suitably altered (sickle tips were destroyed right before being deposited in a grave) became important grave goods.

Keywords: flint sickles, use-wear analysis, cemeteries, Strzyżów culture, Early Bronze Age, south-east Poland
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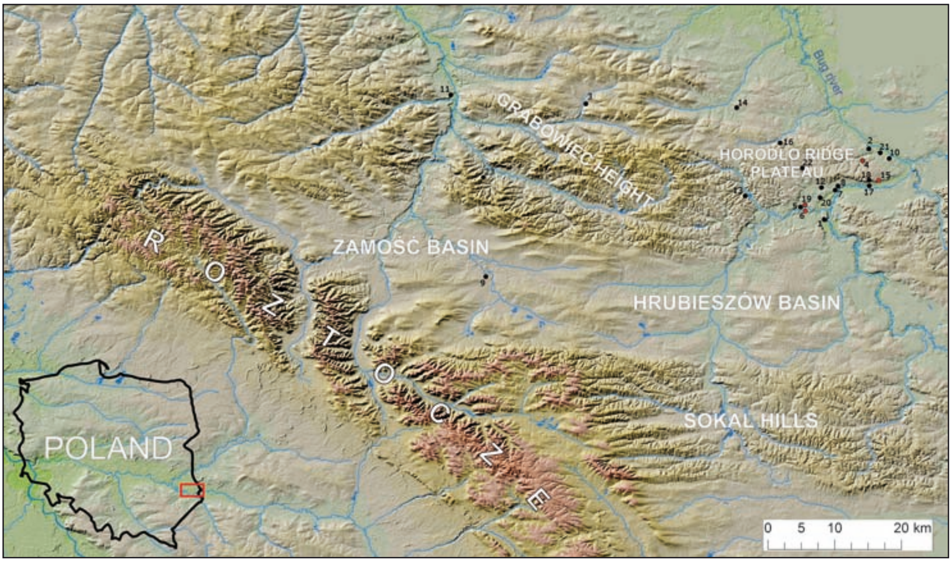

Fig. 1. The most important sites of the Strzyżów culture in Poland. Red colour marks sites that yielded the analysed sickles (on the background map of the lie of the land of the Lublin province as produced by L. Gawrysiak): 1 – Gródek, sites 1C, 6; 2 – Horodło, site 12; 3 – Horodysko, sites 1, 13; 4 – Hrebenne, sites 10, 24, 31, 34; 5 – Hrubieszów, site 16; 6 – Hrubieszów-Podgórze, sites 1, 1B, 5; 7 – Husynne, site 2; 8 – Husynne Kolonia, sites 5, 6; 9 – Hyża, site 1; 10 – Janki Dolne, site 11; 11 – Krasnystaw, site 1; 12 – Moroczyn, site 46; 13 – Nieledew, site 1; 14 – Raciborowice Kolonia, sites 1, 2; 15 – Rogalin, site 15; 16 – Stefankowice, site 23; 17 – Strzyżów, site 1; 18 – Strzyżów, sites 27, 28; 19 – Świerszczów, site 28; 20 – Teptiuków, site 19; 21 – Wieniawka, site 6; 22 – Wołajowice, site 1; 23 – Stryjów, site 30

Bifacial tools, particularly their morphological analysis, as well as typological, chronological and cultural division have not been the subject of interest or thorough analysis of many researchers exploring flint manufacturing. One of the most noteworthy works on these implements – which are unique in terms of craftsmanship and precision of manufacturing – is a publication by J. Libera (2001 – further literature there). On the basis of available sources, and taking into account several hundred artefacts recorded in Poland and the west of Ukraine, the author established criteria for the classification of various bifacial forms – above all, projectile points, arrowheads and sickles, thus creating a valuable comparative database and a point of reference for further exploration of this research problem. The analysed specimens included sub-triangular sickles characteristic of the Early Bronze Age, Mierzanowice and Strzyżów cultures, which were frequently used as grave goods. During the last two decades, due to, among other things, excavations conducted in the Hrubieszów region, the source base has grown significantly. On top of that, the use-wear analysis has enabled a more thorough examination of these flint tools, not only in terms of their form but also function.

The flint sickles that are the subject of this paper were recorded during excavations carried out at the following cemeteries of the Strzyżów culture in the south-east Poland: Rogalin, site 15, Hrubieszów-Podgórze, site 1, Hrebenne, sites 10 and 31, and Świerszczów, site 5 (Hrubieszów district, Lublin province – Fig. 1). Thirteen flint sickles were subjected to analysis. Graves singled out for the study include both those in which a sickle was the only, or one of the few objects deposited with the deceased, and richly-furnished burials, in which a sickle was deposited along with approx. a dozen copper, bone or shell ornaments, as well as a necklace made of several dozen faience beads, pottery or other flint articles.

METHOD

In order to determine the function of the selected sickles used by the prehistoric communities, comprehensive use-wear analysis was conducted. This was performed with the use of a Nikon LV150 metallographic microscope and a Keyence VH-Z100R digital microscope, with magnification from 20x to 300x. Interpretation of microscopic polishes, linear traces, and chipping correlated with the results of experimental studies made by one of the authors in the previous years, and the data available in the literature (among others, Keeley 1980; Moss 1983; Vaughan 1985; Anderson-Gerfaud 1988; Juel Jensen 1994; Van Gijn 1990; 2010; Korobkowa 1999; Małecka-Kukawka 2001; Rots 2010; Osipowicz 2010; Pyżewicz 2013), has made it possible to determine not only the activities for which flint tools were used, but also the presence of hafting.

MATERIALS

Rogalin, site 15 – the site was discovered in 2008 following reports about ploughed out graves. It is situated on an exposed area in the edge zone of the Bug valley, on a slope descending to the south. Excavations conducted in 2009-2018 yielded 19 burials of the Strzyżów culture (Hyrchała 2015; 2021).

1. Sickle made of Volhynian flint, distal end snapped off (Fig. 2). Dimensions: length 14.5 cm, width 5.1 cm, thickness 1.4 cm. The object was found on the surface of the site, and probably comes from a destroyed grave.

2. Sickle made of Volhynian flint, distal end snapped off (Fig. 3). Dimensions: length 13.6 cm, width 4.9 cm, thickness 1.7 cm. Grave 1. The burial pit, 270 × 160 cm, in shape resembling a rectangle with rounded corners, was situated along the W-E axis. The skeleton of a man who died aged between 40 and 45 was deposited at the bottom of the pit, laid extended and supine, with the head to the east. The sickle was within the chest, by the left arm. Grave goods: three clay vessels (cup, vase and amphora), two temple rings made of copper wire, 36 faience beads. ^{14}C dating: 3440±35 BP (All ^{14}C dates mentioned in the

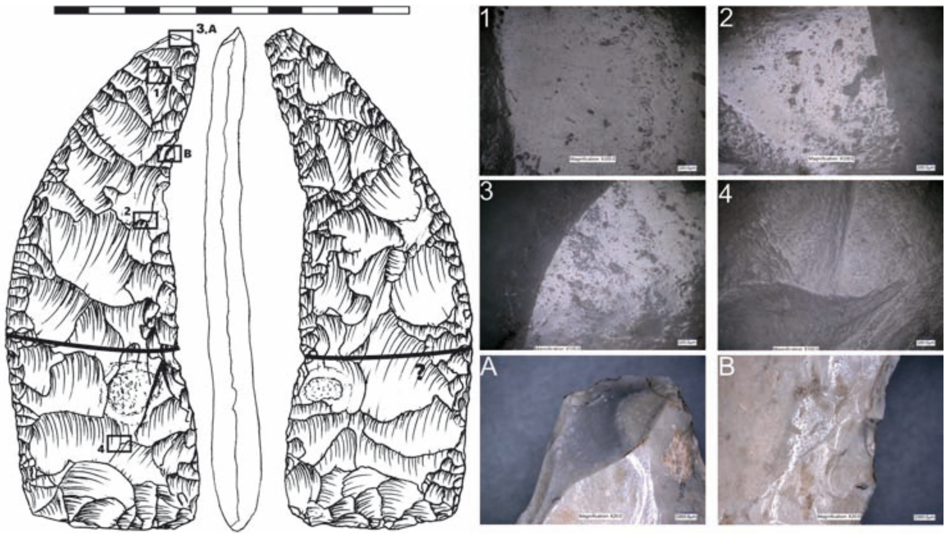

Fig. 2. Rogalin, site 15, destroyed grave (the surface of the site).
1-3 – traces related to cereal harvesting, 4 – hafting traces, A – scar resulting from snapping off of the distal tip, where no use traces were recorded, B – character of the working edge; chip scars with no use traces

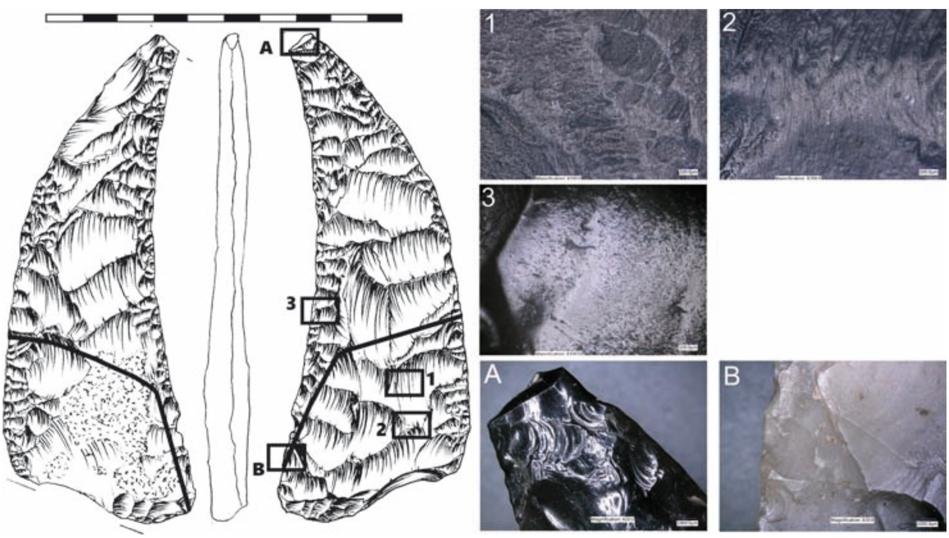

Fig. 3. Rogalin, site 15, grave 1.
1-2 – hafting traces, 3 – traces related to cereal harvesting, A – character of the working edge, distal end snapped off, B – boundary between the hafted part and the one protruding from the haft; single chip scars with no use traces

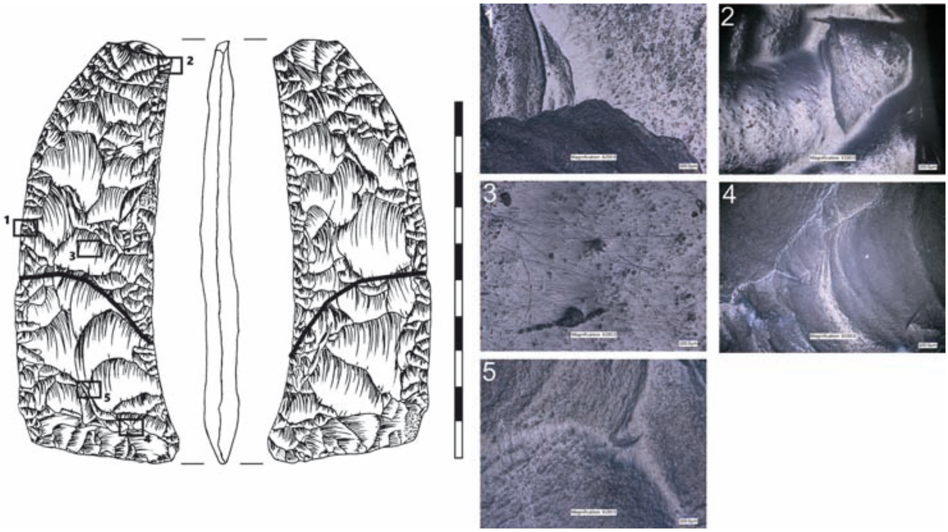

Fig. 4. Rogalin, site 15, grave 4.
1-3 – traces related to cereal harvesting, 4-5 – hafting traces

publication were established by the Poznan Radiocarbon Laboratory). Literature: Hyrchała 2015, 54, 55; Lorkiewicz-Muszyńska *et al.* 2015, 131.

3. Sickle made of Volhynian flint, distal end snapped off (Fig. 4). Dimensions: length 12.3 cm, width 4.3 cm, thickness 1 cm. Grave 4. The burial pit, 280 × 115 cm, in shape resembling an elongated oval was oriented along the W-E axis. The skeleton of a woman who died aged between 35 and 40 was lying extended and supine, with the head to the west. Additionally, on the east of the burial pit, a left ulna of a small girl was found. The sickle was laid next to pottery, in the west part of the burial pit. Grave goods: three clay vessels (two amphorae and a pot), two temporal rings made of copper, 16 faience beads, two bone beads. ^{14}C dating: 3495±30 BP. Literature: Hyrchała 2015, 57-59, Lorkiewicz-Muszyńska *et al.* 2015, 131.

4. Sickle made of Volhynian flint, distal end snapped off (Fig. 5). Dimensions: length 12.5 cm, width 4.3 cm, thickness 1.1 cm. Grave 6. The burial pit, 260 × 120 cm, in shape resembling a rectangle with rounded corners, was situated along the W-E axis. At the bottom of the pit was the skeleton of a woman who had died aged between 18 and 20, fragmentarily preserved and burnt, with the head to the east. The sickle was on the left of the skeleton, at the waist. Additionally, on the east of the burial pit, small fragments of the skeleton of a girl who died aged between seven and nine were discovered. Grave goods: fragments of a clay vessel; copper articles: two temporal rings made of sheet and wire, two temporal rings made of wire, nine rings made of wire, sheet fitting of a headband, frag-

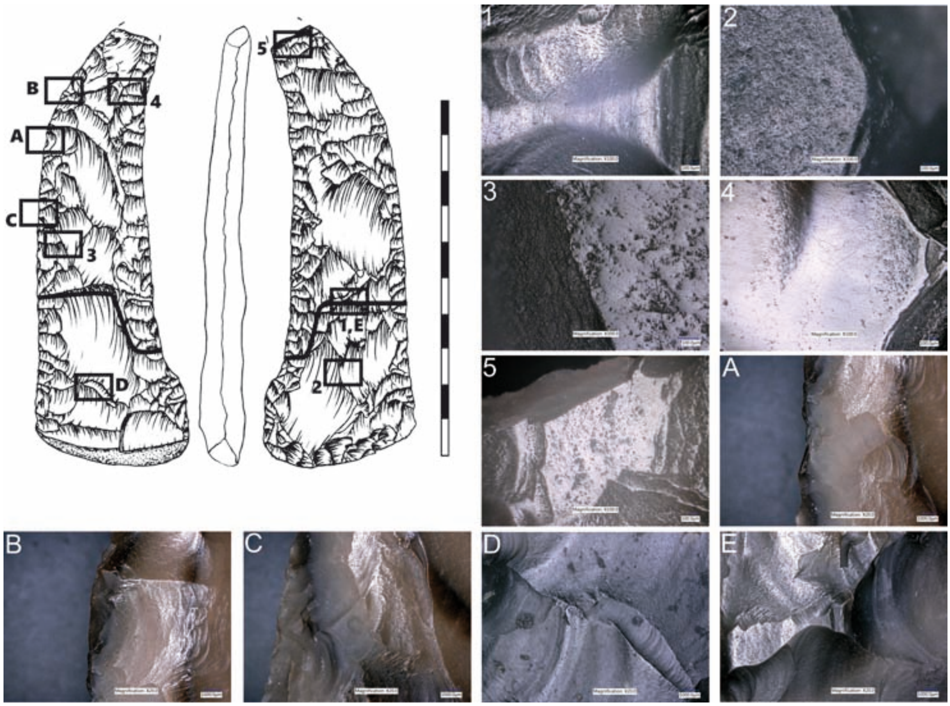

Fig. 5. Rogalin, site 15, grave 6.
1-2, D – hafting traces; 3-5 – traces related to cereal harvesting; A-C – chip scars with no use traces; E – boundary between the hafted part and the one protruding from the haft with visible use traces

ment of a bracelet; 90 faience beads; five shell pendants; a stone grinding plate. ^{14}C dating: 3535±35 BP. Literature: Hyrchała 2015, 60-64; Lorkiewicz-Muszyńska *et al*. 2015, 131.

5. Sickle made of Volhynian flint, distal end snapped off. No traces of use. Dimensions: length 13.4 cm, width 5 cm, thickness 1.1 cm. Grave 8. The burial pit, 270 × 130 cm, shaped like a rectangle with rounded corners, was situated along the W-E axis and was destroyed as a result of ploughing. Of the whole skeleton, only fragments of a skull of a woman who died aged between 25 and 30 were preserved in the west part of the pit. The sickle was recorded in the north of the pit. Grave goods: near-bottom parts of three clay vessels. ^{14}C dating: 3535±40 BP. Literature: Hyrchała 2015, 64, 65, Lorkiewicz-Muszyńska *et al*. 2015, 131.

6. Sickle made of Volhynian flint, distal end snapped off. Dimensions: length 11.9 cm, width 5.1 cm, thickness 1.1 cm. Grave 10. The burial pit, 220 × 95 cm, in shape resembling a rectangle with rounded corners was situated along the NS-SE axis. At the bottom of the pit was the skeleton of a man who died aged approx. 47, lying extended and supine, with the head to the north-west. Additionally, on the east of the burial pit a left ulna and the first right rib of a small girl was discovered. The sickle was recorded by the left arm. Grave

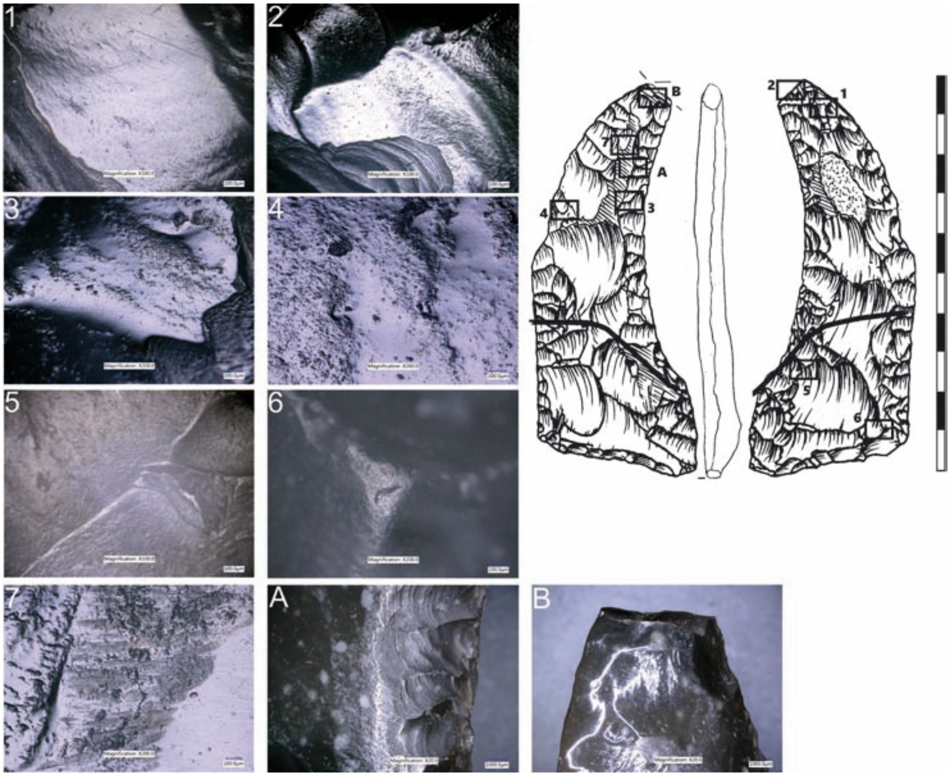

Fig. 6. Rogalin, site 15, grave 12.
1-4 – traces related to cereal harvesting, 5-6 – hafting traces, 7 – traces resulting from polishing the flint surface and harvesting cereals, A – character of the working edge; chip scars with no use traces, B – character of the working part; scar resulting from snapping off of the distal end, no use traces visible

goods: flint articles: a projectile point, 16 arrowheads, a blade-like flake; two faience beads; a bone pin; a bone disc with a large, central perforation and two side ones. ^{14}C dating: 3405±35 BP. Literature: Hyrchała 2015, 66-69; Lorkiewicz-Muszyńska *et al.* 2015, 131.

7. Sickle made of Volhynian flint, distal end snapped off, polishing traces discernible on one of the surfaces (Fig. 6). Dimensions: length 9.7 cm, width 4 cm, thickness 0.9 cm. Grave 12. The burial pit, 230 × 120 cm, in shape resembling a rectangle with rounded corners, was situated along the NE-SW axis. The skeleton of a man who died aged between 40 and 45 was lying extended and supine, with the lower limbs slightly bent. The sickle was found above the right femur. Grave goods: near-bottom part of a clay vessel. Dating: Early Bronze Age. Literature: Hyrchała 2015, 70, 71, Lorkiewicz-Muszyńska *et al.* 2015, 131.

Hrubieszów-Podgórze, site 1 – the site is located on a loess headland covered with a layer of chernozem, extending from the south in the Huczwa basin. It was discovered by

A. Kokowski in the course of surface surveys in 1980. The rescue excavations conducted there in 1983-1986 and 2001 yielded features from the Neolithic (the Linear Pottery culture, the Lublin-Volhynian culture), the Bronze Age (the Lusatian culture), the Roman period and the Middle Ages. Thirteen graves of the Strzyżów culture were subjected to investigation.

8. Sickle made of Volhynian flint, distal end snapped off, polishing traces discernible on both surfaces. Dimensions: length 11.6 cm, width 5.1 cm, thickness 1.3 cm. Grave 2. The funerary pit was situated along the N-S axis contained a skeleton, probably of a man who died aged approx. 40, lying extended and supine, with the head to the south. Grave goods: two clay vessels (pot and bowl), fragment of a faience bead, five fragments of a wild boar's tusk. Dating: Early Bronze Age. Literature: Banasiewicz 1990, 213, 216, 218.

9. Sickle made of Volhynian flint, distal end snapped off. Dimensions: length 12.8 cm, width 5.8 cm, thickness 1.1 cm. Grave 4. The funerary pit was in the shape of a rectangle contained a skeleton of a man who died aged approx. 55, lying extended and supine, with the head to the north. Grave goods: four clay vessels (two amphorae, bowl, pot), three faience beads, a flint arrowhead. Dating: Early Bronze Age. Literature: Banasiewicz 1990, 217-218.

10. Sickle made of Volhynian flint, distal end snapped off, the object broken in two. Dimensions: length 12 cm, width 5 cm, thickness 0.9 cm. Grave 13. The burial pit, 290 × 100 cm, in shape resembling a rectangle with rounded corners, was situated along the W-E axis. At the bottom of the pit was a skeleton of a woman who died aged approx. 23-24, out of anatomical order and mixed up. The skull was found in the east part of the pit. One part of the sickle was by the skull, the other one – near the vessel in the centre of the grave. Grave goods: a clay bowl, 100 faience beads, a copper pin, two copper plates with perforations, a temple ring made of copper wire, seven bone beads with incisions, two bone tubes, six bone pipes, six pendants made of shell, four bone pendants. ^{14}C dating: 3575±35 BP. Literature: unpublished; documentation Niedźwiedź *et al.* 2001; Lorkiewicz-Muszyńska *et al.* 2021, 229-230.

Hrebenne, site 10 – the was site discovered in the course of surface surveys in 1982. It was situated on the edge of a small, unnamed stream. In 1992, following reports about destroyed graves, W. Koman conducted rescue works which yielded one grave. In 1997, M. Polańska discovered another 12 graves, including two graves of the Strzyżów culture (Polańska 1998, 75-85).

11. Sickle made of Volhynian flint, distal end snapped off (Fig. 7). Dimensions: length 12.4 cm, width 4.2 cm, thickness 1.2 cm. Grave 1. The burial pit shaped like an elongated oval was situated on the NE-SW axis, and was destroyed due to ploughing and by an amateur discoverer. At the bottom of the pit was a skeleton, lying extended and supine, with the head to the south-west. The sickle was discovered by the right tibia. Grave goods: none recorded. ^{14}C dating: 3345±40 BP. Literature: Koman 1992, 22-24.

Hrebenne, site 31 – the site was discovered by S. Jastrzębski in the course of surface surveys conducted in 1984. It encompasses the edge of a headland in the basin of a small,

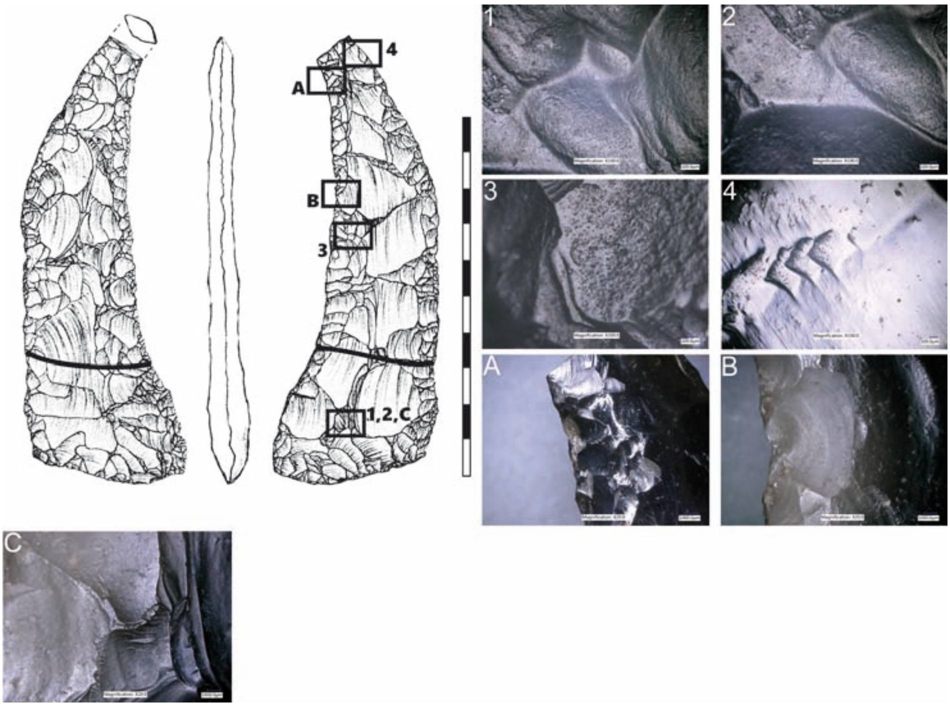

Fig. 7. Hrebenne, site 10, grave 1.
1-2, C – hafting traces, 3-4 – traces related to cereal harvesting, A – character of the working edge, B – chip scars with no use traces

nameless stream running through Hrebenne and joining the Bug. In 1991, following the reports about clusters of pottery and bones on the surface, W. Koman conducted rescue works which yielded a grave of the Strzyżów culture. He resumed research in 1993, in the course of which another three graves were discovered.

12. Sickle made of Volhynian flint, distal end snapped off. Dimensions: length 9.5 cm, width 4.2 cm, thickness 1.3 cm. Grave 1. The burial pit was elongated along the N-S axis, in its southern part – irregular in shape, roughly oval; in the northern part – rectangular. The skeleton was lying extended and supine, with the head to the south. While the lower limbs were in anatomical order, the upper part of the skeleton, above the pelvis, was mixed up. The sickle was lying on the foot bones. Grave goods: three vessels (amphora, bowl and pot). Dating: Early Bronze Age. Literature: Koman 1991, 13-14.

Świerszczów, site 5 – the site was discovered during farm works and subjected to rescue investigations in 1984. These, conducted by A. Kokowski and W. Koman, yielded a grave of the Globular Amphorae culture (Ścibior *et al.* 1991, 80-84). In 2014, two graves of the Strzyżów culture were discovered during construction of a ring road around Hrubieszów.

13. Sickle made of Volhynian flint, distal end snapped off. Dimensions: length 13.7 cm, width 5.5 cm, thickness 1 cm. Grave 1. The burial pit, 286 × 114 cm, in shape resembling a rectangle with rounded corners was situated along the W-E axis. A skeleton of a woman who died aged between 20 and 25, was laid at the bottom of the pit, extended and supine, with the head to the west. The sickle was by the left femur. Grave goods: four clay vessels (two amphorae, pot, cup), two copper temple rings, five copper rings, five copper beads, 89 faience beads, two beads made of shell, a bone pin with an eye, a bone pendant, animal bones. Dating: Early Bronze Age. Literature: unpublished, documentation Jączek 2014; Lorkiewicz-Muszyńska *et al.* 2021, 239-241.

RESULTS OF ANALYSIS

The sickles singled out for analysis represent the sub-triangular type as classified by J. Libera (2001). They are lenticular in section and their dimensions do not exceed 9.5-14.5 × 4-5.8 cm. The surface of two specimens – from grave 12 in Rogalin and grave 2 in Hrubieszów-Podgórze – bear traces of polishing.

The group of sickles which underwent microscopic analysis appears to be remarkably uniform in terms of their function. Out of 13 bifacial tools subjected to use-wear analysis, 12 artefacts exhibit similar use traces and marks indicating the presence of hafting. Only one specimen – recorded in grave 8 at the cemetery in Rogalin – does not exhibit any use traces – it was not used for any activities which would leave permanent traces on the flint surface. The knife was probably produced directly before its deposition in the grave as one of the grave goods.

All 12 sickles exhibit major use-traces associated with the processing of siliceous plants, above all cereals. They appear in the form of mirror-like polishes and have “flat” textures. Within the sheen one can observe numerous linear traces, running (in various directions) parallel and diagonally in relation to the working edge of the implement. This evidence indicating that the tool was used for harvesting plants is discernible on large areas of the surfaces in their upper and medial parts. However, they are most prevalent on the distal ends and along the working edges. The boundary between the working part and the hafted one is very distinct. Upon inspection, it can be assumed that the end of the haft ran transversely or diagonally in relation to the axis of symmetry of the sickle. Moreover, due to the presence of another type of microscopic traces recorded in the lower parts of sickles it was possible to determine the form of hafting, most likely made of harder materials, such as antler or bone. The flint surface, though, was in direct contact with a soft material – hide, or, in some instances, probably plants. Traces indicating such solutions were recorded mostly on the protruding parts – ridges on the bases of sickles. They are mostly in the form of polish, which resembles that resulting from contact with hide or plants and which also displays groups of linear traces, which corroborate the fact that the flint implement moved in the haft.

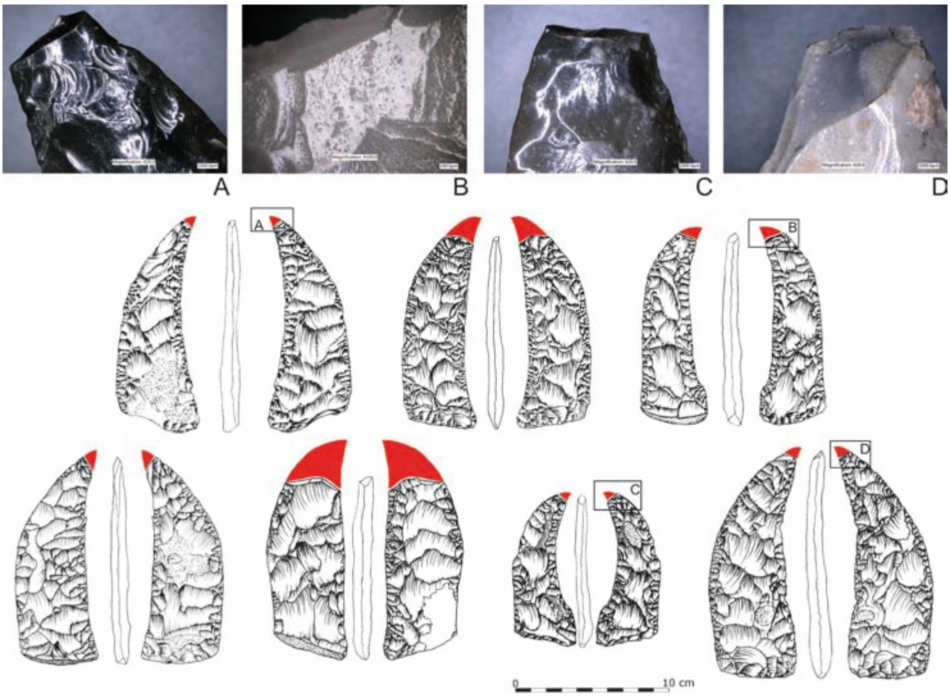

Fig. 8. Marks resulting from snapping off distal ends of sickles from Rogalin, site 15.
A – grave 1, B – grave 6, C – grave 12, D – surface of the site, probably comes from a destroyed grave

It is noteworthy that some sickles bear small flake or chip scars, which run along the working edge or form the backed edge, and which do not exhibit any use traces (but occur between parts used while harvesting cereals). This might indicate that before their deposition in graves, bifacial tools were "repaired" by retouching individual near-edge parts. Moreover, after sickles were used for cereal processing, their distal ends were snapped off – the scars resulting from such treatment do not bear any microscopic traces (Fig. 8).

The presented results of use-wear analysis largely correspond with functional studies of sickles from the Early Bronze Age published in the literature. Such flint implements should be associated with the processing of silica-rich plants – mostly harvesting cereals, though similar specimens are sometimes related to activities connected with obtaining reeds or cutting peat, which might have been used to insulate dwelling houses (*cf.* Balcer and Schild 1978a; 1978b; Van Gijn 1988; 2010; Baron and Kufel-Diakowska 2013; Grużdź *et al.* 2015; Grużdź *et al.* 2017; Pyżewicz and Grużdź 2019). Results of use-wear analysis of sickles from cemeteries of the Strzyżów culture in Raciborowice Kolonia published recently confirm the use of such articles in harvesting cereal, cutting sod, and even ploughing (Wolski 2020, 99-111). At the same time, it cannot be excluded that analysed sickles were

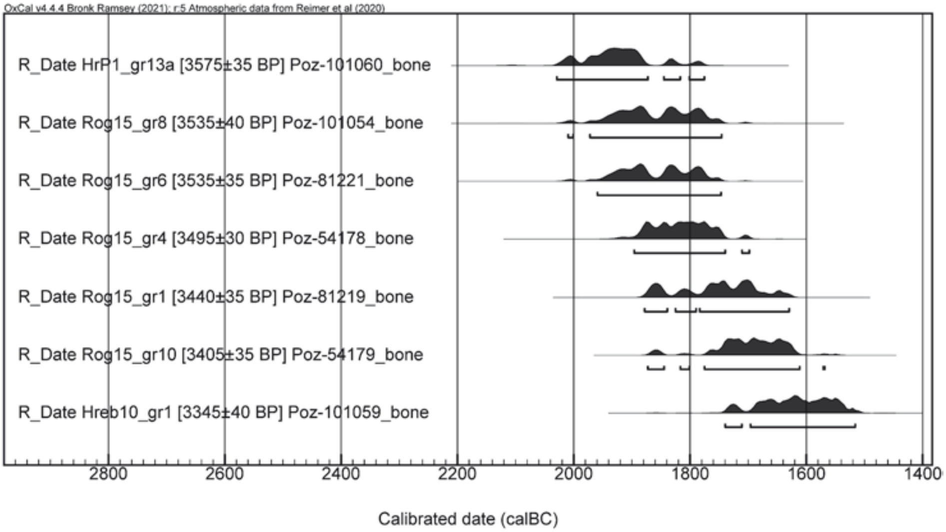

Fig. 9. List of radiocarbon dates for graves of the Strzyżów culture.
Based on the programme OxCal v4.3.2

used by the Early Bronze communities for other purposes, as a result of which they do not bear permanent traces, this having already been indicated in literature concerning similar tools (Bąbel 1974; Bąbel and Budziszewski 1978; Bąbel 2013, 104). However, at the present stage of research we do not have reliable or convincing data supporting this assumption.

Among 13 burials containing sickles discussed in this text, seven underwent radiocarbon dating (Fig. 9). Generally, their dating is set within the range 2000-1500 BC. The oldest inhumations containing artefacts of this type are grave 13 in Hrubieszów-Podgórze and graves 6 and 8 in Rogalin. Bones from grave 13 are dated to 2029-1874 BC, with the probability being 87.7%. Graves 1 and 4, as well as grave 10 from the same site, which is rich in flint materials, are younger. The youngest burial containing a flint sickle is grave 1 from site 10 in Hrebenne; this artefact was the only item deposited with the deceased. Bones from this grave are dated to 1699-1527 BC, with the probability being 88.1%. It is the youngest of all ^{14}C dates published for the Strzyżów culture.

SUMMARY

In the light of the presented results, the analysed sickles were undoubtedly articles of everyday use, and were used mostly for harvesting cereals or other siliceous plants. This might indicate the sedentary, agricultural character of the economy, geared towards farming plants on the fertile lands occupied by the Strzyżów culture. Use-wear analysis also revealed that these objects, suitably altered (by repairing the working part and damaging the distal part) became important grave goods. Sickle tips were destroyed right before being deposited in a grave, as indicated by the fact that the snapped off parts do not display characteristic polish which results from their use. In many instances, the degree of damage would make it possible to repair and use them, yet the ritual necessitated their deposition in a grave in this form. This custom is in accordance with the funeral rituals of the Strzyżów culture. In addition, the results of the analysis conducted expand our knowledge about bifacial tools.

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KRUMMESSER-TYPE KNIVES FROM THE SETTLEMENT OF THE TRZCINIEC CULTURE IN TUR DOLNY-BUSINA, SITE 3, DISTRICT PIŃCZÓW

ABSTRACT

Górski J., Orzechowski M. and Stefański D. 2022. Krummesser-type knives from the settlement of the Trzciniec culture in Tur Dolny-Busina, site 3, district Pińczów. *Sprawozdania Archeologiczne* 74/1, 501-512.

The paper discusses four Krummesser knives discovered on a multiphase settlement in Tur Dolny-Busina, site 3, Pińczów area, which is dated from the Early Bronze Age to the Early Iron Age. Until now, finds of these types of knives have not often come from safe archaeological contexts, which has fuelled discussions about their chronology. Two of the presented knives come from archaeological features linked with the Trzciniec culture, which provides valuable information on their chronology. The article presents a detailed description of the morphology of the artefacts. The geological analysis allowed us to identify the raw material. In addition, all artefacts were subjected to microscopic examination to determine the method of their production and documented traces of use on their surfaces. As a result of the conducted analysis, it was found that three of the knives were made from local raw materials with minimal modification, while the fourth seems to be made in a specialized workshop and is probably imported.

Keywords: Krummesser, stone knife, Trzciniec culture, Older Bronze Age
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I. INTRODUCTION

At the end of the Early Bronze Age or the beginning of the Older Bronze Age, a new specific type of knives made of non-siliceous rocks (*Krummesser*) emerged in some regions of Poland. Their appearance is commonly linked with Transcarpathian influence (*cf.* Kopacz 2011, older literature there). Depending on the region of Poland, knives made of non-siliceous rocks are associated with the Trzciniec culture (Budziszewski 1998, 324, 325) or with the Otomani-Füzesabony culture (Valde-Nowak and Gancarski 1999, 183). They have recently been comprehensively studied (Libera *et al.* 2015). It seems that the connection of these particular tools with the Transcarpathian areas is obvious. Petrographic analyses of the finds showed that some of the tools were made of local raw materials (Libera *et al.* 2015), which seems to indicate their local manufacture.

These interesting finds are almost always devoid of an archaeological context. Therefore, the evidence of four knives of this type discovered in the village of Tur Dolny, commune of Michałów, located at the south-eastern end of the Jędrzejów Plateau (Fig. 1), is an important cognitive addition to the database known so far. An extensive settlement complex comprising over thirty, often multi-cultural settlements and cemeteries was located at the confluence of the Businka and Nida valleys. The excavations carried out in this area for nearly forty years have contributed to the identification of prehistoric sites dating from the Early Bronze Age to the Late Roman Period. The scientific value of the documented settlement is impacted not only by its broad chronological framework but also by its continuity

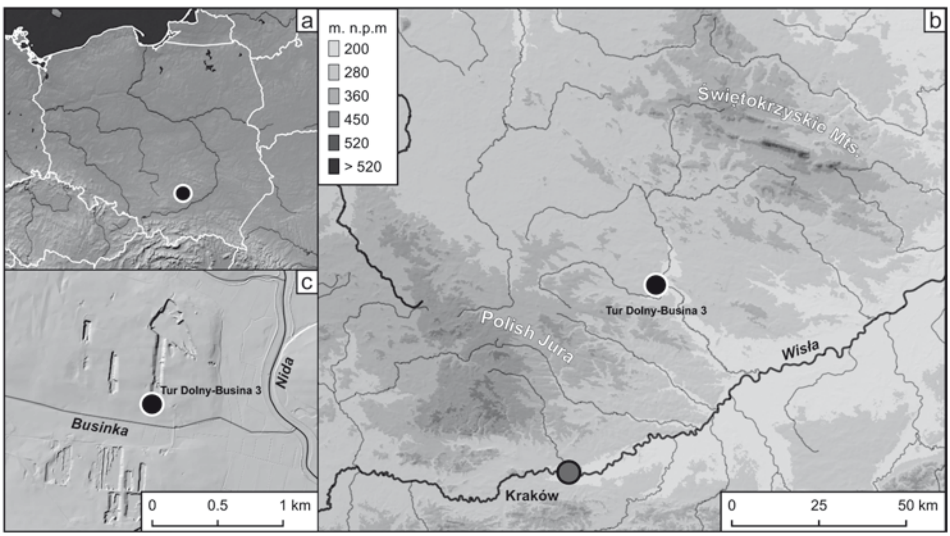

Fig. 1. Location of Tur Dolny, site 3
(prepared by M. Orzechowski, D. Stefański)

and the diversity of its character. All this has made it one of the most important complexes of prehistoric settlements in the Kielce region (Matoga 1998).

II. TUR DOLNY-BUSINA, SITE 3

The Older Bronze Age stadium of the prehistoric complex in Tur Dolny is documented by several archaeological sites. In most cases, the presence of the Trzciniec culture is indicated only by potsherds collected during numerous subsequent surveys. On the other hand, the excavated sites provided extensive, diverse and scientifically valuable archaeological evidence that confirms the entire development cycle of the Trzciniec culture in this part of the Nida Basin. It began with the contact of the newly arrived population with the Mierzanowice culture communities, then continued developing its patterns, and finally completed as a cultural contribution to the emergence of the early Lusatian cultural model in this region.

Tur Dolny-Busina, site 3 (Fig. 1), which is a large, multi-phase settlement located on the left bank of the Businka River, is a site of particular significance. Several seasons of excavations covering an area of 63 ares produced more than six hundred archaeological features, most of them associated with the Trzciniec culture settlement. A small settlement of the Mierzanowice culture, as well as a large settlement and two cemeteries (233 graves) of the Lusatian culture were also discovered here The majority of the pits were of a household nature. There were no features interpreted as residential, however, their traces could be seen as concentrations of post-holes discovered in different parts of the site. Excavations provided a massive amount of archaeological evidence. This is represented amongst other things by four Krummesser-type knives, labelled A-D (Figs 2, 4, 5). They were discovered in the area of an extensive, multiphase and well-documented settlement of the Trzciniec culture. Additionally, two of them come from features that have been precisely dated based on their distinctive ceramic finds.

III. ANALYSIS AND CULTURAL CONTEXT OF THE FINDS

These particular stone artefacts should be classified as knives. The typical nomenclature of flint knives (Krukowski 1939-1948) including terms such as working edge, back, half-back, and base was used for their description.

The first item, Knife A (Fig. 2) comes from the fill of a large pit (feature 252). It was recorded at a depth of *ca* 30 cm, it had the form of irregular and strongly blurred outline and measured *ca* 220 × 270 cm. During the exploration, the feature gradually decreased in size, finally taking on a near-circular shape. It had a flat bottom, reaching a depth of about 140 cm. The lower part of the pit contained an intensively black fill, saturated with a considerable amount of charcoal and ash. The finds were scattered mostly at a depth of *ca* 75-120 cm, while on the floor and in the uppermost fill of the feature they were less numerous.

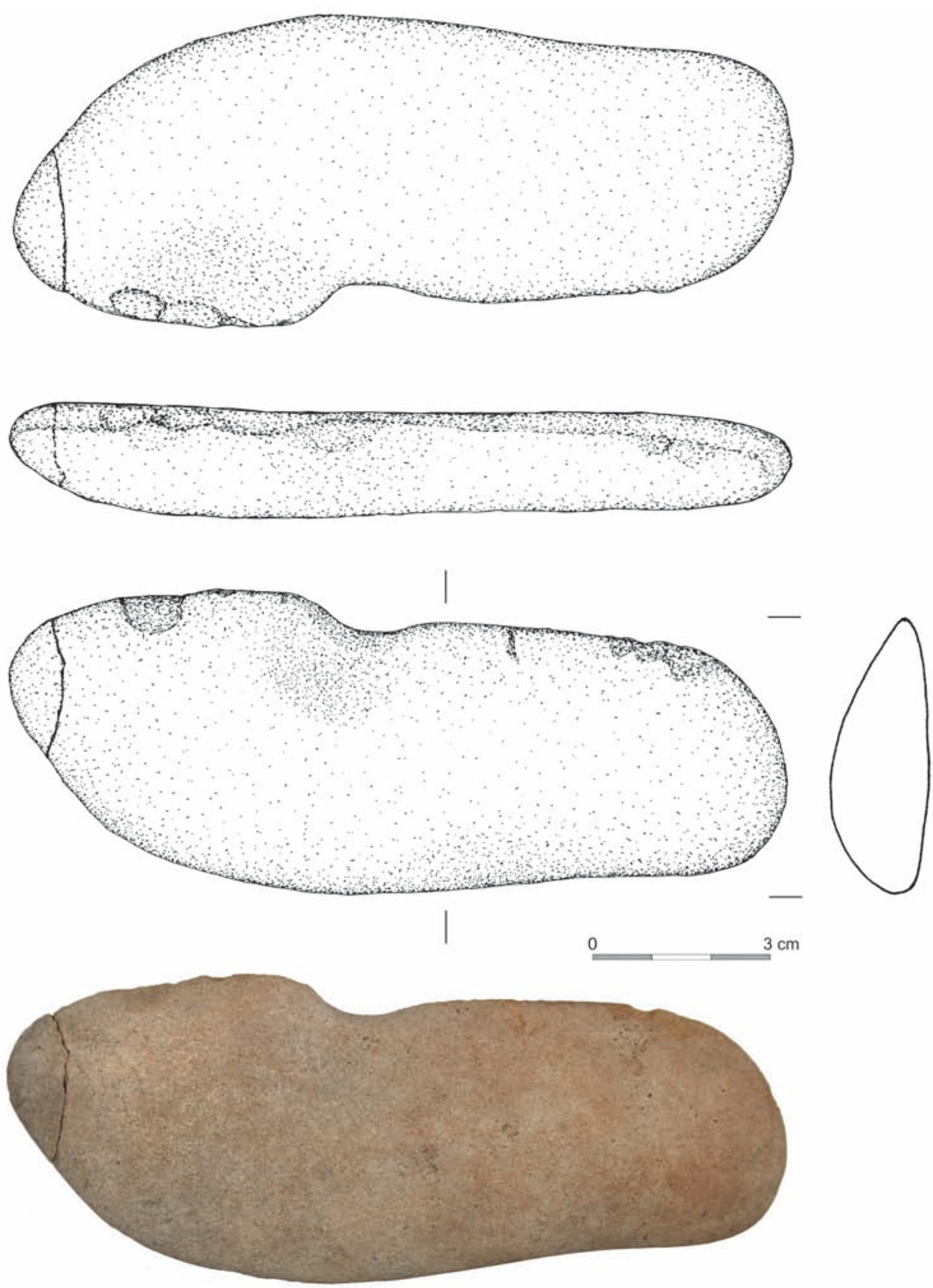

Fig. 2. Tur Dolny 3. Stone knife A, feature 252
(illustrated by A. Dziedzic, M. Orzechowski, D. Stefański)

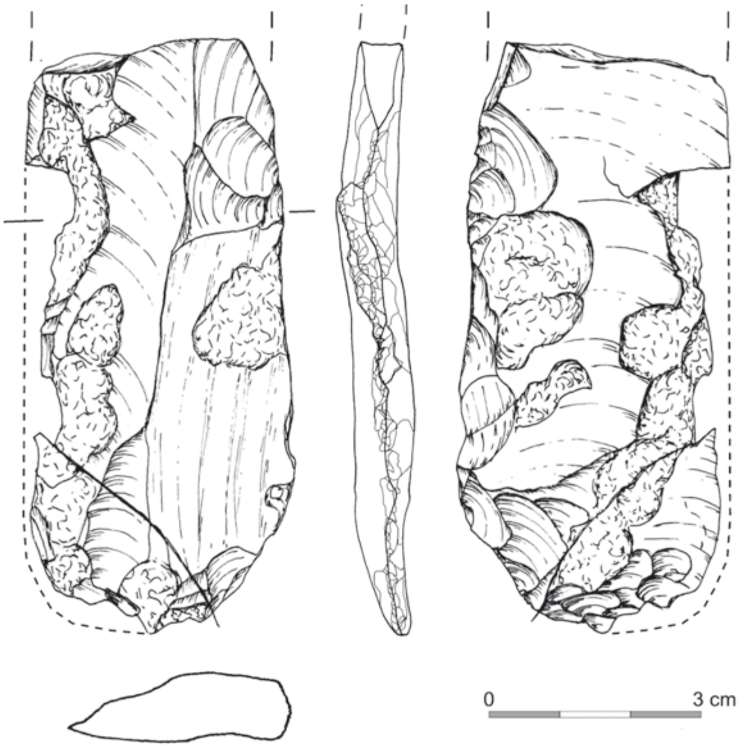

Fig. 3. Tur Dolny 3. Flint knife, feature 252
(illustrated by A. Dziedzic)

They included approximately 130 potsherds from several vessels (mainly pots) and lumps of daub with impressions of wooden structures and animal bones. The Krummeser was found at a depth of approximately 90-110 cm. An additional flint knife was discovered nearby (Fig. 3). The ceramic inventory refers to the so-called A2 type assemblages, which allows linking it to the classic phase of the Trzciniec culture (Górski 2007, 56-62). The observations made during the exploration of the pit and the presence of a considerable amount of constructional daub in its fill indicate that it was originally a large pit with walls strengthened by vertically driven stakes, lined from the inside with clay. There are indications that the described feature may have served as a smokehouse.

Krummesser A is made of very fine sandstone. The dimensions of the artefact are 132 × 52 × 17 mm. It is asymmetrical, plano-convex in the cross and longitudinal sections. The edge defined by the rounded base, the back and the adjacent diagonal half-back is strongly rounded. The working edge is more penetrating, with a distinct notch that starts at the base of the knife and extends to about 2/3 of its length. Due to the properties of the rock, the manufacturing marks are barely legible. The flat side of the tool was probably

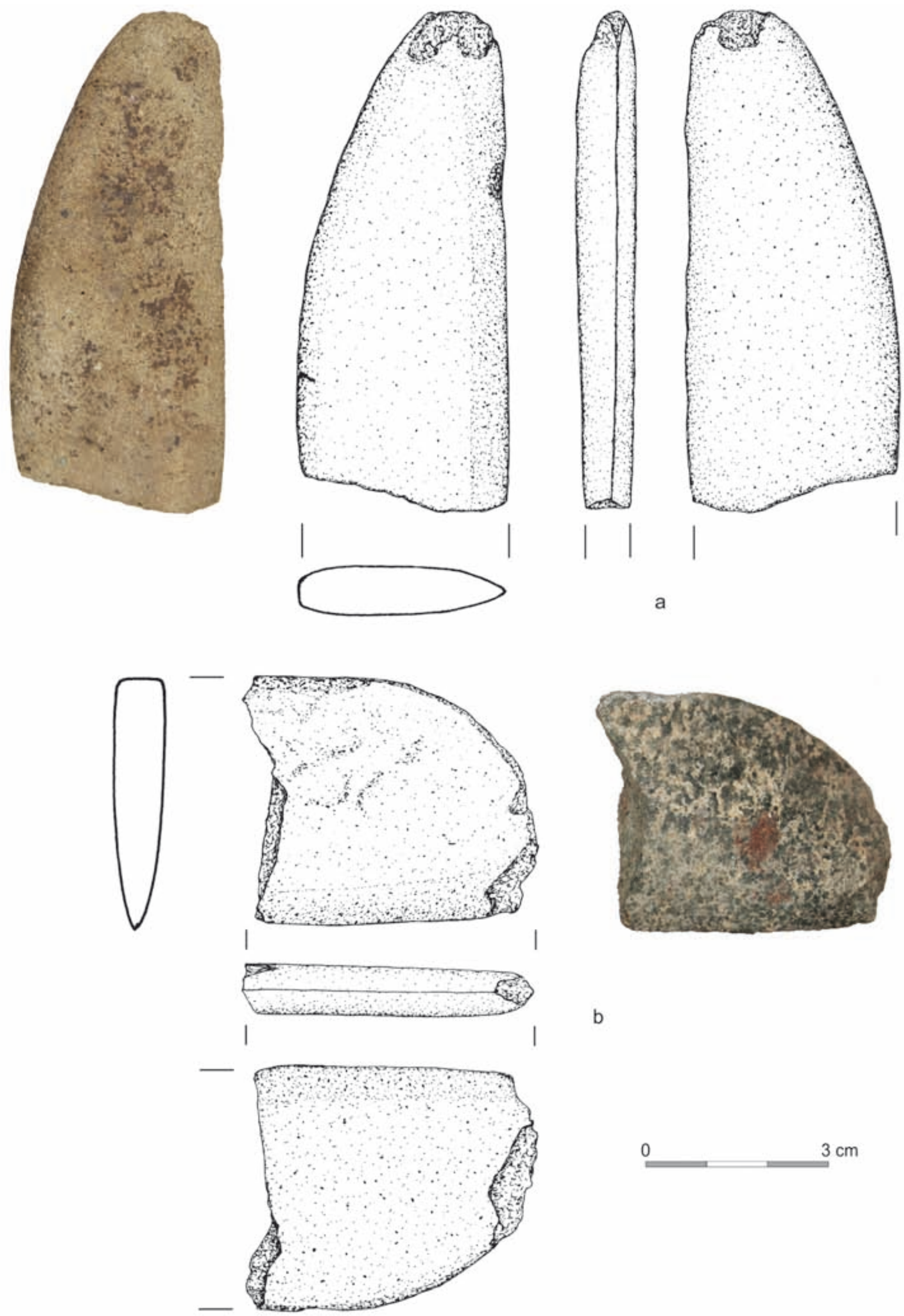

Fig. 4. Tur Dolny 3. Stone knives: a – Knife B, feature 315; b – Knife C (illustrated by A. Dziedzic, M. Orzechowski, D. Stefański)

ground. There is evidence of a clear bevel of the working edge. The separated, bladed part of the tool has clear use-wear marks in the form of a micro-retouch. Slight denting is visible on the half-back and along the entire length of the working edge.

Although lithics are not the focus of this study, a flint knife found nearby is worth mentioning. This (Fig. 3) is a partially preserved, burnt and cracked knife made of a macrolithic, partially cortical blade. The preserved dimensions are 84 × 37 × 7 mm. The back has been shaped on the right edge with a bifacial, semi-steep retouch. Only in the middle part, is the back angled and blunter. This part is made with an additional, steep retouch, which has severely crushed this part of the tool. The proximal part is thinned using a flat, bifacial retouch. There is a well-developed sickle gloss on the left edge of the tool.

The second Krummesser, Knife B (Fig. 4: a) was discovered in the fill of feature 315. The pit was recorded at a depth of approx. 30 cm, it had an oval shape and measured *ca* 160 × 180 cm. With the exploration of successive levels, the feature decreased its size and took on a near-circular shape (in the middle part it had a diameter of *ca* 100-110 cm). It took the shape of a somewhat asymmetrical basin with the bottom reaching the depth of *ca* 140 cm in the cross-section. A nonhomogeneous fill yielded in total several dozens of potsherds dated to the period of the Trzciniec culture, a small number of lumps of daub and pieces of charcoal. Finds were discovered throughout the fill, but a clear accumulation was noted in the central part of the pit. The knife was found in the western part of the feature, at a depth of about 85 cm. The character of the fill and the recovered archaeological evidence indicate the economic character of the pit; however, it is not possible to define its function more precisely. The potsherds, although less numerous and more fragmented compared to the above – described feature (252), show analogous formal and chronological links.

Krummesser B (Fig. 4: a) is made of sandstone. It is partially preserved. The dimensions of the artefact are 82 × 36 × 10 m. The object is asymmetrical, similar to lenticular in the cross and longitudinal sections. The longer edge is convex and the back merges gently into the half-back. The convex edge is poorly penetrating. The preserved fragment of the working edge is formed by a distinct bifacial bevel. It is straight and much more penetrating. Due to the properties of the rock, the manufacturing marks are poorly legible. Use-wear marks include slight denting on the edge of the half-back and chipping of the tip.

The third Krummesser, Knife C (Fig. 4: b), is made of amphibolite. The artefact was found in a cultural layer. It is partially preserved. Its dimensions are 52 × 41 × 8 mm. The object is asymmetrical, wedge-shaped in cross-section and rectangular in longitudinal section. The longer edge is convex and the straight back merges into a strongly rounded half-back. The back is angular along its entire length. The surviving fragment of the opposite edge is straight, penetrating. The object has been made by grinding all surfaces, including the back, and slightly bevelling the working edge. Use-wear marks include bifacial chipping of the tip (or base).

Krummesser D (Figs 5, 6) is made of quartz sandstone. The artefact was found in a cultural layer. The item is asymmetrical, and the faces of the sides are slightly twisted. The dimensions of the artefact are 112 × 43 × 14 mm. It is lenticular in cross-section and rectangular

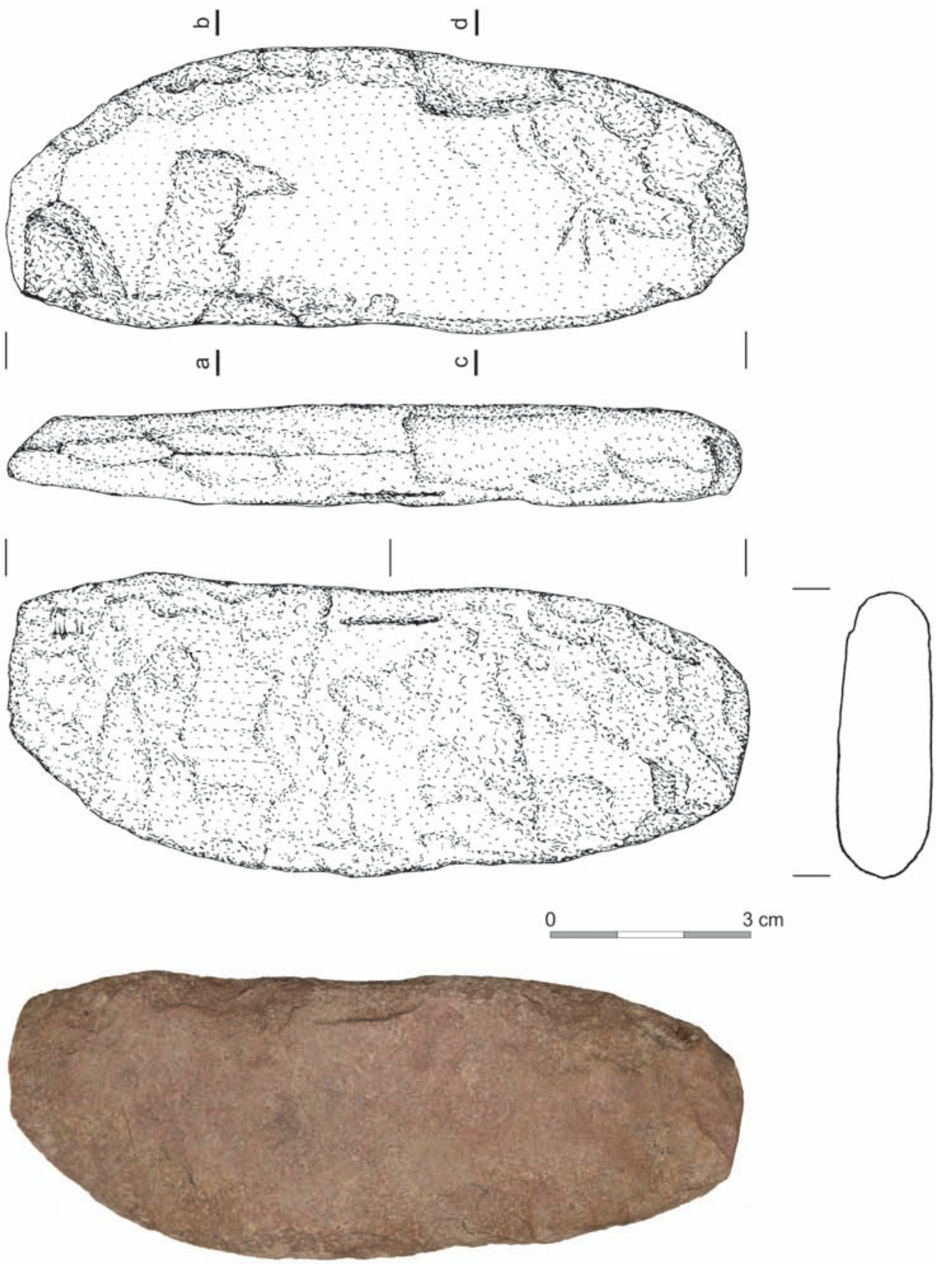

Fig. 5. Tur Dolny 3. Stone knife D
(illustrated by A. Dziedzic, M. Orzechowski, D. Stefański)

in longitudinal section. The longer edge is convex and the straight back merges into a strongly curved half-back. The natural surface has been preserved on the tips and locally on both flat sides. Its character indicates that the artefact was based on a flat erratic chunk.

IV. MANUFACTURING AND USE-WEAR TRACES

The surface of the worked stone artefacts was examined using stereoscopic and metallurgical microscopes. One of the artefacts, Knife D, was scanned with an Artec Space Spider 3D handheld scanner (Fig. 6). The inspection confirmed the thesis that, due to the nature of the rock materials used, the legibility of processing traces, as well as use-wear traces, is severely limited. However, this does not completely exclude the possibility of research on stone artefacts, as indicated for example by analyses of the function of stone grinders (Zupancich and Cristiani 2020; Dubreuil *et al.* 2015).

The presence of manufacturing traces in the form of surface grinding can be assumed from the general shape of the knives. The state of preservation of the natural surfaces indicates that it mostly involved only selected parts of the tool. Only in the case of Knife C, which differs from the other artefacts due to its shape and the raw material used, the processing of the entire surface should be assumed. In the case of specimens made of pebbles, it included only rough levelling of side faces and edges, as well as bevelling of the working edges. The microscopic examination did not confirm any obvious traces of grinding. Knife C features a slight polish on the whole surface. Only in some places, *e.g.* at the back, is the polish more intensive, which may indicate that the knife was hafted, more likely, that this part of the item was more intensively smoothed. On the other hand, in the

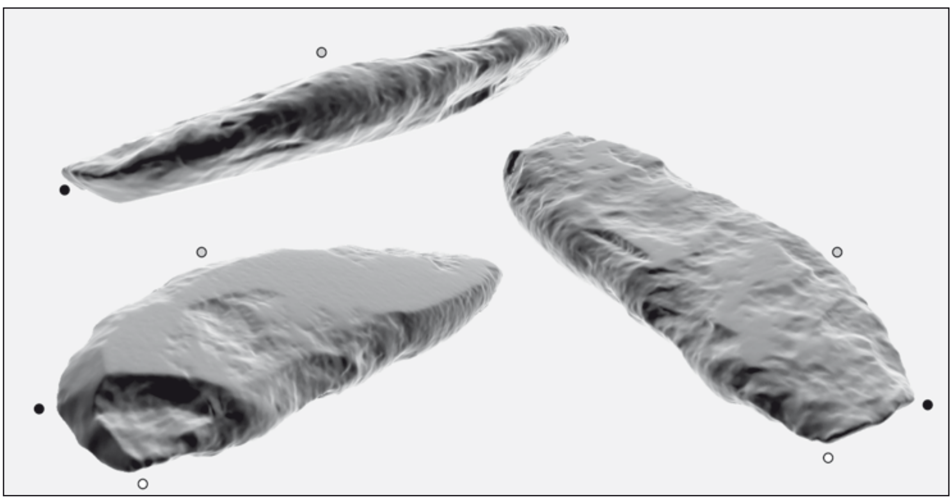

Fig. 6. Tur Dolny 3. 3D scan of stone knife D (illustrated by M. Orzechowski, D. Stefański)

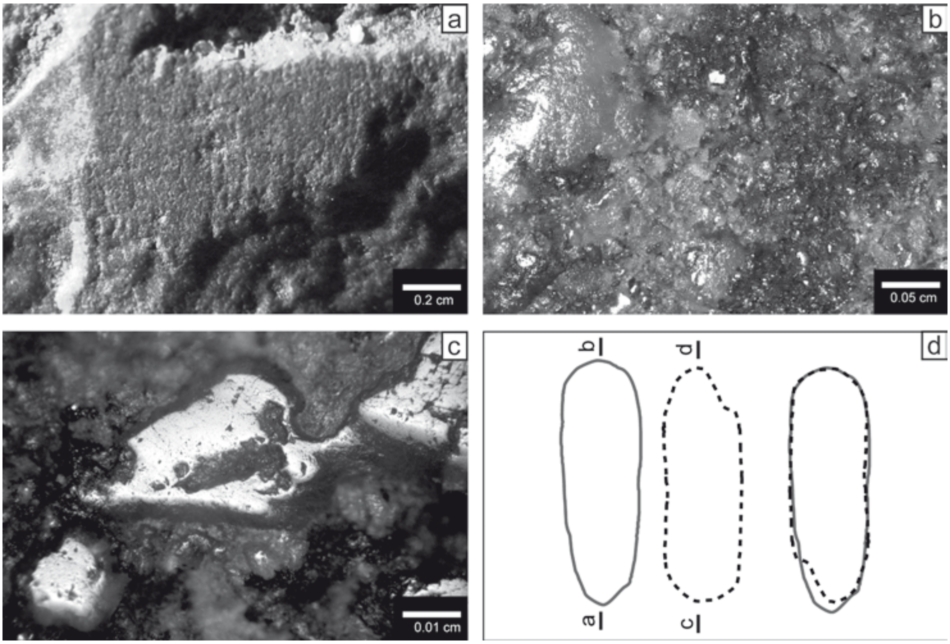

Fig. 7. Tur Dolny 3. Photographs of use-wear on stone knives: a – striations Knife D; b, c – polish Knife B; d – stone knife cross-sections obtained from the 3D scan of Knife D (illustrated by M. Orzechowski, D. Stefański)

case of Knife D, the presence of poorly visible striations, irregularly distributed and transverse to the tool axis, was noted (Fig. 7: a).

Use-wear traces on the knives were preserved mainly in the form of macro traces, such as microretouch, crumbling and edge denting. A common feature observed on the tools is the intense chipping of the knife tip (specimens B-D). This seems to be a typical feature, as we can observe similar ones in published examples (Libera *et al.* 2015). It should be mentioned that, apart from Knife C, which was probably manufactured in a specialised workshop, the other specimens were made *ad hoc* from readily available materials. The working edges of specimens A and B, even despite their bevelling, are characterised by poor penetrability and are not very functional. On the other hand, in the case of Knife D, the working edge as well as the back are blunted, and heavily rounded along a considerable length. A comparison of cross-sections generated from the scan (Fig. 7: d) indicated that this chamfer is identical for both edges. This suggests that the knife was reversible and both edges were formed by grinding in an identical groove or that the knife was used to form such a groove.

Microscopic traces on the analysed artefacts are almost non-existent. Only in the case of Knife B, intensive polishing of some grains of quartz crystals embedded in sandstone was documented (Fig. 7: b, c). They are different from the unpolished grains, which makes it possible to indicate the zones of the tool that were in contact with the workpiece, as well as to determine its nature. The gloss is particularly intense on the working edge and one of the lateral faces in the section of the tip of the knife. Strong gloss, penetrating the relief of the grains indicate intensive work in unspecified soft material. At the same time, the tool itself must have been at an angle to the material being worked on, suggesting a scraping rather than cutting activity.

V. CONCLUSIONS

An analysis of the distribution of the artefacts in question did not reveal a clearly defined zone concentrating these finds at Tur Dolny-Busina Site 3. Features 252 and 315 were located in the central and northern parts of the site respectively approximately 40 metres apart. Another two Krummesser-type knives were discovered randomly in the cultural layer in different parts of the site. It should be noted, however, that both of these objects were discovered accompanied by numerous fragments of pottery linked with the Trzciniec culture.

The functionality of stone knives is severely limited by the mechanical properties of the worked material, which does not allow for such a sharp edge as characterised by flint or metal objects. Nevertheless, such tools were manufactured, as evidenced by archaeological and ethnographic analogies. Mention can be made of stone sickles found in Neolithic Southeast Asia (Yang *et al.* 2014), or "Ulu" stone knives used by the Inuit for fish processing, among other things. A strong functional limitation due to the nature of the stone raw material is evident in the case of three knives (items A, B and D), probably made *ad hoc* at the site from sandstone pebbles. The situation is different in the case of Knife C, which seems to be made in a specialised workshop. The properties of the raw material and its variation make the functional analysis very difficult and the results obtained are not uniform. Nevertheless, the data collected indicate that the knives were in use. Their function has not been definitively determined, although it seems that they were not standardised, as evidenced by the comparison of Knives B and D.

Although the presented flint knife is only an addition to this study, it is worth a few words in conclusion. The macrolithic size of a blade, the presence of a back and a harvesting function resemble Zele-type knives which are well documented for the Lusatian culture (Lech and Lech 1997, Trela-Kieferling 2013). While remains of this cultural unit are widely present at the site, the archaeological context indicates that the item should be linked with the Trzciniec culture. Additionally, the shape of the back differs from the very steep retouch characteristic of the Zele-type knives, which makes this artefact hard to interpret unequivocally.

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FLINT AND BRONZE SPEAR AND ARROWHEADS FROM THE BRONZE AND IRON AGE SETTLEMENT AT RUSZOWICE IN SW POLAND

ABSTRACT

Hrynkiewicz-Bogenryter A. and Baron J. 2022. Flint and bronze spear and arrowheads from the Bronze and Iron Age settlement at Ruszowice in SW Poland. *Sprawozdania Archeologiczne* 74/1, 513-524.

We analysed a small collection of three arrowheads and one piece of spearhead. They were made of flint and metal and come from the Bronze and Early Iron Age settlement at Ruszowice in today SW Poland. Although only one comes from a settlement pit, we argue they were used by the community occupying the site at the beginning of the Urnfield period which starts around 1300 BC. All four objects bear clear traces of use including hafting and sharpening proving they use in every-day life.

Keywords: arrowheads, flint, metal, Bronze Age, settlement
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1. INTRODUCTION

In recent years, flint objects found at various Bronze Age sites in today's Poland have received more attention and are not considered just relics of the past technologies (*e.g.*, Lech and Piotrowska 1997). It seems obvious that the implementation of metal tools took a long time and depended on access to raw materials, individual skills, and knowledge transmission models. This process was stretched over centuries and represented various dynamics. This is particularly well observed at Early Bronze Age high-rank sites like Bruszczewo or Maszkowice with early evidence of the use of metal tools (on bone and antler objects: Kneisel 2010; Przybyła and Jędrysik 2018). The evidence from other contemporary sites proves rather co-use of tools made of various raw materials at least to the early part of the Iron Age (for bone and antler see Baron and Diakowski 2018). There is also evidence of intense re-use of older Neolithic flint tools on one hand, and the continuation of production of flint tools in the Bronze Age demonstrating a surprisingly unified style (Masojć 2018, with further literature therein). The latter was based on surface-collected erratic flint and in some areas raw material obtained from flint mines, well-dated to various stages of the Bronze Age (Lech *et al.* 2011). Flint objects were, therefore, present in the everyday life of Bronze Age communities together with the metal, wooden, lithic, bone, or antler ones.

This paper discusses the chronology and function of three arrowheads and one spearhead found at the Bronze Age site at Ruszowice in SW Poland (Fig. 1: 1). Two are made of flint and two of copper-based alloy. We assume it is tin bronze (as were most of the objects of this type and chronology) and will use this term in further paragraphs. We analysed the micro traces on the arrowheads using an Olympus SZX9 stereoscopic microscope and a metallographic microscope Nikon Eclipse LV 100 at the Institute of Archaeology, University of Wrocław. The interpretation of observed traces on the flint objects was based on published libraries (van Gijn 1989; Osipowicz 2010; Nowak and Osipowicz 2012; Kufel-Diakowska and Bronowicki 2017; Małecka-Kukawka 2017). The metal objects were documented under the microscope both before and after conservation work.

2. THE SITE

The settlement is located on a slope of a small hill with SE exposition and near a seasonal stream called Krzemienica, 5 km east of Kłodzko (Fig. 1: 2). After a successful surface survey, the excavations started in 2014 and were continued until 2018 (Baron *et al.* 2018; 2021). They produced 321 pits, 7618 pottery sherds, 28 flint objects, three metal artefacts of prehistoric chronology, and two stone axes (Fig. 1: 3). All the pits and all the artefacts are dated to two stages of the settlement use: one is the beginning of the so-called Urnfield

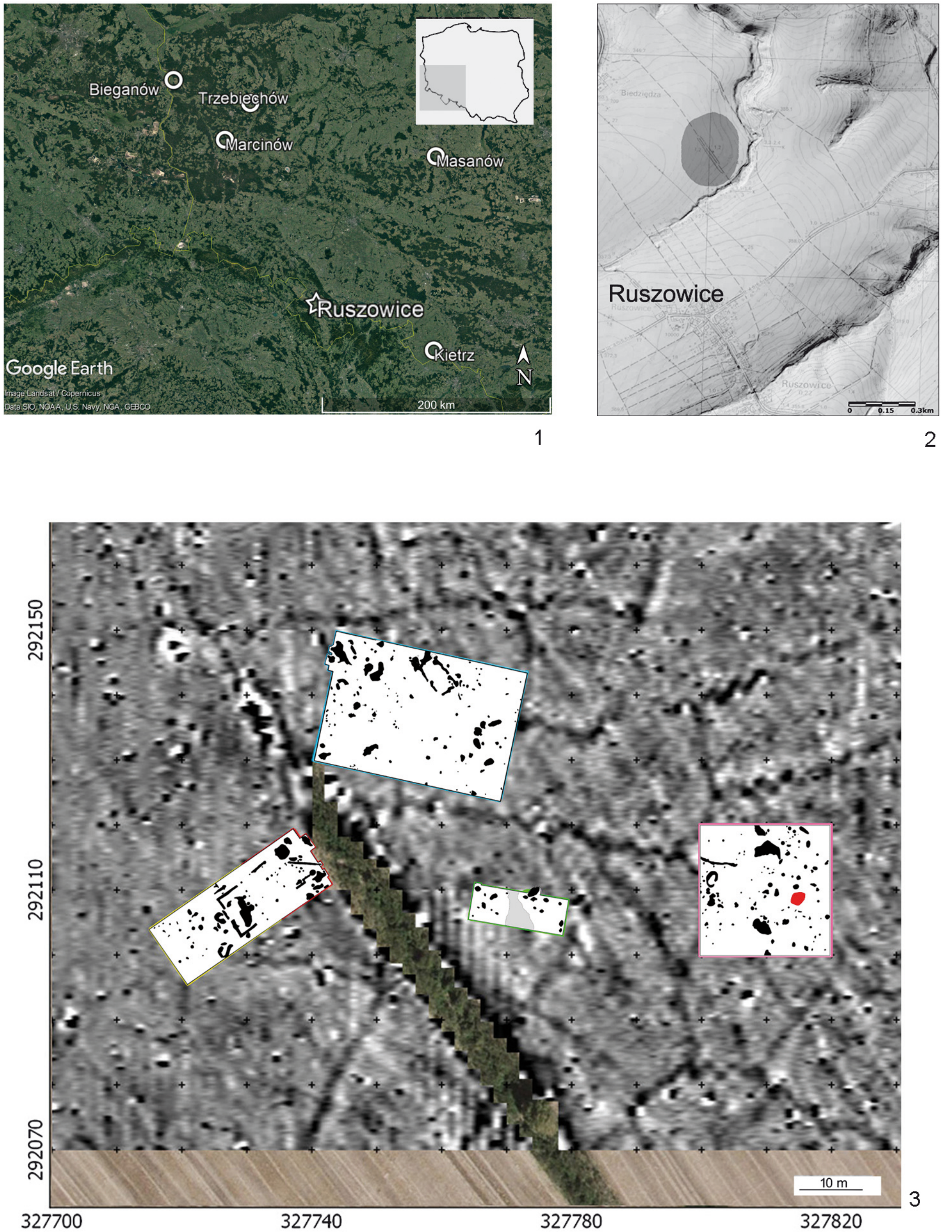

Fig. 1. Localisation of site Ruszowice.
1 – locations mentioned in the paper, Ruszowice is marked by a star; 2, 3 – part of the settlement at Ruszowice excavated in 2014-2018, a red dot marks a storage pit where one of the arrowheads was found.
Source: google maps; Baron *et al.* 2018

period (starting around 1300 BC) and the other to the Early Iron Age (starting around 750 BC). A settlement with similar structures and the same two-stage chronology comes from Kłodzko-Książek about 5 km NE of Ruszowice (Romanow 1971; 1974). On the surface of the Ruszowice site and in the topsoil many objects of the late medieval and modern periods were found as well. It is noteworthy that no evidence of Neolithic or Early Bronze Age was found neither at the site nor in its vicinity. Due to a complete lack of organic material, no ^{14}C dating was possible and the dating is based entirely on the characteristics of artefacts, in this case mostly ceramics.

3. ARROW- AND SPEARHEADS

On the site, three arrowheads and one piece of spearhead were found. Except flint arrowhead no. 1 which comes from a large storage pit no. 276, all were found on the site surface and in the topsoil. We realise this makes their chronology disputable, due, however, to the fact that the site was settled only during the Bronze and Early Iron Ages, we treat them as evidence of these settlement episodes.

The site produced a collection of 25 flint objects. They are mostly half-products and debris including chips (4), blades (4), flakes (6), and splintered pieces (2). The objects representing more advanced working are retouched blades (2), retouched flakes (5), and the two arrowheads that are discussed in this paper.

Arrowhead 1 comes from a large structure with flat bottom interpreted as a storage pit. Today the artefact is 20 mm long with maximal width of 18 mm and thickness at the base reaching 4 mm (Fig. 2: 1). Both faces of the tool are retouched at the edges. Arrowhead 2 was found in 2014 during the surface survey which proceeded each excavation season. The maximal length of the specimen was 18 mm, width 12 mm, and thickness of 3 mm (Fig. 3: 1). Like arrowhead no. 1, this item was retouched on both faces along the edges. Both arrowheads were made from the locally accessible erratic Baltic flint of rather poor quality (Hrynkiewicz-Bogenryter 2021, 11). According to a classification offered by *e.g.*, Borkowski and Kowalewski (1997), they represent Early Bronze Age heart-shaped arrowheads. They are slender with maximal width situated above the barbs and arch-shaped base (Borkowski and Kowalewski 1997, 208-209).

A metal detector was used to search the topsoil preceeding each excavation season at the site, one of the finds made by this means was a complete socketed bronze arrowhead. It is a small object with a triangle-shaped leaf and a socket with a perforation in its wall which is probably a miscast (Fig. 4: 1). The arrowhead is 25 mm long and 10 mm wide. The socket section is oval and measures 7 × 8 mm. The mouth of the socket is slightly bent inwards which was designed to stabilise the core in course of casting (comp. Baron *et al.* 2020). The triangle-shaped leaf arrowheads without barbs are mostly dated to the early Urnfield period which starts roughly around 1300 BC. M. Gedl argues they occur mostly in

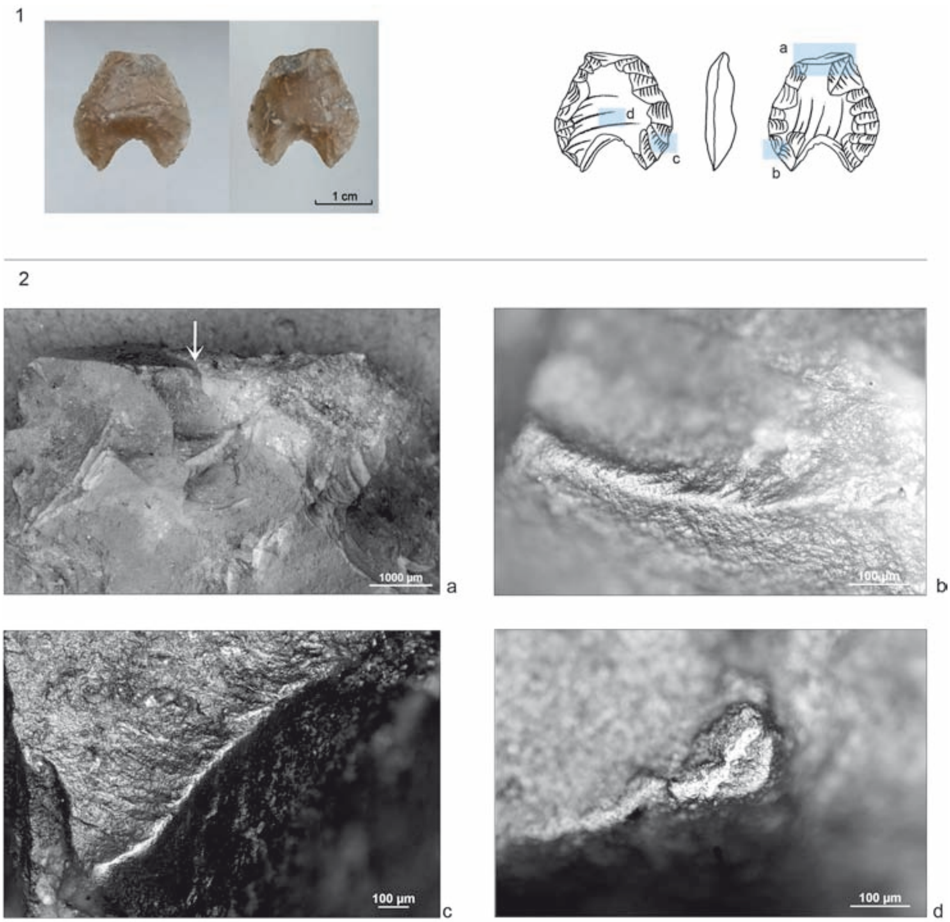

Fig. 2. Flint arrowhead no. 1:
1 – general view; 2 – microctraces: a – impact scar, b, c – rounded negative edges, d – glossy spots.
Drawing and photographs A. Hrynkiewicz-Bogenryter

graves, while they are extremely rare at settlements (2004, 24). The chronology of the arrowhead corresponds therefore with the first stage of the settlement.

A piece of metal spearhead is 51 mm long and 23 mm wide (Fig. 4: 2). In its cross-section, the top of a socket is observed. In this part, the maximal thickness of the piece was 7 mm. The specimen is heavily damaged, the tip is rounded and along the edges many notches and cracking are noticed. The fragment is too small to date it, the general shape and patina are, however, completely different from other copper-based objects found at the site.

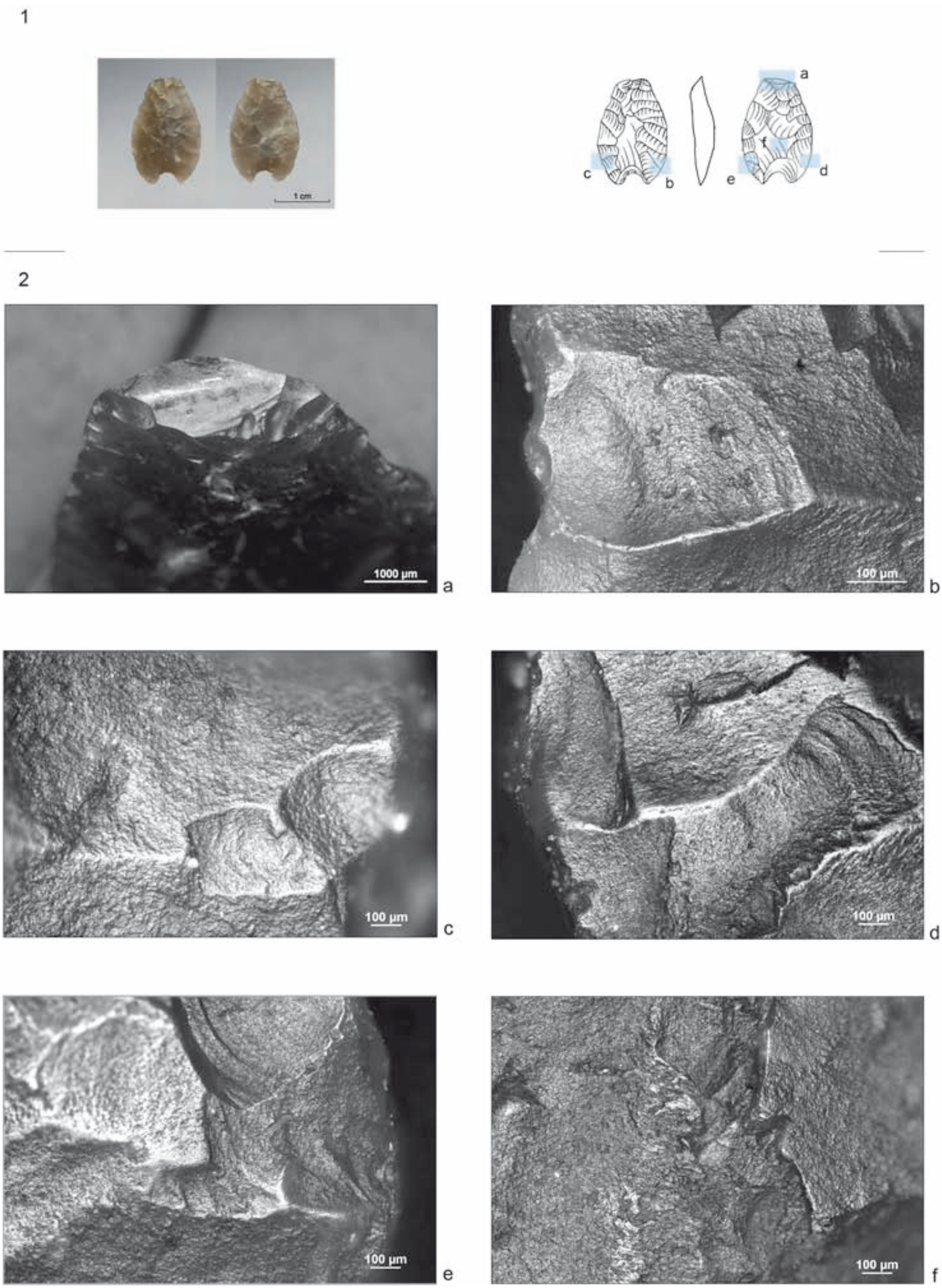

Fig. 3. Flint arrowhead no. 2:
1 – general view; 2 – microctraces: a – impact scar, b-e – rounded negative edges, f – glossy spots.
Drawing and photographs A. Hrynkiewicz-Bogenryter

4. MICROTRACES

Flint arrowhead 1

The object was used, proved by an impact scar at the tip (Fig. 2: 2a) and numerous chips along the edges. The facture of the surfaces made the observations difficult but at the barbs, on both faces, rounded retouch ridges were noticed (Fig. 2: 2b-c). In the central part of the specimen, some glossy spots were also visible (Fig. 2: 2d). Both the spots and rounded retouch ridges may confirm hafting.

Flint arrowhead 2

Breakage of the tip is observed however its origin remains unclear (Fig. 3: 2a). At the barbs, the ridges between surfaces of flake scars are rounded and abraded (Fig. 3: 2b-e). The origin of such traces is not clear. One of the interpretations is that they reflect a deliberate

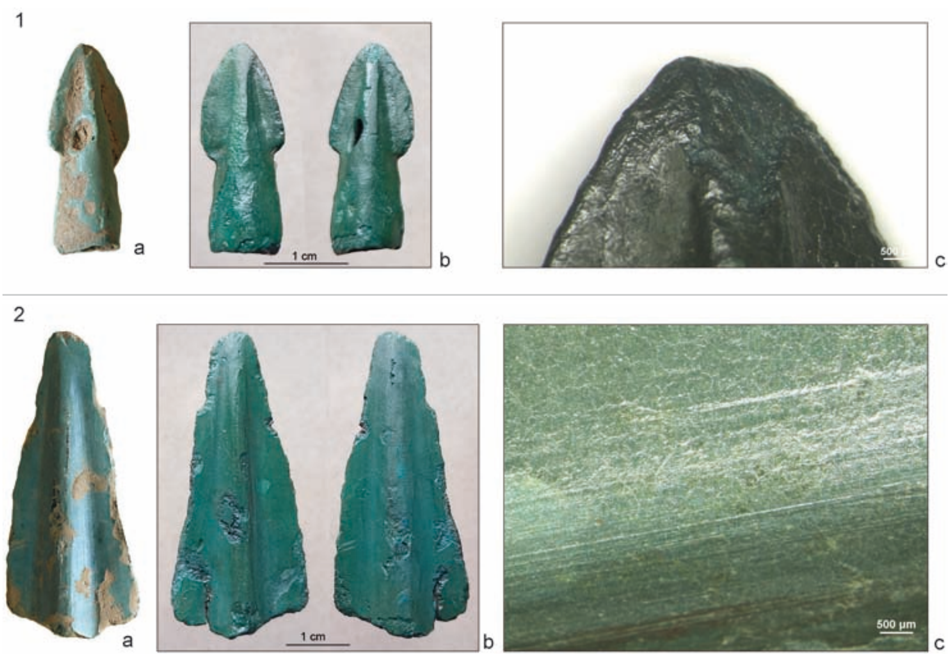

Fig. 4. Metal objects:
1 – socketed arrowhead: a general view before (a) and after (b) conservation, c – rounded tip;
2 – a fragment of a spearhead: a general view before (a) and after (b) conservation, c – traces of sharpening.
Photographs M. Konczewska, J. Baron

abrasion before hafting (van Gijn 2010). In the central part of the arrowhead, some glossy areas were also observed (Fig. 3: 2f). They might have also resulted from hafting.

Bronze objects

The only clear trace on the arrowhead is the rounded tip, which can be the result of the use (Fig. 4: 1c). On the fragment of a spearhead, long parallel striations are visible, both in macro (Fig. 4: 2a) and micro observations (Fig. 4: 2c). They are located on the leaf along with the socket and are typical traces of sharpening observed on objects of similar shape (*e.g.*, Baron *et al.* 2020).

5. DISCUSSION

The use traces were observed on all four specimens. Flint objects were hafted and their tips were broken, metal ones were intensively used which resulted in a rounded tip or repaired as proved by sharpening traces. What was the function of these objects? This question may be trivial but only the function of metal arrowheads is usually obvious. They were shafted and launched from bows to reach distant targets. Flint arrowheads were sometimes used as sickle inserts (*e.g.*, Schlichtherle 1992) and bronze spearheads might have been both thrown or used in direct combat (Anderson 2011). The numerous finds of arrow- and spearheads in graves and settlement pits prove their use was a common skill in all stages of the Bronze Age (*e.g.*, Gedl 2004). They come from the site with only Bronze and Early Iron Age registered stages. Were they produced in the Neolithic or Early Bronze Age and then collected and incorporated into tool sets used in the Urnfield period? There are many examples of such procedures in the literature (*e.g.*, Gackowski and Osipowicz 2013, 187) and it seems that it was the case at our site. At Ruszowice the collection consists of both artefacts of the Neolithic chronology (retouched blades), Early Bronze Age (arrowheads), or late Bronze Age (splintered pieces).

J. Libera notes that many flint arrowheads are grave-goods in later stages of the Bronze Age (2001, 92). They also occur in several well-dated Urnfield contexts (Gedl 1997, 218, 219) also in today western Poland which represents less developed ”late” flint knapping compared to the eastern areas. They were found in at least four urn graves at Kietrz, in one case accompanied with bone and metal objects (Fig. 5: 1). The arrowheads were cremated together with the bodies and then deposited with the bones in urns or shallow pits. Grave 3228 contained the remains of an *Adultus* and *Infans* I (Gedl 1997, 218). All the graves can be dated to the early Urnfield period starting in this area c. 1300 BC which corresponds with the first stage of occupation at the Ruszowice settlement.

An interesting collection of flint objects (N=186) comes from a small urnfield (43 graves) at Masanów (Ziąbka and Martyniak 2001). Two arrowheads come from the topsoil,

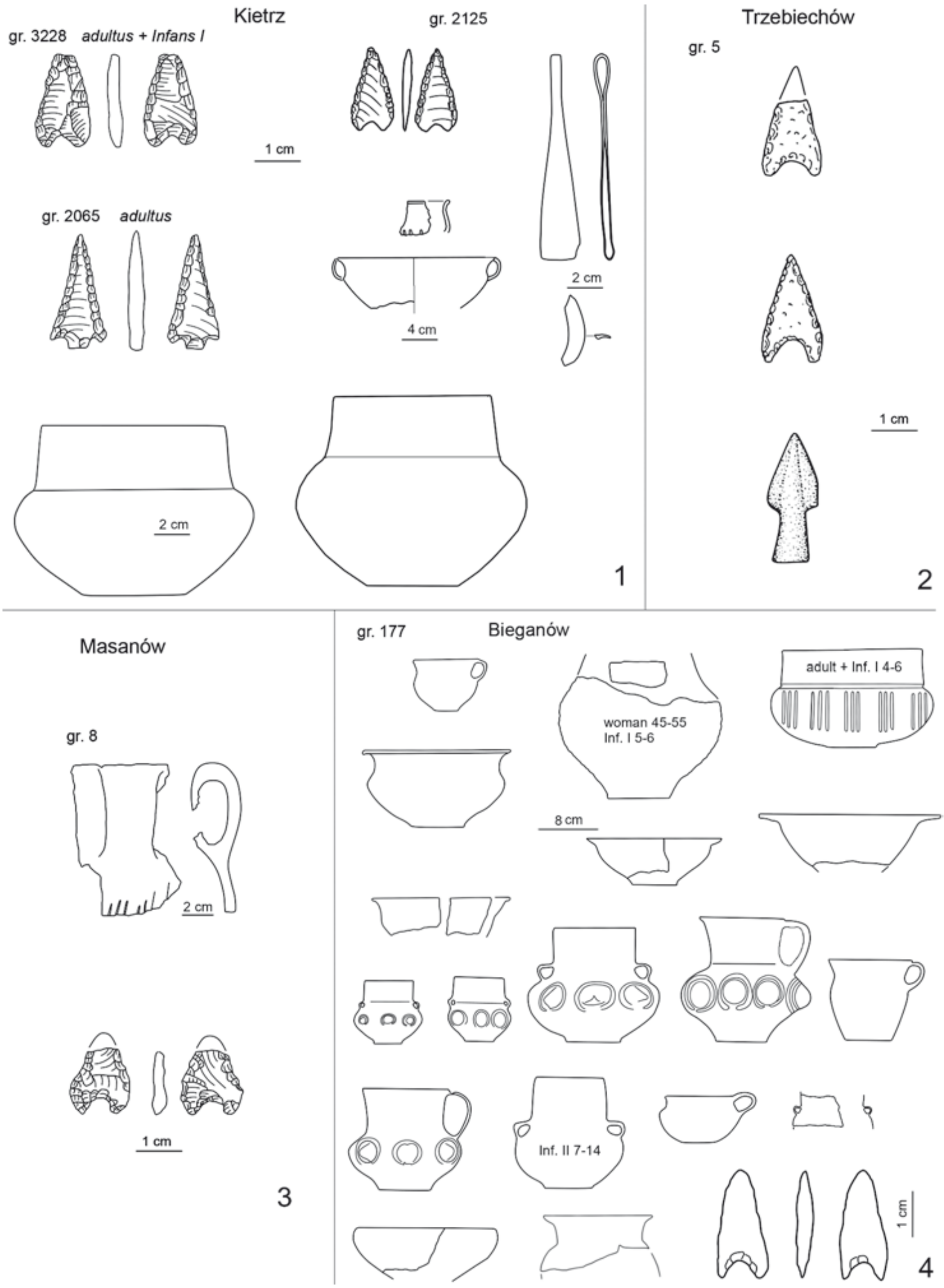

Fig. 5. Flint arrowheads in Urnfields contexts:
1 – Kietrz, 2 – Trzebiechów, 3 – Masanów, 4 – Bieganów. Source: Gedl 1997, Ziąbka and Maryniak 2001, Marcinkian 2010a

while other two were found in the grave pits (Fig. 5: 3). Another arrowhead made of metal was found in Grave 5 which contained remains of an *Infans* I. The authors date the site to the Montelius period III which corresponds with the chronology of the Kietrz graves.

Two other sites of the same chronology are cemeteries at Marcinów and Trzebiechów. At Marcinów a burnt arrowhead, probably cremated together with the body was found under a barrow. In Trzebiechów, two flint arrowheads were placed together with a metal one in an urn (Fig. 5: 2). Both sites were dated based on the properties of the pottery to the Montelius III period (Gedl 1997, 218-219).

At the Bieganów urnfield in today's western Poland, one flint arrowhead was found in a layer of broken ceramics and stones placed above grave 177 (Fig. 5: 4). The grave contained remains of at least five people deposited in three urns, both adults and children of various ages (Marcinkian 2010a, 79-80). According to Marcinkian, the grave is dated to period IIIb which is 1100-1000 BC (2010b, 20-21). In this case, that would be the youngest context producing a flint arrowhead.

These examples clearly show that flint objects, even if not produced as late as the Urnfield period were recognised, collected and reused by the Urnfield communities around 1300 BC onwards. We have discussed only selected examples of well dated grave contexts, but there are hundreds of them found at the settlements in most parts of today's Poland (Libera 2001; Gedl 2004). Clearly they occurred more densely in the areas with long-lasting flint knapping traditions typical for the Mierzanowice followed by Trzciniec culture. In a grave from Skurcz in Volhynia, they co-occurred with metal ornaments dated to the final Bronze Age (Libera 2001, 91). Flint arrowheads were given a similar meaning and value in the tradition of grave furnishing as the metal ones which is proved by co-occurrence of both types on the same site (Masanów) or even in the same grave (Trzebiechów). We are not able to answer if the flint arrowheads were produced by the community which lived at Ruszowice settlement around 1300 BC. However we argue that they were incorporated into this community's every day activities. Our collection, although modest, illustrates therefore well the successful co-existence and use of various raw materials.

Acknowledgements

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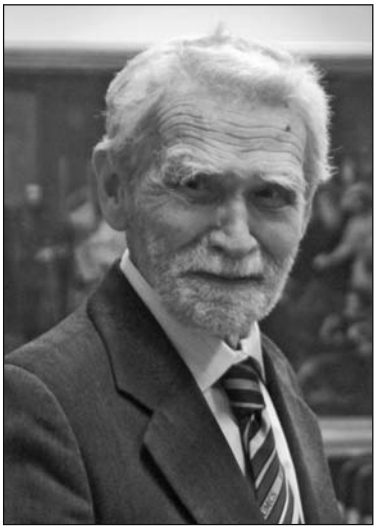
CHRONICLE

Anna Zakościelna[1]



JAN GURBA PHD, DSC
(15 February 1929 – 30 October 2021)

30 October 2021 was marked by the death of Jan Gurba PhD, DSc – our Teacher, Boss for many years and Friend – who left us at the age of 92. Crowds bid him farewell on a sunny Tuesday, 16 February, first in the Academic Church of the Catholic University in Lublin and then in the 'Lime Park', at the cemetery by Lipowa Street in Lublin, where he was buried next to his wife Stefania and his parents.

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Jan Gurba was born in Lubartów, but his whole life was related to Lublin, where his parents moved in the middle of the 1930s. It was here where he received his entire education. He studied in the primary school and then at the Union of Lublin Secondary School, where he passed his matura exam in 1948. Next, Jan started two degree courses at the Faculty of Mathematics and Natural Sciences – prehistory and geography. He defended his Master's thesis *Kultura wenedzka na Lubelszczyźnie* (*The Venedian culture in the Lublin Region*) in 1951. The work was written under the supervision of Prof Stefan Nosek. Jan Gurba graduated in geography in 1952 – specialisation in cartography – with the defence of his Master's thesis – *Geograficzny obraz świata w atlasach: Powszechny atlas geograficzny E. Romera (wyd. II) i Sydow-Wagnera Methodischer Schulatlas (wyd. XXIII)* (*Geographical Image of the World in Atlases: Romer's General Geographical Atlas [2nd ed.] and Sydow-Wagner's Methodischer Schulatlas [23rd ed.]*) – supervised by Prof. Franciszek Uhorczak. The same year, Jan Gurba started working as an assistant lecturer at the Department of Polish Archaeology, Humanities Faculty, Maria Curie-Skłodowska University (UMCS). In 1961, he defended his PhD thesis *Wpływ środowiska geograficznego na kształtowanie się neolitycznego osadnictwa w Małopolsce* (*Influence of the Geographical Environment on Shaping the Neolithic Settlement in Lesser Poland)* (Gurba 1961) – written under the supervision of Prof. Stefan Nosek – and then was employed as an assistant professor. In 1969, Gurba obtained the title of the Doctor of Science in the Department of Polish and General Archaeology (from 1970 – Department of Ancient History and Archaeology at the Institute of History UMCS, from 1983 – Department of Archaeology, from 2003 – Institute of Archaeology).

Jan Gurba – archaeologist and geographer, scholar, academic lecturer, regionalist and bibliophile – spent his professional life researching the earliest history of the Lublin region. The period of his university studies was the time directly after the Second World War, when new centres were being created in Lublin and the Lublin region: the scientific archaeological centre at the university and monument preservation offices in central and local administrations. Therefore, working together with Prof. Stefan Nosek PhD, and Jan Kowalczyk, PhD, he was one of the pioneers of the local archaeological research, which was initially concentrated on gathering materials and exploring the previously unknown territories of the Lublin region, neglected during the interwar period. He consecrated his entire professional activity to these tasks. Before he became an assistant lecturer at the Department of Archaeology, UMCS in 1952, in January of that year he had started working as an inspector-expert of the Ministry of Culture and Art, that is the conservator of monuments for Lublin and Kielce voivodeships (until 1961). He spent nearly all of his professional life on monuments conservation, researching and rescuing many sites. In 1975-1990, he also presided in the Archaeological Research and Conservation Centre in Lublin.

Jan Gurba's entire professional life was linked with the Maria Curie Skłodowska University in Lublin, where he worked for 42 years, until he retired in 1994. His work at the University was not limited to research activity and education (he supervised 115 MA and 5 PhD theses), but it also encompassed occupying different positions in the administration of the university. In 1969-1970 and 1975-1981, he was the associate dean of the Humanities Faculty at the UMCS. In 1970-1975, Gurba was the head of the Main Library at the UMCS. In 1974, he took the post of the director of the Department of Polish Archaeology at the Institute of History, UMCS. In 1981-1983, he was the vice-director of the Institute of History at the UMCS, and in 1986-1987 – once again the associate dean of the Humanities Faculty, UMCS. In 1987-1990 he occupied the post of the dean. He was the head of the Department of Archaeology continuously until 1994.

In an enormous number of publications – over 1150 titles – the late Jan Gurba tackled the cultural development of the interfluve of the Vistula and Bug Rivers, starting with the arrival of the first human groups in the Palaeolithic to the beginnings of the Polish state (Goworczyk 1988; Kurzątkowska 2007). He contributed to the archaeology of our region, country and Central Europe with numerous important discoveries and publications. We owe to him the discovery of the first site of the Chłopice-Veselé culture in the Lublin region (Gurba 1955), distinguishing the materials of the Madarovce culture from the Early Bronze Age (Gurba 1957a), the first publication on Roman imports from the Lublin region (Gurba 1958), identification of the first monumental tombs of the Funnel Beaker culture in the Nałęczów Plateau (Gurba 1957b; 1959), the first description of the Eneolithic Lublin-Volhynian culture of Painted Pottery (and the introduction of this name into the archaeological literature – Gurba 1973). Among Jan Gurba's professional achievements, most noteworthy are his settlement research aimed at explaining the relationship between human communities and the environment. He started them early, when writing his doctoral dissertation –he published the most important theses of this work in an article *Neolithic Settlements on the Lublin Loess Upland* (Gurba 1961) – and later he continued these studies, also in relation to the Early Middle Ages (Gurba 1978; 1983). In Polish archaeology, but also in geomorphology, he was the pioneer in ecological studies of settlements, which were later developed by Janusz Kruk (1973), Jolanta Nogaj-Chachaj (1993; 2004) and many other scholars (*e.g.*, Rydzewski 1986; in geomorphology: Śnieżko 1995). Later, this research direction attained the status of a subdiscipline of archaeology. Gurba was the author of chapters consecrated to the Funnel Beaker and Globular Amphora cultures in the monograph on the prehistory of Poland (Gurba 1989a; 1989b). An important place in his professional life was occupied by bibliographical notes announcing new, important publications, especially those about the archaeology of Eastern Europe (Goworczyk 1988; Kurzątkowska 2007).

Jan Gurba's archaeological excavations and scholarly achievements are mainly associated with the Younger Stone Age and early Middle Ages across the Lublin region. Research devoted to the former period include expeditions to Chruszczów Kolonia, Nałęczów Kolonia, Strzelce Kolonia, Drzewce Kolonia, Las Stocki, Stok, Wąwolnica and Bochotnica, research at the sepulchral sites of the Funnel Beaker and Globular Amphora cultures, excavations of the multicultural settlement in Strzyżów, in Gródek, Werbkowice, Żuków, Moniatycze Kolonia and at many other sites of the Hrubieszów Basin. Researches on the early Middle Ages in the region focused mainly on the stronghold in Czermno-Czerwień along with the adjacent settlement and cemetery (1986; 2004). Among many spectacular discoveries of the expeditions to Czermno, the most important is a famous icon with the image of Christ Pantocrator (Gurba 1982).

Jan Gurba presented the results of his field research and cabinet studies at numerous conferences and scientific congresses in Poland and abroad. He participated, *e.g.*, in the international congresses of the Prehistoric Union in Belgrade (1971) and Nice (1976) as well as in international congresses on Slavic archaeology in Warsaw (1965), Berlin (1970), Bratislava (1975), Sofia (1980) and Kiev (1985). Other events in which he took part include the Congress on Ancient History in Tokyo (1987), International Congress of Historians in Bucharest (1980) and International Palaeontological Congress in Nice (1982). He was an active scholar – in Poland and abroad – and initiator of various scholarly projects, which were not limited to the archaeological circles of Lublin. In 1954-1959, 1974-1987, he was a member and the president of the Lublin Branch of the Polish Archaeological and Numismatic Society and member of its main board. He was also included in the editorial staff of a popular science magazine *Z Otchłani Wieków,* which was issued by the Society. Gurba was also a member of the Association of Art Historians, Polish Historical Society, Polish Geographical Society, Scientific Society of Lublin, Social Commission for the Protection of Monuments at the Polish Tourist and Sightseeing Society (PTTK), honorary member of the Regional Society of Hrubieszów (he also belonged to the editorial board of the Society's bulletin), Society of Enthusiasts of Lublin and the board of the Society in 1969-1970; member of the Polish Teachers Association, Scientific Board of the Institute for the History of the Material Culture at the Polish Academy of Sciences and Council for Archaeological Monuments at the Ministry of Culture and Art. He actively worked with the museums of our region and country as the co-author of numerous archaeological expositions and publications and as a member of museum councils (including the National Archaeological Museum, Lublin Museum, Zamość Museum and Vistula River Museum in Kazimierz Dolny).

The popularisation of the archaeological heritage of the Lublin region was always an important part of Jan Gurba's work. He was an author of many popular science publications and chapters on archaeology in monographs describing various towns of our region. He gave an enormous number of lectures for various people, he was a frequent guest of the local media. His cooperation with regional associations operating across the Lublin region – especially the Regional Society of Hrubieszów – where he actively worked as a member and the honorary chairman – was another aspect of this activity.

Jan Gurba was a great admirer of books and literature. For many years, he held the position of the chairman of the Lublin Society of Book Enthusiasts. He was decorated with the Order of the White Raven with Sunflower. Gurba was a collector and expert in small graphic forms – especially *ex libris*. He popularised archaeological *ex libris* in various publications – especially in the magazine *Z Otchłani Wieków*. He himself was an owner of *ex libris*– especially those linked with archaeology– made for him by various artists.

He was decorated with the honorary distinction of the Polish Student Association. Other accolades include the Gold and Silver Cross of Merit, order of *Polonia Restituta*, medal of the Commission of National Education, medal of the Polish Archaeological Society *Meritorious for the Polish Archaeology,* UMCS medal *Science at the Service of People*, medal *Meritorious for the UMCS*, silver and gold medal *Meritorious for the Hrubieszów District*, gold badge *For Monument Protection*, gold badge of the *Polish Teachers Association*, gold honorary badge of the PTTK, distinction *Meritorious Activist of Culture*, distinction *For Merits for the Lublin Region*, medal and prize awarded by the Mayor of Lublin. Jan Gurba was the laureate of individual and collective prizes of the Minister of Science, Higher Education and Technology. The students of the Humanities Faculty, UMCS honoured him several times with the title of *Homo didacticus*. In 2020, he was awarded by the creative circles of Lublin with the *Angelus Lubelski* prize in the category 'Lifetime Achievement' for 'active, brave and successful people and for those whose attitudes give hope and restore respect for every person'.

The late Jan Gurba was a broad-minded man with a great heart, thoroughly honest and modest, kind to everyone he met in his life, always smiling and with a great sense of humour. He did not pay attention to titles and honours and he did not expect much from life. At the same time, he was extremely sensitive to others' needs. He always had time to pay attention to them and offer pieces of advice. He helped many and many owe him what they are today.

Rest in peace, Boss. We miss you dearly.

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REVIEWS AND SHORT REVIEW NOTES

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(review) Peter Stadler and Nadezhda Kotova, *Early Neolithic Settlement Brunn am Gebirge, Wolfholz, in Lower Austria* 1. *Early Neolithic Settlement Brunn am Gebirge, Wolfholz, Site 2 in Lower Austria and the Origin of the Linear Pottery Culture (LPC)* (= *Beiträge zur Ur- und Frühgeschichte Mitteleuropas* 88). Langenweißbach 2019: Verlag Beier & Beran. ISBN 978-3-95741-100-6. 2 volumes, 1082 pages with colour figures and tables.

Further authors: Franz Brandstätter, Otto Cichocki, Svend Hansen, Ian G. Hedley, Nadezhda Kotova, Matthias Kucera, Eva Lenneis, Michaela Lochner, Alexander Minnich, Alexey G. Nikitin, Friederike Novotny, Beate Maria Pomberger, Erich Pucher, Leopold Puchinger, Anna Rauba-Bukowska, Roman Sauer, Friedrich Sauter, Julian David Schrattenecker, Peter Stadler, Maria Teschler-Nicola, Kurt Varmuza, Wolfgang Werther, Silvia Wiesinger.

The field surveys in Brunn am Gebirge conducted for many years by Peter Stadler, PhD are widely known amongst the European archaeologists. These investigations have delivered a great amount of new data referring to the Linear Pottery Culture (LBK). This research has produced much significant information on the settlement, architecture, and economy of these first farming societies that, starting from the half of the 6th millennium BC, lived in and expanded over vast areas of Europe, from the Paris Basin to Ukraine. Until present, the results of these investigations have been presented in numerous articles and papers given during various scientific conferences.

The publication in question is the first of the long-awaited monographs devoted to reporting the sites in Brunn am Gebirge. It consists of two volumes addressing, in particular, pottery from the sites 2a and 2b, as well as interpretations of radiocarbon datings and certain specialised analyses (archaeobotanical, anthropological, petrographic and mineralogical), research performed on ceramic materials, thermo-chemical analysis of hearths, and chemical analysis for the remains of some organic materials.

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Volume 1/part a is arranged in 28 main chapters. Chapter 1 by R. Sauer and P. Stadler presents a brief overview of the geology and types of soils identified in the area of the sites in Brunn am Gebirge, and the following (Chapter 2, M. Kucera, A. Minnich, P. Stadler) addresses the issues of the topographical situation. Then, (Chapter 3) P. Stadler discussed the history of investigations of particular areas, namely Area 01-Area 19. The entire undertaking was launched in 1989 and was intended as a rescue survey preceding a public highway project. This area turned out to be very rich in archaeological findings, so the research was continued and ultimately completed in 2005. In the following sections of the publication, the introductory issues are discussed one by one, namely, total station surveying maps and aerial photos, then results of geomagnetic analyses and finally, the systems of the recording of the ceramics.

The main part, dedicated to archaeological artefacts, starts from Chapter 7. This is indeed an introduction to the discussion on the specialised analyses. In this section, E. Lenneis characterised the basis of ceramic assemblages, describing the major forms and ornamentation of vessels as well as other artefacts made of clay. In similar style, S. Hansen discussed (Chapter 8) two clay idols.

The following sections address the issue of the Neolithic hearths from Site 2 (Chapter 9, I. G. Hedley; Chapter 10, A. Minnich). Four human graves were also encountered within the boundary of the settlement discovered on Site 2 They were described in detail in the following chapter (P. Stadler), together with presentation of radiocarbon datings and comparisons with other graves.

Chapter 12 is dedicated to the Image Database Montelius (for Building a Neolithisation Archive), created by P. Stadler especially for the purpose of processing the information from the complex of sites in Brunn am Gebirge. Step by step, this database has been extended enormously, enclosing the data from the LBK sites from the entire area of Europe. This is the first tool of this type providing very easy access to the entire published literature and allowing us to process the archaeological data in any required, multi-aspect manner. This database has been created, modified and improved for ten years, during which time over 500 thousand pieces of information from the whole of Europe have been entered. Amongst many possibilities it provides, one can name an ability to deliver data almost immediately and automatically, on the following issues: 1) analogies and typologies; 2) one's own typologies; 3) various graphical presentations of statistical analyses and comparisons, such as seriation, correspondence analysis (WinSerion); 4) maps presenting *e.g.*, distribution of types of artefacts over the territory of Europe, dispersion of archaeological sites or particular types of features; 5) the so-called global mapping (Montelius Entry GoogleCode) in cooperation with Google Maps (mapping any required data gathered for a selected part of the Google Maps); 6) the so-called local mapping enabling graphical presentation of data within the investigated archaeological site, for instance, distribution and spatial relationships between particular types of features and artefacts; 7) maps reconstructing the extent of cultural groups in Europe. This tools was employed for the processing of ceramic assemblages from the settlements in Brunn am Gebirge.

A very significant element of the monograph in question is Chapter 14 (P. Stadler, N. Kotova), presenting the sequences of numerous radiocarbon datings (including from PPN, Starčevo, Körös), in comparison with those referring to the Linear Pottery Culture. Then, these dates were interpreted in the context of chronological schemes functioning in the European Neolithic (according to R. Tichý, J. Pavúk). Based on this, an ultimate periodisation of Site 2 in Brunn am Gebirge was presented in the volume's Chapter 15 (N. Kotova). The following three chapters by N. Kotova and P. Stadler are dedicated to the processing of all of the fragments of the LBK vessels collected from Site 2, starting from technology, typology of forms, ending with ornamentation and presentation of these assemblages against the European background. An extremely precise typology of vessel forms was obtained, which can now be successfully used for classification of pottery from the entire extent of the LBK; this is very useful in every present and future analysis of sites of this culture. The next two chapters contain descriptions of all other clay artefacts, such as figurines, amulets, discs, musical instruments, etc.

In the successive sections of the monograph, one can find two synthetic texts that are of great interest for researchers of the Early Neolithic. Chapter 21 (N. Kotova, P. Stadler) contains a summary and characterisation of the LBK formative phase, while the Chapter 22 (P. Stadler) is dedicated to considerations upon the relationships between the Mesolithic and Early Neolithic societies, exemplified by traces of massacres, mass graves and fortifications recorded at many archaeological sites.

The last section of the Volume 1/part a consists of a few chapters and is dedicated to several selected issues. One of these is the petrographic analysis of the LBK pottery against the background of the neighbouring regions, namely Hungary, Croatia, Ukraine and Slovenia (A. Rauba-Bukowska), as well as petrographic and mineralogical analysis of the pottery from Brunn am Gebirge, Wolfholtz (R. Sauer). Another chapter contains the analyses of charcoals from the site in question (O. Cichocki), plant remains, (S. Wiesinger), a text addressing the issue of utilisation of honey bees (P. Stadler), and finally the analysis of animal remains (E. Pucher). Most of these chapters could have been successfully published as separate articles.

The Volume 1/part b consists of 15 main chapters, enclosing further analysis and auxiliary material. Chapter 29 (M. Teschler-Nicola, F. Novotny) presents the results of the anthropological analysis of human skeletons from the graves 1-4. Then, there is an analysis of remains of dyes preserved on the surfaces of ceramic vessels performed with the use of the Scanning Electron Microscopy (F. Brandstätter), followed by a chemical analysis of organic materials preserved on the surface of one of the clay idols (F. Sauter, K. Varmuza, W. Werther, P. Stadler), chemical analysis of pitch (L. Puchinger, F. Sauter, J.D. Schrattenecker), as well as radiocarbon dating of samples of birch bark pitch used as an adhesive substance to attach decorative applications recorded on a few vessels from Brunn am Gebirge, Wolfholtz (P. Stadler). Chapter 34 (A.G. Nikitin) addresses the issue of the Anatolian Neolithic migration from the archaeogenetic viewpoint.

The following chapters, all written by P. Stadler and N. Kotowa, contain illustrative and auxiliary materials, such as: plates with ceramics, abstract, conclusions, references, catalogue of radiocarbon dates, list of authors, excavation photos from Brunn am Gebirge, Wolfholtz, Site 2.

The monograph in question constitutes a very significant contribution to the current state of research on the neolithisation of Europe and is an extremely valuable supplement to the studies upon the Linear Pottery Culture. It is an outstanding piece of work, abundantly illustrated with colourful figures, photographs, maps, tables and lists of artefacts.