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CONTENTS

Grzegorz Osipowicz, Justyna Orłowska
Editorial 9

ARTICLES

Natalia Bulyk
Kazimierz Żurowski (1909-1987): life and work in Lviv till 1945 13

Marzena Woźny
The beginnings of Polish archaeological museums in the 19th century 33

Sylvie Beyries, Cristina De Stefanis, Eugénie Gauvrit Roux
Combining experiment and ethnoarchaeology to differentiate the surface conditions of animal hides 53

Dagmara H. Werra, Marcin Szeliga, Katarzyna Pyżewicz, Pavel Burgert
Value, significance and use of 'exotic' materials in the light of the presence of obsidian at Neolithic sites in Poland ... 71

Kamil Nowak, Dawid Sych
Traceology of metalwork – limitations and new perspectives 99

Ana Tetruashvili
Grinding Installations in Pre- and Protohistoric Eurasia. A case study from Georgia – typological, traceological and experimental study of a grinding installation from Grakliani Hill Archaeological site 123

Éva David
On the Polysemic Nature of Traces and Co-occurring Patterns in Anthropized Material — contribution of a "Retoucher" with a Flaked Bone Aspect from Roc-en-Pail (France) 139

FIELD SURVEY AND MATERIALS

Magdalena Sudoł-Procyk, Grzegorz Osipowicz, Kacper Baranowski
The Magdalenian site Kleszczowa 9, Pilica commune, Silesian voivodship (Kraków-Częstochowa Upland, Poland). Multi-aspectual analysis of the flint inventory and the importance of the site 159

Katarzyna Pyżewicz, Michał Przeździecki, Witold Grużdź, Bartosz Kozak, Dominik Kacper Płaza, Beata Sobko
Biographies of Swiderian blades – various examples from the Polish territory 187

Tomasz Płonka, Marcin Diakowski, Marcin Chłoń, Robert Niedźwiedzki
New data on fossils in the Mesolithic of the Polish Plain 205

Justyna Orłowska
Mesolithic Ulna "daggers" from Dąbki Site 9 – on the track of their function 221

Emanuela Cristiani, Justyna Orłowska, Grzegorz Osipowicz
Identifying collagen residues on ground stone tools from Mesolithic sandy sites: selected examples from Paliwodzizna 29 in Central Poland 237

Krzysztof Kurzyk, Grzegorz Osipowicz, Justyna Orłowska, Justyna Kuriga
What has the sea taken from us? Cognitive possibilities of studying artefacts from newly-discovered submerged prehistoric sites in Puck Bay (Gulf of Gdańsk, Baltic Sea) 251

Marcin Szeliga, Grzegorz Osipowicz, Mariusz Bosiak
On the issue of functional use of picks during the Early Neolithic: a case study from the Linear Band Pottery culture site in Wólka Wojnowska (S. Poland) 285

Aldona Kurzawska, Iwona Sobkowiak-Tabaka, Małgorzata Mrozek-Wysocka, Tomasz Oberc
Tracing the Past: Microwear Analysis of Stone and Shell Beads Unearthed in Early Neolithic Burials at Samborzec, Poland 309

Anna Zakościelna, Grzegorz Osipowicz
Made of flint, bone and boar's tusks – burial goods from male Grave No. 2 in Świerszczów (Kolonia) Site 28, Hrubieszów District – attributed to the Malice culture – in the light of traceological analysis 335

Grzegorz Osipowicz, Gytis Piličiauskas, Giedrė Piličiauskienė, Grzegorz Skrzyński
Use-wear studies of the function of prehistoric wooden products, is it really possible? The example of pestles from sites in Šventoji, Lithuania 359

Bernadeta Kufel-Diakowska, Marcin Chłoń, Wojciech Bronowicki, Michał Borowski
Hidden lithic treasures. Research perspectives on museum collections of Neolithic stone tools 381

Kamil Adamczak, Magdalena Sudoł-Procyk
Macrolithic retouched blades from Kałdus and Stare Marzy: foreign technology and new ideology in the lithic traditions of the TRB communities in the Lower Vistula region 405

Piotr Mączyński
Old find – new information. Hoard of long flint blades from Wąworków (Sandomierz Upland, Poland) 427

Tomasz Oberc
Organisation of activities in settlements of the southeastern group of the Funnel Beaker Culture. Patterns of use and deposition of lithic artefacts from Zawarża, Site 2, Pińczów commune 445

Agnieszka Brzeska-Zastawna, Bernadeta Kufel-Diakowska, Albert Zastawny
A superb axe-head of G-type flint from the vicinity of Bronocice as a reason to consider the production of macrolithic four-sided tools in the Eneolithic of Lesser Poland 469

Andrzej Pelisiak, Thomas Saile, Maciej Dębiec
A contribution to research on the knapped lithic assemblage from the Late Neolithic site of Altheim in Lower Bavaria 497

Walenty Pankowski, Małgorzata Rybicka, Joanna Piątkowska-Małecka
Red Deer Antler Artefacts from Gordineşti II-"Stînca goală" and Vynnyky-"Zhupan": Shape-and-Trace Formation Processes in Natural, Functional and Depositional Contexts 533

Jerzy Libera, Piotr Mączyński
Flint arrowheads from assemblages of the Corded Ware culture: morphology and function – the example of the grave from Mydłów (Sandomierz Upland) 555

Jacek Gackowski
Flint arrowhead from a hoard in Papowo Biskupie, Chełmno district: comments on the discussion on the sacral function of lithic artefacts from the turn of the Iron Age 583

Janusz Budziszewski, Katarzyna Pyżewicz
Unusual transformations of sickle-shaped knives made of Ożarów flint 601

Justyna Baron, Kamil Nowak
Shifting techniques in perforating animal teeth and metal objects. Some examples from Early Bronze Age contexts 615

Krystyna Sulkowska-Tuszyńska, Justyna Orłowska
Osseous artefacts from the Church of St James in Toruń as a source of information on the production and use of everyday bone objects in Poland from the 14th to the 18th centuries 629

REVIEWS AND SHORT REVIEW NOTES

Andrzej Pelisiak
(Review) Janusz Kruk, Tomasz Oberc, Kathryn M. Hudson and Sarunas Milisauskas, *Neolithic Flint Technology at Bronocice (4th millennium BC)*. Kraków 2023: Institute of Archaeology and Ethnology. Polish Academy of Sciences, 314 pages, 33 tables, 55 figures, 37 plates, ISBN: 978-83-66463-78-3 657

Information for Contributors 663

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EDITORIAL



Professor Jolanta Małecka-Kukawka

Sadly, our friend, teacher, mentor, and colleague, Professor Jolanta Małecka-Kukawka, is retiring this year. She is a person without whom the Polish traceology school would probably not exist and certainly would not be as strong and dynamic as it has been for many years. It is tough for us to believe that the time has come when we will no longer see Jola so often at congresses and conferences (especially those on traceology), in the corridors of Institutes and Faculties of Archaeology, or simply in the field (though we hope this will still happen from time to time). We will greatly miss conducting with her joint archaeological experiments and engaging in discussions about use-wear traces, archaeological theory, and ordinary conversations about life. We sincerely hope, Jola, that you will still honour us with your presence and invaluable advice, even though you have decided that the time has come to rest and devote more time to matters more important than archaeology, namely yourself and your family.

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Professor Jolanta Małecka-Kukawka was born on September 4, 1955, in Lubsko, where she completed her high school education. She graduated with a degree in archaeology from Adam Mickiewicz University in Poznań, where she defended her master's thesis in 1980. Since 1982, she has been associated with the Nicolaus Copernicus University in Toruń, working her way up from an intern assistant to assistant, adjunct, and finally professor at the University. She defended her doctoral thesis in archaeology at the Institute of Archaeology and Ethnology of the Polish Academy of Sciences in Warsaw. Her doctoral thesis, titled *Krzemieniarstwo społeczności wczesno rolniczych ziemi chełmińskiej w II poł. VI-IV tysiącleciu p.n.e* [*The Flintworking of Early Agricultural Communities in the Chełmno Land in the Second Half of the 6th-4th Millennia BCE*] was supervised by Professor Jacek Lech and was defended in 1992. An important milestone in her career was the translation of Galina Fyodorovna Korobkova's traceology textbook into Polish, titled *Narzędzia w pradziejach Podstawy badania funkcji metodą traseologiczną* [*Prehistoric tools: Basis for the traceological method of functional study*] which was published in 1999. In 1995, Prof. Jolanta Małecka-Kukawka had participated with a group of students in a traceological camp in Izhevsk (Udmurt Republic, Russian Federation) organized by the Russian Academy of Sciences. As a result of the established cooperation, a two-week course of traceological analysis (the first in Poland) was organized at the Institute of Archaeology NCU in Toruń in April 1996.

In 2002, Professor J. Małecka-Kukawka earned her habilitation degree in the humanities in the discipline of archaeology from the Faculty of Historical and Pedagogical Sciences at the University of Wrocław, based on her academic achievements and habilitation thesis titled *Między formą a funkcją. Traseologia neolitycznych zabytków krzemiennych z ziemi chełmińskiej* [*Between Form and Function. Traceological Analysis of the Neolithic Flint Assemblages from Chełmno Land*]. In 2008, thanks to her efforts, the first official Traceology Laboratory in Poland was established at the Institute of Archaeology at Nicolaus Copernicus University in Toruń, which she headed for many years (from 2008 to 2019).

Another stage in Jolanta Małecka-Kukawka's research career involved studying flint materials from mining sites outside the Polish Lowlands. This work culminated in another monograph titled: *Traseologia w studiach nad pradziejowym krzemieniarstwem. Przykłady z osad i kopalń krzemienia w dorzeczach Wisły i Odry (neolit – epoka brązu – wczesna epoka żelaza* [*The use-wear analysis in studies of the prehistoric flint working – examples from settlements and flint mines from the Vistula and Odra basins (the Neolithic – Bronze Age – Early Iron Age)*], published in 2017. This book also served as the basis for Jolanta Małecka-Kukawka's application for and subsequent attainment of the title of professor in 2019.

Since 2008, Professor Jolanta Małecka-Kukawka has been a member of the Commission for Anthropology of Prehistory and the Middle Ages of The Committee of Pre- and Protohistorical Sciences of the Polish Academy of Sciences and, since 2012, a member of the International Union for Prehistoric and Protohistoric Sciences (UISPP). Since 2006,

she has also been a member of the commission for Flint Mining in Pre- and Protohistoric Times within the UISPP Permanent Committee. She is the author of four books and the author or co-author of nearly seventy scientific articles. She has supervised 56 bachelor's and master's students, as well as 4 doctoral students.

We all owe a lot to Jola and greatly appreciate her contribution to the development of Polish archaeology, especially the Polish traceology school. Therefore, as a tribute to her, we have decided to dedicate this volume to her, which, in our opinion, well reflects the current state of traceological research in Poland. We have also included several articles devoted to the history of archaeology, a subject that has always been very close to Jola's heart. Dear Friend and Teacher, we sincerely hope you will enjoy this volume.

Grzegorz Osipowicz, Justyna Orłowska

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ARTICLES

Natalia Bulyk[1]

KAZIMIERZ ŻUROWSKI (1909-1987): LIFE AND WORK IN LVIV TILL 1945

ABSTRACT

Bulyk N. 2024. Kazimierz Żurowski (1909-1987): life and work in Lviv till 1945. *Sprawozdania Archeologiczne* 76/1, 13-32.

The Lviv stage of life and scientific activity of the famous Polish archaeologist Kazimierz Żurowski is covered in this article. Based on documents preserved in the Lviv region State Archive and private archival collections, his studies at the Department of Prehistory of the Jan Kazimierz University of Lviv, the first archaeological research, site protection documentation, and conservator's reports on the work done are examined. Special attention is paid to the topic of scientific research conducted in his Lviv period and the influence of Lviv on the further scientific life of the archaeologist. Studies and cooperation with such famous archaeologists as Leon Kozłowski, Tadeusz Sulimirski, and Markiyan Smishko, who played an important role in the development of K. Żurowski as an archaeologist, seem to be important. A particular place in the article is given to photos from excavations conducted by K. Żurowski and his scientific travels, which are introduced into the scientific literature for the first time.

Keywords: Kazimierz Żurowski, Lviv archaeology during the interwar period, Bronze Age, Kolokolyn, Markivtsi, Department of Prehistory of the University of Lviv

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In recent years, more and more researchers have turned to the topic of individual personalities, involving as many sources as possible to create a complete image. Such research has become possible in past decades due to the opening of access to previously forbidden archives, as well as the possibility of working with private archival collections. It is from them, using such sources and various documents, we can create "living portraits" of famous people with their strengths and weaknesses, with elements of friendship and enmity, with victories and defeats in a scientific career, and not limit ourselves to a dry biographical data from personal files (State Archives of Lviv Region (later SALR), fonds 26 (Lviv University), series 5/688). It is precisely such portraits that the modern history of archaeological science still needs because often we know very little about the people whose contribution to science is difficult to overestimate, and our knowledge is limited to encyclopaedic notes.

The archival heritage left by archaeologists of the interwar period is often spread not only across different cities but also across countries. This certainly also applies to the famous Polish archaeologist, and professor of the universities in Poznań and Toruń Kazimierz Żurowski (1909-1987) (Fig. 1). It is worth emphasizing that several short encyclopaedic notes dedicated to K. Żurowski have already been published, which reveal slightly the scientific achievements of the researcher (Kalembka 2006, 797; Malieiev 2009; Pohoralskyi 2011, 502). However, there are no larger publications dedicated to this interesting figure.

In Kazimierz Żurowski`s life, we can distinguish three periods: Lviv, Toruń, and Poznań. Accordingly, the documents that remained after K. Żurowski's activities should be found in those three places. The author has managed to process the Lviv collection of sources that give an idea about the formation of the vision of the archaeologist, his teachers and colleagues, his first field studies, and the beginnings of his pedagogical activities. In Lviv, government documents and permissions for the first field studies, rough sketches from excavations, his photos from the field, and those showing him among fellow archaeologists have been preserved.



Fig. 1. Kazimierz Żurowski (1909-1987)

In the article, we will consider only the "Lviv" period, which covered fifteen years and was the most important in the formation of K. Żurowski as an archaeologist. After all, here he graduated from the university, discovered and explored several archaeological sites, published his first

scientific works, and declared himself to the scientific world. His path in science began in Lviv, therefore, to create a complete portrait, it is necessary to reproduce the influence of the city and its surroundings on the subsequent life and career of the archaeologist.

The Lviv period in the life of K. Żurowski can be divided into several blocks conditioned by various factors. Separately, it is worth looking into the environment in which the future researcher found himself after arriving there; teachers and colleagues played an important role in the formation of his personality; his work with students, main field achievements, and publications deserve special attention.

In the period between the two World Wars, Lviv developed as a powerful scientific centre, where archaeology was not in the last place. At the Faculty of Humanities of the University of Lviv, which was named after the Polish King Jan Kazimierz in 1919, there were two archaeological departments (details see Bulyk 2006, 99-124; Lech 2006, 5-57; Piotrowska 2006, 61-98). The heads of both departments were well-known archaeologists. The Department of Classical Archaeology from 1916 was headed by Edmund Bulanda, and Prehistory (the full name is the Department of Prehistoric Archaeology with a special review of the Prehistory of Polish lands) was headed by Leon Kozłowski in 1921 (SALR fonds 26, series 5/891, p. 14). Initially, Józef Kostrzewski, who completed his habilitation in Lviv in 1918, was offered the position of head the Department of Prehistory. However, he did not accept the offer to stay in Lviv and went on to head the department at the University of Poznań. In part, their scientific interests overlapped, because the main interest was archaeology and it would be a mistake to think that classical archaeologists did not conduct field archaeological research on our territory. There were expeditions in which members of both departments participated. As an example, mention may be made of the survey expedition to Borshchiv region that took place in July 1937. The assistant of the Department of Classical Archaeology K. Majewski received permission to participate in these works, and in addition to I. Starchuk, the assistant of the Department of Prehistory, M. Smishko was involved in the investigation (Department of Manuscripts of the Vasyl Stefanyk National Scientific Library of Ukraine in Lviv (below – V. Stefanyk NSLU), fund 26, dossier 42, part 5, p. 61).

In addition to the two archaeological departments of the university, archaeological research was conducted by the Shevchenko Scientific Society (hereafter ShSS), where Yaroslav Pasternak and Yuriy Polyanskyi worked on the problems of archaeology.

In 1928, the reform of site-protection measures took place, after which, to conduct archaeological research, it was necessary to obtain permission from the conservator (details see Bulyk 2017, 258-284). The conditions of the work for archaeologists at the University of Lviv and SHSS differed significantly. If the Ukrainian archaeologists of the ShSS literally begged for permission to practice archaeology and were constantly under close supervision, the university archaeologists, on the contrary, could visit the sites without any bureaucratic obstacles, cooperated closely with the conservator service, and were informed about the discovery of certain sites. They, by their scientific interests, had the opportunity



Fig. 2. Building of Lviv University during the interwar period

to make trips and survey the territories of western Ukraine (details see Bulyk 2019, 362-378). The privileged position of the Department of Prehistory of the University of Lviv allowed not only the participation of students in excavations conducted by professors and associate professors of the department but also facilitated allowing students to conduct research independently. Although he was still a student, in 1928 Markiyan Smishko was one of the first university archaeologists who received permission for field work Department of Manuscripts of V. Stefanyk NSLU fund 26, dossier 17, part 2, p. 385). However, this does not in any way mean that there was no cooperation between the archaeologists of the University of Lviv and ShSS. There were many examples of successful joint work.

In Polish Lviv. K. Żurowski, a native of Zagórza, came to Lviv from Sanok. The researcher's Lviv period began with education at the Hetman Stanisław Żółkiewski V State Gymnasium in Lviv, in which he passed the matriculation exam on May 25, 1932 (Sprawozdanie Dyrekcji 1932, 33). After graduating from the gymnasium, K. Żurowski continued his studies. In 1934-1938, he studied archaeology at the Faculty of Humanities of Jan Kazimierz University of Lviv (Fig. 2). There his teachers were Edmund Bulanda (archaeology), Leon Kozłowski, and Tadeusz Sulimirski (prehistory). In addition to classical archaeology

and prehistory, he studied ethnology with Adam Fisher and anthropology with Jan Czekanowski. This was primarily because, in the interwar period, archaeology with ethnology and anthropology at the University of Lviv represented a single specialization "Anthropology, ethnology and prehistory".

During 1921-1939, in addition to professor L. Kozłowski, assistant Karol Stojanowski, private associate professor Tadeusz Sulimirski (adjunct from 1935), assistant Jan Bryk (until 1932), assistant, and from 1937 adjunct Markiyan Smishko, assistant Władysław Jagiełło. By the time he graduated (1938), K. Żurowski was already a deputy assistant in the Department of Ethnology with a Special Review of the Ethnography of Polish Lands (1937-1938). In 1938-1939 he was a junior assistant at the Department of Prehistory under L. Kozłowski (Archive of I. Franko NUL, fund 119, inventory 1, dossier 490, p. 1; Bilas 2009, 206; Pohoralskyi 2011, 502). While working as an assistant at the department, K. Żurowski lived in Lviv at the address J. Galla Street, 7 (today – Krypiakevych Street, 7) (Skład uniwersytetu 1938, 104). It is worth noting that in the 1938/39 academic year, only L. Kozłowski, M. Smishko, K. Żurowski, and a technician worked at the department (Skład uniwersytetu 1938, 68).

During K. Żurowski`s studies at the University of Lviv, the number of students at the Department of Prehistory was small. This can be explained by the poor possibility of employment after graduation. Usually, during the first or second year of study, those who had considerable interest and talent for future independent research were selected and encouraged to work in the field. These students chose a prehistoric seminar and took an active part in it. In the 1936/37 academic year, only five female students and three male students enrolled in the prehistoric seminar (Bilas 2009, 2014-2015). The main form of work at the seminar was the presentation of abstracts and discussion of new archaeological literature. In this academic year, K. Żurowski studied the works of T. Sulimirski dedicated to the Bronze Age and gave an essay "Brązy Małopolski środkowej – na podstawe studium T. Sulimirskiego [Bronzes of Central Małopolska – based on the study by T. Sulimirski]" (SALR fonds 26, series 5/1547, p. 33-34). This issue belonged to the sphere of his scientific interests. The following academicyear, K. Żurowski presented "Kultura scytyjska, wg. pracy T. Sulimirskiego «Scytowie na zachodnim Podolu» [Scythian culture, according to T. Sulimirski's work "Scythians in Western Podolia"]". In the same academic year, the defence of his master's thesis "Skarb brązowy z Gruszki, pow. Tłumacz [Bronze hoard from Grushka, Tlumach district]" took place (Fig. 3). This hoard of bronze artefacts consisting of 142 items had been discovered in November 1935 in the village of Grushka in the Stanislaviv region on the field of the local Schultheiß (soltys) Ivan Shkromeda. The district government immediately tried to ensure the protection of the area from lovers of easy profit. The local police were informed about the find (V. Stefanyk NSLU fond 26, dossier 42, part 4, p. 27). All the items of the hoard had been deposited in a ceramic vessel. The hoard was transferred to the Stanislaviv voivodeship. T. Sulimirski, who at that time was a corresponding member of the conservation commission, was entrusted to examine the



Fig. 3. Hoard of bronze items from Grushka. Lviv Historical Museum

territory and investigate the find. The archaeologist visited the place of discovery of the hoard several times, where he recorded that it was found in Mohylky Place between two barrows. The hoard included 94 items and 39 fragments of raw materials (Żurowski 1949, 199). The voivodship government, in cooperation with the local police, informed the local residents that the law forbids illegally excavating the area, and the worker of the field owner Maksym Michal received a reward of 20 Polish zloty (V. Stefanyk NSLU fond 26, dossier 42, part 4, p. 27). T. Sulimirski received 50 Polish zloty from the conservator's office for this trip, which covered travel expenses (V. Stefanyk NSLU fund 26, dossier 42, part 4, p. 23) – analysing the documents of the conservation service after 1928, this was more the exception than the rule. T. Sulimirski entrusted studying these finds to his talented student K. Żurowski. The following year, after defending his master's thesis, an article was published in the pages of the magazine "Przegląd Archeologiczny" (Żurowski 1938-1939, 204-221).

After receiving his master`s degree, K. Żurowski began work on his doctorate devoted to the hoards of the Bronze Age. At one of the scientific seminars of the Department of Prehistory, K. Żurowski presented a report on the work done: "Sprawozdanie z dotychczasowych wynikow pracy nad skarbami brązowymi południowo-wschodniej Polski [Report on the results of work so far on bronze treasures of south-eastern Poland]". K. Żurowski

defended his habilitation work only in 1948 on the topic "Zabytki brązowe w młodszej epoki brązu i wczesnego okresu żelaza z dorzecza gornego Dniestru [Bronze artefacts from the Later Bronze Age and the Early Iron Age from the Upper Dnistr basin]". In the publication on the pages of the scientific journal "Przegląd Archeologiczny" (volume 5, 1949) the author emphasizes in the introduction that all materials for the doctorate had been collected in Lviv museums before 1939.

Throughout his studies at the university, K. Żurowski participated in field research and various scientific trips. In this area of activity, we can notice his close cooperation with T. Sulimirski and M. Smishko.

We can reconstruct the list of fieldwork in the expeditions of the Department of Archaeology with the participation of K. Żurowski based on the reports and diaries of the heads of these expeditions. It should be noted that it is not always possible to find all the information about these works. One of the first field trips in which the then-student K. Żurowski was involved can be dated to June 1935. At that time, M. Smishko researched a site in Kolokolyn near Rohatyn in the Stanislaviv region (Figs 4-7). This work was preceded by a visit there in the spring of 1935 by T. Sulimirski, who was invited by local residents to the place of the ruined cave to examine two partially destroyed burials (Fig. 5) (Śmiszko 1935, 155).



Fig. 4. Excavations of barrows led by M. Smishko and K. Żurowski in Kolokolyn. Summer, 1935. Smishko family's archive



Fig. 5. Kazimierz Żurowski, Irena Sivek, Markian Smishko. Kolokolyn, June, 1935. Smishko family's archive

At the same time, they transferred to him the bronze items found in another grave field near this village. Research conducted by T. Sulimirski on the site allowed him to believe that the fragment of the bronze vessel came from a secondary burial in the barrow of the Eneolithic era (Śmiszko 1935, 155). The grave field included seven barrows. T. Sulimirski, while studying one of the mounds, discovered a rich secondary burial of the Lypytska culture (Machnik *et al.* 2002, 497).

In the summer of the same year, a group of archaeologists from the University of Lviv led by M. Smishko continued work on the Bronze Age barrows (Fig. 4). Irena Siwek, Kazimierz Żurowski, and Markiyan Smishko excavated six more barrow mounds in Kolokolyn (Fig. 6). As a result of the conducted research, traces of inhumations and cremations were recorded, as well as a small number of grave goods (Sulimirski 1968, 141-142). From this expedition, several photos of K. Żurowski in the field and during rest with colleagues have been preserved in the private archive of M. Smishko (Fig. 7-8).

In the next field season (1936), students of the Department of Prehistory I. Siwek and K. Żurowski were involved in the excavations conducted by Tadeusz Sulimirski in the village of Komariv (in that time Komarów) in the Stanislaviv region (1934-1936).

In 1938, K. Żurowski conducted excavations in the area of Markivtsi (in that time Markowce), Tlumach district. From these excavations, several photos of the finds have



Fig. 6. Markian Smishko, Irena Sivek, Kazimierz Żurowski. Kolokolyn, June, 1935. Smishko family's archive



Fig. 7. Excavations of barrows led by M. Smishko and K. Żurowski in Kolokolyn. Summer, 1935. Smishko family's archive



Fig. 8. Kazimierz Żurowski, Irena Sivek, Markian Smishko. Kolokolyn, June, 1935. Smishko family's archive



Fig. 9. Clay pot from excavations conducted by K. Żurowski in Markivtsi. 1938. Archive of DA IUS NASU

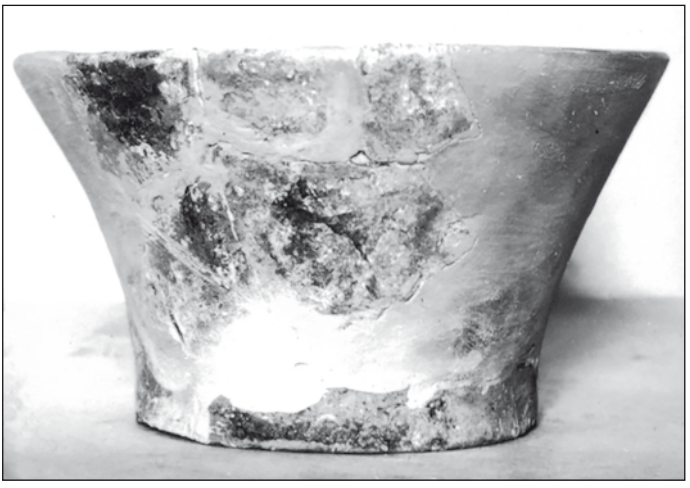


Fig. 10. Clay pot from excavations conducted by K. Żurowski in Markivtsi. 1938. Archive of DA IUS NASU

been preserved, as well as records in the inventory book about the arrival of exhibits from K. Żurowski's research to the museum at the Department of Prehistory (Department of Prehistory of the University of Lviv. Inventory book, p. 116). Glass negatives with images of the exhibits from Markivtsi, which entered the museum collection of the Department of Prehistory of the University of Lviv, are interesting (Figs. 9, 10). It is known that about ten barrows of the Late Roman period were examined.

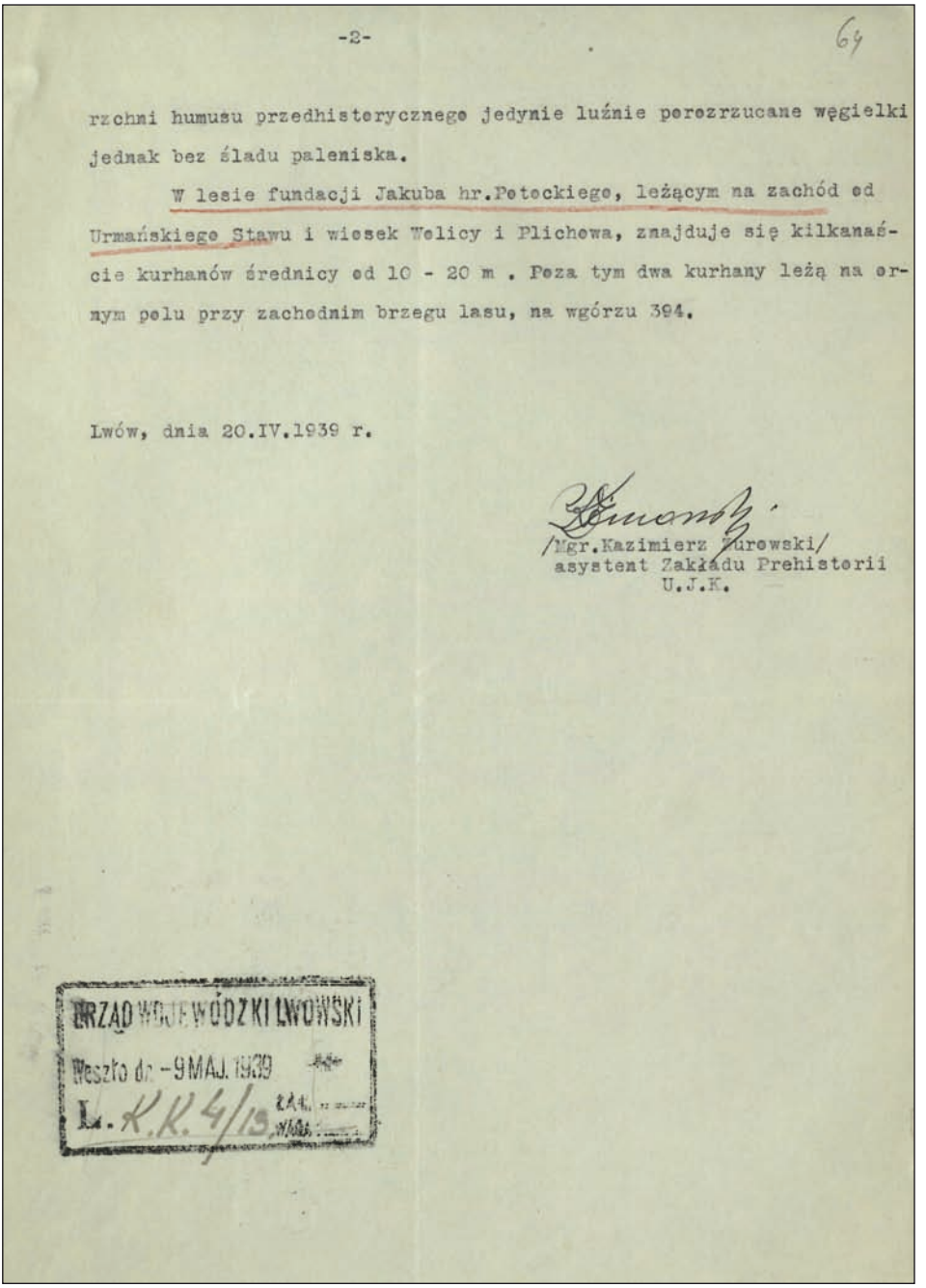


Fig. 11. Archeological finds from excavations led by Markian Smishko and Kazimierz Żurowski in Horodnytsya. 1938. Archive of DA IUS NASU

In 1938-1939, M. Smishko excavated a well-known multi-layered site in Horodnytsia (in that time Horodnica), Horodenkiv district, Stanislaviv region. Junior assistant K. Żurowski was also involved in the work of 1938. Preliminary results dedicated to Neolithic finds (Fig. 11) were published in 1939 (Śmiszko 1939, 67-73). However, the author of the excavations did not publish most of the materials. It is recorded in the inventory book of the Department of Prehistory which of the finds from these studies entered the museum collection at the department and it is noted there that these were from the joint investigations of "Dr. Smishko and Mgr. Żurowski" (Department of Prehistory of the University of Lviv. Inventory book, p. 96).

From individual fieldwork, detailed reports have been preserved, which serve as an important source for reconstructing the events of that time. Thus, in April 1939, the conservator's office informed the Department of Prehistory of the University of Lviv that in the village of Urman` of Berezhany district, burials were discovered during excavations. On April 16, the administration of the department sent assistant K. Żurowski (Fig. 12) there, who recorded in the report that he examined the early medieval hillfort and in the "test excavation" at the hillfort also came across cist burials. Near the hillfort around the forest on the Tserkvisko field, fragments of ceramics were found, which indicate that there was a settlement at the same time as the hillfort there (V. Stefanyk NSLU fond 26, dossier 42, part 7, p. 64). Meanwhile, the neighbouring location of Plikhiv was surveyed, and there too cist burials and fragments of early medieval ceramics were recorded. These were one of the few independent excavations conducted by K. Żurowski in the "Lviv" period of his scientific activity.

During his studies at the university, K. Żurowski, together with the teachers of the Department of Archaeology, participated not only in field research. As an example, we can mention the excursion of archaeologists of the department in 1936 to the site of Funnel Beaker Culture in Mali Hrybovychi near Lviv, which was being investigated by Markiyan Smishko in 1933 and 1934. Interesting photos and documents have been preserved, which demonstrate that almost all the employees of the Department of Prehistory visited this



-2-

64

rzchni humusu przedhistorycznego jedynie luźnie porozrzucane węgielki jednak bez śladu paleniska.

W lesie fundacji Jakuba hr.Potockiego, leżącym na zachód od Urmańskiego Stawu i wiosek Welicy i Plichowa, znajduje się kilkanaście kurhanów średnicy od 10 - 20 m . Poza tym dwa kurhany leżą na ornym polu przy zachodnim brzegu lasu, na wgórzu 394.

Lwów, dnia 20.IV.1939 r.

/Mgr.Kazimierz Żurowski/
asystent Zakładu Prehistorii
U.J.K.

URZĄD WOJEWÓDZKI LWOWSKI
Wpłynęło dn. - 9 MAJ. 1939
L. K.K. 4/13

Fig. 12. Fragment K. Żurowski's report to the conservator from 1939
(V. Stefanyk National Scientific Library of Lviv)



Fig. 13. Excursion of staff of the Chair of Prehistory of Lviv University on the site in Mali Hrybovychi. 1936. Smishko family's archive



Fig. 14. Lviv archeologists in Biskupin. From left to right: second stand – Kazimierz Żurowski, sit – (?), Jozef Kostrzewski, Irena Sivek, Markian Smishko. 1937. Smishko family's archive

place repeatedly (Fig. 13), and for students who enrolled in prehistory classes, trips here were mandatory (SALR fonds 26, series 5/1583, p. 51-52; Bilas 2009, 215).

In June 1937, teachers and students of the Department of Prehistory travelled to Przemyśl, Kraków, Gniezno, Biskupin, and Poznań. Professor L. Kozłowski was the scientific supervisor, and M. Smishko was the technical supervisor. The trip lasted from June 16 to 21, 1937, and during this time the participants visited the Paleolithic site in Przemyśl, the archaeological research conducted by expeditions of the Poznań University on the early historic settlement in Gniezno and the Early Iron Age settlement near Biskupin, conducted by J. Kostrzewski, and got acquainted with the archaeological collections of Kraków and Poznań. K. Żurowski was also among the participants. Interesting photos from this trip have been preserved in the private archive of M. Smishko (Fig. 14).

In addition, K. Żurowski worked a lot with the museum collections of Lviv. In particular, he studied the collections of the Museum of the ShSS, the Department of Archaeology, and the Dzieduszycki Museum and prepared them for publication. World War II broke the measured rhythm of the scientific life of the young archaeologist in Lviv.

In Soviet Lviv. Before World War II Lviv was a part of Poland. The beginning of the War and the establishment of Soviet power in western Ukraine at the end of September 22, 1939 dramatically changed the lives of scholars in Lviv. The archaeological milieu could not avoid these changes. The ShSS stopped working, and the Departments of Archaeology of the University of Lviv were reorganized. All archaeological museum collections were united into one state museum. Most archaeologists had to seek new employment. On February 8, 1940, the Lviv Department of the Institute of Archaeology of the Academy of Sciences of the Ukrainian SSR was established (details see Sytnyk 2006, 106-133; Bulyk 2021, 89-120). K. Żurowski stayed out of the university. At that time, K. Żurowski's older brother, a graduate of the Lviv Polytechnic Tadeusz Żurowski (1908-1985), also lived and worked in Lviv. Both brothers were looking for jobs in institutions related to archaeology.

On April 20, 1940, Kazimierz Żurowski was accepted as a tourist guide at the Lviv Historical Museum, and on April 23, he was transferred to the position of senior researcher (Zarubii 2020, 51). At that time, the director of the Lviv Historical Museum was the famous Ukrainian archaeologist Yaroslav Pasternak. Before the beginning of the Second World War, Kazimierz Żurowski carried out the duties of the head of the department (Fig. 15) (Pohoralskyi 2011, 502). Already in June 1940, Ya. Pasternak was removed from the position of director of the museum, and he worked with K. Żurowski on the creation of the Department of Pre-Class Society on Market Square, 4. The famous archaeologist Ihor Sveshnikov, who was acquainted with K. Żurowski from the University of Lviv, left interesting memories about this time. He recalled his meeting with Kazimierz Żurowski in the summer of 1940: "I found Żurowski on the third floor of the "Black House", where the exposition of the Department of primitive society was located. He had just finished installing a showcase with materials from the Early Iron Age, and the director of the museum, Linyov, was inspecting the results of this work. The director did not like something in the



Fig. 15. Kazimierz Żurowski. 1940s

already installed showcase, he shouted at Żurowski and his two female assistants and closed the showcase with a sharp movement so that the upper glass crumbled into small fragments, covering the exhibits displayed in the showcase. Evidently, K. Żurowski had already gotten used to the fact that the representatives of the Soviet authorities coming from the east could shout at us and treat us as people of a lower category. He calmly explained to me: «Don't pay attention, he is insane»" (Svieshnikov 2008, 10).

Since the mid-1940s, Tadeusz Żurowski worked as a painter-draftsman at the Lviv Department of the Institute of Archaeology of the Academy of Sciences of the Ukrainian SSR (Fig. 16) (Bulyk 2021, 90). The first entry in T. Żurowski 's work record book is dated September 16-17, 1940 (SA DA IUS NASU. Work record book, 1940). It is worth noting that T. Żurowski went into the field with archaeologists of the department as an engineer (SA DA IUS NASU. Żurowski T. List of cartographic works, plans and drawings. 1940-1941).

At the end of January 1941, Lviv was well-represented at the IV Scientific Conference of the Institute of Archaeology in Kyiv. K. Żurowski made a report "The Bronze Age in the Western Regions of the Ukrainian SSR" (SALR fonds P-2591, series 1/1, p. 101). He worked on a monographic study and excavations planned for July 1941 in Zatoka in Horodok dis-

trict, for which 2,000 roubles were allocated (SALR fonds P-2591, series 1/1, p. 83-85). The 1941 German invasion of the Soviet Union found K. Żurowski in the expedition led by Ya. Pasternak in Krylos in Ivano-Frankivsk region. He resigned from the museum, but in the spring of 1942, K. Żurowski remained on the staff of the Lviv Historical Museum (Zarubii 2020, 71). In 1942, he was arrested by the Gestapo and imprisoned (Lech 2006, 44). Soon K. Żurowski was condemned to death. However, he survived and after the front line reached Lviv and the Soviets took the city, he continued his work at the museum. In September 1944, he was reinstated as the head of the department and started the reconstruction of the museum's exposition. However, without finishing it, in the spring of 1945, he left Lviv forever and went to Poland (Lech 2006, 44; Kozlovskyi 2012, 122). K. Żurowski recommended I. Sveshnikov for his position at the museum, which was reflected in the memoirs. About the state of the abandoned department, I. Sveshnikov noted in his memoirs: "I received a large, but absolutely not organized collection. True, before leaving, Żurowski mainly built the exposition of the department, but in every corner, there were cabinets literally jam-packed with archaeological material, where an Egyptian mummy lay next to a Paleolithic flint hand axe and a Bronze Age pot of unknown origin. Archaeological



Fig. 16. In the Department of Archaeology. Unidentified person, M. Smishko, T. Żurowski. 1940s. Smishko family's archive

finds were scattered throughout the museum in both of its buildings. On the fourth floor of the "Black House", intended for the exposition of Kyivan Rus', there were no showcases yet, the exhibits were lying on the floor, and flint tools and Scythian acinaces were lying among the artefacts of Medieval Rus'. This required immediate work to finish the exposition and organize the collections..." (Svieshnikov 2008, 11). But that was another page of history...

CONCLUSIONS

Summarizing the "Lviv" period of Kazimierz Żurowski's life and work, we note that this city and the environment where the young man came to continue his studies at the gymnasium played a significant role in the formation of his personality. The Lviv archaeological school during the interwar period was one of the strongest in Poland and produced a whole constellation of famous archaeologists who continued their work in Wrocław, Kraków, Poznań, Toruń and other cities. However, for each of them, the basics they received during their life in Lviv were important. K. Żurowski became a specialist in Lviv, his future lines of research were determined there, it was there he conducted his first independent excavations (Markivtsi, Urman`, Plikhiv) and it was where he published his first works; there too he learned to study archaeological collections and created a strong base for future scientific studies. We can say without exaggeration that K. Żurowski belongs to the constellation of Lviv interwar archaeologists and his name is forever inscribed in its history.

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Marzena Woźny[1]

THE BEGINNINGS OF POLISH ARCHAEOLOGICAL MUSEUMS IN THE 19TH CENTURY

ABSTRACT

Woźny M. 2024. The beginnings of Polish archaeological museums in the 19th century. *Sprawozdania Archeologiczne* 76/1, 33-52.

The first Polish archaeological museums or those with archaeological departments – institutions dealing with gathering collections, conducting research, organizing exhibitions and publishing works devoted to archaeology, as it was understood at that time – began to be established in the mid-19th century. They were created by scientific societies or on the initiative of private individuals. They were: the Museum of Antiquities of the Kraków Scientific Society, the Museum of Antiquities in Vilnius, the Museum of Polish and Slavic Antiquities in the Grand Duchy of Poznań, the Museum of the Toruń Scientific Society, the Museum of the Lubomirski Princes in Lviv and the Dzieduszycki Natural History Museum in Lviv. The article discusses the beginnings of Polish archaeological museums, their creation, the scope and shape of the collections, methods of obtaining artefacts, the headquarters and the further fate of these institutions.

Keywords: archaeological museums, archaeological collections, antiquities, Poland, 19th century
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Before specialized museums began to be established in Europe in the 19th century, archaeological artefacts – mainly from the ancient world – were gathered in various collections. Interest in objects of this type increased especially from the 18th century, as a result of spectacular, imagination-stirring discoveries made in Italy, in Pompeii and Herculaneum. This trend also affected Poland. King Stanisław August Poniatowski was a collector of antiquities, as were a number of members of the Polish aristocracy. During this period, finds of local prehistoric cultures aroused less interest than works from classical antiquity. It often was the case that prehistoric artefacts were classified as "fossil objects" and thus were considered the subject of interest to scientists dealing with natural history. On the Polish lands, it was only since the beginning of the 19th century that small collections of prehistoric artefact were collected by various institutions and associations. They were, for example, in the possession of the Warsaw Society of Friends of the Sciences, the Office of Antiquities at the University of Warsaw, the Secondary School in Krzemieniec, the Płock Scientific Society and the Society of Collectors of National Antiquities in Szamotuły. However, they constituted a rather random part of the collections, which generally consisted mainly of historical artefacts, works of art, various historical souvenirs or mementoes and natural specimens (Abramowicz 1967, 31-41; 50-51; 1991, 19).

In the 19th century, a museum was a "public institution", that is, one "to which everyone has access" (Słownik Arcta 1916/2, 462) and which is "dedicated to the general benefit" (Słownik Arcta 1916/3, 484). Meeting these requirements was the ambition of the creators of the Public and School Museum of the Płock Voivodeship, founded in 1821 by the Płock Scientific Society. Its various collections were used by pupils of the school, and there were plans to make them available to a wider audience. However, in 1830, the Society was dissolved and the collection it had gathered was transferred to the Provincial Junior High School (Szczerba 2012, 98; Kruszewski 2021, 13).

The first archaeological museums or those with archaeological departments – institutions dealing with collecting collections, conducting research, organizing exhibitions and publishing works devoted to archaeology, as it was understood at that time – began to be established on the Polish lands in the mid-19th century (Kostrzewski 1949, 39-40). They were created by scientific societies or on the initiative of private individuals.

In 1850, the Museum of Antiquities of the Kraków Scientific Society (TNK) was established (Abramowicz 1967, 99-101; 1991, 30-31; Nosek 1967, 19; Schnaydrowa 1971; Woźny 2016, 214-222). In 1855, thanks to the efforts of Eustachy Tyszkiewicz [1814-1873], a Polish-Lithuanian archaeologist, the Archaeological Commission was established in Vilnius, and a year later the Museum of Antiquities operated within it (Fig. 1; Kirkor 1856, 227-228; Ustawa 1856; Urządzenie Muzeum 1856; for the arrangement of the museum, see Abramowicz 1967, 105-107; 1991, 35-37; Blombergowa 1992, 69-71; 1993, 39-42; 1997, 91-92; Ilgiewicz 2005, 105-146; Mizerniuk-Rotkiewicz 2016, 39-51). In 1857, the Society of Friends of Sciences was established in Poznań, and the Museum of Polish and Slavic Antiquities in the Grand Duchy of Poznań was established (Działyński 1860, 587, 596; *cf.*



Fig. 1. A. Żamett, C. C. Bachelier, Archaeology room in the Museum of Antiquities in Vilnius, 1855. From the collections of the National Library in Warsaw

Wojtkowski 1928, 260-266; Abramowicz 1967, 116-117; 1991, 38-39; Kaczmarek 1996, 56-60; Linetty 2020, 222-223). A little later, in 1875, the Toruń Scientific Society began its activity, and a museum was established in 1876. In this institution, the archaeological department was a separate, dynamically developing section (Abramowicz 1967, 151-152; 1991, 72; Lech 2002; Wawrzykowska 2002, 38-41; Małecka-Kukawka and Wawrzykowska 2004, 110-112). Two museums founded on private initiative in Lviv also had a public character. These were the Museum of the Lubomirski Princes attached to the Ossoliński Institute in Lviv (opened to the public in 1870) and the Dzieduszycki Natural History Museum (opened in 1880). In both of these institutions, archaeological artefacts also constituted only part of the collections – in the case of the Dzieduszycki museum these were mainly natural history exhibits (Dzieduszycki 1895) and in the case of the Lubomirski museum they were historical objects and works of art (Zawadzki 1874; Katalog 1877; Bulyk 2014, 49-59). In the second half of the 19th century in Warsaw, however, the conditions for the establishment of a museum were not favourable. The former collections of the Archaeo-

logical Cabinet of the University were kept in the Government Library (later the Main Library). Archaeological collections were also gathered by the Society for the Encouragement of Fine Arts, established in 1860, and the Museum of Industry and Agriculture, established in 1875. However, a public archaeological museum in Warsaw was established only in the 20th century (Piotrowska 2003, 13-15; Szczerba 2012, 153-159).

In the 19th century, there were also a number of private archaeological collections created (such as those of Tomasz Zieliński [1802-1858] in Kielce or that of Karol Rogawski [1820-1888] in Ołpiny – see Łepkowski 1860; Śliwa 2015; Woźny 2022). Collections were also accumulated by various institutions (*e.g.*, an Archaeological Cabinet was established in the Jagiellonian University in Kraków, to perform teaching functions – see Woźny, Dzięgielewski 2018). However, they were not museums and did not have a public character, so their discussion is beyond the scope of this article.

An important inspiration for the first museum institutions collecting archaeological artefacts in the lands of the former Polish-Lithuanian Commonwealth was the museum operating at the Royal Nordic Society of Antiquaries founded in 1825 in Copenhagen. In his "Letters on Sweden" Eustachy Tyszkiewicz (the founder of the Museum of Antiquities and the Archaeological Commission in Vilnius), spoke with admiration about the activities of the Danish association and its museum, in which prehistoric artefacts were collected in several rooms (Tyszkiewicz 1846, 5-17). He emphasized the close relationship between these collections and scientific research. He noted: "When looking through the treasures of northern antiquities in Copenhagen, one cannot fail to be reminded and not be indifferent to the fact that the same kind of artefacts are also found in our lands. The desire to explore our past awakened today, the collections being created here and there in private hands, fill the mind with sweet comfort" (Tyszkiewicz 1846, 17). Karol Kremer [1812-1860], the initiator of the creation of the Museum of Antiquities at the Kraków Scientific Society, postulating activities in the field of research and protection of historical monuments and calling for the establishment of a museum, also encouraged the use of Danish models (Kremer 1849, 559-560).

In the mid-19th century, archaeology was understood not only as the study of prehistory – it also included the history of art and other auxiliary sciences of history. This was reflected in museum collections. In addition to archaeological finds, the Museum of Antiquities of the Kraków Scientific Society also collected works of art, handicrafts, ethnographic objects, engravings, maps and archival materials. Józef Majer [1808-1899], president of the Society, said after the opening of the first exhibition in the museum:

"Today it [the Museum] is located in a spacious and bright room on the first floor and in an adjacent room, decorated in accordance with our possibilities and in accordance with their purpose. The more spacious premises allow for a more appropriate layout to facilitate scientific viewing. (…) The Museum in its current state includes: 1) Ethnographic department, including cultural objects of contemporary peoples and nations, namely Chinese and Nubian; 2) The section of pre-Christian antiquities, namely: a) Antiquities of the clas-

sical world, b) Antiquities of pagan Slavs; 3) Department of medieval artefacts, namely a) weapons, b) works of painting and sculpture, c) household utensils, d) clothes, e) badges of dignity and honours, f) musical instruments, g) objects of religious associations, h) artefacts of domestic industry, i) graphics, k) sphragistic collection, l) numismatic collection, m) collection of engravings, n) archival materials, o) gallery of casts, p) finally, objects with the character of historical mementoes" (Majer 1866, 20-21; *cf.* Schnaydrowa 1971, 68-69).

The beginnings of the Museum of Antiquities in Vilnius were the collections of its founder, Eustachy Tyszkiewicz – a library, a collection of numismatics, engravings and works of art, as well as a collection of manuscripts. Prehistoric artefacts, initially numbering over 2,000 specimens, constituted only part of the museum's collection (Kirkor 1856; see Tyszkiewicz 1874, 10; Cehak-Hołubowiczowa 1938, 9-10; Mizerniuk-Rotkiewicz 2016, 44-45).

The collections of the Museum of Polish and Slavic Antiquities of the Poznań Society of Friends of Sciences also reflected the very broad definition of archaeology of the time. Thus, in addition to prehistoric finds and numismatics, there were also memorabilia of historical figures and events, works of art, engravings, archival materials and books (Wykaz 1860; see Sprawozdanie 1865, 621; 1869, 366-367). In 1882, the museum was named the Museum of the Mielżyński family. Its inventory still included primarily works of art, as well as (apart from archaeological), historical, natural, ethnographic, numismatic collections and a cabinet of engravings (Kłudkiewicz 2018; *cf.* Wojtkowski 1928, 97-98; Kaczmarek *et al.* 2013, 16).

Museum exhibits were primarily obtained from donors. With a view to expanding the collection, after the Museum was founded in 1850, the Kraków Scientific Society published two appeals to the public to donate artefacts (Odezwa 1851; 1857). Thanks to this, a year after its establishment, the Museum received its most valuable exhibit – a statue of the Slavic god Światowid (Fig. 2), excavated from the Zbruch River (now in western Ukraine), which later became its symbol (Wiadomość 1851). Initially, numismatic items dominated among the gifts. In the years 1848-1852, the Kraków Scientific Society received 800 coins and medals; and only 46 pieces that consisted of "ancient artefacts, equipment and curiosities" (Majer 1858, 79). This trend continued in the following years – for example, in 1861, approximately 900 coins and medals and 29 pieces of "equipment, tools and various relics" were donated to the Museum (Majer 1862, 23). In 1871, when the Kraków Scientific Society was transformed into the Academy of Learning, the assets of the association were counted, which also included the Museum of Antiquities. At that time, it had in its possession: "a) 2,250 Polish coins and medals, b) 520 foreign coins, c) 850 engravings, maps, photographs, d) 1,000 mementoes and archaeological items" (Inventory of the assets of the TNK, 1871, Archive of Science of PAN and PAU, No TNK-4, p. 83).

In the Museum of Polish and Slavic Antiquities in Poznań there were also collections that had been obtained primarily through gifts (see Działyński 1860, 596; Sprawozdanie



Fig. 2. Statue of the Slavic god Światowid.
From: Przezdziecki, Rastawiecki 1860-1869



Fig. 3. The Mikorzyn stones with the "Slavic runic writing" and other archaeological artefacts. 1859. Photo: K. Beyer. From the collections of the Polish Academy of Learning

1865, 623; 1872, 252; Wojtkowski 1928, 261-262). In 1857, a proclamation was published in one of the Poznań daily newspapers encouraging the donation of artefacts (Muzeum 1857, 1; see Kaczmarek *et al.* 2013, 14-15). It listed groups of objects that the Museum wanted to acquire: "items found in ancient graves"; "items belonging to Slavic rituals" (especially figurines of Slavic deities); "weapons, medieval and later equipment"; and any memorabilia related to historical figures; coins; works of art and objects of artistic crafts (Muzeum 1857, 1). The scale of donors' generosity is illustrated by the correspondence preserved to this day, sent along with the finds to the Poznań Museum (see Kaczmarek *et al.* 2013). In Toruń, the issue of expanding the museum collection through gifts was even included in the statute of the Toruń Scientific Society (Ustawy 1878, 88).

Gifts came from private researchers and collectors, but museums themselves also exchanged them. In 1861, the Poznań Society of Friends of Sciences donated the Mikorzyn stones to the Kraków Museum of Antiquities (Majer 1862, 26). The famous stones (as it later turned out, forgeries) with the "Slavic runic writing" aroused great interest among researchers at that time (Fig. 3). Gifts from the Poznań Society of Friends of Sciences were also in the collections of the Museum of the Lubomirski Princes in Lviv (Zawadzki 1874, 360; Katalog 1877, 14-15).

Material to augment the collections were also obtained through archaeological research. For example, in the Vilnius Museum, many artefacts came from the excavations of Eustachy Tyszkiewicz and his brother Konstanty [1806-1868], as well as those of Adam H. Kirkor [1818-1886] (Kirkor 1856, 245-247; see Blombergowa 1997, 92). In Poznań, the

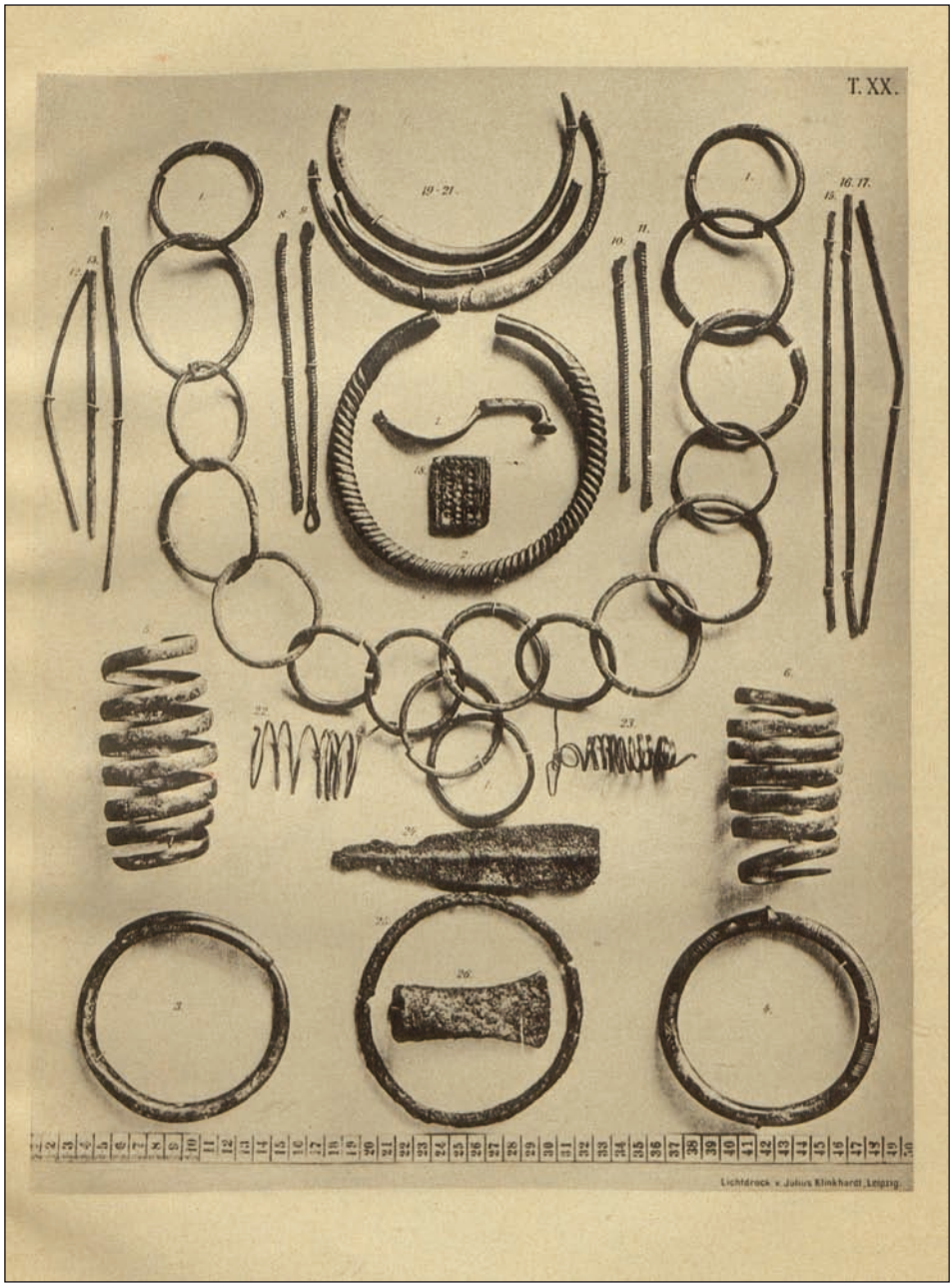


Fig. 4. Archaeological finds from the collection of the Poznań Society of Friends of Sciences. From: Erzepki 1893



Fig. 5. Archaeological finds from the collection of Bolesław Podczaszyński. From the collection of the Archaeological Museum in Kraków

development of the collections was supported by the Archaeological Commission (later becoming the Archaeological Section, and finally the Archaeological Department), operating within the Poznań Society of Friends of Sciences. Members of the association conducted a number of excavations in Greater Poland, donating the finds to the museum (Fig. 4, Abramowicz 1967, 117-120; Kaczmarek 1996, 56-58; Kaczmarek *et al.* 2013, 16; Linetty 2020, 197-222). In Toruń, on behalf of the Society and to enrich its collections, archaeological research was conducted by the museum curator Gotfryd Ossowski [1835-1897] (Działowski 1878, 11; Ossowski 1878; Przegląd 1880, V-VII; see Lech 2002, 19-24). At the end of the 1870s, a resolution was even passed to organize archaeological expeditions on behalf of the Society (Przegląd 1880, V). The collections of the TNK Museum of Antiquities were enriched to a small extent by field research, but since the 1870s, *i.e.* after the institution was transformed into the Archaeological Museum of the Academy of Learning, annual research expeditions were organized on behalf of the Academy, during which numerous finds were acquired for the collections (Kostrzewski 1949, 64-68; Nosek 1967, 45-63).

Only rarely were antiquities acquired by purchase (*cf.* Majer 1852, 168). However, attempts were made to obtain financial resources for them. In Kraków, for example, a small amount was raised through the sale of admission tickets to the Exhibition of Antiquities of 1858/9 (Schnaydrowa 1971, 71). In 1880, the Academy of Learning in Kraków allocated a significant amount of money to purchase the collection of the architect and collector Bolesław Podczaszyński [1822-1876] (Fig. 5, Woźny 2022, 87-91).

In the period when archaeology was synonymous with antiquarianism (from the end of the 18th century to around the 1860s), prehistoric artefacts were generally organized according

to aesthetic criteria, taking into account the raw material from which they were made and their mutual similarity. Therefore, bronzes were placed next to bronzes, iron objects next to other items of iron, ceramics next to ceramics, swords next to swords, spearheads next to spearheads, regardless of where they were found (Leitfaden 1837; Tyszkiewicz 1846, 5-17). Later, attempts were made to give them a substantive arrangement, but often without meaningful consequences. The decisive factor here was the creativity of the organizer of the collection. For example, in the Museum of Antiquities in Vilnius, archaeological collections were assigned to several sections. The first contained artefacts (originals and copies) considered to be statuettes of Slavic deities. The second one contained "excavated objects from the earth", *i.e.* various archaeological finds as well as human remains. The third one contained artefacts from barrows (almost 30 items), brought to Vilnius by Eustachy Tyszkiewicz. The fourth one contained archaeological artefacts dating back to Christian times. The fifth section – one of the richest – contained stone weapons from both prehistoric and historic times (*e.g.,* stone balls). The sixth, by analogy, held weapons from different periods and eras made of metals. The seventh room was used to store artistic crafts and souvenir items. The last, eighth section consisted of archaeological finds from the excavations of A. H. Kirkor (Kirkor 1856, 237-247). The Vilnius Museum developed very dynamically during the short period of its existence. In 1862, two new departments were created – ethnographic (with exhibits donated by members of the Kronstadt naval expedition around the world) and a department consisting of Egyptian antiquities donated by the collector Michał Tyszkiewicz [1828-1897] (Ilgiewicz 2005, 124-126; Mizerniuk-Rotkiewicz 2016, 47).

Over time, however, archaeological museums became more and more specialized. In the second half of the 19th century, even strictly archaeological institutions were created in Europe, such as the Museum of Celtic and Gallo-Roman Antiquities in Saint Germain-en-Laye near Paris, founded in 1862, headed by the famous anthropologist and prehistorian Gabriel de Mortillet [1821-1898]. In Europe, the issue of establishing museums, their contents and methods of organizing them was discussed at many universities at that time. In Oxford, there was a debate on how to isolate, organize and complement the specimens in the Ashmolean Museum and create a historical and archaeological museum on their basis (Resolutions [1864]).

The creation of a new type of institution was possible thanks to the transformation of archaeology as a scientific discipline (focusing on the study of prehistory), as well as thanks to the establishment of other museums specializing in art, craft and ethnographic collections, which began to receive other collections. Established in the mid-1870s, the museum of the Scientific Society in Toruń from the beginning gathered collections in three separate sections – historical, natural and archaeological, clearly separating prehistoric and historical artefacts as well as works of crafts and art (Działowski 1878). In the early 1890s, the Archaeological Museum of the Academy of Learning in Kraków (formerly the Museum of Antiquities of the Kraków Scientific Association) was transformed into a specialized archaeological museum where prehistoric artefacts were collected. Its curator was Godfryd



Fig. 6. Prehistoric pottery from Horodnica (today in Ukraine) in the Museum of Academy of Learning in Kraków 1878. From the collection of the Archaeological Museum in Kraków

Ossowski, who came from Toruń to Kraków (Demetrykiewicz 1929, 19-20; Chochorowski 2016, 37). In the Museum of the Lubomirski Princes in Lviv, archaeological collections constituted a separate department (archaeological and historical; historical souvenirs; works of art; "miscellaneous"). The prehistoric artefacts in the archaeological and historical section were separated from those from historical times, antiquities, coins, documents, and seals (Zawadzki 1874, 359-360; Katalog 1877, IV). In the Dzieduszycki Natural History Museum, the prehistoric department was one of seven departments (along with zoological, botanical, paleontological, geological, mineralogical, ethnographic sections) (Dzieduszycki 1895, XIII, XVI).

At the end of the 19th century, the arrangement of museum collections began to take on a scientific character. Efforts were made to convey information obtained during research, among other things, by showing the artefacts in the context in which they were discovered. It was in this way that the archaeological collections from the excavations of Gotfryd Ossowski and collected in the archaeological department of the museum of the Toruń Scientific Society were arranged:

"When collecting and arranging our treasures, we were guided by this guiding principle: to collect everything from a given place, not omitting the most inconspicuous things (...) and to move and arrange them in such a way that things from one place, coming from one place, appear to the viewer in one place. From this principle came the second one, which required us to immediately arrange the collections in geographical order, keeping as far as our Prussia is concerned with the course of the Vistula from south to north and both of its banks" (Działowski 1878, 11).

The artefacts were accompanied by explanatory boards that made them easier to study: "all uncovered graves are fully prepared, and next to them there is a plan with a cross-section of the grave and its drawing" (Sitting of the Archaeological Commission of the AU, 7 V 1878, Archive of Science of PAN and PAU, No PAU W II-51, pp. 60-60'). The Toruń museum owed this shape and systematization of its collections to Ossowski (Działowski 1878, 9-12; *cf*. Ossowski 1878; Demetrykiewicz 1929, 19; Lech 2002, 19-25; Wawrzykowska 2002, 38-40; Małecka-Kukawka and Wawrzykowska 2004, 112; Chochorowski 2016, 13-17). At the end of the 1870s, it was decided to organize and catalogue the prehistoric collections in the Archaeological Museum of the Academy of Learning in Kraków (Fig. 6). This task was entrusted to the archaeologist Teodor Ziemięcki [1845-1916]. He was instructed "that fragments of pottery, flint products, bronze objects, *etc*. extracted from one grave, are to be placed together on one box. This will make it easier to see the whole excavated material and prevent individual items from getting mixed up or lost" (Letter of P. Umiński to T. Ziemięcki, 20 I 1879, Archive of Science of PAN and PAU, No PAU W II-51a). In May 1879, the catalogue, prepared on separate pages, was two-thirds ready (Letter of P. Umiński to T. Ziemięcki, 20 I 1879, Ibid.). In the early 1890s, Gotfryd Ossowski developed the "Catalogue of Anthropological and Archaeological Collections at the Anthropological Commission of the Academy of Learning in Kraków". However, he did not manage to complete it because he left Kraków in 1893 (Chochorowska 2001, 14; Chochorowski 2016, 37; Skrzyński 2018, 158-162). Neither of these inventories have been published. The catalogue of the collections of the Museum of Antiquities in Vilnius, prepared by Adam H. Kirkor (1856), was published, and later also those of the collections of the museums in Poznań and Lviv (Katalog 1877; Erzepki 1893; Dzieduszycki 1895; see Wojtkowski 1928, 264-265).

From the very beginning of the existence of public collections, it was important to provide appropriate rooms for their storage and exhibition. Almost all Polish museums struggled with this problem. From its foundation in 1815 until the mid-1850s, the Kraków Scientific Society was connected with the Jagiellonian University. For this reason, its collec-



Fig. 7. Exhibition of antiquities and art objects in Kraków. 1858/9. From the collections of the Museum of Kraków

tions were initially kept in the Jagiellonian Library. After the Society separated from the University in 1856, until the construction of the Society's own building in 1864, the collections were kept not only in the Jagiellonian Library, but also in the private home of one of the TNK members. In 1864, they found a permanent home in the Society's building (Schnaydrowa 1971, 71; Woźny 2016, 220).

Eustachy Tyszkiewicz's collections were initially stored in his private homes, and then also in rented rooms. It is worth mentioning that they were already made available to the public at that time. Ultimately, the Vilnius Museum of Antiquities was located in the auditorium of the former Vilnius Imperial University (Kirkor 1856, 227; Mizerniuk-Rotkiewicz 2016, 41). The Poznań collections were initially kept in the Raczyński Library, but after twelve years they had to be taken away (Sprawozdanie 1871, 361; *cf*. Kaczmarek 1996, 59-60). They found temporary shelter first in the building of the Poznań Bazaar, and later, thanks to the donation by Seweryn Mielżyński [1804-1872] of a building plot, from the end of 1872 in the seat of the Poznań Society of Friends of Sciences at 17 Młyńska Street (currently Mielżyńskiego Street; Sprawozdanie 1871, 362; 1872, 253; *cf*. Kaczmarek *et al*. 2013, 12). In 1881, the cornerstone was laid for the building that was to house the collections of the Toruń Scientific Society. A year later, the collections were made available in new rooms



Fig. 8. Archaeological finds from the collection of the Poznań Society of Friends of Sciences at the first Kraków Exhibition of Antiquities and Objects of Art in 1858/9.
Photo: K. Beyer. From the collections of the Polish Academy of Learning

(Sprawozdanie 1884, 127; Wawrzykowska 2002, 40). Only the archaeological collections in Lviv were exhibited from the beginning in the offices of the institutions to which they belonged. The exhibits of the Museum of the Lubomirski Princes were housed in the headquarters of the Ossoliński National Institute (on Ossoliński Street), and those from the Museum of the Dzieduszycki family in a tenement house in Lviv, specially purchased for museum purposes. The issue of the availability of collections for researchers and the public is directly connected with the matter of the premises where they were kept. Before they obtained their own premises, the museums in Kraków and Poznań displayed their collections only during exhibitions organized on various occasions and in various places. Part of the Poznań and Kraków collections was shown, for example, during the first Kraków Exhibition of Antiquities and Objects of Art in 1858/9 (Cieszkowski, Wegner 1863, 782; Fig. 7, 8). Before the collections of the Toruń Scientific Society were made available in their own building in 1882, part of them was exhibited in 1878 during the World Exhibition in Paris and in 1880 during the Congress of the Anthropological Society in Berlin (Sprawozdanie 1884, 127-128; see Wawrzykowska 2002, 40; Małecka-Kukawka and Wawrzykowska 2004, 114).

Museums played a variety of roles in the 19th century. It was around them and around scientific societies that archaeology developed before it achieved the status of a university discipline. In 1900, Włodzimierz Demetrykiewicz [1859-1937], curator of the Archaeological Museum of the Academy of Learning, the most important Polish archaeological museum at the turn of the 19th and 20th centuries, emphasized that they played a key role in the organization of archaeology as a scientific discipline (Demetrykiewicz 1900, 4).

These early museums had a variety of fates. The Museum of Antiquities in Vilnius ceased to exist after only ten years of existence as a result of repression by the Russian authorities after the 1863 January Uprising. They began its liquidation in 1865. A year later, the collection was parcelled out and the most valuable part was sent to Moscow. Some artefacts, including prehistoric antiquities, remained in Vilnius but were transferred to the public library (Blombergowa 1997, 92; Ilgiewicz 2005, 136-142; Mizerniuk-Rotkiewicz 2016, 51-58). The archaeological department of the Toruń museum went into decline after Gotfyd Ossowski left. After a period of prosperity, there was a stagnation in the Historical and Archaeological Department of the Scientific Society in Toruń. It was even considered whether to transfer the collection to Poznań (Osmólska-Piskorska 1948, 21-22; Abramowicz 1967, 159; Wawrzykowska 2002, 40). The museums in Kraków and Poznań were much luckier. They developed dynamically – and although they underwent organizational changes – they survived and continue to operate to this day. The Dzieduszycki and Lubomirski Museums operated in Lviv until the mid-20th century. After World War II, most of their collections were taken over by the USSR and today they are divided among several Ukrainian institutions. Only a small part of the Dzieduszycki museum collection was transported to Poland.

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COMBINING EXPERIMENT AND ETHNOARCHAEOLOGY TO DIFFERENTIATE THE SURFACE CONDITIONS OF ANIMAL HIDES

ABSTRACT

Beyries S., De Stefanis C., Gauvrit Roux E. 2024. Combining experiment and ethnoarchaeology to differentiate the surface conditions of animal hides. *Sprawozdania Archeologiczne* 76/1, 53-70.

There is a wide range of technical processes involved in working animal skins, depending on the environment, the size of the skins and the purpose of the work (clothing, tent covers, *etc.*). The archaeological tools and their shape, weight, and use-wear are often the only evidence of these technical processes. Their understanding requires an experimental approach combined with ethnoarchaeological data to establish protocols allowing processes compatible with the type of skin to be treated and carry out the correct gestures at each stage of the process.

This study, dedicated to the processing of very large hides, presents the experimental replication of the production process of moose hides observed in Canada (B.C.) in an Athaspakan group. The functional analysis of the experimental tools allows identifying different wear patterns corresponding to different surface conditions of animal hides; each of them having particular implications for the interpretation of the archaeological record.

Keywords: Ethnoarchaeology; experiment; Use-wear analysis; Hide processing; Large hide
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INTRODUCTION

The ethnographic record of the traditional ways of working animal skins shows that a broad range of techniques can be used. Although the choices of techniques are closely related to the cultural context and the social organisation, they also depend upon the particular animal, the intended use for the skin and the environment (Perkins *et al.* 2008; Frink and Weedman 2005; Audoin-Rouzeau and Beyries 2002). According to the dimensions and particularly the thickness of the skin to be treated, several elements can differ. These include the method of tensioning (stretched on a frame, on the ground, on a plank), the shape of the tool's working edge, the tool's weight, and the materials it is made of (bone, stone, metal) (Gallagher 1974; 1977; Beyries 2008; Beyries 2003; Beyries and Rots 2008b; Weedman 2006; Steinbring 1966; 1992; D'iatchenko and David 2002; David *et al.* 1998; Delaporte and Roué 1978; Robbe 1975; Beyries and Rots 2008a, 2008b; Tepper 1994; Emmerich Kamper 2020; Kobayashi Issenman 1997; Klokkernes 2007; Clark and Kurashina 1981; Schultz 1989). The stone tools usually have handles and the gestures practiced with these tools are correlated with the method of stretching the skin, its state (fresh, dried, rehumidified, soaked) and the shape and weight of the handles into which the tools are inserted. Following several ethnoarchaeological studies carried out in different traditional communities that practice the working of hides using various technical methods, in the Canadian British Columbia (Athapaskan), in the Siberian Far East (Chukchi, Koryak) and in Ethiopia (Konso, Gamo) (Beyries 2002; Beyries 1999; Brandt and Weedman 2002; Weedman 2000), it has been demonstrated that the formation of wear traces on the working edges of the tools used vary significantly from one technique to another (Beyries 1999; Beyries and Rots 2008b, 2008a).

In the archaeological record, the poor preservation of skin render the importance of this material in daily life difficult to discern. Vestiges are rare and often difficult to interpret (Beyries 2002; Beyries *et al.* 2001); the tools, made of stone or bone, generally provide the only evidence that comes down to us. Thus, it is based only on the study of these tools that it may be attempted to determine the techniques employed. Once the technical process has been identified and the conditions in which these processes take place has been defined (presence or absence of water, wood, *etc.*), it is possible, under certain conditions, to approach the organisational aspects of the groups studied, such as the rhythms of nomadisation, for which hide weights, stretching methods and process segmentation can provide crucial data (Audouze and Beyries 2007; Gauvrit-Roux 2019; Gauvrit-Roux and Beyries 2018).

To be validated, the observations made in present-day contexts should be subject to experiments in order to enable control of parameters such as intensity of the physical gestures (force and amplitude), variations in the state of the skin at different moments of being worked, the duration of the preparation of a skin – difficult to determine precisely during fabrication in a real situation.

In this perspective, in collaboration with the *Centre Archéologique de Pincevent* (Seine-et-Marne, France), an experimental program of two years was set in place in 2014 and 2016. This consisted of working hides of very large size close to that of moose hides, with the techniques observed in 1994 and 1995 in the Athapaskan Beaver-Doig River communities in northern British Columbia (Beyries 2002; Beyries 1999; Beyries 2008). Two skins of adult bisons (*Bison bison*) raised in captivity were worked. The skins were thicker than that of a moose (*Alces alces*), in particular for the rump, the shoulders and the length of the spine (3 to 4 cm vs. 1 to1.5 cm). One of the skins was stretched on the ground, the other on a wooden frame; these two techniques are the only ones that allow skins of this size to be properly tensioned. Throughout the defleshing, hair removal and thinning, this skin remained stretched on a single frame. All the stages were carried out with bone scrapers and hafted stone end-scrapers.

The aim of this experiment was to understand the variability of marks that can be observed on tools during the different stages of working a large skin stretched over a frame. The first year, two weeks in July 2014 were devoted to defleshing and hair removal. The latter was carried out by striking with two bone tools and one stone tool. One of the bone tools, shaped by working a deer (*Odocoileus hemionus*) metapodial, was brought from Canada; the other was created on the site by working the metapodial of a bullock (*Bos taurus*). The second year, two weeks in 2016 were devoted to the thinning of the skin on the flesh side. In this article, we will deal only with the skin stretched on a frame and the stage of thinning (2016 session).

THE EXPERIMENTAL PROCESS

Stretching the skin

The stage of stretching the skin so that it was under tension began with the fabrication of a frame in fresh ash wood (*Fraxinus*; 4.80 × 3.80 m). Once the frame was constructed, it was leaned against two trees (Fig. 1).

The skin was preserved frozen between the two sessions of experiments. This method of preservation was chosen because, after slow thawing, the skin returns to its original state. In fact, all we do is change the state of the water contained in the tissues. When ready to start the experiments again, it was left to thaw in the open air, then immersed in water to recover its elasticity.

Once the skin had recovered its original state of humidity and size, it was spread on the ground under the frame without any particular precautions (*i.e.*, the ground was not cleaned before spreading); it was then stretched on the frame with ratcheted straps, beginning at the top then progressing symmetrically around the frame. When it had been stretched and rinsed with a jet of water, it was left until completely dry; here three days were necessary for the drying on account of the ambient temperature and the thickness of the skin.



a b

Fig. 1. Moose hide stretched on a 3.5 m2 frame, Doig River, British Columbia, 1994 (a), Bison hide stretched using the same technique, Pincevent, 2014 (b)

When drying, the skin shrank, and the straps tightened progressively; when completely dried the skin was stretched to maximum tension.

When cleaning or removing hair from the skin, the skin must always be under tension when the cutting edge of the tool comes into contact with it. It's the intensity of the tension that ensures even thinning without the risk of tearing. This stage of stretching is essential as it guarantees the proper progression of all the following operations; whatever the process, the efficiency of the tools is correlated with the tension of the stretched skin that is necessary for its treatment.

The fabrication of the tools

In parallel with the placing of the skin under tension, we fabricated the composite tools for the reduction of the thickness of the skin.

A series of blades in Senonian flint from the north of the Paris basin were knapped by direct percussion with a tender organic striker by an experienced knapper (P. Bodu, CNRS UMR 8068 Temps). On the distal extremities, the fronts of the wide and convex end-scrapers were formed by direct retouch.

Three end-scrapers were fitted into bent wooden handles, and 13 were fixed into straight handles fabricated on the site by each experimenter (Table 1). These are sections of fresh, de-barked ash wood of about 30 × 5 cm which were shaped. A slit to insert an end-scraper was made on each of the handles with a metal knife. The insertion of the end-scraper was occasionally accompanied by light percussion on the front with a hard material; the tool was inserted to the maximum to stabilise it. The sharp stone tool was fixed to the handle with ligaments and rough leather strips that had been soaked; the composite tool was then left to dry. While drying the leather shrank and the tie became more solid. The scraping of the skin could begin as soon as the ties around the handles were dry (Fig. 2).

Seven days of scraping were necessary to reduce the thickness of the hide over approximately two square meters of the skin, that is, half of the complete hide.

Table 1. Functional parameters for the 16 experimental tools

Tool N°	Haft type	Working angle	Amplitude of the gesture	Launched percussion	Position of the experimentator on the hide	Position of the experimentator relative to the tool	Sharpening	Length of the flint tool *before* sharpening (mm)	Length of the flint tool *after* sharpening (mm)	Working time after the last sharpening (minutes)	Edge morphology before sharpening	Edge morphology after the last sharpening
1	straight	*ca.* 90°	low	light	seating on the hide	facing it	no	57	_	30	convex	_
3	straight	60-80°	high	violent	standing up in front of the hide	facing it	yes	52	47	60	convex	rectilinear
4	bent	*ca.* 90°	high	light	seating on the hide	variable	yes	71	65	40	convex	rectilinear
7	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	67	63	70	convex	rectilinear
8	straight	*ca.* 90°	low	light	seating on the hide	facing it	yes	56	51	25	convex	rectilinear
9	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	73	63	45	convex	convex
10	straight	45-60°	high	violent	standing up in front of the hide	facing it	yes	48,5	48	30	convex	convex
11	straight	*ca.* 90°	low	light	seating on the hide	lateral	no	30	_	5	convex	_
12	straight	45-70°	low	light	seating on the hide	facing it	no	67	_	25	rectilinear	_
13	straight	30-45°	low	light	seating on the hide	facing it	yes	71,5	71	15	convex	denticulated
14	bent	*ca.* 90°	low	light	seating on the hide	facing it	no	62	_	45	convex	_
15	bent	*ca.* 90°	low	light	seating on the hide	facing it	no	75	_	30	convex	_
16	straight	*ca.* 90°	high	light	seating on the hide	facing it	no	56	_	30	convex	_
17	straight	*ca.* 90°	low	light	seating on the hide	lateral	yes	59	48	10	convex	convex
18	straight	*ca.* 90°	high	violent	seating on the hide	lateral	no	53	_	20	rectilinear	_
24	straight	*ca.* 90°	low	light	seating on the hide	lateral	no	46	_	5	convex	_

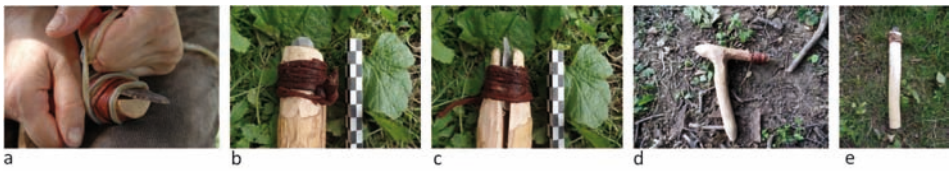


Fig. 2. Immobilisation of a flint blade with wet leather laces (a), b and c) Distal end of the handle (b and c), bent handle used for the experiment (d), straight handle used for the experiment, Pincevent, 2016 (e)

Thinning the hide

The reduction of the thickness follows the defleshing and hair removal, its objective being to make the reticular layer (dermis) thinner (Chahine 2002; Beyries 2008; Emmerich Kamper 2020). The duration of the stage of thinning is correlated to the thickness of the skin and to the objective to be attained.

This stage was carried out on dry skin, *i.e.*, completely dehydrated skin without any elasticity. Bison hide is very thick and also very hard when it is dry and stretched under tension; for instance, sitting upon it produces no deformation.

The work was carried out by scraping to eliminate the successive layers of dermis. The extreme hardness of the reticular layer and its high fat content often prevented the tool from biting into the dermis. When this occurred, local and very superficial rehumidification was applied. Unlike soaking, in which water impregnates the heart of the hide, rehumidification is selective and superficial. To rehumidify, the hide is wetted very selectively with a little water, preferably tepid, and rubbed by hand so that it lightly penetrates the upper part of the dermis. This operation relaxes the dermis, releases and swells the surface fibers of collagen. The hydrated part of the dermis, which takes on a milky colour indicating the saponification of the fats, becomes easier to work. After rehumidification, the tool can again bite into the skin. Selective rehumidification facilitates the removal of matter using a tool and enables evaluation, by the change in colour, of whether fat remains on the skin. The operation can finish when all fats are removed from the skin (Steinbring 1966; Beyries 1999; Beyries 2008; Emmerich Kamper 2020). The scraping operation is continued until the desired thickness is obtained.

Position of the body, handling of the tools and gestures performed

Given the size of the frame, the working of the highest and most central parts requires sitting upon the skin; a wooden bar is placed transversely to stabilise the workers on the frame inclined against the trees (Steinbring 1966; Beyries 1999; Beyries 2008; Emmerich Kamper 2020). For the parts closest to the ground or on the edge of the frame, it was possible to work standing up, leaning above the hide (Fig. 3).

The tools were held in two hands: in this case one of the hands was very close to the working edge which enabled force to be applied in the gesture, while the other hand at the middle or at the extremity of the handle, enabled the movement to be directed.



Fig. 3. Position of bodies: a) Moose hide, Doig River, B.C., 1994; b) Bison hide, Pincevent, 2016



Fig 4. Tools working angle. Moose hide, Doig River, B.C., 1994 (a). Bison hide, Pincevent, 2016 (b)

Sometimes the tool was held with only one hand; in this case one hand performed both roles (Fig. 4).

The choice of the manner of grasping the tool was instinctive according to the position of the three craftswomen and the zone of the skin being worked or the tiredness of the arm. The amplitude of the gestures, the force used and the working angle of the tools varied according to the positions of the craftswomen: an angle for working of between 30 and >90° for the straight handles and around 90° for the bent handles. The gesture used was a thrown percussion, the tool being pulled once in contact with the skin. It was necessary to regularly clean the cutting edge as it became clogged with fat contained in the dermis that accumulated on the edge. The percussion was very light and controlled and did not create splinters.

Resharpening of the tools

The first tools rapidly became worn; after ten minutes the cutting edges became blunted and lost their efficiency. The skin was very dry and dirty (and thus abrasive), and thick

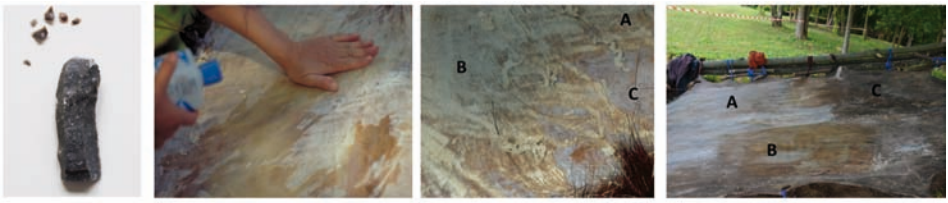


Fig. 5. Sharpened tool during the Pincevent experiment, 2016 (a). Local moiturising of a moose hide to saponify the fat, Doig River, B.C., 1994 (b). A – Unscraped hide; B – Dry thinned hide; C – Saponified fat on the hide; The hide is correctly cleaned when it loses its iridescent appearance on contact with water (c). Experimental hide, Pincevent, 2016; A – Dry thinned hide; B – Rehumidified hide; C – Dirty hide (d)

and dirty. Despite washing, residues of dust, sand and earth related to transporting the skin and setting it in place were present. These residues were highly abrasive, and significant blunting rapidly appeared. The hardness and thickness of the dry bison skin rendered it particularly difficult to work.

Two technical solutions were thus rapidly adopted to allow the tools to properly work the dermis (Fig. 5):

– The tools were frequently resharpened;

– The skin was regularly rehumidified locally.

The resharpening was carried out using direct percussion with a hard striker on an anvil. Without resharpening, the blunt tool slid on the skin, in particular on the thick and very fatty zone of the spine.

Successive sharpenings of a tool modify the angle of the cutting edge and can generate hinged removals which obstruct further resharpening and thus lead to abandonment of the tool. This also leads to a reduction in the length of the tools, and finally the space between the active edge and the handle is too short for the tool to be efficient (the handle scrapes the skin). In anticipation of this reduction in length of the stone tools after successive sharpenings, the distal part of the wooden handle was made thinner by a metal knife so that the handle would not be in direct contact with the skin (Jardon and Sacchi 1994). The reduction of length is variable and ranges between 11 mm and 0.5 mm in relation to the length of the flint tool at the beginning of use. The successive sharpenings do not always change the morphology of the tool front, which remained convex for three of the eight tools sharpened; four tools changed from convex to rectilinear and one tool from convex to denticular. Following the sharpening of the end-scrapers, certain fronts presented a slight denticulation. This irregularity in the cutting edge could have been desirable as it enabled the tool to better bite into the dermis. In certain cases, the cutting edges were evened to increase the zone of contact of the front.

Replacement of fats

Once the phase of thinning by scraping was achieved, the skin was washed with water to remove the shavings of skin, then left to dry. This time, the drying phase took only a few hours as the water had not penetrated to the interior of the skin.

Then it was necessary to replace the unstable fats of the skin by regreasing with a more stable fatty matter to help make the skin supple. In a traditional context, a number of fatty substances can be used: cooked brain crushed by hand, olive oil… We applied by hand about 1.5 kg of vegetable fat (melted margarine) on the scraped surface; 24 hours later, the skin was washed with black soap diluted in hot water while being rubbed with a stiff-bristle brush and scraped with a metal knife (Fig. 6).

Softening

Making the skin supple, it being still in the frame and lightly stretched, was achieved by beating it with wooden sticks to break the fibres. This enabled the smoke to penetrate the leather during the stage of smoking (Fig. 7). Softening took place over several hours.



Fig 6. Greasing a moose hide with melted margarine, Doig River, B.C., 1994 (a). Greasing a bison hide with margarine, 2016, Pincevent (b)

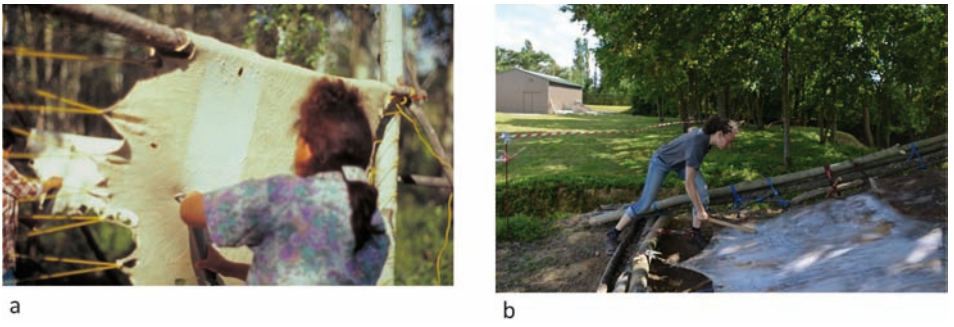


Fig. 7. Softening a moose hide by hitting it with scrapers, Doig River, B.C., 1994 (a). Softening a bison hide by beating it with a wooden stick, Pincevent, 2016 (b)

Cutting the skin

The skin was then cut near the eyelets to remove the frame. This operation was performed with unretouched flakes and blades, then with a metal wood-saw. This phase was difficult in certain parts; even after the thinning, the hard edge of the thick skin was still very thick after the fat had been removed (5-7 mm) and the zone of the spine was also thick (3-5 mm). The skin of the flanks was however thinner (1-3 mm). The cutting operation needed an hour of work and much force as the material is very resistant.

Smoking the skin

For smoking the skin, we dug a hole of about 50 × 50 × 50 cm, gathered fresh moss and rotten wood, which are available in large quantity at the place of experimentation, and lit the fire. The skin was positioned above the hole, leaving a space for the oxygenation of the hearth. The burning of the moss and the rotten wood created dense smoke that penetrated the skin positioned over the hole (Fig. 8). During this operation, the aldehydes (alcohol) and phenols contained in the smoke, by combining with the collagen in the skin, enable it to remain supple. The heat reinforces the tanning effect of the fats previously introduced by oxidizing them. The gases filled with alcohols, ketones, essential oils and tar penetrate the fibres of the skin, which ensures good preservation and impermeability (Chahine 2002; Beyries *et al*. 2001; Beyries 2008; Emmerich Kamper 2020). The tars gave a yellowish tint to the skin (Edholm and Wilder 1997).



Fig. 8. Smoking structure; Doig River, 1994 (a) Pincevent, 2016 (b)

Different states of the surface during the treatment of one skin

The state of the surface of the skin varied during the course of thinning; thus, at the beginning we worked a dirty skin with abrasive particles from the ground on which the skin had lain, then a dry skin, then a dry skin with a dermis rehumidified selectively and superficially. The analysis of the tools used was carried out with a stereomicroscope Leica Z16 APO ×10-×180 and a reflected light microscope Leica DMRM ×100-×200 (Fig. 2).

The dirty skin with abrasive particles

The beginning of the work was carried out on a skin covered with sandy sediment and/or earth containing plant material. These abrasive elements were deposited on the wet skin when it lay on the ground before being installed on the frame; at no point was an abrasive element deliberately added.

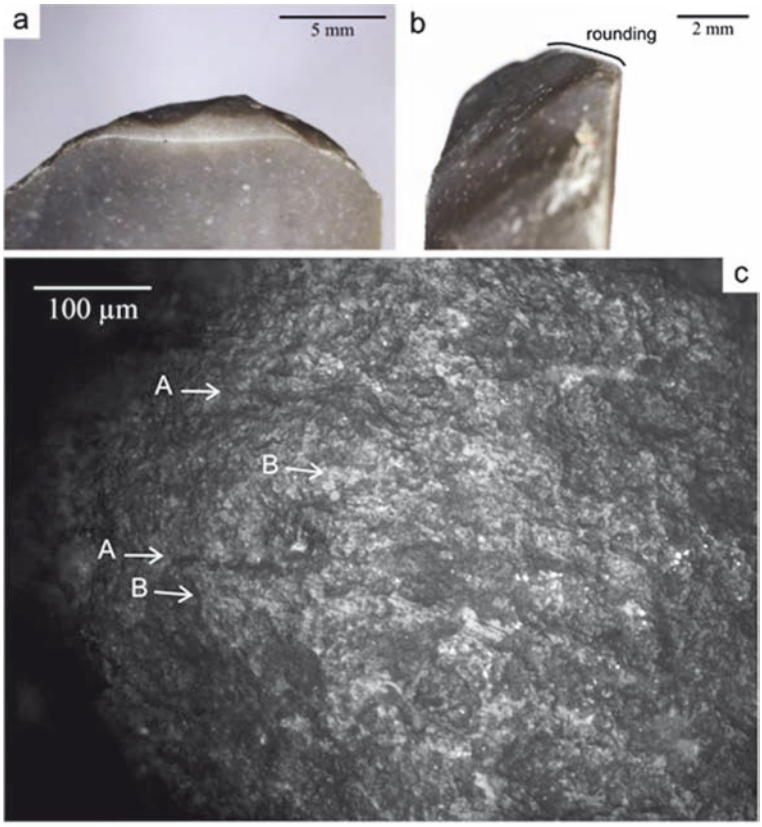


Fig. 9. Traces due to scraping dirty dry hide. Intense rounding of the working edge (a, b). Micro-wears with two types of striations: long deep striations with a rough bottom (A) and fine short striations with a smooth bottom (B) (c)

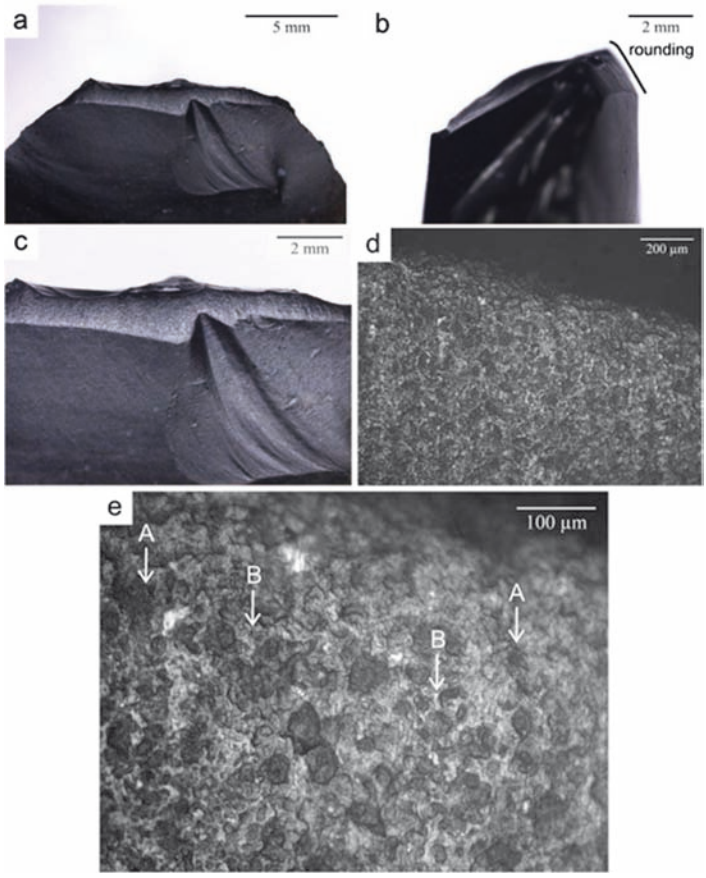


Fig. 10. Traces due to scraping dry hide. Intense rounding of the working edge (a-c). Micro-wears with two types of striations: deep, wide and long striations (A) and abundant thin striations with a rough bottom (B) (d, e)

The end-scrapers used for cleaning the skin developed significant rounding, leading even to the appearance of large flat areas related to the abrasive particles contained in the sediment. The many striations are of two types: on the one hand fine short striations with a smooth bottom, which correspond to the contact with mineral particles; on the other hand long, deep striations with a rough bottom, which correspond to contact with abrasive particles of skin-shaving type or with larger mineral particles. The polish is dull, irregular and rough with an open network (Fig. 9).

The dry skin

The dry skin caused well-developed areas of rounding where flat areas were formed on the cutting edge when the work angle was stable. The many striations are of two types: the

most numerous are fine, with a rough bottom, relatively superficial and moderately long, typical of working on dry skin. Other striations, less frequent, indicate contact with a hard and abrasive material, such as the residues of dirt and/or large shavings of dry skin removed by the scraping. These striations are long and deep with a rough bottom. The polish associated with the working of dry skin is dull with a rough and irregular aspect and a closed network (Fig. 10).

The skin locally rehumidified

The working of a skin that has been locally rehumidified also causes well-developed rounding that forms a flat area if the work angle is stable. Most striations are fine, short, relatively superficial, with a bottom that is rough or even smooth; others are deep, wide and long. On the high points of the microtopography, the polish is smooth and brilliant with a closed network; it corresponds to contact with the skin that is fatty and humid on the surface. On the low points of the microtopography the polish is dull, rough and irregular, with a semi-closed network; the latter corresponds to contact with dry skin (Fig. 11).

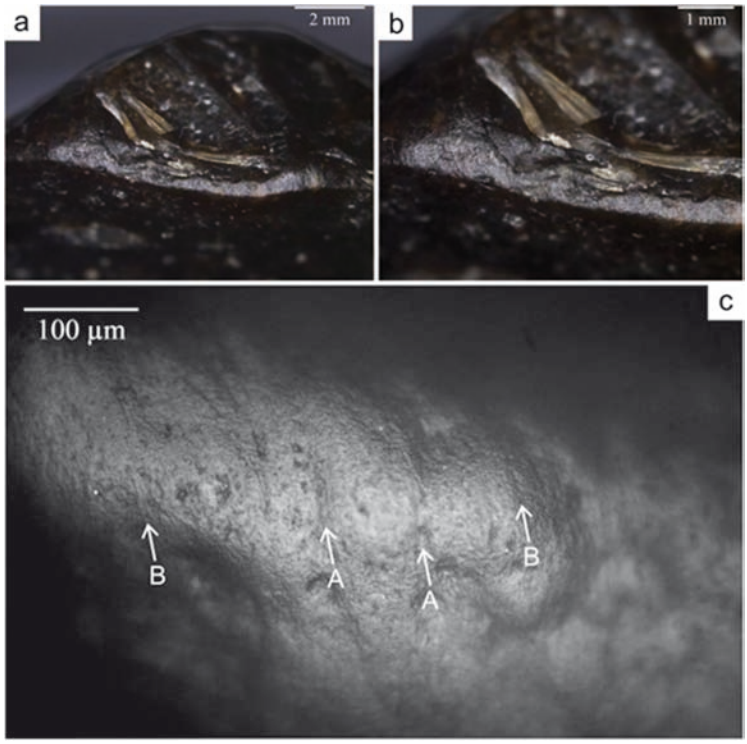


Fig. 11. Traces due to scraping rehumidified dry hide. Intense rounding of the working edge (a, b). Micro-wears with two types of striations: deep, wide, and long striations (A) and thin, relatively superficial striations (B) (c)

Differentiation of these states of the surface: implications for the archaeological record

The rounding alone does not allow discrimination between a dry skin, a selectively rehumidified dry skin and a dirty dry skin; the only differences that can appear correspond to the morphology of the abrasive particles deposited. More generally, the morphology of the rounded area is a parameter to be approached with caution as it does not depend only upon the hardness of the skin (which can vary according to the degree of dryness and/or the tension at which the skin is stretched). The morphology of the blunted area is also dependent upon the gesture used to work the skin (variation or stability of the angle of the tool, amplitude, force applied); the influence of this parameter is closely correlated to the type of handle and to the position of the skin and/or to that of the craftsperson.

Although the demarcation of the polish is not so pertinent, the topography, the intensity of light reflection and the striation network appear to be discriminating factors. The working of a dry skin causes an irregular surface to appear on the tool which reflects very little, whereas humidification of the skin surface wears down the high points of the polish, thus increasing light reflection.

Concerning dust particles/dirt on a dry skin, the result seen on the tool depends on the hardness, density and morphology of the abrasive particles (size and angularity) as well as the amount of humidity. The dust particles increase the irregularities formed on the surface; the more abrasive the particles are, the more the surface is irregular and less reflective.

The lower the level of humidity of the skin, the more accentuated the striations will be. For a clean skin, the width, the length and the aspect of the bottom of the striations (rough/smooth) are to be correlated to the amount of humidity.

In an archaeological context, the identification of these states of skin provides information of different orders.

The identification of a non-specific abrasive during treatment of the skins does not signify that its addition is voluntary. On the other hand, its presence can indicate the beginning of work on a skin that was kept without any particular precautions. With archaeological material, it will be in any case generally impossible to identify whether the abrasive was an intentional addition (additive) or not (dirty skin); the traces obtained at this stage are thus extremely difficult to interpret.

The working of dry skin can involve the treatment of skins of varying thicknesses with distinct methods of applying tension and different stages of the process (defleshing, thinning, epilation). The working of a dry skin stretched on a frame, for stages of epilation and/or thinning, should always be carried out on a skin presenting no elasticity. A very dry skin, stretched on a frame, rapidly wears out the cutting edges of the tools and frequent sharpening is necessary.

In an archaeological context, the identification of a dry skin that has been selectively rehumidified provides crucial information for defining the type of process set in place

(type of skin worked, method of tension, stage in the *chaîne opératoire*); it gives key information to at least grasp the minimum duration of the presence of a group on a given site and possibly the function of the site:

The working of a skin that has been selectively rehumidified is a strong indicator, as this stage occurs only for the thinning of a thick skin stretched on a frame. The analysis of the distribution of traces according to the microtography of the surface of the tool (*cf.* supra) enables identification of this stage, which is often wrongly interpreted as the working of a humid skin (that is, a fresh or soaked skin). The working of this type of skin implies a period of immobilisation of the human group of at least 2 weeks, as the stretching frame is large and heavy and thus not transportable. This minimum duration for the thinning of a thick skin can increase according to the climate, which is a determining factor, as the skin must be completely desiccated before being worked. However, the finer skins (skins of small animals, skins of stillborn deer) are not worked on frames of such a large size and the immobilisation of the group would not be necessary in this case (Audouze and Beyries 2007; Beyries and Rots 2008a; 2008b).

CONCLUSION

A detailed analysis of the traceological criteria on the tools with working edges used to scrape skins provides access to rich archaeological interpretations that enable access to certain aspects of the technical systems and of the mobility. For example, the highlighting of the work of large skins on a very large frame means that the craftsmen will be immobilised for a number of days and even weeks. To access such information, even partially, a perfect understanding of the material and the underlying rules of a technical process are necessary; the current models emphasize in fact that there exists an assemblage of unavoidable rules for the *chaîne opératoire* in the working of skins. Particular attention should be paid to the state of the material worked: a dry skin should not have any elasticity and only when desiccated is a segmentation of the production process possible, transport possible (especially when large in size) and the mobility of the human group conceivable. It must not be lost from view that skin is a living organic material and that environmental variables influence the choice of process, as well as the adaptation of the work to the advancement of each stage.

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VALUE, SIGNIFICANCE AND USE OF 'EXOTIC' MATERIALS IN THE LIGHT OF THE PRESENCE OF OBSIDIAN AT NEOLITHIC SITES IN POLAND

ABSTRACT

Werra D. H., Szeliga M., Pyżewicz K. and Burgert P. 2024. Value, significance and use of 'exotic' materials in the light of the presence of obsidian at Neolithic sites in Poland. *Sprawozdania Archeologiczne* 76/1, 71-97.

At Neolithic archaeological sites in Poland, obsidian stands out as the most common 'exotic' raw material. There are over several hundred Neolithic sites where artefacts made from this raw material have been recovered. Given the absence of natural obsidian outcrops in Poland, it is evident that these artefacts were imported to the sites through various means, such as direct procurement or exchanges.

One of the most extensive collections was found at Opatów, representing the Samborzec-Opatów group of the Late Neolithic. This collection forms the core of our discussion, in which we aim to explore the economic systems involved in the acquisition of obsidian. Results obtained from our analyses (technological, morphological, and traceological) constitute the foundation for considering various hypotheses regarding the significance and value of 'exotic' materials for Neolithic communities.

Keywords: obsidian, value, economy, exchange, import, long-distance contacts, use-wear analysis, Neolithic, Poland

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Cultural facts do not exist as objective phenomena in contrast to natural ones. Cultural facts should be comprehended with due consideration of the perspective of the participants of the investigated culture.

Małecka-Kukawka 1997, 245

INTRODUCTION

Archaeology focuses on studying the material remains left by prehistoric communities and uses them to develop theories and models regarding the past. Additionally, archaeologists define prehistoric communities based on material remains, known as archaeological cultures. The main element defining these cultures is the material culture component most abundant at archaeological sites. In the case of Neolithic communities, this is often ceramics, such as the Linear Pottery culture, Funnel Beaker culture, or Corded Ware Culture (see Chapman 2007, 207). In this way, archaeologists define prehistoric communities, but was this indeed the determining factor in the Neolithic period for individual groups to affiliate with a particular community? Or it was not? Affiliation with a group could be determined by unique, rare elements, often called exotic items.

Obsidian is one of the most well-known and frequently discovered 'exotic' raw materials at archaeological sites on the northern side of the Carpathian and the Sudeten Mountains. In these areas, this material was particularly popular during the Neolithic period, specifically in its Early and Middle phases, being a reflection of intensive intercultural contacts maintained by local early agricultural communities with communities inhabiting the areas on the inner side of the Carpathians. Based on current research, these interactions were initiated by the communities of the Linear Pottery Culture (LBK) and underwent a significant intensification during the development of post-linear groups (*cf.* Kulczycka-Leciejewiczowa 1979; Kadrow 1990b; Szeliga 2007; 2009; 2021).

Considering the data so far known, the conveyance of obsidian from the Carpathian Mountains should be studied in terms of phenomena whose origins and nature are primarily non-economic and socio-culturally relevant and not purely practical or functional. New, essential data on this issue are provided by the results of interdisciplinary analyses of one of the most numerous obsidian inventories from the upper Vistula basin, from the archaeological site in Opatów, Świętokrzyskie Voivodeship. This paper aims to address this issue by presenting research on obsidian materials found at this site, as well as the results of the analysis of their technological, metric and traceological attributes.

NEOLITHIC OBSIDIAN IN THE AREA OF PRESENT-DAY POLAND

Research on obsidian extraction, utilisation, and distribution is conducted globally. In the context of investigating the use of obsidian by prehistoric communities in East-Central Europe, the most significant sources of this material are the southeastern regions of Slovakia (known as Carpathian 1 chemical type), the northeastern regions of Hungary (Carpathian 2 chemical type), and deposits in Transcarpathian Ukraine (Carpathian 3 chemical type). The last one was identified relatively recently and appears to have been exploited by local prehistoric communities (Rosania *et al.* 2008; Přichystal 2013, 159; Werra *et al.* 2021; 2022; see Fig. 1).

The oldest Neolithic obsidian materials discovered in Poland are associated with the LBK communities; currently, at least 100 sites where products made of this raw material have been discovered (Fig. 1: A). These obsidian artefacts are rarely found at sites dated to the earliest phase (Ib – Zofipole), where they are mostly singular specimens (*e.g.*, Mateiciucová 2008, 126; Wilczyński 2016; Wilczyński and Kufel-Diakowska 2021, 169). As we move into the later phases, there is a gradual increase in their occurrence. Several to several dozen obsidian items have been documented in the second phase (classical, Music Note, Notenkopfkeramik phase). Those finds were widely distributed across uplands as well as lowlands, sometimes in considerably distant settlement clusters (Fig. 1: A). Despite a high number of such sites, finds dated to the period in question indicate that the import of obsidian north of the Carpathians and Sudetes was not intensive, which is mainly reflected in the modest quantities of obsidian in inventories, only sporadically exceeding 3% (*e.g.*, Kozłowski 1970, tab. I; Milisauskas 1986, 145; Kaczanowska *et al.* 1987, 94; Caspar *et al.* 1989, 159; Michalak-Ścibior and Taras 1995, tab. V; Wilczyński 2014a, tab. 2; 2015).

Exceptions are the sites of the Rzeszów and Przemyśl LBK clusters, where the participation of this raw material in inventories dated to the Music Note phase often reaches over ten per cent or even more (Kozłowski 1970, tab. I; Balcer 1983, tab. 4; Kadrow 1990a, fig. 24: a-c; 1990b, fig. 14: b; Pelisiak 2014, tab. 14).

An increased influx of obsidian into territories located north of the Carpathians is dated to the Želiezovce phase of the LBK, which is indicated by more numerous finds, concentrated mainly in southern Poland, especially in the Rzeszów and (to a considerably lesser degree) Nowa Huta settlement clusters of the LBK (Kulczycka-Leciejewiczowa 1979, tab. 5, fig. 26; Kaczanowska 1985, Abb. 22; Kadrow 1990a, fig. 24: d-e; Szeliga 2009, tab. I). This increase in the number of obsidian items remained unchanged in the subsequent period, linked with younger Danubian cultural groups developing in the drainage basins of the Upper Vistula and Oder Rivers after the decline of the LBK. This period – especially interesting in the context of the problems discussed in the present article – is currently represented by at least several dozen sites at which obsidian artefacts were found (Fig. 1: B). The

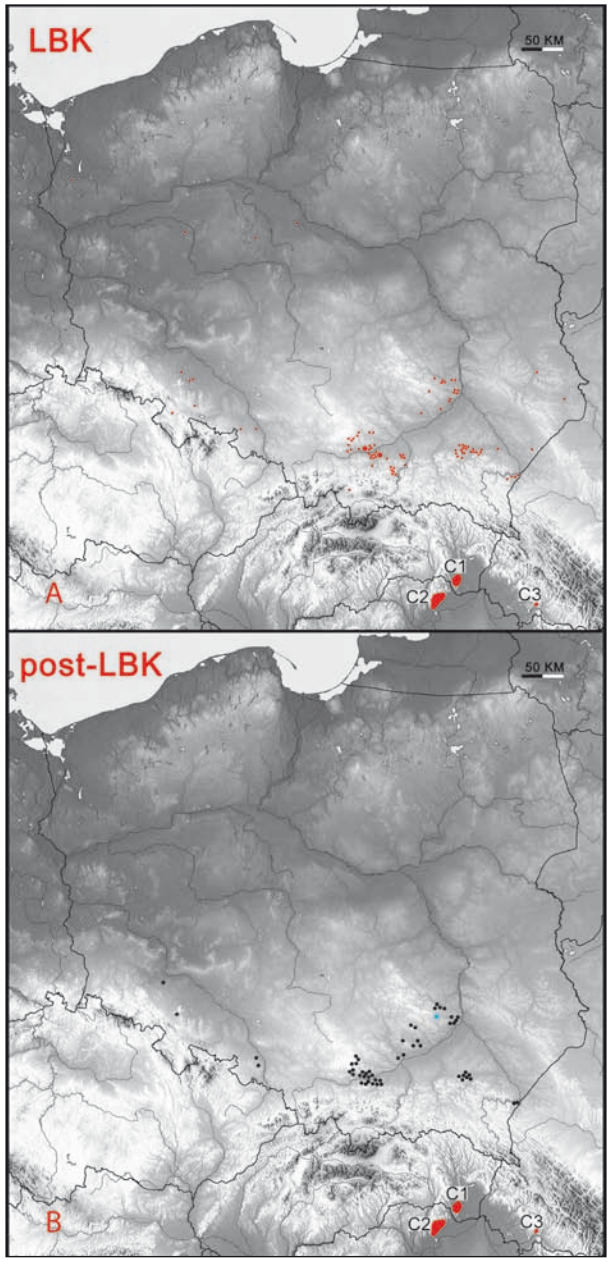


Fig. 1. Location of LBK (A) and post-Linear (B) sites with obsidian artefacts in archaeological inventories. Blue dot – location of Opatów, Site 2, Świętokrzyskie Voivodeship. C1 – Carpathian 1 geological obsidian outcrops; C2 – Carpathian 2 geological obsidian outcrops; C3 – Carpathian 3 geological obsidian outcrops. Graphic design by M. Szeliga. Map background prepared by Ł. Figura

discussed process increase in obsidian imports was the most distinctive in the first half of the 5th millennium BC. It was mainly linked with the early Lengyel cultural groups (the Samborzec-Opatów group [hereafter SOG] and the early phase of Pleszów-Modlnica group), and especially Phase Ib of the Malice culture (MLC; Szeliga 2007, 298-300; 2021, 74-77; Wilczyński 2015). During this period, the influx of obsidian still encompassed all the main settlement clusters in the drainage basin of the Upper Vistula (Fig. 1: B). The most significant numbers of products made of this raw material were recorded in the Rzeszów and Targowisko settlement microregions (*cf.* Kadrow 1990a, fig. 24: f; Wilczyński 2010, 26; 2018, tab. 1; Dębiec and Pelisiak 2022), whereas in the Sandomierz, Nowa Huta and Przemyśl microregions their quantities did not exceed 5%. (*e.g.*, Cabalska 1964, 124-125; Kozłowski 1969; Kaczanowska 1971, 16; 1985, 139; Więckowska 1971, 128; Kamieńska and Kozłowski 1990, 19, 28; Michalak-Ścibior 1992, 39; Szeliga 2021, fig. 6). A similar tendency continued in the second half of the 5th millennium BC. However, the intensity of obsidian influx into southern Poland dramatically decreased and was limited mainly to settlement clusters associated with the late classical and Rzeszów phases of the MLC around the middle Wisłok and San Rivers (Szeliga 2021, figs 7, 9). Nevertheless, a considerably low number of those finds (Kadrow 1990a, fig. 24: g; Dębiec 2003, tab. 8; Mitura 2004, tab. II) may result mainly from insufficient state of research. We must remember that the distribution of obsidian artefacts was still wide-range in nature, which is confirmed by single finds linked with the Brześć Kujawski group in Kuyavia and the younger Lengyel groups in Upper Silesia and western Lesser Poland (Fig. 1: B; see Kozłowski 1966: 15; 1972: 113, 177, 178; Kulczycka-Leciejewiczowa 1979, 111, fig. 50, p. 112).

For the entire period discussed above, obsidian was delivered to settlement clusters across southern Poland, mainly in the form of concretions and, sometimes, of prepared blade cores. There, they were processed, and the products were redistributed further in the settlement clusters (*e.g.*, Kozłowski 1969, 138; Kaczanowska 1985, 65; Michalak-Ścibior 1992, 44; Szeliga 2009, 298; 2021, 82-83). It appears that this tradition's decline occurred as late as in the last quarter of the 5th millennium BC in the environment of the late MLC. A change in the distribution pattern of obsidian north of the Carpathians probably occurred at the same time, which is indicated by triangular bifacial arrowheads discovered at a dozen or so sites located on the left side of the Vistula, between the Sandomierz Upland and Olkusz Highland. Those arrowheads are associated with the late MLC (Sałacińska and Zakościelna 2007, 83). However, in part, they may be linked to the Lublin-Volhynian culture and Wyciąże-Złotniki group as an effect of strong influences from the Transcarpathian Bodrogkeresztúr culture (Kaczanowska 1980, 40-41; 2006, 114; Szeliga 2021, 80-81). Unfortunately, for the majority of such discoveries, lacking the context of features makes it impossible to precisely and definitely determine their cultural association.

OPATÓW. HISTORY OF RESEARCH

The site of Opatów is situated on the Sandomierz Upland, on the slope of the left bank of the Opatówka River, a left tributary of the Vistula River (see Fig. 1: B). The prehistory of the Opatów region was initially studied between 1913 and 1915 by Józef Milicer, an amateur archaeologist and in the interwar period, from 1922 to 1929, was excavated by Zofia Podkowińska (1894-1975). During these excavations in the interwar period, 38 features related to the activities of Neolithic (post-linear) communities and the Bronze Age (Trzciniec culture) were examined (see Fig. 2; Kulczyński and Pyzik 1959; Kosterski-Spalski 1963; Podkowińska 1968; Jędrzejczyk 2013).

Podkowińska continued her research in Opatów after World War II, conducting excavations in 1965 with Leokadia Wrotek (1934-2017). Some articles have been published based on the results (Podkowińska 1953, 1968). The only comprehensive study of the materials from Opatów, apart from interim reporting articles, is the study of lithic inventories compiled by Hanna Więckowska (1927-2013; Więckowska 1971; Kowalewska-Marszałek 2004, 2007, 2012).

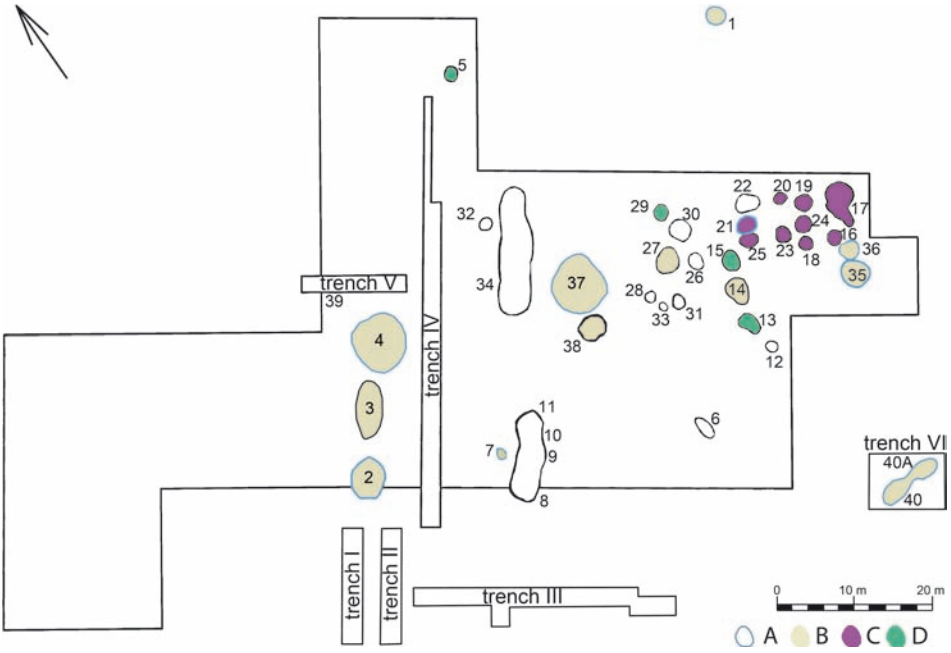


Fig. 2. Opatów, Site 2, Świętokrzyskie Voivodeship. Site plan with features no. 1-40A and trenches from 1924, 1929 and 1965. A – features with obsidian; B – features connected with Samborzec-Opatów group domestic activities; C – features associated with Trzciniec culture communities' activities; D – features of unspecified chronology. After Więckowska 1971, fig. 1. Graphic by P. Burgert, D.H. Werra

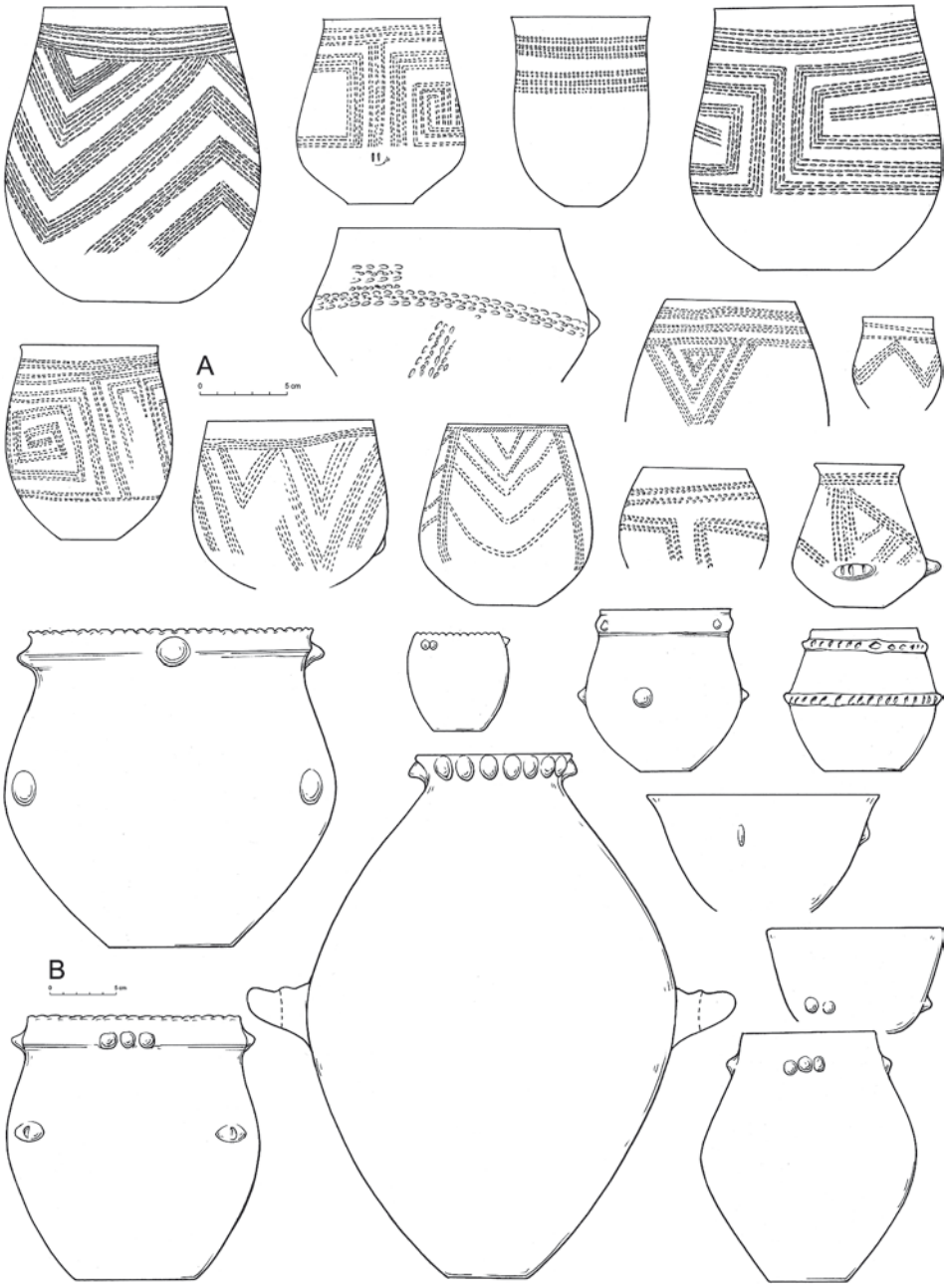


Fig. 3. Selection of typical ceramic shapes from Opatów, Site 2, Świętokrzyskie Voivodeship. A – scale for decorated vessels (upper part); B – scale for undecorated vessels (lower part). Drawing by P. Burgert, M. Černý, T. Davidová

The unclassified nature of the archaeological materials from the Samborzec and Opatów sites prompted Podkowińska to establish the SOG within the Lengyel culture (c. 4900-4700 BC). This cultural group represents the oldest horizon of the Danubian communities on the northern side of the Carpathians after the decline of the LBK. According to Podkowińska, it developed under the strong influences of the Lengyel culture, the Stroked Pottery culture (hereafter SPC), and the socio-cultural systems from the Upper Tisza River basin. These diverse cultural interactions significantly impacted the syncretic nature of the SOG, primarily reflected in its ceramics (Podkowińska 1953, 32-44). We present our current insight into the degree of involvement of individual cultural elements in this group in the discussion of this article.

The SOG group was first defined by Podkowińska (1953, 32-44) and has since been redefined several times (Kozłowski 1966; Kamieńska 1967; Kamieńska and Kozłowski 1970; Kozłowski and Kozłowski 1977; Kaczanowska and Kozłowski 1994; Kadrow and Zakościelna 2000; Kowalewska-Marszałek 2004; Kozłowski 2004; Kulczycka-Leciejewiczowa 2004; Zápotocká 2004).

In the Sandomierz Upland, the pottery assemblages are characterised by the frequent presence of vessels with bulging necks and thick walls, with horizontal bands dominating



Fig. 4. Blades and their fragments from Opatów, Site 2, Świętokrzyskie Voivodeship. Photo by D.H. Werra

the ornamentation (Fig. 3). The lithic industry is dominated by chocolate flint, with a frequent presence of obsidian items (Fig. 4; Kaczanowska 1990; Kaczanowska and Kozłowski 1994; Kadrow and Zakościelna 2000, 196).

This unique character of the ceramic materials, in turn, significantly influences the classification of this cultural group within the basic cultural taxonomy. The materials of the SOG from western Lesser Poland (Southern Poland) have been classified as part of the Lengyel culture. At the same time, those from the Sandomierz Upland (including the Opatów site) have been defined as an "early Malice – Lengyel mixed group" (see references in Kadrow and Zakościelna 2000).

Regardless of recent discussions on the cultural classification of the SOG and the archaeological site in Opatów, this obsidian assemblage has played a vital role in the study of obsidian distribution to the north of the Carpathians during the Neolithic period, including the continuity and intensity of this phenomenon after the disappearance of the LBK (Szeliga 2007, 297-298; 2021, 74-75; Werra *et al.* in print).

OBSIDIAN FROM OPATÓW – DECOMPOSED INTO PRIMARY FACTORS

During the excavations at the Opatów site of the 1920s and the 1960s, 292 obsidian artefacts were recovered (5.04% of the entire lithic assemblage). This is the largest and most chronologically homogeneous obsidian assemblage so far, related to the oldest post-linear cultural horizon in the upper Vistula basin (Więckowska 1971; Szeliga 2007, 297; Werra *et al.* in print).

Technological, morphological, and refitting analyses were conducted, along with the observations of use-wear, all to understand the methods of obsidian knapping used by Middle Neolithic communities. These analyses aim to gain insight into the daily life of these prehistoric communities and explore obsidian's presence within their socio-cultural context.

Furthermore, these items underwent energy dispersive x-ray fluorescence (EDXRF) analysis using a QuanX EDXRF spectrometer (Hughes and Werra 2014; Hughes *et al.* 2018). Among them, 69 artefacts were of sufficient size to allow for quantitative composition estimates, while the other 195 artefacts were too small for reliable quantitative analysis (see Hughes 2010). The EDXRF analyses were conducted in the Geochemical Research Laboratory by Richard E. Hughes. The results indicated that all artefacts were made from obsidian of the Carpathian 1 chemical type found in the Zemplén Mountains in southeast Slovakia (Werra *et al.*, in print). Those results, showing the domination of the Carpathian 1 chemical type obsidian in the inventories, correspond closely to those obtained from neighbouring regions (see Biró 2014; 2018; Constantinescu *et al.* 2014, 148; Kabaciński *et al.* 2015; Burgert *et al.* 2017; Riebe 2019; Szeliga *et al.* 2021; Werra *et al.* 2021).

Morphometric and typological analysis

In total, 264 items out of the entire number of artefacts discovered during excavations were available for analysis (*cf*. Więckowska 1971). Their morphological analysis indicates that blades are clearly predominant. They are nearly twice as numerous as flakes. Cores and prepared tools are very rare (Fig. 5). All the cores are partly exploited or even vestigial forms used in blade production, having considerably small or even microlithic sizes (length: 17.5-29 mm) and masses (3.99-21.83 g). The sizes of blade scars preserved on their flaking surfaces are also very small (usually 18-22 mm in length; Werra *et al*., in print). All cores from the collection are single platform forms (typologically, mainly subconical and conical) with prepared striking platforms. They bear traces of intensive repair, concentrated mainly on correcting the core angle. This correction also included *ad hoc*, careful and intensive polishing of the edges of the striking platforms prior to removing new blades, as well as delicate or complete rejuvenation of the striking platforms. The commonness of these repair procedures is corroborated by the results of analyses conducted on blade butts (*i.e*., frequent traces of polishing) as well as by the presence of rejuvenation flakes. On specific cores, traces of changing the orientation of exploitation were detected (Werra *et al*. in print).

The most numerous category of obsidian artefacts is blades (Fig. 5), represented mainly by various fragments. Complete blades are very rare (Fig. 6). They are tiny, with a length ranging from 20 to 30 mm. This precisely corresponds to the sizes of the cores and negative scars formed on their flaking surfaces. Specimens with dorsal surfaces covered entirely by negative scars – detached at advanced stages of core exploitation – are clearly predominant. Most of them are blades having a trapezoidal or triangular cross-section.

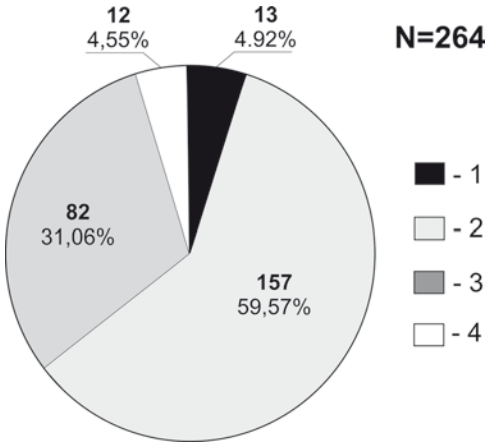


Fig. 5. Opatów, Site 2, Świętokrzyskie Voivodeship. Morphological structure of the obsidian artefacts: 1 – cores; 2 – flakes and chips; 3 – blades and their fragments; 4 – retouched tools. Graphic by M. Szeliga

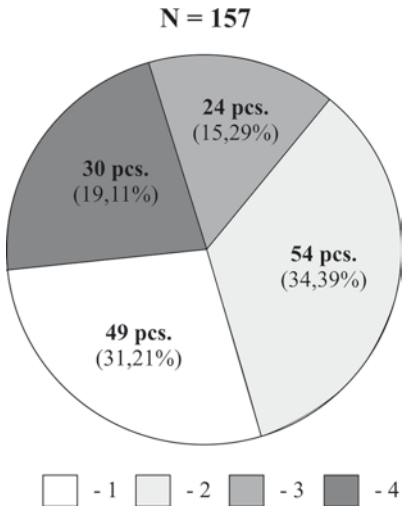


Fig. 6. Opatów, Site 2, Świętokrzyskie Voivodeship. State of preservation of blades:
1 – complete blades; 2 – proximal parts; 3 – median parts; 4 – distal parts. Graphic by M. Szeliga

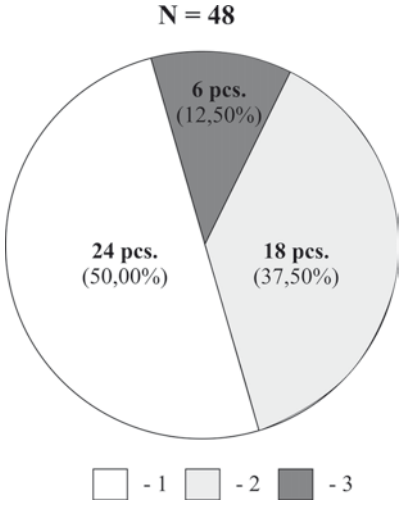


Fig. 7. Opatów, Site 2, Świętokrzyskie Voivodeship. Differentiation of the dorsal surfaces of flakes:
1 – partially cortical flakes; 2 – completely cortical flakes; 3 – completely scar flakes. Graphic by M. Szeliga

Specimens wholly or partly covered with cortical surface are represented by 53 specimens, which jointly makes 32.71% of the entire number of the blades. Among them, the most numerous are partially cortical specimens formed during expanding flaking surfaces to the sides of the cores (27 specimens; 17.20%).

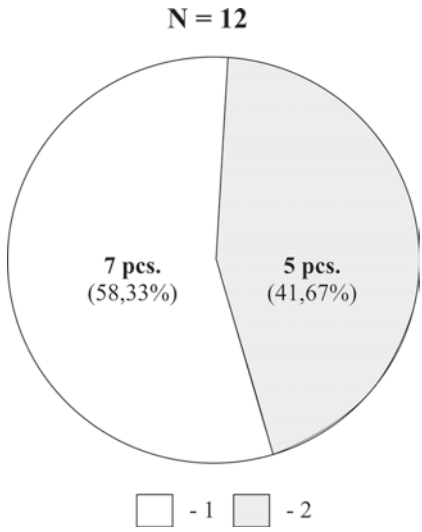


Fig. 8. Opatów, Site 2, Świętokrzyskie Voivodeship. Structure of the prepared (retouched) tools: 1 – retouched blades; 2 – retouched flakes. Graphic by M. Szeliga

Flakes (48 specimens), together with chips (33 specimens) and a single spall, are the second most numerous group of the inventory, jointly constituting c. 31.06% of the collection (Fig. 5). An analysis conducted on the dorsal surfaces of flakes indicated that a large part of them are cortical and partly cortical items (30 specimens; 62.5%; *cf.* Fig. 7). They are represented on the one hand by the products of initial preparation of cores, and on the other hand by remains of their repairs performed during exploitation. The characteristic remains of core repairs (core tablets and rejuvenation flakes) were also found among specimens with dorsal surfaces completely covered with negative scars (Werra *et al.* in print).

The least numerous category of obsidian artefacts is prepared (retouched) tools, represented by the total number of 12 specimens (4.55% of the collection; see: Fig. 5), mainly retouched blades (7 specimens) and, to a lesser degree, retouched flakes (5 specimens; Fig. 8). They appear not to show any regularity as to the technology of their production, sizes of particular specimens as well as locations and outlines of the retouched edges.

Microscopic analysis

Microscopic studies were performed on 264 obsidian artefacts. The group included all artefacts made of obsidian obtained from the Opatów site, *i.e.*, debitage products, blades, bladelets, flakes, and their fragments, as well as single technical forms, splintered pieces, chips and cores. The analyses were performed based on the standard methodology of use-wear studies (Marreiros *et al.* 2015; Pyżewicz 2021). The study was conducted using the

digital microscope Keyence VHX-7000 series (VHX-S770E; VH-Z100R and VH-Z20R lens). The magnification range (according to digital microscopes) used was ×50 to ×300. The obsidian artefacts were washed with acetone before microscopic analysis. The analysis focused on identifying any kind of traces: micro-flake scars, fractures, rounding, abrasion, striations and potential polishes. The interpretation of the traces was made primarily based on comparisons with traces identified on experimental specimens made of obsidian – made and used during experiments conducted at the Faculty of Archaeology, Warsaw University and the archaeological reserve at the Archaeological Museum in Biskupin. During the experimental tests, direct percussion with a stone hammer, indirect percussion and pressure techniques (with antler tools) were used. Blades, flakes, and other items made of obsidian were used for various activities, such as processing of plants, wood, meat, skin, and bones. The reference collection is kept at the Faculty of Archaeology, Warsaw University.

As a result of the microscopic analyses, it can be concluded that some of the analysed artefacts bear technological traces (produced in the manufacturing process), but most of them do not.

To summarize the data on technological traces, linear traces were recorded on 44 specimens as sets of relatively wide scratches running more or less parallel to each other and deeply penetrating into the surface of the raw material. They were recorded primarily on the butts of blades (14 items), bladelets (seven items; Fig. 9: 1-2), and flakes (12 items; Fig. 9: 3-4), but also on the butt of a splintered piece, the surface of a rejuvenation flake, a crested blade and the striking platforms of cores (eight items; Fig. 9: 5-6). Based on the experimental reference, these traces were most likely caused by such actions as abrading or trimming an edge with a stone hammer for preparing a point of percussion before flake/blade detachment, but also by detaching the flake or blade. Unfortunately, it is challenging to identify technological traces caused by the use of antler/bone tools due to the low possibility of preservation of such traces (which is confirmed by experimental tests).

It is quite problematic to determine the function of obsidian specimens from Opatów. Most of the analysed specimens do not show any sign of use. Possible use-wears were identified on 30 specimens, occurring in the forms of micro-flake scars, abrasion, and linear traces. These traces are difficult to interpret, mainly due to the nature of the raw material – on obsidian specimens, use-wear is in general not distinctive (see works by Hurcombe 1992; Korobkowa 1999; Clemente Conte *et al.* 2015). In the case of nine specimens (seven blades, one bladelet, one flake) small chipping, abrasion, and numerous striations were noted along the edges, aligned obliquely and parallel to the edges with a relatively high degree of regularity (Fig. 10: 3-4). These blanks may have been used for cutting organic materials. Another six specimens (four blades, one bladelet, one flake), show similar traces, except for striations that are perpendicular to the edges, which may indicate scraping motion (Fig. 10: 1-2, 5-6). Another blade bears the two categories of traces described above. Therefore, it could be used by transverse and parallel motion to the working edge. For the

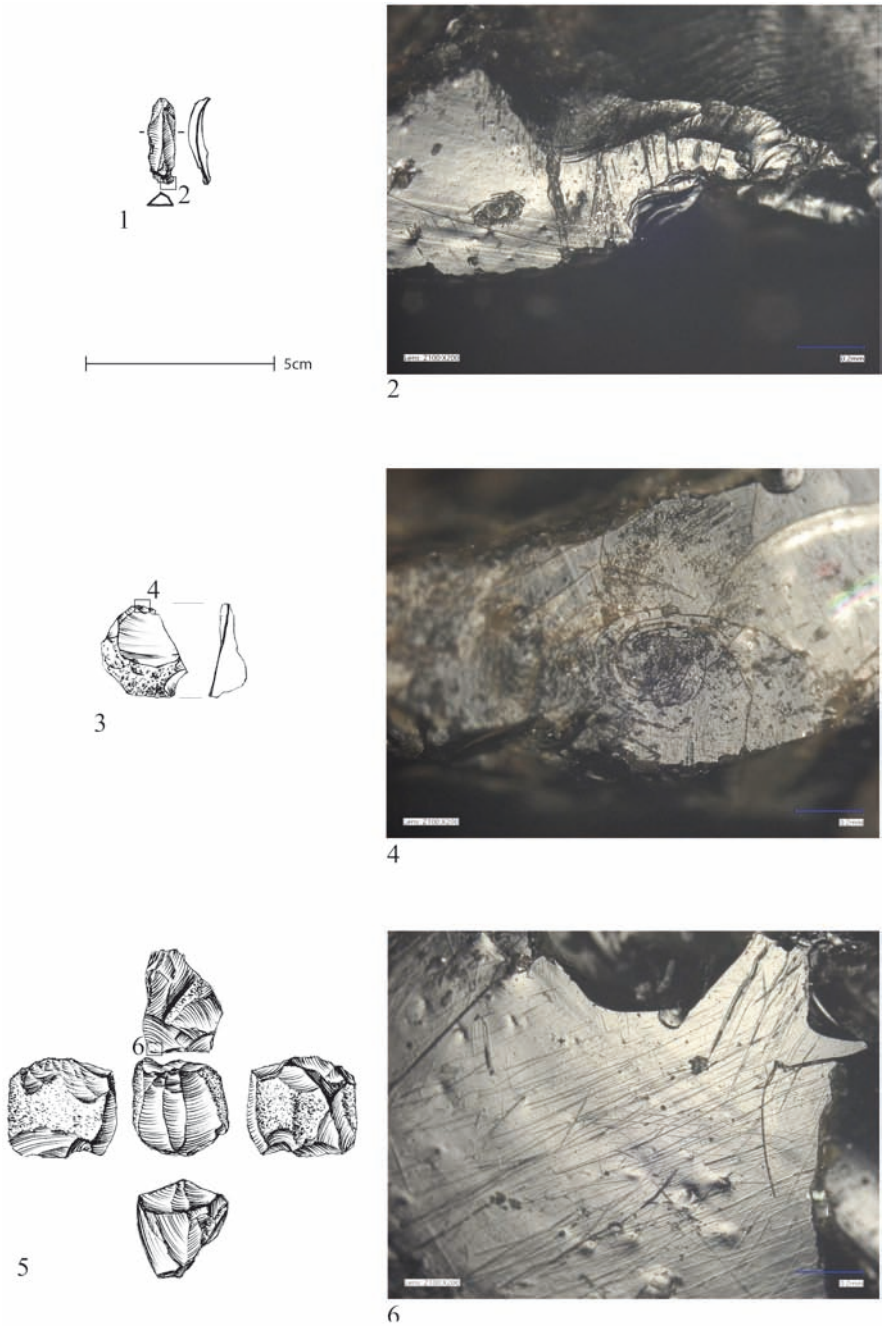


Fig. 9. Microscopic technological traces visible on bladelet butt (1-2), flake butt (3-4), and striking platform (5-6). Photos by K. Pyżewicz. Drawing by E. Gumińska, D.H. Werra

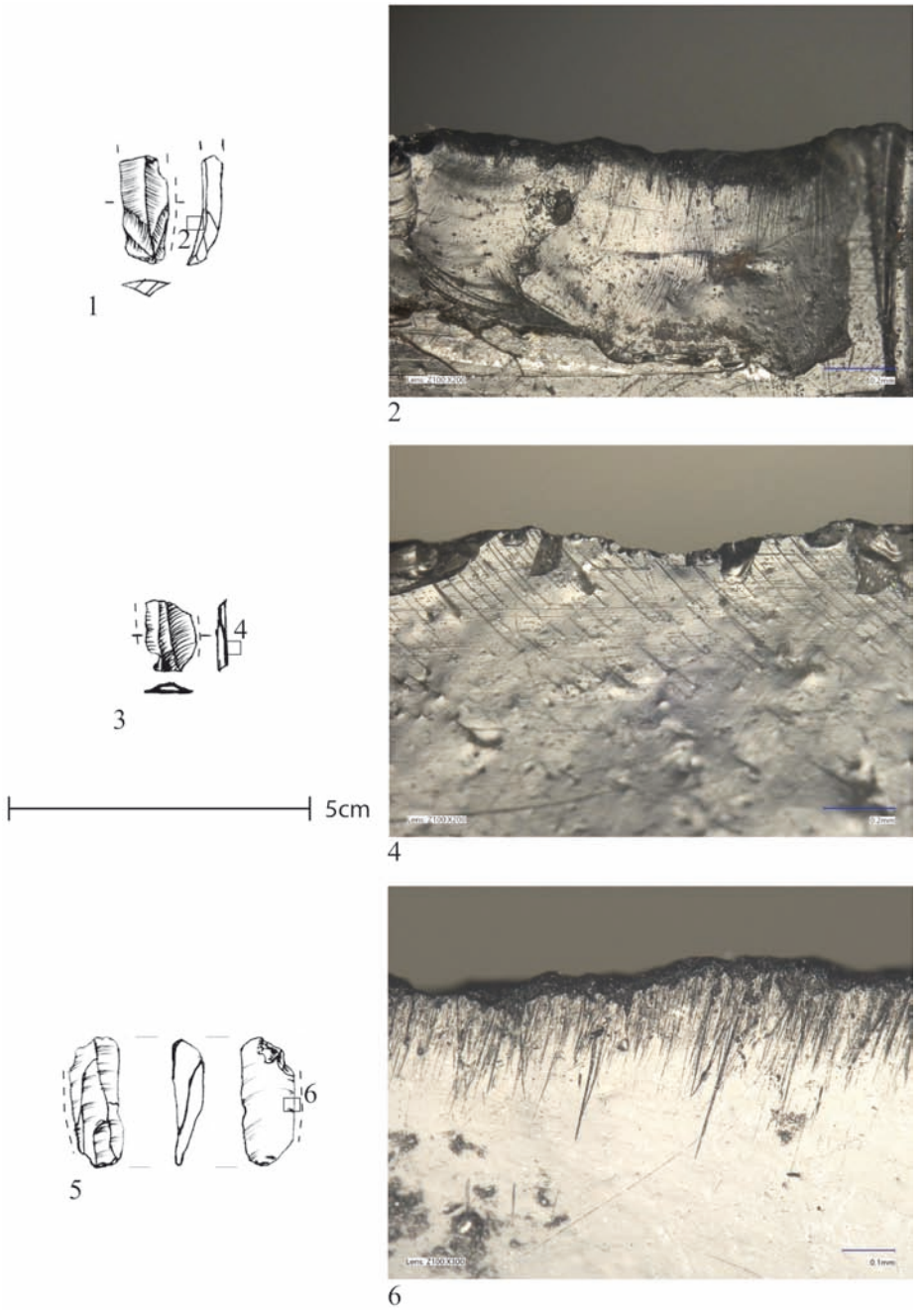


Fig. 10. Use-wear traces – micro-flake scars, abrasion, and striations visible along the edges of the bladelets. Photos by K. Pyżewicz. Drawing by E. Gumińska, M. Szeliga, D.H. Werra

remaining 14 specimens, it is difficult to determine whether the traces are post-depositional or anthropogenic in nature.

It should be emphasized that none of the recorded traces described above are intensive or distinctive, so it is difficult to consider with certainty that we are dealing with tools used for some kind of repetitive work in subsistence or domestic activities, which is likely to cause distinctive wear. These data differ from the results of the use-wear analysis of flint materials obtained from the same Opatów site. In the sample of 100 flint specimens, formal tools and blades, 53 show use-wear traces (Pyżewicz 2022). These tools were used primarily to process plants, mainly as sickle inserts, and to process skin (including scraping).

DISCUSSION

The conducted use-wear analysis did not provide a conclusive answer regarding the purpose of obsidian conveyance (exchange). The detected usage traces were infrequent, weak, and lacked diagnostic characteristics. Several factors may account for this situation. First, the preservation state of the materials is a critical factor to consider. The earliest obsidian artefacts were excavated nearly a hundred years ago. Throughout the time, artefacts have been handled and studied by numerous archaeologists. This may have blurred the traces. Nevertheless, most of the specimens have suitable surface conditions for use-wear analysis. Hence, the import of obsidian, as well as the low occurrence and faintness of usage traces on the obsidian tools, are more likely to be attributable to the nature of activities practised in the prehistoric communities.

The distribution and use of obsidian should not be considered as depending only on the accessibility to the sources and on the quality of the raw material. However, local value systems should also be taken into account. One of the motivations for its acquisition seems to be that obsidian could be a status symbol, as its presence or absence could indicate alliances or affiliations, hierarchy or heterarchy (Burger *et al.* 2006, 110; Carrignon *et al.* 2023, 2).

Research on the use of obsidian in Albania in the Late Neolithic and the Bronze Age showed that this raw material was of low interest to the prehistoric communities there. The reasons for this can be because the local material is of high quality, so there was no need for imported materials, or because there was a geographical gap between the distribution zones of obsidian. Nevertheless, Ruka *et al.* (2019) proposed a socio-cultural point of view on this distribution pattern. Looking at the distribution pattern at that time, they observed that materials other than obsidian were transported, even in huge amounts (*i.e.*, pottery). Therefore, obsidian was unnecessary or there could be an "embargo" on this raw material. The communities in this region most probably were not interested in activities connected with the use of this raw material. The authors follow Carter's suggestion that Early Bronze Age Aegean individuals used obsidian blades for depilation and/or scarification and they were commonly deposited in burials. Apparently, western Balkan

peoples did not practice these forms of body modification (Ruka *et al.* 2019, 46; see Carter 1994, 1997).

Considering obsidian artefacts as used for a rare practice, connected maybe with personal use, can shed light on the question of infrequent and weak usage traces without diagnostic characteristics. Experimental research on grooming and shaving human skin with obsidian showed that thin and sharp edges are efficient for this task only for a very short time (2 to 5 minutes) before the edges become blunted (Kononenko 2011, 34). Shaving human skin produced very few if any, extremely short and thin striations restricted to the tool edge visible on the ventral surface. The results of all undertaken experiments reveal that use-wear analysts will likely be unable to identify personal grooming as an activity on archaeological tool specimens (Hurcombe 1992: 46; Kononenko 2011, 34; Walton 2019, 927, 937). The same conclusions regarding all activities with skin/hide were undertaken for a short duration and did not leave clear and unambiguously characteristic traces. This may suggest the use of sharp obsidian flakes in conjunction with the human body, *i.e.*, for tattooing and scarification, cutting and shaving human bodies for personal adornment or medical treatment (Kononenko 2011, 70; 2012; Walton 2021, 275, 281) and so on. All these indicate the treatment of 'exotic' material "not according to the production conditions, but according to the rules of communication, constant mutual services and reciprocation regulated by cultural norms and the form of common consciousness. Eventually, it established solid social ties" (Małecka-Kukawka 1994, 50).

Obsidian as an intercultural link with Western Neolithic communities?

The Opatów site has extraordinary importance in relation to the western range of the Central European Neolithic (Fig. 11). This is the eponymous locality of the SOG, which in the evolution of ceramic decoration suggests genetic relationships with the SPC (5100/5000 – 4500/4400 cal BC), the Lengyel culture and the Tisza River basin cultural environment (especially Tisza and Herpalý cultures; *cf. e.g.*, Kaczanowska and Kozłowski 2006). The place of presumed origin of the SPC was located on the border of northwestern Bohemia and Saxony, where it followed-on from the late phase of the LBK – the so-called Šárka type (*cf.* Zápotocká 1998; 2007). During its later evolution, it occupied the whole of Bohemia, Saxony, Bavaria, western Moravia, Upper and Lower Silesia, and isolated localities are known from Austria and even Kuyavia. This post-LBK evolution is part of the Western European contemporary cultural range. This is characterised by the decoration of the surface of the pottery by hollow decoration (*e.g.*, Rössen culture, Obelauterbach group).

In contrast, groups characterized by polychrome decorated ceramics (the Lengyel cultural range, as well as the Tisza and Herpalý cultures) were formed, in the eastern part of the Central European area. The SOG seems to combine these two essential traditions, representing, on the one hand, the periphery of the Western cultural scope and on the other hand (especially the Sandomierz subgroup) the northern range of the strong cultural influences

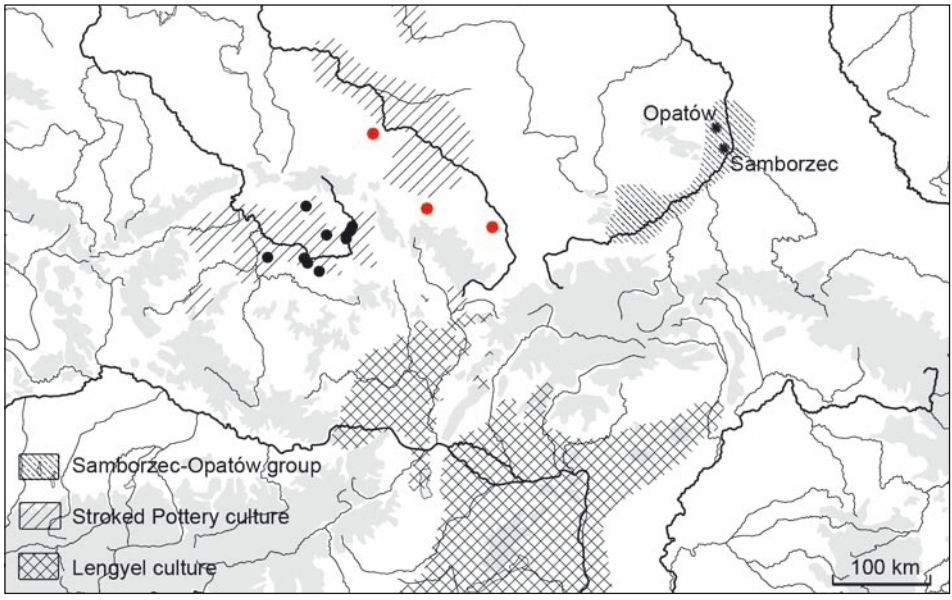


Fig. 11. Samborzec-Opatów group and other contemporary archaeological cultures approximately the first half of the 5th millennium BC. Red points: sites with obsidian from Silesia (after Furmanek 2010, fig. 9). Black points: localities with obsidian finds in settlements of the Stroked Pottery culture in Bohemia – about 100 pieces from approximately 15 sites. The absolute majority comes from two workshops, at other sites always 1-2 pieces. Drawing by P. Burgert

both from the Lengyel culture and the Tisza basin cultural environment (Fig. 3). Hence, it becomes pertinent to consider the role of this group in the transition of Eastern elements towards the West and vice versa, in the exchange of influences. Obsidian, in this context, emerges as a compelling factor for consideration.

In Bohemia, obsidian had been an exceptional raw material throughout prehistoric times (Fig. 11). We know about rare finds from the Mesolithic (Vencl *et al.* 2006, 61, 130). However, we observe a distinctive trend of increase in the number of artefacts from this raw material in the later phase of the SPC. In neighbouring Moravia, the appearance of obsidian is generally more common in the Lengyel culture. However, the peak of its distribution falls at the beginning of the older Lengyel (*c.* 4800-4700 BC). In Bohemia, this corresponds to the beginning of the late SPC (Trampota 2015; Trampota and Květina 2020). Based on the typology of ceramics, we also include the SOG in this period (Zápotocká 2004).

At this time, there is generally an increase in the amount of exotic raw materials in the assemblages (*e.g.*, chocolate flint, Bavarian Jurassic chert). The later SPC also brings about other changes observable in material culture (change of floor plan of houses, construction of rondels, new decorative styles and shapes of ceramics). The increase in the amount of exotic raw materials at sites probably has a more comprehensive social background.

Looking at the spatial cultural scheme of Central Europe (Fig. 11) raises the question of the routes by which obsidian, as an exotic raw material, was transported into the area of SPC. Based on previous analyses of Czech finds of this raw material, it is known that, with one exception, representing a Hungarian source, most of the finds came from the dominant prehistoric source in eastern Slovakia (Burgert *et al.* 2016). Due to the localization of sources, two schemes are possible. The first – most commonly assumed – is that obsidian was distributed to Bohemia through the neighbouring Lengyel culture. The second possibility is that the SOG played the role of an intermediary in this distribution. Given the genetic proximity of this group to the SPC, this hypothesis is not excluded. Obsidian products at the few SPC sites in Silesia have a crucial meaning in this context (Furmanek 2010, 179, Fig. 9).

CONCLUSIONS

One of the most intriguing questions in the study of obsidian is the reasons behind the phenomenon of its significant and long-term popularity among early agricultural communities on the northern side of the Carpathian and the Sudeten Mountains. This may have been caused by the material's physical properties (sharpness and cutting ability of its edges), and perhaps its unique aesthetic qualities (colour, lustre, transparency; see Chapman 2006; 2007).

The aforementioned data and results allow us to consider the conveyance of obsidian as resulting primarily from other needs rather than the sole desire to obtain a high-quality raw material. This is also supported by the compositional structures of analysed Neolithic inventories, in which the percentage of obsidian rarely exceeds 5%. Higher amounts are sometimes recorded, but are only found in the southern and especially the southeastern regions of Poland (*e.g.*, Kulczycka-Leciejewiczowa 1979, table 5, fig. 26; Kaczanowska 1985, fig. 22; Kadrow 1990a fig. 24: a-i, 26: c; Pelisiak 2014, tab. 14; Wilczyński 2014b, fig. 12). It should be emphasized that the processing of obsidian at individual sites for the production of tiny, even microblade-like flakes and the minimal presence of retouched tools have been documented (*e.g.*, Szeliga 2009, 296-297; Wilczyński 2010, 4; Szeliga *et al.* 2021, fig. 4).

The results of existing, very limited functional analyses (Grygiel 2004, tab. LII, 582, fig. 461: B; Szeliga *et al.* 2021, 37-04; Wilczyński and Kufel-Diakowska 2021, 175) do not provide definitive confirmation of one, primary purpose of use of obsidian. This allows for consideration of numerous intended uses and scopes for utilising this material by Neolithic communities.

Yuval Noah Harari emphasises in his publications that human success is based on sharing collective myths. He points out that the ability to create stories, myths, symbols, and systems of shared belief was crucial to the success of *Homo sapiens* (Harari 2019, 28). We propose to move the research focus beyond the characterisation of the raw material for producing sharp and precise tools and move forward to questions concerning its value,

meaning and significance. Could an 'exotic' material (obsidian) have been a symbol or an element that indicated an affiliation to a specific community? Could it indicate the existence of a hierarchy or heterarchy among these communities? Did these artefacts have not only economic value but also, or perhaps above all, socio-cultural value (Chapman 2007; Pearce and Moutsiou 2014; Belfer-Cohen and Hovers 2020; Carrignon *et al.* 2023, 2)?

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TRACEOLOGY OF METALWORK – LIMITATIONS AND NEW PERSPECTIVES

ABSTRACT

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The article focuses on the traceology of metalwork, its methodological limitations, and new research perspectives. In the text, we explain what studies on traces on metals entail and how they are characterized. We provide examples from both Poland and other regions of Europe. We highlight possible directions for the development of the method as well as factors that hinder it.

Keywords: archaeology, traceology, metalwork, archaeometallurgy, wear analysis
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INTRODUCTION

The analysis of traces found on artefacts made from various materials has been developing for many decades. Traceological studies are primarily associated with the analysis of the surfaces of stone objects (*e.g.*, Pyżewicz 2021). The precursor to the use of traceology in archaeology is often attributed to the Russian scholar S. A. Semenov, who studied artefacts made from stone (1957; English edition in 1964).

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Currently, this method is still used primarily to study objects made from stone materials (*e.g.*, Osipowicz 2022; Kufel-Diakowska *et al.* 2022), but also bone and antler (*e.g.*, Płonka *et al.* 2022; Orłowska 2021; Stelmasiak 2021; Orłowska and Osipowicz 2021; Winnicka 2019), as well as artefacts made from shells (*e.g.*, Alarashi *et al.* 2021; Kurzawska 2021), wood (*e.g.*, Caruso Fermé *et al.* 2015; on a broader macroscopic scale, Thomas 2018), or ceramic materials (Vieugué 2014; Gawron-Szymczyk *et al.* 2022). Many important and interesting works related to artefacts from specific sites or areas have been produced, as well as research on the methodology of wear analysis on such objects (*e.g.*, Adams 2014). It would be challenging to list all the works related to wear analysis on stone artefacts alone, as there is a specialization in specific types of rocks (flint, sandstone, etc.) and types of action that would leave wear traces.

An integral part of wear research is the creation of a reference database consisting of traces on copies of archaeological artefacts. Here, too, stone, bone, and antler artefacts take the lead in databases of experimentally acquired traces (*e.g.*, Kufel-Diakowska *et al.* 2020; Orłowska *et al.* 2022; 2023; Sobkowiak-Tabaka and Kufel-Diakowska 2019; Orłowska and Osipowicz 2017). In Polish traceology of non-metallic artefacts, researchers from the Toruń and Wrocław centres stand out in terms of the quality and scope of their studies.

Observations of the surfaces of metal objects, mainly made of copper and its alloys, in comparison to stone artefacts, have received significantly less attention among researchers. The main reason for this is the effects of the corrosion process affecting the majority of metals used in the past which was assumed to have concealed all the wear (Kasprowicz 2022, 77-78; Sych 2014, 36-37). Many researchers also believed that copper and even bronze were too soft to be a proper material for the manufacture and use of tools and weapons; therefore, it was believed that they played mostly symbolic and wealth accumulation roles (Kristiansen 2002, 319-320). However, this situation has changed dramatically in recent decades. This shift is due to a number of experiments and research publications by archaeologists who have proven that wear analysis of metalwork is as valid as the analysis of objects made of other materials. As a result, metalwork wear analysis has firmly established itself in the repertoire of research on metal artefacts (Dolfini and Crellin 2016). In Poland, too, we see a significant rise of interest in this type of research.

Metalwork wear analysis is an invaluable research tool. A careful study of metals and the objects with which they came in contact can tell us a lot about past societies: from their beliefs, economy, and social hierarchy to their sense of aesthetics and perception of quality. Currently, we are able to create new narratives not only about assemblages of artefacts but also to create detailed biographies of individual objects.

The aim of our article is to outline the state of research on the traces present on metalwork and to present new directions in the development of this method. The reader should be aware that in this text we use the terms 'traceology' and 'wear analysis,' as well as 'wear' and 'trace' interchangeably due to their significant similarity in meaning. It can

differ slightly depending on the general context, but we feel that both are appropriate in the majority of cases.

CURRENT STATE OF RESEARCH

Researchers who analyse metalwork under a microscope are interested not only in whether a particular object was used in the past, how it was precisely used and how intensively but also in how it was made and whether the method and quality of production can tell us more about its function in the economic, social, and religious context of various prehistoric societies (Gener 2011; Kuijpers 2015). Similar to the field of research on stone and bone artefacts, in this case, the primary source of information is the work "*Pervobytnaia tekhnika. Opyt izucheniia drevneishikh orudii i izdelii po sledam raboty*" by S.A. Semenov from 1957, which gained more attention after being translated into English by M.W. Thompson in 1964. However, research on metal artefacts began more than two decades later, in the late 1980s (Wall 1987) and the 1990s (Bridgford 1997). It was during this time that researchers began to take an interest in particularly impressive artefacts from the Bronze Age, such as daggers and swords. The first publications dedicated to bronze tools, especially axes, also appeared (Kienlin and Ottaway 1998).

In the first decade of the 21st century, archaeologists continued to focus primarily on bronze swords (Kristiansen 2002; Molloy 2008; 2010). However, over time, their interest shifted towards other categories of artefacts, such as axes (Roberts and Ottaway 2003), halberds (O'Flaherty 2007), shields (Molloy 2009), as well as spearheads (Anderson 2011) and arrowheads (Gutiérrez *et al.* 2010; Sych 2011, Baron *et al.* 2020).

In the second decade of the 21st century, there was a significant increase in the number of analyses and an expansion of the scope of research. Researchers began to examine the impact of artefact conservation on the preservation of production traces and use-wear, especially since many of the analyzed artefacts came from museum collections (Sych *et al.* 2020). More artefacts also became available for study before conservation (*e.g.*, artefacts from Karmin IV, Kaliska I and II, Nowe Kramsko, from the vicinity of Sanok, Jodłowno; Baron *et al.* 2019; Sych 2021; 2022; Nowak 2019; 2022; Nowak and Gan 2023) and before and after the conservation process (Baron *et al.* 2019). Above all, attempts to consolidate and synthesize the results of many years of research began to emerge (Uckelmann and Mödlinger 2011; Gutiérrez and Lerma 2014; Dolfini and Crellin 2016; Hermann *et al.* 2020).

Metalwork wear analysis typically requires smaller magnifications compared to, for instance, that of flint. Magnifications of 20-50× are usually adequate. For basic initial analysis, a simple magnifying glass and natural daylight or a lamp are sufficient. However, it is necessary to observe artefacts under a microscope's eyepiece to identify traces, make notes, and prepare a written report. It is important to note that additional equipment is needed for photographic documentation of traces. Portable digital microscopes such as the Dino-Lite line or similar models are suitable for basic or initial analysis.

The recommended equipment for in-depth analysis includes stereo and metallographic microscopes with additional adjustable light sources. These tools allow the user to observe the surface under different lighting conditions, which is a key aspect of the analysis. We have tested many microscopes, such as the Zeiss Stemi 508 and 2000-C, Zeiss V20 with Axiocam 208 colour, Olympus SZX9, Nikon SMZ745T and SMZ 800N, Hirox RH-2000, and Keyence VHX-7000, all of which have proven to be suitable for metalwork wear analysis. Using high-quality digital cameras allows the creation of composite images that are sharp across the entire surface, thus, appropriate quality documentation. Recently, we have also tested 3D scanning and printing as a method of observing and recording wear on metal objects.

NEW PERSPECTIVES

While the traceological study of metalwork is gaining increasing popularity among Bronze Age archaeologists and researchers interested in other epochs and is slowly establishing solid methodological frameworks, some scholars are already charting new directions for its development. Until recently, archaeologists were primarily interested in the analysis of weapons and tools. The former due to their prestigious nature, and the latter due to their abundance. The fact that both categories had working edges was also significant, making it easier to observe use-wear.

The metalwork wear analysis method is evolving, and its scope of interest is expanding to include new categories of artefacts. New research questions are being posed, and valuable answers are being obtained through traceology. We have selected several examples of new research directions that we believe will be in the centre of interest in wear analysis in the near future.

Residue Analyses

A promising direction for the method is the search for traces of organic residues on bronze artefacts. "Residues refer to materials that are transferred and adhere to an artefact" (Fullagar 2014, and further literature). These residues can include organic materials (grasses, reeds, bast) or traces of textiles, used to tie or cover metal artefacts. This type of traces are often visible already at the macroscopic level (Fig. 1). The remains of organic materials used to bind deposited metals (*e.g.*, Chvojka *et al.* 2014; Nowak *et al.* 2023), that accompanied tubular applications (Blajer *et al.* 2022), or were imprints of fabrics and leather that wrapped metals (*e.g.*, casting moulds in the case of Rosko and the "from Sieniocha river" hoards – Kłosińska and Sadowski 2017, 400; Sikorski 2006) are documented. However, determining the type of organic material used requires microscopic analysis (Mueller-Bieniek and Cywa 2022). Recent discoveries in Poland and beyond have revealed previously undocumented organic residues accompanying metal artefacts.

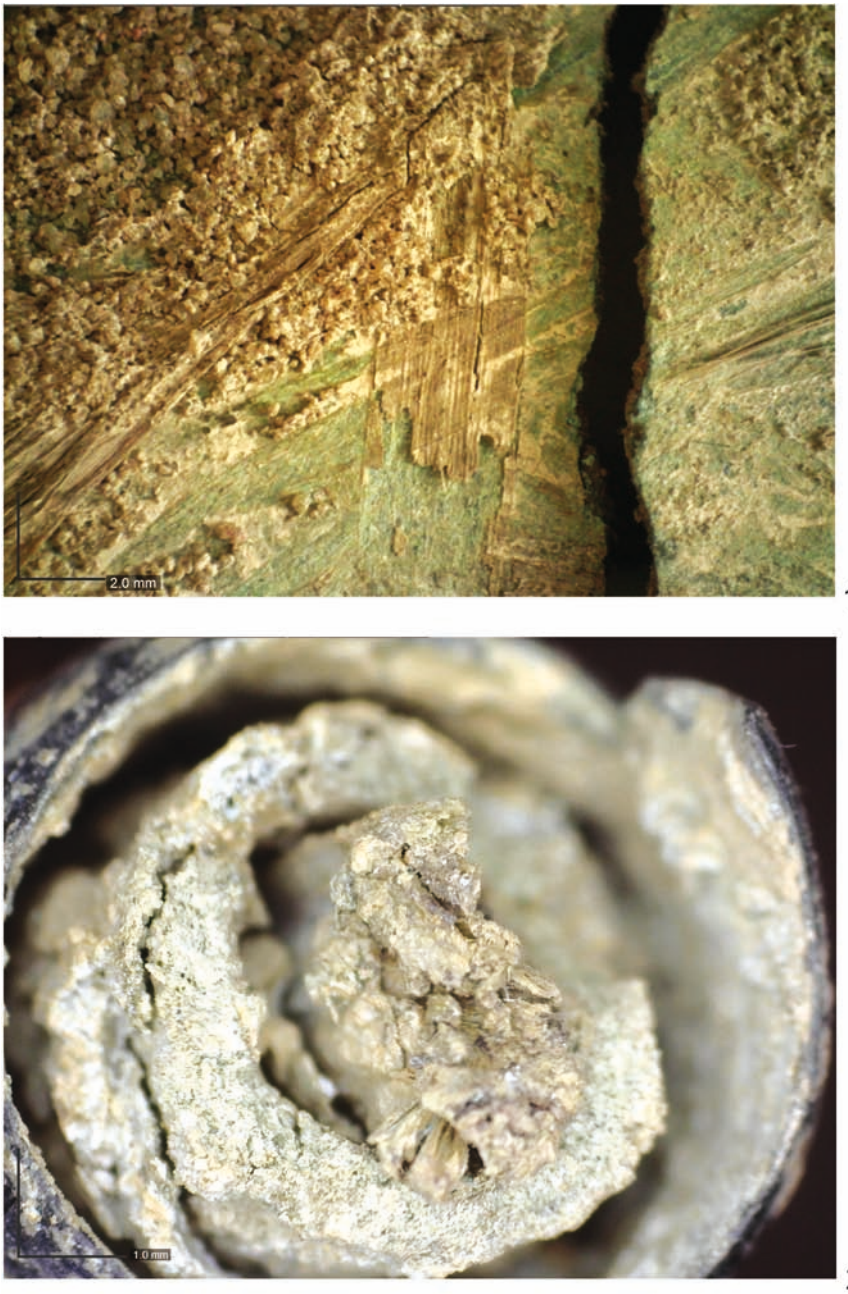


Fig. 1. Organic residues on the surface of metal artefacts and constituting their part: 1 – Residues of grass or cereals stuck to the surface of the hollow ankle ring, 2 – A fragment of wood found inside the saltaleone spiral in the hoard from Wola Sękowa (photo: K. Nowak)

In the hoard no. I from Kaliska, the metals were accompanied by fragments of bast string attached to the metals (Przymorska-Sztuczka 2021) and fragments of leathers, probably cattle and pigs, on which the shapes of metal buttons were imprinted (Sawoszczuk *et al.* 2021). In the hoard from Sanok (Biała Góra) and Wola Sękowa, metal artefacts were accompanied by fragments of processed willow twigs, stems of green plants (grasses and millet), cereal remains and leather (Mueller-Bieniek and Cywa 2022; Kuropka 2022). The research carried out allows for obtaining detailed data on the types of raw materials and animal species used. The presence of elements made of organic substances is not always a residue in the strict sense, but usually these types of materials interact directly with metals and their identification provides us with valuable information.

Of particular interest are studies of residues of pitch-like substances that accompanied metal ornaments in the Kaliska I hoard (Kaczmarek *et al.* 2021, plate 59B; Pietrzak 2021, fig. 1). Physicochemical analyses, including infrared spectroscopy (FTIR), melting point measurements, and electron paramagnetic resonance (EPR) spectroscopy, suggest that the metal was coated with a pitch-like substance resembling resin from trees (Pietrzak 2021).

Methods commonly referred to as physicochemical provide an excellent tool for obtaining highly detailed data on residues. Recently, a team led by Isabella Caricola (2022) analyzed the surfaces of daggers from the Bronze Age. An application of biochemical staining and SEM–EDX analysis

> "has proven successful in extracting and identifying animal residues located on cutting edges, including bone, muscle, and tendons. These are interpreted as evidence of prehistoric carcass butchering and carving. Further residues were observed on blade faces and hafting plates or tangs; these are interpreted as remnants of bone handles and sheaths, the latter made of either wood fibers or processed hide and fur" (Caricola *et al.* 2022).

The identified remains suggest that these objects were used not only as weapons but also as tools for processing animal meat. In turn, the team led by Kayleigh Saunderson (2022) managed to identify remains of human skin and textiles on one of the La Tène brooches from the Potzneusiedl cemetery, Burgenland, Austria.

Another excellent example of using physicochemical methods in residue analysis is the application of gas chromatography-mass spectrometry (GC-MS). The use of this laboratory technique for the analysis of the interior of metal vessels (an amphora and three hanging vessels) from the Kaliska I hoard is considered exceptional, as GC-MS is rarely used for metals and involves an extraordinary extraction procedure (Grześkowiak *et al.* 2021, 375-376). Despite the limitations of the extraction method mentioned by the authors, animal fat residues (mainly ruminants) were identified, mixed with plant lipids. The obtained results differ for amphora and hanging vessels, which may indicate that the analyzed fatty acids are largely related to the archaeological context rather than later contamination (Grześkowiak *et al.* 2021, 380).

Analyses of Ornaments

Researchers are increasingly exploring additional categories of artefacts, such as ornaments, clothing components, and vessels. The lack of clear working edges complicates their interpretation, making further research in this direction an intriguing prospect. The initial results of Marcin Kasprowicz's experiments (2021, unpublished master's thesis) are promising because he managed to distinguish traces left by contact with various materials on bronze pins, including wool, flax, and leather (Fig. 2; Kasprowicz 2022, fig. 4-5).

Production traces and use-wear are also clearly visible on artefacts from hoards I and II from Kaliska (Sych 2021; 2022). These include traces created by contact with human skin or other materials, as well as repair traces using the cast-on technique (Fig. 3) and



Fig. 2. Surface traces of contact of a pin with different materials (from the top left to lower right): nothing, linen, leather, wool (photo: M. Kasprowicz)



Fig. 3. Repair using cast-on technique on different necklaces from the Kaliska I hoard (photo: D. Sych)

grinding of broken elements. Bracelets from the hoards in Falejówka exhibit characteristic flattening and wear of ornamentation associated with intensive use (Nowak 2022, 82, fig. 37). The surfaces of folded tubes and knobs from the Sanok (Biała Góra) hoard are heavily worn. In this case, the rubbing of the external side of the objects against some type of surface (possibly fabric or animal fur) erased previous manufacture traces (Nowak 2022, 84-85, fig. 39-40). Additionally, in the case of these discussed hoards, traces related to the creation of ornamentation on bracelets and decorated plaques have been identified, including its imperfections (Nowak 2022, fig. 36: 3; 41: 7-8).

Focusing on New Types of Traces – Manufacturing, Repairs, Fragmentation

Wear studies are not limited to traces associated solely with the use of objects. As indicated above, the repertoire of analyzed traces is no longer restricted to those related to combat, agricultural activities, or cutting (*e.g.*, meat or flesh). New directions in wear research include the examination of activities related to production, repairs, or fragmentation.

Objects made of copper and its alloys provide an excellent basis for identifying traces associated with their manufacture. They were created through forging or casting techniques,

and both production methods allow for determining the *chaîne opératoire* that resulted in the manufacture of the object. Through comparison with the analysis of the negatives of casting moulds used for casting specific categories of objects, it is possible to identify the locations of sprues or the places where casting seams were formed. Comparisons with casting moulds can rule out the drilling of holes by identifying the core technique and the location of the placement of casting cores that create hollow spaces (*e.g.*, Stolarczyk *et al.* 2020, 158, fig. 45). Sometimes, metal artefacts are accompanied by remains directly related to the casting process. This includes unremoved casting mould remnants, documented, for instance, in the case of kidney-shaped bracelets from the Stolpe auf Usedom hoard, Mecklenburg-Western Pomerania, Germany (Bartel *et al.* 2009, 25-26, fig. 8), or inside a hollow bracelet recently discovered in Jodłowno, Gdańsk County (Nowak *et al.* 2023, fig. 8). The analysis of traces related to production allows for determining whether the object was ever used or whether it was deposited in a raw state (Nowak 2019, 180-183, fig. 1.4; Nowak *et al.* 2022; 2023).

Production by using the forging technique is associated with all sorts of metal cracking and deformation resulting from substantial force applied to it. Cracks on the surfaces of artefacts due to plastic deformation are visible in the case of Early Bronze Age necklaces (Ösenhalsringe) from the Marcinowice hoard, Krosno County, Lubusz Voivodeship (Nowak 2020, fig. 8), or bracelets from the Falejówka hoard, Sanok County, Podkarpackie Voivodeship (Nowak 2022, fig. 35). The manufacture of objects from sheet metal also leaves distinctive production traces. In the Sanok (Biała Góra) hoard, folded tubes were hammered out of sheet metal, and knobs were formed, leaving traces of cutting and bending (Nowak 2022, fig. 39-40). In the Zarszyn hoard, dense forging traces, which were used to shape the vessel, were documented on one of the metal vessels made of thin sheet metal (Nowak 2022, fig. 42.3-4).

Another interesting issue is the identification and documentation of traces of repairs to metal objects. Two types of repair can be distinguished: usually clearly visible repairs using cast-on technique and using riveted elements, and less conspicuous traces of repairs involving grinding of broken tools or weapons. The first category often includes fillings of incomplete holes in the case of vessels, joining with cast-on technique (with or without the use of additional elements) of cracked objects, or riveting elements of collars. All traces of that kind are clearly visible in the case of the Kaliska I hoard (Kaczmarek *et al.* 2021, plates 4B-4C, 6B, 9B, 10A-10B, 24A-24B [selection]).

Traces of the second type of repairs are decidedly more challenging to interpret, as they often do not differ from traces associated with production, such as sharpening or grinding. Occasionally, the shape of the artefact – especially in the case of weapons and tools – may suggest that it underwent numerous repairs, as can be inferred, for example, from the asymmetry of the blade. In the case of arrowheads from the Wrocław-Widawa hoard, such traces associated with sharpening and repairing of the barbs were identified (Baron *et al.* 2020).

The issue of dividing and destroying metal objects has recently gained a lot of interest (*e.g.*, Knight 2021; Lago *et al.* 2023). The topic of fragmentation has been the subject of many studies and is associated with many behaviours, ranging from ritual and symbolic, through social, and purely utilitarian ones connected with issues of weights and premonetary systems of exchange (*e.g.*, Rezi 2011; Chapman 2012; Ialongo and Lago 2021; Nowak and Ialongo, in press). The places of fractures are also examined, thanks to which it is possible to reconstruct the process of dividing objects and indicate whether the fragmentation was intentional or could be related to use (Knight 2021). There are traces of bending and breaking on the edges of broken objects (*e.g.*, sickles from the hoard from Paszowice, Jawor district or Velké Bílovice, Breclav district; Nowak *et al.* 2019, 448, fig. 3.b-d; Parma *et al.* 2021, 126, fig. 10). Traces of intensive bending were often associated with the ritual destruction of objects (Nebelsick 2000). However, as per

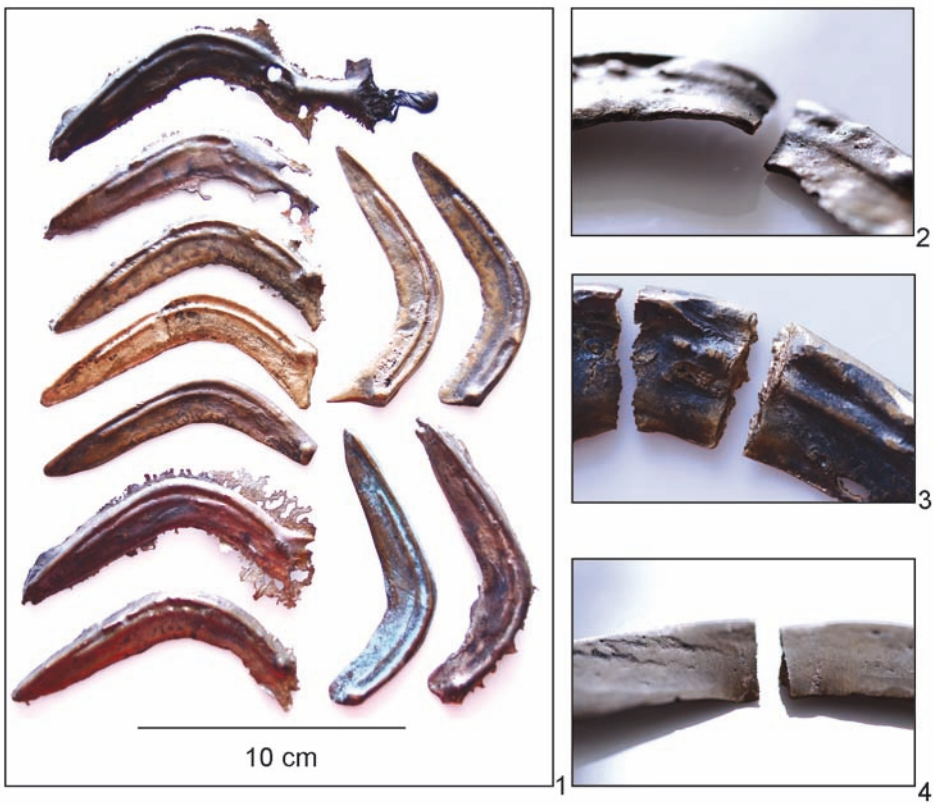


Fig. 4. Archaeological experiment related to the fragmentation of bronze sickles: 1 – Replicas of Lusatian knobbed sickles made in analogous casting moulds. Various casting quality, 2 – Fragmentation using wooden basis and wooden hammer, 3 – Granite basis and metal (Fe) chisel, wooden hammer as impact factor, 4 – Granite base and wooden hammer (photo: K. Nowak)

M. Knight's observations and experimental research, we now understand that intentional damage may not produce discernible marks on metal owing to the controlled application of heat to the item. Moreover, bending is just one among several characteristics linked with deliberate destruction, others include twisting, crushing, notching, breakage, burning, stabbing with a pointed object and, in the instance of socketed objects, the plugging of sockets. Considering all of these factors and discerning their quantitative and qualitative relationships would enable us to attempt to answer the questions: was the destruction intentional, and if so, was it for ritualistic or practical purposes? If not, was it a result of intense use or just corrosion (Knight 2021)?

Another category of traces related to fragmentation are longitudinal concavities and cuts, which are intended to indicate the place of breaking and also to facilitate it. These types of marks are often observed on the surfaces of plano-convex ingots (casting cakes) and were intended to divide the raw material into smaller portions (Nessel 2014, 405). In Poland, such fragmentation was identified in the case of a small casting cake from the Paszowice hoard (Nowak *et al.* 2022, 96, fig. 4.d), it is also visible on objects discovered in neighbouring areas (*e.g.*, Drslavice 2, Uherské Hradiště district or Feldkirch, Vorarlberg; Salaš 2005, plate 169.340; Nessel 2014, 406, fig. 6). Cuts intended to facilitate and divide the object, as well as even division lines indicating the use of this technique, were also identified on fragments of sickles and bracelets from the hoard from Nowy Kramsko, Zielona Góra district (Nowak and Ialongo, fig. 8.3, 9.1, in press). Experiments are also performed on dividing objects after heating them (Knight 2019; Lago *et al.* 2023). One such experiment was carried out using replicas of Lusatian knobbed sickles (Fig. 4). Experiments related to the fragmentation of sickles were carried out on replicas made by one of the authors of this paper and broken by him and by archaeology students of the Institute of Archaeology University of Wrocław during a seminar led by Dr. Bernadeta Kufel-Diakowska. Some of the recorded traces are analogous to those visible on the original artefacts.

Traces of Metal Implements on Bone, Antler, Stone, and Wood Artefacts

Equally intriguing as the analyses of bronze artefacts are studies of objects that had direct contact with them, including bones and antlers. A good example of a pioneering approach to this issue is the research conducted in recent years by Justyna Baron and Marcin Diakowski (Baron *et al.* 2018; 2023). Although traces of bronze tools have been found in older periods (Osipowicz *et al.* 2018; Baron *et al.*, in press), J. Baron and M. Diakowski demonstrated that even in the late Bronze Age in southwestern Poland, metal tools were rarely used for working bones (2018). The change in this regard only came with the Early Iron Age.

Stone objects also bear traces of processing, which can be associated with the use of metal tools. Preparing the surface of rocks requires appropriate equipment and knowledge.



Fig. 5. Manufacture traces on the stone casting moulds from the Legnica, Spokojna Street:
1 – Chiselling of the outer surface of the mould from Grave 42, 2 – Narrow and longitudinal chisel marks on the mould from Grave 153 (photo K. Nowak)

In addition to the remains of direct use of casting moulds, crucibles and nozzles in the pyrometallurgical process (*e.g.*, Erb-Satullo *et al.* 2015; Miazga 2016; Figueiredo *et al.* 2021; Żurkiewicz *et al.* 2023), traces of production are often visible on their surfaces. Such traces, made with saws, chisels, or axes, have been noted in the literature. Lüben Leschtakow describes traces related to the production of casting moulds from the Pobit Kamak hoard in Bulgaria (2016 [2019], 219-221). Burger Wanzek (1989, 35) also points to the use of saws and chisels in the initial processing of rock surfaces.

Traces of production have also been identified in the case of casting moulds discovered in southwestern Poland. Casting moulds for the production of socketed axes from Wołów (Wohlau-Ost), Lower Silesia bear traces of sawing and breaking, as well as chiselling. On one of the narrower sides of the mould, there is a distinct, even incision trace approximately 0.5 cm deep. Below it is an uneven surface, indicating that the stone was first incised in a characteristic manner and then broken. On the remaining narrower sides, there are also dense traces of a small tool, most likely a chisel. Chiselling was aimed at smoothening the break (Nowak, in press). Traces of processing are also visible in the case of stone moulds discovered at the cemetery in Legnica, Spokojna Street (Nowak and Stolarczyk 2016). Tool marks such as wedge-shaped chisels or small axes are visible on the external and lateral surfaces of the moulds for producing axes from Graves No. 42 and 153 (Fig. 5).

Wear and metal residue on tools used in the metallurgical process are also of interest to researchers. The results recently published by Czech researchers indicate that metal processing residues (in this case silver) are identified on percussion tools made of copper (Peška *et al.* 2023). The surfaces of stone objects used in metal forming have been analyzed for many years (*e.g.*, Butler and van der Waals 1966, 72). The surfaces of hammers and anvils are examined macro- and microscopically and by using spectral methods to identify metal remnants (*e.g.*, Freudenberg 2009; 2014; Müller *et al.* 2023). Gold and tin residues on stone objects from the United Kingdom have been recently identified, altering our perspective on the interconnections between different materials used in the past (Crellin *et al.* 2023; Carey *et al.* 2023). These connections between different materials are further explored through the "A New History of Bronze: crafting, leadership, and violence" (https://bit.ly/a-new-history-of-bronze) project at the University of Leicester under the supervision of Rachel Crellin. This project is the largest in terms of the amount and diversity of analyzed artefacts so far in the field of metalwork wear analysis, and one of the present authors is involved in it.

Modern Methods of Documenting Traces

The development of metalwork wear analysis involves not only expanding the method to new categories of artefacts and deepening analysis but also advancing documentation methods. In earlier analyses, dental impression materials were used to record wear (Roberts and Ottaway 2003). Today, digital photography is primarily used, along with

photogrammetry and 3D scanning (Molloy *et al.* 2016; Sych *et al.* 2018). The results of such pairing can be seen at: https://www.bit.ly/traseoskan3d.

LIMITATIONS

Challenges and Limitations in Traceological Analysis

One significant limitation of the traceological method is the conservation process. Often, conservation procedures are necessary to preserve artefacts and prevent irreversible damage. Surfaces damaged by rapidly advancing corrosion are also less amenable to reliable analysis. For many years, we have appealed to the archaeological community, museum professionals, and conservators to make artefacts available for wear analysis before undertaking conservation procedures. To minimize the impact of post-depositional processes on the identification and interpretation of traces, it would be beneficial to examine artefacts shortly after their discovery, still retaining soil deposits, or to document each step of artefact cleaning meticulously. This way, we can ensure that any new trace resulting from the use of brushes or other cleaning/conservation tools is not mistakenly attributed to prehistoric times.

We advocate that such actions should be adopted as standard procedure for metalwork wear analysis. For this to succeed, the dissemination of information about the method among archaeologists is necessary. Curators and those responsible for artefacts should be made aware that before conserving artefacts, it is worthwhile to have them analyzed by a metalwork wear specialist. They should also inform conservators about plans for such analyses in the future, so they are extra careful while cleaning metal surfaces.

Another limitation of the method, besides issues related to the preservation state of artefacts and conservation, is that many researchers conduct independent analyses rather than working in teams or groups. Traceological analyses are often carried out as part of researchers' individual interests, master's or doctoral theses, or grant projects. Researchers seldom convene at thematic conferences to discuss methodological issues, resulting in a lack of clearly defined methodological frameworks. The issue of a common nomenclature for identifying traces remains unresolved, as highlighted by Andrea Dolfini and Rachel Crellin a few years ago (2016). Information on recommended equipment and observation conditions or trace documentation protocols is also hard to find.

The issue of conducting archaeological experiments and creating databases of traces obtained on replicas, as is the case with artefacts made of other materials (stone, bone, antler), poses a significant limitation to the traceology of metals. It is no longer just a lack of easily accessible digitized databases; the problem lies in the absence of any reference database created according to universally accepted and established standards. This issue is a pressing concern for future traceological research, and this gap should be filled in the

near future. One of the steps we have taken is an attempt to create a database of traces on original and replica Lusatian socketed axes. The research is conducted by the authors with the participation of Mr. Albin Sokół from the Archaeological Museum in Biskupin. The preliminary results of the experiments were presented during the 13th Experimental Archaeology Conference #EAC13, which took place on April 30-May 3, 2023, in Toruń (paper: Nowak K., Sokół A., Sych D. "From Mould to Earth: Experimental and Traceological Study of Lusatian Socketed Axes"; link to the presentation: https://bit.ly/from-mould-to-earth-exarc-2023).

DISCUSSION AND CONCLUSIONS

In recent years, the traceology of metal artefacts has experienced significant growth. The method is no longer just a curiosity but is increasingly used as a standard analysis in the examination of deposits of bronze artefacts (and more). The short outline of the state of research and new perspectives we have presented indicates the possibilities of further development of the traceological method.

Simultaneously, individual experiments are being conducted that push the boundaries of metal traceology, such as the search for organic residues on artefacts or the analysis of various categories of objects that came into direct contact with bronzes. Unfortunately, despite all the positive aspects mentioned above, the postulates of A. Dolfini and R. Crellin (2016, 82-85) from a few years ago still remain relevant. Researchers are dispersed throughout Europe, rarely collaborating with each other, and they do not strive for the standardization of the method and the creation of common frameworks. Until this happens, we will not be able to take the next step forward.

The works published so far on traceology of the metalwork in Poland are mainly focused on the work of researchers descending from the Wrocław centre. We are developing the method, but we see that other researchers are interested in methodological issues (Kasprowicz 2022) and creating databases of traces. It is worth mentioning here the works of Paweł Dziechciarz, a PhD student at the Faculty of Archaeology of the University of Warsaw, focused on the multi-aspect analysis of traces on spearheads. The preliminary results were presented during the meeting "SIDEROS. Seminarium z archeologii Europy Środkowej w I tys. przed Chr.," May 24, 2023, and are very promising. We hope that our article will be an encouragement and inspiration to use the metalwork wear analysis method in the research of metal artefacts and to the development of traceology of metalwork in Poland.

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GRINDING INSTALLATIONS IN PRE- AND PROTOHISTORIC EURASIA. A CASE STUDY FROM GEORGIA – TYPOLOGICAL, TRACEOLOGICAL AND EXPERIMENTAL STUDY OF A GRINDING INSTALLATION FROM GRAKLIANI HILL ARCHAEOLOGICAL SITE

ABSTRACT

Tetruashvili A. 2024. Grinding Installations in Pre- and Protohistoric Eurasia. A case study from Georgia – typological, traceological and experimental study of a grinding installation from Grakliani Hill Archaeological site. *Sprawozdania Archeologiczne* 76/1, 123-137.

The paper investigates grinding installations found across diverse archaeological sites in Eurasia, spanning from the Neolithic (10000-8800 BCE) to the Early Roman period (2nd century BC) in regions such as Georgia, Bulgaria, Turkey, Israel, and Moldova. The study employs typological, traceological, experimental and comparative analyses. A significant focus is on the interdisciplinary examination of an installation at Grakliani Gora, representing the first comprehensive study within Georgia's territory.

This study aims to fill knowledge gaps regarding the origin, types, and functions of grinding installations found at archaeological sites like Gesher, Ulucak Höyük, Varvarovka VIII, Branzeni III, Kodzadermen, Liga, Ilipinar, Shiqmim, Tel Rehov, Grakliani Gora, Tsikhiagora, and Dedoplis Gora. Notable shared characteristics include indoor placement, using clay in platform construction, surrounding walls to contain scattered flour and the incorporation of side recesses for the material being ground or the produced flour. These installations were constructed to enhance the efficacy of working devices, increase flour yield, and minimize physical strain during daily activities.

Keywords: Neolithic, Bronze Age, Classical Period, Georgia, Grinding Installation
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INTRODUCTION

The use of grinding stones as essential agricultural tools spans a wide historical timeline, dating from the Upper Paleolithic period to the Classical period (Ebeling and Rowan 2004, 109; Dzidziguri 2000, 135-184). These artefacts are commonly discovered both within and outside buildings at archaeological sites. This study specifically delves into the examination of grinding stones positioned on a clay structure found in Room B at the Graklian Gora site (settlement and cemetery), located in Central Transcaucasia, Georgia, within the territory of the Samtavisi and Igoeti villages in the Kaspi district. The chronological position of the platform was determined by the ceramic artefacts found within the layer of the building's collapse (Licheli 2014, 12, 13; 2020, 48), attributing the room to the Achaemenid period (5-4 century BC) (Fig. 1). The structure comprises a quadrangular platform where two querns were affixed. Notably, this investigation marks the pioneering analysis of the grinding platforms at Grakliani Gora. A comprehensive approach integrating typological, traceological, and experimental methodologies was adopted to comprehend these structures. According to the typological system revealed the presence of an oval-shaped basalt quern with a flat working surface and a saddle-shaped sandstone quern with a concave working surface (Tetruashvili 2018, 92, 93). Traceological research confirmed that these grinding stones were primarily used for grain processing. Moreover, experimental efforts were pivotal in reconstructing the entire cycle, from the construction of the grinding installation to the actual grain grinding process.

A grinding installation is a specially prepared platform designed for grinding stones (querns). The term 'grinding installation' was first introduced in the article by J. Ebeling and Y.M. Rowan in 2004, in which they discussed devices found in archaeological sites in Israel, including Shiqmim and Tel Rehov (Ebeling and Rowan 2004, 11-114). Further exploration into scientific literature revealed evidence of grinding devices at various archaeological sites such as Gesher in the Pre-Pottery Neolithic A period in Israel, dated 9600-9200 BC (Garfinkel and Dag 2006, 51-53); the Late Neolithic site Ulucak Höyük in Turkey, dated 5840-5710 BC (Cilingiroglu *et al.* 2004, 1-51). They also occur at Neolithic-Chalcolithic sites, such as Varvarovka VIII and Brandzeni III in Moldova, dated 5500 to 2750 BC (Cotiuga *et al.* 2016, 703-706); Chalcolithic sites Liga and Kodzadermen in Bulgaria dated to the 5th millenium BC (Merkyte 2005, 54, 55); Ilipinar in Turkey, dated to 5700 BC (Sagona and Zimansky 2009, 130-136); Shiqmim in Israel, dating to 4500 BC (Ebeling and Rowan 2004, 111). They are found on the Late Bronze Age archaeological site of Tel Rehov, Israel, dated to the 9th century BC (Ebeling and Rowan 2004, 114); the Achaemenid period building of site Grakliani Gora, Georgia, 5-4th century BC (Licheli 2014). Other examples are found in Post-Achaemenid (3rd century BC- the middle of the 2nd Century BC) and Hellenistic period (3rd-2nd century BC) buildings of the site at Tsikhiagora, Georgia (Tskit'ishvili 2003, 19; Makharadze *et al.* 2023, 13, 17), as well as the Early Roman period (2nd century BC) building of Dedoplis Gora, Georgia (Gagoshidze 2019, 187-188).

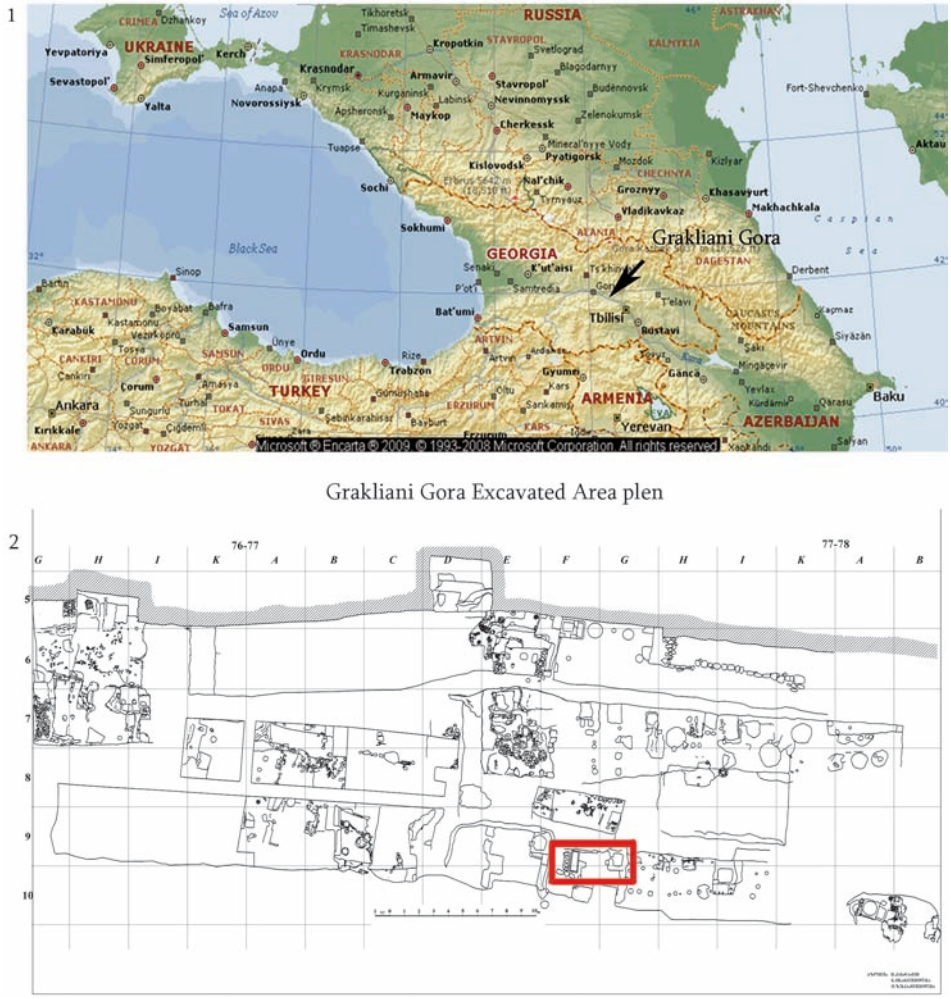


Fig. 1. 1. Location of Grakliani Gora archaeological site; 2. Plan of the Grakliani Gora excavated area, with the red-marked area indicating Room B where the grinding installation was discovered. Photo by D. Dolaberidze and I. Zukakishvili

The tradition of utilizing grinding installations in the territories of Eurasia is well-documented from the Neolithic period to the early Roman period. By studying the Grakliani Gora installation and comparing it with similar findings in the scientific literature, two distinct types of installations may be identified. The first type consists of a floor-based installation featuring a boundary wall, examples of which are found at: Gesher (Garfinkel and Dag 2006, 51-53; Varvarovka VIII and Brandzeni III (Cotiuga *et al.* 2016, 703-706); Ulucak Höyük (Cilingiroglu *et al.* 2004, 1-51); Liga and Kodzadermen (Merkyte 2005, 54, 55).

The second type consists of a platform-based installation characterized by side recesses and a flour container situated in front of the grinding stone. Examples have been found at: Ilipinar (Sagona and Zimansky 2009, 130-136); Shiqmim (Ebeling and Rowan 2004, 111); Tel Rehov (Ebeling and Rowan 2004, 114); Grakliani Gora (Licheli 2014); Tsikhiagora (Tskit'ishvili 2003, 19; Makharadze *et al.* 2023, 13, 17) and Dedoplis Gora (Gagoshidze 2019, 187-188).

MATERIALS AND METHODS

Investigative Area and Description of the Grakliani Gora Installation

This study centres on Room B of the Grakliani Gora site, where a platform with grinding stones was found in situ. Room B measures 5 metres in length from east to west and 3.4 metres in width. Positioned on the northwest side of the oven is a clay-plastered platform measuring 1.35 centimetres in length, 50 centimetres in width, 30 centimetres in height, with two querns affixed to it (Fig. 2).

Grinding stone No. 1, made of basalt, with a width of 28 centimetres, is fixed in a specially prepared clay quadrangular structure. It features two oval-shaped recesses plastered with clay: one on its left side measuring 34 centimetres in length, 18 centimetres in width, and 8 centimetres in depth; the other on its right side with dimensions of 33 centimetres in length, 17 centimetres in width, and 8 centimetres in depth. Grinding stone No. 2, made of sandstone and saddle-shaped with a width of 26 centimetres, it also has two side recesses plastered with clay. These recesses, separated by an 11-centimetre ramp from the recess on the right side of grinding stone No.1, have dimensions of 33 centimetres, 18 centimetres in width, and 8 centimetres in depth, and the one located on the right of hand grinder No. 2 has dimensions 34 centimetres in length, 17 centimetres in width, and 10 centimetres in depth (Tetruashvili 2018, 61, 62).

Typological-comparative analysis of grinding installations

A comprehensive examination of 14 grinding installations involved a systematic categorization based on distinct platform and quern characteristics. These installations commonly comprised attached querns, surrounding walls, side recesses, and flour containers (Fig. 3).

A characterisation of the platforms revealed the prevalence of circular, oval, and quadrangular shapes with some sites demonstrating the use of surrounding walls. Side recesses, intended for the placement of materials before or after the grinding process, as well as flour containers, were observed in installations such as at Shiqmim, Grakliani Gora, Tsikhiagora, and Dedoplis Gora, facilitating the containment and efficiency of the grinding process (Table 1).

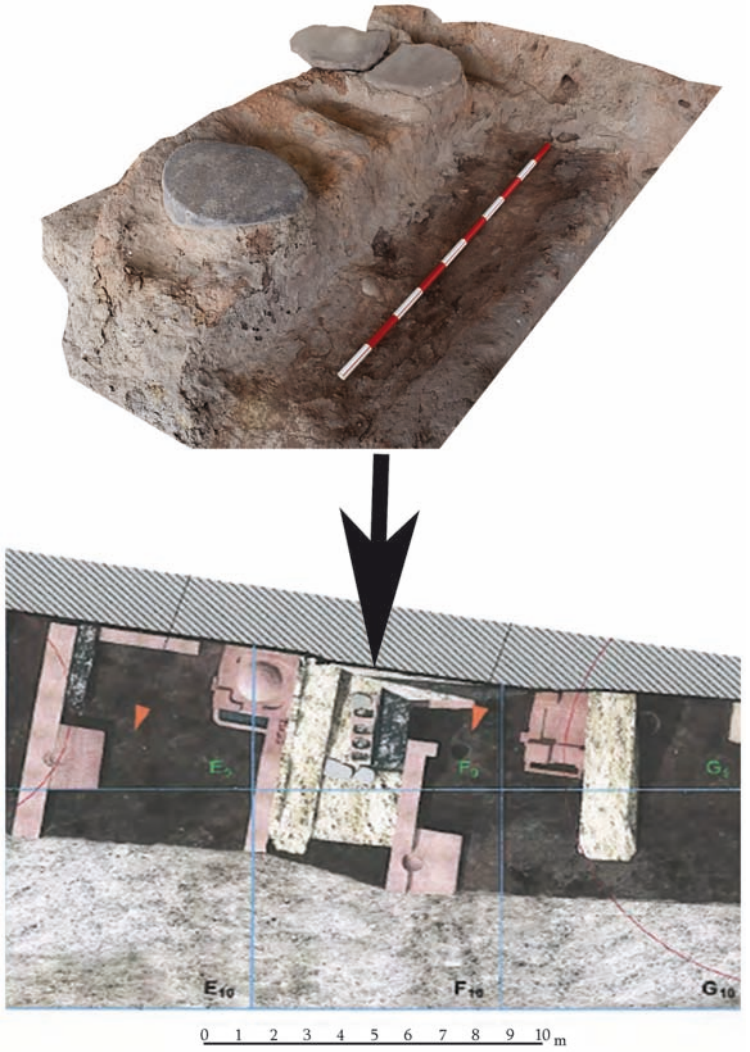


Fig. 2. Grakliani Gora, third terrace, Room B and location of installation.
Photos were taken during the archaeological fieldwork in 2014.
Photo by D. Dolaberidze and the plan was made by the architect M. Kasradze

Determining quern characteristics was facilitated by a reference collection, highlighting the shapes and working surfaces, predominantly featured quadrangular and oval-shaped querns, with flat and concave working surfaces. Additionally, some instances indicated the use of basalt as a raw material for the quern. The number of grinding stones attached to the platform is 1 or 2, with 32 in one exceptional case (Table 2).

Table 1. Grinding installation – platform characteristics

Chronology	Archaeological Site	Installation Placement Inside the Building	Platform shape	Platform structure			Recess	Surrounding wall	Flour container
				clay	Earth, stone, clay	N/A			
Neolithic, PPNA, 9600-9200 BC	Gesher, Israel	●	Circle	●					
Late Neolithic, 5840-5710 BC	Ulucak Höyük, Turkey	●	Circle	●				●	
Neolithic-Chalcolithic, 5500 to 2750 BC	Varvarovka VIII, Moldova	●	Circle			●		●	
Neolithic-Chalcolithic, 5500 to 2750 BC	Branzeni III, Moldova	●	Circle			●		●	
Chalcolithic, 5th millenium BC	Kodzadernen, Bulgaria	●	Oval	●				●	
Chalcolithic, 5th millenium BC	Liga, Bulgaria	●	Oval	●				●	
Chalcolithic, 5700 BC	Ilipinari, Turkey	●	Oval	●					
Chalcolithic, 4500 BC	Shiqmim, Israel	●	Circle		●		●		●
Late Bronze Age, 9th century BC	Tel Rehov, Israel	●	Circle	●				●	●
Achaemenid period, 5-4th century BC	Grakliani Hill, Georgia	●	Quadrangular	●	●		●		●
Post-Achaemenid period, 3rd century BC- the middle of the 2nd Century BC	Tsikhiagora, Georgia	●	Oval	●			●		●
Hellenistic period, 3rd -2nd century BC	Tsikhiagora, Georgia	●	Oval	●					●
Hellenistic period, 3rd -2nd century BC	Tsikhiagora, Georgia	●	Quadrangular	●					●
Early Roman Period, 2nd century BC	Dedoplis Gora, Georgia	●	Quadrangular	●			●		●

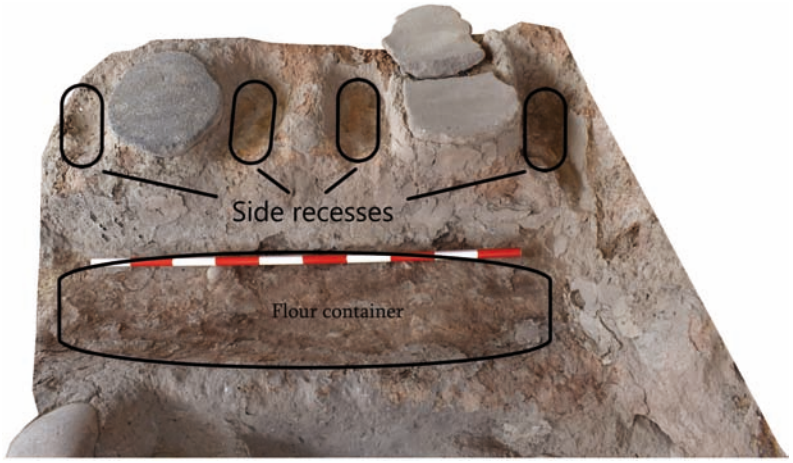


Fig. 3. Grakliani Gora characteristics of the grinding installation. Photo by D. Dolaberidze

Table 2. Grinding installation – quern characteristics

Chronology	Archaeological Site	Quern type	Quern working surface	Quern position	Quern raw material	Amount
Neolithic	Gesher, Israel	Quadrangular	Concave	Horizontal	N/A	1
Late Neolithic	Ulucak Höyük, Turkey	Oval	Flat	Horizontal	N/A	1
Neolithic-Chalcolithic	Varvarovka VIII, Moldova	N/A	N/A	Horizontal	N/A	1
Neolithic-Chalcolithic	Branzeni III, Moldova	N/A	N/A	Horizontal	N/A	1
Chalcolithic	Kodzadernen, Bulgaria	Oval	Flat	Horizontal	N/A	1
Chalcolithic	Liga, Bulgaria	Oval	Flat	Horizontal	N/A	1
Chalcolithic	Ilipinari, Turkey	Oval	Flat	Inclined	N/A	1
Chalcolithic, 4500 BC	Shiqmim, Israel	Oval	Concave	Inclined	Basalt	1
Late Bronze Age, 9 century BC	Tel Rehov, Israel	Quadrangular	Concave	Inclined	N/A	1
Achaemenid	Grakliani Hill, Georgia	Oval	Flat, concave	Horizontal	Basalt, and Sandstone	2
Post-Achaemenid	Tsikhiagora, Georgia	Oval, and quadrangular	Flat, concave	Inclined	Basalt	32
Hellenistic	Tsikhiagora N12, Georgia	Quadrangular	Flat	Inclined	N/A	2
Hellenistic	Tsikhiagora N17, Georgia	Quadrangular	Flat	Inclined	N/A	2
Early Roman Period	Dedoplis Gora, Georgia	Quadrangular	Flat	Inclined	Basalt	1

Traceological analysis

In the study of the grinding installation from Grakliani Gora, traceological analysis was applied, involving the examination of the querns' working surface using an Omax binocular microscope and Dino-Lite digital microscope with a magnification ranging 50×-100×. This analysis revealed that the basalt quern's working surface was smooth and polished, with traces covering the entire surface (Fig. 4). Intensive use was evidenced by concentrated traces in the middle of the tool's working surface. Similarly, the sandstone quern's working surface exhibited parallel linear traces, which were concentrated in the middle (Fig. 5).

Experimental Study of the Grinding Installation

The experimental study of the Grakliani Gora grinding installation involved the collection of necessary building material for construction: 20 bags of clay (approximately 50 kilograms each) from Bozham village (4.4 km away from Grakliani Gora), cobblestones collected from the banks of the Lekhura river near Samtavisi village, and stubble purchased from a local farmer. The construction of the installation lasted 18 days, hindered by adverse weather conditions such as rain and low temperatures, necessitating the use of fire to dry the clay. A man and a woman were involved in the construction process, using 400-470 kilograms of clay for installation, a bundle of stems and 70-80 cobblestones (Tetruashvili 2023, 56).

The experimental installation (Fig. 6) measured 60 centimetres in height and 95 centimetres in width, matching the dimensions of the Grakliani Gora grinding installation except for its length, which extended to 157.5 centimetres due to adjustments necessitated by the experimental querns' width and the deformed left-side wall of the Grakliani Gora installation (Tetruashvili 2023, 56).

The grinding process, conducted by a woman took approximately 2 hours to grind 2 kg wheat and barley grain. The process involved repeatedly grinding the product three times to obtain fine-grained flour (Tetruashvili 2023, 57).

Data Analysis

In the examination of grinding installations, our objective was to discern both common and distinctive features by conducting detailed assessments involving reference collections, and typological,traceological, experimental, and comparativeanalysis.

The typological and petrographic study of the Grakliani Gora grinding installation revealed two distinct quern attachments made from different raw materials. The petrographic study of the artifacts was conducted by PhD M. Makadze from Iv. Javakhishvili Tbilisi State University, using binoculars, various types of handheld magnification (10×,

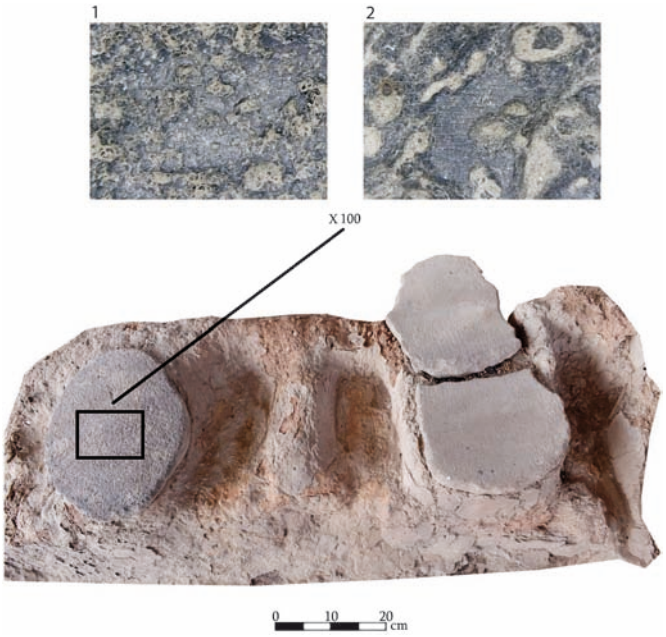


Fig. 4. Use-wear traces observed on basalt quern from Grakliani Gora grinding installation:
1. Polish and smooth traces; 2. Smooth and scratch traces. Photo by A. Tetruashvili and D. Dolaberidze



Fig. 5. Experimental grinding installation. Photo by D. Dolaberidze



Fig. 6. Linnear trace on sandstone quern from Grakliani Gora grinding installation.
Photo by A. Tetruashvili

20×), and 3% hydrochloric acid. This discovery prompted inquiries into the specific materials to be processed on the basalt and sandstone querns. In response to this question, we pursued traceological and subsequent experimental studies. Initially, it was believed that the presence of hand grinders with two distinct tool materials at the Grakliani Gora site indicated their use for processing different materials. However, experimental studies have confirmed that the use-wear marks on the querns of the Grakliani installation match those produced during grain processing experiments.

It is crucial to note that all examined installations were situated indoors, often placed close to ovens. Most of these installations had an oval shape and were predominantly constructed using clay as the primary material. Some grinding installations were enclosed by walls, primarily designed to minimize flour dispersion. Notably, the installations equipped with boundaries did not integrate side recesses. The positioning of the querns within these installations varied, either inclined or horizontal, based on the shape of the grinding installation.

Several key observations arise from the typological analysis:

1. Grinding installations at Ulucak Höyük, Varvarovka VIII, Branzeni III, Kodzadermen, Liga, and Tel Rehov although placed directly on the building's floor, all featured boundary walls (Cotiuga *et al.* 2016; Cilingiroglu *et al.* 2004; Merkyte 2005).

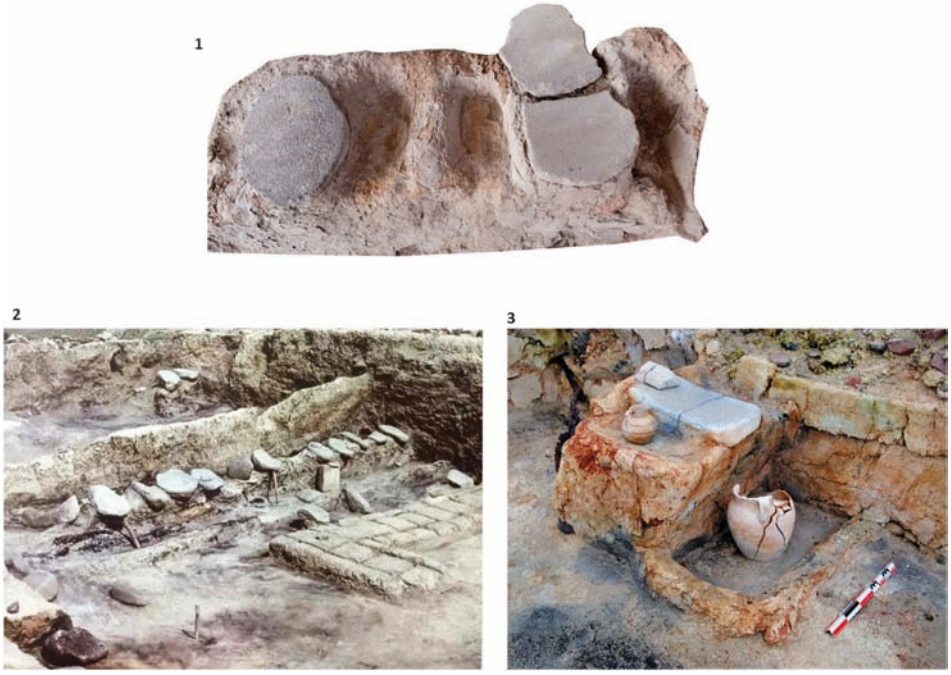


Fig. 7. Grinding installations: 1. Grakliani Gora; 2. Tsikhiagora (Makharadze *et al.*, 2023); 3. Dedoplis Gora, photo by D. Gagoshidze

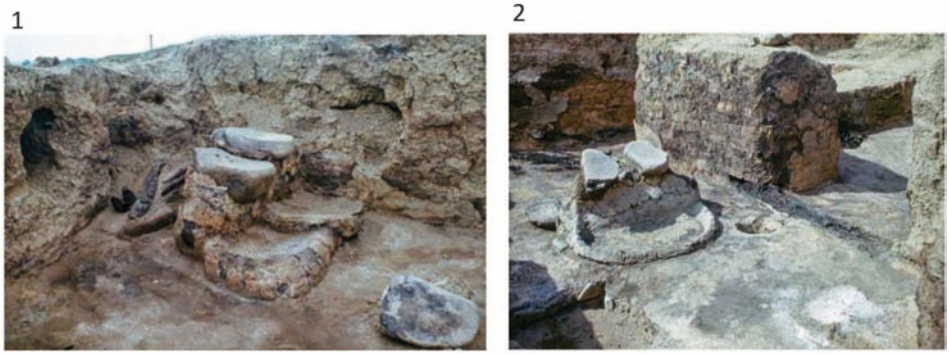


Fig. 8. Grinding installations: 1. Tsikhiagora, Room N17; 2. Tsikhiagora, Room N12 (Makharadze *et al.* 2023)

2. Installations with a boundary wall typically contained fixed horizontal quern stone(s) and did not include a flour container.

3. The installations at Shiqmim, Grakliani Gora, Tsikhiagora, and Dedoplis Goragrinding lacked a boundary wall, but featured side recesses meant for grinding or containing the milled flour. For instance, in the case of the Tsikhiagora grinding installation, the excavators suggest that the side recess adjacent to the quern was designed to contain the flour produced (Tskit'ishvili, 2003). The function of the recesses in the Grakliani Gora installation depended on the dynamics of the motion of the grinder. With a single-handed grinder using a circular motion, the ground flour accumulated in the recesses, whereas the flour produced by a two-hand grinder, operating with a back-and-forth motion, was discharged in front of the quern (Fig. 7).

4. Flour containers were exclusively present in installations (Grakliani Gora, Tsikhiagora and Dedoplis Gora) situated on platforms (Fig. 8).

CONCLUSION

The widespread presence of grinding installations across Eurasia from the Neolithic to the Early Roman period has revealed a spectrum of forms and functions integral to these essential tools. Notably, two primary types of installations have been discerned: 1. Floor-based structures with boundary walls (Gesher, Varvarovka VIII, Branzeni III, Ulucak Höyük, Kozadermen, and Liga), and 2. Specialized platform-based installations, the latter distinguished by the inclusion of flour containers or recesses (Shiqmim, Tel-Rehov, Ilipinar, Grakliani Gora, Tsikhiagora, andDedoplis Gora).

The manner of utilization of these grinding installations is closely connected to the type of installation and the positioning of the individual operating it. For instance, while the first type requires the user to kneel directly on thefloor, the second type accommodates



Fig. 9. 1. Back side of Dedoplis Gora grinding installation, photo by D. Gagoshidze; 2. Position of user during the grinding process, photo by D. Dolaberidze and drawings by T. Davadze; 3. Position of user during the grinding process, photo by D. Dolaberidze and drawings by T. Davadze

different stances, such as using the recesses on the back wall of the platform (as observed in Dedoplis Gora) or standing directly on the ground behind the installation. The hypotheses were validated during experimental work (Fig. 9).

Furthermore, the traceological study carried out on the querns at the Grakliani grinding installation have unveiled evidence of tool usage in cereal processing, a finding supported by subsequent experimental research. Our experiments, involving the grinding of cereals like wheat and barley, revealed identical characteristics on both the experimental and querns and those from the Grakliani installation. Additionally, the intentional use of two different types of stone tools was discovered: the cereal was initially ground on a porous basalt stone and then refined on sandstone to obtain a finer flour.

Upon assessing the quality of these grinding installations, it becomes apparent that installations with boundary walls or recesses offer a more productive and efficient grinding environment. These structures minimize the loss of the milled product and maintain fineness during the process, in contrast to mobile grinding stones.

In conclusion, the prevalence of grinding installations across various chronological stages and geographical regions is closely intertwined with the development of agriculture and the advancement of working devices. The evolution and variations in these installations indicate progression in human civilization. In the early stages of the development of these installations, they were placed on the floor, while in later periods, specialized platforms were created. The pivotal experimental and traceological studies conducted have significantly contributed to unravelling the intricacies of these ancient tools and understanding their significance in early human societies.

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ON THE POLYSEMIC NATURE OF TRACES AND CO-OCCURRING PATTERNS IN ANTHROPIZED MATERIAL — CONTRIBUTION OF A "RETOUCHER" WITH A FLAKED BONE ASPECT FROM ROC-EN-PAIL (FRANCE)

ABSTRACT

David É. 2024. On the Polysemic Nature of Traces and Co-occurring Patterns in Anthropized Material — contribution of a "Retoucher" with a Flaked Bone Aspect from Roc-en-Pail (France). *Sprawozdania Archeologiczne* 76/1, 139-158.

This article presents a new archaeological material to discuss methodological issues encountered by scientists working both on minimally-modified bones from Mousterian assemblages, to those dealing with the identification of "retouchers" having a flaked bone aspect. The technological approach integrates complementary analytical study-frames in order to assess archaeological information. On the one hand, analogies with similar experimentally produced patterns reduce the functional identification of the archaeological specimen. They do not deal with a single artefact-type in the category of "retouchers", which thus remains generic. On the other hand, the recording of the patterns in their chronological order, combined together with that of modifications relative to the diagenesis of the bone as an artefact, suggests the "retoucher" was reduced in a relatively fresh state by a carnivorous predator also. The evidence of this co-occurrence, if characterizing the successive anthropic-originated bone beds ultimately degraded by predators in situ, would suggest a relatively short period of human occupation generated by the use of the site in a singular cyclical conception "prey-hunter-predator" at regional scale.

Keywords: Mousterian, retouch, flake, puncture, percussion, pattern, temporality, bone technology
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INTRODUCTION

Identification of minimally modified bone artefacts from Palaeolithic assemblages is generally done by using large categories of archaeological material; the "tool" category takes priority over other modified bones (Child 1995; Shipman 2001). The "tool" category, as defined by using high-resolution optical observation on large bone fragments bearing flake scars and/or impact marks, mainly regroups "retouchers" (Baumann *et al.* 2020; Doyon *et al.* 2018), or retouched tools (Romagnoli *et al.* 2017; Villa *et al.* 2021) and other tools used for smoothing, scraping, battering, *etc.* (d'Errico and Henshilwood 2007; Parfitt *et al.* 2022). The other parallel category of discoveries reflects all other kinds of materials, mainly osseous items reduced by predators and/or by taphonomical factors or agents (Maté-González *et al.* 2019). As vestigial remains of consumption and/or marrow fracturing, the bone remains also display impact marks and/or flake scars (Vettese and Daujeard 2021; Schiffer 1983). In order to distinguish the artefacts in their attribution to one or another category of the archaeological materials, patterns in used bones are compared with those due to natural formation processes (Bello and Parfitt 2023). The dichotomy approach gives reliable identification of bone pieces originating from anthropogenic action in prehistoric archaeology. Meanwhile, it implies to give little interest in discussing other features such as co-occurring or co-related patterns and this may lead to possible conflicting identifications of the same type of artefacts. Occurrence of flake scars or scaling retouch are either recognized as being due to taphonomical events – effects of trampling (Dominguez-Rodrigo *et al.* 2010) or actions of predators (Villa and Bartram 1996) – or, conversely, damage or intrinsic attrition to the use of the bone as a tool or a retoucher (Bauman *et al.* 2023; Blasco *et al.* 2013; Daujeard *et al.* 2018; Mateo-Lomba *et al.* 2019). When "retouchers" display additionally point-ended morphologies, as is the case of the archaeological piece that, therefore, is used as an example in this paper (Fig. 1), the identification of such bone artefact is even more difficult; a point-broken end possibly being perceived as a pointed-shaped product which, as such, is integrated into the category of the bone industry (Iakovleva *et al.* 2018, p. 55, fig. 15). Given the dual possibility, it is necessary to present more material to discuss the relevance of documentation in similar-looking patterns (Parfitt and Bello 2024). This is conducted in detail by means of a qualitative analysis perspective at first sight, *i.e.*, prior to the quantitative analysis it enables (*e.g.*, Courtenay *et al.* 2020): flake scars or scaling retouch versus removal marks relative to knapping or the using of the bone as a tool; impact marks versus scores relative to retouching lithic. The illustrated material is highlighted using the concept of tool biography (David and Ducroq 2023) or the *chaîne opératoire* of the item (Turner *et al.* 2020), *i.e.*, the process of transformation of a bone through the diacritical reading of its surface modifications, from the anatomical matrix to the artefact as a bone material remnant of a cultural context.

RESEARCH AND METHODOLOGICAL BACKGROUND

Very early in French prehistoric research, archaeological excavations carried out on Middle Palaeolithic cave sites fuelled a debate on the polysemic nature of the traces present on some fragments of long bones (from epiphyses and diaphyses) found among the faunal remains of large mammals (Baudoin 1906; Henri-Martin 1906). Observations of flake scars on bone fragments, found as such or with additional impact marks, raised epistemic issues. The identification of this material as a peculiar category of objects became important because it was recorded from faunal bone floors of human origin (Daujeard *et al.* 2014). This brings to question as to whether these different patterns, in the form of flaked and/or impacted bones, are the result of a single technical human action? And, conversely, could diverse or distinct technical actions shape the bones the same way? By addressing these questions, the then technological approach, albeit unnamed in bone studies, began to develop through empirical research and experimentation (see Bello and Parfitt 2023, for a complete list of references).

If the aim of the (bone) technologist is to reconstruct the technical behaviour of prehistoric human groups from archaeological information, this is however achieved by applying various implicit academic prisms in reading past materiality, which makes the interpretation of bone remains among Middle Palaeolithic assemblages controversial when discussing ancient conceptions from surface modifications (d'Errico *et al.* 1998). The reconstruction of past technical actions on bones mainly depends on the ways of looking at archaeological osseous material: vestigial (Burke 2018; Farizi *et al.* 1994; Stiner 2004) or artefactual (Vincent 1988). These perspectives implicitely bring out a relationship between a feature and a corresponding agent, action or activity (Chase 1990; Holen and Holen 2011; Thiébault *et al.* 2019; Toth and Woods 1989). Despite a few experiments, targeted surface changes of the tool depending on the duration of its usage (Castel *et al.* 2003), archaeological and experimental studies in French research turned the interest in towards the identification and the reproduction of marks through the repetition of tasks (Vincent 1993; Armand and Delagnes 1998) and knapping and retouching or shaping lithic products using bones (David and Pelegrin 2009; Langlais *et al.* 2010; Mallye *et al.* 2012; Schwab and Rigaud 2009; Tartar 2012). In this sense, the necessary conditions for carrying out any replications were taken for granted (for clarification on this issue, see David *et al.* 2023-a), and the applied analytical framework relied less on how to base experimental work to promote an adequately equivalent level of understanding of the experimentally produced marks, but rather on reproducing patterns as many times as possible under varying study parameters to support interpretation based on analogy with the archaeological material. This research perspective generated a significant source of imagery for the identification expertise through the use of developed available high-quality optical resolution equipment (Abrams *et al.* 2014; Fernández-Jalvo and Andrews 2016; Hutson *et al.* 2018). The historical question posed by Henri-Martin as to the origin of the appearance of a modification on a bone was

implicitly abandoned in favour of comparative studies of traces carried out term by term, in order to guarantee universality. Against this, our approach is to analyse the patterns based on a prior understanding of the nature of the minimally-modified bone material (*e.g.*, David and Valentin Eriksen 2021). In other words, to what extent does the artefact testify to an earlier being by its present appearance alone, rather than by its well-preserved traces that are otherwise similar to those found in other archaeological finds?

Because organic matter irremediably undergoes diagenetic change, all bone artefacts are not automatically comparable in terms of study. Considering experiments only as a validation of observations seems to detract from the contribution of wear and techno-functional approaches and we believe that it should be applied in conjunction with the latter two, also in the field of minimally-modified hard materials of animal origin. We subscribe that the different disciplines involved in worked bone studies – anatomy, traceology, technicity and taphonomy – are all contributing in the (technological) reading of an archaeological bone material (David 2007). This is done by taking into account the original aspect of the unmodified bone element in relation to the traces resulting from its reduction as a recovered item. Only those that appear to have been produced by the technical action of a biological agent as part of an intentional design can be identified as man-made products (*e.g.*, Diedrich 2015). This involves reading the surface of the bone to identify the raw material, characterizing its patterns and the steps by which it has been transformed in chronological order and ordering. In the field of minimally modified bone remains, the study of the impact marks prior to that of the bone artefact, as an extracted flake modified by its usage, would lead to a reduction of our understanding of the archaeological object to a mere knowledge of its sole material aspect. As the two aspects under discussion – flake scars and impact marks – may relate to distinct categories in the domain, it is important to raise the issue of a common scale of resolution for the study of slightly modified diaphyseal fragments, which are more appropriately referred to as "bone with impressions and scars" (Patou-Mathis 2002). This scale of resolution is reached via the diacritical analysis of the artefact with reference to the bone blank as a given anatomy, using five principles of reading the bone artefact – trace-recording, overlaying, over-crossing, arranging and framing (*e.g.*, David *et al.* 2023-b).

MATERIAL AND METHOD

A specimen found in a Palaeolithic site is used as a didactic example of our technological reading (Fig. 1: top right). It was found in square 10/5 from the Roc-en-Pail site, Maine-et-Loire (Soriano *et al.* 2021), where it was attributed to a unit of stratigraphy n°305 (erosion of US n°401) Mousterian horizon. The specimen is chosen for its distinctive morphology among the "retouchoirs" available from the 2017's excavations (David and Gargani 2018, Annexe I-n°152). The archaeological specimen constitutes a valuable representative for

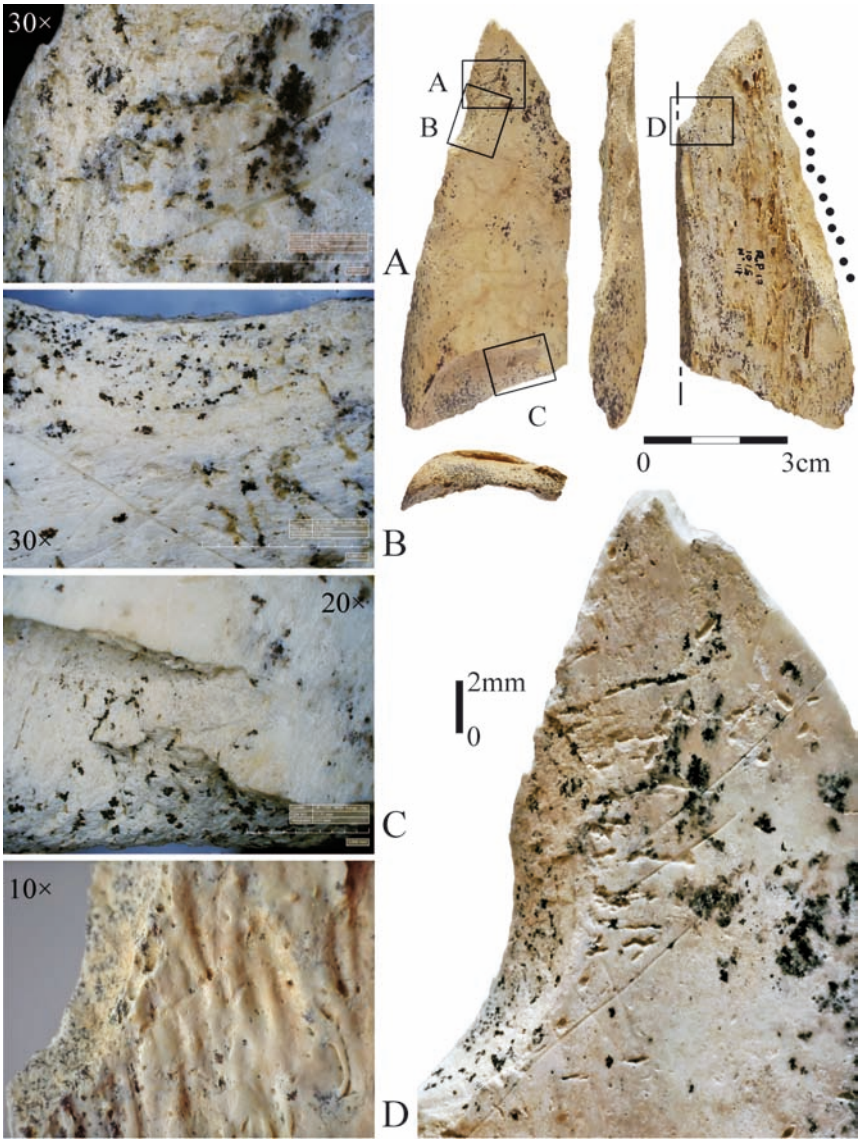


Fig. 1. A Mousterian "retoucher" with a flaked bone aspect bone from Roc-en-Pail (France). Illustrated by É. David

our purpose as a well-preserved anthropized bone piece: 88 mm long; 37.4 mm wide; 11.4 mm thick. From its morphological aspect alone and according to the classical approaches to such bone item, this specimen can be identified as a retoucher flake damaged by use, a bone flake shaped by retouching for a use as a retoucher, or even a bone point

shaped out from an initially impacted bone matrix. Its observation was undertaken using a RX-100 Hirox microscope for 3D imaging under low magnifications (20× and 30×). The same equipment was used to document features from other specimens, recently-gathered bone flakes bearing similar impact marks, but from dog gnawing. The percussion marks, as visible on other used bone fragments recently obtained from an experiment involving lithic tools, on which patterns on the bones were observed using a motorized Zeiss Axio Imager Z2m microscope with an Axiocam 506 colour (10×), and assembled for this purpose (Figs 2 to 4), are shown for their value as comparative materials.

Contribution to the methodology using two experiments

A first experiment on 'bone tool-making tools' was conducted with fresh bones of large ungulates used in lithic reduction and percussion by a skilled flint knapper – Jacques Pelegrin – originally in answer to a previous Postglacial archaeological issue (David and Pelegrin 2009). The experiment was conducted to account for technical actions possibly performed during the Stone Age as regular procedures using bone-blanks on lithic material. For the purpose of this paper, the surface of each of these used bones was newly micro-photographed after being first coated with a light smoke deposit of ammonium chloride salts to give an improved optic resolution under magnification (unfortunately bone grease still remains in the form of large brown dots in Figs 3: A and 4: B). The use of a skilled knapper – *i.e.*, with more than 10 years of regular lithic practice – was required to ensure that all the marks recorded on the surface of the bone fragments would indeed result from an effective action even if the knapper sometimes might 'miss' his strike. In this way, "replications for replication of marks" as well as parasitic marks were avoided. In other words, the technical action was stopped when, for instance, the lithic edge was retouched with satisfaction – *i.e.*, the lithic tool produced with the use of the bone fragment was considered to be usable as such by the flint knapper. The obtained impact marks on the bone are all percussion marks (Vettese *et al.* 2020) corresponding to a realistic achievement of technical performance.

During this experimental test, ten bone fragments were employed as active or passive tools. When using each bone fragment such as a small hammer (active), four tasks were conducted: 1) to retouch a flint product (Fig. 3: A); 2) to detach burin spalls from a truncated flint end (Fig. 4: B); and, with the flint product used as an intermediate piece, 3) to carve a large standing piece of dry wood (Fig. 2: B, C); and 4) to split a fresh long wooden piece lengthwise (Figs 2: D and 3: B-D). Conversely, using a bone fragment as a standing anvil (passive), (two) flint edges were retouched respectively by percussion (Fig. 2: A) and by pressure (Fig. 4: A).

The results of this experimental test show that, depending on how the intermediate lithic piece was precisely held during the action, very distinct marks were obtained from performing similar tasks (see Fig. 2: B compared with C). The contrary is also true: striking

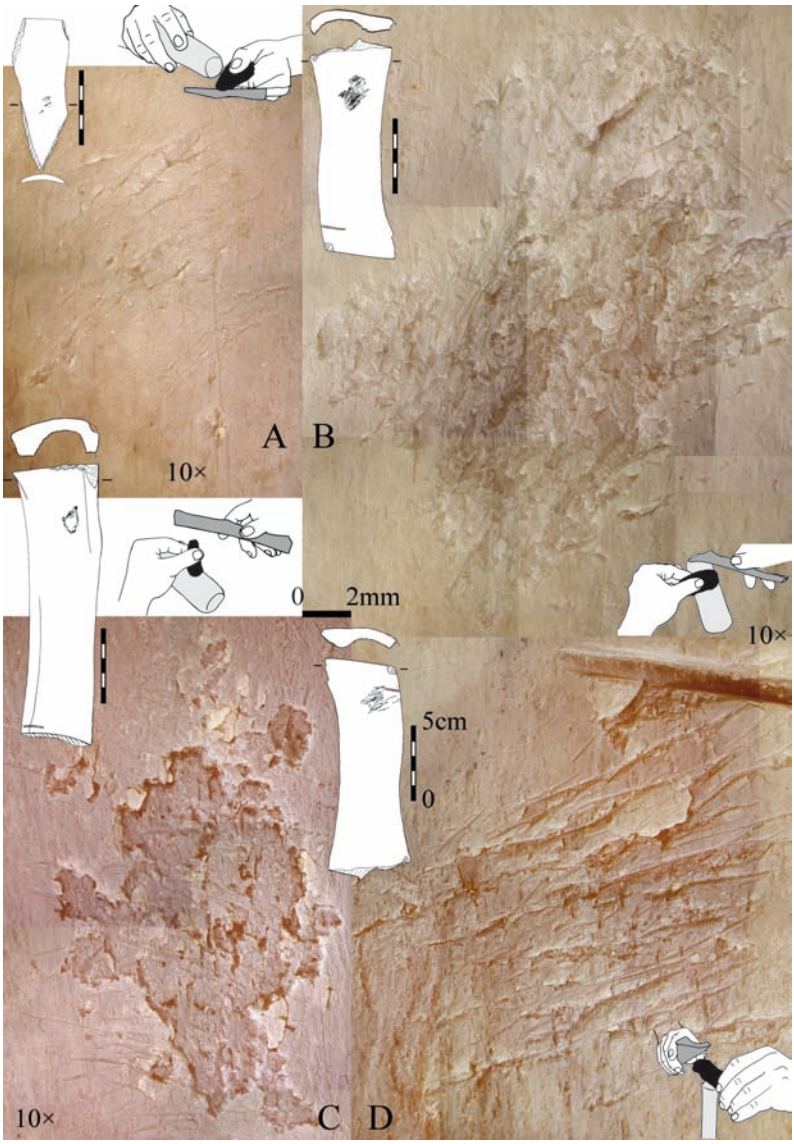


Fig. 2. Aspect of bone surfaces after having retouched a lithic edge (A), carved (B, C) and split wood (D). Illustrated by É. David and J. Orłowska

on the butt end of any lithic products yielded very close features regardless of the task (see Fig. 2: C compared with Fig. 3: C). Moreover, the type of impact marks appearing on the bone surface used as a small hammer to strike a flint edge depended actually on whether the later was previously regularized by retouch or not (see Fig. 2: D compared with Fig. 3:

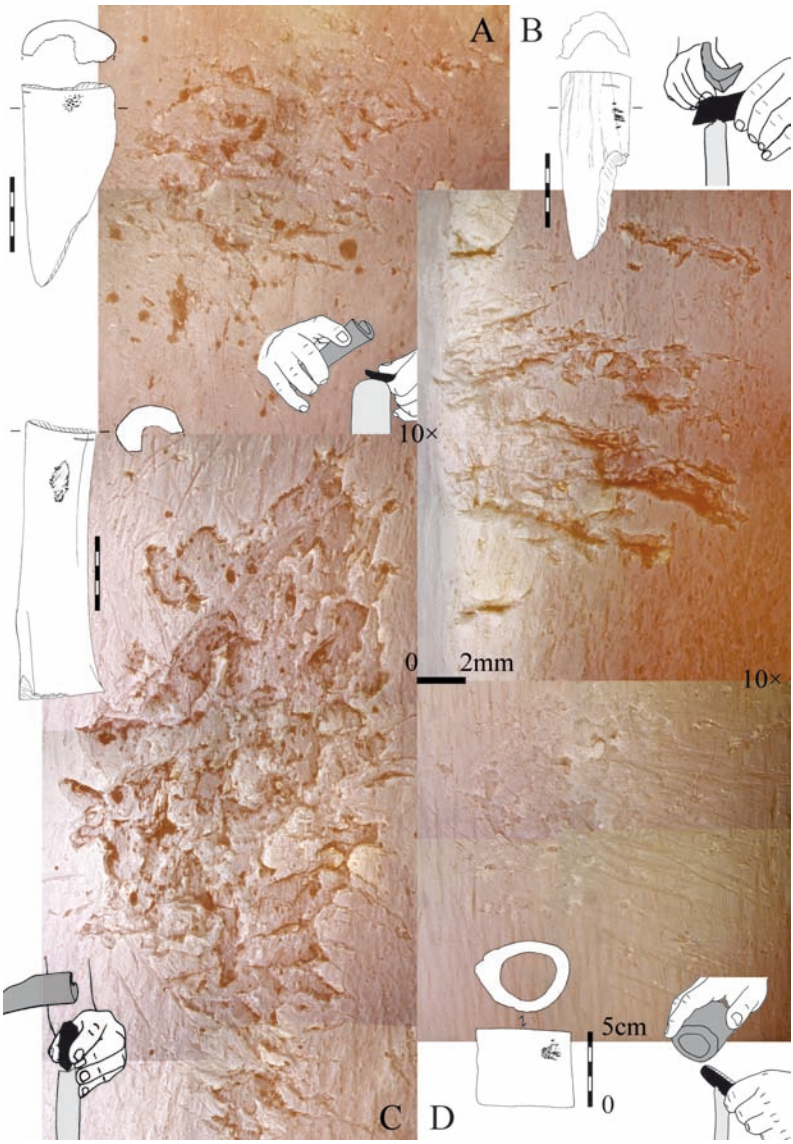


Fig. 3. Aspect of bone surfaces after having retouched a lithic edge (A) and split wood (B, C, D). Illustrated by É. David and J. Orłowska

D). Most technical actions resulted in impacting an area that is close to the upper edge of the bone tool (except Fig. 2: A) with a more or less important osseous loss sometimes associated to transversal series of marginal striations. This feature seems to reveal the motion of the gesture when using a bone fragment in percussion, leading to percussion marks

that are always group concentrated where the bone is deliberately impacted. The use of the bone fragment as a retoucher in the strict sense of the term has produced results that are not particularly different from those of other types of action, if not in depth (see Fig. 3: A compared with B). The term "retoucher" should thus be placed between inverted commas. In addition, the shape of the bone fragment itself played a role in how the percussion marks distributed transversally or obliquely in the form of scores, from a concentration of isolated sharp straight marks to clustered deep zigzag lines (see Fig. 2: D compared with Fig. 3: B). Thus, it is not possible here to assess for any specified functional identification of the archaeological artefact based on the traces on the bone surface only.

A second experimental test on a 'worked bone-appearance accumulating agent' was carried out with the contribution of a trained hunting dachshund dog, a three years old male weighing 11 kg, called "Timone" (Fig. 4). The aim of this test was to refine parameters for the identification of the pointed attribute of the archaeological specimen through observations of resembling pointed morphologies of bone flakes resembling it, but gathered from the results of the dog's actions when gnawing. Although the initial quantity of carcass parts of several slaughtered white-tailed deer (mainly given to the dog) could not be sampled, 41 pieces of split bone fragments less than two centimetres-long cortical chips, 92 of long splinters from *ca* 2 to 19.2 cm long, from 0.6 to 1.9 cm wide and 0.1 to 1.2 cm in thick, and 14 half-complete diaphysis and large epiphyseal parts deposited over a period of six months (hunter's pers. comm.) were gathered from the farm where the dog was kept. These constitute a reference material that is only partly used in this paper and remain available for a more complete study.

Among the collected diaphyseal fragments, there are three large pointed pieces resembling the archaeological specimen. Their basal end appears as if intentionally broken off and a point-broken end is located at the upper extremity. The general shape suggests a bone point. This is however due to that the longest edges of the bone fragment are incidentally convergent, merging together in pseudo-symmetry on the upper face (Fig. 4, gnawed bone piece above D). These edges are not planes obtained from percussion, but planes of breakage that naturally developed in the osseous material when scars split following mainly the lamellar elongated structure of the osseous material from a more complete bone. This breakage originally developed from one or several impacts marks identified as tooth punctures, in the shape of cupule-shaped pits either aligned in a row located on the surface across the bone hard tissue (Fig. 4: C), or possibly including the adjacent plane (Fig. 4: F, arrows). These punctures with pits associated to consecutive planes of breakage located opposite to one another involved the pinch-biting of the bone (Fig. 4: E, arrows). Etching marks also drift as a result of the teeth slipping during the action of splitting the bone. Some hatched areas appeared superimposed on the edges of the breakage planes, showing a smooth aspect at prominent bone reliefs on broken parts. This smooth aspect possibly developed locally on the bone edge when in radial contact with the dog's jaw (Fig. 4: F, see abraded area between arrows). The surface also displays several parallel-aligned, large and superficial scratches (Fig. 4: D, arrows from above). These marks were

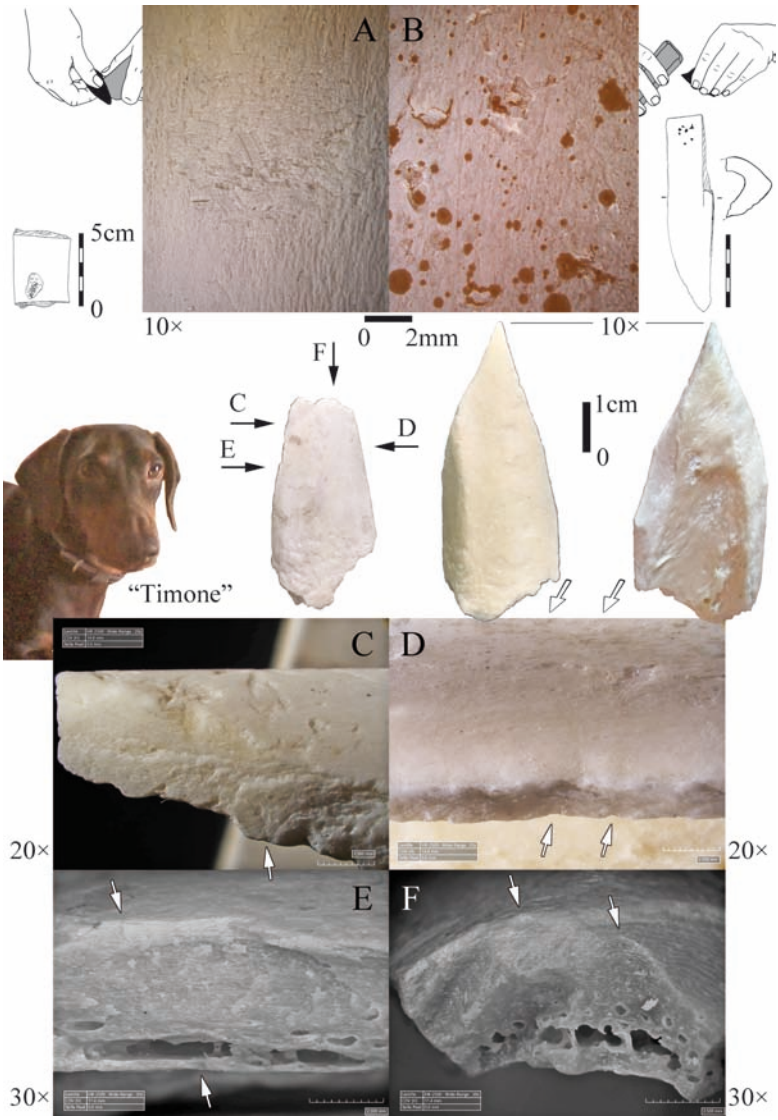


Fig. 4. Aspect of bone surfaces after having erased a lithic edge (A) and detached burin spalls (B) and results from a recent dog gnawing (C to F). Illustrated by É. David and J. Orłowska

left by the dog attempting to immobilize the bone by pressing it with its (paws and) claws. The collected diaphyseal fragments show more of these shallow grooves towards the end of the bone anatomy. The dog spent time gnawing the epiphyseal parts and the bone flake once split from the diaphysis was left by the dog and abandoned for the bony parts containing more cartilage.

The fragments collected from this observed experience on bone crushing and gnawing, where Timone was recorded in action both as a bone-modifying and as an accumulating agent, attest to a pattern containing three principal stigmata. As they usually occur together, the pattern is constituted in that they are related to each other through their systemic association on the bone piece as evidenced by:

a) cupule-shaped pits – known as punctures (Binford 1981, 51) – with various sizes and distinct morphologies, up to half a millimetre deep and sometimes in the form of an isolated elongated biting mark up to 3.5 mm of diameter; when pits are side by side, a maximal distance between the two, 5.8 mm, might indicate the effect of the cusps of a the same tooth or, more likely, the cusps of different teeth but with a same elevation on the dentition;

b) planes of breakage developed in either axial – known as butterfly-like wings or X-shaped fracture and chipped edges (Binford 1981, 51) – oblique – known as spiral-step fracture (Haynes 1983, 112) – and hinge fracture for the transverse-facial scar (Henri-Martin 1907, 301-302). These often wavy or even twisted planes of breakage are successive cracks in bone constituted of rough reliefs with flake scars deriving from the above-mentioned punctures. Where the hard tissue is impacted and cupulated, the associated planes appear in some areas relatively abrupt or perpendicular compared with the outer face of the bone (c. >106°), and;

c) etching marks – also referred to as "channelled bone" (Binford 1981, 51) – randomly distributed on the surface, but mainly coming from the opened pits, and in the form of long scratches or striations, micro-scars with sometimes (towards the upper face) smooth planed and/or shiny (hatched) areas (*e.g.*, Madgwick 2014). In addition, superficial parallel scratches (each, up to 200 μm deep and c. half a millimetre wide) with a possible additional smooth aspect can be seen on the largest bone surfaces that include epiphyseal elements, respectively at the extremities and on the broken parts.

From the two experimental tests briefly described in the frame of this paper, these slightly improved our method in that the polysemic nature of the traces guide us to a mere focus on the nature of the archaeological specimen: the artefact is a bone showing percussion marks with a pointy and flaked aspect due to gnawing. The traces on the surface are not as significant as how these relate to one another and, through time in their chronology, with the different parts of the recognized skeletal part. This is further developed with the reading of the archaeological specimen.

DIACRITICAL READING OF THE ARCHAEOLOGICAL SPECIMEN

The archaeological specimen displays a trabecular structure, axially distributed all over the inner face that anatomically corresponds to a medullar canal (Fig. 1: top right). Because of its large dimensions, the rectilinear delineation in the main profile and of the large curvature of the thick hard bone (6.9 mm) in the transversal profile, as reconstructed

with its complete circumference (Fig. 5: top left, cross section), the piece is in all probability a diaphyseal part of one of the largest skeletal elements of the limbs of a large mammal (like a radius or a tibia of reindeer); the slightly thinner part of the tip-like end seems to point towards a metaphyseal part.

The artefact is mainly constituted by three convergent edges displaying planes with scars aligned along the length and even developed both on the upper and lower anatomical sides, and a large facial scar that represents the basal transverse broken end. The upper face shows a few isolated and slightly pronounced short zigzagging lines that constitute a concentration of impact marks on the tip-like end. One of the few well-preserved lines is made of three consecutive equal sharp marks, c. less than c. 2 mm long in a row. These impact marks relate to percussion due to passive or active modes on/with a lithic, such as a "retoucher". They occur sparsely with no marginal striations or extra bone loss on the surface, and have a slight transverse-oblique orientation in an area that would correspond to a flat side of the bone, anatomically (Fig. 5: top left). The area displaying these marks is damaged by a large transverse-facial scar coming from the side of the artefact; thus, a large part of the initial bone surface, bearing the anthropogenic percussion marks, is missing.

Considering that the only remaining primary edge of the artefact (Fig. 1: top right, dash lines) suggests that the bone fragment had a much longer size when initially used, it is unknown whether the concentration of percussion marks would have been close to the upper end – as required from the bone retoucher used in the above described experiment (Fig. 3: A) – or, on the bone's mid-part as a standing bone anvil to retouch a lithic edge (Fig. 2: A). By placing the location of the concentration virtually where it would remain in an initial curvature, the first hypothesis is most likely, since the percussion marks would have remained anatomically concentrated on the same and most centrally placed flattest area of the curved anatomical edge (Fig. 5: top left, between parallel lines). This being said, it is not possible to assess the possibility that the bone fragment was extracted as a bone-blank, because there is no evidence of a deliberate anthropogenic cause impact fracture. However, the very straight delineation of the remaining primary edge, where two transverse-facial scars are superimposed, which could favour of the hypothesis that the bone diaphysis was broken lengthwise prior to its use as "retoucher", as if split in a controlled manner, also recall the natural-half broken off bone which, as such, would have served in its complete osteological shape as a tool.

These flake scars derive from pits superimposed over the straight broken edge. Three oblique parallel long incisions cross over the whole impacted area on the surface and must therefore have appeared after the concentration of percussion marks. The incisions clearly end where cupule-shaped marks are superimposed on the lateral flake scar (Fig. 1: A) and extend above, and even change the surface aspect of the bone, where even flaked, which is largely transformed in pits of various depth toward the concentration of previous percussion marks. These incisions are actually made of several in a row and heterogeneously punctuated with cupule-dots just as these described for the experimental material resulting

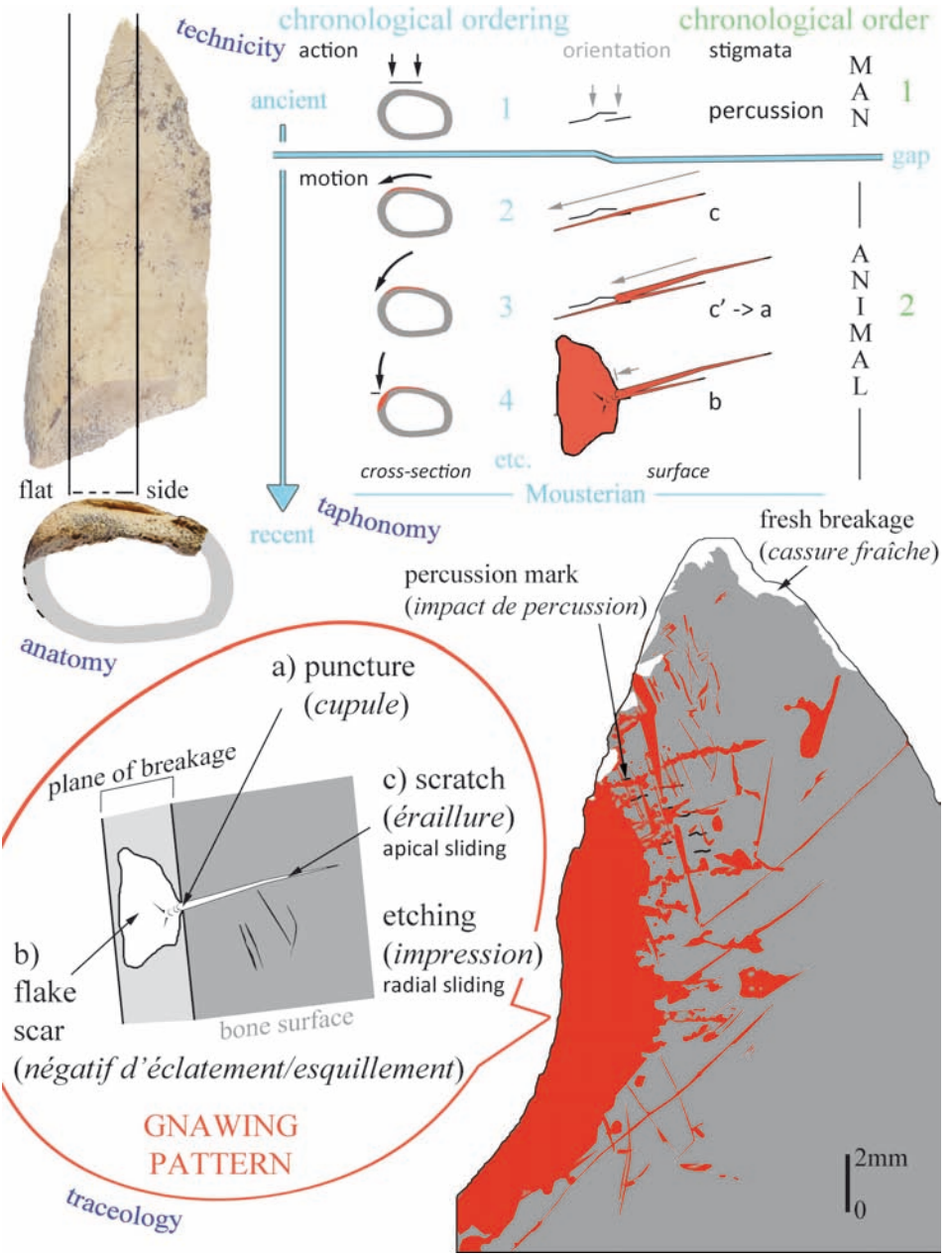


Fig. 5. Diacritic reading (synthesis) of the archaeological specimen presented in figure 1. Illustrated by É. David

from gnawing. On the other side of the artefact, the bone surface is also damaged in the same manner *i.e.*, by similar incisions cutting off the trabecular structure of the bone, albeit less easy visible due to the more developed osseous relief at that point (Fig. 1: D). The subsequent chipping of edge precisely emerges from cupule-shaped pits joining the inner trabecular tissue from above the broken edge where incisions also display. No matter which face of the artefact is considered, the planes in the shape of transverse-facial flake scars, hinge fracture and chipped edges arise from cupule-shaped pits located in surface above the broken planes. These attest to the reduction of the limb bone as with a (half) complete diaphysis in cross-section initially. Because cupules merging from incisions are rare on the medullar side, compared to the outer side of the specimen, the inner trabecular tissue must have recorded effects of the only last gnawing action, just before the bone cracked almost with its actual aspect. And, judging from the (counterclockwise) orientation and the ordering of the marks that developed with respect to the natural morphology of the bone in cross section (Fig. 5: top, chronological ordering), the bone tissue was crushed, here from left to right and from up to bottom, following a clear carnivore-gnawing pattern that gave the specimen its final pseudo-pointed morphology (Fig. 5: bottom left, gnawing pattern).

Since the lateral flake scar develops as the chipped edge, *i.e.*, into single wavy broken planes instead of step-terminating fracture (*e.g.*, Binford 1981, 51), it is most likely that the bone was still in a relatively fresh state of preservation when it was gnawed. In addition, all scars, broken base and chipping of edges have a lighter shade compared to the otherwise more brownish colour of the bone artefact that is additionally showing manganese dots. While these concretions spread all over the surface, this makes it difficult to know whether the specimen's rectilinear edge (dash lines) is the result of a deliberate fracturing of the bone in its length previous to being used as a "retoucher", or as an anatomical matrix that has naturally broken off due to that the osseous deposit eventually underwent prior to being used as a "retoucher" a kind of taphonomic pressure due to a lateral displacement of the sediment deposit locally (*e.g.*, Bertran *et al.* 2019). In some parts however the manganese dots are not present all over the flake scars. This suggests the cracks which have developed into the bone from gnawing eventually detached as complete flakes and fragments long but only after the material was buried, meaning the present aspect of the archaeological specimen as an artefact relates to its very last osseous diagenesis as a Mousterian calcified gnawed fresh bone. The archaeological specimen can be identified as genuine anciently-modified bone material by two distinct biological agents successively: human and carnivorous (Fig. 5: top, chronological order). The latter damaged the tool which served in percussion shortly after the time when the human agent accumulated and used bones. In this respect, and except some recent alterations around the tip (Fig. 5: bottom right), all the features of a lighter shade occurred soon after the bone was abandoned as a "retoucher" but quite shortly before being definitively buried.

From the diacritic reading through optic observation of the archaeological specimen, as analyzed as if out of context for our methodological purpose, the identification of the Mousterian artefact has been refined by using a dual variable – volumetric and technic. The relationship between the used anatomical matrix and the recorded patterns – percussion with gnawing stigmata – illustrates its unique morphology. With the ordering of the patterns in chronology, it was possible to distinguish the pseudo flake-retouched aspect of the bone fragment edges identified as finally deriving from gnawing, from the traces left on the original bone-blank by its use, eventually a small hammer made of a large diaphysis used in percussion.

CONCLUSION

The paper shows that percussion and gnawing patterns co-occurred and not co-related, *i.e.*, no gradient exists in the way the pseudo-retouch pattern developed through time on the bone surface during action, from zigzagging lines to flake scars. The gnawing pattern overlap the prior percussion zone, but after a while only. There is thus no strict contemporaneity between the human activity and the carnivorous degradation of the used bone piece (this would be expected in the case that the carnivorous were companions to the hunters), but a differed co-occurrence: human occupation first, the site was then occupied by predators.

This kind of co-occurrence from the study of "retouchers" might further contribute to attest to the human origin of bone floors recorded *in situ* and to the relative dating of the successive osseous deposits of the site, if containing more of such evidence, within the frame of the Mousterian to refine the absolute chronology (Richard *et al.* 2021). If the kind of Mousterian work done using bone on/with the lithic need to be specified, as well as the carnivorous species responsible for the reduction of the anthropogenic-used skeletal parts, this differed co-occurrence—in that the bone matrix was used as a practical percussive tool and, soon after, was remaining as a fresh available material to be gnawed over a relatively short time span—unearths new insights into the temporality of human occupations *in situ*. If characteristic to the bone deposits in the stratigraphy, as resulting from successive similar frequentations of the site, this temporality might have been relatively short and generated by a recurrent cyclic conception of the territorial occupation at the regional scale.

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FIELD SURVEY AND MATERIALS

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THE MAGDALENIAN SITE KLESZCZOWA 9, PILICA COMMUNE, SILESIAN VOIVODSHIP (KRAKÓW-CZĘSTOCHOWA UPLAND, POLAND). MULTI-ASPECTUAL ANALYSIS OF THE FLINT INVENTORY AND THE IMPORTANCE OF THE SITE

ABSTRACT

Sudoł-Procyk M., Osipowicz G. and Baranowski K. 2024. The Magdalenian site Kleszczowa 9, Pilica commune, Silesian voivodship (Kraków-Częstochowa Upland, Poland). Multi-aspectual analysis of the flint inventory and the importance of the site. *Sprawozdania Archeologiczne* 76/1, 159-186.

This paper presents the results of multi-aspectual analysis of the flint inventory from Late Paleolithic inventory from the site Kleszczowa, located in the middle part Kraków-Częstochowa Upland. The technological and typological features of flint artefacts indicate a Magdalenian cultural tradition. Raw materials used for production of artefacts were high quality Jurassic flints, the outcrops of which occurred within direct surroundings of the site.

In this paper the authors would like to stress the results of use-wear analysis. Nearly half of the artefacts investigated in this respect bore traces of utilisation for processing of wood, meat and hide. Some of the forms bore traces indicating processing of silica plants and elaboration of soaked bone and moreover traces of hafting and organic substance.

The results of analysis correspond well with the current knowledge referring to utilisation of tools by the Magdalenian societies, and they undoubtedly extend our knowledge upon behaviour of humans at the decline of the Pleistocene in southern Poland.

Keywords: Late Palaeolithic, Magdalenian Culture, flint inventory, typological analysis, raw material analysis, use-wear analysis

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INTRODUCTION

Site no. 9 in Kleszczowa, lying within a distance of c. 7 km from the locality named Pilica (Silesian voivodship), is situated on the highest part of the Sachalin Hill, located in the northern part of the so-called Barańskie Mountains, at an altitude of c. 406 m.a.s.l. (Fig. 1). The Barańskie Mountains is a cuesta-type ridge situated c. 2-3 km to the west of the Udorka Valley. The western slope of the ridge is steep and falls to another valley, parallel to the Udorka Valley, currently dry. The location of the site is convenient for occupation since it opens towards two valleys; moreover, there are outcrops of a few variants of flint along its boundaries (Sudoł-Procyk 2021).

Field surveys conducted in this area since the beginning of the 1990s by K. Cyrek, J. Moszczyński, B. Muzolf and A. Pelisiak (Cyrek *et al.* 1992), and then, in the years 2014-2016 by J. Jędrysik and T. Wagner (Wagner and Jędrysik 2016), have revealed an occurrence of numerous sites associated with the Neolithic. Therefore, a discovery of the Magdalenian site in Kleszczowa 9 during a survey aimed at mapping of siliceous material outcrops carried out by a geologist, M. Krajcarz, in 2012 (Sudoł *et al.* 2016), was quite surprising.

In August 2014, in the region of the site, preliminary research was conducted, the objective of which was to verify the spots where surface accumulations of flint materials were encountered. This survey confirmed the existence of two concentrations of flint artefacts as well as allowed the specifying of their cultural and chronological affiliation, indicating the Magdalenian provenance. Within the investigated parts of the site, under the topsoil

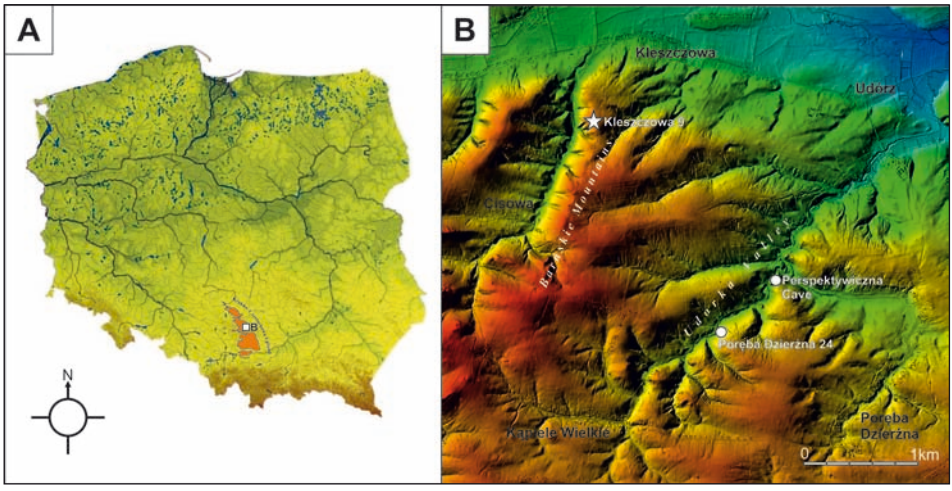


Fig. 1. Location of the Udorka Valley region on the map of Poland (A) and the site Kleszczowa 9 (B) in this region (drawing M. Jakubczak and M. Szubski, with authors' changes)

layer, there were identified loess sediments with a thickness ranging from 10 to 70 cm, lying directly over the residual clay.

In this paper, the authors present the results of typological, functional and raw material analyses of the assemblage, and draw conclusions based on the analysis of these data.

MATERIALS AND METHOD

A technological analysis encompassed the entire flint assemblage, namely 930 specimens coming from trial trenches and the ground surface in their direct surroundings. The great majority of the flints were collected from the surface (67%) and topsoil layer (29.7%), and only a few (3.3%) were recorded within the loess sediments *in situ*. Therefore, it is unsurprising that many finds were covered with patina and bore traces of post-depositional destruction.

All of the specimens were classified into particular typological groups, following the rules established for the standard classification of assemblages of this type (Sonneville-Bordes and Perrot 1956; Ginter and Kozłowski 1990; Demars and Laurent 1989). Due to the location of the site within an area intensively exploited for agricultural purposes and impossibility to determine whether some objects were prehistoric flint processing waste and recent plough-related debris, such controversial specimens were excluded from the investigations. Moreover, this article does not cover six natural flint concretions found on the ground surface. From the statistical viewpoint, their number does not seem to be reliable since it is very likely that due to their close location to flint outcrops and a workshop type of the site, they must have been much more numerous and could have been strongly fragmented during many years of farming activity, which is confirmed by a great number of flint chunks.

An analysis of raw material structure was based on a classification system proposed by M.T. Krajcarz (Krajcarz *et al.* 2012, 2014; Krajcarz 2023), using the comparative material obtained from flint outcrops surrounding the site, in various states of preservation, including specimens with "fresh" (non-patinated) and patinated fractures (with various intensity of patina cover), aeolized materials and objects discoloured due to natural factors, water activity, among other factors. The flint assemblage was investigated based on a few main criteria, such as the nature of the flint substance, the occurrence of intrusions within the flint substance as well as the occurrence and the nature of cortex. Strongly patinated or burnt specimens were not classified into either of the raw material categories. The selection of flint specimens presented in Figures nos. 2-6 was dictated by their diversified nature in terms of typology, raw material and function.

A use-wear analysis covered 70 artefacts, previously cleansed with pure ethyl alcohol, using the Nikon SMZ-2T microscope-computer set, coupled with the Nikon D7100 camera. This equipment allows obtaining lens magnification up to 12.6× (objective lens magnification up to c. 120×) as well as computer-aided digitalisation and processing of optical

images. For observation of polishes on the flint surface the Zeiss-Axiotech metallographic microscope was used, coupled with the Axiocam 105 camera, which enables obtaining lens magnification up to 50× (objective lens magnification up to 500×). With the use of the above-described equipment, a series of micro-photographs were taken, presented in the Figures nos. 7: A-N; 8: H, M-O and 9: A, E-O. Other micro-photographs were taken using the Zeiss Axioscope 5 metallographic microscope, coupled with the Axiocam 208 camera.

Use-wear terminology applied in this paper was based on the nomenclature used in the related literature (Ho Ho Committee 1979, 133-135; Vaughan 1985, 10-13, Glossary, VII; van Gijn, 1989, 16-20; Juel Jensen 1994, 20-27; Korobkowa 1999, 17-21; Osipowicz, 2010, 24-35), but adapted to the needs and requirements of the analysis presented here.

RESULTS

Typolo-technological and raw material analysis

The raw material structure of the assemblage in question was clearly strongly correlated with local outcrops of siliceous rocks occurring within a radius of 3 km from the site (Krajcarz *et al.* 2012, 2014; Krajcarz 2023). Half of the specimens were made of flint from the Barańskie Mountains (49.8%). Less numerous were specimens made of local variants of chocolate flint (18.9%) and striped flint (15.5%). The least frequently represented were flints from Wierbka (2.5%) and the Udorka Valley (1.3%). Concerning 2% of the assemblage raw material revealed mixed traits of local Jurassic flint, due to which such specimens were counted to a general group of undetermined Jurassic flint (Table 1). Moreover, there was recorded a marginal proportion of Cretaceous flint and cherts (including banded variants) (0.5%). In reference to 9% of the specimens, it was impossible to classify them into any of the raw material groups due to a convergence of morphological traits or their state of presentation (strongly burnt or patinated) (Table 1).

In terms of typology, the most numerous were blanks enclosing both flakes and blades. Most likely due to the nature of the site, more than half of these artefacts have been preserved fragmentarily (51.6%). Flakes and their fragments in the number of 428 specimens constituted as much as 46% of the entire flint assemblage, while blades and their fragments were nearly twice less numerous (221 items = 23.7%) (Table 1).

Particularly noteworthy were blades with the so-called *en éperon* butt (Inizan *et al.* 1999, 134, 136), which are very rarely recorded at archaeological sites in Poland. The *"en éperon"* technique was typical of the Magdalenian lithic tradition and they were used for the production of long and slender blades. Blanks obtained in this manner were the major material for production of tools (Połtowicz-Bobak 2013, 232). Within the assemblage recovered from the site Kleszczowa 9 there were identified 21 such blades (or their fragments), of which eleven specimens have retouched edges. Preferences in the selection of

Table 1. Kleszczowa, site 9. Typological and raw material structure of flint products

Typological structure / Raw material structure	Cores and cores forms*	Flakes*	Blades*	Technical forms	Other		Tools									
						Retouched flakes*	Retouched blades*	Endscrapers	Burins	Perforators/ Borer	Truncation pieces	Backed pieces	Combination tools	Mining tools	Unidentified tool fragments	TOTAL
Flint from the Barańskie Mountains	19	181	75	51	26	45	27	10	13	4	1	0	2	8	2	**464**
Chocolate flint	11	62	37	14	2	26	9	3	5	1	3	1	0	2	0	**176**
Striped flint	6	40	29	20	11	12	14	2	4	2	1	0	0	3	1	**145**
Flint from Wierbka	0	9	6	4	1	1	1	0	0	0	0	0	0	2	0	**24**
Undetermined local Jurassic flint	0	6	2	2	3	3	1	0	1	0	0	0	0	1	0	**19**
Flint from Udórz	0	6	3	0	4	0	0	0	0	0	0	0	0	0	0	**13**
Other (cretaceous, chert)	0	1	0	1	1	0	0	0	1	0	1	0	0	0	0	**5**
Undefined	3	29	17	5	17	7	0	1	4	1	0	0	0	0	0	**84**
TOTAL	**39**	**334**	**169**	**97**	**65**	**94**	**52**	**16**	**28**	**8**	**6**	**1**	**2**	**16**	**3**	**930**

* – including fragments

certain raw material for the production of blades with *en éperon* butts (48% flint from the Barańskie Mountains, 24% chocolate flint and 19% striped flint) corresponded well with the general tendencies observed at the site.

Noteworthy was also a significant number (146 items) of retouched flakes (*e.g.*, Figs 2: 3-4; 4: 5-7) and blades (*e.g.*, Figs 2: 1, 5; 3: 2; 4: 2, 4; 5: 1, 3; 6: 1), which together with their fragments constituted 22.4% of blanks. Concerning this group, the raw material structure was also consistent with the general raw material tendencies visible at the site. The great majority of the blanks were made of flint from the Barańskie Mountains (49.3% of all retouched blanks), chocolate flint (23.9%) and striped flint (17.8%).

Advanced exploitation of cores at the site is confirmed by technical forms, the total number of which amounted to 97 artefacts (10.4% of the entire assemblage). Amongst them, there were distinguished platform rejuvenation flakes (41 specimens; 42.2% of all technical forms), partly-crested blades (17 items; 17.5%), crested blades (16 pcs; 16.4%)

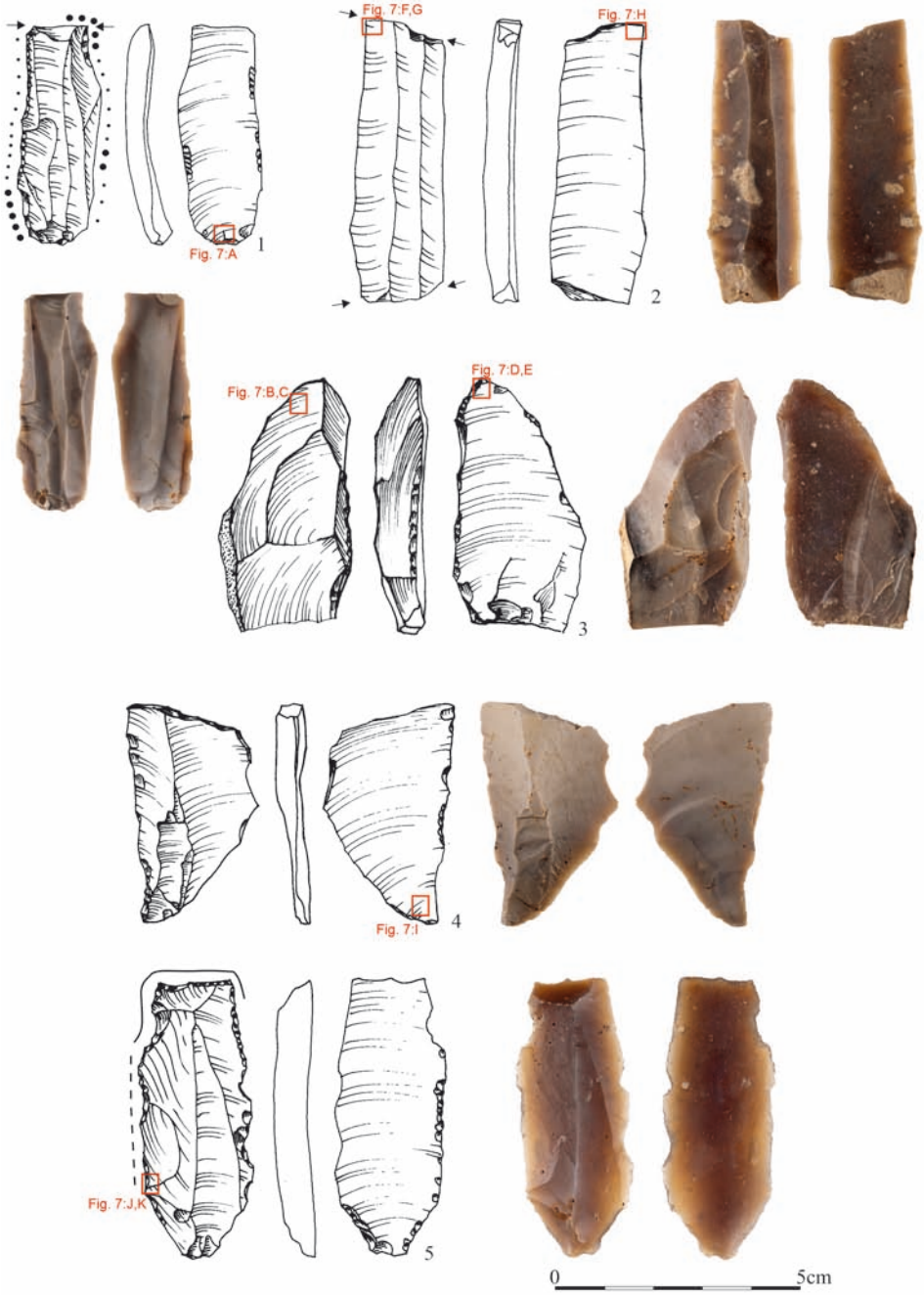


Fig. 2. Selection of flint products with the location of micro-photographs marked (drawing M. Sudoł-Procyk, photo W. Ochotny)

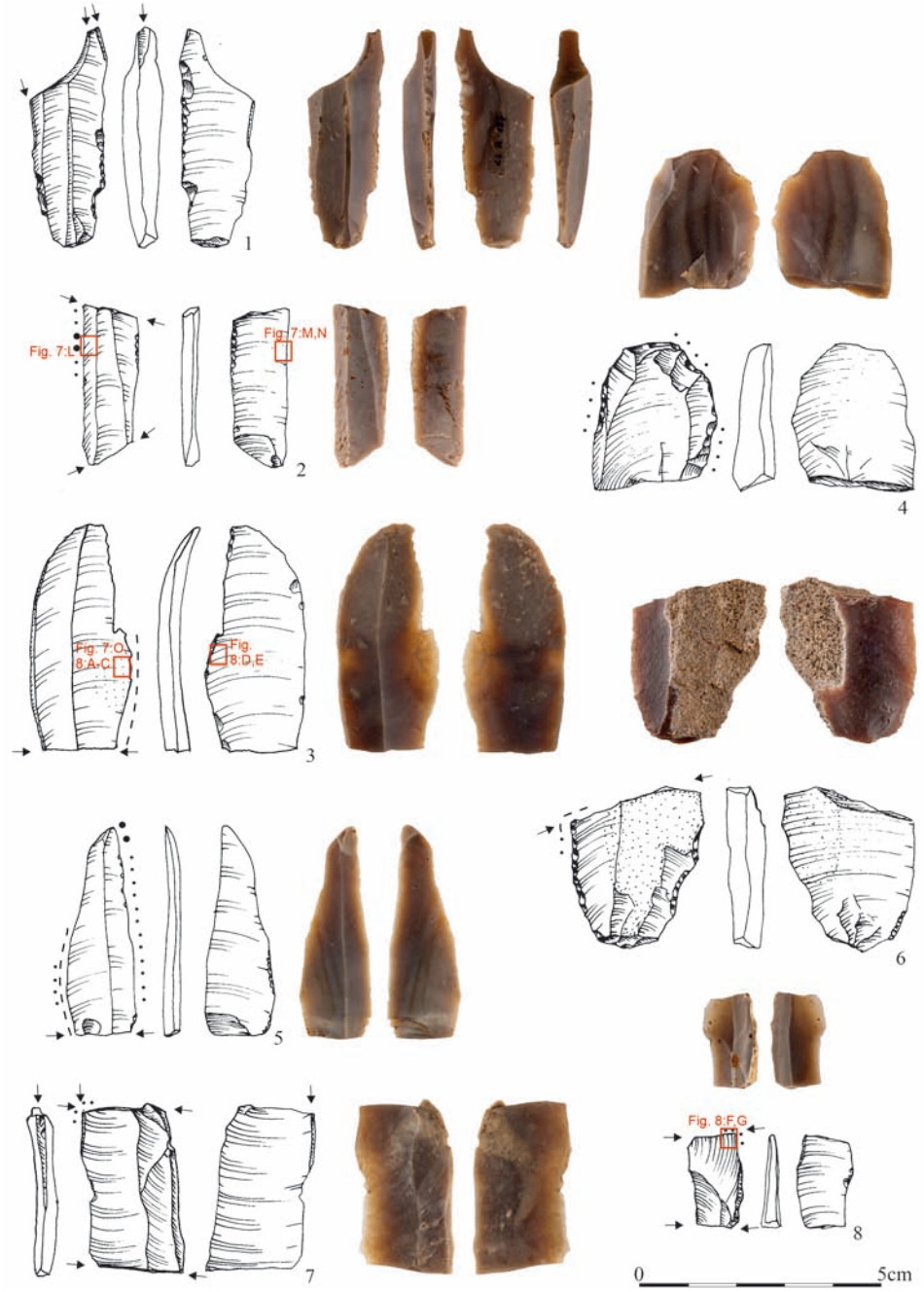


Fig. 3. Selection of flint products with the location of micro-photographs marked (drawing M. Sudoł-Procyk, photo W. Ochotny)

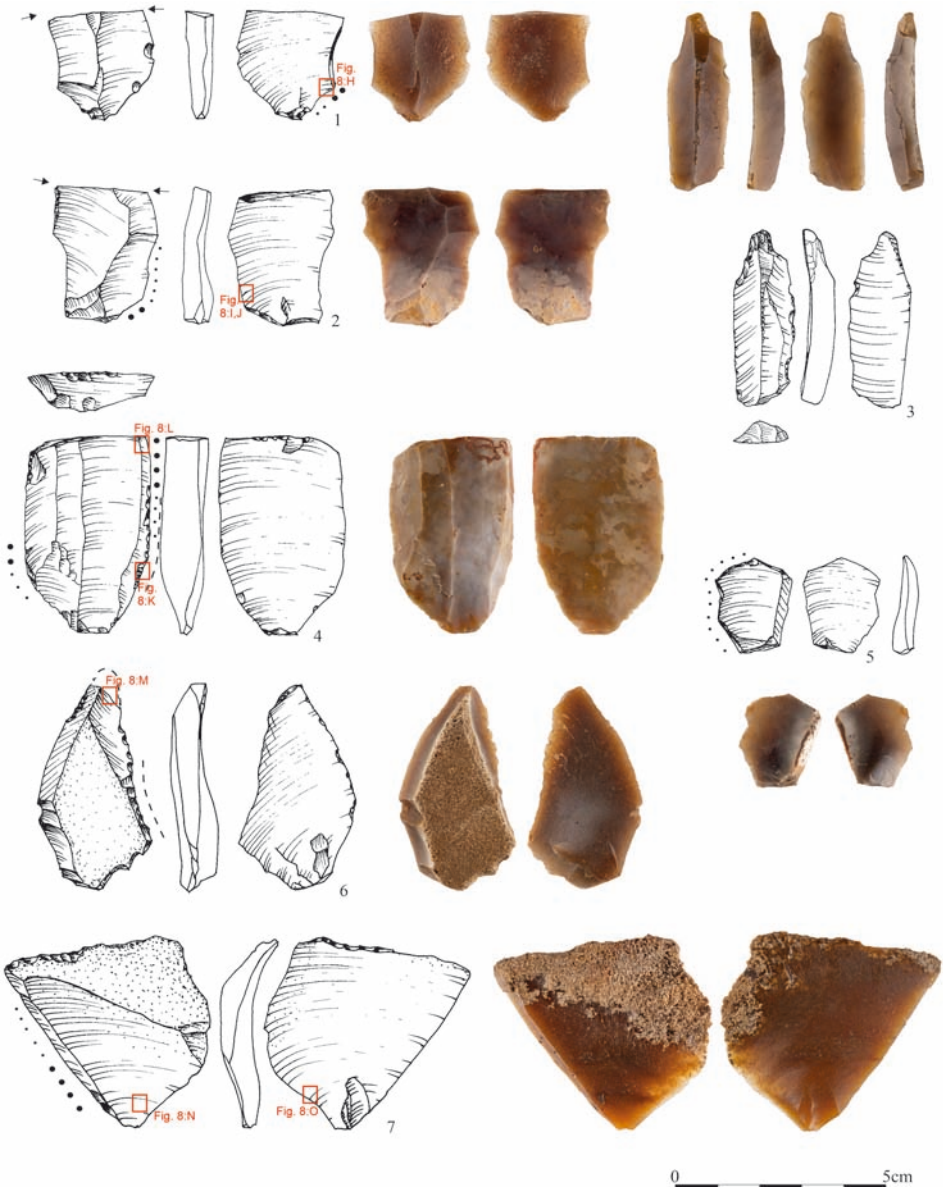


Fig. 4. Selection of flint products with the location of micro-photographs marked (drawing M. Sudoł-Procyk, photo W. Ochotny)



Fig. 5. Selection of flint products with the location of micro-photographs marked (drawing M. Sudoł-Procyk, photo W. Ochotny)

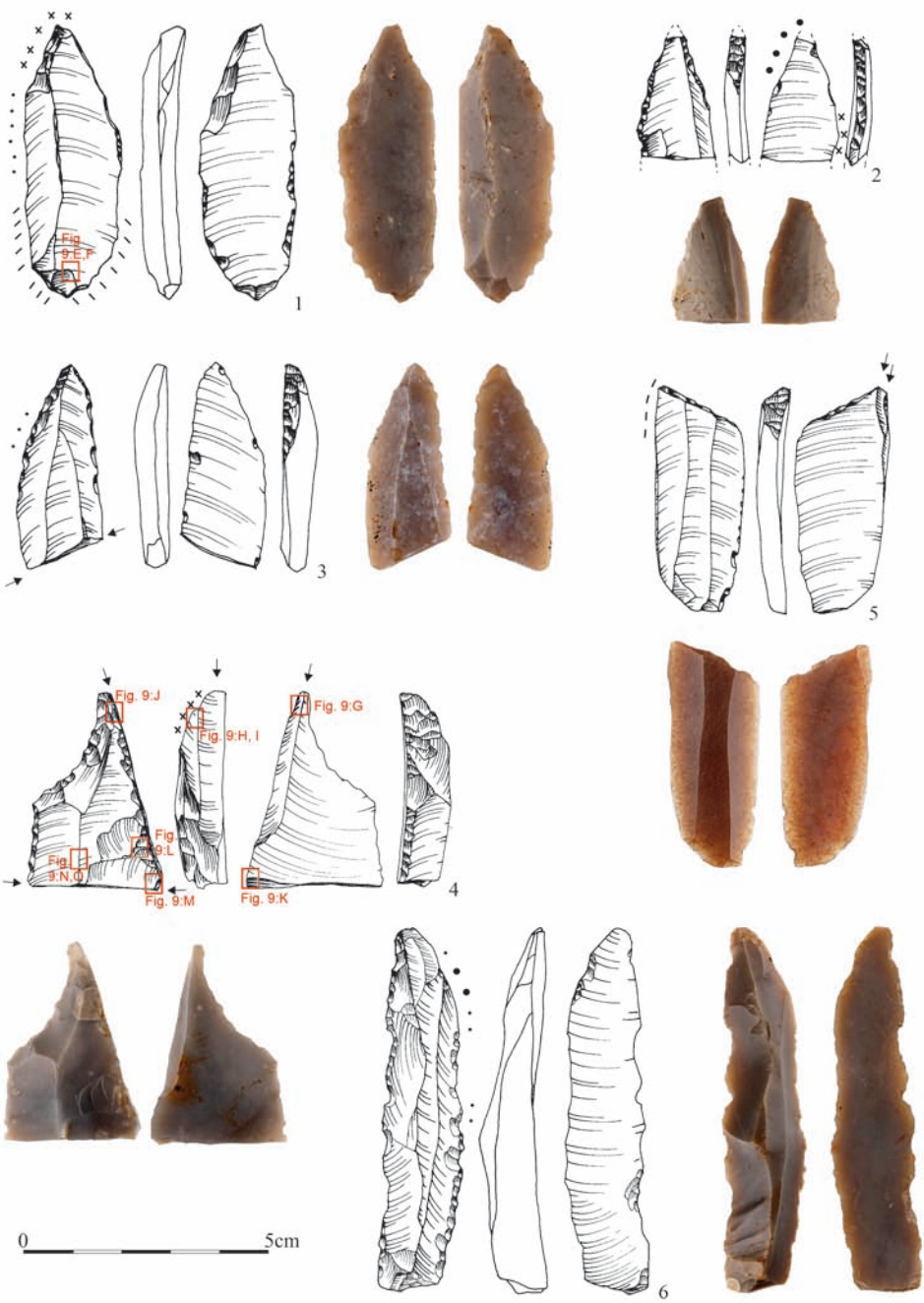


Fig. 6. Selection of flint products with the location of micro-photographs marked (drawing M. Sudoł-Procyk, photo W. Ochotny)

and core-tablets (10 examples; 10.3%). Other undetermined technical forms constituted 9.2% of the group in question. Such a high proportion of core processing debitage confirms the workshop nature of the site.

A group of cores included forms with initial blows, cores and their fragments. There were 28 cores (3% of the entire studied assemblage). They were represented by single-platform cores for blades, preserved at various stages of exploitation (Sudoł-Procyk 2021). Cores registered in Kleszczowa provided information about each stage of the production cycle. The ratio of cores in the preliminary phase of production is similar to the number of cores in the main as well as residual phase of production. Most débitage products are plain flakes that show that the cores were meticulously processed to produce regular, thin blades. Striking platforms were prepared and they bore traces of rejuvenation or correction. Cores at an advanced stage of exploitation were characterised by an acute angle between the prepared striking platform and the flaking surface; the latter, in some cases, embraced also the sides of the core. The backs of the cores were formed by concentric blows made from the core sides. A characteristic trait of the cores in question was also an occurrence of traces of changing orientation of striking platforms, which were identified on 31% of all cores (9 specimens). Moreover, there were noticeable tendencies in the exploitation of fragments of cores, residual forms or cores with unsuccessful blows, for shaping simple, *ad hoc* tools, mainly hammers. The secondary use of cores as hammers is often found in other flint workshops, especially in areas where access to other hard mineral raw materials (*e.g.*, stone pebbles) was difficult. This situation was met, on a much larger scale, in the case of the neighbouring site related to the extraction and preliminary processing of raw materials at Poręba Dzierżna 24 (Sudoł-Procyk *et al.* 2021b). In addition to 28 cores, there were also encountered six residual forms (20%).

Amongst tools, the total number of which accounted for 80 specimens (8.6% of the entire assemblage), a group of burins was distinctive (28 items; 35% of all tools; Fig. 3: 1, 7; 6: 4, 5). This category of tools was represented by: dihedral burins (9 specimens), truncation burins (4 examples), burins on a break (2 items), and single examples of the following forms: multiple burin; double burin; double ended burin; and a Lacan burin. For the production of burins, apart from blades and flakes, waste products were also used. In terms of raw material, burins were mainly made of flint from the Barańskie Mountains, and less frequently, from chocolate and striped flints (Table 1). Production of burins at the site is also confirmed by an occurrence of burin spalls (4 specimens found).

Less numerous endscrapers (Fig. 3: 4; 5: 2, 5, 6), represented by 16 specimens, constituted 20% of all tools. The great majority of them were made on slender blades, the width of which, in most cases, did not exceed 3.5 cm. Their fronts were low and poorly distinguished. Endscrapers were made exclusively of local variants of flint, outnumbered by flint from the Barańskie Mountains (10 items; 62.5% of all endscrapers).

Six artefacts were counted into the category of perforators (Fig. 6: 2, 3), constituting merely 8.7% of all tools. In general, they were made on shortened blades. Only one specimen

was made on a larger flake. One perforator revealed an alternating retouch, which brings it closer to a borer, in terms of typology (Fig. 4: 3; 6: 1).

There were 16 specimens (20%) of mining tools (items typical of workshops located near flint extraction areas). They were characterised by a considerable variability in terms of typology and a significant primitivism of forms (Ginter 1974, 32). Mining tools from the site in Kleszczowa were formed on massive waste products or fragments of cores, rarely on massive flakes. The great majority had a transversal edge shaped with abrupt or semi-abrupt retouch, forming a sort of simple side-scraper.

A significant proportion of the assemblage under analysis was constituted by waste products, of which 63 specimens were found (6.77% of the entire inventory). These resulted from fragmentation of artefacts due to post-depositional processes or human activity in the past and in the more recent past. Few of them (5 items) bore traces of intentional retouch. In this regard, there were identified distinctive fragments of intentional forms, which together with scarce chips were counted to the category named "other" (comp. Table 1).

Modern farming activity has undoubtedly contributed to a considerable destruction of the flint materials from this site. As mentioned above, most of the artefacts were obtained from the topsoil layer, which is reflected in the assemblage by an occurrence of pseudo-retouch, in some cases, undistinguishable from intentional retouch. Interestingly, there were detected hardly any waste products of chocolate flint (Table 1).

Use-wear analysis

Traceological analysis showed an extremely high degree of postdepositional damage, including different types of natural polish (particularly glossy) and natural retouch (contemporary as well). Detailed results of performed microscopic analysis with thorough characteristics of recorded use-wear (and other) traces are presented in the Table 2. The data contained there are merely generally summarised below.

Amongst 70 flint artefacts subjected to the use-wear analysis, 29 specimens bore traces supporting an assumption that they might have been used as tools (Table 2). Nevertheless, 17 of them (about 58%) were changed post-depositionally to such a degree or/and had been used so briefly that it was possible to classify them merely to groups named "used" or "probably used", without any more precise interpretation of their primary function. The remaining artefacts constituted a collection quite uniform in terms of their function, dominated by tools associated with hide processing and meat cutting, as well as tools for wood processing, represented by equal numbers of artefacts (7 specimens, *i.e.* 41% per each group). Moreover, there were identified two artefacts most likely connected with processing of herbal plants with high amounts of silica, so-called Si-accumulators (later called here "silicious plants"; *cf.* for example: Anderson-Gerfaud 1988; van Gijn 1989, 40; Anderson 1992; Juel Jensen 1994, 28). Another one could have been used for processing of soaked bone.

Table 2. Kleszczowa, site 9. Results of the traceological analysis of the selected flint artefacts. Explanations: Edge A – left edge, Edge B – right edge, Surface A – dorsal (upper) face of the debitage, Surface B – ventral (lower) face of the debitage, Surface C – side surface

No.	Morphological description	Use-wear	Function	Comments	Fig.
T1	Blade with distal part broken off	**Edge A:** *Retouch:* close/regular, on one side, single- and double-step, scars with mainly feather terminations; *Polish:* none **Edge B:** *Retouch:* practically none on most of the edge length (visible scars of post-depositional origins). By the fracture in the distal part, one can observe varied retouch on the dorsal face of the artefact. *Polish and striations:* in the central part of the edge generic weak polish and singular, oblique linear traces. In the distal part (by the fracture): polish on both sides of domed topography, smooth texture and medium degree of intrusion.	**Edge A:** probably used. **Edge B:** central part – used, possibly for planing of soft wood; distal part (fracture) – used, most likely for carving of wood.	On a bulb bright polish in the form of bright spots (Fig. 7: A), most likely traces of hafting.	2: 1
T2	Flake with retouch	**Surface A** (distal part of the artefact): *Retouch:* microburin scars and single-step retouch formed by scars with feather and hinge terminations; *Polish and striations:* very bright/ glossy, abrasive, of domed/flat topography and slightly rough texture. Linear traces: mainly filled in striations, oriented slightly obliquely to the line of the distal edge (Fig. 7: B, C). **Surface B**: *Polish:* abrasive, glossy, destroys completely flint's micro-relief, flat/corrugated topography, slightly rough texture, very invasive degree of intrusion. Linear traces associated with polish: linear depressions – wide, semicircular in cross-section, arched in longitudinal section, concentrating in groups (Fig. 7: D, E). Distal part: striations analogical to those visible on the Edge B, rougher polish texture. **Surface C:** peck-ness and scattered polish of invasive extent;	Used: distal part, most likely for processing (carving) of bone soaked in natural acids.	Polish on the Surface C – most likely of post-depositional origin.	2: 3
T3	Mesial part of a blade	**Surface A:** *Retouch*: individual scars with feather terminations. *Polish:* bright/glossy, linear, invasive degree of intrusion, covering upper parts of the micro-relief, flat and slightly pitted topography (from a wider perspective, slightly corrugated), smooth texture, oriented obliquely to the line of the working edge (Fig. 7: F, G). *Linear traces*: aligned obliquely, filled in, wide and narrow linear depressions and striations. **Surface B**: *Retouch*: formed by a few scars with feather terminations. *Polish and linear traces:* hardly legible polish, which rounds and abrades the upper parts of the micro-relief, flat topography and smooth texture (Fig. 7: H).	Probably used	Polish on the upper surface can be considered a post-depositional "abrasion", however, its correlation with the polish on the ventral face can indicate that the artefact in question could be a specific "planing" tool used for processing of material containing (probably) acids. An accurate interpretation of the possible function of this specimen undoubtedly requires further experimental studies.	2: 2
T4	Truncation piece made on a flake combined with a notched tool	**Edges A and B:** *Retouch:* on both sides, formed by scalar and half-moon scars, with various terminations, single- and double-step (a significant part of the retouch is of post-depositional origins). No other traces of use-wear destruction. **Truncation:** none	Probably used (due to traces of hafting)	In the lower part of the artefact, mainly on the dorsal face, remains of black, pitchy substance (glue?) most likely marking the extent of hafting. On a bulb bright polish of flat topography and rough texture (Fig. 7: I), most likely also connected with hafting (though, post-depositional origins cannot be excluded).	2: 4
T5	Blade with retouched edges/ truncation blade	**Edges A, B and truncation:** *Retouch:* close/irregular, on both sides, from single- to multi-step, formed by scars with various terminations. *Polish:* preserved in the zone of the Edge "A", various, in some parts strongly abrasive with flat or (eventually) domed topography and slightly rough texture (Fig. 7: J). In other parts, of definitely more "hide-like" characteristics, with cratered/domed topography. Cutting edge: rounded (Fig. 7: K).	Probably used, the "marginal" extent of polished areas hinders a reliable interpretation of their genesis.	Remains of black substance (tar?), side edges crushed, with post-depositional retouch, lots of destruction traces of very "fresh" characteristics.	2: 5

Table 2.

No.	Morphological description	Use-wear	Function	Comments	Fig.
T7	Mesial part of a blade with retouch	**Edge A:** *Retouch:* singular scars on both sides of the edge (wide/irregular retouch), formed by scars with mainly feather terminations; *Polish:* discontinuous, thin line along the edge, marginal to medium degree of intrusion, glossy, flat topography, smooth texture (dorsal face: Fig. 7: L; ventral face: Fig. 7: M, N). **Edge B:** *Retouch:* close/irregular, mainly on the ventral face, a great majority of scars of a very "fresh" nature;	**Edge A:** cutting of silicious plants, most likely grasses, wet reed, etc. (not cereals)	Initial traces. Retouch on the Edge B – uncertain origins (hafting? post-depositional?)	3: 2
T8	Blade with proximal part broken off	*Retouch:* individual scars with feather terminations. **Surface A:** *Polish:* very invasive, semicircular shape of the polished area, linear, flat topography, rough texture, associated with linear traces: filled in and black striations oriented perpendicularly to the line of the working edge (Fig. 7: O; 8: A-C). **Surface B**: *Polish:* an individual bright spot, with a polish of flat topography and slightly rough texture, associated with linear traces (black, and filled-in striations), oriented only slightly obliquely to the line of the working edge (Fig. 8: D). It does not correspond with traces observed on the dorsal face. Moreover, on this side, one can observe gentle, metallic polish that slightly rounds the upper parts of the micro-relief. It has a smooth texture and undetermined topography. There are no linear traces. (Fig. 8: E)	Used + post-depositional alterations?	Polish on the dorsal face in some parts resembles "hide-like" or polish typical of the contact side of the so-called polish type 23. Nevertheless, in other parts, it looks like a result of covering the artefact with some substance (Fig. 8: C), so its origins cannot be determined without more precise analysis.	3: 3
T9	Initial endscraper	**Surface A:** *Retouch:* multi-step, on the dorsal face, formed by scars with step and hinge terminations. *Polish:* generic weak, practically illegible;	Probably used, a scraper for processing hard materials?		3: 4
T10	Blade with proximal part broken off	**Edge A:** *Retouch:* close/irregular, on both sides, single-step, formed by scars with feather terminations; *Polish:* thin line along the edge, bright, cratered topography, smooth texture. Cutting edge rounded. **Edge B:** *Retouch:* on one side (on the dorsal surface), single-step, formed by scars with feather terminations. In the part marked with double dots in Fig. 3: 5, oblique with hinge terminations (fresh). *Polish:* none	Edge A: probably used (maybe for cutting of meat);	Retouch on the Edge B is most likely of post-depositional origins	3: 5
T11	Proximal part of a flake	**Edge A:** *Retouch:* on the fracture, apart from intentional retouch, there is a visible single-step use retouch formed by scars with step and hinge terminations. There are also microburin scars. *Polish:* none	Probably used (maybe burin used for a short period of time)	By the butt, on the dorsal face, bright polish of post-depositional origins.	3: 6
T12	Mesial part of a bladelet	*Retouch:* clearly visible microburin scar (possibly intentional) on the surface of the fracture and single-step retouch formed by scars with feather terminations. *Polish:* linear, orientation slightly oblique, domed topography (covers the upper parts of the micro-relief), invasive degree of intrusion, smooth texture (Fig. 8: F, G)	Carving of wood		3: 8
T13	Burin on a break	**Edge A:** *Retouch:* multi-step, formed by scars with hinge terminations. Visible peck-ness. *Working edge and polish:* The working edge slightly rounded. From the dorsal face visible bright polish of domed topography, slightly rough texture and marginal degree of intrusion.	Carving of wood	On the cutting edge, in some parts, there were observed zones with completely abraded micro-relief, which could indicate the processing of more abrasive materials. Nevertheless, these traces are most likely of post-depositional origins.	3: 7

No.	Morphological description	Use-wear	Function	Comments	Fig.
T14	Proximal part of a blade-flake	**Edge A:** *Retouch:* on both sides, close/irregular, formed by tiny scars with feather terminations; *Polish:* on both sides (but mainly, from the ventral face) one can observe a pale polish of slightly rough texture and cratered/slightly pitted topography (Fig. 8: H). *Working edge:* slightly rounded.	Cutting of meat (alternatively, soft hide)	Pitted topography and slightly rough texture of the polish indicate that the processed material could have been contaminated with some abrasive substance, which makes the interpretation of hide processing more probable.	4: 1
T15	Fragment of a flake	**Edge B:** *Working edge:* rounded; *Retouch:* mainly on the ventral face, close/irregular, single-step, formed by scars with feather terminations; *Polish:* scattered, smooth texture, cratered topography turning into domed, in some parts even flat/slightly pitted; invasive degree of intrusion, visible as a line along the edge. Polish associated with linear traces: singular filled-in striations, parallel to the tool edge orientation (Fig. 8: I, J).	Cutting of hide		4: 2
T16	Flake	**Edge A:** *Retouch:* single- and double-step, on one side, formed by scars with step and hinge terminations, visible delicate peck-ness; *Polish:* thin, discontinuous line along the edge, marginal to medium degree of intrusion, bright, domed topography, slightly rough texture. Polish, visible only on the dorsal face, covers mainly the upper parts of the micro-relief.	Probably used		4: 5
T17	Proximal part of a massive blade	**Edge A:** Retouch and polish like on the Edge B, outside of the zone marked "red" in the Figure 4: 4. **Edge B:** *Retouch:* In the zone marked „red", visible retouch on one side, multi-step, oblique, formed by scars mainly with step and hinge terminations. In the remaining part tiny retouch, on both sides, close/irregular, formed by scars with feather terminations; *Polish and striations:* in the middle part, on the ventral face, surface polish, bright, obliquely linear, of invasive degree of intrusion, domed topography and smooth texture. It is accompanied by linear traces in a form of oblique, filled-in striations (Fig. 8: K). In the part of the edge that is not covered with oblique retouch, from the side of the fracture, there is a blurred, pale polish "melting" the working edge. It has cratered topography and smooth texture (Fig. 8: L). Its degree of intrusion is marginal and it is legible as a thin, discontinued line along the edge.	The zone marked „red" of the Edge B was most likely used for planing of wood. It was a secondary activity in relation to meat cutting, which was performed with the tool earlier. Most probably, the Edge A also served for cutting meat.		4: 4
T18	Flake with retouch	**Edge B:** *Retouch:* indistinguishable from the intentional one; peck-ness, intentional retouch made with a hard hammer; *Polish:* none **Tip of the flake:** *Polish:* linear, cratered topography, parallel to the line of the side edge of the flake, smooth texture, medium and invasive degree of intrusion (Fig. 8: M). Cutting edge is rounded in this part.	Edge B: unused or used for a short time; Distal part: most likely used for cutting of hide	Distal part: use-wear traces preserved partially due to the breaking of the edge	4: 6
T19	Flake	**Edge A:** *Retouch:* none; *Polish:* thin line along the edge, marginal and medium degree of intrusion, bright, "melting" the line of the cutting edge, visible only from the ventral face. On the dorsal face, legible abrasive destruction resembling grinding. **Edge B:** *Retouch:* none; *Polish:* On the dorsal face legible "bright spots" of the bright/glossy polish of invasive degree of intrusion, flat topography and smooth texture (Fig. 8: N). On the lower face there is a polish of completely different characteristics: invasive, in a form of a band along the edge, gently linear (perpendicular/oblique), of domed/flat topography and smooth texture (Fig. 8: O).	Probably used. Edge A could have been used for cutting soft material, possibly meat.	In various parts of the artefact there is a visible very bright polish of post-depositional origins. The tool could have been used, which is supported mainly by the characteristics of the polish observed on the ventral face of the specimen. Significant alterations having modified the surface of the specimen due to post-depositional processes hinder any reliable interpretation of its function.	4: 7

Table 2.

No.	Morphological description	Use-wear	Function	Comments	Fig.
T20	Retouched blade	On all of the edges of the artefact (except for the fracture edge) there is a legible multi-step retouch formed by scars with various terminations, which is not accompanied by any polish.	Probably used, maybe as a scraping tool for processing of hard materials		5: 1
T21	Endscraper	**Endscraper front:** *Retouch:* indistinguishable from the intentional one. *Polish:* visible on a few protruding points, where the working edge is gently rounded. Polish of smooth texture, domed topography and marginal degree of intrusion.	Used (used for a very short time, possibly rejuvenated; most likely used for scraping soft wood).	Endscraper front was secondarily retouched with a hard hammer, possibly for rejuvenation. Its right side is covered with multi-stage peck-ness of post-depositional origins.	5: 2
T22	Endscraper	**Endscraper front:** *Working edge:* strongly rounded; *Retouch:* indistinguishable from the intentional one, due to rounding of the working edge practically illegible; *Polish:* band along the edge, quite bright, cratered topography, slightly rough texture, degree of intrusion – up to invasive. Polish is associated with linear traces – short, irregular striations, oriented perpendicularly (Fig. 9: A). **Edge B:** *Retouch:* wide/irregular, on both sides, single-step, formed by scars mainly with feather terminations; *Polish and striations:* thin, discontinuous line, basically points, marginal degree of intrusion, merely by the endscraper front there is a band of medium extent. Polish bright, of domed topography and smooth texture.	Endscraper front: scraping of soft (greasy) hide	Edge B: traces of post-depositional origins (though, it cannot be excluded whether this edge was also used, to a small extent, for planing of wood)	5: 5
T23	Retouched blade	**Edge A:** *Retouch:* close/irregular, on both sides, single-step, formed by various types of scars with various terminations; *Polish:* atypical/initial, on both sides, thin, discontinuous line along the working edge (which is slightly rounded), degree of intrusion – mainly marginal to medium; topography and texture illegible.	Probably used	There are no use-wear traces on the Edge B, retouch was most likely performed to make the opposite side blunt, for more convenient hafting or better handling.	5: 3
T25	Endscraper	**Endscraper front:** *Retouch:* indistinguishable from the intentional one; *Polish and striations:* thin line along the edge, degree of intrusion up to medium, domed topography, smooth texture, linear (Fig. 9: B). **Edge A:** *Retouch:* on both sides, though mainly on the ventral face, practically single-step, close/irregular (tiny scars with feather terminations), merely in some parts disrupted by scars of different characteristics; *Polish:* visible as a thin line along the edge, which is rounded, bright, mainly marginal degree of intrusion, cratered topography, slightly rough texture. The polish is associated with linear traces – oriented parallel to the line of the working edge singular black striations of various characteristics (Fig. 9: C, D). **Edge B:** *Retouch:* close/irregular, singular scars with various terminations, oriented mainly towards the dorsal face; *Polish and striations:* dispersed, the working edge in some parts is gently rounded, mainly individual points, atypical.	Endscraper front: planing of wood Edge A: sawing of wood; Edge B: used for cutting of soft materials		5: 6

No.	Morphological description	Use-wear	Function	Comments	Fig.
T26	Borer/perforator	**Edge A:** *Retouch:* close/irregular, on both sides, singular scars with various terminations; *Polish:* singular points, cratered topography, smooth texture, linear (parallel to the line of the working edge); associated with linear traces: thin and shallow, black striations perpendicular to the line of the working edge. **Edge B:** *Retouch:* on one side, multi-step, formed by scars with hinge and step terminations, close/irregular; *Polish:* thin line along the edge on the very tip of the sting, bright, linear, domed topography, smooth texture.	Edge A: cutting of soft hide (used also for scraping of this raw material); Edge B: carving of wood	In the proximal part there are visible hafting traces of "hide-like" characteristics (rounding of side edges and negative ridges, as well as "hide" polish - Fig. 9: E). By some "protruding" points much brighter polish can be observed, most likely having emerged as a result of contact with the bone (?) part of the handle (Fig. 9: F).	6: 1
T27	Perforator/fragment of a backed bladelet	**Edge A:** *Retouch:* indistinguishable from the intentional and post-depositional one; *Polish:* thin, discontinuous line along the edge, on both sides, cratered topography, smooth texture. In some places "bright spots" of abrasive characteristics. **Edge B:** *Polish:* gentle "melting" of the cutting edge; filling up the micro-relief; cratered topography and smooth texture.	Edge A: hafting traces Edge B: cutting of meat (?)	There are visible "bright spots" of post-depositional origins. The artefact is broken and it cannot be excluded whether it was actually a fragment of an arrowhead.	6: 2
T28	Blade with truncation	**Edge A:** *Retouch:* in the retouched part - indistinguishable from the intentional one; in the remaining part of the edge: close/irregular, on both sides, basically single-step, formed by scars with various terminations; *Polish:* in the retouched part there is no legible use polish. In the central part of the edge, spots of polish can be observed on both faces. This polish has a marginal degree of intrusion, cratered topography and smooth texture. The cutting edge is gently rounded here.	Probably used, possible contact with soft material of organic origins	Patinated artefact and covered with retouch of post-depositional origins.	6: 3
T29	Lacan burin	*Retouch:* there is no retouch that can be univocally considered utilitarian. However, the presence of multi-step retouch (directed on one face) should be stressed, formed by scars with step terminations, on the tip of the truncation (at the base of burin spall scars); *Polish:* there is no use polish on the burin spall scar. There is also no polish next to the burin spalls from the ventral face of the „sting" of the specimen. Merely on its very tip (from the ventral face) there is a legible slight rounding of the edge and polish of domed/cratered topography and smooth texture (Fig. 9: G). A more developed polish of invasive degree of intrusion was observed at the base of the burin spall scar. It is bright, linear, of domed topography and smooth texture. Also, it is associated with singular linear traces (Fig. 9: I) in a form of narrow and short, black striations oriented slightly obliquely (similar to the polish linearity) to the line of the side edge of the tool (Fig. 9: H). This polish covered probably a wider area, but it was partially "removed" by the burin blow. It can be suggested that it is connected with the primary function of the tool. An identical polish was observed on the other surface of the edge, on the specimen's dorsal face (Fig. 9: J). The cutting edge in this zone is additionally significantly rounded.	Used, processing of plants	By the fracture, on one side of the artefact (Fig. 9: K) and on the ridges between scars (Fig. 9: L) one can observe a polish of "hide-like" characteristics. Additionally, a bright/glossy abrasive polish associated with oblique striations was observed on one of the ridges. It overlaps the rounding and "hide-like polish" (Fig. 9: M). Along the main ridge, there is a line of glossy polish of flat topography and smooth texture, bearing traces of having been etched with plant acids (Fig. 9: N, O).	6: 4
T31	Truncation burin	**Surface C:** *Retouch:* on the burin spall scar – tiny, single-step retouch on one side, scars with feather terminations; *Polish:* initial/atypical;	Probably used (carving of wood?)		6: 5
T32	Blade	In some, better preserved parts, on one of the side edges there is a visible gentle rounding and a polish with marginal extent, undetermined topography and rather smooth texture.	Probably used	The artefact is strongly destructed by a post-depositional process (strongly developed, invasive retouch and peckness).	6: 6

DISCUSSION

Results of multi-aspect analysis of flint assemblage obtained from the site Kleszczowa 9 allow linking it with the Magdalenian Culture. The general technological and morphological characteristics of cores and blade blanks (*cf.* Sudoł-Procyk 2021) under scrutiny correspond well with similar artefacts discovered at other Magdalenian sites in Poland, particularly with regard to the method of obtaining blades with *en éperon* butts, *e.g.* in Wilczyce (Schild 2014), Hłomcza (Łanczont *et al.* 2002), Klementowice (Wiśniewski 2015), Stare Baraki (Wiśniewski 2020). Moreover, the structure of the toolset and the stylistics of tools reveal a close resemblance to other Magdalenian sites in Poland, in particular, in the context of the discovery of a Lacan burin (Fig. 6: 4), considered a distinctive form for the Magdalenian Culture (Brézillon 1968, 179, 180; Połtowicz-Bobak 2013, 269).

The assemblage presented in this paper displays additional traits typical of workshop sites. This concerns the regular utilisation of core processing waste products for the production of simple, *ad hoc* tools. Moreover, the workshop nature of the site under scrutiny is manifested by the dominance of blanks in the assemblage, which has already been underlined in the related literature (Sudoł-Procyk 2020, 300). A noticeable high percentage of retouched flakes and blades within the inventory in question was also recorded at other Magdalenian sites of similar characteristics, among others, in Klementowice (Wiśniewski 2015, 56) or Sowin (Wiśniewski *et al.* 2012, 403).

In the surroundings of the site in Kleszczowa, there occur numerous outcrops of various siliceous rocks (Baranowski and Sudoł-Procyk 2023). The site itself lies directly over the outcrops of various types of Jurassic flints, such as flint from the Barańskie Mountains, however, within a distance not exceeding 3 km from the site there are located outcrops of local striped flint, flint from the Udorka Valley, flint from Wierbka or chocolate flint (Krajcarz *et al.* 2012). The flint from the Udorka Valley was the raw material of the greatest extent and most easily available. Nevertheless, at the site in Kleszczowa, there were no fine blades or tools made of this raw material recorded, most likely due to its low utilitarian quality. Instead, the most preferably utilised materials are represented by three variants, namely predominant flint from the Barańskie Mountains (part of the outcrops of which occur within the extent of the site itself), followed by chocolate and striped flints, with outcrops situated within a distance up to 3 km from the site. This tendency is well visible in both the general raw material structure of the assemblage, as well as within particular typological groups, including tools. More than 85% of all tools were made from the three aforementioned types of raw materials, i.e., Barańskie Mountains flint, striped flint and chocolate flint. In the group of tools, no significant preference of any of these types was observed. The only exception may be found in the group of cores, dominated by chocolate flint, significantly outnumbering specimens made of flint from the Barańskie Mountains and striped flint. Interestingly, outcrops of chocolate flint are located within the greatest distance from the site. Therefore, it can be assumed that this particular raw material was

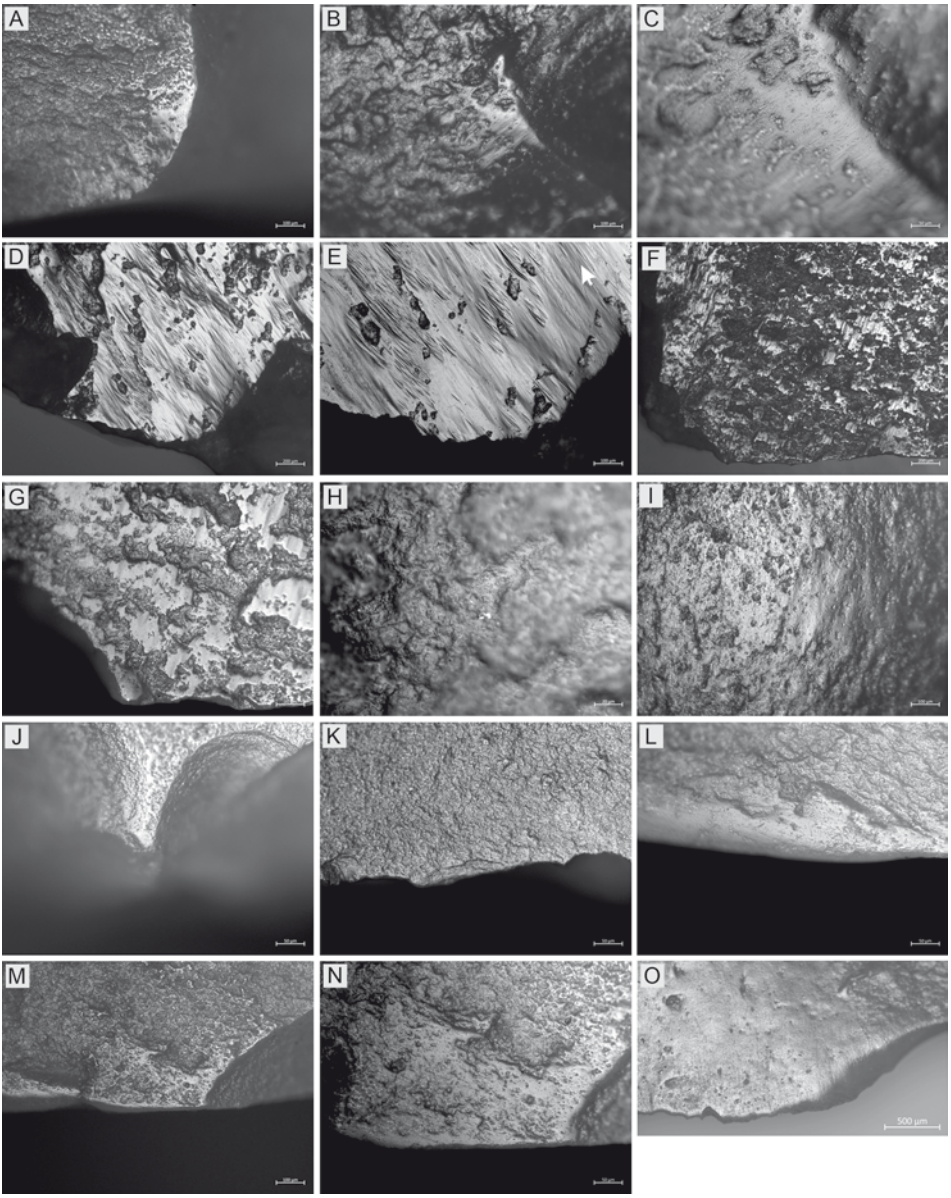


Fig. 7. Micro-photographs of use traces on flint products (photo G. Osipowicz)

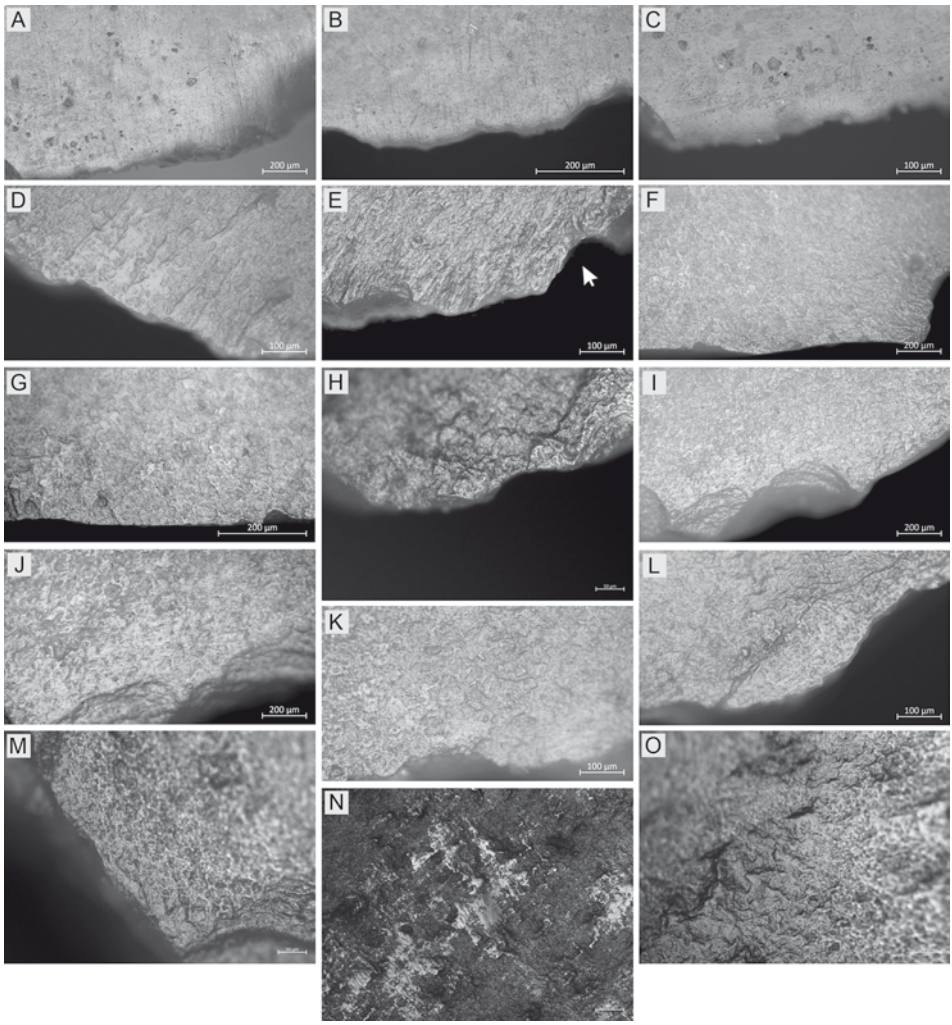


Fig. 8. Micro-photographs of use traces on flint products (photo G. Osipowicz)

exceptionally appreciated, which is additionally confirmed by the smallest number of waste products of chocolate flint.

The flint materials from the site Kleszczowa 9 are a perfect example of a collection, the state of preservation of which seems to be very good in macroscopic assessment, though under microscopic analysis it reveals post-depositional damage to such a degree that it hinders conducting any reliable functional studies for the great majority of artefacts. The most problematic are not only various types of pseudo-retouch, being the most common type of post-depositional damage observed on the edges of prehistoric flint artefacts. A far

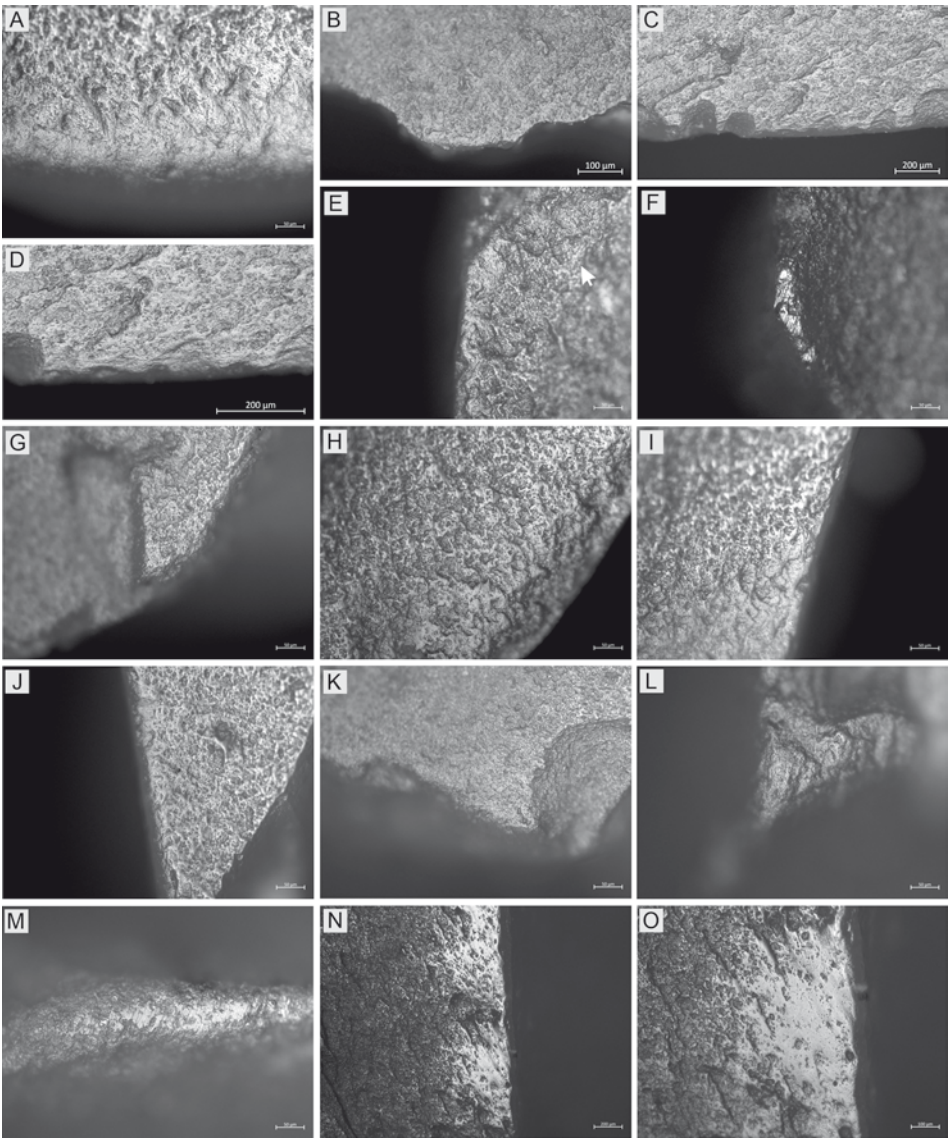


Fig. 9. Micro-photographs of use traces on flint products (photo G. Osipowicz)

more troublesome obstacle in such studies is natural polish, usually changing completely the structure of micro-relief of flint materials over large surfaces and therefore, totally removing use-wear traces if there were any. Importantly, in many cases these polishes reveal characteristics resembling those of use-wear traces and can be very uniform over larger surfaces or radically changeable along one edge of the artefact (*cf*. Table 2, for example

artefacts T5 – Fig. 2: 5 and T19 – Fig: 4: 7). In this context, an exceptional case is represented by glossy polishes of flat or corrugated topography, of which there is a high variability observed on the materials from Kleszczowa. Some of their identified types display a unique structure (*e.g.*, Fig. 7: D, E) and understanding their genesis should be undoubtedly a goal of independent interdisciplinary studies. Investigations of this kind would be surely very helpful for an accurate and univocal interpretation of traces with characteristics like those identified on the artefact T3 (*cf.*, Table 2, Fig. 2: 2), which to a certain degree resemble destruction traces visible on a few types of the so-called *curved knives* (Osipowicz 2019). Such studies could also be important for the explanation of the genesis of extremely interesting traces observed on the artefact T8 (*cf.*, Table 2, Fig. 3: 3). The "hide-like" characteristics of the abraded zone visible on the dorsal face of this specimen (Fig. 8: A, B), with clear striations oriented perpendicularly to the line of the working edge and rounding of the tool end, in the context of the "silicious" characteristics of the *bright spot* recorded on the ventral face, could provide the grounds for interpreting these traces as a variant of the so-called polish type 23. A difficulty in this case is an inconsistent pattern of striations within the *bright spot* and its individuality, which supports an assumption that it emerged as a result of post-depositional processes. The other type of polish visible on the ventral face of the artefact (Fig. 8: E) is non-specific, though different from the one recorded on the dorsal face. This could be an argument for placing the described artefact "functionally close", at least, to the group of tools associated with the Type 23 polish (van Gijn 1989, 85; 2010, 105). However, an intriguing issue is an exceptionally invasive extent of the abraded zone of "hide-like" nature on the dorsal face (about 1 cm; see Fig. 7: O), and its characteristics at particular spots (see Fig. 8: C), which indicates an occurrence of some sort of a substance on the surface of micro-relief of flint within the abraded zone, changing partly, if not completely, its properties. This hinders any univocal determination of the genesis of the traces observed on the artefact in question, before commencing more thorough multi-aspect studies on the described "modification" (or other similar alterations recorded on artefacts from Kleszczowa).

Due to the post-depositional destruction of artefacts, traceological studies on the assemblage from Kleszczowa provided only a few data in relation to what could have been obtained if their state of preservation had been better. Nevertheless, it confirmed the pre-Neolithic chronology of the collection, since in the group of tools identified as being for silicious plant processing, there were no sickle inserts for cutting of cultivated cereals. The investigations also revealed the great significance of wood, hide and meat processing in the activity of the society occupying the Kleszczowa site.

Undoubtedly, the most interesting specimen subjected to analysis was a Lacan burin (Fig. 6: 4). This tool was surely mounted in a hafting made of hide and possibly bone. Interpretation of its function is troublesome. The retouched zone and the scar of the burin blow did not display any traces of utilisation, whereas the edge by the burin blow scar was most likely used for processing soft wood, possibly even lignified stems of silicious plants,

in a manner resembling carving/cutting. Such an interpretation, however, does not explain the reasons for performing the burin blow. Maybe, this was an unsuccessful treatment, namely it was supposed to rejuvenate the worn-out cutting edge of the tool, but it was made slightly aside of the intended spot. Noteworthy are also traces visible on the tip of the artefact, on its ventral face. Characteristics of the polish observed there may indicate processing (cutting? carving?) of dried and hard hide. Nevertheless, the low invasiveness of the recorded traces does not provide much support for such an interpretation. Along the main ridge of the artefact, there is a line of glossy polish of flat topography and smooth texture, revealing traits of having been etched by plant acids (Fig. 9: N, O). The genesis of this polish is uncertain, although it is surely not of post-depositional origins. It might have emerged as a result of close contact of this part of the tool with fluids coming from the material being processed or results from a specific manner of hafting of the artefact (such as using a cord/material made of fresh silicious plants).

There have been discussions about the typological and functional interpretation of tools of the Lacan burin type since the middle of the 20th century (Cheynier and Bouyssonie 1955) and are caused by a sequence of treatments that is unusual when compared with other burins (Połtowicz-Bobak 2013, 239). This type of burin is shaped by a concave, strongly oblique retouch, following the burin blow, and forming a sort of a tip, one side of which is sometimes reduced by a secondary retouch (Demars and Laurent 1989, 74). Thus, the Lacan burin was produced using a specific method, where the retouch (concave truncation) followed the burin blow (Tixier 1978, after Stefański 2013). Thorough, in-depth analysis of use-wear traces visible on this tool will undoubtedly contribute greatly to the discussion concerning its application at the end of the Pleistocene.

SUMMARY

The site in Kleszczowa is an example of one of few Magdalenian workshops known from the territory of Poland (Połtowicz-Bobak 2013, 155). A summary structure of artefacts (Table 1) univocally indicates that the most numerous group was represented by flakes and blades, constituting over 75% of all the recovered flint materials. This percentage would even grow if technical forms were also included (nearly 11%). The occurrence of technical forms confirms the special preparation of cores at the site, which means that we are dealing with a workshop site where the raw material was being processed, mainly aimed at the production of fine, long blades, employing a common and distinctive method of preparing the spot for the blow, namely forming an *en éperon* butt (Pyżewicz 2022, 67). Another trait of the site in question in the occurrence of numerous retouched blanks, which corresponds well with assemblages gathered from other Magdalenian workshop sites in Poland, such as the Zalasie Cave or Sowin (Bocheński *et al.* 1985; Połtowicz-Bobak 2013, 368, 377, 378). At the site Kleszczowa 9 the percentage of tools was also relatively

high (9%). The high percentage of blanks and tools, including utilised tools, which was confirmed by the results of use-wear analysis, can be explained by the possible existence of various functional zones within the site boundaries, enclosing flint workshops and utilitarian zones where everyday activities were performed. This conclusion is also confirmed by an occurrence of concentrations of artefacts within, at least, two regions of the site, recorded during both field surveys and trial excavations (Sudoł-Procyk 2021).

The Magdalenian societies consciously made a selection of high-quality raw materials. Despite the common availability of flint from the Udorka Valley, it was not used on a greater scale since it did not provide flint knappers with the opportunity to produce fine blades and flakes. Instead, more preferably used raw material sources were local outcrops of flint from the Barańskie Mountains, chocolate and striped flints, which in total constituted 84% of the entire assemblage. However, due to excluding specimens revealing convergent morphological traits, patinated and burnt, from raw material classification an assumption can be made that the contributon of the above-mentioned three variants of flint could have amounted to over 90%.

The investigations carried out in Kleszczowa have proven how important the region of the Kraków-Częstochowa Upland was to Magdalenian societies. This is the region where the largest archaeological sites of workshop type have been encountered, such as Brzoskwinia (Sobczyk 1993; Krygiel-Kozłowska 2010), Wołowice (Sobczyk 1992), and finally, Kleszczowa 9 described in this paper. This phenomenon is connected with the occurrence of numerous outcrops of flint, and the location of flint workshops in the area of these outcrops reflect the strategies of raw material management, distributed to other regions. The best example is chocolate flint, which was distributed from Poland over the territories of Western and Southern Europe (Přichystal 2018). In this context, the region of the Barańskie Mountains and the Udorka Valley could have affected the development of the Magdalenian communication routes and distribution of siliceous materials (Sudoł-Procyk *et al.* 2021a; Sudoł-Procyk 2021).

The Magdalenian settlement in its eastern zone, including the territory of Poland, was associated with short-term, seasonal periods of occupation by hunting societies, also engaged in the exploitation of siliceous and mineral materials, which corresponds well with the results of studies presented in this article (Połtowicz-Bobak 2013; 2016). The results of research on the described site have provided new data on Late Paleolithic human activity in the central part of the Upland. It seems that the location of the Kleszczowa 9 site is directly related to the raw material management of very good quality flints. The Udorka Valley region undoubtedly played a certain role on the communication routes of Magdalenian communities. We observe such stops of Magdalenian groups, for example, in the form of short-term cave camps, documented in the central and southern Kraków-Częstochowa Upland (*e.g.*, Sudoł-Procyk 2020).

Investigations on the function of tools made of siliceous rocks coming from those sites refer to individual assemblages and their tradition is much younger when compared with

Western Europe. Nevertheless, they have proven that flint tools were used for activities connected with hunting and processing of animal carcasses, as well as work connected with the processing of mineral materials, and extraction and processing of wood and herbaceous plants (Pyżewicz 2022, 67). The results of the analysis performed for the assemblage from the Kleszczowa 9 site can successfully be related to the current state of knowledge regarding the use of tools by Magdalenian societies, and they undoubtedly extend our knowledge of behaviour of humans at the decline of the Pleistocene in the territories of the Kraków-Częstochowa Upland.

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BIOGRAPHIES OF SWIDERIAN BLADES – VARIOUS EXAMPLES FROM THE POLISH TERRITORY

ABSTRACT

Pyżewicz K., Przeździecki M., Grużdź W., Kozak B., Płaza D. K. and Sobko B. Biographies of Swiderian blades – various examples from the Polish territory. *Sprawozdania Archeologiczn*e 76/1, 187-204.

The article discusses the use of unretouched blades by Swiderian societies. To answer the question regarding the function of the artefacts, we analysed macroscopically and microscopically selected blades from five sites: Kołomań, Kielce district, Świętokrzyskie voivodship, Sulejówek Site 4, Mińsk district, Mazowieckie voivodship, Kochlew Site 1, Krzeczów Site 2 and Troniny Site 5, Wieluń district, Łódzkie voivodship. Based on the results, it can be concluded that the unretouched blades, although fulfilling the conditions of being tools, were not used in everyday activities. We can presume that the unretouched blades were usually treated among the Swiderian societies as a waste product, or an element of exchanges or stock.

Keywords: Swiderian, blades, use-wear analysis, lithic technology
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INTRODUCTION

Functional studies of lithic materials from Swiderian sites are primarily associated with analysis of distinctive types of retouched tools, the so-called formal tools. They concern groups of tanged points, willow-leaf points, end-scrapers, and burins. Unfortunately, the issue of blades devoid of intentional retouching is rarely addressed (*cf.* Pianowski 1977; Winiarska-Kabacińska 1988; 1990; 1992; 1993; 2002; 2005; 2009; 2010; 2014; 2016; Osipowicz 2010; 2019; Nowak and Osipowicz 2012; Osipowicz and Weckwerth 2016; Pyżewicz *et al.* 2017; Osipowicz *et al.* 2018; Sobkowiak-Tabaka *et al.* 2018; Bielińska-Majewska 2019, 133-134; Pyżewicz 2019; 2022; Sobkowiak-Tabaka and Kufel-Diakowska 2019).

In this article, we would like to discuss the use of blades that have not been transformed into formal tools. We would like to know whether the blades whose morphology indicates utility potential, *i.e.*, their slenderness, relatively regular course of lateral edges, significant size, and length, were realistically used or should be treated as non-tool forms.

To answer the question of the potential use of blades, we undertook an analysis of lithic materials from selected sites associated with the Swiderian culture: Kołomań, Kielce district, Świętokrzyskie voivodship, Sulejówek Site 4, Mińsk district, Mazowieckie voivodship, Kochlew Site 1, Krzeczów Site 2 and Troniny Site 5, Wieluń district, Łódzkie voivodship. We compared the obtained results of the analyses with data presented in the literature.

MATERIALS AND METHODS

The blades in the collections studied here are from five Swiderian sites in central-southern and southwestern Poland (Fig. 1). To answer the question posed above, the collections were divided into two empirical categories:

a. Reference assemblages, *i.e.*, where all the blades preserved in full or almost in full recorded at the sites were analysed, although burned specimens and those >25 mm in length were excluded from the study. Reference assemblages, on the one hand, are supposed to allow us to identify forms bearing traces of use by investigating whole lithic assemblage. On the other hand, they should allow us to study used forms in a broader context of morphological parameters or technological attribution in relation to forms without traces of use and retouched (formal) tools.

b. Comparative assemblages are those where only a sample of blades with potential utility values was analysed. They were treated as a comparative basis for the results obtained during the analysis of reference assemblages. This allowed us, on the one hand, to define the criteria for such a selection method and, on the other hand, to confront its effectiveness with the results of use-wear analysis.



Fig. 1. Map of the sites presented in the article. Data source: GUGIK. Author W. Grużdź

Blades from the sites of Kołomań, Kielce district, Świętokrzyskie voivodeship, located in Góry Świętkorzyskie (Kondracki 2002, 273) and Sulejówek 4, Minsk district, Mazowieckie voivodeship, which is located on the southwestern edge of Równina Wołomińska, were taken as reference collections (Kondracki 2002, 188, 193-196; Solon *et al.* 2018; Korpak 2020). The Kołomań site was excavated in 2014-2015 (Kozak 2014), the site at Sulejówek was investigated in 2019 (Przeździecki 2021). In both cases, these are sites that have been completely excavated during systematic archaeological excavations. In addition, similar methods – exploration, documentation, were used during the excavations, considering the perspective of use-wear analysis. The similarities between the assemblages also relate to the state of preservation of the artefacts (a small number of patinated or thermally transformed specimens), raw material (chocolate flint), abundance (about 600 artefacts) and typological structure. The last aspect is mainly expressed in the dominance of debitage products. In addition to the forms associated with the core reduction process, in both inventories, were also recorded a similar set of tools, which included end-scrapers, burins and retouched blades. In addition, seven Swiderian points occurred at the Sulejówek site.

Another important aspect due to which we decided to choose these inventories for the study is their relative homogeneity. On the one hand, this is confirmed by the spatial distribution of the artefacts – in the form of isolated, relatively compact clusters, and on the other, by the consistent raw material, typological and technological structure of the analysed materials. Especially important are the similarities in technology – debitage methods and

techniques. We noticed the distinctive set of knapping products, *i.e.*, specific categories of blades, bladelets, flakes (Dziewanowski 2012a; 2012b) and macro- and micromorphological details (Klimek 2006; Przeździecki 2006; Grużdź *et al.* 2012; Płaza 2012a; 2012b). It should be noted that in the case of the Kołomań site, an argument directly confirming the connection between artefacts is also the high frequency of refittings.

The cultural-chronological classification of the lithic inventories was based on typological and technological criteria. In case of typological aspect, the presence of a distinctive three-element tool set – including end-scrapers, burins, but most importantly Swiderian tanged points and willow-leaf points – was crucial (Taute 1968, 12; Kozłowski 1999). For the rest of the types of retouched and unretouched forms, we focused on analysis of morphological attributes, which are crucial for identifying cultural-chronological traditions.

The most important features are:

a. double-platform cores with traces of intense preparation of the back, sides, and striking platforms.

b. predetermined blades, *i.e.*, slender, with negatives of bidirectional treatment, with a leaf-like outline, straight profile and wedge-shaped longitudinal cross-section with a specific shaping located about halfway along its length.

c. predetermining/corrected blades (Dziewanowski 2006; 2012a; 2012b; Migal 2007), including the most distinctive bladelets with a trapezoidal outline, *i.e.*, extending towards the distal part, with a characteristic preserved fragment of the negative related to the detachment from the opposite striking platform.

d. fine, linear or punctiform butts with traces of trimming and abrasion.

The blade types mentioned in points “b” and “c” reflect the two components of the “stadial knapping” according to Bradley and Giria (1996, 23-26) or “predetermined debitage” according to Inizan *et al.* (1999, 61). Based on analyses of the Late Palaeolithic materials and experimental research, the application of this debitage method is confirmed for the Swiderian culture (Migal 2007; Dziewanowski 2006; 2012a; 2012b).

It should be noted that in the case of the analysed materials, classifying specific specimens as predetermined blades or as predetermining blades was not always possible. It is also worth noting that the above division does not mean the automatic uselessness of predetermining forms, which cannot be treated as products. In many cases, their morphometric parameters successfully allowed them to be used as tools. This is confirmed, among other things, by the results of morphological analysis of blades from the site Rydno IV/57 (Fiedorczuk 1992; 1995).

The comparative assemblages are represented by a selected sample of blades from three Late Palaeolithic sites located in the region of Zakole Załęczańskie of the Warta valley: Kochlew Site 1, Krzeczów Site 2 and Troniny Site 5, Wieluń district, Łódzkie voivodship. These sites were comprehensively and methodically investigate during excavations conducted by Krzysztof Cyrek in the 1970s and 1980s (Cyrek 1983, 1996; Cyrkowie M. i K. 1987). As a result of excavations, numerous and representative Swiderian assemblages,

mainly the remains of lithic workshops, were retrieved. The presence of formal tools indicates that other activities, related to the daily functioning of the camp, were also carried out in these sites. The concentration of the Late Palaeolithic sites in Zakole Załęczańskie is due to the presence of Jurassic flint outcrops in this area. Artefacts made of this raw material dominate in the analysed inventories, only single forms made of Cretaceous flint were noticed. The blades selected for our study came from isolated concentrations, distinguished by Krzysztof Cyrek (1996). In addition to spatial distinctiveness, consistent typological, technological, and functional structure (cores and debitage products), their homogeneous nature is confirmed by the refittings.

As in the case of reference assemblages, the taxonomic classification of comparative assemblages was based on typological and techno-morphological considerations. Also, attention was paid to specific sets of tools, *i.e.*, burins, end-scrapers, retouched blades, but the presence of points with retouched base on ventral side – Swiderian tanged points and willow-leaf points – was considered a crucial argument. Similarities also applied to the macro- and micromorphological attributes defined above in the context of the reference sites.

Our lithic studies were conducted at the macroscopic (first stage) and microscopic (second stage) level. As part of the first stage, the selected blades were analysed to note the modifications visible to the naked eye in the form of small negatives and micro scars occurring along the edges. In addition, a morphometric and technological analyses of the studied artefacts were performed. The second stage of the study were microscopic analyses, which were carried out using a standard methodology. Before analysis, the materials were washed, including primarily wiped with acetone. The research was conducted using a Keyence VHX-7000 series digital microscope and using magnifications from ×20 to ×300. Attention was focused on the identification of retouches, abrasion, rounding, linear traces and polishes. The interpretation of the microscopic traces was made with reference to experimental base composed of lithic forms with technological, use-wear and postdepositional traces (the collection is located at the Faculty of Archaeology, University of Warsaw).

RESULTS

The Swiderian inventory from the Sulejówek site consists of 590 specimens. They are all made of chocolate flint, the nearest outcrops of which are located more than 100 kilometres south of the site. The dominant categories are debitage products and cores, although the percentage of retouched tools is relatively high – about 5%, moreover, they represent a wide set of types including tools of daily use (end-scrapers, burins, truncated blades, perforators), as well as elements of hunting weapons (Swiderian points). There are 209 blades from the Sulejówek site, but only 83 specimens met the criteria established in the study (without severe thermal transformations, length >25 mm) – 21 complete forms, 23 proximal fragments, 24 mesial fragments and 15 distal fragments.

The Swiderian inventory from Kołomań consists of 594 specimens. They are all made of chocolate flint, deposits of which are known within a radius of several kilometres to the north and east of the site. Only one retouched form was recorded at the site. The remaining artefacts are debitage products and cores, which clearly allows us to interpret this assemblage as the remains of a flint workshop. From this inventory, 56 blades were analysed, including 24 preserved in their entirety, 18 proximal fragments, six mesial fragments and eight distal fragments.

Besides the raw material, among the important common characteristics of the blades from the reference sites, we should include their regularity and large size. The first attribute is expressed in a symmetrically convergent course of lateral edges, an orderly parallel arrangement of negatives, pronounced slenderness, a trapezoidal cross-section, and a gentle feathering of the tip. In case of the size of the blades from the "reference assemblages", we can conclude that their average length is 55 mm – for blades from Kołomań, and 52 mm – for blades from Sulejówek (only whole pieces were measured).

In the case of comparative assemblages, we are dealing with sites very rich in lithic artefacts. Most of them are made of a local variety of Jurassic flint, there is also a small number of forms made of erratic Cretaceous flint and hornstone. Outcrops of Jurassic flint *in situ* or redeposited sediments are located from several hundred meters to several kilometres from the sites. The dominance in the described inventories of debitage and cores indicates that we are dealing with the remnants of a flint workshop. A total of 32 blades were selected from the comparative assemblages: from Kochlewo, five complete forms and one mesial fragment; from Krzeczów, eight complete forms, three proximal fragments; from Troniny, 12 complete forms, three distal fragments. In selecting them, apart from the metric criterion, attention was paid to their regularity, and the presence of macroscopic traces (microretouches, micro scars) that may indicate their use. It is noteworthy that the blades from the comparative assemblages are less regular and smaller than the forms from the reference assemblages. They are mainly distinguished by a lower degree of standardization, less symmetrical lateral edges, more stocky proportions. The sampled blades from the "comparative assemblages" (Krzeczów, Kochlew and Troniny) have average length of 50 mm.

The linking element between blades from reference and comparative assemblages is the technological aspect, mainly expressed in:

a. concept of double platform core treatment – it is associated with a detachment of blades characterized by straight profile, wedge-shaped cross-section;

b. a stadial knapping method – the occurrence of predetermined and predetermining blades;

c. the direct percussion technique with a soft stone hammer, using rotation "parallel" to the plane of the striking platform – linear or punctiform butts, small, not well pronounced bulbs (sometimes with a lip).

Macroscopic analysis

Based on macroscopic observations, two categories of modifications/traces on the blades were identified. Most often, only one category of traces was recorded on an individual specimen, although a few blades characterized by the co-occurrence of modifications/traces of both types were also noted. For the purposes of further stages of the analysis, these modifications/traces were defined as:

1. Potential intentional, functional, or postdepositional retouches (Fig. 2; 3). These retouches are continuous (linear), semi-steep, composed of small, morphometrically similar negatives, covering a small section of the edge (a maximum of several millimetres in length).

2. Potential functional or postdepositional traces – edge chipping, micro scars (Fig. 4). They usually cover the entire length or most of the edge. Sometimes they are accompanied by extremely fine (though visible to the naked eye), negatives of quasi-retouch. Unlike the retouches described above, they are not continuous, linear. Most often they occur singly or in small clusters randomly scattered along the edges. In addition, they are characterized by far greater morphological diversity.

Blades belonging to the first category occurred at the sites: Kochlew – one specimen, Krzeczów – one specimen, and Sulejówek – 12 specimens. Based on the criteria mentioned earlier, they should be described as regular, symmetrical, large, or very large, mostly slender (index >4). Most often, the retouching was located only on one edge (nine specimens), in the proximal part, about 0.5 cm below the butt, covering a section from 6 mm to 12 mm (Figs. 2; 3). In only one case did the length of the retouched fragment reach 21 mm (Fig. 2: 3, 4). Interestingly, this type of traces was recorded slightly more often on the left edge (five specimens.). Only two blades with retouching in the proximal part had additional retouching on the other edge or in another part. A separate subcategory consists of four artefacts with retouching in the mesial part (Fig. 2: 1, 2). Unfortunately, only one of them was preserved in its entirety, which makes it possible to determine the actual length of the retouched section, which was 11 mm. Modifications/traces of the second category, *i.e.*, edge chipping and/or quasi-retouch, were noted on five blades with potential intentional, functional or postdepositional retouching. They occurred on one or two edges, usually covering all or most of their length (Fig. 2: 3; 3: 3, 5).

Blades representing the second category of traces occurred only at the Kochlew, Krzeczów, Troniny and Sulejówek sites. The most pronounced modifications, *i.e.*, chipped edges and quasi-retouch negatives were recorded on three artefacts from Sulejówek (Fig. 4). In one case, they were found on both edges, while in the other two cases, they were found on one edge. Blades from sites in Zakole Załęczańske have traces less intense, making it much more difficult to determine which are forms with and without edge modifications. This meant that distinguishing the group of blades with modifications/traces (second category)

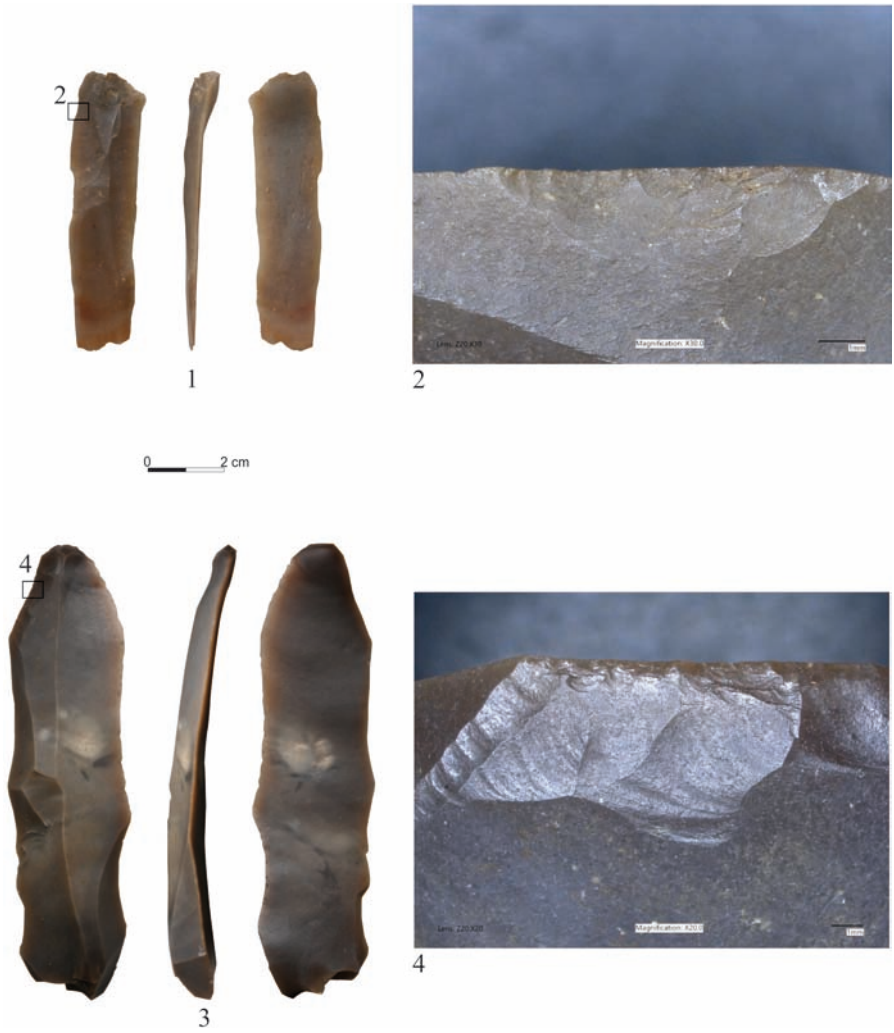


Fig. 2. Sulejówek Site 4.
1-2 – blade with potential intentional, functional, or postdepositional retouches located in the proximal and mesial parts; 3-4 – blade with potential intentional, functional, or postdepositional retouches located only on one edge in the proximal part and with additional traces of edge chipping and/or quasi-retouch.
Photos by K. Pyżewicz, W. Grużdź

was much more subjective than in the case of the materials from Sulejówek or Kołomań. Considering the mentioned limitations, modifications belonging to the second category were registered on: four specimens from Krzeczów, three specimens from Kochlewo, and five specimens from Troniny.

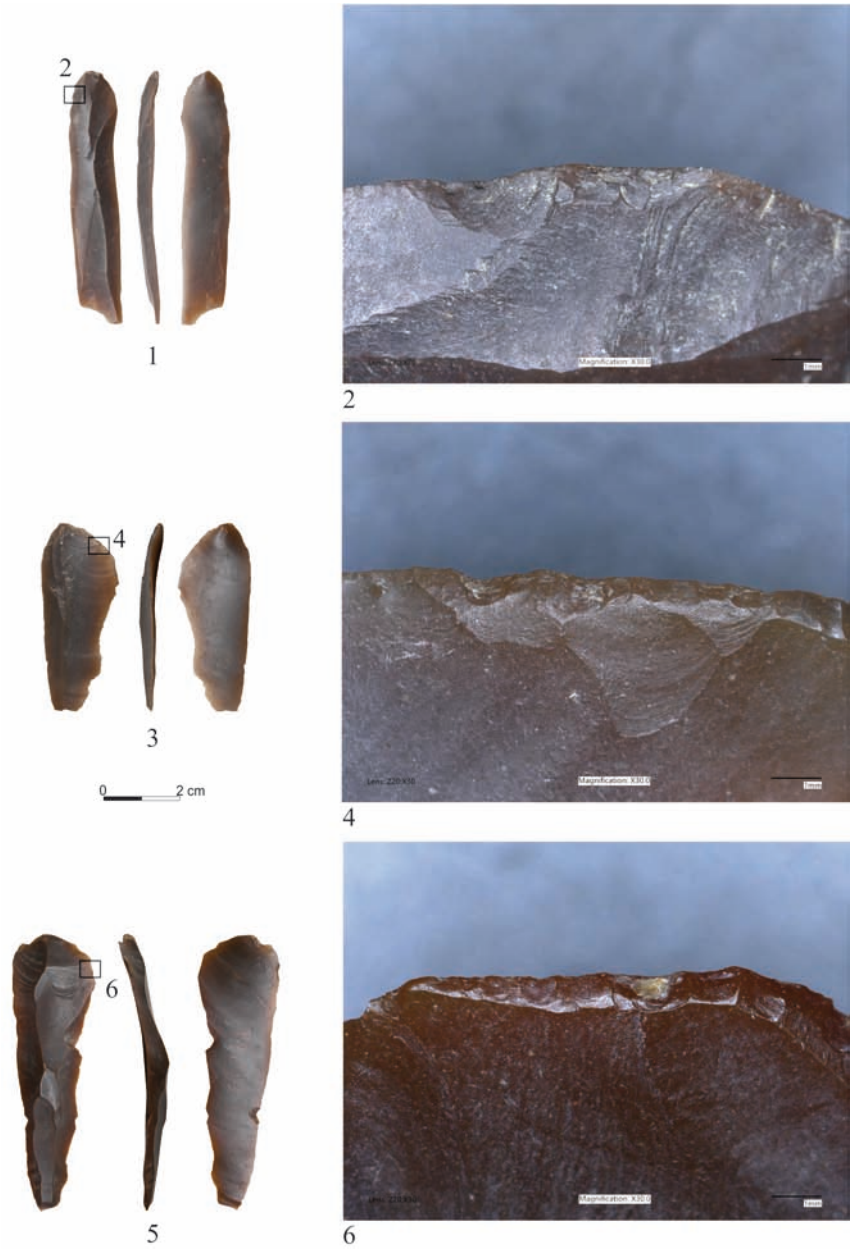


Fig. 3. Sulejówek Site 4.
1-2 – blade with potential intentional, functional, or postdepositional retouches; 3-6 – blades with potential intentional, functional, or postdepositional retouches and with additional traces of edge chipping and/or quasi-retouch. Note that all of them have retouch on one edge in the proximal part.
Photos by K. Pyżewicz, W. Gruździ

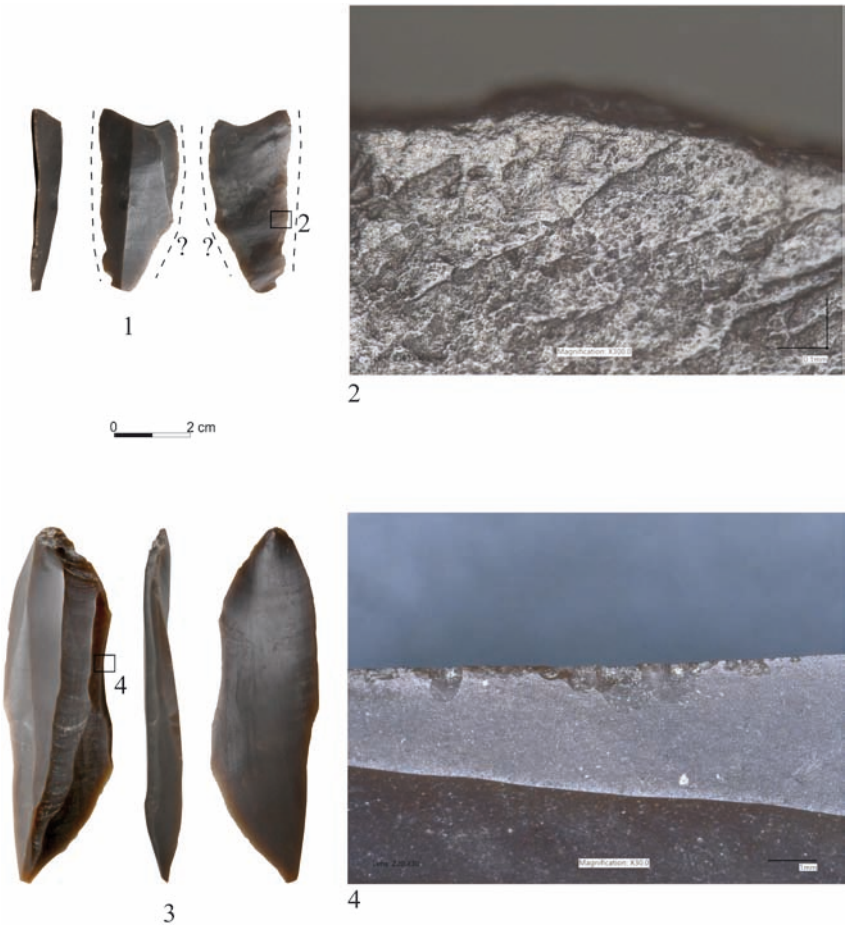


Fig. 4. Sulejówek Site 4.
1, 3-4 – blades with potential functional or postdepositional traces – edge chipping, micro scars/quasi-retouch; 2 – use-wear traces related to the processing of skins. Photos by K. Pyżewicz, W. Gruźdź

Microscopic analysis

Based on the microscopically analysed group of blades from the sites at: Kołomań (47 specimens), Sulejówek (49 specimens), Kochlew 1 (six specimens), Troniny 5 (20 specimens), Krzeczów 2 (12 specimens), it can be concluded that in most cases these specimens were not used (the difference in the number of blades selected to macroscopic and microscopic analysis is due to the exclusion of a number of blades from microscopic analysis due to their state of preservation). It should be noted that in the analysed group of blades, there are forms that did not change due to significant postdepositional modifications.

Artefacts are not covered by patina, or they are covered with a light shiny patina of a spotty nature, which does not significantly affect the possibility of identifying usable traces. Additionally, as pointed above, these specimens morphologically and metrically may have been functional tools used in everyday activities. The retouching and chipping identified at the macroscopic level, should be considered to have occurred incidentally or because of the activity of postdepositional factors. They are not accompanied by any additional microscopic traces – rounded edges, abrasions, linear traces, or polishes that could indicate a utilitarian character.

Only two specimens from the analysed group of blades from the Sulejówek site, are characterized by use-wear traces. The first is a fragment of a massive blade (Fig. 4: 1). The retouch extends along one of its edges, and at the microscopic level, there are polished areas, linear traces and rounding of the working part (Fig. 4: 2). The polished areas are placed near the working edge, are "greasy", dull, and penetrating the microstructure of the specimen. Based on this, it can be concluded that the blade was used in the processing of skins. The preserved linear traces, which are arranged parallel to the working edge, suggest that cutting movements were made. The second blade, also massive, is characterized by non-distinctive utilitarian polishing and micro scars. Therefore, it was not possible to identify its function.

DISCUSSION

Based on the results of the analysis presented above, regarding the selected blades from sites from Zakole Załęczańskie and Kołomań lying on the edge of Góry Świętokrzyskie, there are no identified blades used by Swiderian societies. Only two of the blades from Sulejówek near Warszawa bear signs of use.

To some extent, these data correspond to information obtained from microscopic analyses of blades from other Swiderian sites. Approaches to the use of unretouched blades vary from region to region, including distance from raw material deposits. Based on studies of a selected group of blades from the Rydno IV/57 site, from the workshop next to the "cache" and "hut", specimens from the mounds and from the so-called home area, it was concluded that they were not used in daily activities (Fiedorczuk 2006, 141). Also, the selected group of blades (44 specimens) from the Kraków-Bieżanów site (Pyżewicz *et al.* 2017, 2019) was not characterized by signs of use. The same observation is associated with the analysis of a group of debitage products from the Suchodółka site (Grużdź *et al.* 2012). Single blades, sometimes with additional intentional retouching, from sites such as Wojnowo "a" and 2, Cichmiana, Całowanie, Kraków-Kurdwanów, Lubrza and Sandomierz, were used for processing animal carcasses, as well as scraping and cutting wood and sometimes antler, and cutting plants (Winiarska-Kabacińska 1992; 2002; 2005; 2009; 2014; 2016; Sobkowiak-Tabaka and Kufel-Diakowska 2019; Płaza and Pyżewicz 2023). Among the

exceptional ones are the results of use-wear analyses of blades from the sites at Brzoza (Kotlina Toruńska) and Stare Marzy (on the border of Bory Tucholskie and Kotlina Grudziądzka) (Osipowicz 2010, 122 and others, Table 82; 2019). In both cases, almost entire inventories were analysed (artefacts corresponding in parameters to potential tools and in a suitable state of preservation were analysed). Based on the results of use-wear analysis, the author of the study concluded that at least 60% of the total group of identified used tools were unretouched forms, mainly blades, but sometimes also flakes. These specimens were used primarily for cutting meat, as wood chisels, sometimes also as piercers (such as for skin), skin scrapers, antler or bone scrapers and chisels, wood scrapers or burins, or individually for other activities.

We should consider what the reasons are for not using so many blades that morphometrically correspond to analogous specimens that can be used in everyday activities. We can investigate that based, among other things, on data from the literature or experimental results (more Pyżewicz 2022).

Some researchers interpret the unused Swiderian blades as "stock" or "take-away" items, "exported" blades, semi-products of tanged points (see among others Ginter 1974; Cyrkowie M. i K. 1987; Szymczak 1992, 113; Fiedorczuk 1995; 2006; Cyrek 1996; Sulgostowska 2005; Pyżewicz 2022, 110-127). In this concept, the distinctive morphology of the blades is emphasized – these are blades that were selected by the Late Palaeolithic producers. They are usually larger and thicker, made more precisely compared to other blades. They are referred to as selected blades (Fiedorczuk 2006). It should be noted that the results of the conducted morphometric analysis of the blades indicate that the forms used in our study correspond to the definition of selected blades described by Jan Fiedorczuk (according to this definition, the group included both predetermined and predetermining forms).

Also, in case of describing the issue of "preferential" blades, the issues of selection and choice of blades with appropriate parameters are emphasized (among others, by Dziewanowski 2006; Migal 2007; Pyżewicz 2022, 110-127). In this concept, which was first formulated by Witold Migal, the goal of the Swiderian flintknappers was to obtain a blade of the right size and shape. Such a blade could be used to make a potential point, the tip ending with feathered termination would not require further shaping by retouching, since the distal part of the blank is sharp. In contrast, all other blanks produced during core treatment, even those with favourable parameters for use, could be treated as waste products. Witold Migal, presenting the concept of the phenomenon of preference, referred to the refittings of Swiderian materials, especially to Rydno IV/57 blocks refitted by Jan Fiedorczuk (see, among others, 1992; 2006). He pointed to a numerous group of blades contained in the refittings that were without any signs of use. It is possible that the blades that we analysed were also treated as waste products, due to same reasons.

Based on the data presented above, it can be concluded that the Late Palaeolithic producers selected blades intended for further use. This process was also related to the

availability of good quality raw material, access to sources of material, to outcrops. At the sites interpreted as flint workshops, where numerous traces of the processing of raw material, whose deposits are in proximity, are found large numbers of unused blades (see, for example, Ginter 1974; Schild 1984; Fiedorczuk 1997; Schild *et al.* 2011). Most likely, the flintknappers wanted to produce blanks with certain parameters, and because of easy access to the raw material base, they did not care about the number of waste products. They were able to make selections of blanks from the considerable number of specimens they acquired. The presence of retouched blades in these types of sites may be related to the activity of postdepositional processes leading to the formation of pseudo-tools. This reason was already pointed out by Jan Fiedorczuk (1995), who paid special attention during his studies to the issue of retouched blades identified in flint workshops. He pointed out two important things: first, that the flint workshops were places not very convenient for carrying out other types of activities than those related to the knapping process, and second – the forms there are typologically uncharacteristic and do not have distinctive retouches.

In contrast, from the areas of the camps, located further away from the outcrops of the good quality flint (*i.e.*, from the areas where the presented sites are located, including Stare Marzy, Brzoza and Lubrza), blades, but also other unretouched intentionally collected debitage products, were used more often in daily activities.

It should be added that at sites where nodules of raw material were worked intensively and used tools are also recorded, such as Suchodółka, the toolkits come from production sequences not captured at the site from different raw material and were certainly transported from the previous settlement site. In contrast, the specific specimens formed at the site were carried away for further potential use – in daily activities or for exchange.

CONCLUSION

In the present article, we have attempted to answer the question of potential use of Swiderian blades, which are not formal tools. According to the results of our analyses, but also based on data from other studies (presented in the article), a significant number of blades were not used. Only a small number of specimens were intended for working with skin, animal carcasses, wood, bone or antler and plants. It can be concluded that blades, sometimes additionally retouched, were multifunctional tools. This represents a dissimilarity compared to formal tool groups – Swiderian points were usually used during the hunting strategies and activities undertaken during hunting, end-scrapers were associated with the processing of skins, and burins were used in work related to the processing of harder materials, that is, antler, bone, or wood.

Summarizing the results of the study, it should be considered that the lack of traces on the forms recognized as selected blades according to Fiedorczuk's definition (among others,

2006; *i.e.*, with morphometric parameters that allow use as a tool), indicates that we still do not fully understand which criteria were the basis of decisions made by people in the past about the utility or non-utility of specific forms. It is possible that the unused blades were a waste product, or a elements of exchanges or stock for the Swiderian societies.

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NEW DATA ON FOSSILS IN THE MESOLITHIC OF THE POLISH PLAIN

ABSTRACT

Płonka T., Diakowski M., Chłoń M. and Niedźwiedzki R. 2024. New data on fossils in the Mesolithic of the Polish Plain. *Sprawozdania Archeologiczne* 76/1, 205-219.

Two fossil shark teeth (B1 and B6/2014) were discovered in a cluster of flints excavated in 2014 on the Mesolithic site Wierzchowo 6, in Pomerania, NW Poland. Found a small distance apart, the surface of both teeth displays natural modifications. The apex of tooth B1/2014 was broken off after deposition, and on its surface were some marks of trampling and transport. On tooth B6/2014 marks clustered on three surfaces labelled G1-G3. The most apparent striations and irregular points seen on surface G1 are interpreted as trampling marks caused by low intensity action of the sand deposit. The occasional occurrence of fossil shark teeth in Quaternary sediments in Poland suggests the specimens from Wierzchowo were brought deliberately to the camp site by Mesolithic settlers. Fossilized shark teeth are recorded in Palaeolithic and Mesolithic sites in Europe and have been used for various practical and symbolic purposes by modern age foragers.

Keywords: fossil, shark teeth, Mesolithic, Maglemosian, trampling, sedimentary abrasion
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INTRODUCTION

Fossil use by humans is rarely documented on Mesolithic sites in the European Lowland Plain. Some have been encountered as a natural element of the sediments containing artefacts. Any fossil attributable to some form of human activity must attract attention and raise questions about its significance for the users and the community at large.

During the excavation in 2014, two fossil shark teeth were found in a flint concentration on the Mesolithic site Wierzchowo 6, in Pomerania, NW Poland. They were mentioned in an interim article on this site but they have never been studied meticulously up to now (Chłoń and Płonka 2016). The present article reports on the study of marks identified on the surface of these fossil teeth, and discusses their significance in light of other fossils found on Mesolithic sites in Europe.

MATERIALS AND METHODS

Site no. 6 at Wierzchowo lies in the western area of the Wałcz Plain (Fig. 1), a physico-geographical unit of the Western Pomerania Lakeland (Kozarski 1998; Solon *et al.* 2018). Two seasons of excavation have produced an assemblage of 8221 flints from 1989 (Trench

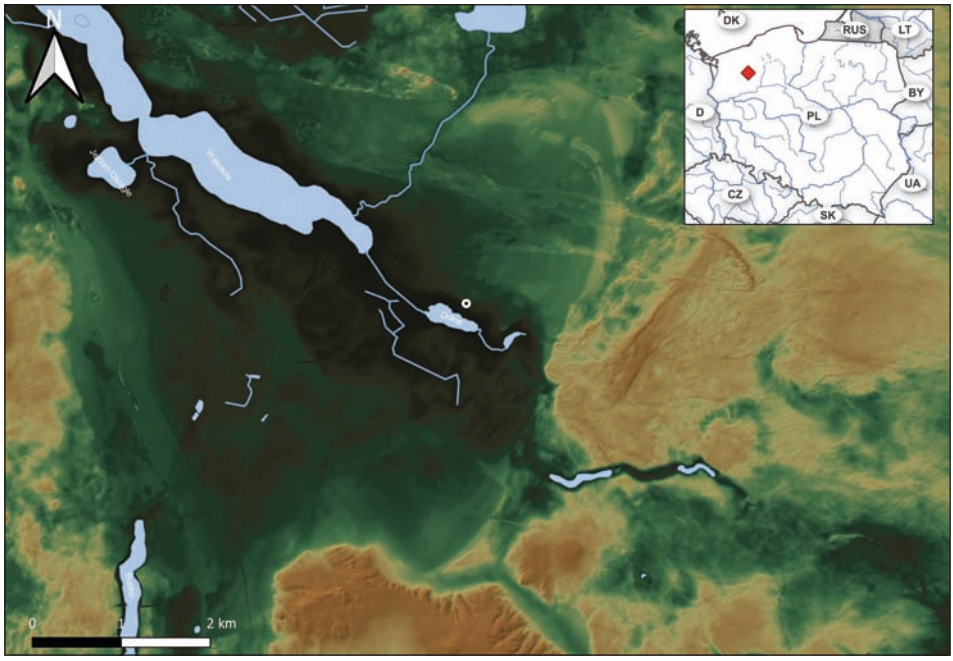


Fig. 1. Wierzchowo 6. The location of the site. Prepared by M. Chłoń

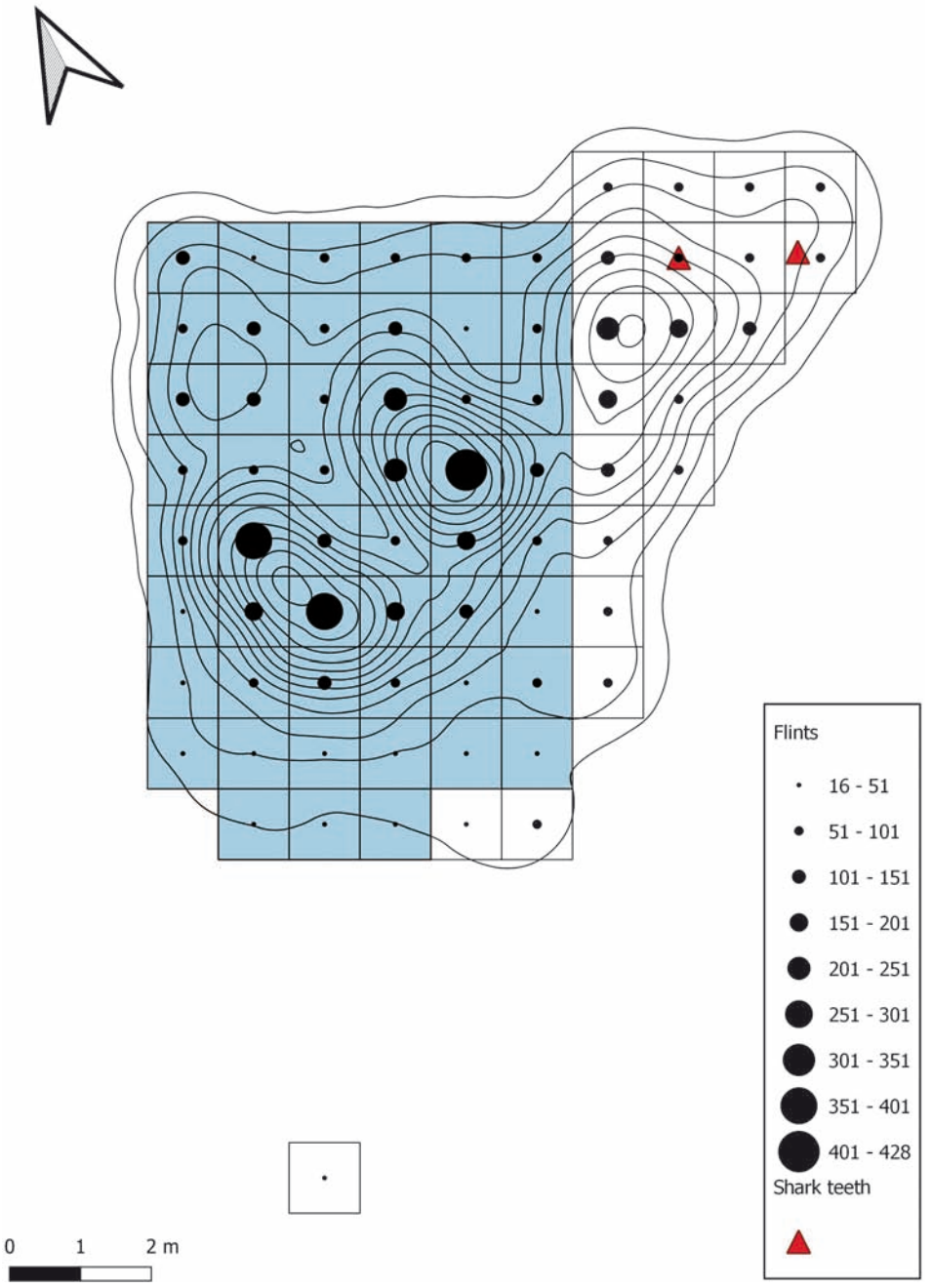


Fig. 2. Wierzchowo 6. The frequency of flint artefacts and the location of the two fossil shark teeth. Prepared by M. Chłoń



Fig. 3. Wierzchowo 6, tooth B1/14. *Lamniformes indet*. distal, lingual, labial and mesial view. Photo B. Miazga; computer processing by N. Lenkow



Fig. 4. Wierzchowo 6, tooth B6/14. *Lamniformes indet*. distal, lingual, labial and mesial view. Photo B. Miazga; computer processing by N. Lenkow

I/89; n = 6126) and 2014 (Trenches II/14, III/14; n = 2095) (Bagniewski 1991; Chłoń 2013; Chłoń and Płonka 2016). The Mesolithic finds were made of the local erratic flint. Both blade and flake cores were present (n = 73; 0.89%), but unidirectional blade cores were the predominant form. Retouched tools make up a minor percentage (n = 322; 3.92%). Most of them were macrolithic forms represented by tranchet adzes and picks, the second largest group of tools were geometric microliths. The artefacts and technology of knapping are characteristic of the Maglemose culture of the Boreal period (Brinch Petersen 1973; Bille Henriksen 1976; 1980; Bagniewski 1991)

After the excavation in 1989, the excavated compact scatter of flints (6 × 8 m) was originally identified as the remains of a Mesolithic dwelling (Bagniewski 1991). A more recent interpretation is that the site was revisited several times by a group, or groups of hunter-gatherers of the Maglemosian culture (Chłoń 2013; Chłoń and Płonka 2016). We distinguished three clusters – two with a larger number of artefacts (western and central

clusters) and a less apparent eastern cluster, investigated in 2014. The forms of the dwelling structures are unclear.

The teeth, recorded as B1/14 and B6/14, were discovered in grid units 8H and 8J (Fig. 2), within layer 2 composed of sand and gravel sediments underlying the modern topsoil. Tooth B1/14 from grid unit 8H (Fig. 3) was found during sieving, thus its location shown on the site drawing must be approximate. The second tooth (Fig. 4) came to light during excavation and has been precisely recorded in 3D. In effect, the two fossils could have been separated by 1.25-2.25 m.

Both teeth survived incomplete and are weathered and slightly eroded. Specimen B6/14 is a crown fragment and specimen B1/14 has a crown and part of the root. Both crowns are straight, narrow, slender and smooth with a slightly sigmoid profile in lateral view. The cutting edges are prominent without serration. Because of the poor state of preservation their species or genus could not be determined. We managed to classify them broadly as teeth of representatives of order *Lamniformes* (specimen B1/14 probably to family *Odontaspididae*) which were present from the Cretaceous to recent times (Cappetta 1987). However, the state of fossilization precludes them are of the Quaternary age. They were eroded from the sea rocks dated to the Upper Cretaceous – Paleogene, which are present under the Quaternary deposits of Pomerania (Stankowski 1996) or were brought from the north by Scandinavian glaciers in the Quaternary.

In our analysis of the shark teeth, we used the widely accepted procedures of observation of bone surface modifications where the key role is played by microscopy techniques (Behrensmeyer 1978; Binford 1981; Behrensmeyer *et al.* 1986; Olsen and Shipman 1988; Villa and Mahieu 1991; Fisher 1995; Domínguez Rodrigo *et al.* 2009; Fernández-Jalvo and Andrews 2016). The marks were documented in general using the portable digital microscope Nikon ShuttlePix P-400R, and in more detail, using the Hirox 3D digital microscope RH-2000 available in the Laboratory of Archaeometry and Archaeological Conservation University of Wrocław.

ANALYSIS

Tooth B1/14

Damaged during excavation, the tooth additionally has earlier damage on its apex and root, and on the labial surface between the break and the root (Fig. 3; 5: 1). Its length at present is 15.6 mm, its width and thickness at its crown are respectively, 6.6 mm and almost 3.6 mm. The surface of the tooth is light grey, shiny, covered by longitudinal cracking, and is stained rusty brown and dark brown by iron and manganese oxides. The cracking resembles bone weathering stage 1 of Behrensmeyer (1978). Generally speaking, the preservation of the tooth shows that after the animal's death, it rapidly passed into a layer where the environment favoured its survival and subsequent fossilization.

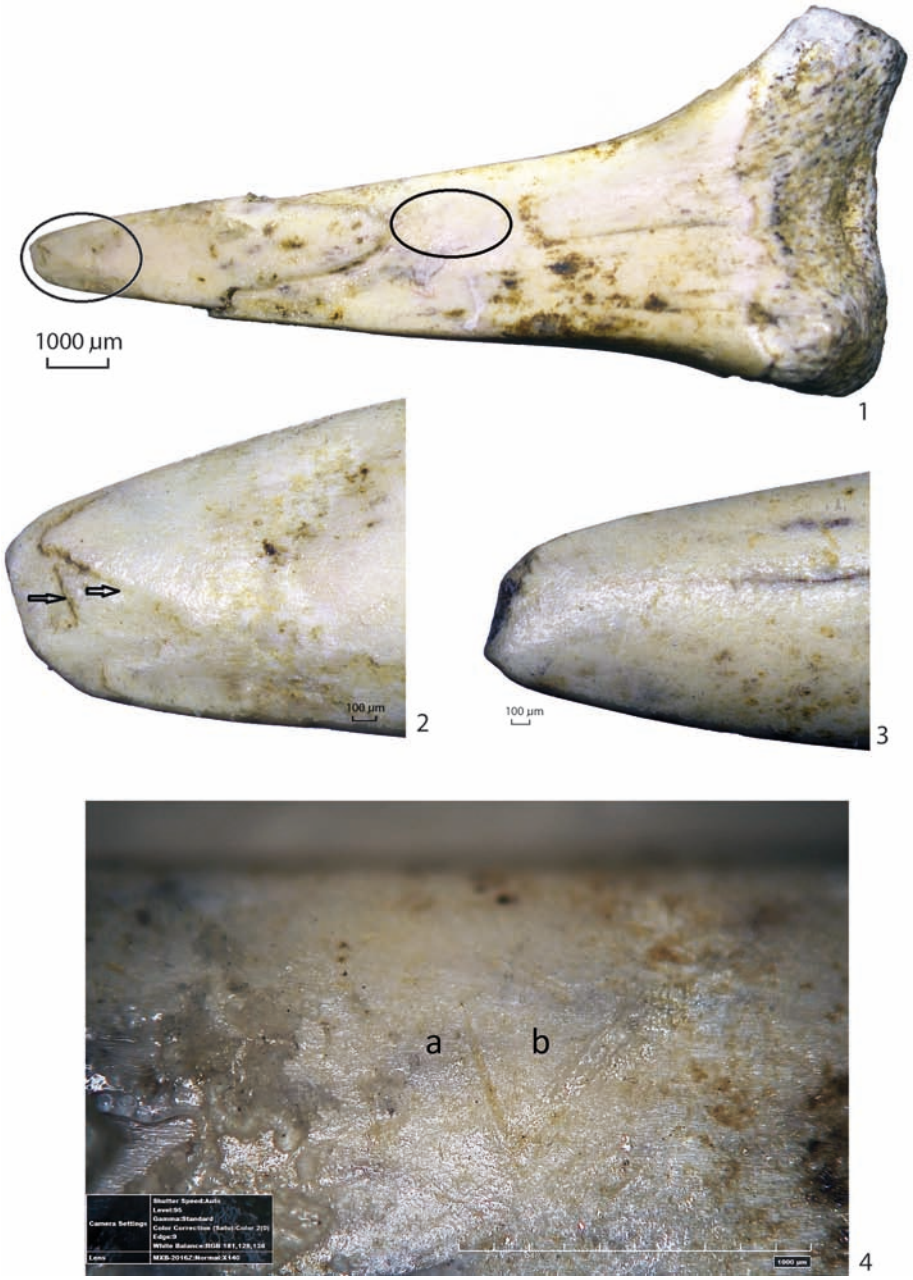


Fig. 5. Wierzchowo 6, tooth B1/14. 1 – general view showing magnified areas (Fig. 5: 2, 4) and exfoliation at the root; 2 – fracture of the apex, labial surface (arrows indicate the ridges); 3 – fracture of the apex, lingual surface; 4 – linear traces on labial surface (a – single linear mark; b – set of striations). Photo M. Diakowski; computer processing by N. Lenkow

The apex of the tooth is broken (Fig. 5: 2; 3). On the labial side, the fracture has a step-like form and consists of two ridges (Fig. 5: 2), and on the lingual side it has the form of a crack at right angles to the tooth axis (Fig. 5: 3). This form of damage suggests substantial force exerted parallel to the longer axis of the tooth, probably during a single episode, or possibly, two episodes. It is rather unlikely that this happened when the shark was still alive, and *e.g.*, was feeding, since shark teeth tend to fall out upon contact with hard elements in the shark's food (for example, a bone) and rarely break according to the line root – crown. The shark teeth are stuck in the soft tissue of the protective membrane, and are not lodged permanently within the jaw (Cappetta 1987). The fracture is more likely to have occurred when the tooth was being redeposited by glacial processes. It is probable because the state of preservation of the surface of the scar and the remaining surface of the tooth do not differ.

An exfoliation visible at the root of the tooth on its outer surface occurred when the tooth was entering the deposit (Fig. 5: 1), presumably at the same time as the longitudinal cracking before it was buried in the deposit and underwent fossilization.

The second area of damage is visible on the labial surface of the tooth in its central part – an individual linear mark and a group of several parallel striations (Fig. 5: 4a, b). Interestingly enough, the direction of the single linear mark and the striations is ifferent. All of them are shallow, with irregular edges, and do not resemble cutmarks (Olsen and Shipman 1988). The width of the single linear mark is nearly 30 μm, and the width of the striations is in the range of 6-20 μm.

Tooth B6/14

Its proximal and distal end broke at the time it was buried. The surviving length of this specimen is 10.8 mm, its width and thickness are respectively 5.3 mm and 3.5 mm. The surface of the tooth is light grey and shiny, stained dark brown and black by precipitated iron and manganese compounds. Also visible is longitudinal cracking, a larger number on the lingual surface tooth resembling bone weathering stage 1 of Behrensmeyer (1978). The

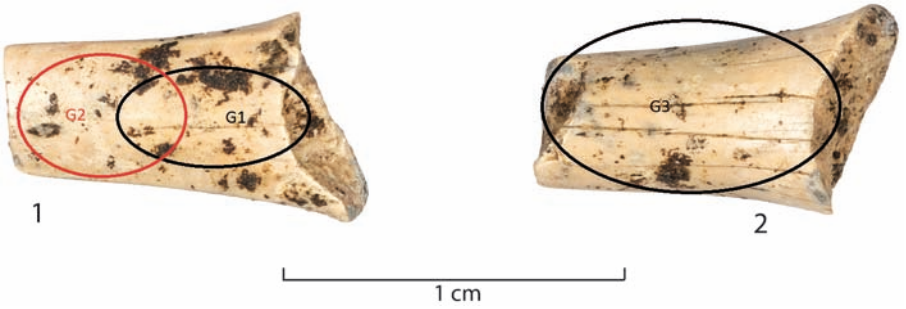


Fig. 6. Wierzchowo 6, tooth B6/14. 1 – areas with groups of marks – G1 and G2 – on labial surface; 2 – area with group of marks – G3 on lingual surface. Photo B. Miazga; computer processing by N. Lenkow

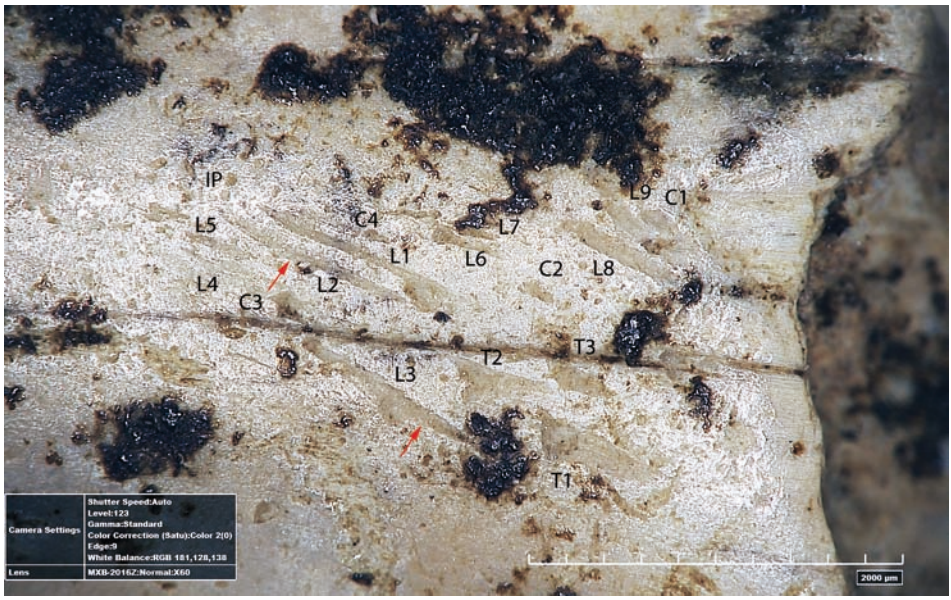


Fig. 7. Wierzchowo 6, tooth B6/14, area G1. Linear marks L1-L9, C1-C4, triangular marks T1-T3, and selected pit mark – IP. Arrows indicate cross-sections through marks L2 and L3. Photo M. Diakowski; computer processing by N. Lenkow

preservation of the tooth, except for its two fractured ends, is good and indicates deposition in a favourable environment. It could have broken when it was eroded from the Paleogene or Neogene layer by the ice sheet and transported south.

Striations and irregular points (IP) were identified in three areas (Fig. 6: 1, 2): i./ on the lingual surface, on the proximal end of the tooth (area G1); ii./ on the lingual surface, between G1 and the broken off apex (area G2); iii./ on the labial surface, near to the broken off end (area G3). The most wide-ranging set of marks was observed in area G1 (Fig. 7). It includes some approximately parallel striations with a length of 240-1200 μm, oblique to the longer axis of the tooth (L1-L9). The width of these striations is in the range of 20-100 μm, and is not uniform the entire length of a striation. Viewed at a higher magnification, the edges of these linear marks are not straight – they are wavy and resemble a winding path (Fig. 8: 1). Cross-sections have the form of a shallow bowl (Fig. 8: 2); the angle between the sides of the linear mark is strongly obtuse, the depth is small, in the range of 1.7–15 μm. Also found in area G1 are shorter striations with a length of 20–210 μm (C1-C4), which run in the same direction as marks L1-L9. By contrast, these short striations are relatively wide - 20–100 μm. The depth and wavy edges of these shorter linear marks are similar to those in marks L1-L9. The third type of mark is quite different from the longer and shorter striations L1-L9 and C1-C4 (Fig. 7). These are triangular marks (T1-T3), their starting point is narrow, and the maximum width is at their ending point. Their length

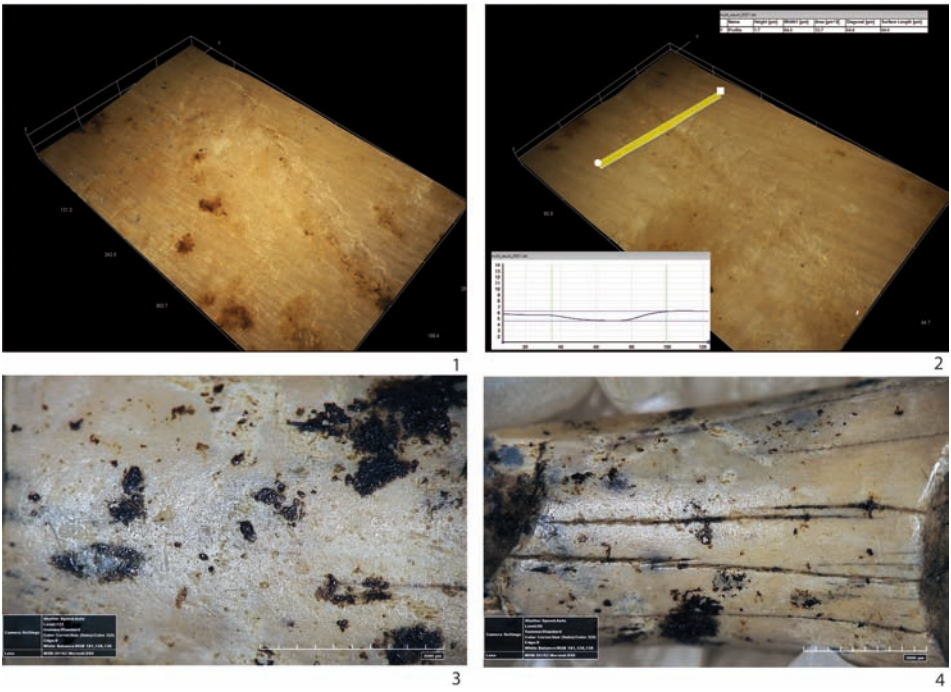


Fig. 8. Wierzchowo 6, tooth B6/14. 1 – edges of mark L2 in area G1; 2 – cross-section through mark L2; 3 – view of the group of marks in area G2; 4 – view of the group of marks in area G3. Photo M. Diakowski; computer processing by N. Lenkow. 1, 2 – original magnification 280×

ranged between 400 and 800 μm, and their maximum width between 160 and 260 μm. The triangular marks had approximately the same alignment as L1-L9 and C1-C4, and wavy edges. While for the longer and shorter striations the starting and ending points were not easily identifiable, marks T1-T3 were formed during a movement of an engraving factor from the proximal part towards the apex of the tooth, slightly obliquely to its axis. The inventory of marks in area G1 is completed by pitting – roughly oval points with irregular edges (IP). Their diameter is between 20 and 80 μm.

Next to marks in area G1, modifications occurred in areas G2 and G3 (Fig. 6: 1, 2). They have the form of short, irregular linear marks lacking alignment, up to 30 μm in thickness (Fig. 8: 3, 4). They are accompanied by some minor pitting – roughly oval points with irregular edges (IP).

DISCUSSION

Our analysis has confirmed the presence, other than fractures on tooth B1/14, and in areas G2 and G3 of tooth B6/14, of mainly three types of marks: i./ individual short stria-

tions of a small width, length and depth; ii./ linear marks of different width, length and depth – always small – and lacking any discernible alignment; iii./ a group of parallel linear marks. Finally, in areas G2 and G3 of tooth B6/14, we identified small irregular oval pits (IP). Variant i./ and ii./marks are mostly regarded as an effect of sedimentary abrasion caused by the shifting of sediments against the surface of the objects they contain (Behrensmeyer *et al.* 1986; Olsen and Shipman 1988; Domínguez Rodrigo *et al.* 2009; Fernández-Jalvo and Andrews 2016). One of the key causes of this phenomenon observed in archaeological sites is trampling by humans and animals but some of these traces could result from the redeposition by glacial processes. Another effect of trampling are characteristic groups of parallel striations, such as were observed on tooth B6/14 (variant iii./).

However, the most complex marks were discovered on the labial surface of tooth B6. Setting aside the irregular points (IP), all the other modifications regardless of their morphological differences, form a set of aligned marks (L1-L9, C1-C4 and T1-T3). It is legitimate to assume they are all the result of the same action (episode). The irregular shape of their edges and small depth indicate that they cannot be cutmarks, or lines of ornament (Behrensmeyer 1978; Behrensmeyer *et al.* 1986; Olsen and Shipman 1988; Bello and Soligo 2008; Domínguez Rodrigo *et al*. 2009; Fernández-Jalvo and Andrews 2016; Płonka *et al.* 2023). The marks do not resemble traces which were found on shark teeth used as tools and ornaments by traditional societies – ancient and modern (Gilson *et al.* 2021, 2023). Striations L1-L10 resemble trampling marks made when the particles building the sediment eroded the surface layer of the tooth. The origin of the short marks C1-C4 must be similar. However, in their case, the contact of the grains of sand with the surface of the tooth was more short-lived. Marks T1-T3, with a different, triangular shape, could have formed when the force acting on the grain of sand made it burrow into the surface of the tooth, forming a wide ending point of the trampling mark. On the other hand, no satisfactory explanation has been found for the origin of the IP marks. Possibly, they are the result of trampling too, when the force acting on the surface of the bone was perpendicular – producing pits (points) instead of linear striations. In short, the small density of the marks suggests rather that during the trampling incident, the force exerted on this particular tooth was moderate.

Thus, our analysis of the fossilized shark teeth from Wierzchowo has confirmed the non-intentionality of the marks identified on them, identifying them as taphonomic damage. Since shark fossils are rarely recorded in Quaternary deposits in Poland, the occurrence of two shark teeth in the same site and in the neighbouring square metres is unlikely to be random. We may safely assume that they were brought to the Mesolithic camp site by its settlers. Fossils, shark teeth among them, have long fascinated forager and early farmer communities (Oakley 1985; Jackson and Connolly 2001; Gumiński and Bugajska 2016; Macâne 2020). On the Iberian Peninsula, shark teeth have been recorded in Gravettian deposits, and are next encountered in Solutrean and Magdalenian inventories, as well as on Neolithic, Eneolithic and Bronze Age sites (Cortés-Sánchez *et al.* 2020, table 3). Fos-

sils have been encountered in quite a few Magdalenian sites in the Swabian and Swiss Jura, Rhineland and Thuringia (Eriksen 2002; Płonka 2012, table 38). A fossil shark tooth was found at the Mirkowice 33 site, in palaeosoil together with artefacts of the Hamburgian culture (Chłodnicki and Kabaciński 1998). In the Jura, fossil Gastropod shells traced to Steinheimer, Mainzer and Paris basins, have been found in Early Mesolithic deposits (Eriksen 2002, table 3). The interest of Mesolithic people in these items is confirmed by finds of belemnites, crinoids and other fossils from the cemetery at Dudka, Site no. 1 in Poland (Gumiński 2014; Gumiński and Bugajska 2016), including an undetermined fossil shark tooth found in collective burial no. VI-16 (Late Mesolithic) of eleven individuals (Gumiński 2014, fig. 10: l). One tooth each of a porbeagle (*Lamna nasus*), a shark then in existence, was found in burials at Skateholm I and Skateholm II in Sweden (Jonsson 1986, 1988; Grünberg 2013, 245). Fragments of porbeagle teeth were also found in a collective burial (Grave no. 46), and next to the foot of a 25-year old man (Grave no. XV). Two other burials in these cemeteries produced fossil shark teeth, one of them found by the head of a 40-50-year old woman (Grave no. 36), the other in the fill of a cut with the remains of a 20-year old man (Grave no. XVII). L. Jonsson (1986; 1988) interpreted them as objects with a 'special meaning, rather than the remains of food offerings, proposing they could have been obtained through barter. Porbeagles, regular visitors to the Baltic, late summer to winter, were approximately 2-metres long and could have become stranded on the seashore (Jonsson 1988, 76, 78).

In Scandinavia, fossil urchins are also found at Mesolithic and Neolithic sites (Ljunggren 2019; Nyland 2020). According to Nyland (2020), the finds of fossil urchins in these sites in Rogaland prove that owing to their special properties they played a part in the life of these communities, enmeshed in a subtle network of relationships determined by different contexts and metamorphoses. We cannot hope to grasp their meaning without leaving behind the nature/culture dichotomy inherent in our own education and cognition. Without this dichotomy the world would be a continuum, and different forms of metamorphosis between different spheres identified by us would be something entirely natural for the foragers.

Fossils have played an important role in various early modern hunter-gatherer societies and folk culture. They were used, among other things, for medicinal purposes, due to their apotropaic properties and as ornaments and amulets (*cf.,* Macâne 2020). They were used by First Nations forager peoples of Northern America. The Tlingit in British Columbia used fossil shark teeth as earring pendants (De Laguna 1972). The Blackfoot of the Great Plains used fossils, mostly ammonites, as medicine (Wissler 1912, 242, 243) considering as the most effective those of their fragments which resembled living things – buffalo, humans, *etc*. The Crow prayed to rocks and fossils of a peculiar shape, asking for good fortune and health (Wildschut and Ewers 1960). The Gros Ventre described some fossils with corrugated septa – the dividing walls that separate the chambers of ammonites – as "thunder-stones", and used them as neck ornaments (Kroeber 1908, 275, fig. 44). They were

known under the same name among the Assiniboine, while the Blackfoot referred to them as "buffalo-stones" and treated them with great respect. Among the Western Apache people fossils, with other objects from the realm of nature, are used as objects of supernatural power (fetishes) (Reagan 1929). The above examples show that next to playing a major role in the structure of the symbolic world of the forager societies fossils could have been used as objects and ornaments which build the social identity of their owner. At the same time, fossil shark teeth, mainly those with a serrated edge, were used in various regions of the world to make cutting tools (Lowery *et al.* 2011; Gilson *et al.* 2021, 2023). In this case, however, they show traces of modification and/or traces of use on the surface.

CLOSING REMARKS

Use-wear analysis of the fossil shark teeth discussed here identified natural modifications on its surface, identifiable as trampling marks and sedimentary abrasion during redeposition. Contextual analysis suggests that the teeth are not a random element of the Quaternary deposit underlying the site, but they were brought to the camp site by Mesolithic foragers. The described marks probably formed after the teeth had entered the sandy deposits of the lake terrace occupied by the Mesolithic settlers. Therefore, we can assume that the fossilized shark teeth were brought to the camp site due to their symbolic meaning. At the same time, we cannot define their function and meaning more precisely.

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MESOLITHIC ULNA "DAGGERS" FROM DĄBKI SITE 9 – ON THE TRACK OF THEIR FUNCTION

ABSTRACT

Orłowska J. 2024. Mesolithic Ulna "daggers" from Dąbki Site 9 – on the track of their function. *Sprawozdania Archeologiczne* 76/1, 221-236.

So-called "bone daggers" made from ulna bones of Cervidae are commonly found at Late Mesolithic hunter-gatherer sites of the western circum-Baltic area. The main objective of this paper is to showcase the results of the technological and functional analysis conducted on three tools found at the Dąbki 9 site in northern Poland. During the traceological analysis, technological traces facilitated the reconstruction of the chaîne opératoire of the tools' production process. The use-wear also points to the probable function of the artefacts. The results presented in this work are discussed in the context of other artefacts of a similar type known from various prehistoric contexts.

Keywords: Mesolithic, bone tool, ulna dagger, traceology, experimental archaeology, Dąbki 9
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1. INTRODUCTION

During the excavations carried out at the site Dąbki 9 in northern Poland (Fig. 1: A, B), bone tools made of the ulna bones of large *Cervidae* (red deer and elk) were discovered (Fig. 1: C). Due to the shape of the anatomical element from which these tools were made (which suggests that they were used for stabbing rather than cutting), they were commonly named "daggers" (see Płonka 2003, 108, 109, and references therein). Generally, their morphology is characterised by a broad natural base (proximal end of the bone),



Fig. 1. A, B – The location of Dąbki Site 9; C – analysed ulna "daggers" (photo W. Ochotny)

which most likely served as a handle, and a sharpened blade (the distal end of the bone was removed and shaped into a more or less pointed tip).

This type of artefact belongs to the typical set of tools produced by the Late Mesolithic hunter-gatherers of the western circum-Baltic area (Andersson 2004). Usually, in literature, they are described as "typical multipurpose tools that could serve during butchering, hide cleaning, fish processing, *etc.*" (Kabaciński and Terberger 2015, 145). However, their function has never been studied microscopically.

The primary objective of this paper is to present the results of the traceological analyses of three ulna "daggers" discovered at Dąbki Site 9, Darłowo commune. The microscopic studies reported in this paper were conducted to determine the production methods and to interpret the possible function of the analysed artefacts. The results are discussed in the context of current knowledge about "ulna daggers" in prehistoric times.

1.1. Dąbki Site 9

Dąbki Site 9 is located on a terrace monadnock located near a peaty water body. In 1978-1984, the site was excavated by Jolanta Iłkiewicz from the Museum in Koszalin (Ilkiewicz 1989; 1997). In 2003, a Polish-German research team led by Jacek Kabaciński and Thomas Terberger resumed work at the site (Kabaciński and Terberger 2009; Terberger *et al.* 2009; Terberger and Kabaciński 2010; Czekaj-Zastawny *et al.* 2013). This work has covered the parts of the settlement on the island terrace and on refuse layers within today's peaty marginal zone. Rich flint and ceramic materials, bone and antler products, and numerous fauna and plant macro remains (confirming intensive hunting, fishing and food gathering) were obtained. The long series of radiocarbon dates hitherto obtained indicate a more than thousand-year period of the development of the settlement in Dąbki, covering the period between about 5100 BC (KiA-26388: 5960±32 BP) and about 3700 BC (Poz-27412: 4920±40 BP). The results of the previous studies confirm the presence of two primary development phases at the site, characterised by a hunting-fishing-gathering type of subsistence strategy. The first of them, falling in the 5th millennium, is associated with the settlement of Mesolithic communities. In contrast, the second phase, from the end of the 5th and the beginnings of the 4th to the middle of the 4th millennium, is associated with the local evolution and development of the Funnel Beaker culture (Kabaciński 2001).

2. MATERIALS AND METHODS

For the needs of the presented study, three artefacts were available for traceological analysis. All pieces were found during excavations led by Jolanta Ilkiewicz from the District Museum in Koszalin in the early 1980s (Ilkiewicz 1989; 1997). They are stored in the Museum in Koszalin under the inventory numbers listed in Table 1, which contains other

Table 1. General description of all analysed artefacts from site Dąbki 9

No	Site	Museum Inv. No.	Date of recovery	Context of the recovery	Dimensions (cm)			Element, species	Current holding
					lenght	width	thickness		
1	Dąbki 9	MK/A/2621/1:1	1980	WKT II/80	15	7	4	Ulna bone, elk (*Alces alces*)	Museum in Koszalin
2	Dąbki 9	MK/A/2799/1:4	1985	WKT I/85	13	6,4	3,1	Ulna bone, red deer (*Cervus elaphus*)	Museum in Koszalin
3	Dąbki 9	MK/A/2685/5:1	1981	WKT III/81	15,5	6	3,2	Ulna bone, red deer (*Cervus elaphus*)	Museum in Koszalin

basic information about the analysed artefacts. These objects are dated to the 5th millennium BC, associated with the settlement of Mesolithic communities at Dąbki 9 (see Kabaciński and Terberger 2015).

Initial traceological observations of the general state of preservation of artefacts and technological and use-wear traces were made using a Nikon SMZ–745T microscope with a magnification range of ×10 to ×63, fitted with a Delta PixInvenio6EIII camera. The photographs presented in Figs. 2: A-C, 3: A-C, and 4: A-C were taken with this equipment. Images of the use polish were recorded using a Zeiss Axioscope 5 Vario microscope fitted with an Axiocam 208 camera. This allows obtaining objective magnifications up to 50× (actual magnifications up to 500×). The photomicrographs of Figs. 2: D-J, 3: D-J and 4: D-K were made with this equipment.

The location, morphology and distribution of micro-wear on the artefacts' surface was recorded. The possible use of the implements for various activities and processing of different types of materials, for example, wood, soil and hide, was verified by comparative analyses of micro-wear traces observed on experimental bone and antler products from former experiments that can be found in the Institute of Archaeology NCU in Toruń (*e.g.*, Orłowska and Osipowicz 2017).

The terminology used for characterising the patterns observed through microscopic observations was based mainly on criteria established in the traceological and archaeological literature concerning osseous artefacts (*e.g.*, Legrand 2007; Buc 2011; Orłowska 2016) that was adjusted to the needs and requirements of the present study.

3. RESULTS OF TRACEOLOGICAL ANALYSIS

3.1. Results of technological studies

The identified technological traces are similar on all of the analysed artefacts. The proximal end of the bone was left in its natural form and was not modified in any way. The

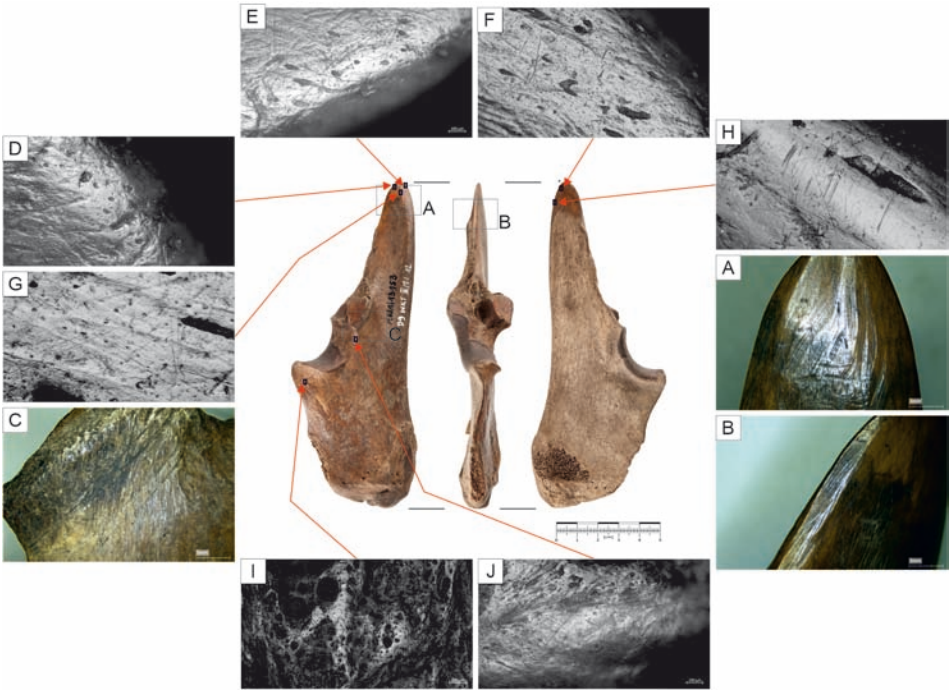


Fig. 2. Dąbki, Site 9.
Examples of the technological (A-C) and use-wear (D-J) traces discovered on the ulna dagger

visible difference in the morphology of the proximal part of the bone between Specimen 1 and two other ones (Fig. 1: C) is because we have the wholly preserved olecranon in the first case. In contrast, this part of the epiphysis has not been preserved in the other two cases.

The distal end of the ulna was removed in each case to create a sharp edge on the shaft of the bone. Due to the extensive processing of this part of the bone, we cannot determine whether the unwanted fragment was broken off or cut off to create the blade. However, in this case, a simple fracture was a more practical choice and partly gave a sharpened shape to the fractured bone. The basic techniques for shaping the artefact's pointed end were based on whittling and scraping bone surfaces along the bone axis (Figs. 2: A, 3: A, 4: A). Scraping traces appear mainly as linear bands of variable width and depth. In most cases, these comprise a series of parallel striae of varying sizes. Traces of scraping/whittling preserved on distinct surfaces are characterised by the presence of 'ridges' of the worked surface (Fig. 2: B). Moreover, in many places, the so-called 'chatter marks' (traces typical for whittling activity) were preserved, *i.e.*, singular perpendicular lines occurring at regular intervals, most often resulting from a flint tool being forcefully passed across the worked surface (Figs. 3: B, 4: A; compare Olsen 1984; Orłowska 2016).

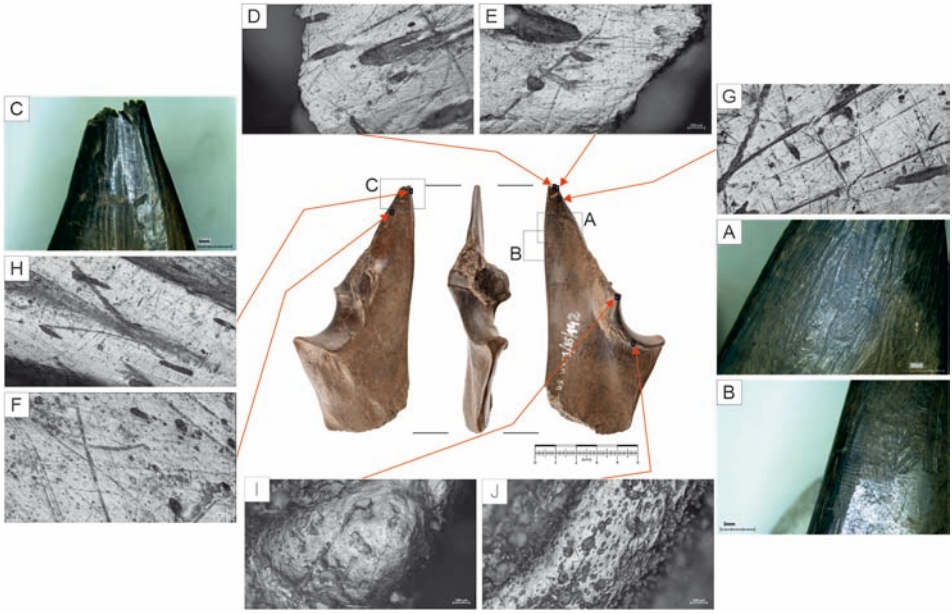


Fig. 3. Dąbki, Site 9.
Examples of the technological (A-C) and use-wear (D-J) traces discovered on the ulna dagger

Besides scraping and whittling, single-cut marks were also identified (Figs. 2: C, 4: C), mainly near the olecranon and the surface initially connected with the radius bone (places where ligaments and muscles were attached to the bone). These cuts were probably associated with cleaning the bones to make them ready for use. No other intentional surface transformations that could indicate the use of tools for processing the described items were recorded on their surface.

3.2. Results of functional studies

The microscopic analyses allowed the author to identify visible use-wear traces on the "daggers". In Specimen 1 (Fig. 1: C), looking with the naked eye, it is possible to see that the tip of the tool is slightly rounded and glossy. There is polish covering the whole surface of the tip of the tool and is most invasive at a distance of about 2-3 cm. Observed polish destroys (smoothens) the underlying technological traces very invasively (Fig. 2: A). Analysis under the higher magnifications shows that the polish is bright, and the micro-topography of the tool surface in that place is homogeneous (basically flat), leaving only the deepest parts of the bone unpolished (Fig. 2: D-F). Micro-relief is regular; high point topography is flat and smooth. Identified polish is accompanied by linear traces whose characteristics vary in different parts of the specimen. On the flat surfaces of the working edge, the distri-

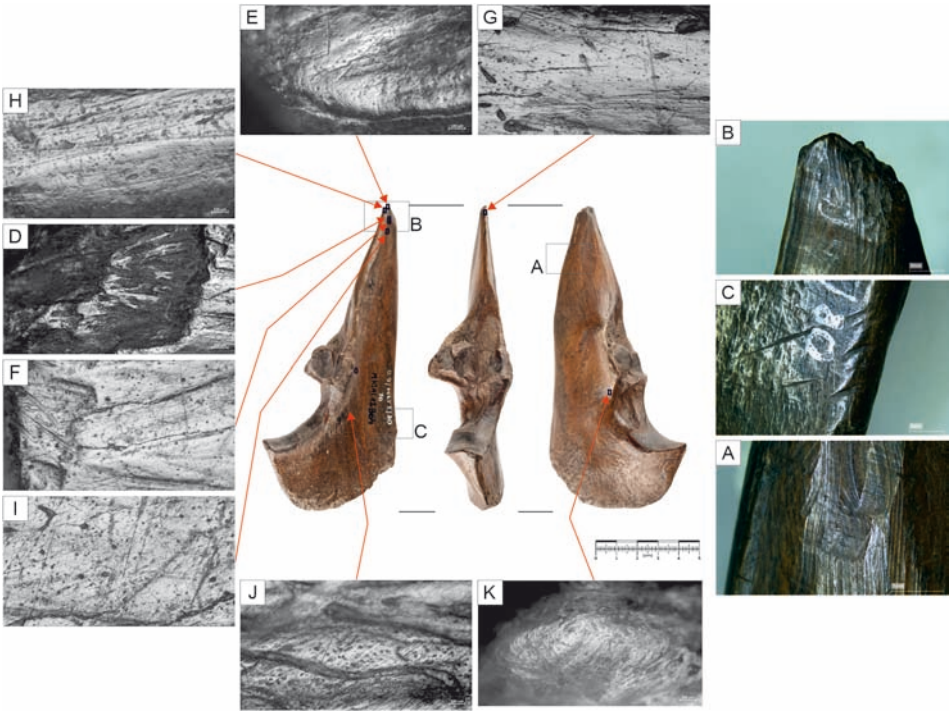


Fig. 4. Dąbki, Site 9.
Examples of the technological (A-C) and use-wear (D-K) traces discovered on the ulna dagger

bution of the linear traces is random, and they are arranged irregularly to each other (Fig. 2: G). Towards the sides, striations become more frequently parallel and transversally orientated to the axis of the tool (Fig. 2: H). Looking towards the distal end of the bone (at the base), well-developed polish and "etching" of the surface associated with holding the specimen in the hand were identified. In all cases, observed use-wear has heterogeneous micro-topography, irregular micro-relief, and flat, smooth high points (Fig. 2: I, J). This is associated with many prominent pits and craters (osteons and osteocytes). Multidirectional, often crossed, striations also accompany the identified polish.

Almost analogous use-wear traces were observed on Specimen 2 (Fig. 1: C). Unfortunately, in this case, the dagger blade is not entirely preserved. Its tip is broken; however, the fracture is "fresh" and must have occurred at the time or after the discovery of the artefact. Nevertheless, the microwear traces are consistent with those observed in Specimen 1. The traces of use overlap the blade at a length of about 3 cm. The micro-topography of the working edge is homogeneous; only the deepest parts of the bone are unpolished (Fig. 3: D, E). Micro-relief is regular; high point micro-topographyis primarily flat and smooth. Observed linear traces are mostly multidirectional. The morphology of the traces is the

same along almost the entire length of the working surface (Fig. 3: F). However, closer to the side edges of the blade, the observed linear traces seem more parallel to each other (Fig. 3: G, H). Also, in this case, traces of use were identified on the proximal part of the bone. The identified polish has heterogeneous micro-topography, irregular micro-relief, and flat, smooth high points (Fig. 3: I, J) and is accompanied by multidirectional, varied in size but mostly very delicate striations.

The traces of use recorded on the last of the analysed items coincide with those described for the two previous objects. The only significant difference is that, in this case, we are dealing with a damaged tool (broken tip) that was repaired and used further. Traces of re-sharpening of the tip are visible in the form of scraping of the broken tip's surface (Fig. 4: B). After sharpening, the tool was still used, as evidenced by traces of use registered on the re-sharpened tip (Fig. 4: D). As before, the use-wear traces are characterised by regular micro-relief, with flat and smooth morphology of the high points (Fig. 4: E-G). Linear traces are mostly multidirectional. Towards the sides, striations become slightly more parallel and transversally oriented to the tool axis (Fig. 4: H). Further from the tip, the use-wear traces retain their morphology; however, they are slightly less developed (Fig. 4: I). As with the two previous tools, on the proximal part of the bone, well-visible use-polish was identified (Fig. 4: J, K).

3.3. The experimental programme

The origin of the use-wear traces observed on the ulna "daggers" from site Dąbki 9 was interpreted against a reference collection of tools made of osseous materials stored at the Institute of Archaeology at Nicolaus Copernicus University in Toruń. Additionally, some new experiments were conducted associated with hypothesised functions from literature of this type of tool. During these experiments, the osseous tools were used for cutting fish and removing bark from deciduous and coniferous trees to obtain the bast.

Four large fresh tench fish (genus *Tincatinca*) were prepared for the needs of the fish-cutting experiments. The experiment was conducted as fish remains are a significant part of the collection of bones from the Dąbki 9 site (Zabilska-Kunek *et al.* 2015). Moreover, some researchers link ulna "daggers" to fish processing and suggest that they could have been used "to open the flesh to cut fish skin from the inner side (removing the eggs?)" (David 2015, 161). The experiment began with an attempt to cut the fish with a bone dagger from the ventral side. Unfortunately, this attempt failed. The blade was unable to cut through the fish skin. It was, therefore, decided to make an incision with a flint blade to facilitate fish processing. From that moment on, the experimental dagger was used to remove the entrails and separate the fish skin from the meat (Fig. 5: A). Unfortunately, due to the work's low efficiency, the test was terminated after 30 minutes.

The experiments with the debarking of the trees were based on the characteristics of the wear traces observed on the bone tools and archaeological data, as well as suggestions about possible methods of using analogous morphological forms by prehistoric and modern

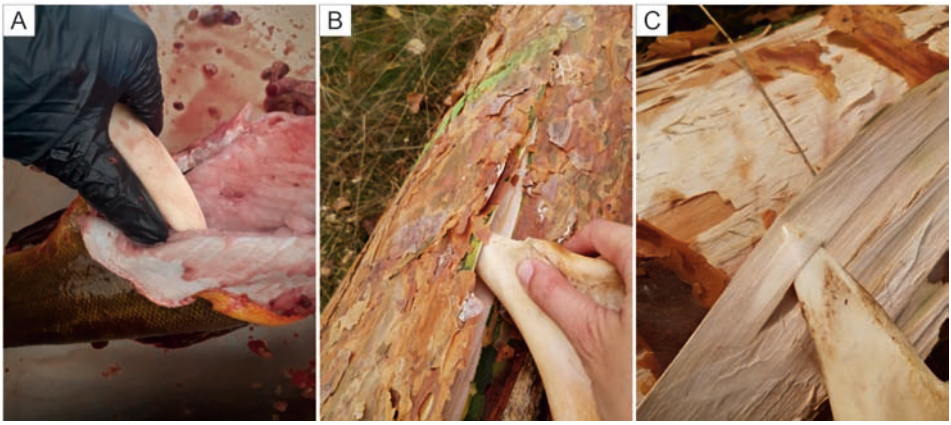


Fig. 5. Experimental work:
A – fish-slitting; B – debarking coniferous tree; C – separating bast from a fresh coniferous tree

archaic communities (*e.g.*, Keddie 2012). For the needs of this experiment, two tools were prepared from elk ulna. One tool was used to remove bark and separate the bast from the fresh coniferous tree (pine; Fig. 5: B, C), and the second was used for a deciduous tree (lime). Each tool was used for an hour. The tools proved highly effective. It should be noted that during the debarking process, the trees started to release a significant amount of plant juices, and in the case of coniferous trees, resin was also present. As a consequence, the surface of the experimental tools became coated with these juices, extending beyond just the working edge to other parts of the tools.

3.4. Use-wear observed on the working edges of experimental tools

The microscopic analysis of the tool's working edge used to cut fish showed that the tool's surface was modified mainly on the highest points of the bone's micro-topography. The polish is dull; it has a heterogeneous micro-topography. Micro-relief is irregular; high points are slightly rounded and have a rough texture. The polish is accompanied by sparse, delicate linear traces arranged irregularly to each other (Fig. 6: A).

The situation looks different when we examine the tools used to debark trees. The traces made on tools working on deciduous and coniferous material have a similar morphology. The polish is bright, and it has, in general, homogeneous micro-topography. Micro-relief is regular, and high points are flat but have a rough texture (Fig. 6: B, C). The distribution of striations is random. They are variable in size; at the tips of the working edges, they are narrower, but further from the tip, they begin to be broader and deeper and mostly crossed, irregular aligned to each other. On the sides of the working edge, striations are more parallel to each other and transverse to the axis of the tool (Fig. 6: C: b).

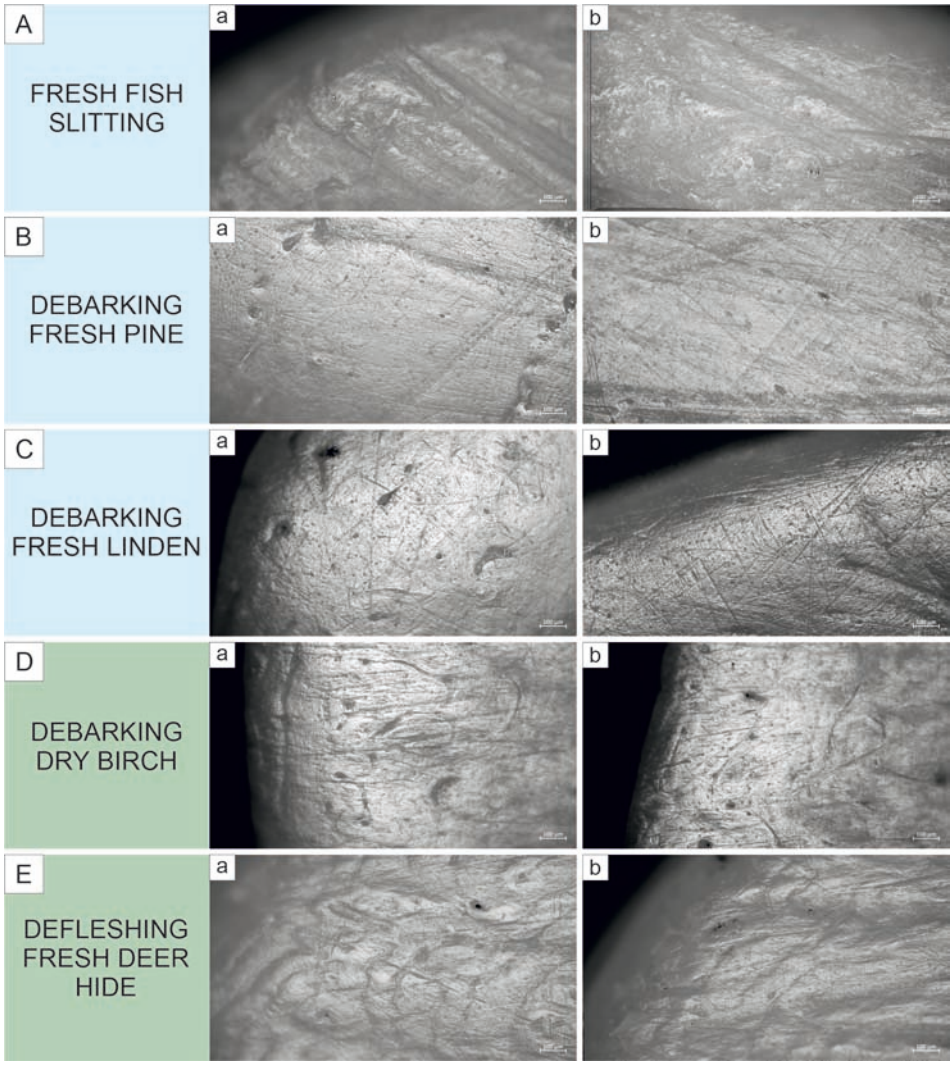


Fig. 6. Examples of use-wear traces on bone tools resulting from contact with various materials (photo J. Orłowska)

4. DISCUSSION

In prehistoric Europe, the vast majority of ulna "daggers" made from red deer or elk bones have been discovered in Denmark, at Late Mesolithic sites such as Bloksbjerg, Level D, Dyrholm I and Kolind, Layer I (Mathiassen *et al*. 1942, 71,73; Andersen 1972, 97; Brinch Petersen 1973, l05, fig. 4) dated to the early stage of the late Atlantic period. "daggers"

found at the Ertebølle site (about 4710-3800 BC), Ralswiek-Augustenhof (about 4450-4120 BC) and Sølager (about 4490-4250 BC) came from the late stage of this period. Similar artefacts from Nivå and Kolind, Layer III, are broadly dated to the late Atlantic period (Płonka 2003, 109). However, single specimens were also found at Mesolithic sites dated to the Boreal period like Mullerup 1 in Denmark (Sarauw's Island; David 2005, 479, pl. 5: 9); Hohen Viecheln, Horizon C (David 2005, 516, pl. 42:10) and Friesack 4, Phase II in Germany (David 2005, 529, pl. 55: 12). Single discovered specimens have ornaments engraved on their surface. Usually, these are motives composed of fine, skilfully incised lines (Płonka 2003, 108-109). In the case of the Polish territories, we have data on only eight such artefacts, the ones from Site 9 in Dąbki, Darłowo commune (Ilkiewicz 1989; 1997; Kabaciński and Terberger 2015). Using ulna bones from other animal species, *e.g.*, *Ovis/Capra* or *Bos taurus*, to make analogous morphological tools is also known from later periods. A good example is the Italian sites Farneto and Sa Osa, dated to the Late Copper Age (Thun Hohenstein *et al.* 2020). In addition, tools of this type were widely used outside Europe. Rich collections of them come from, *e.g.*, North America, where analogous forms made from red deer were utilised by Paleo/Archaic Native Americans (*e.g.*, Keddie 2012).

In the literature, numerous suggestions regarding the function of Mesolithic ulna "daggers" can be found. One of the earliest references to them dates back to the first half of the twentieth century, suggesting that due to their shape, the nature of the working edge, and their size, they were most likely tools used for stabbing (Westerby 1927; Mathiassen *et al.* 1942; Płonka 2003, 108, 109). Over time, it began to be suggested that they are most likely multipurpose tools (Kabaciński and Terberger 2015, 145). Some researchers linked them to fish processing (David 2015, 161). Interesting information in this regard is also provided by researchers focusing on materials from Paleo/Archaic Native American contexts from Northern America. Among the potential functions that tools of this type could fulfil, suggestions include those associated with piercing holes in various materials, cutting fish, splitting bark, and pressing fibres (Keddie 2012). Other interpretations connect these tools with digging (Griffitts 2001, 187), working in wood, or bark stripping (Penders 1997, 136, 158).

Despite the relatively large number and versatility of the studies carried out so far, the contemporary knowledge of the probable function of these objects still needs to be completed. The problem arises primarily from the need for a more detailed characterisation of the damage observed on these tools, which should be made through a proper microscopic use-wear analysis. In the context of prehistoric tools from Europe, use-wear analysis of ulna "daggers" was recently published regarding tools from the Copper Age sites Farneto and Sa Osa. Results showed that pointed ulna tools discovered at these sites were probably used to pierce animal hides (Thun Hohenstein *et al.* 2020). Unfortunately, no such analyses have been made in the context of tools found at Mesolithic sites until now.

In the case of the analysed tools, we can reconstruct only a part of the activities associated with their production, mainly related to their shaping and finishing stage. No unambiguous traces could be seen on any of the specimens, which could be the remains of, for example,

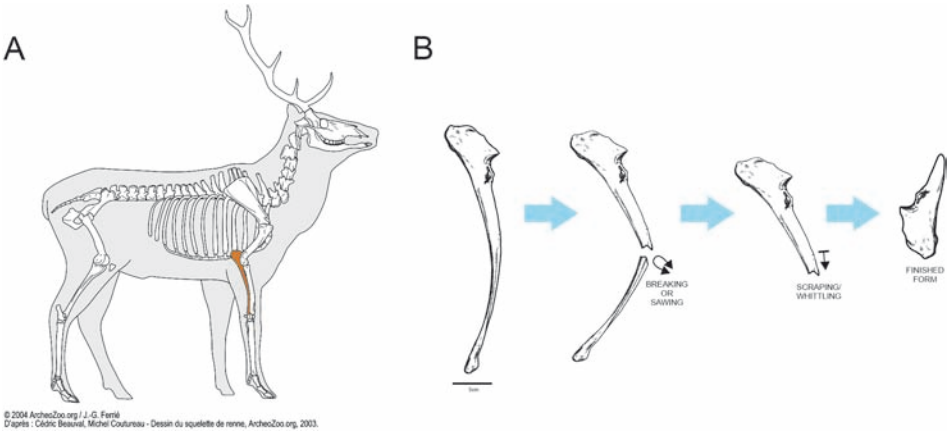


Fig. 7. A – a deer skeleton and a schematic representation showing the skeletal elements used to produce ulna "daggers"; B – an operational chain illustrating the probable steps in making ulna "daggers"

bone splitting to obtain the appropriate semi-finished product, which results from the intense processing of the distal part of the bone in further stages of its processing. For this reason, we are unable to say whether the removal of the unwanted part of the bone consisted of breaking or sawing it off (Fig. 7). After obtaining the appropriate fragment of the partially finished product, the tools were given the required shape as a result of surface treatment of the distal bone fragment using two basic techniques: scraping and whittling. Entire objects were not subjected to this treatment, but only their specific fragments, *i.e.*, blades. This way of treatment and the techniques used find analogies among other products of this type from Mesolithic contexts (see, for example, David 2005). What is interesting from a technological perspective is that it was not possible to identify grinding marks on the analysed artefacts. This technique was, however, observed on the other three ulna "daggers" from this site that were discovered after the resumption of excavations in Dąbki 9 in 2003 (Kabaciński and Winiarska-Kabacińska 2023).

The use-wear traces observed on the Dąbki "daggers" are similar to those observed on experimental tools used for processing plant materials. At the same time, they differ from the traces observed on experimental tools used to gut fish (Fig. 6: A) or those used in defleshing animal hides (Fig. 6: E). The degree of intrusion of the observed polish, its morphology and the accompanying linear traces indicate that these objects were not used to stab, pierce or drill a given raw material. The activities performed with them were related to levering and separating parts and layers of worked material. Similar traces were identified on tools used during experimental work for debarking trees (Fig. 6: B, C, D). Differences in intensity and nature of polishes on tools used to work plant materials like wood can be seen as a result of the diversity of hardness and moisture of the raw material, which depends, among other things, on its species. Another significant factor is the devastating

effect of organic acids in hemicellulose, which occurs in higher levels in young wood (Krzysik 1997, 120-122). That is the reason why the surface of the tools can be slightly etched on the areas adjacent to the surfaces in direct contact with the processed raw material. The tool's surface was covered by the vegetable juices that were released during processing. Additionally, this effect may be enhanced by post-depositional effects in the environment in which the artefacts were deposited (Orłowska 2018).

In the Dąbki 9 site, there are many indications that bark was an important raw material for the people using it. In 2011, large remnants of bark, measuring c. 4.0 × 1.8 m, with numerous traces of cutting and grooving, were recorded in the peat-bog close to the beach zone. They are interpreted as remains of a bark canoe flattened by the pressure of about 1 m of overlying sediments (Czekaj-Zastawny *et al.* 2013). The bark, about 4 cm thick, came from pine or spruce (Kabaciński and Terberger 2015, 150, 151). The collection of bark at the site is also evidenced by, among others, a unique find of a double cord string, c. 30 cm long, made of the phloem of lime tree bast, which was found in the upper part of the Late Mesolithic layer (Kabaciński and Terberger 2015, 148).

Considering the previously quoted information regarding the purpose of this type of tool (*e.g.,* Thun Hohenstein *et al.* 2020), it can be assumed that they could be used for multiple activities. However, in the case of the three tools analysed here, we are dealing with one analogous way of using them. Traces associated with holding them in the hand were also identified on each archaeological specimen. However, handling wear was sometimes difficult to distinguish from use-wear documented on the pointed edge of the tool. Nevertheless, we must remember that hands are not sterile during work. Experimental work proved that, during debarking, fresh trees begin to release juices or even resin. This, in turn, causes intense hand soiling and the transfer of wood acids to the parts of the tool held in the hand. Thus, the visible traces may be challenging to distinguish from the damage visible on the usable edges.

To summarise, it is highly probable that the use-wear traces observed on the ulna "daggers" from the Dąbki 9 site were formed by contact with plant material. The repeatability of the observed use-wear traces and the very form of the tools may suggest that they could constitute some specialist tools related to performing a specific type of activity. However, to fully understand the purpose of the discussed type of objects, it would be necessary to carry out traceological analyses for other artefacts of this type known from Mesolithic contexts.

CONCLUSIONS

This research is the first detailed traceological analysis of ulna "daggers" discovered at Site 9 in Dąbki, Poland. It is worth noting the high uniformity in the technological procedures employed during the production of the discussed type of artefacts. Simultaneously, their degree of standardisation – limiting activities to only those necessary to achieve the

goal of forming the working edge of the artefact – is noteworthy. The functional analyses carried out, in turn, made it possible to conclude with high probability that the analysed tools from Dąbki were used to work plant material, probably for debarking trees. Traceological studies of this type of artefact should be considered prime research postulates in future studies on using osseous raw materials by hunter-gatherer societies in prehistory. Undoubtedly, many researchers automatically assume the function of this type of artefact, based mainly on their shape, forgetting that actual interpretation of their function is impossible without proper traceological analysis. The presented study shows how much precious information we can obtain and how easily we can verify the ideas of others, which are very often reproduced unreflectively in the literature.

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IDENTIFYING COLLAGEN RESIDUES ON GROUND STONE TOOLS FROM MESOLITHIC SANDY SITES: SELECTED EXAMPLES FROM PALIWODZIZNA 29 IN CENTRAL POLAND

ABSTRACT

Cristiani E., Orłowska J. and Grzegorz Osipowicz. 2024. Identifying collagen residues on ground stone tools from Mesolithic sandy sites: selected examples from Paliwodzizna 29 in Central Poland, *Sprawozdania Archeologiczne* 76/1, 237-250.

During excavations at the Mesolithic site Paliwodzizna 29 (central Poland), in addition to the flint artefacts typical for this period and region, a collection of 175 non-flint stone artefacts was discovered. This collection included various "macro-lithic tools" displaying visible intentional modifications and usage traces. This observation prompted a preliminary traceological analysis of a selection of tools. The primary goal of the presented research was to assess the possibility of analysing and interpreting use-wear traces and potential residues on these tools. The ultimate aim was to investigate the feasibility of conducting such analyses on macro-lithic tools from the sandy sites of the Polish Lowland dating back to the Mesolithic.

Keywords: use-wear; residues; collagen; macro-lithic tools; Polish Lowland; Mesolithic
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1. INTRODUCTION

Stone artefacts constitute one of the sole sources identified at sites from the early Holocene periods in Central Europe. The territory of Poland is rich in flint resources, making it the primary material used for stone tool production. Other types of rocks, especially those with larger crystals, were considered less significant in this regard. However, it is widely believed that they were used for creating various types of macro-lithic forms. The term "macro-lithic tools", including ground stone tools and other non-flaked artefacts, encompasses a diverse category of non-flint artefacts utilised for percussion, abrasion, polishing, cutting, and grinding activities (Adams *et al.* 2009; Adams 2014). Common tool types found in macro-lithic assemblages include hammerstones, abraders, grinding implements (*e.g.*, grinding slabs, querns), as well as pounding (*e.g.*, mortars and pestles) and cutting (*e.g.*, axes and adzes) implements. What is worth mentioning is that this category of artefacts is generally characterised by extended life histories (Dubreuil *et al.* 2015; Dubreuil and Savage 2014). In recent years, our knowledge of the function of this category of artefacts and their significance in the daily life of prehistoric European hunter-gatherers has greatly advanced. This progress has been made possible through the application of use-wear and residue analysis to these artefacts (*e.g.*, Aranguren *et al.* 2007; Revedin *et al.* 2010; Lippi *et al.* 2015; Cristiani and Zupancich 2020; Cristiani *et al.* 2012; Cristiani *et al.* 2021).

In the Mesolithic period, ground stone tools played an essential role in the toolkit of hunter-gatherer communities (*e.g.*, Gilabert *et al.* 2016). Tools of this type were often used in the Mesolithic for processing plant materials, although many other activities were also performed with them (Holst 2010; Gilabert *et al.* 2016, 213, 214; Cristiani and Zupancich 2020; Cristiani *et al.* 2021).

Various types of macro-lithic tools are also documented within the stone assemblages of Mesolithic sites in Poland, *e.g.*, Pobiel 10 (Bagniewski 1990), Pomorsko 1 (Kobusiewicz and Kabaciński 1991), Luta 1 (Więckowska-Chmielewska 2007), Bolków 1 (Galiński 2014), Ludowice 6 and Sąsieczno 4 (Osipowicz 2017, 68-71). Usually, studies of these artefacts have focused on describing their morphological and technological attributes, and despite their presence, these tools usually remain poorly understood, as no analyses have been conducted to investigate their use so far. Many researchers, of course, are tempted to interpret the functions of these types of objects. Still, these interpretations are usually based solely on macroscopic or low magnification observations and are not supported by more detailed analyses (Bagniewski 1990).

In the collection of stone artefacts discovered at Paliwodzizna 29 (central Poland), several items are considered macro-lithic tools. They are dominated by various types of hammerstones, grinders, smoothing stones or pebbles with traces of use (various pebbles bearing visible macroscopically minor traces of processing or use). Most of the described products are made of different types of granite and quartz sandstones. This article

aims to present the preliminary results of a functional analysis of selected stone artefacts discovered during excavations at the site Paliwodzizna 29. The primary goal was to address the question of the feasibility of conducting effective and reliable functional analyses of macro-lithic stone tools from this site and other Mesolithic sandy sites in the region in general.

1.1. Site Paliwodzizna 29

The Paliwodzizna 29 archaeological site is located in central Poland in the Drwęca River Valley, which separates the Dobrzyń and Chełmno Lakelands (Fig. 1; *cf.*, Solon *et al.* 2018). It lies on a flat-topped ridge situated in a place where the subglacial valley of Lake Grodno and Lake Plebanka becomes the valley of the Drwęca River (Osipowicz *et al.* 2023). Over five years of archaeological work, an area of 468 m² was explored at the site, 429 m² of which constitute trenches situated in its sandy (dry) part, whereas 39 m2 of excavations

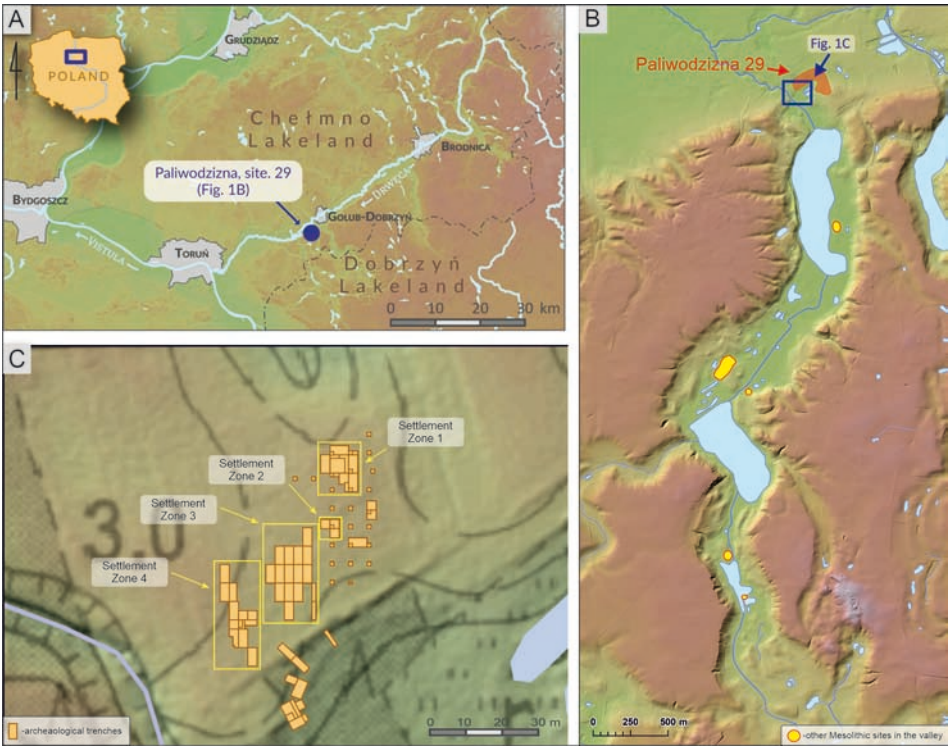


Fig. 1. Location of Site 29 in Paliwodzizna: A – location within the Chełmno-Dobrzyń Lakeland; B – location in the valley of Grodno and Plebanka Lakes; C – situational-altitude plan of the site with the archaeological trenches and settlement zones (based on Osipowicz et al. 2023, Fig. 1)

were made in the wetlands, which are the littoral zone of the former lake. As a result of the work carried out in the dry zone of the site, four clusters of Mesolithic features and artefacts were identified (Fig. 1; Osipowicz *et al.* 2023). Only the archaeological materials from settlement zone 2 have been subjected to more detailed analyses (Osipowicz 2021).

The primary period of usage for the site falls within the Mesolithic. Artefacts from this period were discovered in the site's sandy (dry) part and the peat (wetland) trenches. In the "dry" zone, these artefacts were found within distinguishable flint scatters and cloud-like structures associated with numerous hearths, economic and ritual pits (up to 2 metres deep), and other structures. The flint tool typology from this area and radiocarbon dating indicate that this part of the site was used throughout the Mesolithic. In the peat zone, Mesolithic materials were discovered in two layers of sand with a gyttja admixture. These layers contain many large charcoal fragments and seem exclusively associated with Early Mesolithic settlements (Osipowicz *et al.* 2023). The long series of radiocarbon dates hitherto obtained indicate a more than a three-thousand-year period of the development of the Mesolithic settlement in Paliwodzizna 29, covering the period between about 9290 cal BC (Poz-121364: 9700±60 BP) and about 5731 cal BC (Poz-121444: 6780±40 BP; Osipowicz *et al.* 2023).

Various types of non-flint artefacts were identified among the many discovered artefacts at the site. In total, 175 stone items were unearthed. Many of them can be interpreted as an example of the elements of a specific industry from non-flint rocks, represented by flakes, chips, *etc.* (44%), similar to industries identified on other Mesolithic sites in the region (Osipowicz 2013, 2014; Osipowicz *et al.* 2014; Osipowicz and Sobkowiak-Tabaka 2014). However, a significant majority represents a classic set of macro-lithic tools, initially classified by visual inspection and macroscopic use wear as hammers (6%), grinders (25%), smoothing/grinding plates (11%), or pebbles with traces of use (14%).

2. MATERIALS AND METHODS

2.1. Materials

The subject of the analysis reported in this article are two stone artefacts that can be treated as an archaeological sample from Paliwodzizna 29, referred to as Specimen #1 and Specimen #2. Both artefacts were discovered in Early Mesolithic layers of the site.

The first specimen was found in the site's northern part of Settlement Zone 1, in Feature 81 (inv. No. W933; Fig. 2: A), and it is a naturally rounded pebble measuring 15 × 10.4 × 6.4 cm. The weight of the artefact is 1.30 kg. The tool does not present any technological modification on its surface. Based on its morphological features, the artefact was initially identified as a grinder due to the two flatter surfaces with clear signs of use opposite each other. It was made of granite.

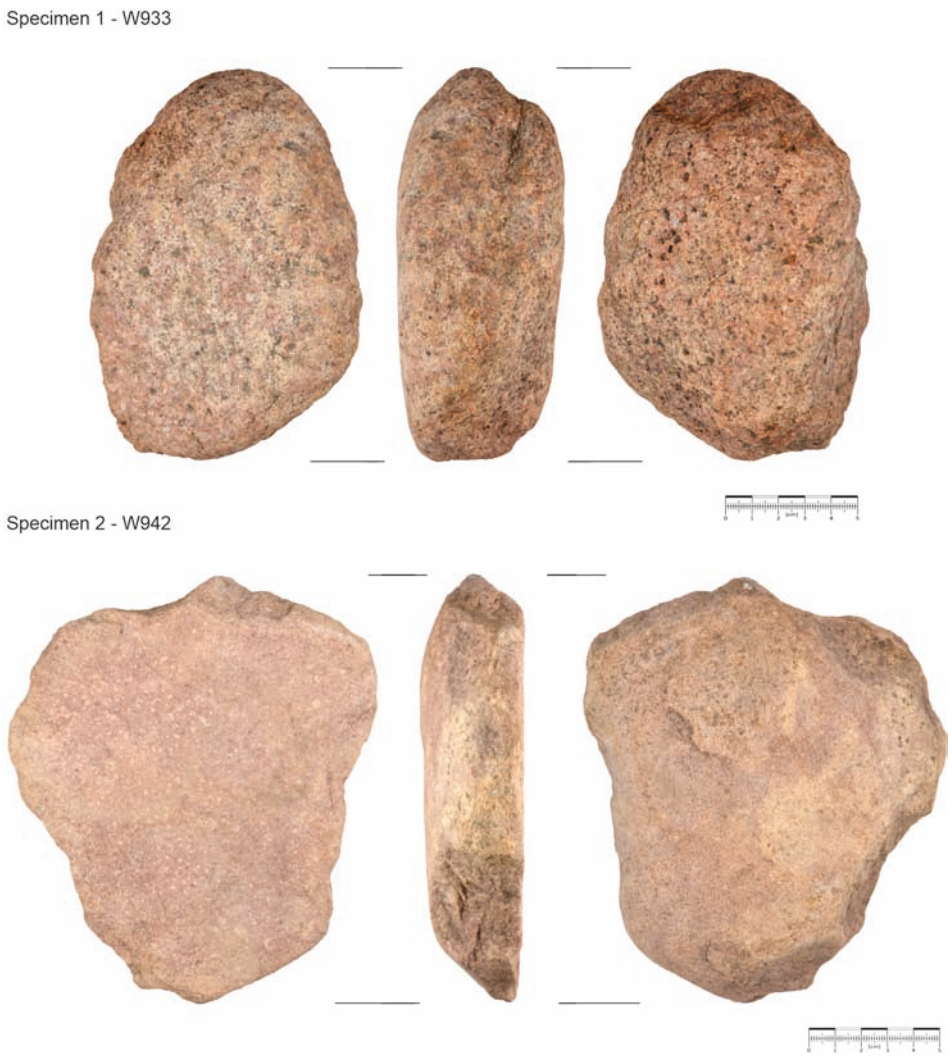


Fig. 2. Ground stone tools analysed in the study from the Paliwodzizna 29 site (photos by Justyna Orłowska)

The second specimen was found in the site's northern part of Settlement Zone 4 (inv. no. W942; Fig. 2: B). The item is characterised by a flat, even surface, which was processed around the circumference, likely to attain the desired tool shape. The dimensions of this tool fall between 16,4 × 14,1 × 4 cm. The weight of the artefact is 1,35 kg. The object can be considered as a type of grinding slab. The tool was made from a block of Jotnian sandstone.

2.2. Methods

The analysed tools were secured directly after their discovery at the site and were not washed.

The macro-lithic tools were sampled and analysed at the DANTE-Diet and Ancient Technology laboratory at the Sapienza University of Rome. Strict protocols were followed to control modern contamination during the residue sampling and functional analysis of GSTs. Before analysing each tool, the bench surfaces were meticulously cleaned with ethanol and hot water and then covered with aluminum foil. Starch-free gloves were used while handling the GSTs. Use-wear and residue analyses were carried out on surfaces unaffected by severe post-depositional modifications and free from concretions. Additionally, the reliability of residues was contingent on their association with use traces.

Use wear study. The functional study examined use-wear traces on the macro-tool surfaces using two magnification levels. At low magnification (0.75×-168×), a Zeiss Axio Zoom V16 stereomicroscope was employed, while high magnification analysis (200×-500×) utilised a Zeiss AxioScope A1 metallographic reflected light microscope (Cristiani and Zupancich 2020; Dubreuil *et al.* 2015). The low magnification facilitated the evaluation of material preservation and the identification of residues still adhering to the surfaces. Factors such as appearance, morphological features, and spatial patterns of macro-residue distribution were taken into consideration (Langejans 2010).

Residues. Subsequently, 20µl of ultra-pure water was applied to various areas of the tool surface for extraction. After pipetting out, each sample was mounted on a glass slide with a 50% solution of purified water and glycerol. The observation was conducted in transmitted light (TL) using a Zeiss Imager2 with magnification up to 1000x, 10x eyepiece, and cross-polarizing (CP) filters. Following this, samples underwent staining using Picro-Sirius Red (PSR) according to established protocols (Cristiani and Zupancich 2020; Stephenson 2015) and were analysed in transmitted cross-polarized light. PSR, a biochemical stain known for its ability to react with Type I and Type III collagen fibres, transforming them into a vivid red and enhancing their birefringence in cross-polarized light, was employed (see Stephenson 2015, pp. 236 for details). Additionally, PSR was chosen for its capability to provide a contrast-enhanced view of plant structures, including starch grains or phytoliths (Stephenson 2015).

Photogrammetry

3D Models of analysed artefacts have been created through the application of photogrammetry. The tools were placed on an automatic turntable in order to produce 360° sets of each of the tool's surfaces. Images of the tools were captured using a Nikon D7100 DSLR camera fitted with a Nikon Nikkor AF Micro 60mm f/2.8D lens. A total of 151 images per object were captured and then imported into RealityCapture 1.3 to create high quality, dense point clouds and meshes.

3. RESULTS

Technological analysis

Only in the case of Specimen #2 were traces identified that indicate intentional shaping. In a few places around the circumference of the tool, there are visible traces of deliberately removed flakes (Fig. 4: a). All negatives visible on the surface of the artefact were knapped by hitting the edges of the upper, flat surface of the object, and they vary in shape and size. Their morphology suggests that they were removed using the hard hammer technique.

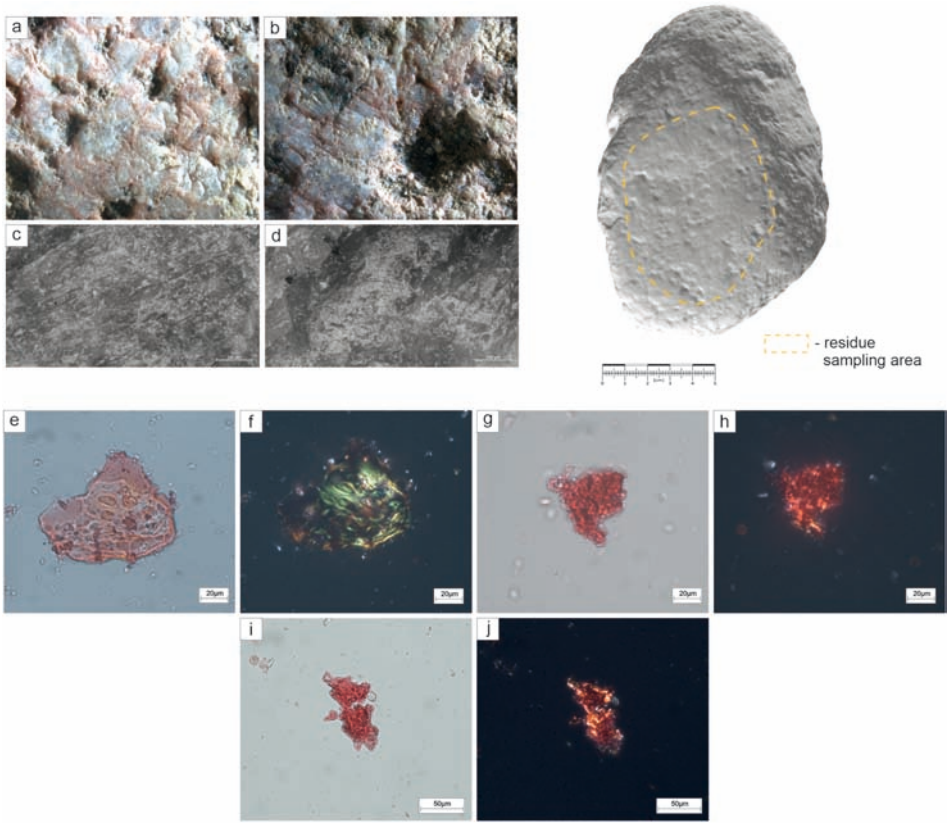


Fig. 3. The 3D model of Specimen #1 with marked residue sampling area (W933) and the examples of the use-wear and organic residues observed on its surface: a, b) sinuous micro-relief of the used surface and grain extractions; c, d) a smooth, domed, and occasionally striated micro-polish; e-j) PSR stained residues documented in extracted solutions under the TL
(photos by Emanuela Cristiani and Justyna Orłowska)

Use-wear analysis

The macroscopic involved the analysis of various usage traces, including flattened surfaces, pitted areas, and rounding of single grains, among other things.

In the case of both analysed specimens, the identified use-wear consists of sinuous micro-relief of the used surface, grain extractions and smooth domed micro polish affecting the low and high micro topographies. In many places the surfaces appear slightly abraded (Fig. 3: a,b; Fig. 4: b-d). In the case of Specimen #1, at high magnification, both high and low micro topographies on the macro-tool surfaces exhibit a smooth, domed, and occasionally striated micro-polish (Fig. 3: c, d), frequently related to material processed of medium hardness (see *e.g.*, Cristiani and Zupancich 2020). A high degree of micro rounding of the edges of the grains is also visible (Fig. 3: d).

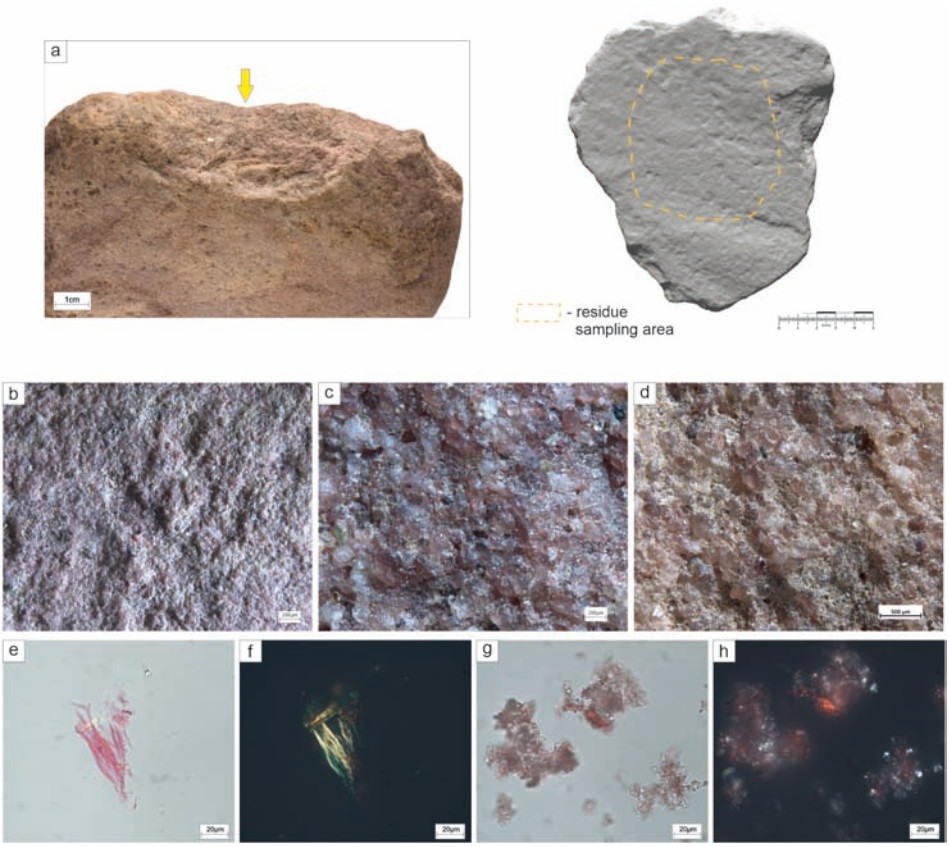


Fig. 4. The 3D model of Specimen #2 (W942) and the examples of the technological, use-wear and organic residues observed on its surface: a) negatives of deliberately removed flakes with the direction of impact marked (yellow arrow); b-d) sinuous micro-relief of the used surface and grain rounding and extractions; e-h) PSR stained residues documented in extracted solutions under the TL (photos by Emanuela Cristiani and Justyna Orłowska)

Residue analysis

Residues in the form of the organic film and possibly animal fibres were identified on both analysed tools (Fig. 3: e-j and Fig. 4: e-h). These residues were sampled and stained using PSR for observation in cross-polarized light, highlighting the presence of collagen. In cross-polarized light, certain fibres transformed into a yellow-green colour (Fig. 3: f and Fig. 4: f), typical of Type III collagen, characterising the reticular fibres present in flat collagen tissues. Others observed in cross-polarized light, displayed an enhanced yellow-orange birefringence, typical of Type I collagen (Fig.3: h, j; Fig. 4: h).

4. DISCUSSION

Building on prior research into the composition and frequency of Fennoscandian erratics found in the Polish Lowlands, it is established that the primary source of raw materials for stone processing in prehistory was local post-glacial rock resources. Specifically, Fennoscandian erratic boulders and pebbles found in sediments shaping various forms of the young glacial landscape in the Polish Lowland played a crucial role (*e.g.*, Chachlikowski 2013). These raw materials were likely acquired by Mesolithic people through gathering from the ground surface and also extracted using the open-pit method to obtain suitable stone raw materials in terms of their lithology and size from the surrounding Pleistocene deposits (Chachlikowski 2013, 40-59, 97-106). It is important to note that the boulder pavement (lag deposits) found at the site Paliwodzizna 29 served as a resource for the Mesolithic people, who utilised it to extract stones and, potentially, flint. Pits excavated for this purpose reached depths of up to approximately 2 m and diameters of about 5 m. Engaging in such extensive earthmoving not only indicates the extraction of resources but also suggests the possibility of a more permanent settlement at the site (Osipowicz *et al.* 2023).

As mentioned in the introduction, various collections of Mesolithic stone macro-lithic tools were discovered at many sandy sites in the Polish Lowland, *e.g.*, Pobiel 10 (Bagniewski 1990), Pomorsko 1 (Kobusiewicz and Kabaciński 1991), Luta 1 (Wieckowska-Chmielewska 2007), Bolków 1 (Galiński 2014), Ludowice 6 and Sąsieczno 4 (Osipowicz 2017, 68-71). However, the limited archaeological visibility of certain types of tools, especially those presenting minimal or no technological modifications, may have contributed to many tools being overlooked or interpreted as ordinary stones. However, as the example of stone tools discovered at the Pobiel 10 site shows, the first attempts to analyse their surface using low magnifications were also made (Bagniewski 1990). Nevertheless, these tools remain insufficiently understood, as no specialised analyses have been conducted to investigate their function.

A preliminary traceological and residue analysis of macro-lithic tools from site Paliwodzizna 29 has revealed the presence of technological and functional modifications as

well as well-preserved residues on their surfaces. The patterns of distribution and orientation observed in both macro and micro wear indicate the use of analysed non-flaked stones in activities involving thrusting and resting ("scraping") percussion including longitudinal movements. Similar gestures are used to soften dry hides, for example (compare Cristiani and Zupancich, 2020). The nature of the residues observed on the tools – fibres typical of Type I and Type III collagen- confirms functional interpretations based on the use-wear traces. Collagen is the most abundant mammalian protein and is commonly found in tendons, skin, ligaments, bone, the gut, and blood vessels. It is a crucial component of connective tissues, such as tendons, ligaments, skin, and bones. It provides structure, strength, and support. In tissues like skin and tendons, collagen fibres are arranged in bundles, providing tensile strength (Di Lullo *et al.* 2002; Stephenson 2015). More importantly, collagen can endure for extended periods in archaeological contexts, particularly within the thick-crystalline morphology of macro-lithic stone tool surfaces (Buonasera 2005; Field *et al.* 2009, 228). Different types of collagens can be distinguished, two of which have been identified on tools from Paliwodzizna 29. Type I collagen is the most abundant collagen and is found in virtually all connective tissues. It is a component of the interstitial matrix and the major structural protein of bone, skin, tendon, ligament, sclera, cornea, blood vessels, as well as being an important component of other tissues. Of these tissues, bone and skin are the organs with the most prominent functional role for type I collagen (Henriksen and Karsdal 2016). In turn, Type III collagen is a fibrillar collagen and, unlike most other collagens, consists of only one collagen *alpha* chain. This type of collagen is abundant in connective tissues such as skin, lung, liver, intestine and the vascular system, and is often associated with type I collagen, except in bone. Together with type I collagen, type III collagen is the major component of the interstitial matrix (Nielsen and Karsdal 2016). The observed tools from Paliwodzizna often exhibit a combination of use-wear and residues, which characteristic is frequently associated with sandstone macro-tools used for working hides (Cristiani and Zupancich 2020).

The obtained results are consistent with the situation at the site. Mammal remains constitute nearly 99% of all discovered bones. Among them, bones belonging to various-sized mammals were identified, including deer (0.6%) (Osipowicz *et al.* 2023). The significance of animal resources for the settled hunter-gatherers at Paliwodzizna is evident in the predominance of pike remains among the animal bones dating back to the second settlement phase at the site. Specifically, 52.5% of all bones are from the 'wetland' zone and a remarkable 92.8% of the fish bones belong to the pike species. This finding strongly suggests that an abundance of pike could constitute the main reason for visiting this place in the early Mesolithic (Osipowicz *et al.* 2023). Importantly, in the context of the obtained results, one of the bone accumulations was discovered right next to Feature 81, from which the analysed Specimen 1 originates. This could be indirect evidence that macro-lithic tools may have been important in processing animal materials at the site, including skin or meat.

Unfortunately, it is challenging to relate the obtained results to findings from other Polish Mesolithic sites due to the lack of more detailed analyses conducted on stone macro-lithic tools. Regrettably, products of this type were often overlooked in the detailed characterisation of sites, or their analysis ended with typological classifications or functional interpretations based solely on morphological features. Unfortunately, the situation doesn't look much better in other European regions, where we can also observe a substantial lack of information about these types of artefacts for the Mesolithic period. One of the more detailed studies relating to the function of macro-lithic tools was carried out in the context of materials from the Mesolithic site of Font del Ros (southeastern Pre-Pyrenees, Spain; Gilabert *et al.* 2012; 2016). The analysis revealed specific functions of ground stone tools that can be connected with particular domestic activities, including, among others, processing of fauna materials and hide-working. Analyses of macro-lithic tools from other European Mesolithic sites showed that tools of this type were often used for processing plant materials, for example hazelnuts in northern Germany (Holst 2010) and wild cereals in central Balkans (Cristiani *et al.* 2021). The versatility of ground stone tools at early Holocene hunter-gatherer sites suggests that they played an essential role in the daily lives of these communities, contributing to various aspects of their survival and cultural practices.

CONCLUSIONS

The article presents the preliminary results of the technological and functional analyses conducted on two macro-lithic artefacts from the Mesolithic site at Paliwodzizna 29 in central Poland. The role of macro-lithic tools in Mesolithic Europe remains poorly understood. The collection of macro-lithic tools from site Paliwodzizna 29 appears to be an excellent material for conducting traceological and residue research on Mesolithic stone tools. The obtained results indicate that both use-wear traces and residues on these materials are well-preserved and identifiable. Subsequent stages of the research will involve incorporating additional materials and conducting experimental work. This phase will consider the variability of stone raw materials and the specificity of local plant and animal raw materials that could have been processed using macro-lithic tools. In the future, they can serve as a foundation for comparative analyses and interpretations of similar artefacts in studies encompassing other sites in the region and across Europe. The research on the Paliwodzizna assemblage will be continued.

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WHAT HAS THE SEA TAKEN FROM US? COGNITIVE POSSIBILITIES OF STUDYING ARTEFACTS FROM NEWLY-DISCOVERED SUBMERGED PREHISTORIC SITES IN PUCK BAY (GULF OF GDAŃSK, BALTIC SEA)

ABSTRACT

Kurzyk K., Osipowicz G., Orłowska O. and Kuriga J. 2024. What has the sea taken from us? Cognitive possibilities of studying artefacts from newly-discovered submerged prehistoric sites in Puck Bay (Gulf of Gdańsk, Baltic Sea). *Sprawozdania Archeologiczne* 76/1, 251-284.

The article presents the latest results of research in the area of the Bay of Puck. After the last glaciation, the Bay of Puck was gradually flooded by sea water. As a result, we can expect submerged Stone Age sites in this area. The article discusses the latest results of underwater research in this area and analyses in detail four new underwater sites from this region, including a loose find of a *bâton percé* from Hel dated to about 7000 BC, a collection of flint artefacts, including a flint dagger and pottery from Late Neolithic/Protobronze Age site on Seagull Sandbar and two antler adzes from Site 23 in Puck. A typological and technological analysis of the artefacts was carried out, including analyses of working traces and radiocarbon dating.

Keywords: Baltic Sea, Puck Bay, submerged Stone Age sites, flint dagger, bâton percé, absolute chronology
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1. INTRODUCTION. SEARCHING FOR SUBMERGED PREHISTORIC SITES

During the last glacial and post-glacial periods, the southern Baltic area was dry land, with the terrain morphology characteristic for modern-day Pomerania, but was later submerged and partially destroyed by the sea. The southern Baltic area was free of ice approximately 15 500-15 000 BP (Gałka *et al.* 2018; Uścinowicz 2014). The retreat of the ice sheet between the Słupsk Bank and the southern Middle Bank approx. 15 000-14 500 BP led to the creation of the Baltic Ice Lake. In the period 11 700-11 500 BP, the sea level dropped to 55 m below the present day, which designates the maximum land area of the southern Baltic (Gałka *et al.* 2018, 23). These changes led to the transformation of the freshwater Baltic Ice Lake into the saltwater Yoldia Sea, which, during the subsequent geological changes, approximately 10 800-10 700 BP transformed into the freshwater Ancylus Lake (Gałka *et al.* 2018, 23; Uścinowicz 2014). The next phase of the evolution of the Baltic was the gradual forming of the brackish Littorina Sea. During the first stages (9 500-7 500 BP), the sea level was approximately 9-10 m lower than today (Gałka *et al.* 2018, 23; Uścinowicz 2014).

The early Holocene (Pre- Boreal and Boreal period) was also a time in which, thanks to the improvement of environmental conditions, forests with pine dominance developed (Gałka *et al.* 2018, 23). Sea water, for the first time, reached the contemporary Puck Lagoon region approximately 7.500 years ago. About a thousand years later, waters reached the contemporary Rzucewo Deep, marking the beginnings of the Puck Lagoon (Gałka *et al.* 2018, 24). Large areas of the region between Piaski Dziewicze and Piaski Zachodnie in Puck Lagoon still remained dry land with many areas of wetlands (Gałka *et al.* 2018, 24, 25, fig. 12d; Miotk-Szpiganowicz and Uścinowicz 2016).

After connecting with the ocean, the water level in the southern Baltic rapidly rose, and approximately 6000 BP it was 4 m lower than today. The last 6000 years were marked only with small changes to the sea level. At the end of the Atlantic period (about 6000 BP), most southern Baltic spits, bays and shore lakes were formed, and the coastline became "similar" to the modern one (Uścinowicz 1999; 2014).

The rising sea level is the reason why there are well-preserved remains of fossil submerged forests present in the Baltic Sea. These grew in the early Holocene and their remains lie on the seabed in Polish, Lithuanian, Danish, German and Swedish maritime areas, potentially indicating the areas with preserved sunken cultural paleolandscape (Fischer 1997; Žulkus and Girininkas 2020; Uścinowicz *et al.* 2011).

There is a possibility of discovering the underwater archaeological sites from the Stone Age on the submerged land in the southern Baltic Sea, especially in the Puck, Vistula and Szczecin Lagoons. This lagoon-maritime environment was undoubtedly alluring for the Stone Age hunter-gatherers. To this day, the maritime areas of Denmark are one of the better surveyed, namely the shores of the Jutland peninsula, the Danish archipelago and

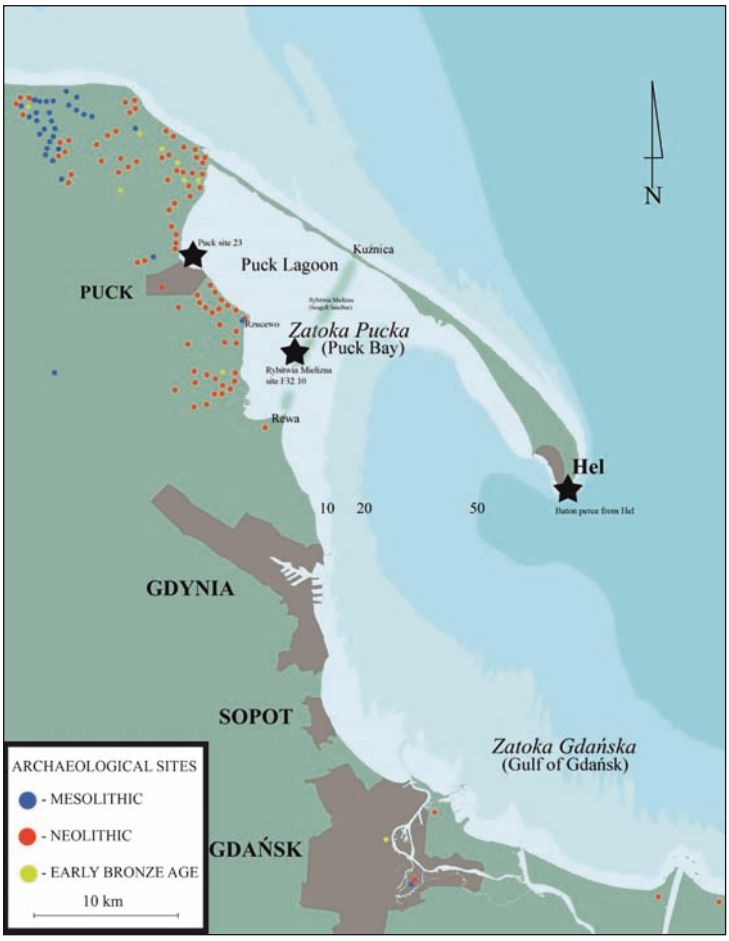


Fig. 1. Location of the sites from Puck Bay with the context of dry-land Stone Age-Early Bronze Age sites from Pomerania (after Król and Rudnicka 1990; Król 2015 with authors' modifications)

the Holstein shoreline, with the numerous underwater Stone Age archaeological sites studied and documented (Fischer and Vang Petersen 2018). The latest work has brought more discoveries in Mecklenburg-Vorpommern and on the southern coast of Sweden (Fischer 2018; Lübke *et al.* 2011). However, until recently, the Polish maritime areas have not been studied extensively.

Despite its potential, the land area around the Bay of Puck (the Kashubian Coast and the Hel Spit) is still an area with a poor state of archaeological research on the settlement of the Stone Age communities (Fig. 1). The settlements of the Rzucewo culture are relatively best recognized (in Rzucewo, Osłonino and Rewa), but there is still no complete monograph on the entire pottery material from the eponymic site in Rzucewo (Król and

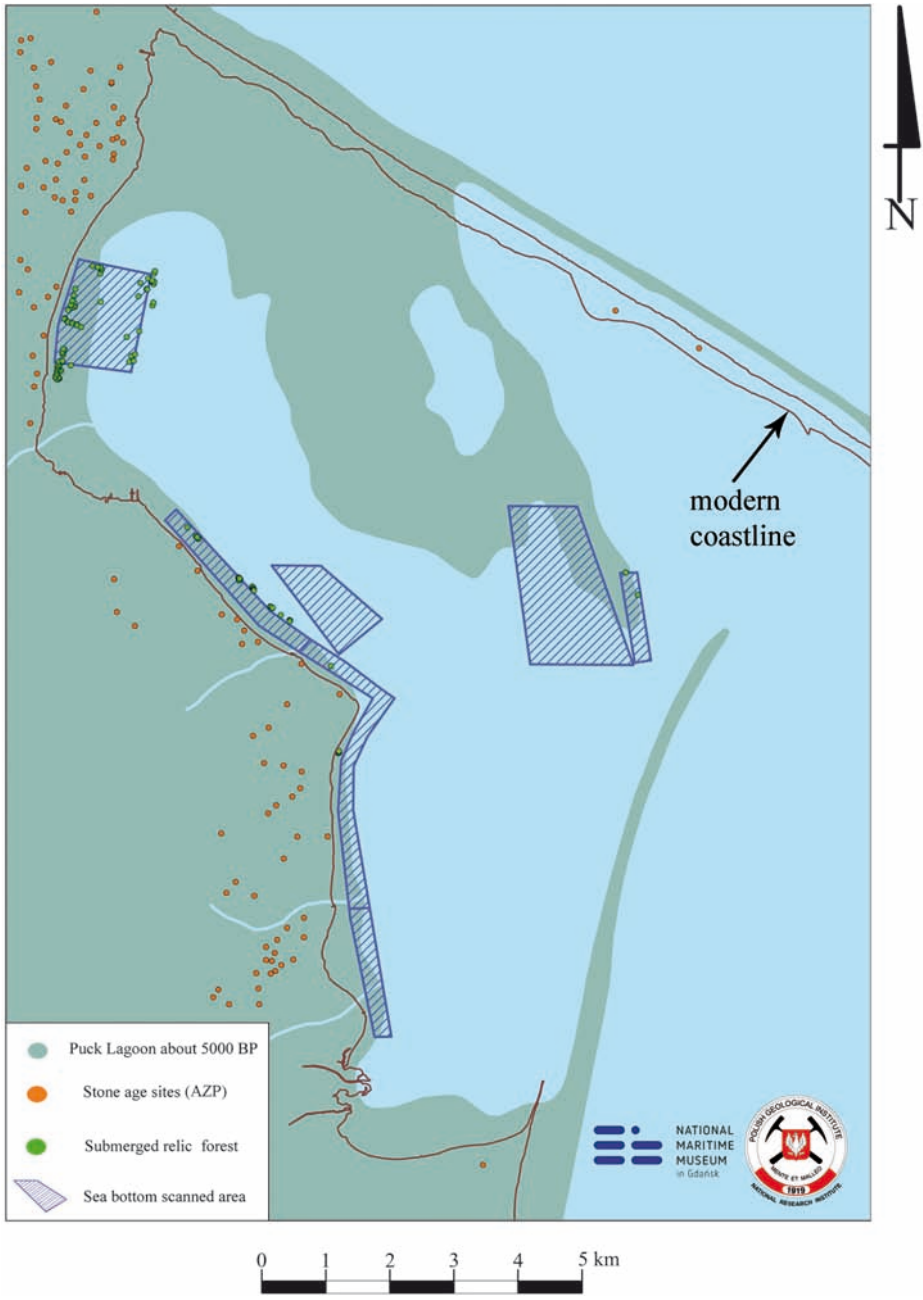


Fig. 2. Paleogeographic reconstruction of the shoreline c. 5000 BP (Puck Lagoon) with correlation of the sea scanned areas, drowned relic forest and terrestrial Stone Age sites from the Polish Archaeological Record (paleogeographic base map after Uścinowicz 2019 with modifications by J. Różycki and K. Kurzyk)

Schild 2009; Król 2018). Geologically it is the youngest region of the coastline, which could be inhabited only after the ice sheet had receded. During the latest research, several sites on the Kashubian Coastline region in the Żarnowiecka Upland have been found and dated to the Late Palaeolithic (Wąs 2009; 2012; 2018). From the perspective of current archaeological knowledge, the first more intensive traces of settlement in the areas surrounding the present Bay of Puck date back to the Atlantic period (Mesolithic, subneolithic communities and the first farmers), but the highest number of sites are probably associated with the Rzucewo culture from the Late Neolithic period, unfortunately, most of them are settlement traces discovered on the surface in a research program called (AZP) Polish Archaeological Record (Król 2015; 2017; Król and Rudnicka 1990).

The existence of as yet undiscovered submerged archaeological sites in this area is probable. Because of the erosive effects of water movement, the areas of the seabed with preserved Stone Age paleo landscape relics such as peat layers and remains of submerged tree trunks are especially interesting as a place with the greatest potential to preserve hard-to-discover submerged Stone Age artefacts.

During the last few years, our team from the Underwater Archaeology Department of the National Maritime Museum in Gdańsk (NMM) has analysed the land Polish Archaeological Record (AZP), correlating their location with the paleogeographic analysis of the prehistoric coastline performed by the Polish Geological Institute (Uścinowicz 2019). Several test areas in Puck Lagoon were selected and scanned with the side-scan sonar (Fig. 2). The initiating research was conducted by the team of the NMM as a part of the Interreg project Baltic RIM, which has contributed to the integration of coastal and underwater cultural heritage into maritime spatial planning in the years 2017-2020 (Lehtimäki *et al.* 2020). The scanning results were later verified by underwater archaeologists by field survey. The discovered remains of the submerged stone age forests (mostly roots and lower parts of tree trunks) and peat layers were found on the seabed, at small depths of 1.5 to 4 metres (Fig. 3, 4: A). During the field survey, samples were taken from the submerged tree trunks and peat, of these 26 have been radiocarbon dated in the Laboratorium Datowań Bezwzględnych in Kraków by Marek Krąpiec: in the Swarzewo area, dates span from 9580±50 BP (MKL-4590) to 9000±50 BP (MKL-4755), in the Puck-Rozgard area, they are 9610±40 BP (MKL-5062) and 9260±35 BP (MKL-5062); in the Jastarnia area, dates of 6360±40 (MKL-5385) and 6310±40 BP (MKL-5384) and in the Rzucewo area, from 7070±50 BP (MKL-4596) to 5930±50 BP (MKL-4597).

Since 2019, a team of underwater archaeologists from the NMM has been investigating these areas, several small underwater test trenches in the seabed were carried out using a set of sieves connected to an ejector in the area of Rzucewo (Fig. 4: B). Unfortunately, so far, no Stone Age artefacts have been discovered at the bottom at any of the sites with preserved submerged palaeolandscapes.

Since 2017, a search has also been carried out in the NMM collections. As a result, it was possible to discover two prehistoric antler adzes from an underwater site – the remains of

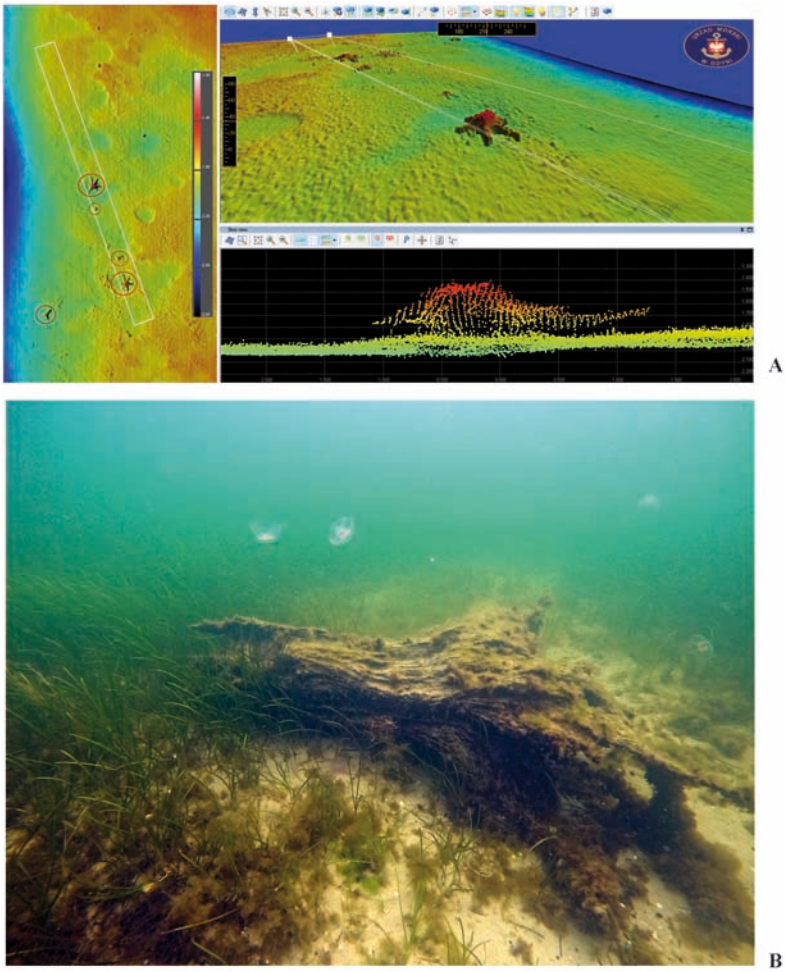


Fig. 3. A – Seabed sonar scan with the visible drowned forest from the Stone Age near Jastarnia (Maritime Office in Gdynia, Jacek Koszałka), B – The underwater photography of one of the Stone Age radiocarbon-dated drowned tree trunks – Pinus sylvestris (K. Kurzyk) (Illustration by K. Kurzyk)

the medieval harbour in Puck (Figs 6-7). Both adzes were found in 1997-1998, during the underwater research and inventory of medieval wooden port structures (piles and elements of quays and piers), which was led by Iwona Pomian. Both artefacts had been found on the sea bottom without context in two separate spots on the measurement grid, hectares 9G/44/A (adze no. P/92/97) and 9F/100/B (adze no. P/136/98).

The year 2022 was a lucky season for us. Holidaymakers enjoying the charms of the Bay of Puck have found and enriched the NMM's collections with some new, very interesting artefacts.



Fig. 4. A – Submerged relic forest and fossil peat near Rzucewo, B – Test trenches in seabed with use of a set of sieves connected to an ejector near Rzucewo (Illustration by K. Kurzyk)

At the beginning of August 2022, an antler *baton percé* was found on a sandy beach in Hel City (Fig. 8). This artefact (no. Hel/1/2022) was discovered without archaeological context; probably, it was washed up by the sea from an eroded submerged Stone Age site.

At the end of August 2022, we received from another two members of the public information for verification about new underwater site in Puck Bay. This was the Rybitwia Mielizna [Seagull Sandbar], site no. F32.10 in the Register of Underwater Archaeological Sites of the National Maritime Museum in Gdańsk (EPSA). The official name of the site in Polish is Rybitwia Mielizna, but local traditional names like Mewia Rewa or Ryf Mew are

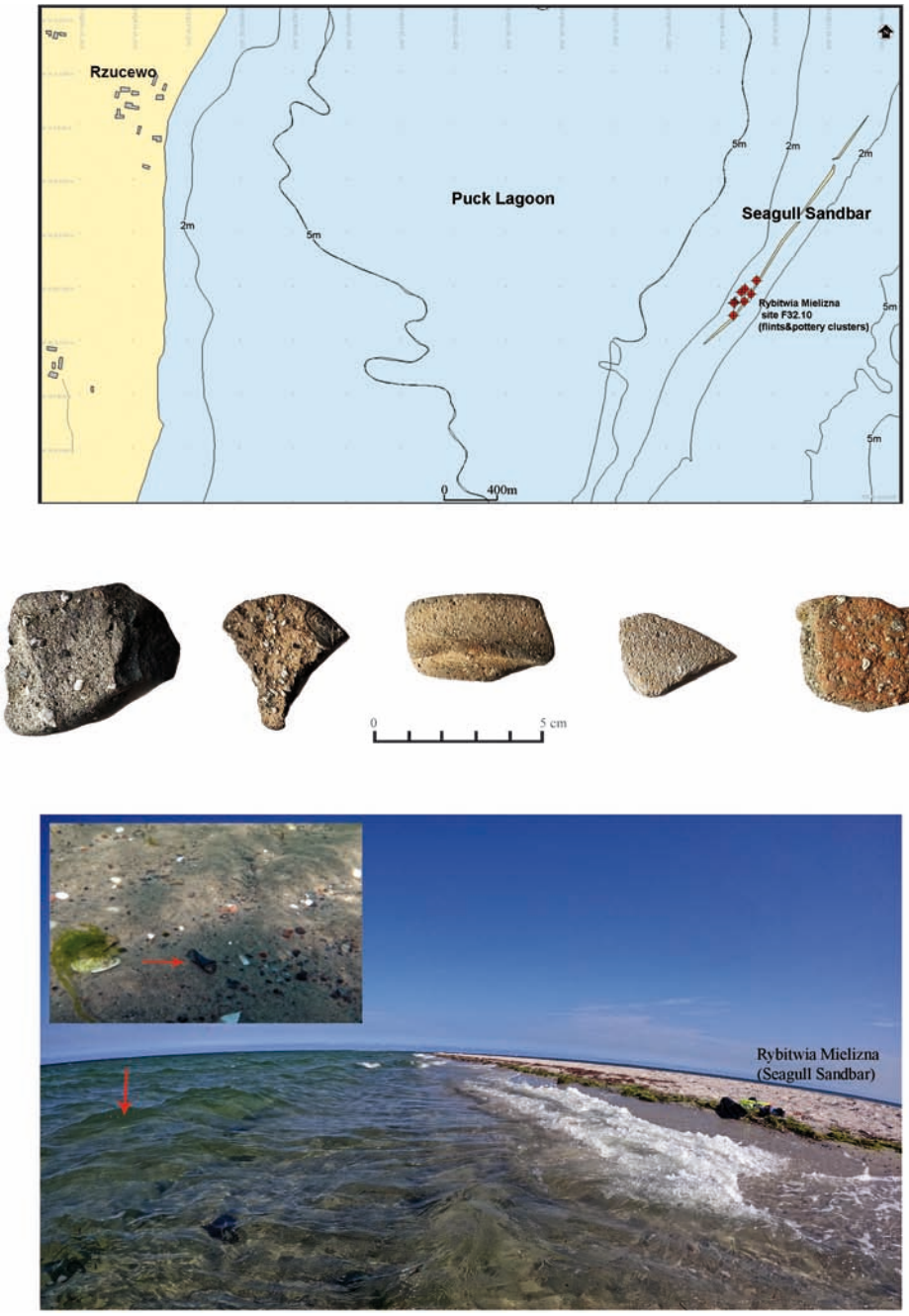


Fig. 5. A – Seagull Sandbar, a view direct to Kuźnica, B – Late Neolithic/Proto-Bronze pottery, C – One of the flint artefacts visible on the seabed (red arrow) (Illustration by K. Kurzyk)



Fig. 6. Puck, Site 23 (Puck Lagoon), antler axe (no. P/143/98)
(drawing P. Dziewanowski; illustration by G. Osipowicz)

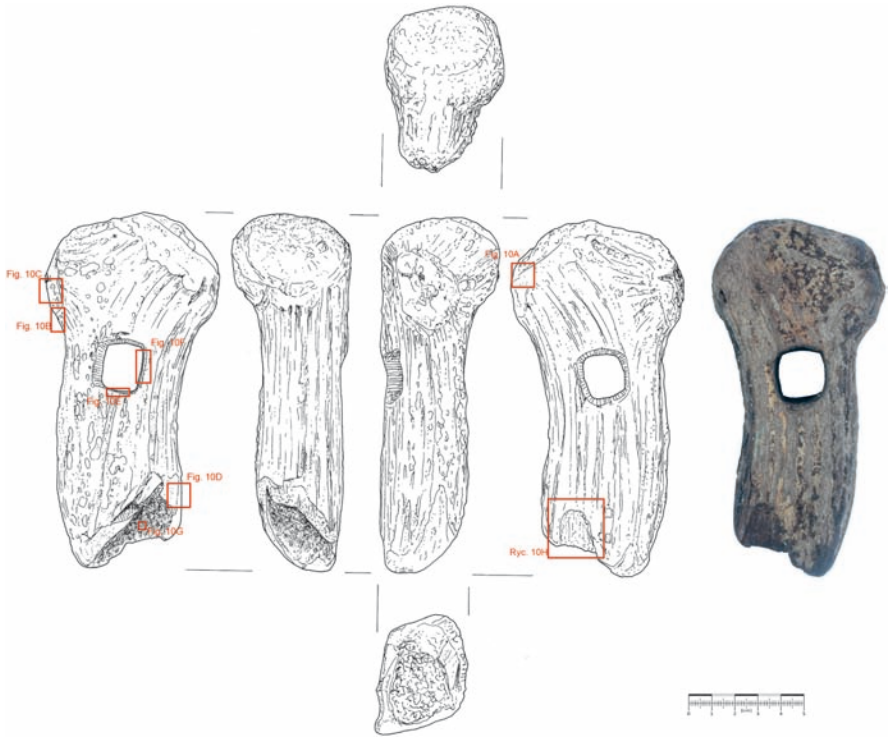


Fig. 7. Puck, Site 23 (Puck Lagoon), antler adze (no. P/892/97
(drawing P. Dziewanowski; illustration by G. Osipowicz)

also still in use. During a holiday cruise along this sandbar in the middle of the Puck Lagoon, Sylwia and Jacek Klekowicki discovered a collection of 86 flints with traces of processing, including a flint dagger (Fig. 14: 6). On the 24th of August our team of underwater archaeologists conducted a surface and underwater inspection. The site is located in shallow water (up to 0.5 m deep) in the coastal zone of a small sandbank forming the Seagull Sandbar. During the inspection, another 98 flints, 6 fragments of pottery and a fragment of an animal tooth (destroyed wild boar's tusk?) were found. The artefacts occur on the surface of the sandbank and in the surf zone (Fig. 5). During the underwater survey, no remains of archaeological features were observed. A small fragment of eroded fossil peat bed was also located at the bottom.

It is very difficult to clearly define the function of the site Rybitwia Mielizna, site F32.10, but we can probably interpret the discovered artefacts as evidence of a short-term encampment, probably in connection with seasonal fishing and hunting for birds and seals. Until the 20th century, the Seagull Sandbar was a place of seasonal seal hunting. In fact, this feature is a natural sandy shallow connection in the direction from Rewa to Kuźnica in the Hel Peninsula; when the water level is low, it is possible to cross the Bay of Puck on foot.

2. MATERIALS AND METHODS

The subject of the research reported in the article is a collection of flint artefacts (184 specimens) originating from the archaeological Rybitwia Mielizna, Site F32.10 and three finds of loose artefacts made of antler: two adzes (inv. no. P/143/98; Fig. 6; in. no. P/92/97; Fig. 7) from Site 23 in Puck, and a so-called *baton percé* (inv. no. Hel/1/2022) found on the Hel Peninsula, washed ashore by the sea on the beach in the town of Hel (Fig. 8).

These artefacts underwent a comprehensive analysis, including typological, technological, and traceological tests, as well as dating through the AMS method for antler artefacts.



Fig. 8. *Bâton percé* from the Hel city's beach (no. Hel/01/2022) (Illustration by G. Osipowicz)

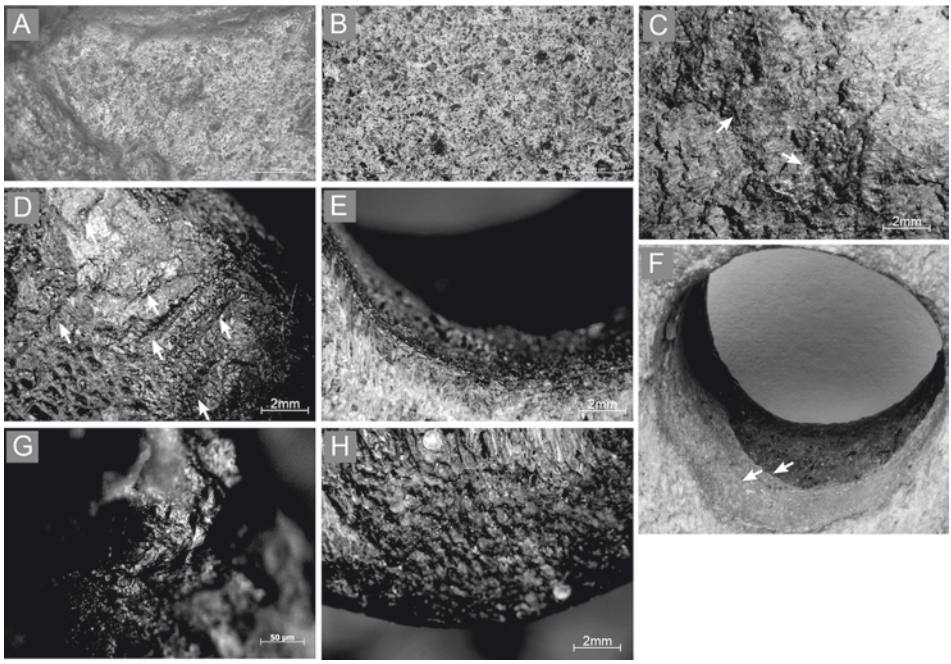


Fig. 9. Examples of post-depositional damage observed on flint artefacts from Rybitwia Mielizna, site F32.10 (A, B) and technological traces (C-F) and possible use-wear traces (G, H) visible on antler adze from Puck, Site 23 (inv. no. P/143/98) (Illustration by G. Osipowicz)

The flint materials were subjected to technological and typological analysis based on the dynamic technological analyses (DTA) method (Schild *et al.* 1975), considering its adaptation to Neolithic materials (Domańska and Kabaciński 2000) and the specifics of the assemblage under study. In the case of the description of bifacial forms, the bifacial points classification system proposed by J. Libera (Libera 2001) was used.

Due to macroscopically noticeable extensive post-depositional damage to the surfaces of the flint artefacts from the site Rybitwia Mielizna, site F32.10, in the preliminary (test-verification) traceological examinations, only the objects morphologically classifiable as tools included in the collection were subjected to analysis. For the antler items, all artefacts mentioned in the article were analysed. Two of them (both adzes) had undergone conservation processes of unspecified scope earlier, and the third artefact (*baton percé*) was provided for analysis in a "wet" state (recently recovered from water).

The prehistoric artefacts described in the article were discovered over several years, and as a result, different microscopic equipment was used for their traceological analysis (depending on what was available to the authors at the time). The antler adzes from the Puck 23 site were analysed using three microscopes. Technological studies and initial stages of functional analysis were conducted using a microcomputer set Nikon SMZ-2T. This

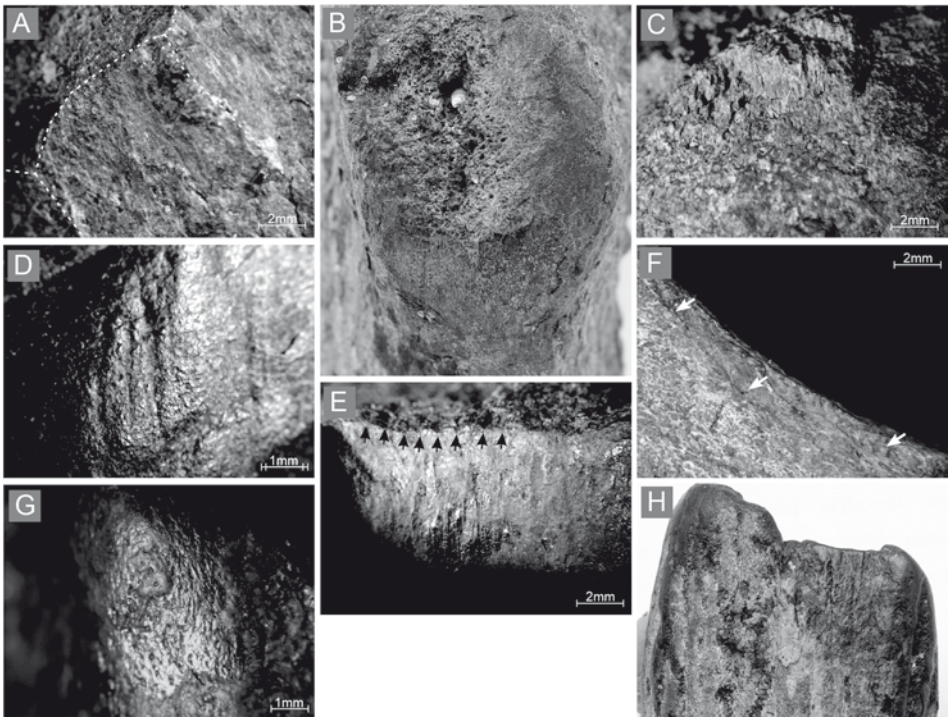


Fig. 10. Examples of technological traces (A-F) and possible use-wear traces (G, H) visible on antler adze from Puck, Site 23 (inv. no. P/892/97) (Illustration by G. Osipowicz)

allows obtaining objective magnifications up to 12.6x (actual magnifications up to 120×). At this stage of work, a microscope Carl Zeiss™ SteREO Discovery V8 was also used (actual magnifications up to 80×), equipped with a photographic camera Canon A620. With its help, photographs presented in Fig. 9: C-E, G, H and Fig. 10: A, C-G were taken. Observations of polish were conducted using a Zeiss-Axiotech, which allows obtaining objective magnifications up to 50× (actual magnifications up to 500×). It was also used to take photographs presented in Fig. 9: A, B.

Different equipment was used for the analysis of the flint artefacts from the "Mewia Rewa" site and the *baton percé* from the Hel Peninsula. The condition assessment of these artefacts, as well as the preliminary analysis of technological and functional traces present on the antler artefact, were conducted using an optical microscope Nikon SMZ-745T (up to 65× magnification) fitted with a Delta PixInvenio6EIII camera. The latter was used to take the photomicrographs presented in Fig. 11: A-I. Observations of polish were conducted using a Zeiss Axioscope 5 Vario microscope fitted with an Axiocam 208 camera. This allows obtaining objective magnifications up to 50× (actual magnifications up to 500×). Microphotographs were taken using it and presented in Fig. 11: J, K. The remaining pho-

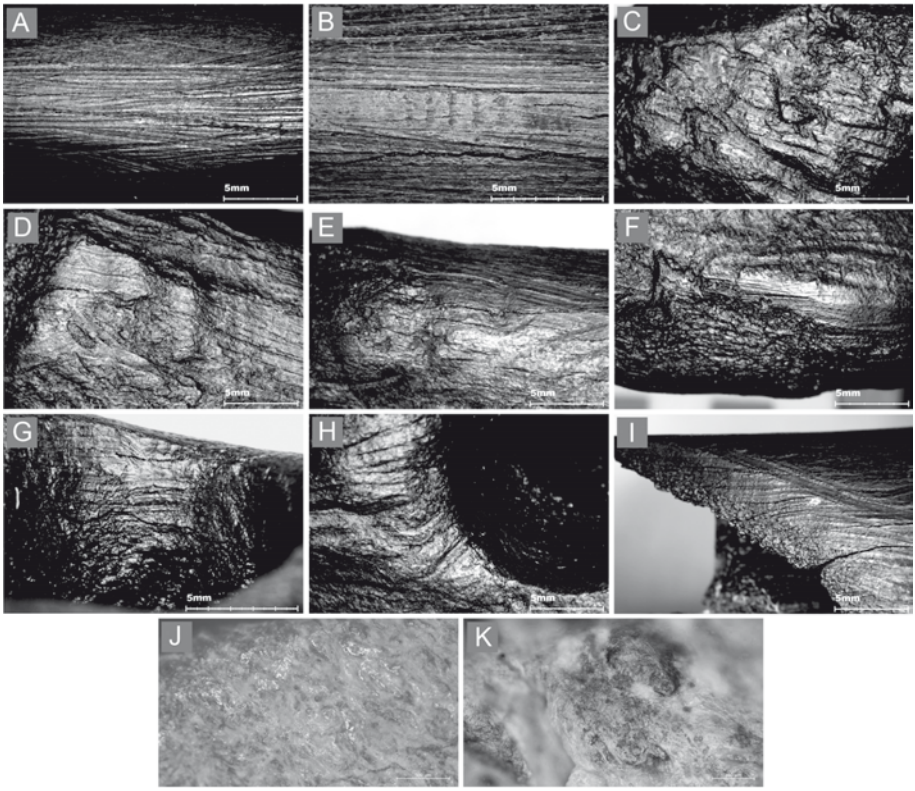


Fig. 11. Examples of technological traces (A-I), post-depositional damage (J) and possible use-wear traces (K) visible on the *bâton percé* from Hel (inv. no. Hel/01/2022) (Illustration by G. Osipowicz)

tographs included in the study (Fig. 9: F; Fig. 10: B, F, H) were taken using a Canon EOS 550D digital camera.

The terminology applied in the presented studies was based on the published conceptual system (Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Korobkowa 1999; Legrand 2007; Osipowicz 2010; Buc 2011), adjusted to the purposes and requirements of the analysis.

The samples for dating were taken from the three artefacts made from antlers. To do this we used a high-speed multi-tool with a core drill bit. Before sampling, the drill bit was cleaned using acetone. Care was taken to avoid damaging any technological, functional, or diagnostic traces and parts of the artefacts during the sampling process in order to preserve as much information as possible for future studies. The samples were dated in the Poznań Radiocarbon Laboratory, Poland. The ^{14}C age was calibrated using IntCal20 (Reimer *et al*. 2020) with OxCal ver. 4.4.4 (Bronk Ramsey 2021). Calibrated dates are reported within 95.4% highest probability density function.

3. RESULTS

3.1. Pottery

The six pottery sherds discovered (Fig. 5: B) with a mineral, sand and mica slimming admixture, were made in a technology typical for the Late Neolithic/Proto-Bronze Age in Pomerania (2300-2000 BC – Bokiniec 1995; Czebreszuk 2001; Czebreszuk and Kozłowska-Skoczka 2008). The surface of the vessels had been destroyed by the sea. The technology of pottery is typical for the Late Neolithic/Proto-Bronze sites from Pomerania (Late Corded Ware culture horizon, Grobsko-Śmiardowska culture) and for so-called "kitchen pottery" of Iwno culture settlements sites in Eastern Pomerania and Chełmno land (Bokiniec 1995; Kurzyk and Ostasz 2015; Wadyl and Kurzyk 2018).

3.2. Results of the typological and morphological analysis of the flint artifacts

A total of 184 flints discovered in eight small clusters were submitted for analysis. Within this collection, 129 flints were identified as man-made artefacts, while 54 specimens were categorised as natural forms (omitted in the present study). Due to the origin of the materials from a mixed context and their relatively homogeneous nature/uniform character, the collection was analysed as a whole, without attempting to divide it into individual clusters.

Out of the 129 flint artefacts, 89 specimens were crafted from Pomeranian flint (constituting 69% of the collection), 37 from Baltic flint (28.7%), 1 from banded flint (0.8%), and in the case of 2 specimens (1.6%) determining the raw material was not possible due to intense patina on their surface.

In the group of items from the preparation and early stages of core processing, only one cortical flake was identified, similar to the group related to flakes reduction, to which one flake from the changed orientation core was assigned (Table 1). The contribution of both groups to the total/overall material is negligible at 0.8% each.

Seven flint artefacts were assigned to the blades' reduction group, accounting for 5.4% of the collection. Two single platform blade cores were distinguished here. The first is a single platform blade core, conical with a rounded flaking face and prepared striking platform measuring 30 × 14 × 11 mm (Fig. 12: 1). The second is a heavily exploited single platform blade core measuring 35 × 11 × 10 mm (Fig. 12: 2). The material also included three blades from single platform cores measuring 22 × 9 × 3 mm (Fig. 12: 3), 40 × 11 × 3 mm (Fig. 12: 4), 21 × 5 × 4 mm, and a fragment of the proximal end of a blade, as well as one bladelet measuring 17 × 6 × 3 mm knapped from a changed orientation core.

The splintered pieces' reduction group constitutes the most numerous technological group in the analysed collection. A total of 99 flint artefacts were classified into this group, accounting for 76.7% of the entire collection (Table 1). This includes 3 unipolar one-sided

Table 1. The technological structure of the flint assemblage from the Rybitwia Mielizna Site F32.10

Group	Amount	%	Category	Amount	%
Group I – Preparation and early stages of core processing	1	0,8	Cortex flakes	1	0,8
Group II – Flakes' reduction	1	0,8	Flakes from the changed orientation cores	1	0,8
Group III – Blades' reduction	7	5,4	Single platform blade cores	2	1,5
			Blades from the single platform cores	4	3,1
			Blades from the changed orientation cores	1	0,8
Group IV – Splintered pieces' reduction	99	76,7	Unipolar one-sided splintered pieces	3	2,3
			Bipolar one-sided splintered pieces	7	5,4
			Unipolar two-sided splintered pieces	2	1,5
			Bipolar two-sided splintered pieces	14	10,8
			Diagonal two-sided splintered pieces	1	0,8
			Combined two-sided splintered pieces	22	17
			Cortex flakes from the splintered pieces	12	9,3
			Flakes from the splintered pieces	37	28,7
			Blades from the splintered pieces	1	0,8
Group V - Repairs	1	0,8	Overpassed blades	1	0,8
Group VI – Indeterminate specimens, chipping debris and retouch	10	7,7	Indeterminate flakes	3	2,3
			Wastes	7	5,4
Group VII – Tools and characteristic wastes from their production	10	7,7	Endscrapers	3	2,3
			Scrapers	1	0,8
			Perforators	1	0,8
			Borers	1	0,8
			Sidescrapers	1	0,8
			Bifacial points	1	0,8
			Truncated blades	1	0,8
			Flakes from axes	1	0,8
Total	**129**	**99,9**		**129**	**100**

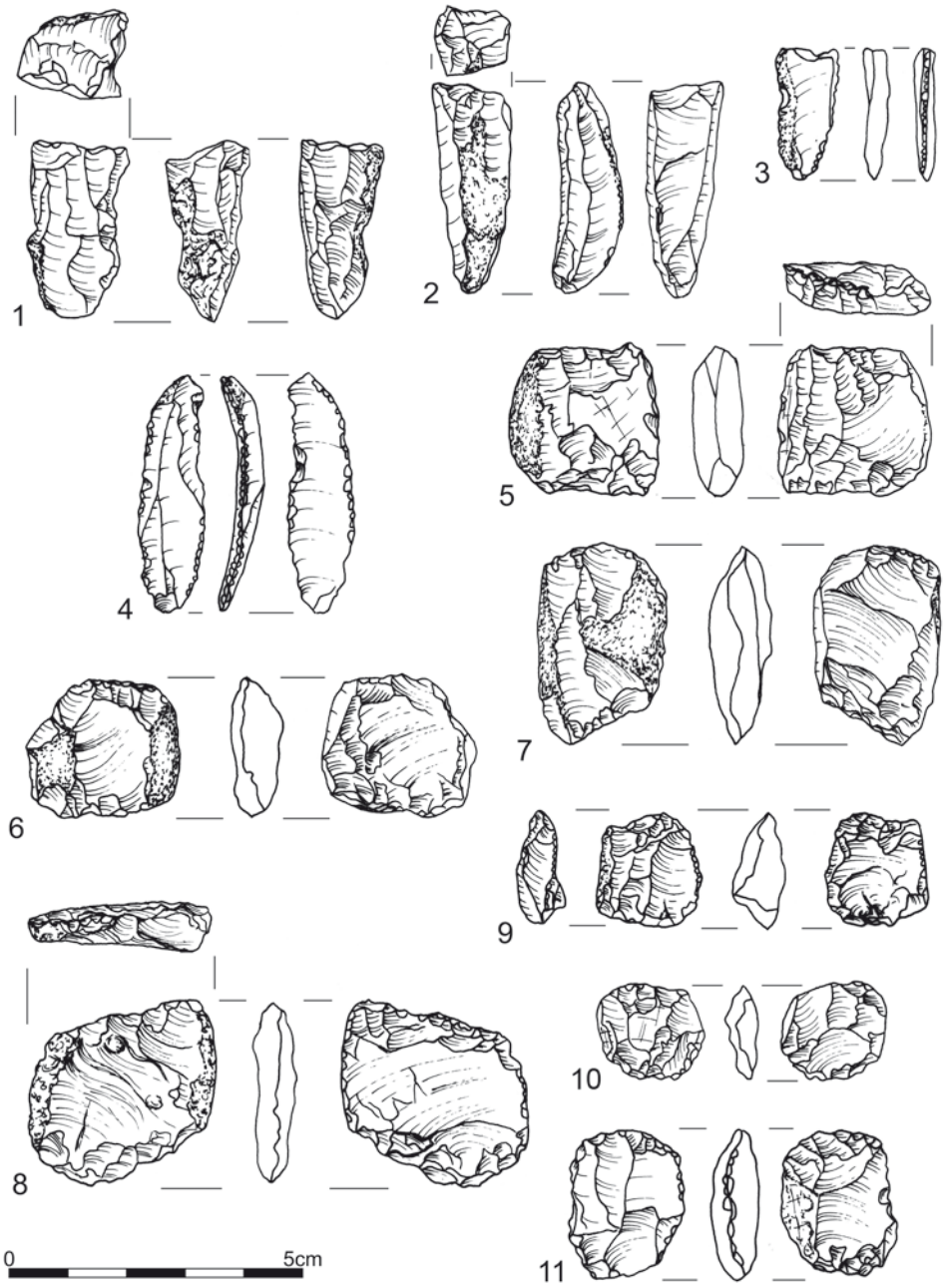


Fig. 12. Rybitwia Mielizna Site F32.10.
Selection of flint artefacts: 1, 2 – cores, 3, 4 – blades, 5-11 – splintered pieces
(drawing D. Nowak)

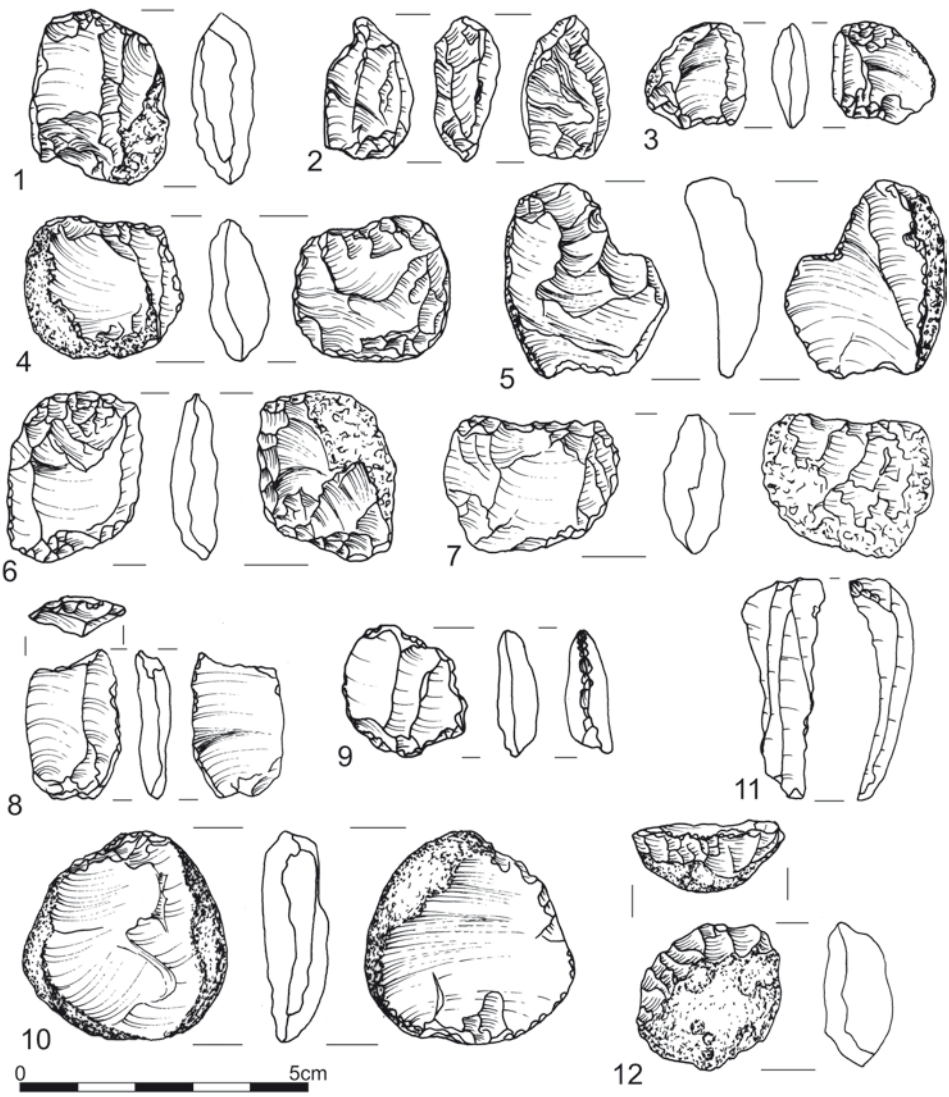


Fig. 13. Rybitwia Mielizna Site F32.10.
Selection of flint artefacts: 1-7 – splintered pieces, 8-10 – flakes, 11 – overpassed blade, 12 – end scraper (drawing D. Nowak)

splintered pieces, 7 bipolar one-sided splintered pieces, 2 unipolar two-sided splintered pieces, 14 bipolar two-sided splintered pieces (Fig. 12: 5-11; Fig. 13: 1), one diagonal two-sided splintered piece, and 22 combined two-sided splintered pieces (Fig. 13: 2-7). The dimensions of the mentioned splintered pieces range from 16 to 45 mm in length (average 25 mm), 10 to 38 mm in width (average 22 mm), and 3 to 12 mm in thickness (average 7 mm)

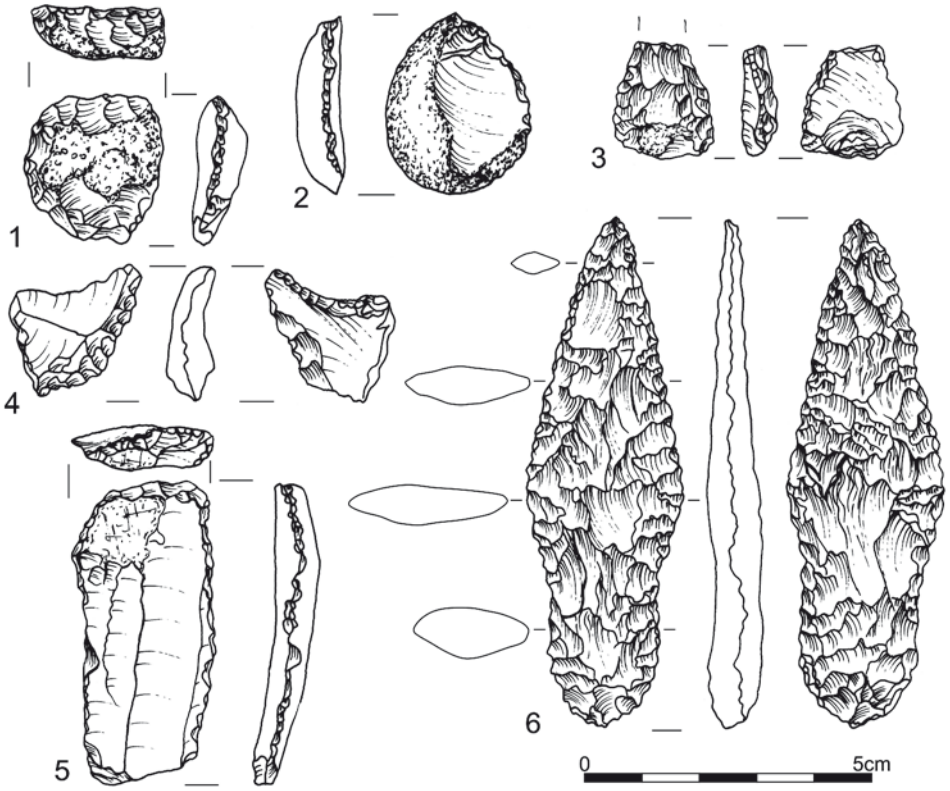


Fig. 14. Rybitwia Mielizna Site F32.10. Selection of flint artefacts:
1 – end scraper, 2 – scraper, 3 – perforator, 4 – borer, 5 – truncated blade, 6 – bifacial point
(drawing D. Nowak)

(Fig. 15). In this group, there are also 12 cortex flakes from splintered pieces ranging from 20 to 34 mm in length (average 27 mm), 12 to 31 mm in width (average 21 mm), and 3 to 8 mm in thickness (average 5 mm). The most numerous category in both the group and the entire collection (28.7%) consists of 37 negative cortical splintered piece flakes and their fragments, among which there are 10 unipolar flakes (Fig. 13: 8) measuring from 15 to 29 mm in length (average 23 mm), 13 to 35 mm in width (average 20 mm), and 3 to 10 mm in thickness (average 6 mm); 14 bipolar flakes (Fig. 13: 9, 10) with a length ranging from 17 to 35 mm (average 25 mm), width from 12 to 35 mm (average 20 mm), and thickness from 3 to 10 mm (average 6 mm); and 8 diagonal flakes measuring from 14 to 29 mm in length (average 21 mm), 16 to 24 mm in width (average 18 mm), and 2 to 6 mm in thickness (average 4 mm) (Fig. 16).

In the repairs group, only one overpassed blade from a single platform core, measuring 38 × 11 × 4 mm, was identified (Fig. 13: 11).

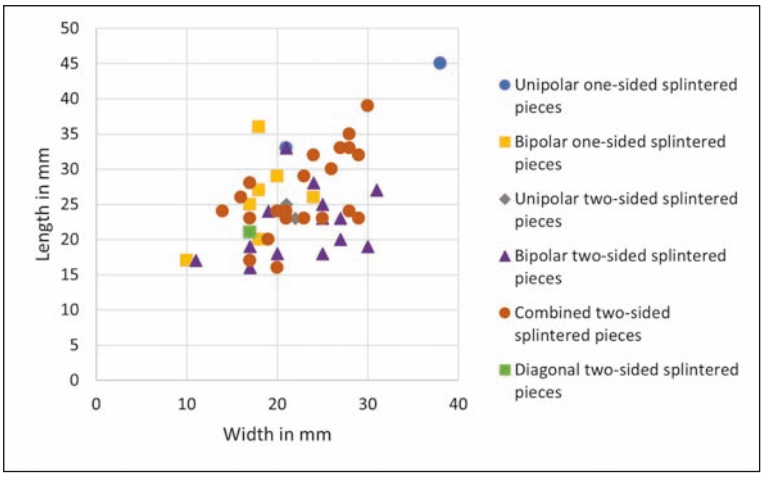


Fig. 15. Metric diagram of splintered pieces from the Rybitwia Mielizna Site F32.10

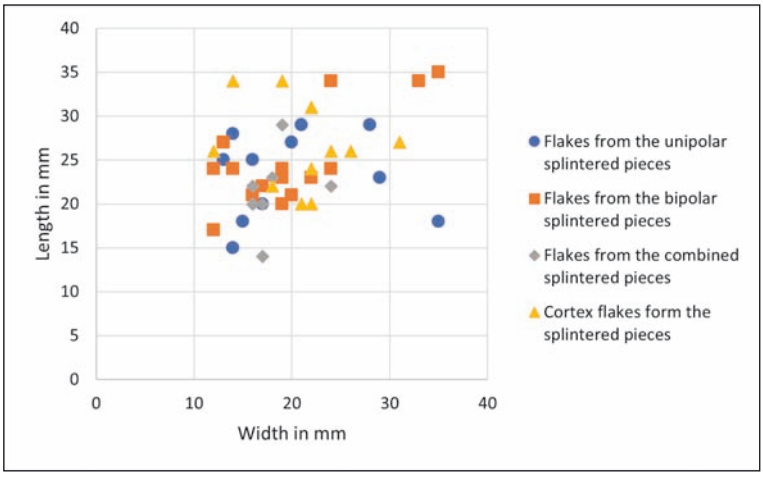


Fig. 16. Metric diagram of flakes from the splintered pieces from the Rybitwia Mielizna Site F32.10

The group of indeterminate specimens, chipping debris and retouch, is represented by three indeterminate flakes and seven wastes.

The group of tools and characteristic waste from their production include 10 flint artefacts, accounting for 7.7% of the entire collection. The most numerous category in this group was end scrapers, represented by three specimens – two end scrapers measuring 22 × 15 × 5 mm and 25 × 23 × 10 mm made from flakes (Fig. 13: 12) and one round end scraper measuring 25 × 23 × 8 mm with incomplete retouch (Fig. 14: 1). Among the tools,

a scraper measuring 30 × 25 × 7 mm made from a flake was also identified (Fig. 14: 2), as well as a single specimen of a perforator with broken point measuring 19 × 18 × 6 mm (Fig. 14: 3). There is also one borer on a flake (which could be classified as a scraper with alternate retouch and both sides converging) measuring 28 × 19 × 7 mm (Fig. 14: 4), as well as a bilateral double side scraper with parallel, straight and curved sides made on a cortical flake measuring 40 × 26 × 7 mm, and a truncated blade on a blade from a single platform core measuring 53 × 23 × 6 mm (Fig. 14: 5) made of Baltic flint with patinated surface. In this group, one specimen of a bifacial point with a length of 87 mm and a width of 28 mm, featuring a poorly defined long tang and a leaf tip, was also distinguished (Fig. 14: 6). Detailed measurements of the tool allowed its classification in J. Libera's typology as a bifacial point of subtype B, variety BA, subvariety II, variant 2 (BA II 2) – bifacial point with a weakly differentiated tang at the base, a leaf tip, and a slender form. In this group, there is also a flake from a polished axe made of banded flint measuring 32 × 21 × 5 mm.

3.3. The results of the morphological-typological analysis of the included antler artefacts

The adze included in the study (inv. no. P/143/98) from site 23 in Puck (Fig. 6) was crafted from the base of a red deer antler beam (beam base), namely from the vicinity of the burr and the place where its branch, known as the brow tine, originates. The object is characterised by a longitudinal, diagonally cut blade opposite a blunt-ended head and a relatively large shaft hole (diameter approximately 2.4 cm). The orientation of the blade and the hole are consistent.The length of the adze is 22 cm, the width is 5.8 cm, and the height is 4 cm. The tool can be classified as Type IA, according to Jolanta Ilkiewiczowa (2010). The form of the specimen is quite unusual and may represent a kind of zoomorphic stylisation, possibly imitating a bird's head, perhaps that of a duck or swan (Fig. 6).

Similarly, the second of the analysed antler artefacts (adze, inv. no. P/92/97 – Fig. 7) was made from the base of a shed antler. Its blade is very short and partially damaged. It is difficult to unequivocally determine its orientation relative to the axis of the shaft hole, whose cross-section is close to a rectangle. The length of the specimen is 15.5 cm, the width is 7.6 cm, and the height is 5.1 cm. The dimensions of the perforation are 2.3 × 2.1 cm. The tool can be classified as Type IA or IB, according to Jolanta Ilkiewiczowa (2010).

The analysed *baton percé* from Hel (such artefacts are also referred to as *bâton de commandement, lochstab, or mattock*; *cf.* Płonka 2003, 28) is characterized by a diagonally cut blade (partially broken) and a relatively large hole (diameter approximately 1.7 cm) located close to the burr (Fig. 8). The blade is oriented perpendicular to the axis of the hole. The specimen has a length of 22 cm and a diameter of about 2.5-3 cm (in the central part). This artefact, too, was crafted from the beam base of a red deer antler.

It is generally accepted that early Holocene *batons percés* can be relatively dated based on their size, diameter, and the method of perforation (Płonka 2003). Boreal and early

Atlantic specimens typically have a length of about 40-50 cm and a width of about 3.3-4.3 cm. Younger *bâtons* are usually longer (about 50-70 cm) and narrower (about 2.7-4 cm), with smaller holes. The specimen analysed in the article should be classified among early Mesolithic forms, noting that it is significantly smaller than "standard" forms.

3.4. The results of absolute dating

All three antler artefacts included in this study underwent absolute dating using the AMS method (Table 2, Fig. 17).

The data obtained for the *bâton percé* from Hel: 7326-7052 cal BC (Poz-168045, 8160 ± 50 BP) indicates a Boreal origin of the artefact or the AT1 phase of the Atlantic period, according to Starkel *et al.* (2013).

The datings of the other two artefacts are similar. Adze inv. no. P/143/98 obtained dating of 1436-1264 cal BC (Poz-93212, 3095 ± 35 BP), and adze no. P/92/97 obtained a dating of 1601-1418 cal BC (Poz-93211, 3225 ± 35 BP). Both dates indicate the Subboreal period

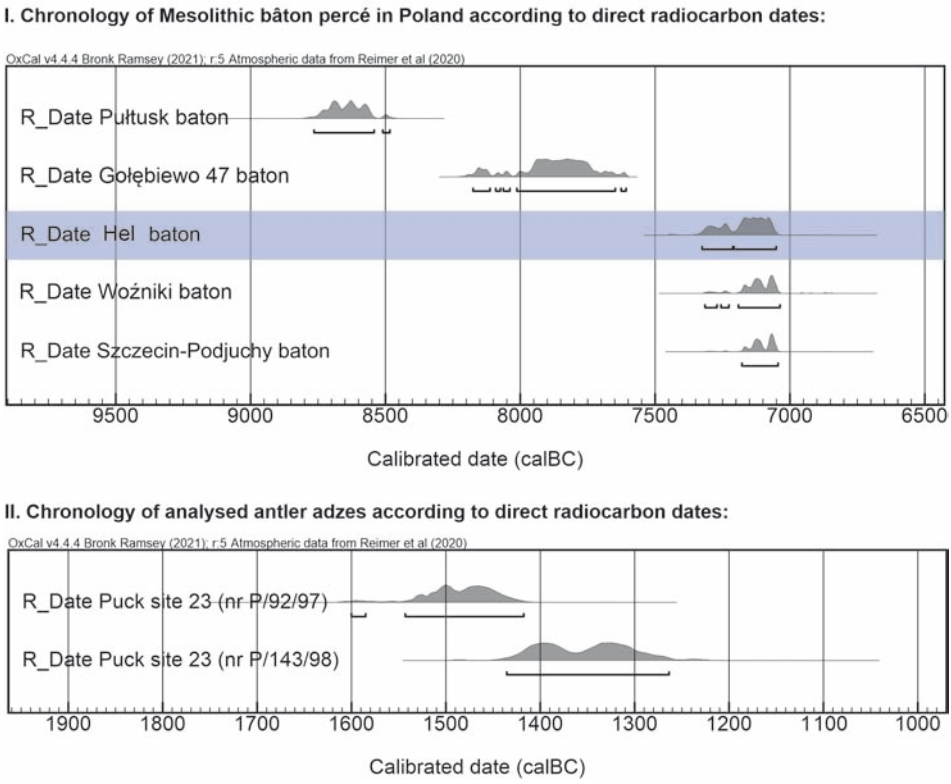


Fig. 17. Results of radiocarbon dating of antler artefacts

Table 2. Antler artefacts, results of the radiocarbon dating

Site	Type of tool, inv. No.	Laboratory code	Date uncal BP	cal BC (95.4%)	Collagen yield (%)	Nitrogen fraction in bone (%)	Carbon fraction in bone (%)	Chrono-stratigraphic phase	Chronology
Hel	Bâton percé, inv. No. Hel/1/2022	Poz-168045	8160 ± 50 BP	7326-7052	0.17g + additional mater	4,2	11,1	Boreal	Mesolithic (Maglemose culture)
Puck 23	Antler adze, inv. No. P/92/97	Poz-93211	3225 ± 35 BP	1601-1418	14	6,4	16,9	Subboreal	Middle Bronze Age (Pre-Lusatian culture?)
Puck 23	Antler adze, inv. No. P/143/98	Poz-93212	3095 ± 35 BP	1436-1264	11	6,2	16,3	Subboreal	Middle Bronze Age (Pre-Lusatian culture?)

(SB2 phase according to Starkel *et al.* 2013), falling within the II period of the Bronze Age according to Oscar Montelius (1986), or the Bronze Age B-C according to Paul Reinecke (1965).

3.5. Results of traceological analysis

The test-verification traceological analyses conducted on selected flint artefacts from the Rybitwia Mielizna Site F32.10, revealed exceptionally extensive fracturing and rounding of all edges, along with the coverage of their surfaces with a type of patina that completely destroyed potential use-wear traces (Fig. 9: A, B). Consequently, it rendered functional studies impossible. For this reason, the traceological analysis of the remaining artefacts in this collection was abandoned. Microscopic examinations of the antler artefacts were also hindered by significant post-depositional damage and the presence of various contaminants on their surfaces, including sponge remains and residues from other marine organisms. The results of the analysis of individual items will be discussed independently.

Adze from Puck, site 23 (inv. no.P/143/98, Fig. 6)

The original surface of the specimen is almost entirely peeled off. It is preserved in small fragments only in the head area, at the end of the blade, and around the cut antler

tines (Fig. 9: C; the original surfaces are indicated by arrows). On the remnants of one of the tines, within the preserved original surface, traces of cutting were observed (Fig. 9: D; arrows indicate the cut marks). After the initial shaping, the tool's blade underwent grinding/scraping with a sharp implement, traces of which are now only visible in a small fragment near its base. Here, as well, a few weakly visible cut marks from this part of the tool's shaping process are preserved.

The visible hole on the artefact was drilled from two sides. In its outer parts (near the edge), it has a slightly polygonal cross-section (Fig. 9: E), which is probably the result of widening its diameter through scraping (but it may also result from the work of the tool's shaft during use). Inside the hole, clear "steps" are visible, resulting from the "non-concentric" drilling from both sides of the artefact (Fig. 9: F). To create the perforation, drills with a width smaller than the diameter of the drilled hole were likely used, as inferred from the outline of the curves they created (the diameter of the drills was probably around 1 cm, while the diameter of the hole is about 2.6 cm). The presence of steps inside the perforation clearly indicates the use of drills with a "flat" end (without a blade), as can be inferred from experiments, most likely made of bone or black elder (Osipowicz 2007). In this case, the use of flint drills can be ruled out with a high degree of probability (*cf.* Orłowska 2015).

The blade of the tool is strongly rounded. On the upper side, to its right, partially preserved delicate relief microfeatures of the antler are observed, along with a rather faint polish of unspecified origin, possibly of a functional nature (Fig. 9: G). On the lower side of the blade, on the preserved fragment of the original surface, there is a noticeable dulling (Fig. 9: H), the origin of which could be varied (use, repair, post-depositional processes).

Adze from Puck, site 23 (inv. no. P/892/97, Fig. 7)

The specimen is relatively well-preserved, with a largely readable, unpeeled original surface. The burr of the utilised red deer antler was calibrated and almost entirely removed through knapping/chiselling (Fig. 10: A). The brow tine was separated through circumferential knapping strikes (Fig. 10: B), resulting in the breaking of the spongy mass (Fig. 10: C). The blade of the tool was also shaped by the chiselling technique, and its remnants are deep incisions on its surface (Fig. 10: D).

The hole made in the specimen currently has a rectangular cross-section, and it is clearly visible that it has been secondarily chiselled. This is evidenced primarily by the distinct linear traces inside and on the edges of the hole (V-shaped grooves in cross-section), which are traces of the blade of the tool used (Fig. 10: E – indicated by arrows). Clear signs of chiselling/knapping are also observed on the edges of the hole (Fig. 10: F – marked with arrows). The characteristics of the technological traces, especially those visible inside the perforation, suggest that a metal tool was used for this process. The hole has a slightly oval cross-section, raising the possibility that it was originally drilled and subsequently chiselled.

The state of preservation of the tool allows for certain suggestions regarding its primary function. Its cutting edge is strongly rounded and entirely covered with a glossy

polish with an invasive degree of intrusion (Fig. 10: G). However, a detailed analysis of its structure using a metallographic microscope was not possible due to the artefact's large size. The spongy mass visible along the working edge is damaged. Clear breakages and crushings of (presumably) functional origin were observed on the cutting edge (Fig. 10: H). The overall characteristics of the use-wear observed on the specimen suggest that it was associated with woodworking.

***Bâton percé* from Hel (inv. no. Hel/01/2022, Fig. 8)**

The overall state of preservation of the artefact is good, although it is cracked and slightly smoothed post-depositionally. However, this does not affect the clarity of the technological traces.

In essence, the entire surface of the object has been precisely scraped (Fig. 11: A). Chatter marks are clearly visible in many places (Fig. 11: B). Remnants of the burr bear traces of nicking/knapping (Fig. 11: C), but it is challenging to determine unequivocally whether its (partial) removal occurred intentionally or, for example, as a result of using the *bâton percé*. In some places, there are scraping marks on the burr (Fig. 11: D), which, however, is most likely a result of the process applied to the entire surface of the artefact rather than specifically to this part. The brow tine was removed using knapping of cortical tissue (Fig. 11: E), followed by breaking within the spongy tissue. Irregularities resulting from this were removed by scraping (Fig. 11: F).

The hole visible in the object could have been drilled using a flint tool, as evidenced by its asymmetrical shape and irregular traces of drilling inside it (Fig. 11: G). Before starting the perforation, the antler surfaces were prepared by knapping (Fig. 11: H). After drilling the hole, its edges were probably scraped (widened?). Scraping marks were also observed on the blade of the *baton* from the lower side (Fig. 11: I).

Investigations into the function of the specimen proved to be essentially impossible due to the covering of its surface with plant remains (algae?; Fig. 11: J). There are no visible signs of functional breakage on its blade, and the connection of the clearly visible linear polish in some places (Fig. 11: K) to the function of the specimen is uncertain. No more definitive signs of use were observed in the perforation of the specimen.

4. CONCLUSIONS

Among the analysed flint materials from Rybitwia Mielizna, site F32.10, attention is drawn to two blade cores (Fig. 12: 1, 2) that may be associated with the flint industry of the Mesolithic community of the Chojnice-Pieńków culture. The overwhelming majority of the collection consists of a relatively uniform set of flint artefacts, primarily related to the processing of flint using the bipolar technique. This technique, appearing in earlier periods, was intensively utilised from the Neolithic (*e.g.*, in the Funnel Beaker culture) to

the Bronze Age inclusive. It is also well represented at the Late Mesolithic (Chojnice-Pieńków culture) site Jastrzębia Góra 4 and other sites of Kępa Ostrowska region (Ruta 1997). However, unlike the situation observed at the Jastrzębia Góra 4 site, the flint collection analysed here did not contain microliths or other tool forms that could be assigned to Mesolithic communities. This makes it impossible to connect this collection more confidently with the activities of early Holocene hunter-gatherer-fishers. In turn, the presence of Neolithic pottery at the site requires considering its relationship with the communities of that period.

In the published collections of flint artefacts from the sites of the Łupawa group of the Funnel Beaker Culture, the Rzucewo culture and the Late Neolithic/Proto-Bronze sites in Pomerania – the scaled method of exploitation, based mainly on the use of Pomeranian flint, definitely dominates in all better-recognized sites (Domańska 1987; Kabaciński 2018; Małecka-Kukawka 2009). In the case of the flint dagger from the Rybitwia Mielizna Site F32.10 (Fig. 14: 6), the closest analogies from Pomerania come from a loose find of a flint dagger from Wrześcienko, Lębork district (type Ig according to Czebreszuk and Kozłowska-Skoczka 2008; type BA II according to Libera 2001). From Eastern Pomerania, we currently know 10 flint daggers (Wąs and Klimaszewski 2015), which is rather a small number compared to slightly more than 200 flint daggers from Western Pomerania (Czebreszuk and Kozłowska-Skoczka 2008). Most of these flint daggers were dated to the Late Neolithic/Proto-Bronze in Western Pomerania (2300-2000 BC, Czebreszuk and Kozłowska-Skoczka 2008). The form of the flint Dagger from Rybitwia Mielizna F53.10 also finds some analogies in the BAII 2 types from the village of Klon (part of the village of Zełwągi) in the Mrągowo district (see: Libera 2001, 144) and in two BBI2 types from Szczytno, Szczytno district, and from Trękus, Olsztyn district (see Libera 2001, 147). All three artefacts are loose finds, but both types, BAII 2 and BB I 2 are associated with the early phase of the Mierzanowice culture (Libera 2001, 125). The typo-chronological analysis of the pottery, combined with the characteristics of the collection of flint artefacts (dominance of the scaled method of exploitation with the absence of distinctive microlithic forms) and analogies in the case of flint daggers, allows us to connect the analysed collection with the period of the Late Neolithic/Proto-Bronze in Pomerania (2300-2000 BC). The origin of the collection from probably a mixed context from the seabed may explain the presence of a few older forms like chip cores and a flake from a polished axe, but their synchronicity with the rest of the collection cannot be unequivocally ruled out. The adzes made of antlers presented in the study belong to a group of artefacts referred to as heavy-duty bevel-ended tools (Orłowska and Osipowicz 2017). Tools of this type were mainly produced from the base of the red deer antler, *i.e.*, the area around the burr and the place where its branch grows, the so-called brow tine, and from the middle part of the antler at the height of the so-called bez tine. They are characterised by a diagonally cut blade, opposite to a blunt-ended butt, and a relatively large hole for inserting a handle. Due to differences in the orientation of the working edge relative to the axis of the hole (*cf.* Pratsch 2006), these

tools can be divided into adzes (blade parallel or slightly inclined) and hoes (blade oriented perpendicularly). The chronology of the use of such artefacts is very long and spans from the Mesolithic to the Iron Age (inclusive).

Heavy-duty bevel-ended tools from the Pomorze region are mainly stray finds, lacking a broader archaeological context and precise chronology, often associated with the Mesolithic or Neolithic periods (Ilkiewicz 2010). The only archaeological site where more artefacts of this type have been found is Dąbki (see Kabaciński and Terberger 2015). However, at this site, heavy-duty bevel-ended tools are represented only by T-shaped axes, which makes them irrelevant to the analyses conducted here.

The results of AMS dating for both artefacts of the discussed type place their chronology around 1600-1260 cal BC. In the Pomorze region, this period corresponds to the development of the so-called pre-Lusatian culture, which is classified within the circle of tumulus cultures and urnfield cultures (Gedl 1975; Bukowski 1998). The "ubiquity" and intercultural character of the discussed artefacts, as well as the lack of direct radiocarbon dating for artefacts of this type from the Pomorze region (*cf.* Ilkiewicz 2010), make finding direct analogies for tools from Puck very challenging.

Bronze Age antler adzes exhibit a continuity of form known from the Mesolithic. However, they also show some differences compared to earlier artefacts. Significant features in their case include the parallel orientation of the blade to the axis of the hole, the treatment of the base (removal of protruding elements of the burr), and the often-encountered rectangular cross-section of the hole for the shaft (Drzewicz 2004; Frost 2020). In many cases, these perforations were originally circular/oval, but they were modified secondarily to give them a square cross-section (Riedel *et al.* 2004). A similar modification is likely to have been applied to one of the tools from Puck.

In the section dedicated to the results of the morphological-typological analysis of the antler artefacts, it was suggested that adze no. P/143/98 may represent a kind of zoomorphic stylisation, possibly referring to the head of a bird (duck or swan). This is, of course, only a hypothesis; however, it should be noted that during the Middle Bronze Age (and more frequently in its later phase), artistic representations in the population inhabiting the area of Poland included many bird figurines (Gediga 1970, 193-197). Ornithomorphic motifs were one of the most popular decorative themes in the art of the Lusatian culture, used in the ornamentation of ceramic and bronze objects (Kaczmarek 2002, 102). These representations often take a simplified form (as possibly seen in the discussed antler artefact) and serve more for symbolism than for a realistic portrayal of the natural world (Gediga 1970, 194). Unfortunately, direct analogies for the described artefact from Puck could not be found.

The analysed bevel-ended tools from Puck exhibit varying states of preservation. However, as a result of the conducted technological analyses, it was possible to reconstruct a general outline of the operational chain performed during their production. The range of activities included:

a) Removal of antler tines using circumferential chiselling to the depth of the spongy tissue, followed by subsequent removal of unwanted prongs through breaking. Remaining irregularities were eliminated using scraping.

b) Shaping the tool's blade using chiselling. Irregularities were removed through scraping/grinding the surface.

c) Shaping the surface of the "coronet", probably by removing it circumferentially, most likely through chiselling/knapping.

d) Forming the hole through double-sided drilling. Its edges could be widened through scraping. Additionally, perforations were secondarily chiselled, giving them a rectangular shape.

The described technological procedures were commonly employed in prehistory for heavy bevel-ended tools (Pratsch 1994; Jensen 2001; Elliott 2012). Secondary chiselling of holes is known from the Bronze Age (Riedel *et al.* 2004).

Unfortunately, the results of the conducted analyses did not provide much information regarding the use of these artefacts. Only in the case of one of them was it possible to suggest its connection to wood processing. Similar artefacts dated to the Bronze Age from Italy (Durante *et al.* 2022) and artefacts with an earlier chronology from Poland (Orłowska and Osipowicz 2017), Germany (Riedel *et al.* 2004), the Netherlands (Van Gijn, 2005), or Denmark (Jensen, 2001) were used in a comparable way. The described *bâton percé* from the Hel Peninsula is considered interesting for several reasons. Its small size and the absence of decoration are undoubtedly noteworthy, which is quite unusual in the context of other artefacts of this kind from Poland, Germany, or Denmark (*cf.* Płonka 2003, 29-32; Osipowicz *et al.* 2017).

The oldest *bâton percé* from northern Poland is an artefact from Pułtusk, which received a radiocarbon date of 9370±45 BP (8765-8484 cal BC, OxA-25759; Sulgostowska 2019). This places it at the transition between the Preboreal and Boreal periods (Fig. 17). The dating of the analysed artefact from the Hel Peninsula (7326-7052 cal BC) is one of four currently available Boreal radiocarbon dates for *bâtons percés* from Poland. The other three artefacts with Boreal dates come from the sites Gołębiewo 47 (8176-7608 cal BC, Poz-73613; Osipowicz *et al.* 2017), Woźniki (7316-7038 cal BC, OxA-25760; Sulgostowska 2019), and Szczecin-Podjuchy (7179-7045 cal BC, OxA-40218; Płonka 2022). Culturally, the analysed *bâton percé* can be associated with the classic assemblages of the Maglemosian culture (Galiński 2019, 120).

Batons produced by Mesolithic hunter-gatherers have been well recognised in terms of the techniques used in their production (*e.g.*, Sulgostowska 2019; Płonka 2017). The method of crafting the analysed artefact does not differ significantly from other artefacts of this kind (*e.g.*, Osipowicz *et al.* 2020).

As a result of the transgression of the Baltic Sea, part of the former Stone Age coast has now been submerged. Research in other areas of the Baltic Sea indicates a frequent concentration of prehistoric sites along estuaries, water reservoirs (lakes, bays), as well as

places of narrowing between the land and islands and sandbanks, as well as the edges of promontories entering the water. These are areas where there are usually periodic concentrations of aquatic organisms, *e.g*., fish or marine mammals. Such areas were attractive to prehistoric societies. This type of model of searching for submerged sites from the Stone Age (the so-called "fishing model") has been successfully applied during exploration and research in the area of the southern Baltic Sea (Benjamin 2010; Fischer 2007; Uldum *et al.* 2018 – further literature there).

Unfortunately, the search for submerged sites from the Stone Age on the Polish coast is a bit like searching for a needle in a haystack. Due to the difficulties in recording underwater the relatively slight remains from the Stone Age sites, the long and relatively straight modern Polish coastline and the dynamics of the southern Baltic Sea, potentially the most promising areas are the modern lagoons and bays in our seacoast (the Bay of Puck, the Vistula Lagoon and the Szczecin Lagoon). We hope that the artefacts presented in the article are a promising beginning of the process of retrieving some more "gifts" from our sea in the near future and a small step for better protection of submerged paleolandscape, which is a unique testimony of the past.

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ON THE ISSUE OF FUNCTIONAL USE OF PICKS DURING THE EARLY NEOLITHIC: A CASE STUDY FROM THE LINEAR BAND POTTERY CULTURE SITE IN WÓLKA WOJNOWSKA (S. POLAND)

ABSTRACT

Szeliga M., Osipowicz G. and Bosiak M. 2024. On the issue of functional use of picks during the Early Neolithic: a case study from the Linear Band Pottery culture site in Wólka Wojnowska (S. Poland). *Sprawozdania Archeologiczne* 76/1, 285-307.

Picks are extremely rare artefacts associated with flint inventories of the Linear Band Pottery culture (hereinafter: LBK). Previously, only three such artefacts attributed to this culture have been found in the drainage basins of the Vistula and Oder Rivers. The contexts of discovery of picks dated to slightly later times indicated that they should be linked with mining activities of early agricultural societies. The presented collection from Wólka Wojnowska is one of the most numerous typological series of LBK picks found at a single site within the entire range of the LBK. The results of traceological and chemical SEM-EDX analyses of residues preserved on their surfaces indicate that these tools were used in processing hematite in order to produce ochre. The obtained data considerably broaden the scope of the functions of picks used during the Early Neolithic and allow us to question the interpretation that they were only employed in mining for siliceous materials.

Keywords: Early Neolithic, LBK, flint picks, use-wear analysis, SEM-EDX, ochre
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INTRODUCTION

Picks are definitely ones of the rarest and – at the same time – most characteristic and original types of flint tools recorded in Early Neolithic inventories (6th-5th millennia BC) from the drainage basins of the Vistula and Oder Rivers. In the archaeological literature, they are interpreted as artefacts directly linked with mining activities performed by early agricultural societies. To be more specific, they have been regarded as one of several types of tools used in extraction of siliceous rocks (*e.g.*, Lech 1981a, 40-42; 1981b, 78). This assumption was confirmed by discoveries of single pick specimens in the fills of Early Neolithic mining shafts (in Jerzmanowice-Dąbrówka I and Tomaszów; see Lech 1981b, tabl. VIII: 5; Schild *et al.* 1985, 60, pl. 4: 2). Slightly greater numbers were also found at settlements, located close to such mines and contemporary with them (*e.g.*, Cabalska 1964, 123; Kaczanowska and Kozłowski 1971, 92; Kaczanowska 1977, 38-41; Balcer 1983, 91, tab. 14).

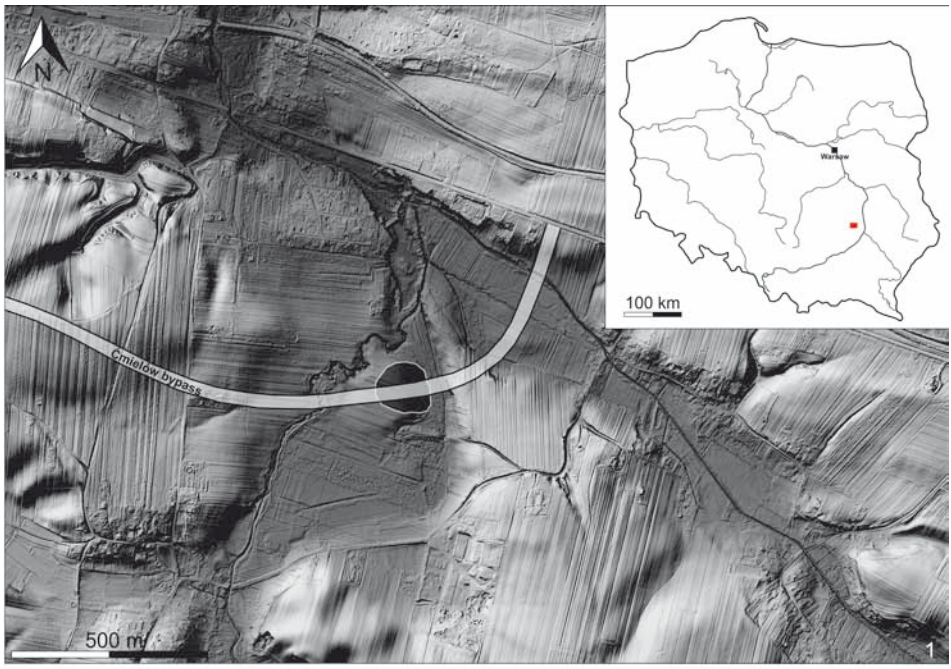
The currently accessible corpus of sources indicates that Early Neolithic picks were morphologically and typologically diverse. They were made of long blades, squat flakes as well as naturally formed chunks and exploited cores (*e.g.*, Cabalska 1964, 123, fig. 9: 2, 3; Kaczanowska and Kozłowski 1971, 92; Kaczanowska *et al.* 1987, 108, 109). These forms were transformed to different extents: with crude steep retouch near the edges, careful retouch on parts of the lateral surfaces or even surface retouch on the entire lateral sides. These procedures resulted in forming a narrow, pointed tip, located on one of the extremities of the tool and playing the role of the working part proper. Finished tools were small (their lengths usually did not exceed 7 cm) and had a triangular or quadrangular cross-section (Cabalska 1964, ryc. 9: 2-3; Kaczanowska and Kozłowski 1971, fig. 40: 3; Lech 1981a, fig. 8: 15; Kaczanowska *et al.* 1987, pl. 14: 3, 4; Michalak-Ścibior 1994; fig. 41: 10, 11), determined by the types of the initial forms as well as the character and final range of retouch on particular surfaces.

Currently, we know only a dozen or so picks discovered in the drainage basins of the Vistula and Oder Rivers and dated to the Early Neolithic. Until recently, a great majority of them were linked with later Danubian cultures, namely with the Malice culture and Lengyel cultural groups developing in these areas in the 5th millennium BC (see Cabalska 1964, 123, fig. 9: 2, 3; Kaczanowska and Kozłowski 1971, 105, fig. 40: 3; Więckowska 1971, pl. 30: 5; Kaczanowska 1977, 38-41; Lech 1981b, pl. 8: 5; Michalak-Ścibior 1994, 75, fig. 41: 10-11). Only several finds were indisputably associated with the earliest phase of the Neolithic, that is with the LBK. This collection was represented only by three specimens discovered at settlements in Mogiła and Bieńczyce, in the Nowa Huta region (Kaczanowska *et al.* 1987, 107-109, 115, pl. XIV: 4), and probably also two potential specimens of this kind from Kraków-Olszanica, which were assigned to the 'Miscellaneous Flint Tools' category in the source monograph (Milisauskas 1986, 137, fig. 115: D, H). Until recently, the above-listed specimens were the only known group of certain and potential LBK picks from vast

areas spreading north of the Carpathian and Sudeten mountains. Completely new and very important data were provided by a rescue excavation conducted in 2017 at site 33 in Wólka Wojnowska, Ćmielów Commune, Świętokrzyskie Voivodeship. The greatest number of known typological picks attributed to the LBK (jointly six specimens) were discovered at this site. Their characteristic features are macroscopic and very distinct use-traces on their edges and surfaces as well as residues of unspecified red substance preserved on the tips of certain specimens. These elements – besides the concentration of the picks at the site – were the main reason to conduct further research and analyses. They appeared to be especially important in the context of the location of the settlement in the direct vicinity of different outcrops of various Jurassic and Cretaceous flints distributed on the Mesozoic fringe of the Holy Cross Mountains and the mining character of the discussed tools suggested in archaeological literature. The main aim of this article is to present this unique collection as well as the results of the conducted traceological and chemical analyses. The information from this research makes a rather important contribution to studies on the role and scope of using such tools by agricultural societies during the earliest phases of the Neolithic.

SITE

Site 33 in Wólka Wojnowska is located within the edge zone of the Sandomierz Upland, occupying part of the culmination and gentle slope of a small promontory on the edge of a loess upland. This promontory is split from the north and west by a valley of a minor watercourse – the Krzczonowianka, near the place where it meets the Przepaść, which is a left-bank tributary of the Kamienna River (Fig. 1: 1). The discussed site was discovered in the 1990s during a surface survey conducted within the framework of the Polish Archaeological Record (Polish: Archeologiczne Zdjęcie Polski, AZP). Verification research carried out several times in the subsequent years made it possible to state that the site was settled by different cultures for a long time, from the Neolithic to the Early Middle Ages. In 2017, a rescue excavation (prior to the construction of the Ćmielów bypass) was conducted in the central part of the site. It resulted in researching an area of 72.4 ares as well as discovering and exploring 115 features, including 49 features attributed to the LBK (Matyaszewski 2017). The remains of the Early Neolithic settlement were mainly concentrated in the western part of the researched area. They were remains of at least several longhouses oriented along a N-S axis (Fig. 1: 2). The results of stylistic analyses performed on the discovered ceramic materials indicate that the settlement was linked with the Želiezovce phase of the LBK (Matyaszewski 2018). The finds made at the site prove that the settlement was clearly influenced by the Eastern Linear cultural circle from the Transcarpathian territories (Szeliga and Gawryjołek-Szeliga 2022).



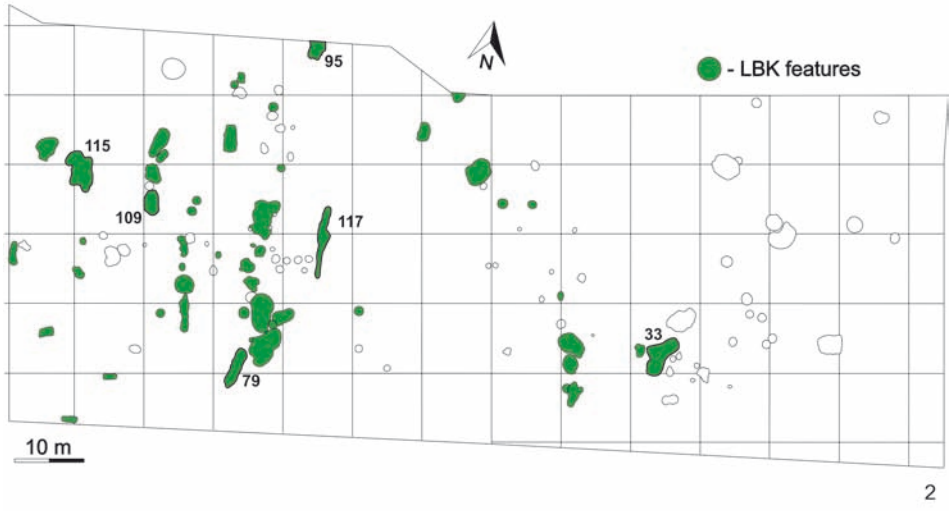


Fig. 1. Wólka Wojnowska, Site 33. Location of the site (1) and LBK features discovered during the excavations prior to building the Ćmielów bypass (2); the numbers indicate features with the picks (after Szeliga and Gawryjołek-Szeliga 2022, fig. 1, with modification)

FLINT INVENTORY AND THE ASSEMBLAGE OF PICKS

The research conducted at the discussed site resulted in discovering a total number of 533 flints and five obsidian artefacts. The numbers of these finds in particular LBK features (pits) were considerably diverse: from one to 97 specimens (Matyaszewski 2018). In terms of raw material, decidedly the most numerous group are artefacts made of Świeciechów flint (82.16% of the total number). Forms made of other siliceous materials and obsidian are much rarer. Morphologically, the most frequent category of products are different flakes, which make up over half of all the finds. They are clearly more numerous than other groups of the inventory, including prepared (retouched) tools, which constitute 15.24% of the entire collection (82 specimens). Among them, the most numerous are endscrapers and retouched flakes (jointly 68.29%). Other intentionally retouched forms are decidedly less frequent. The picks that are the main subject of this study are represented by a total of 6 specimens, constituting 7.32% of all retouched tools and 1.12% of the entire inventory. It should be stressed that these forms generally constituted definitely higher percentages in particular features: from about 7% to as much as roughly 50% (Feature 117) of all the tools discovered within their limits.

All the picks were discovered individually within the features, which were somewhat evenly distributed within the settlement (Fig. 1: 2). They are morphometrically diverse, which is mainly the result of differences between the used initial forms as well as the fact that they were shaped by retouch to varying extents (this mainly applies to preparing particular surfaces and tips). The individual specimens are represented by:

a) A pick broken on both sides, with a quadrangular cross-section; made of Świeciechów flint; discovered in Feature 33; dimensions: 66 × 22 × 22.5 mm (length × width × thickness); weight: 45.59 g (Fig. 2). The specimen was made on an unspecified initial form (exploited blade core having a natural surface or massive flake with a longitudinally natural dorsal surface). It has two surfaces formed with a series of multiple, mainly unidirectional strikes, a single cortical surface and a flaked surface (Szeliga and Gawryjołek-Szeliga 2022, 103, fig. 5: 1);

b) A pick broken on one side, with a quadrangular cross-section; made of Świeciechów flint; discovered in Feature 115; dimensions: 57 × 24 × 19 mm; weight: 30.13 g. The specimen was made of an unspecified initial form. Its three surfaces were shaped with a series of multiple, mainly multidirectional strikes forming surface retouch, the fourth surface is partly natural, with edge retouch and precise, multidirectional strikes shaping the tip (Fig. 3);

c) A pick with a quadrangular cross-section; made of chocolate flint; discovered in Feature 109; dimensions: 52 × 27 × 24 mm; weight: 38.10 g. The specimen was made of an unspecified initial form. All the surfaces were formed with a series of multiple, usually unidirectional strikes forming surface retouch (Fig. 4);

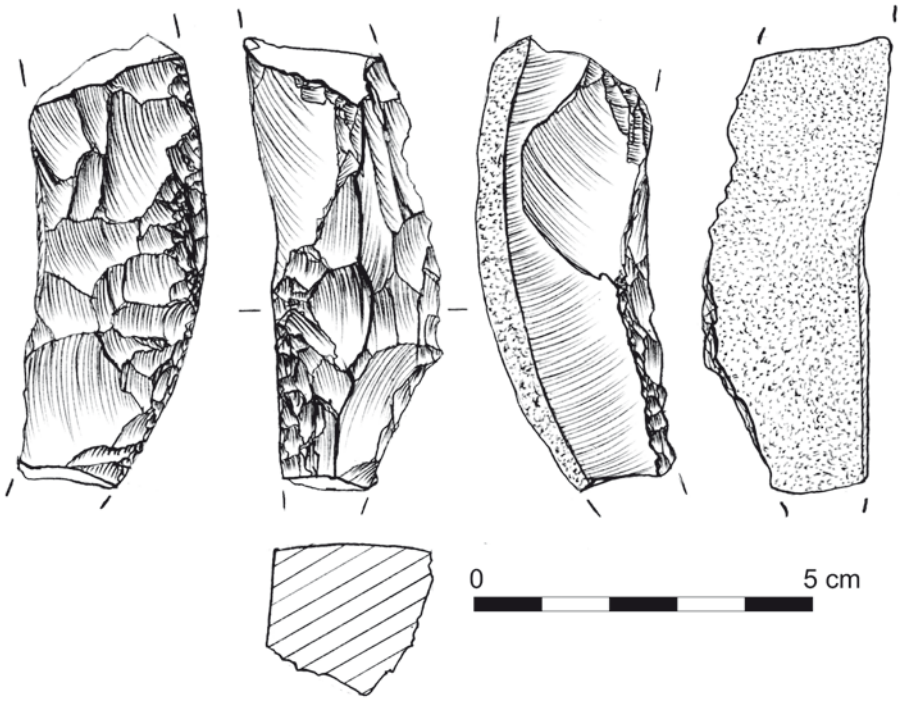


Fig. 2. Wólka Wojnowska, Site 33. Pick made of Świeciechów flint without any use-wear traces from Feature 33 (after Szeliga and Gawryjołek-Szeliga 2022, fig. 5: 1)

d) A pick broken on one side, with a triangular cross-section; made of Świeciechów flint; discovered in Feature 117; dimensions: 34 × 21 × 17 mm; weight: 13.04 g. The specimen was formed on a massive crested blade, whose ventral side was shaped with a series of strikes struck from the left edge. The tip of the tool, formed with multidirectional strikes, is located in the distal part of the crested blade (Fig. 5);

e) A pick broken on one side, with a triangular cross-section; made of Świeciechów flint; discovered in Feature 95; dimensions: 49 × 25 × 20 mm; weight: 23.28 g. The specimen was formed on a massive blade with a completely natural dorsal surface (natural crested blade). One of its natural surfaces was shaped with edge retouch. The ventral surface was formed with edge retouch and in part with surface retouch, with a series of strikes struck from both sides. The edge of the tool is located in the distal part of the blade (Fig. 6);

f) A pick broken on one side, with a triangular cross-section; made of Świeciechów flint; discovered in Feature 79; dimensions: 30 × 20 × 18 mm; weight: 11.3 g. The specimen was formed on a massive crested blade with a partly natural dorsal surface, which was shaped with surface retouch by strikes from the right side. The tip of the tool is located in the distal part of the blade (Fig. 7).

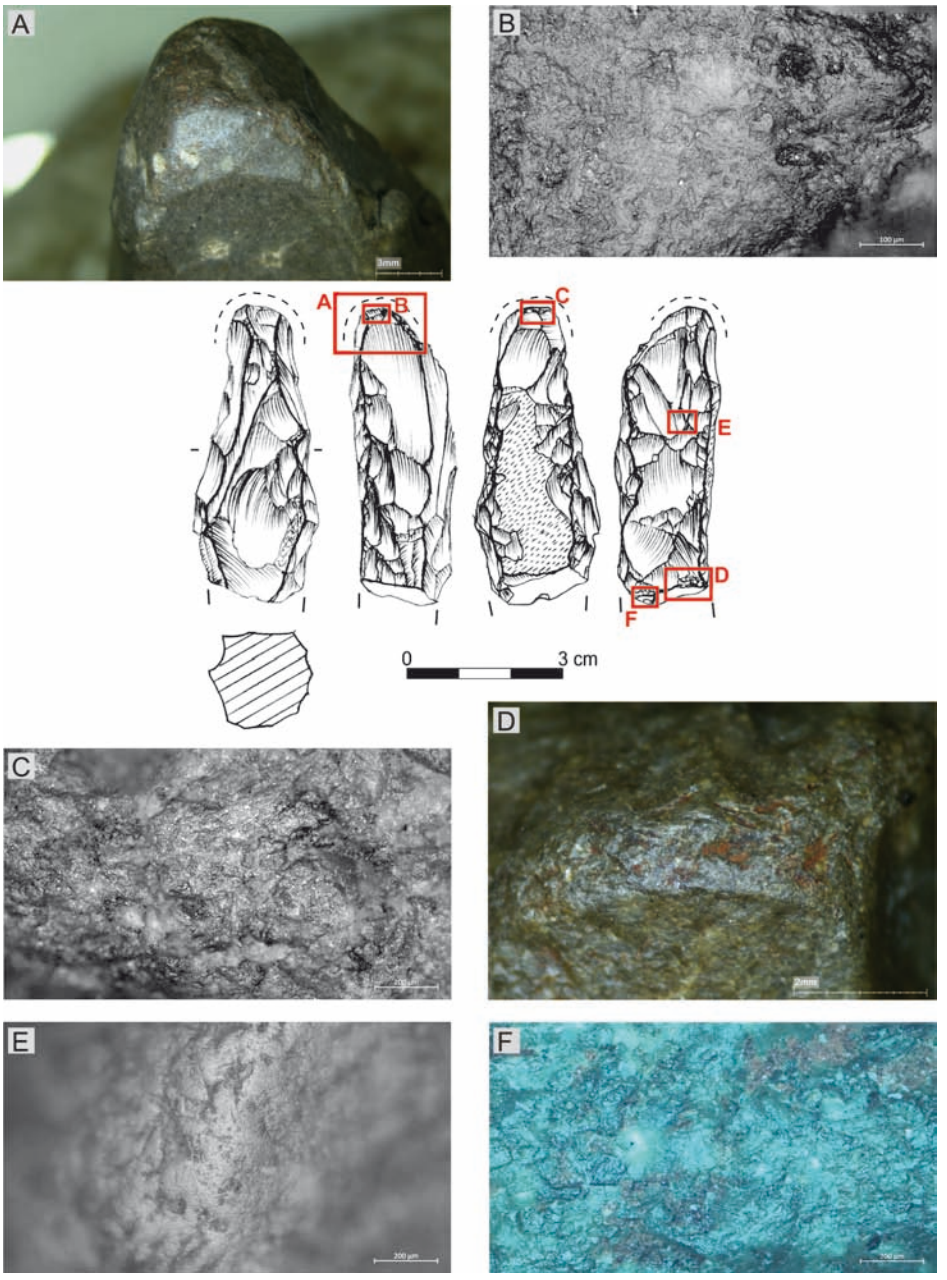


Fig. 3. Wólka Wojnowska, Site 33. Pick made of Świeciechów flint from Feature 115. In the drawing, the dashed line indicates the extent of macroscopic traces of damage of tool (abrasions and crushing). Detailed explanations of the use-wear traces documented in individual photographs are provided in Table 1 (drawn by M. Szeliga, photo by G. Osipowicz)

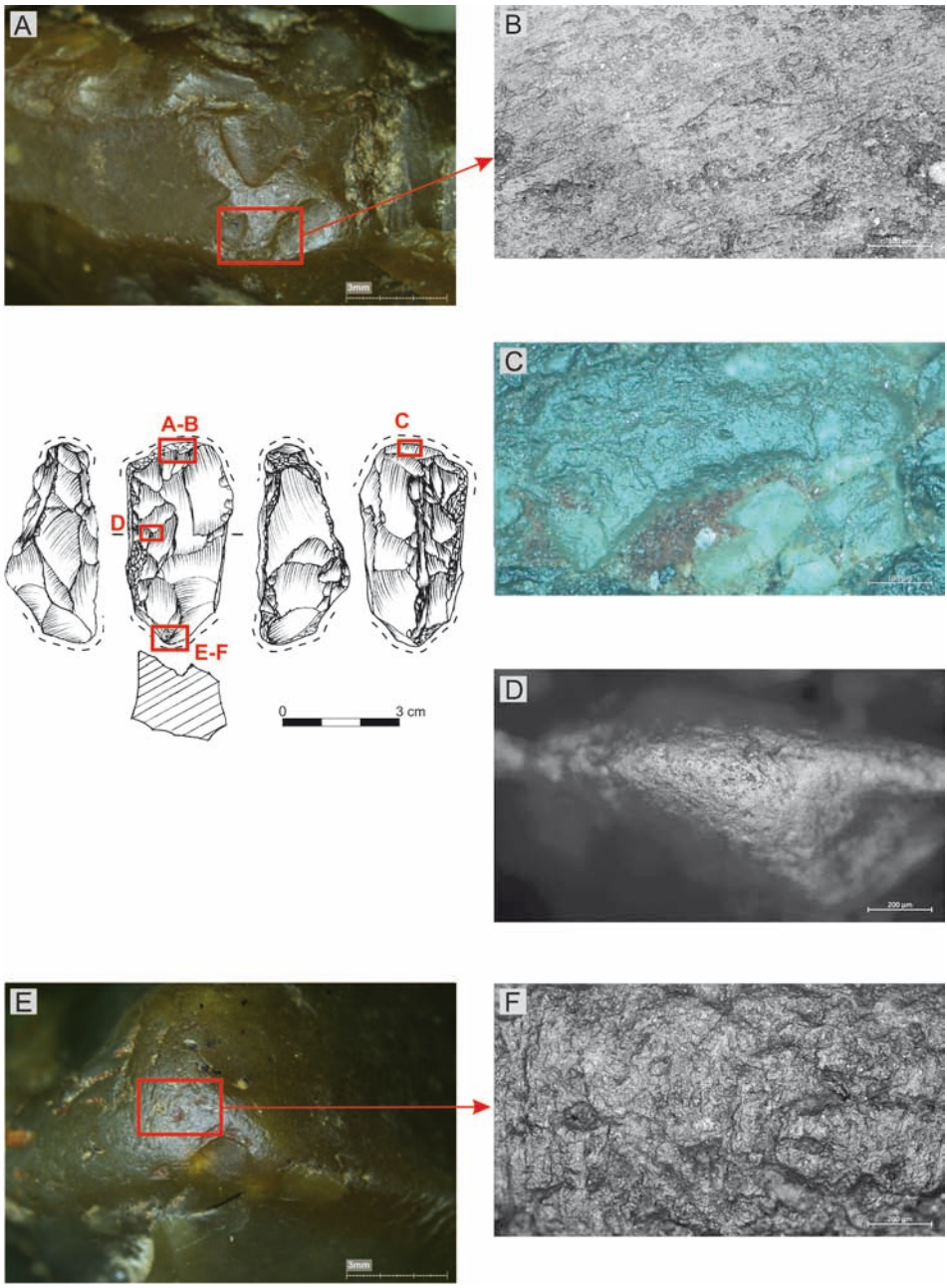


Fig. 4. Wólka Wojnowska, Site 33. Pick made of Chocolate flint from Feature 109. The explanation of markings in the drawing and the information on documented use-wear traces – see caption under Figure 3 (drawn by M. Szeliga, photo by G. Osipowicz)

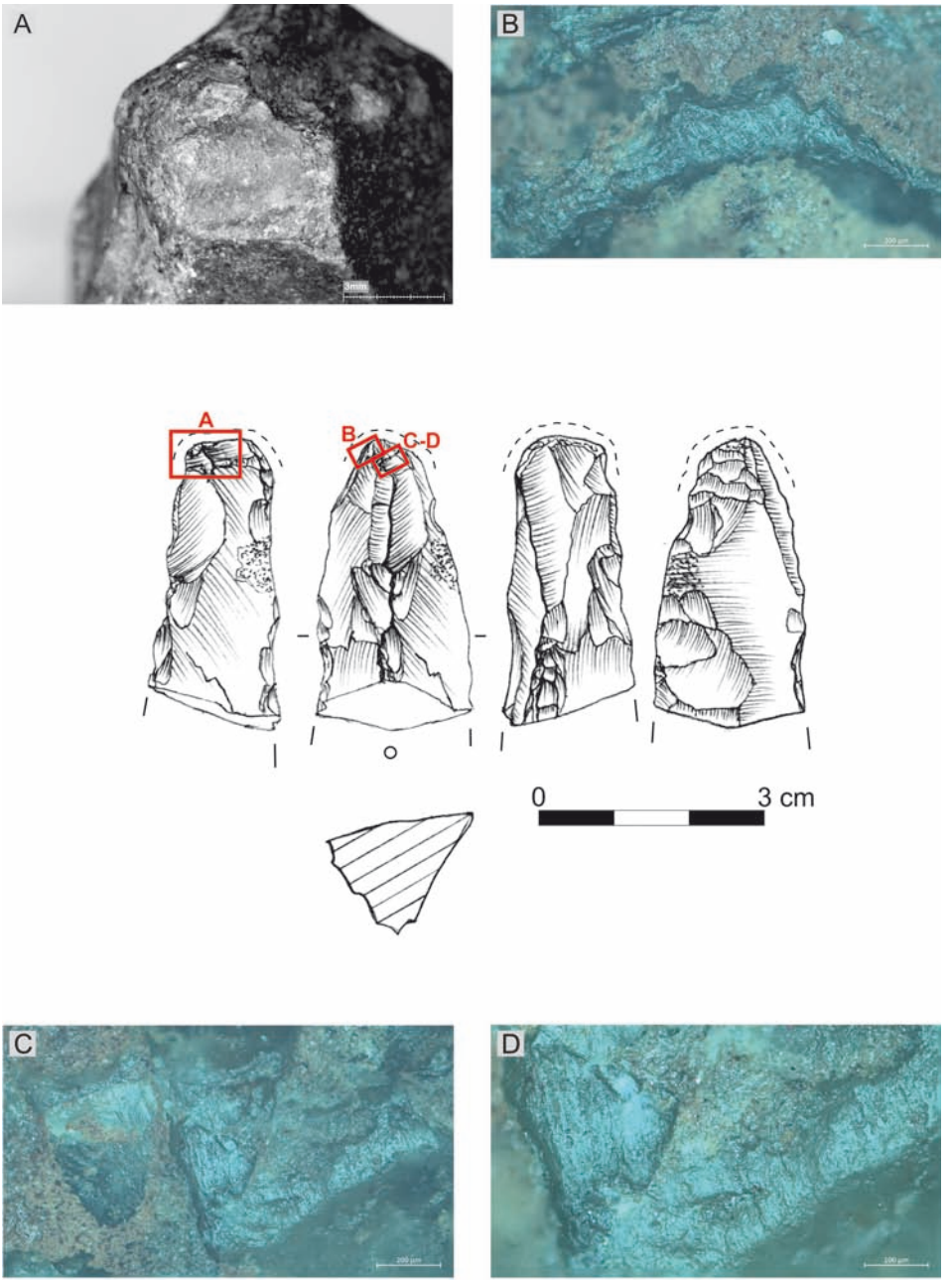


Fig. 5. Wólka Wojnowska, Site 33. Pick made of Świeciechów flint from Feature 117: The explanation of markings in the drawing and the information on documented use-wear traces – see caption under Figure 3 (drawn by M. Szeliga, photo by G. Osipowicz)

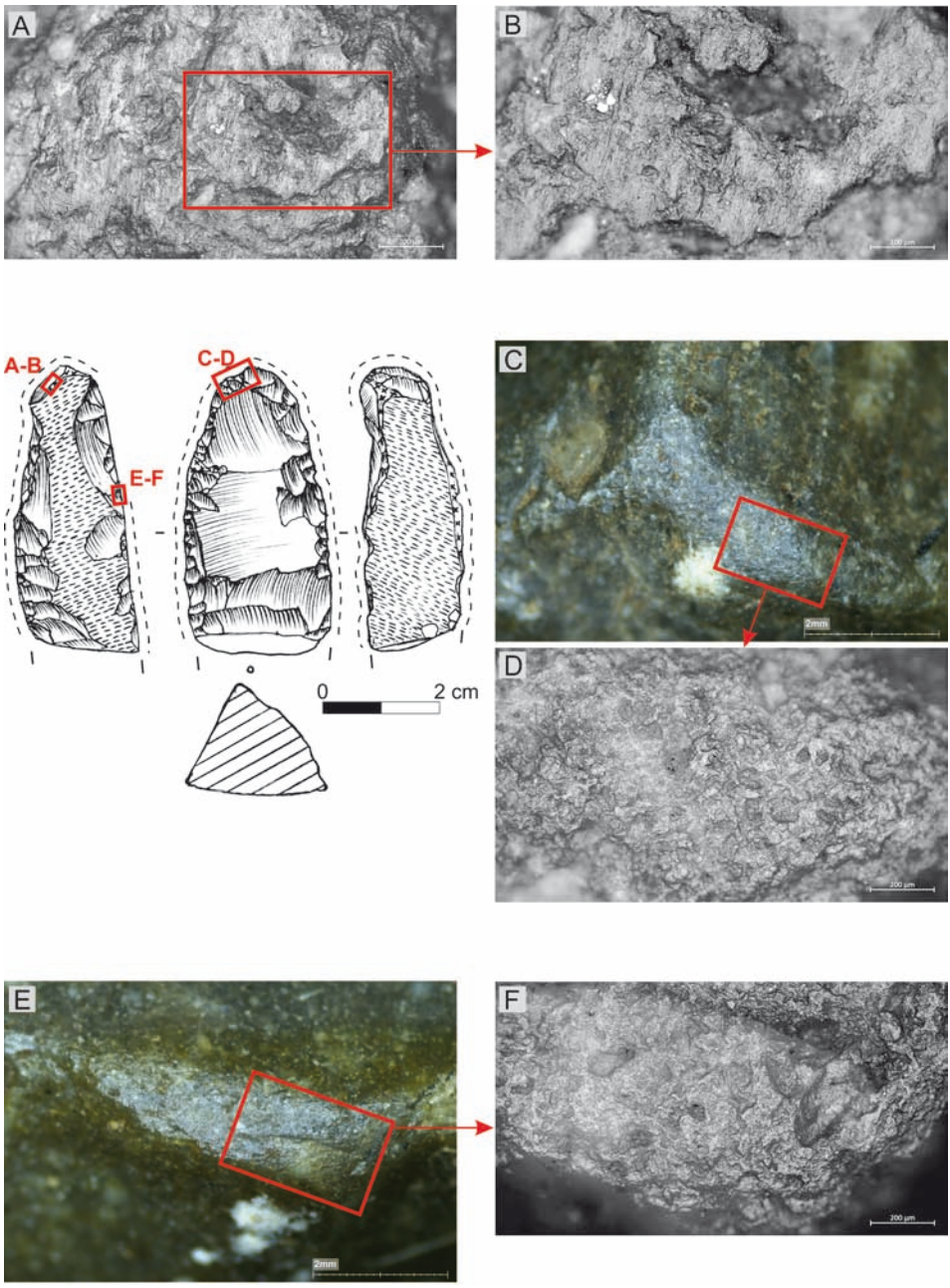


Fig. 6. Wólka Wojnowska, Site 33. Pick made of Świeciechów flint from Feature 95. The explanation of markings in the drawing and the information on documented use-wear traces – see caption under Figure 3 (drawn by M. Szeliga, photo by G. Osipowicz)

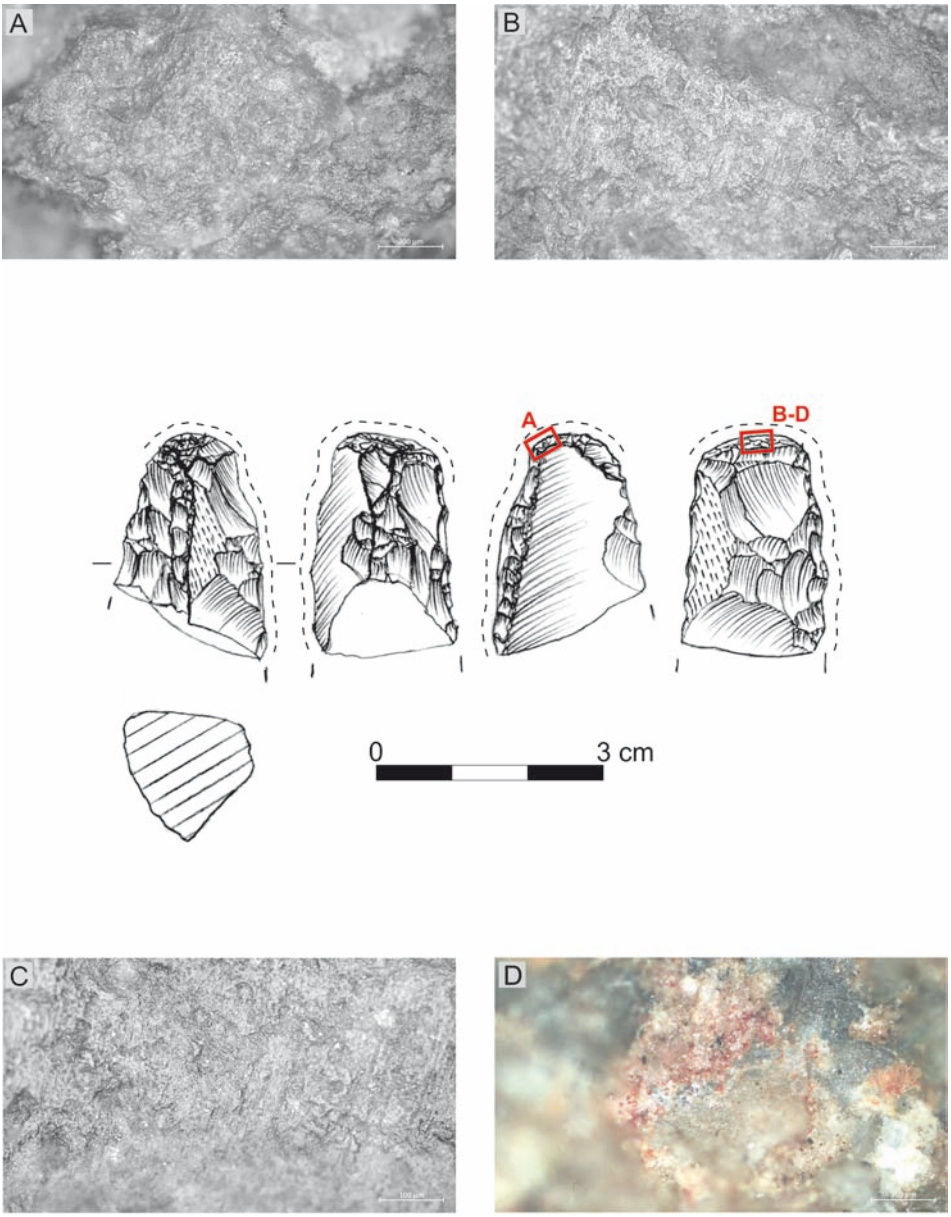


Fig. 7. Wólka Wojnowska, Site 33. Pick made of Świeciechów flint from Feature 79. The explanation of markings in the drawing and the information on documented use-wear traces – see caption under Figure 3 (drawn by M. Szeliga, photo by G. Osipowicz)

METHODS

All the picks discovered at the discussed site were subjected to a traceological analysis. An optical Nikon SMZ-745T microscope (equipped with a Delta Pix Inventio 6EIII camera) – which allows obtaining up to x50 optical magnification – was used to evaluate the state of preservation of the artefacts as well as the features of their working edges and utility retouch. This apparatus was used to take the microphotographs presented in Figs. 3: A, D; 4: A, E; 5: A, 6: C, E, 9: A, B.

A metallographic Zeiss Axioscope 5 Vario microscope, equipped with an Axiocam 208 camera was used to analyse the polish. This piece of equipment allows obtaining up to ×50 lens magnification (optical magnification up to ×500). All the remaining microphotographs presented in this article were taken with the use of this device.

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.

Residue samples for SEM-EDX research were taken from two artefacts. The analysis was conducted using a scanning electron microscope by LEO Electron Microscopy Ltd, England, model no. 1430 VP from 2001. The device is intended for analyzing surface topography of solids and enables controlled vacuum conditions (1e270 Pa), allowing low-conductive and low-hydrated samples to be investigated without prior treatment (*e.g.*, application of a conductive coating). The device was connected to an energy-dispersive X-ray spectrometer (EDX) Quantax 200 with a XFlash 4010 detector produced by Bruker AXS, Germany in 2008, owing to which it was possible to determine the elemental composition of various parts of the investigated objects.

Two experiments were conducted for the studies reported in this article. Both used cores made of chocolate flint, which were used to obtain ochre powder from a hematite lump coming from the prehistoric ochre mine in Rydno, Poland (Schild *et al.* 2011). One of the tools was used for scraping, and the other for chipping. Each tool was worked for 30 minutes. The comparative material for the results of these experiments were experimental tools from the reference base comprising several hundred specimens, gathered at the Institute of Archaeology, Nicolaus Copernicus University in Toruń, primarily the products used as strike-a-light and various tools for processing mineral raw materials such as limestone, sandstone and clay.

RESULTS

Use-wear analysis

Five out of the six macroscopically analysed artefacts bear somewhat homogeneous use-wear traces. They are usually concentrated on the tips of particular specimens, which

can be observed by distinct polished-abraded/matted areas (Fig. 3: A, D; 4: A, E; 5: A; 6: C, E). The highest points of the flint micro-relief are slightly rounded and usually covered with scattered polish here (Fig. 3: B-C; 4: D, F; 5: B, D; 6: A, D, F; 7: A). In the most worn places, there is also bright polish with flat/corrugated topography and rather coarse texture, often connected to numerous linear traces – black striation and grooves (Fig. 3: B; 4: B; 5: C-D; 6: A-B; 7: B-C). The detailed description of the use-wear traces observed on particular artefacts was presented in Table 1. In almost all cases, they indicate that the analysed tools were probably used in percussive grinding of hematite lumps. Only on one pick – the specimen from Feature 33, broken on both sides (Fig. 2) – there are no recorded traces resulting from using the tool. Still, this might have been caused by the fact that the artefact was not completely preserved.

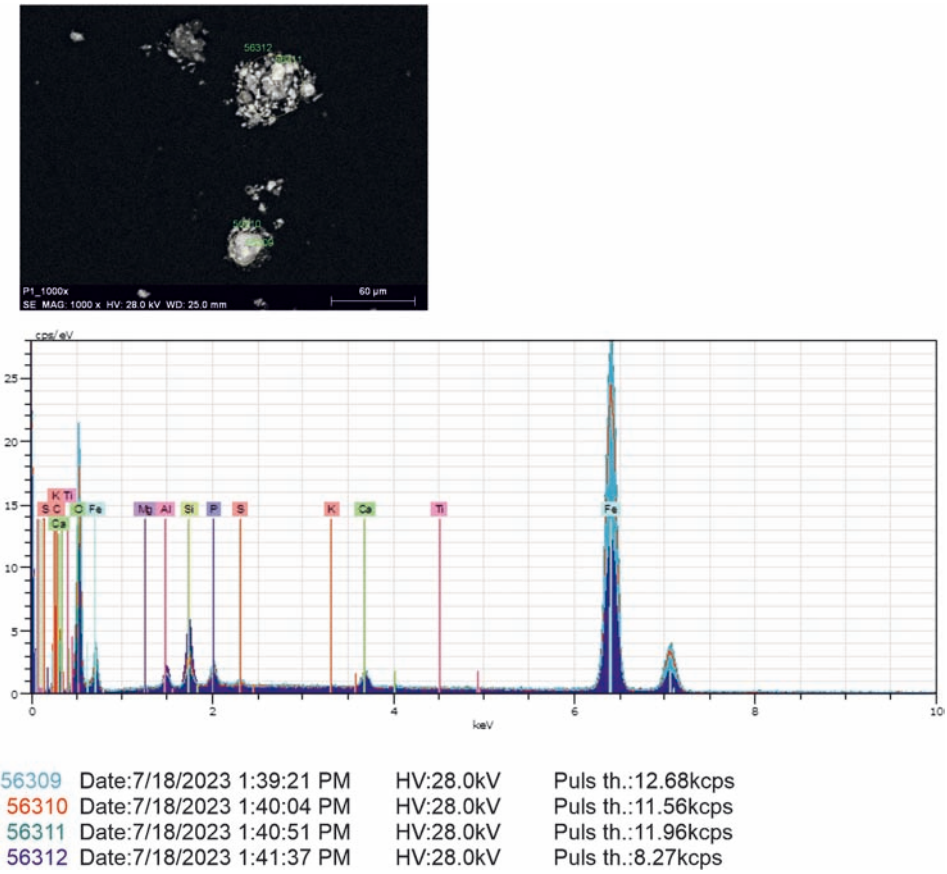


Fig. 8. Wólka Wojnowska, Site 33. Results of the SEM-EDX analysis of residues identified on the surface of pick from Feature 115 (prepared by M. Bosiak)

Table 1. Wólka Wojnowska, Site 33. Results of the traceological analysis of picks (prepared by G. Osipowicz and M. Bosiak)

No.	Inv. no./ feature	Morphological description/ raw material	Use-wear	Residues	Function	Comments	Figure
1	Feature 33	Pick/ Świeciechów flint	No use-wear traces were found on the specimen	lack	Undefined	Tool broken on both sides	Fig. 2
2	Feature 115	Pick/ Świeciechów flint	Both artefact tips are heavily polished-abraded/ matted on all edges (Fig. 3: A). In the polished areas, a visible delicate peck-ness deepens the coarsely crystalline structure of a flint (Fig. 3: C). The higher parts of the micro-relief are smoothed and covered with bright, linear polish with flat topography and smooth texture. It is connected to not numerous linear traces (linear striations and grooves) with irregular edges (Fig. 3: B). The side edges of the specimen and the negative ridges show rounding/ smoothing and polish with a well-developed domed-cratered topography (Fig. 3: E).	On both tips, in the hollows of the negative scars, there is a red mineral substance (Fig. 3: D, F)	Chipping the ocher	The polish on the lateral edges is a result of keeping the artefact in a hide container and/or using it for a long time by holding it in hand. The traces on the tips are not characteristic, changed by 'hide" traces.	Figs. 3, 8; Tab. 2
3	Feature 109	Pick/ Chocolate flint	Both artefact tips are strongly rounded on all edges (Fig. 4: A, E). In the rounded areas, there is a clear peck-ness and linear matting of the higher parts of the flint micro-relief (Fig. 4: F). On the „upper tip", at the higher magnifications, linear polish with flat/ corrugated topography and slightly rough texture is visible. It is connected with numerous linear traces (black striations – Fig. 4: B). The side edges of the specimen and the negative ridges show rounding/ smoothing and polish with a well-developed domed-cratered topography (Fig. 4: D).	On both tips, in the hollows of the negative scars, there is a red mineral substance, which is often legible in the context of distinct use-wear traces (Fig. 4: C).	Chipping the ocher	The traces on the lateral edges are a result of holding the tool in hand or keeping it in a hide container.	Fig. 4

4	Feature 117	Pick/ Świeciechów flint	The tip of the specimen is polished (Fig. 5: A). Here, a bright linear polish with flat/corrugated topography and quite smooth texture was observed, strongly abrading the upper parts of the micro-relief (Fig. 5: B-D). It is associated with linear traces (black striations).	In the hollows of the working surface, there are remains of a reddish mineral substance (Fig. 5: B-D). Its presence is linked mostly with parts which bear use-wear traces	Chipping the ocher	Broken tool	Fig. 5
5	Feature 95	Pick/ Świeciechów flint	There are visible smoothed-abraded/matted areas on all edges (including the side ones) (Fig. 6: E). The highest parts of the flint micro-relief are, in these places, slightly rounded and covered with scattered polish (Fig. 6: F). These traces are best legible at the tip of the specimen (Fig. 6: C, D). Here, in addition, locally bright polish/abrasion with flat/corrugated topography and quite rough texture is visible. It is associated with numerous linear traces - black striations (Fig. 6: A, B).	-	Chipping the ocher	Broken tool	Fig. 6
6	Feature 79	Pick/ Świeciechów flint	Matte smoothing/abrasion is visible on the tip of the specimen. These traces go to one of the side edges and cover about 1 cm of its length. At higher magnifications, roughening of the surface texture connected to scattered polish is visible (Fig. 7: A), and in places, bright polish/abrasion with flat/ corrugated topography and quite rough texture. It is associated with numerous linear traces - black striations and grooves (Fig. 7: B-C).	In the hollows of the working surface, there are remains of a red mineral substance (Fig. 7: D).	Chipping the ocher	Broken tool	Fig. 7

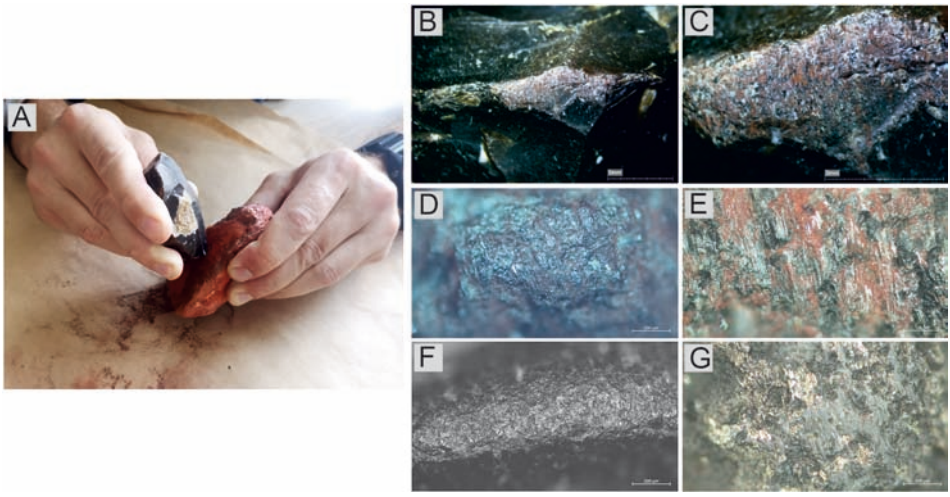


Fig. 9. Wólka Wojnowska, Site 33. Experimental percussive grinding ochre using flint tools (A), the use-wear traces formed during this work (B-E), use-wear traces formed during processing limestone (F), and the traces and residues created during experimental use of strike-a-light (G) (photo by G. Osipowicz)

Table 2. Wólka Wojnowska, Site 33. Results of the SEM-EDX analysis of pick from Feature 115 (prepared by M. Bosiak)

Mass percent (%)											
Spectrum	**C**	**O**	**Mg**	**Al**	**Si**	**P**	**S**	**K**	**Ca**	**Ti**	**Fe**
56309	9.27	41.14	-	0.72	0.87	0.98	0.18	-	0.84	-	46.01
56310	11.58	42.47	0.04	0.66	1.24	0.80	0.15	-	0.89	-	42.16
56311	9.90	33.97	0.15	1.12	2.13	1.07	0.16	-	0.90	-	50.61
56312	13.76	50.39	0.10	1.33	3.70	0.63	0.06	0.20	1.09	0.14	28.60
Mean value:	11.13	41.99	0.07	0.95	1.98	0.87	0.14	0.05	0.93	0.03	41.85
Sigma:	2.01	6.73	0.06	0.32	1.26	0.19	0.05	0.10	0.11	0.07	9.48
Sigma mean:	1.00	3.37	0.03	0.16	0.63	0.10	0.03	0.05	0.05	0.03	4.74

SEM-EDX

The SEM-EDX analysis of a brown substance scraped from the surface of the flint revealed a very high iron content in the range 28-50% for all analysed fragments (Table 2; Fig. 8). The negligible amount of other elements, such as sulphur, combined with the significant amount of oxygen, indicates that the iron does not come from minerals such as pyrite or marcasite, but from iron (III) oxides, possibly ochre.

DISCUSSION

The analysed assemblage of LBK picks from Wólka Wojnowska is the largest known collection of such tools discovered in the drainage basins of the Vistula and Oder Rivers. At the same time, it is one of the most numerous groups of such artefacts found at a single site from the entire range of the discussed culture. This very fact indicates how exceptional it is. Previous finds of this type are known mainly from Western Europe (*cf.* Caspar *et al.* 1989, 202) and are characterized by a relatively high degree of territorial dispersion. Usually, only small numbers of picks, or even single specimens, have been discovered at Belgian, Dutch and German sites – both in settlement and burial contexts (*e.g.*, Modderman 1970, 46, 63; Newell 1970, graph 2; Taf. 122: 11; Farruggia 1973, 124, 125; Cahen *et al.* 1986, 36, fig. 17). Generally, they do not differ from the artefacts from Wólka Wojnowska – in respect of initial forms used in their production as well as the ways of shaping their tips and lateral surfaces. Also, the metric parameters of particular specimens correspond to some extent to the dimensions of the picks analysed in this article (Modderman 1970, Taf. 122:11; 161: 6; Newell 1970, 157; Taf. 229: E334, E170, E137; Farruggia 1973, Taf. 38,4-5; 39,2). Unfortunately, the scope of information presented in source papers does not always allow us to definitely verify and compare particular finds, *e.g.*, due to different ways of their interpretation, and, as a result, differences in final classifications. It appears that two specimens from Kraków-Olszanica – one created on an unspecified form and the other shaped on a conical blade core – can serve as an example (Milisauskas 1986, 137, fig. 115: D, H). Both specimens (especially the former) – presented in the source work as 'miscellaneous tools' – appear to show a clear morphological and metric similarity to the discussed tools from Wólka Wojnowska. This fact indicates that it is possible to interpret them as potential picks, but corroborating this assumption requires a direct and detailed study of the sources. There is a possibility that the same applies to the LBK site in Bolechowice-Zielona, Zabierzów Commune, from where comes an unspecified "macrolithic adze-shaped tool, formed on one side with massive surface retouch" (Breitenfellner and Rook 1991, 17). The fact that there are no illustrations of this specimen makes it impossible to verify the above-presented description.

Putting aside the actual typological classification of the specimens from Kraków-Olszanica and Bolechowice-Zielona, we should stress that there are only three specimens of picks from the drainage basins of the Vistula and Oder Rivers that are definitely attributed to the LBK. They were discovered in features dated to the Želiezovce phase from the Nowa Huta region – in Mogiła (two specimens) and Bieńczyce (one specimen). They were all made on chunks and had a triangular cross-section. One of the artefacts from Mogiła is retouched on three surfaces, and the remaining tools – on two (Kaczanowska *et al.* 1987, 108, 109, Pl. 14: 3, 4). Their morphometric features are similar to the features of the specimens from Wólka Wojkowska. Unfortunately, none of the artefacts from western Lesser

Poland has been subjected to traceological analyses, which makes it impossible to conduct comparative research in this respect.

Because the analysed tools do not find many analogies in Early Neolithic materials from other territories inhabited by LBK societies, it is very difficult to correctly interpret their functions. The character of the use-wear traces observed on the working edges of particular specimens indicates that they were used in processing mineral material (Table 1). Nevertheless, the type of the performed activity and the type of the processed material may be debatable. Characteristic polish/abrasion and roughing of working edges, with scattered polish mainly in the upper parts of the micro-relief, were detected on all the analysed specimens. This type of use-wear is a typical result of processing soft mineral materials, like clay, ochre (Fig. 9: B-E) or limestone (Fig. 9: F). On the most worn parts (not of all the specimens), there was also bright polish with corrugated topography and rather coarse texture, linked with linear traces of a various characteristic having irregular edges (Figs 4: B; 5: C-D; 6: A-B; 7: B-C). This type of polish is a result of processing materials containing harder fractions, which are more resistant to crushing and have a more damaging influence on the working edges of flint tools. Hematite can serve as an example here. During the experiments we have carried out so far, only as a result of processing this mineral (in order to obtain ochre), on the surface of flint tools were created use-wear traces with characteristics corresponding to those observed on specimens from the site in Wólka Wojnowska (Fig. 9: E).

Polish with similar characteristics, but definitely more abrasive, bright and smooth in terms of texture, is a distinctive (and dominant) type of use-wear damage in the case of tools used as strike-a-light (Fig. 9: G). However, on tools with this function, there are rarely such clearly developed use-wear traces typical for the processing of "soft" mineral substances, *i.e.*, matting/rounding of the microrelief with scattered and quite dull polish, which basically dominates in the case of the analysed tools. Therefore, although it cannot be definitively ruled out that some of the studied Neolithic tools were also used as strike-and-light, from the perspective of the overall characteristics of the traces of use, this is unlikely.

The SEM-EDX analysis results on residues taken from the working edges of the discussed Neolithic artefacts proved that the red substance is almost pure iron oxide that may have come from ochre powder. Sulphur (whose presence could indicate that the tools were used in striking fire with pyrite; *cf.* Polit *et al.* 2023) was detected only in very marginal quantities. However, its near absence doesn't necessarily preclude the use of tools for making fire, as this assumes that the pyrite hasn't been post-depositionally remineralized into iron oxide (Leduc *et al.* 2012). For this reason, it cannot be ruled out that the analysed tools were in contact with pyrite or marcasite, even if it seems less probable.

Also, differences in the morphology of residues after ochre processing and striking a fire with pyrite observed in the case of experimental tools (Fig. 9: E, G) do not necessarily have to be significant in the case of artefacts. Red residues similar to those observed on the tools

for ochre processing can be observed on prehistoric strike-a-lights. They results either from in situ remineralization of pyrite residue to iron oxide in some depositional contexts, or from incidental contact with the iron oxide cortex of a pyrite nodule during fire making (see: Sorensen 2019; Sorensen *et al.* 2014; 2018). However, they are usually present in very minor amounts and distributed in specific points. In a case of the analysed artefacts, a red substance was observed in "huge" amounts and in their various parts, although it was concentrated (and most visible) on their working edges, exactly in the same way as with the experimental tools used to ochre processing. This is an indirect argument supporting the hypothesis that we are dealing here with tools for extracting ochre and not the strike-a-lights, in our opinion, quite a strong one. This interpretation, connected to other clues like the widespread use of ochre at the site, the presence of other types of tools related to its processing, i.e., scrapers (certainly not strike-a-light), on which analogical residues were observed, and finally the characteristics of traces of use visible on the analysed artefacts that differ from those typical of strike-a-light are, in our opinion, sufficient grounds to assign them a function related to the processing of ochre (without, of course, excluding, as already mentioned, the possibility of using them also in a different way).

The character of the use-wear traces observed on the artefacts from Wólka Wojnowska allow us to determine the type of activity that they were used for. Most probably, the great majority of them were used in percussive grinding of hematite lumps, that is the removal of material from their surfaces through repeated striking. Performed experimental analyses indicated that it is a very effective method of obtaining ochre powder (Fig. 9: A). The tools from the settlement in Wólka Wojnowska might have been held directly in the hand, which resulted in forming the 'hide-like' polish observed on their surfaces. Still, it should be stressed that these patterns might have been caused by the long-lasting keeping of the artefacts in hide containers or the use of handles lined with hide. The state of preservation of the analysed specimens and, as a result, their present dimensions – especially their lengths, which never exceed 70 mm (only two specimens are longer than 50 mm) – are somewhat troublesome in this context. Most of the picks have fracture surfaces located on the extremities opposite to their tips and formed on already finished tools (Figs 3, 5-7). Unfortunately, their morphological features and the results of the traceological analyses are not enough to help us determine if the artefacts were broken by accident (transverse fracture resulting from using a tool) or intentionally (breaking/detaching the broader part of a finished tool in order to adjust it to its owner's hand or in accordance with its planned function). In most cases, it appears that the latter suggestion is more probable. It may be indirectly corroborated by considerable metric similarities between the analysed specimens and only completely preserved specimen in the collection (Fig. 4) as well as between them and picks discovered at other LBK sites, which are also often transversally broken (*e.g.*, Kaczanowska *et al.* 1987, pl. 14: 4). It appears that the only accidentally broken specimen was found in Feature 33 (Fig. 2). Nevertheless, even in this case, only detaching of its tip can be undoubtedly described as unintentional – result of using the tool (?).

On the other hand, the current state of preservation of the analysed picks does not allow us to exclude the possibility that they are only fragments of more massive, destroyed tools originally used for other activities outside the settlement, *e.g.*, during the extraction of flint raw material or digging in the soil, *etc.*). They may have been brought to the settlement in this form (hence the lack of refits), and then they were recycled/repurposed and used as tools for hematite processing by the people at the settlement. Although this possibility seems less likely due to the lack of clear traceological data, it cannot be clearly ruled out at present.

The conducted experiments allow us to suspect that the working edges of tools used in processing mineral materials (like ochre) get damaged after a very short time. The features of the use-wear traces present on the tools from Wólka Wojnowska indicate that they were not typical 'household goods' intensely used for a long time. They were rather occasionally used in extracting raw materials for current needs. At the same time, the dispersion of the tools (Fig. 1: 2) suggests that they were used by different people, probably in different parts of the settlement. This fact allows us to rule out an assumption that they are remains of a single workshop specialising in processing ochre. At the same time, it indicates that hematite was commonly processed in particular households and that there was considerable demand for ochre among the local society. This is confirmed, on the one hand, by the quite common use of ochre as an intentional admixture in the production of vessels by the inhabitants of the settlement, and, on the other hand, by the presence of its residues documented on the surfaces of other types of flint tools in the collection, including primarily on the "scraping" tools.

The mineral processed with the analysed tools could probably have been better (softer) than the materials used in the previously-mentioned experiments, which is indicated by a relative scarcity of use-wear traces in the form of bright polish/abrasion on the working edges of the artefacts from Wólka Wojnowska. It is possible that this type of hematite was specially selected or prepared in some other, unspecified way. So far, the location of the deposits of the raw material used is unknown.

CONCLUSIONS

The results of the traceological analyses allow us to state that the picks found at the LBK settlement in Wólka Wojnowska were used only to process hematite. The uniform shapes of the discussed artefacts, which are linked with performing similar functions, make us suspect that they were specialist tools formed in a rather standardised way to process the raw material in question. In this context, it is important to answer a question concerning the geographical as well as chronological and cultural origin and scale of this phenomenon. Suggestions – made in some older publications in Western Europe – that this type of tools should be associated with Mesolithic traditions (Newell 1970, 170) were questioned by certain scholars (Farruggia 1973, 124; Löhr *et al.* 248). What is more, ana-

lysed picks from the northern edge of the Sandomierz Upland and specimens discovered across western Lesser Poland (Bieńczyce, Mogiła and possibly Kraków-Olszanica) do not provide us with any typological and cultural link with the local Mesolithic tradition. It appears to be important that all the previously discovered picks explicitly linked with the LBK (Mogiła, Bieńczyce, Wólka Wojnowska) were found in the context of ceramic materials dated to the Želiezovce phase. The authors of previous papers paid attention to this fact (Caspar *et al.* 1989, 180). The lack of such artefacts in assemblages associated with the pre-Music note and Music note phases of the LBK appears not to be accidental or resulting from an insufficient state of research and modest character of the corpus of sources. Then, in the light of the accessible sources, should we consider the appearance of picks in LBK materials as an indication of a growing demand for ochre in the latest phase of this culture? Were these types of tools a completely new technological invention, created solely to meet these needs effectively? Were they a continuation of older forms or adaptation of other, unspecified – and so far absent from the accessible corpus of sources – traditions of the production of specialist tools used in crushing hematite? Or maybe they are just the manifestation of ad hoc reutilization of other, more massive tools, perhaps damaged as a result of earlier use (*e.g.*, mining tools)? The above-posed questions remain unanswered. Finding the answers undoubtedly requires further research, especially augmenting the corpus of sources and widening the scope of specialist analyses. Irrespective of these issues, the obtained results allow us to considerably widen the range of the functional use of picks during the Early Neolithic and definitely discard the interpretation that they were used solely to mine siliceous raw materials. These results correspond very well with previous findings on Late Mesolithic/Early Neolithic picks discovered at Dąbki, which were used for bone/horn processing (Kabaciński 2001; Winiarska-Kabacińska 2015).

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TRACING THE PAST: MICROWEAR ANALYSIS OF STONE AND SHELL BEADS UNEARTHED IN EARLY NEOLITHIC BURIALS AT SAMBORZEC, POLAND

ABSTRACT

Kurzawska A., Sobkowiak-Tabaka I., Mrozek-Wysocka M. and Oberc T. 2024. Tracing the Past: Microwear Analysis of Stone and Shell Beads Unearthed in Early Neolithic Burials at Samborzec, Poland. *Sprawozdania Archeologiczne* 76/1, 309-334.

This paper presents a thorough analysis of ornaments discovered in two Neolithic burials at Samborzec Site 1, providing valuable insights into their origins and significance. The artefacts, retrieved over six decades ago in the burials of a woman and child, have undergone extensive examination, including raw material identification, microwear studies, and the analysis of red residues found on their surfaces. While most of the ornaments concerned were crafted from marble, two beads were identified as *Spondylus* shells. Chemical analysis of residues, primarily found on the marble ornaments, revealed the presence of cinnabar, a red pigment of foreign origin. The remarkable similarities in ornaments between the investigated burials strongly suggest the association of both with LBK communities. The presented studies offer valuable insights into their object biographies, from the acquisition of raw materials from distant regions through their manufacture, assembly, and prolonged use as personal items. In this context, our research emphasizes their belonging to a shared Neolithic tradition in Europe.

Keywords: Neolithic, *Spondylus*, marble beads, LBK burials, cinnabar, red pigment
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INTRODUCTION

It has long been recognized that ornaments, beyond mere decoration, carry significant meanings and can assume various functions, such as indicators of the identity, social status, and social roles of both individuals and groups (d'Errico and Stringer 2011; Rigaud *et al.* 2018; Micheli 2021). This significance is prominently evident in the Neolithic burial practices and differences in grave inventories between buried individuals from the same communities (Czerniak 2012; Kadrow 2008; Siklósi 2013) as only certain deceased individuals were buried with ornaments of specific types. The observed changes in the utilization of ornaments during the Neolithic primarily relate to variations in the use of different raw materials and types that were common throughout Europe during that time (Rigaud *et al.* 2015).

In the territory of modern-day Poland, the Early Neolithic period is primarily associated with the existence of the Linear Band Pottery culture (LBK), which thrived from around the 2nd half of the 6th – the beginning of the 5th millennium BC in Lesser Poland, Silesia, Kuyavia, the lower Oder region, and Chełmno Land, with smaller clusters of settlements in Greater Poland and Polish Pomerania (Czekaj-Zastawny and Oberc 2021; Oberc *et al.* 2022). An outstanding feature of the LBK in Central Europe is the remarkable consistency seen in its material culture, observable in both settlement structures and burial customs. In the inhumation burials discovered in Poland, common grave goods included vessels, animal bones, antlers, and flint tools. Red pigments, either covering the deceased or in the form of lumps or powder deposited in a vessel, are also characteristic (Jeunesse 1997; Kulczycka-Leciejewiczowa 2008; Czekaj-Zastawny *et al.* 2009; Czekaj-Zastawny 2016; Hedges *et al.* 2013). Although ornaments made from white stones (marble/limestone), animal bones, and *Spondylus* shells are frequently discovered in LBK burials across Central Europe, specifically in Germany, Slovakia, the Czech Republic, Hungary, and other regions (see for example, Bonnardin 2009; Nieszery 1995; Séfèriadès 2010), in Poland such items constitute special finds rarely encountered (Kurzawska and Sobkowiak-Tabaka 2020; Kurzawska and Sobkowiak-Tabaka 2024). Despite having been only occasionally studied in detail, such artefacts provide new data and valuable insights into Neolithic communities that once existed in the present-day territory of Poland.

In recent years, the authors have begun extensive studies on the biographies of shell ornaments from the Neolithic and Early Bronze Age context discovered in the area of present-day Poland in order to provide new data about their use and significance. Many of them, however, were artefacts that lacked proper identification or detailed analysis. Encouraged by previous results, we decided to republish some finds that were, in our opinion, unique and deserved detailed analysis and discussion. As such, *Spondylus* ornaments have long been recognized as important items acquired through exchange and trade, associated with the introduction of agriculture and the emergence of a new social order (Séfèriadès 2010). In Poland, such finds are exclusively associated with the early Neolithic period and a total of seven ornaments (discovered at five archaeological sites) have been encountered

in burials associated with LBK, Stroke Band Pottery Culture (SBK), and Brześć Kujawski Culture (BKC) communities (Kurzawska and Sobkowiak-Tabaka 2020). In the published description of a female burial (Burial 208) from Samborzec, Site 1, we discovered information concerning beads that had been identified as being made from a bivalve shell (Czekaj-Zastawny *et al.* 2009). Consequently, we decided to conduct a more detailed analysis of these artefacts – ornaments that were discovered over 60 years ago in two burials, namely the above-mentioned Burial 208 and an additional one, No. V(28), in which ornaments were also found. Fortunately, modern microscopy analysis has made it possible to identify the raw materials from which they were made, trace their object biographies, and assist in associating one of the burials with the LBK culture.

SAMBORZEC SITE 1

Site 1 at Samborzec situated in southern Poland, southwest of Sandomierz, is well-known as a multi-phase settlement and cemetery. It spans various historical periods, including the Neolithic, Early Bronze Age, Bronze Age, Przeworsk culture, and Medieval period. The site was initially unearthed by a team led by J. Żurowski and first excavated in 1930 by Kazimierz Salewicz. Over time, it has been subject to exploration by several archaeological expeditions in the 1950s and 1960s, involving researchers such as Kamieńska (1964a, 1964b), Kamieńska and Kulczycka-Leciejewiczowa (1970), Włodarczak (1999), Kulczycka-Leciejewiczowa (2008), Budziszewski and Włodarczak (2009), Czekaj-Zastawny *et al.* (2009), and Burchard and Włodarczak (2012).

Situated on the southern slopes of a broad loess ridge, the site is located on the high bank of the Gorzyczanka river, which serves as a western tributary of the River Vistula.

The settlement horizons were distinguished based on an analysis of pottery decoration. The oldest corresponds to Phase I (Gniechowice style), the next to Phase II (The Music-Note style), and the youngest to Phase III (Želiezovce style). Confirmation of these distinctions came from two radiocarbon determinations. One was obtained from animal bone, and the other from charred plant remains found within a pot. The nature of the remaining three samples remains unknown (Kulczycka-Leciejewiczowa 2008, fig. 55, 104). Unfortunately, none of the dates are associated with burials.

This settlement comprised multiple households and was inhabited by several dozen individuals. Initially, only five graves were linked to the LBK culture, specifically denoted as Features 41, 42, 60, 71, and 208 (as cited by Kamieńska and Kulczycka-Leciejewiczowa in 1970; further discussed by Kulczycka-Leciejewiczowa in 2008). Among these, particular attention was drawn to the grave denoted as '208' due to the presence of grave goods, particularly personal ornaments. Besides this burial, an additional one containing ornament was found amidst burials associated with the Bell Beaker culture (BBC). Since these were the only burials in which ornaments were discovered, both were subjected to analysis.

Burial 208

The burial was discovered during the archaeological campaign in 1966 in the north-western part of the site. This deep oval pit grave, which extended over a depth of more than 1 m, was meticulously prepared. A 36-year-old female was positioned in a contracted posture, lying on her left side with her palms placed next to her face (Fig. 1). The skeleton was aligned in an east-west direction, with the head oriented towards the east and the face facing south. A layer of red residue covered the head:

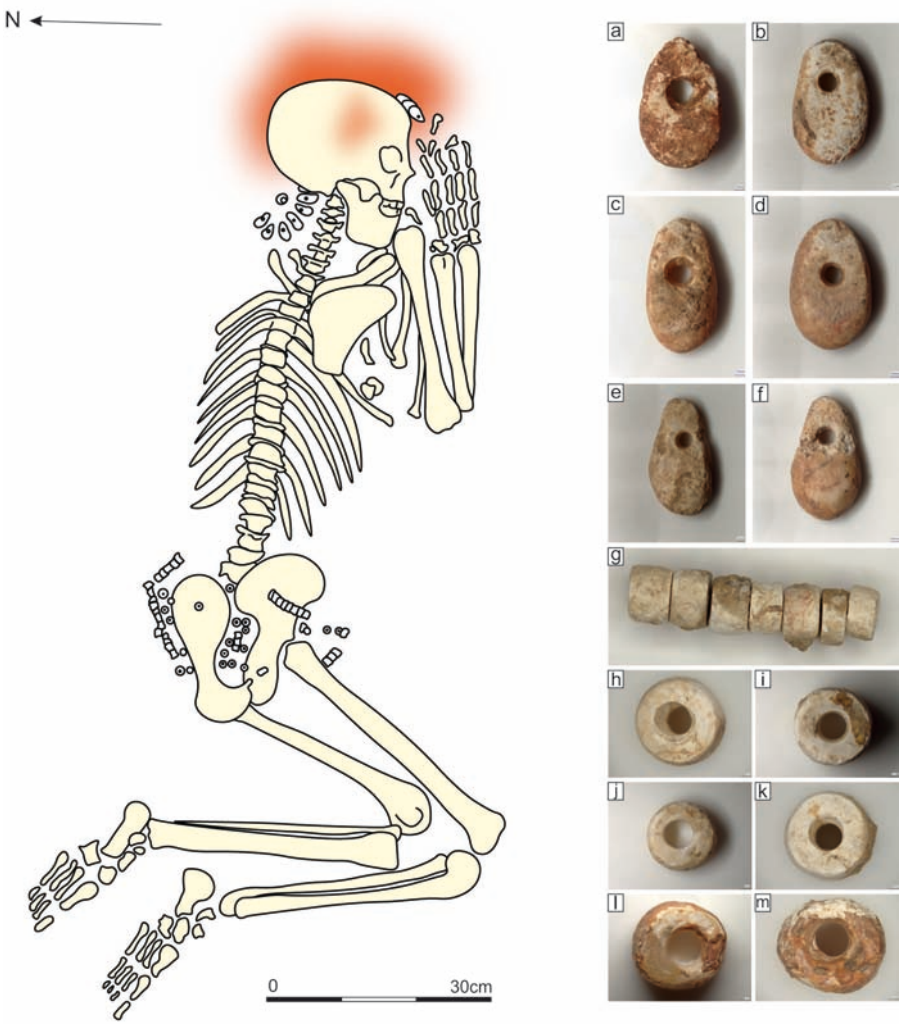


Fig. 1. Burial 208 with examples of discovered marble pendants (a-f), short beads made from marble (g-k), and short beads made from *Spondylus* shell (l-m)
(Burial drawing based on original documentation, prep. P. Rutkowska, photo A. Kurzawska)

Next to the skull were found 31 beads made of animal teeth, initially forming either a necklace or hair ornaments (Kulczycka-Leciejewiczowa 2008), and a necklace of 31 soft limestone beads with visible ochre traces on the surface (Czekaj-Zastawny *et al.* 2009). Additionally, 151 beads made of animal bones (Kulczycka-Leciejewiczowa 2008) and various bivalve shells (Czekaj-Zastawny *et al.* 2009) were discovered on the pelvis, probably associated with a belt or skirt.

Within the pit's infill, various fragments of kitchen pottery, two flint artefacts, and two animal bones were unearthed. Roughly 20 centimetres above the skeleton, fragments from a single pottery vessel were also found. Based on pottery analysis, the burial was associated with phase Ia (Gniechowice) of LBK development (Kulczycka-Leciejewiczowa 2008; Czekaj-Zastawny *et al.* 2009). Although at this point there are only two radiocarbon determinations associated with this phase, which do not allow for reliable dating, the whole phase I (Ia and Ib; pre-Music-Note phase) are can be dated to c. 5350/5300-5250/5200 BC (Czekaj-Zastawny and Oberc 2021; Oberc *et al.* 2022).

Burial V(28)

This burial was excavated in 1962, amidst a series of Bell Beaker burials (Fig. 2). Situated 0.6 meters beneath the contemporary surface, this oval pit grave cradled a child in a contracted posture, lying on their left side with their face turned towards the south. The child's palms were positioned adjacent to the face. The only items interred with the child were ornaments – namely, beads, distributed along the backbone, pelvis, and legs. A single long

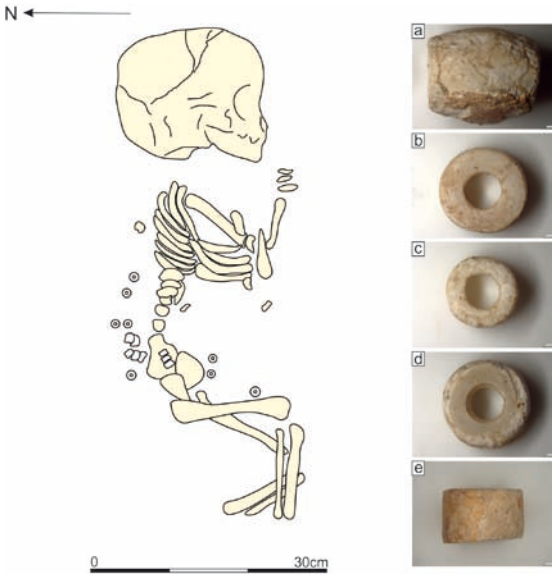


Fig. 2. Burial V(28) with examples of discovered beads (a – long barrel-shaped marble bead; b-e – marble short beads) (Burial drawing based on original documentation, prep. P. Rutkowska, photo A. Kurzawska)

barrel-shaped bead was unearthed at the bottom of the pit, suggesting that it was originally under the head of the deceased (Kamieńska 1963, 1964b).

This burial was initially classified with some caution as associated with the BBC. Probably due to a notable difference in the east-west alignment of the skeleton, unlike other north-south oriented BBC burials (Kamieńska 1964b), a comment about a possible connection to the LBK was added to the field book (by P. Sikora) and marked with a question mark (Kamieńska 1963). It was located c. 120 m, in a straight line from the LBK burial 208 (Kulczycka-Leciejewiczowa 2008).

MATERIALS AND METHODS

All ornaments found in these two burials underwent various analyses, including raw material identification, microwear studies, and the identification of the red residue discovered on their surfaces. The ornaments were classified based on the types they represented following Beck's 1928 and Kenoyer's 1991 definitions below:

A disc bead is a regular bead in which the length is less than one-third the diameter of the bead. A short bead is a regular bead in which the length is more than one-third the diameter of the bead and less than nine-tenths the diameter (Beck 1928, 4).

Pendants are a type of bead that is perforated at one or both ends rather than symmetrically through the middle (Kenoyer 1991, after Choyke and Bar-Yosef Mayer 2017).

Measurements were taken, including the length and width of the pendant, the length and diameter of beads, and whenever possible, the morphology of the perforation was specified (uniform/conical/biconical) along with the diameter of the perforation. Table 1 provides a summary of the measurements, including the mean and standard deviation, in order to enhance comprehension of the bead size trends in the studied assemblage.

We decided to clean, in the ultrasonic tank, only beads that were pre-selected for further microwear studies while using a stereoscopic microscope at low magnification (up to 40×). Beads with traces of red residue were left uncleaned.

The ornaments underwent analysis using a Nikon SMZ 445 optical microscope, a Keyence VHX-7000 digital microscope, and specifically, the identified shell ornaments using a Tescan Vega 4 scanning electron microscope (SEM) at the ArchaeoMicroLab of the Faculty of Archaeology at the Adam Mickiewicz University in Poznań, Poland. The SEM aimed to document the shell microstructure of shell beads for subsequent species identification (BSE-compo detector, low vacuum mode, condition: 25 Pa; 15.0 kV beam voltage). The descriptions of the shell microstructures are based on Sakalauskaite *et al.* 2020, and Gardelková-Vrtelová and Golej 2013.

In the study of ornament technology, we conducted a microscopic analysis of manufacturing use-wear marks and taphonomy using the Keyence VHX-7000 digital microscope. The description and observations were based on the information found in Bonnardin 2009;

Knaf *et al.* 2022; Van Gijn 2017; Groman-Yaroslavski and Bar-Yosef Mayer 2015; Baines 2012; Falci *et al.* 2018; Margarit 2017, and references therein).

To facilitate the analysis, the technique of creating silicone casts of ornament perforations was employed – a method used originally by Gorelick and Gwinnett (1978, 1990). This approach allowed observations to be conducted on the imprint of the entire hole while using the SEM. Among the ten ornaments subjected to silicone casting, six underwent further processing: they were sputtered with a 50 Å gold coating (while using a VAC COAT DSR1 desk sputter coater) before SEM imaging in order to achieve high-quality images. SEM microphotographs were subsequently captured in low vacuum mode using an SE detector (condition: 15 Pa; 20 kV beam voltage).

The petrographic and chemical analyses were conducted at the Laboratory for Scanning Electron Microscopy and Microanalysis, the Faculty of Geographical and Geological Sciences at the Adam Mickiewicz University in Poznań. The description of the raw material was based on petrographic features that could be perceived with the naked eye such as grain size, colour, and homogeneity, supported by SEM-EDS micro-area analyses. They were performed on the selected objects in low vacuum mode using a Hitachi S-3700N Scanning Electron Microscope coupled with a Noran SIX Energy Dispersive Spectrometer (VP-SEM condition: 25 Pa; 15.0 kV beam voltage; images obtained in backscattering electron mode 3D). Colour determination for both the stone ornaments and the reddish pigment was carried out using an objective colour standard, namely the Munsell® Soil Colour Charts, 2000. We chose to prioritize the preservation of the ornaments, being aware of the currently employed standard archaeometric procedures for identifying stone materials, especially archaeological marbles, as demonstrated, among others, by Antonelli and Lazzarini 2015, and Brilli *et al.* 2015, which involve destructive methods for determining petrographical and geochemical parameters (O and C isotopic signatures, CL and/or EPR analyses). Therefore, we decided to confine our research to nondestructive methods.

To acquire essential information regarding the archaeological context of the discovered artefacts, the studies were based on the original documentation of the excavated burials from 1962 and 1966. The documentation (field books, notes, plans, and drawings) was kindly provided by the Institute of Archaeology and Ethnology at the Polish Academy of Sciences in Kraków and was carefully studied.

RESULTS

Typology of ornaments and measurements

In the discussed burials a total of 211 ornaments were encountered. Among them, the following types were identified (after Beck's 1928 and Kenoyer's 1991 definitions):

Pendants:

– These are elongated/oval in shape, resembling known ornaments made from red deer

Table 1. Typology of beads and pendants with their range of measurements (mean – $\bar{x}$ and standard deviation – σ)

Burial No.	Context	Pendant/ Bead type	Length [mm]	width [mm]	perforation diameter [mm]
208	193/66	pendants	14.33-21.06	7.91-12.8	1.08-2.99
			$\bar{x}$ = 17.5; σ = 1.8	$\bar{x}$ = 10.24; σ = 1.19	$\bar{x}$ = 2.29; σ = 0.35
	194/66	disc bead	2.51	7.13	2.92
V/(28)	97/62	disc bead	2.08	8.78	4.3
			3.87	7.66	3.09
	97/62	short bead	2.73-6.43	7.33-10.08	2.95-4.19
			$\bar{x}$ = 4.45; σ = 1.0	$\bar{x}$ = 8.73; σ = 0.86	$\bar{x}$ = 3.6; σ = 0.34
208	194/66	short bead	3.05-6.91	7.22-10.09	1.85-4.61
			$\bar{x}$ = 5.01; σ = 0.85	$\bar{x}$ = 8.65; σ = 0.46	$\bar{x}$ = 2.75; σ = 0.43
V/(28)	97/62	barrel-shaped bead	11.53	9.9	3.2

canines, featuring a single hole located at the slightly tapered end (Fig. 1: a-f). A total of 31 pendants were found in Burial 208, several on the front of the skull and the rest behind it.

Beads:

– Disc beads – a total of three beads were found: one among the marble beads of a hip belt in the woman's burial, and two in the child's burial.

– Short beads constituted the majority in both burials. In the woman's burial, namely No. 208, they are associated exclusively with the hip belt (148 beads made of marble and two made of shell) (Fig. 1: g-m), while 26 beads of marble were found scattered in the child's burial, No. V(28) (Fig. 2).

– A long barrel-shaped bead – only one of this type – was found in the child's burial (Fig. 2: a).

The range of measurements for each discussed artefact is presented in Table 1, including the Mean $\bar{x}$ and Standard Deviation (σ). In the case of the short beads found in both burials, their mean length and width measurements, along with a low standard deviation, indicate that they are roughly the same in size. This observation may suggest a common origin.

Raw material identification

Shell beads

The use of low magnification reaching up to 80× facilitated the identification of shell ornaments among the stone/mineral ones. Within Burial 208, among the marble beads in the pelvic area, two beads were identified as having been made from bivalve shells (Fig. 1:

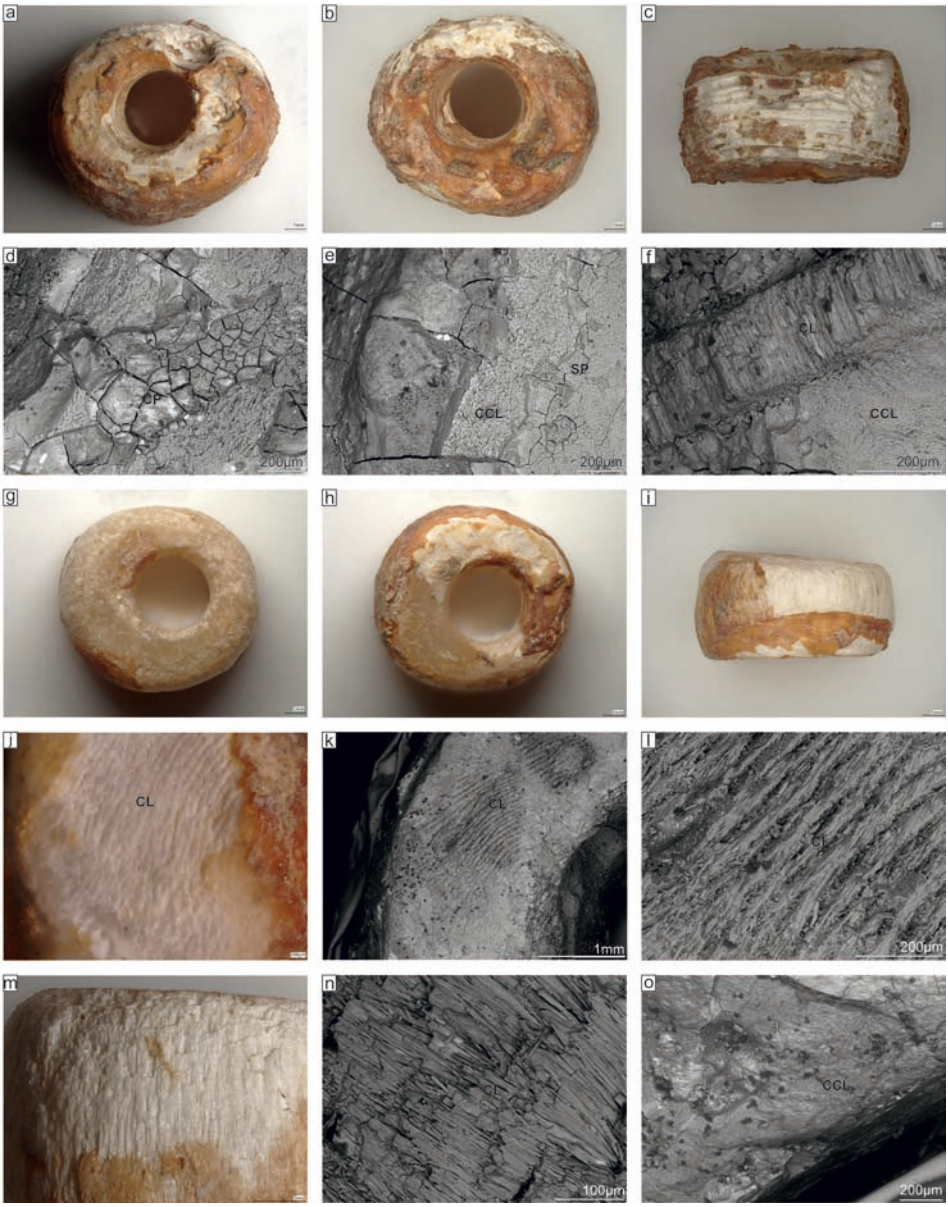


Fig. 3. Two *Spondylus* beads discovered in Burial 208. Bead 194_66_A: a-c – view from different sides; d – view of a bead surface with calcium phosphate (CP) residue; e – view of the bead microstructure: complex crossed foliated layer (CCL) and prismatic structures (SP); f – view of the bead microstructure: crossed lamellar layer (CL) and complex crossed foliated layer (CCL). Bead 194_66_B: g-i – view from different sides; j-n – crossed lamellar layer (CL); o – crossed foliated layer (CCL). Digital photographs: a-c, g-j, m and SEM microphotographs: d-f, k, l, n, o (photo A. Kurzawska)

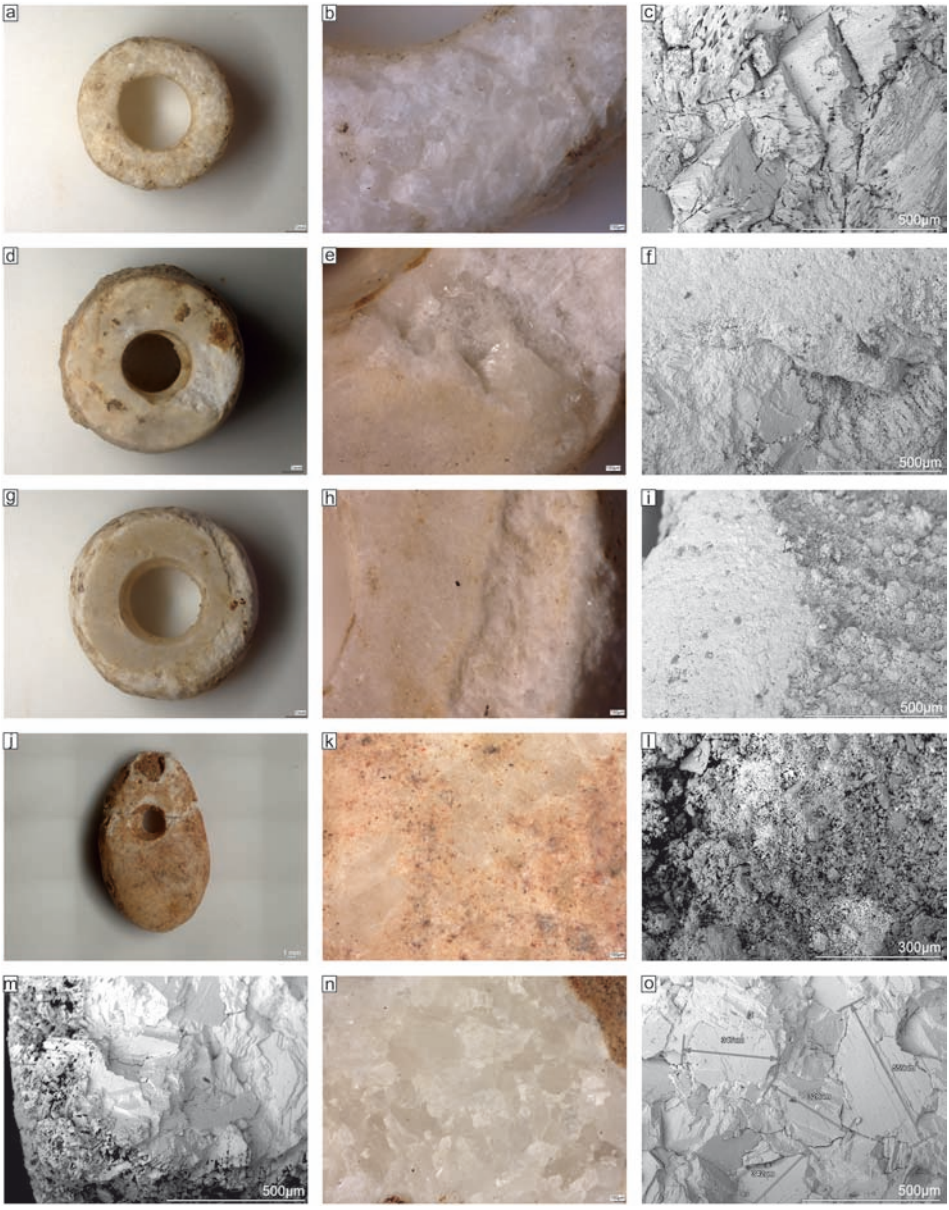


Fig. 4. Stone ornaments from discussed burials, examples of different grain size of crystals in marble: fine-grained marble with visible calcite crystals to the naked eye (bead 97_62_D – a, b, c; Bead 194_66_Z – d, e, f); very fine-grained marble (Bead 97_62_E – g, h, i); state of deterioration of marble (Pendant 193_66_T); heavily weathered surface (j, k, l); fresh cut (m, n, o). Digital photographs: a, b, d, e, g, h, j, k, n and SEM microphotographs: c, f, i, l, m, o

l-m, Fig. 3). Accurately classifying the genus was crucial for determining their provenance. For this purpose, a meticulous analysis of the microstructure of the shell beads was undertaken, followed by a comparative assessment against a reference collection, comprising microphotographs from previous analyses of shell artefacts held by the authors, as well as published studies (Gardelková-Vrtelová and Golej 2013; Sakalauskaite *et al.* 2020). Employing both digital microscopy and scanning electron microscopy (SEM), the microstructures of the beads were documented (Fig. 3).

We compared the microstructure of the beads and that of *Spondylus* shells, drawn by the potential shell thickness and the presence of similarly shaped and sized beads discovered in Neolithic burials in Central Europe, which were made from shells of this particular genus (Sakalauskaite *et al.* 2020). The *Spondylus* shell structure primarily encompasses the subsequent layers, as outlined by Gardelková-Vrtelová and Golej 2013:

1 – The outermost shell layer is composed of foliate calcite (CF).

2 – The middle shell layer consists of crossed lamellar aragonite (CL).

3 – The innermost shell layer is characterized by complex crossed lamellar aragonite (CCL) and prismatic aragonite (SP) which display irregular alternation with CL and CCL layers near the center.

Both beads (labelled as 194_66_A and 194_66_B) exhibit shell microstructures typical of *Spondylus* shells, including aragonitic prismatic structures (SP) (Fig. 3: e), crossed lamellar layers (CL) (Fig. 3: f, j, k, l, n), and complex crossed foliated layers (CCL) (Fig. 3: e, f, o). The foliate calcite, which constitutes the outermost layer of the shell, was not observed during the analysis of the beads. Based on the visible microstructure, it is highly possible that the beads were made from the thickest part of the valve. The outer calcitic layer, responsible for the shell's colouration, was notably absent in these beads. As a result, it is plausible that the beads were manufactured in this manner, suggesting they might have originally been white.

Although the dissolution of aragonite was visible on the bead surfaces, no recrystallization was observed. The distinctive yellow-orange colour relates to areas covered by calcium phosphate CaPO (CP) due to post-depositional processes (Fig. 3: a-d, h-j).

Stone ornaments

The vast majority of the ornaments were made of stone (in Burial 208: 31 pendants and 149 beads; in Burial V(28): 29 beads). They vary in their state of preservation, from those that still retain their polish to those that are significantly weathered. Proper identification of the raw material was sometimes challenging for this reason. Nevertheless, it can be stated without doubt that all were made of a carbonate rock.

The discussed stone ornaments were made from semi-translucent, monomineral, densely compact marble (crystalline calcite) with either a vitreous or dull lustre. Macroscopic observations, confirmed by crystal measurements using an SEM, classified the raw material as very fine to fine-grained saccharoidal marble (Fig. 4). The determination of

grain size took into account the division used in the archaeometric study of marbles, as discussed by Antonelli and Lazzarini in 2015. This division slightly differs from the typical petrographic classification, in which the fine-grained category encompasses sizes up to 2 mm. Although in some beads and pendants, calcite crystals are easily visible to the naked eye (*e.g.*, Bead 97_62_D with measured crystals up to 638 μm in size) (Fig. 4: a-c), this is challenging within the very fine-grained category (as seen in Bead 97_62_E with crystals measuring 22.4-58.3 μm) (Fig. 4: g-i), especially for those that are heavily weathered (*e.g.*, Pendant 193_66_T) (Fig. 5: j-l).

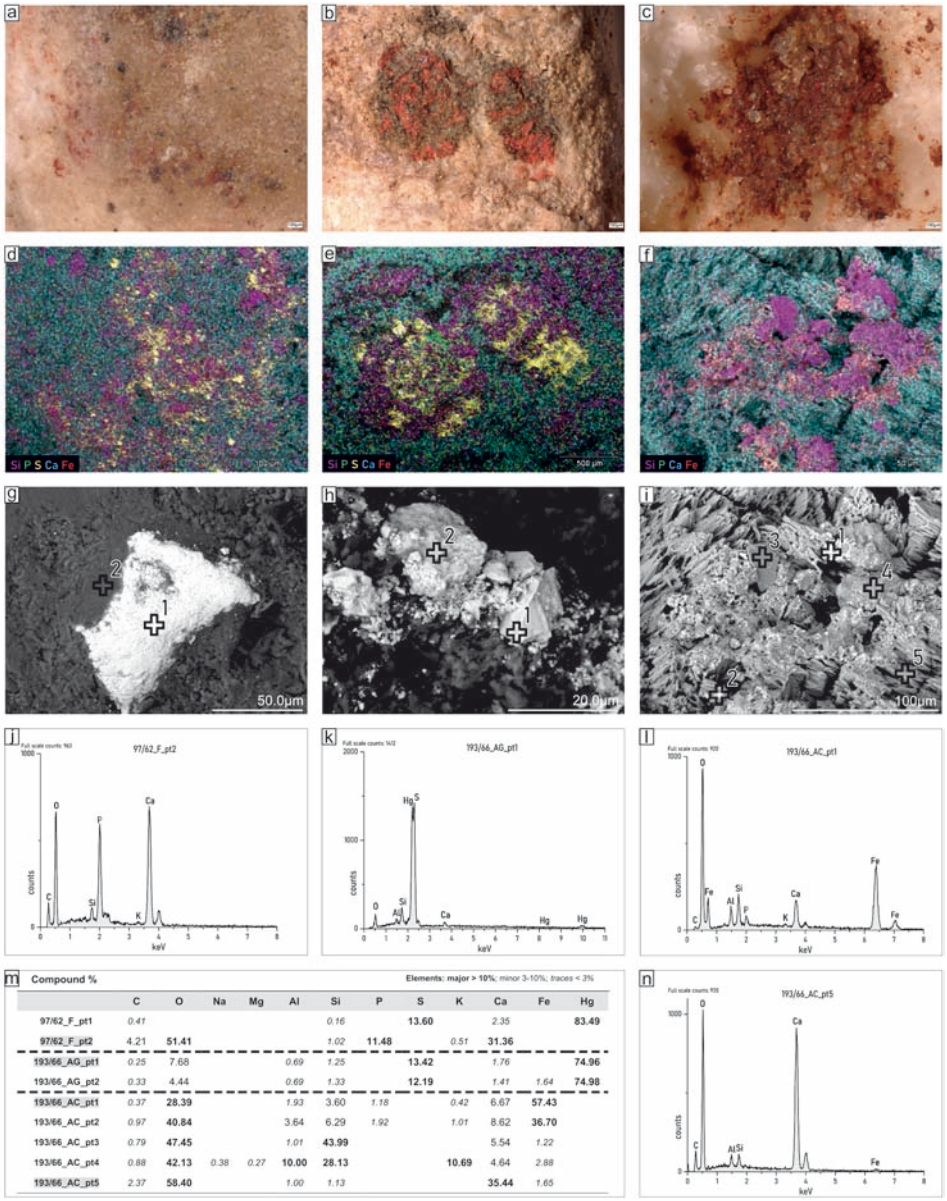
The staining of the surface of the artefacts was influenced by post-depositional processes associated with the long deposition of the artefacts in the grave in loess sediments. According to the Munsell charts, their colours were defined as follows: in a patinated state, they ranged from very pale brown to light yellowish-brown (10YR 6-8/2-4) or white to light pinkish-grey (5YR 7-8/1-2) (Fig. 4: j-k); on a surface not affected by weathering, they appeared as white/light grey (GLEY1 7-8/N) to light bluish-grey (GLEY2 8/10B) or very pale brown (10YR 7-8/1-2) (Fig. 4: a-b, d-e, g-h). A fresh cut reveals the pure white colour of marble (Fig. 4: n). The chemical composition of the raw material, as determined by non-destructive SEM-EDS analysis, indicates pure calcite marble (Fig. 5: n, m). No magnesium ions, indicating the presence of dolomite, were found in any of the analyzed objects.

Stone ornaments, particularly pendants, exhibit varying degrees of deterioration, evident through increased porosity, progressive granular disintegration, or the risk of breakage (Fig. 4: m). Similar to the shell beads, a brown (10YR 4-5/3) or yellowish-red to reddish-yellow/brown (5YR 5-6/4-6) substance, primarily composed of calcium phosphate (Fig. 5: j, m), was also detected on some of the stone ornaments.

Pigments

A red deposit was initially observed during the exploration of Burial 208, with the largest concentration located on and around the skull (Fig. 1). The highest quantity of this deposit was consequently found on the pendants discovered both on and behind the skull. Furthermore, during the analysis of the ornaments, traces of a red residue were also detected on the beads recovered from the pelvic area and on the sole barrel-shaped bead from the child's burial.

The substance on the ornaments exhibits various shades of red and brown, including reddish and brown nuances in colour. Within these residues, semi-quantitative analyses were conducted using SEM-EDS to determine the proportions of major elements (Fig. 5: m). While SEM-BSE images revealed the chemical diversity within the staining, EDS analysis of selected micro-areas (mapping) identified the presence of two distinct pigment compositions, as seen in the distribution of significant elements (Fig. 5: d-f). To a great degree, this division corresponds to the macroscopic colour variation. In areas identified as light red to dark red (10R 3-7/6-8) (Fig. 5: a-b), the results of the EDS analysis indicated the presence of mercury and sulphur peaks (Fig. 5: k) in samples 97_62_F_pt1, 193_66_



	C	O	Na	Mg	Al	Si	P	S	K	Ca	Fe	Hg
97/62_F_pt1	*0.41*					*0.16*		13.60		*2.35*		83.49
97/62_F_pt2	4.21	51.41				*1.02*	11.48		*0.51*	31.36		
193/66_AG_pt1	*0.25*	7.68			*0.69*	*1.25*		13.42		*1.76*		74.96
193/66_AG_pt2	*0.33*	4.44			*0.69*	*1.33*		12.19		*1.41*	*1.64*	74.98
193/66_AC_pt1	*0.37*	28.39			*1.93*	3.60	*1.18*		*0.42*	6.67	57.43	
193/66_AC_pt2	*0.97*	40.84			3.64	6.29	*1.92*		*1.01*	8.62	36.70	
193/66_AC_pt3	*0.79*	47.45			*1.01*	43.99				5.54	*1.22*	
193/66_AC_pt4	*0.88*	42.13	*0.38*	*0.27*	10.00	28.13			10.69	4.64	*2.88*	
193/66_AC_pt5	*2.37*	58.40			*1.00*	*1.13*				35.44	*1.65*	

Fig. 5. Examples of microanalysis conducted on residues found on stone ornaments, specifically Bead 194_66_AB (a, d), Bead 97_62_F (g, j), Pendant 193_66_AG (b, e, h, k), and Pendant 193_66_AC (c, f, i, l, n). The analysis encompassed the examination of colour variations in different red pigments using a digital microscope (a, b, c). SEM-BSE images with chemical mapping (d, e, f), illustration of the elemental distribution of selected elements: silica (pink), phosphorus (green), sulphur (yellow), calcium (blue), and iron (red). Point analysis through EDS (g, h, i) and the corresponding spectra (j, k, l, n). Semi-quantitative results (major, minor, traces identified with SEM-EDS) obtained for the samples (m)

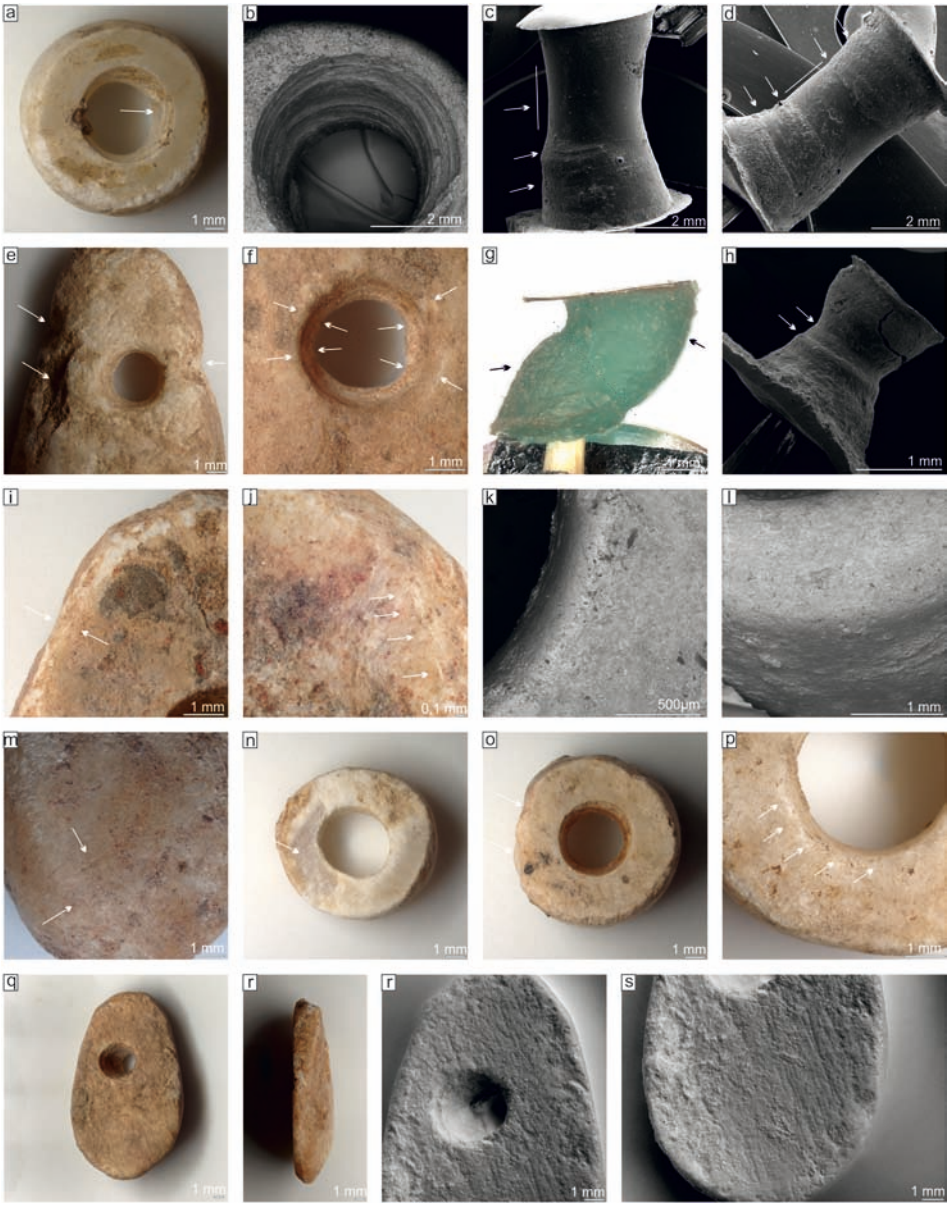


Fig. 6. Examples of microwear traces on beads and pendants from discussed burials: a-d – traces of drilling inside beads and on the silicone casts (straight lines and arrows point to microwear and usewear traces); e-f – usewear traces visible on a pendant's point shown by arrows; g – silicone cast of uneven drilled pendant from both sides; h – traces of drilling in pendant visible in the silicone cast; i-m – traces of usewear – polishing on the pendants (i-j, m) and beads (k-l, p) surfaces; n-o – traces of chipping visible on the surface (n) and edges of beads; q-s – traces of abrasion (grooves) and polishing on the pendant's surface

AG_pt1, and pt2, clearly indicating a cinnabar composition (Fig. 5: m). In contrast, the chemical composition of the darker-coloured areas (ranging from weak red to dusky/very dusky red and reddish/dark reddish brown – 2.5 YR 2.5 -4/2-3) (Fig. 5: c) is dominated by iron oxides (with Fe content ranging from 36% to 57%) with subordinate amounts of aluminosilicates (Fig. 5: i, l; 193_66_AC pt1 and 2). Regarding the morphology of these pigments as observed in the SEM images, the cinnabar appears to be more crystalline and crushed (Fig. 5: g-h), often fused with the calcium phosphate substance, while the iron compounds are in a more powdered and dispersed form (Fig. 5: i).

Microwear analysis

Various micro traces were observed during the analysis of the ornaments. The two *Spondylus* beads (Fig. 3), due to the chemical decomposition of calcium carbonate and the presence of residue on their surface, bore hardly any traces. In contrast, the ornaments made of marble exhibit traces attributed to the manufacturing process, as well as usewear traces produced by contact with string, skin, cloth, or leather to which the ornaments were attached, as well as contact with other ornaments (Fig. 6).

Beads

Concentric lines inside the perforations indicate traces of drilling (Fig. 6: a-d). Morphologically, the perforations appeared straight and biconical, with the latter being the most common. The manufacturing process involved drilling from both sides, clearly visible in the silicone cast (Fig. 6: c, d). Straight perforations, particularly those found in 16 beads (Burial V(28)) and 10 beads (Burial 208), may be indicative of use-wear resulting from subsequent extensive abrasion and polishing caused by the movement of a string (Fig. 6: a). As the beads were originally strung together, friction from the string may have smoothed the central, narrower part of the perforation (Fig. 6: c, d), suggesting that they were loosely strung. Chipping, visible as breakages on the edges and sometimes on the surface of the beads, is likely a result of the beads rubbing against each other during stringing (Fig. 1, Fig. 6: n, o), or contact with other hard material while, for instance, wearing the ornament. The smoothness and polish visible on some of the beads' edges (Fig. 6: k, l) may result from both final polishing in the manufacturing process and usewear, such as contact with soft material (cloth or leather).

Pendants

Manufacturing traces visible on the pendants include drilling (perforation by rotation) performed from both sides, resulting in morphologically biconical perforations that are visible on both the artefacts and in the silicone casts (Fig. 6: g, h). The biconical profiles of the perforations are clear and uneven, with drilling from both sides being sometimes uncentered (Fig. 6: g), at times more extensive, and meeting at a rather sharp angle (Fig. 6: h).

It is at this point that the hole possesses the smallest diameter. The traces of the manufacturing process are visible on the surface of the pendants as traces of abrasion (Fig. 6: r, s), suggesting the use of grinding and polishing in the manufacturing process. These traces typically consist of widely spaced scored lines going in the same direction. The polished surfaces of the pendants (Fig. 6: m, r) exhibit faintly visible lines going in various directions, and the edges display traces of wear (polishing) from contact with other materials. In cases where faint grooves are present, they are indicative of contact with harder materials.

Usewear traces such as chipping (Fig. 6: e), abrasion (Fig. 6: j), and polishing (Fig. 6: f, j) can be observed on both sides of the pendants (Fig. 6: i, j) and on the edges of the perforations (Fig. 6: f), indicating a different method of attachment (Fig. 6: e-g) beyond simple suspension. The pendants were most likely sewn onto a garment, such as a headband, the edge of headgear, or a hood, from both sides of the perforation.

DISCUSSION AND CONCLUSION

Sources of the Raw Material

Shell

Spondylus gaederopus is a well-known species that currently inhabits mainly the western part of the Mediterranean, including the Aegean Sea, the Adriatic Sea, and the Pacific Ocean (Poppe and Goto 2000). The origin of Neolithic ornaments in Europe made from this species has been widely discussed (Windler 2018, 2019; Bajnóczi *et al.* 2013; Todorova 2002). Due to uncertainties regarding the origin of *Spondylus* finds in Poland and their poor state of preservation, strontium isotope analysis ($^{87}Sr/^{86}Sr$) was performed, indicating their Quaternary age (Kurzawska *et al.* 2020). It was confirmed that the ornaments originated from areas around the Adriatic or Mediterranean Sea. All the *Spondylus* artefacts known in the area of Poland to date were either ornaments acquired through exchange/trade from the South, possibly the Aegean region, through the Carpathian basin communities, or they were brought to Poland by the first farmers (Kurzawska and Sobkowiak-Tabaka 2020). Chronologically, all of the *Spondylus* artefacts from Poland coincide with the area of the widest distribution of *Spondylus* ornaments in Europe between 5500 and 5000 BC (Windler 2019).

Marble

Determining the exact provenance of archaeological marbles is a challenging task at this stage of our research, given the limitations in our ability to follow the complete provenance procedure. However, the analytical results obtained thus far, along with archaeological data, allow us to propose and rule out potential sources of this raw marble material.

The nearest known outcrop of white marble is situated in the Śnieżnik Massif (Central Sudetes, SW Poland), where carbonate rocks appear in the Stronie Formation as assemblages of several separate long arrays of lenses along the distance of a few kilometers (see for example, Jastrzębski 2005; Gil *et al.* 2020). Based on differences observed in chemical composition and petrographic properties, several lithotypes of carbonate rocks have been recognized and distinguished by Koszela (1997). Among these, white calcite marbles characterized by a coarse and medium blastic texture with homogeneous and flake microstructures are described, while dolomite marbles are creamy and finely blastic. Significantly, the white purely calcite finely-blastic marble from which the Samborzec beads were made is not present.

The calcite marbles of the Stronie Formation are known to have been quarried since the 19th century for several varieties of marbles including the so-called "White Marianna" variety, nevertheless, within these outcrops, no traces of prehistoric exploitation have been found to date.

This outcrop was only mentioned by M. Doktor (Czekaj-Zastawny *et al.* 2009) as a potential source of raw material for the beads found at the burial site in Szczotkowice. However, this assertion lacked analytical support, as there was a deficiency in both petrographic and chemical analyses. Thus, it is probable that in his assumptions, he selected the nearest source of marble to Szczotkowice. Our exclusion of the Sudetes as the origin of the marble from Samborzec is based on the petrographic characteristics of marbles found in that region, including crystal size and the presence of dolomite. The finds from Samborzec exhibit significantly smaller crystals and lack the magnesium that would be indicative of dolomite within the composition.

Documented evidence of white marble mining in prehistory can be found in the Sazava region of the Czech Republic (Přichystal 2000). Recent research (Přichystal *et al.* 2019, Burgert and Přichystal 2022) has provided new petroarchaeological data concerning the raw material in this area. Two types of marble were identified within a single geological unit, the Šternberk-Čáslav Variegated Group in the Moldanubian Region. These are a calcite marble at the Bílýkámen site and dolomitic marbles around the town of Český Šternberk, located 7 km to the southeast. Consequently, these studies shed new light on craftsmanship in prehistory, particularly in the context of marble bracelets found at Neolithic sites. The stone assemblage in Samborzec exhibits many petrographic characteristics resembling Bílýkámen marble and the latter can therefore be considered a potential source. However, we cannot rule out more distant sources for the marble, such as the Balkans and Greece (Herz 1992).

Until now, marble ornaments have been discovered at just one other LBK burial site, located at Szczotkowice (Krauss 1964). These artefacts consist of 36 long barrel-shaped beads, remarkably similar in both type and dimensions to the one unearthed in the child's burial at Samborzec discussed here. Although it has previously been proposed that the white marble uncovered in Szczotkowice may have originated from the "Biała Marianna" deposit, nestled in the Sudety Mountains (Czekaj-Zastawny *et al.* 2009), considering new

data, these suggestions should be revised. Comparable white stone ornaments in the area of Poland have also been identified at various archaeological sites linked to post-LBK communities, including Domasław, Site 10/11/12, Osłonki, Site 1, the Brześć Kujawski Site 4, and Krusza Zamkowa, Site 3. At Domasław, A. Wójcik conducted an analysis, identifying a total of 21 beads – comprising long cylindrical and short beads – macroscopically as carbonate rock. These beads exhibit a range of colours, from milky white through cream to grey, often featuring white and pink veins (Mozgała-Swacha and Murzyński 2017). In the cases of Osłonki and Brześć Kujawski, stone beads characterized by rectangular cross-sections, were identified as made from calcite. It was assumed that these beads may have reached these sites along with copper imports from the Czech Republic (Grygiel 2008). Recent, comprehensive research into the ornaments from burials at Krusza Zamkowa has shown that several disc beads (previously considered as white stones or calcite) were crafted from marble (Kurzawska *et al.* in prep.).

In light of the uniqueness of ornaments made from marble and white stones, along with the latest analysis, it appears increasingly likely that the raw material (marble), and perhaps even the ornaments themselves, were sourced from more distant locations, the closest possibly located in the Sazava region of the Czech Republic.

Pigments

The examination of the red residue discovered on the ornaments proved to be highly intriguing. In archaeological literature, the common assumption is that red pigments/colour, especially when in powder form, can be attributed to ochre. This approach however lacks precision and potentially leads to incorrect conclusions, as pointed out by Michera 1993 and Woźny 2002, 2007 in their research on the use of red dye in prehistory.

Our studies identified two types of red mineral pigments on the ornaments, namely: HgS crystals, interpreted as cinnabar, and iron oxides combined with aluminosilicates, the basic components of ochre. In the case of Burial 208, cinnabar was predominantly found on the pendants in the head area. The red pigment was however dispersed throughout the grave. Some beads from the belt also showed traces of cinnabar, albeit in smaller quantities. The distribution of these pigments across the artefacts appeared heterogeneous. Dark red ochre was found on only a few beads and one pendant, exclusively within the surface cavities of the ornaments. Regarding the beads from the child's burial V(28), any discolouration observed was not attributed to the presence of pigment but rather to post-depositional processes. A significant exception to this was a single barrel-shaped bead discovered under the skull. On its surface, amidst reddish-brown staining and micro spots of calcium phosphate residue, the presence of cinnabar was confirmed.

The extraction and use of cinnabar, a red mineral pigment composed of natural mercury sulphide (HgS), dates back to the Stone Age. Well-known Neolithic mining sites for cinnabar include Almaden in Spain, Monte Amiata and Spaccasasso in Italy, as well as quarries in the Balkans, including Idrija in Slovenia and Avala in Serbia (Gajič-Kvaščev *et*

al. 2012; Maras *et al.* 2013; Mioč *et al.* 2004; Poggiali *et al.* 2017). The presence of mercury ore from the Šuplja Stena mine, located beneath Mount Avala near Belgrade, Serbia, along the trade route of the first farmers travelling through the Moravian Gate to Poland, suggests the possibility of the cinnabar's provenance. However, further analyses are required to confirm the hypothesis.

Possible sources located in Poland should be discounted due to the exceptionally rare occurrence of cinnabar within predominantly hydrothermal deposits. The most notable deposits linked to polymetallic uranium mineralization are the Kowary and Kletno deposits (Banaś and Mochnacka 1986; Mochnacka and Banaś 2000; Gil *et al.* 2020). Cinnabar identified at these sites is present only in trace amounts, typically as dispersed microcrystals within a network of quartz-calcite veinlets (Kowary) or embedded in veins or nests of secondary uranium minerals (Kletno). Obtaining a significant quantity of powder akin to that found in the woman's grave would not be viable from these locations.

Samborzec, Site 1 is situated on loess deposits, where finding red ochre is unlikely. Therefore, it is reasonable to assume that it was most likely acquired from other regions. In Poland, there are several potential source locations for red ochre, including the Tatras, the Sudeten Foreland, or bog ores in the lowlands. However, a more probable source can be found in the Rydno Complex within the Świętokrzyskie Mountains near Skarżysko-Kamienna, located approximately 100 km northwest of Samborzec. Although Rydno is recognized as a major mining centre for haematite ore in the Palaeolithic and Mesolithic periods, it cannot be ruled out that mining on a smaller scale continued during the Neolithic (Schild *et al.* 2011). Although haematite can be found within a reasonable distance, cinnabar was acquired possibly through trade or exchange from distant sources. It is widely acknowledged that valuable materials, typically those that are rare or require significant efforts in their acquisition, often are considered prestigious or of special symbolic meaning. Moreover, it is plausible that these Early Neolithic societies possessed an understanding of the distinct attributes of each mineral, indicating the deliberate cultural selection of specific pigments based on their intended use (Domingo *et al.* 2012).

Until now studies considering red pigments used throughout prehistory in Poland have primarily concentrated on items originating from sedimentary contexts, such as buildings, clay extraction pits, and ceramics (*e.g.*, Kościuk-Załupka 2023; Mioč *et al.* 2004). Therefore, considering the interesting results presented here as a case study of Samborzec burials, there is undoubtedly a need for more extensive investigations of the red pigments discovered in Neolithic burials.

The ornaments in a burial context

The discussed artefacts have been determined to come from two different burials, as mentioned earlier, namely Burial 208 and, surprisingly, a child's burial, V(28). Initially, the child's burial was classified as being associated with BBC communities, albeit with

a degree of uncertainty. However, considering the contextual evidence, the orientation of the skeletal remains in the burial, the presence of identified marble beads, and their measurements (Tab. 1), the chemical match with red pigment (cinnabar), and the overall close similarities to the findings from woman's burial, we can now confidently associate this burial with the LBK remains (of phase I) at the site. Most of the short marble beads found in the child's burial (Fig. 2) are very similar to those found in the woman's pelvic area in Burial 208 (Fig. 1). Furthermore, several of them were discovered adjacent to each other (see Fig. 2) within the pelvic area of the buried child, possibly indicating a fragment of a similar ornament, such as a hip belt. The location of a barrel-shaped marble bead was mentioned as being positioned under the skull. The presence of red pigment – cinnabar – on the bead suggests that it might have been a head or neck ornament, similar to the marble pendants found with the woman in Burial 208 (the largest concentration of red pigment was usually found in specific areas of the skeletal remains, specifically around the head). The woman buried in Feature 208 was certainly adorned with two pieces of marble ornaments, namely: a head decoration made of marble pendants and a hip belt constructed of marble beads and two *Spondylus* beads. Unfortunately, it is unclear exactly in which part of the belt they were located. The discovery of beads made from *Spondylus* shells amidst marble ornaments is the second find of LBK ornaments in Poland in terms of raw materials, indeed exceptional in terms of typology, constituting a one-of-a-kind find within the territory of Poland. These previously undisclosed artefacts may now be incorporated into the limited catalogue of *Spondylus* ornaments uncovered in Poland (Kurzawska and Sobkowiak-Tabaka 2020). Both ornaments found in the woman's burial (the headdress and hip belt) showed traces of red pigment identified as cinnabar, with the largest amount found on the pendants. Similar LBK burials of women and children, adorned with ornaments made of *Spondylus* and marble, accompanied by the associated red pigment (although chemical studies were not conducted), were discovered at a cemetery in Vedrovice (Podborský ed. 2002). The presence of *Spondylus* ornaments and red pigment, either sprinkled or spread over the head, is more frequently encountered in burials from Central Europe (Hedges *et al.* 2013) and may be considered a distinctive element of different burial traditions within LBK communities (Jeunesse 1997).

Typically, specific raw materials and items made of them, particularly those obtained from distant regions – referred to as 'imports', such as *Spondylus* ornaments – have often been interpreted as symbols, found in burials indicating social status, prestige, or, in the case of children's burials, hereditary status (*e.g.,* Chapman and Gaydarska 2015). However, their roles were likely multidimensional, carrying deeper social messages beyond their decorative and symbolic functions, including religious dimensions (Borić 2015). Through ornaments and common customs (*e.g.*, in funerary rites), Neolithic communities living over a very wide area could express belonging to a shared tradition, beliefs, or ancestry (Rigaud *et al.* 2015). The unique ornaments found in burials discovered in Samborzec can be seen as manifestations of these well-established traits, serving as markers of membership in

this tradition where the choice of raw materials, colour, and the type of decorations held specific significance. It seems evident that colour, particularly the bright and lustrous white, which bears a wide range of symbolic meanings across cultures (Vollmar 2009; Vitezović 2012), played a central role in the selection of raw materials, including white stones such as marble, as well as *Spondylus* shells, from which the outer layer of colour had been deliberately removed.

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MADE OF FLINT, BONE AND BOAR'S TUSKS – BURIAL GOODS FROM MALE GRAVE NO. 2 IN ŚWIERSZCZÓW (KOLONIA) SITE 28, HRUBIESZÓW DISTRICT – ATTRIBUTED TO THE MALICE CULTURE – IN THE LIGHT OF TRACEOLOGICAL ANALYSIS

ABSTRACT

Zakościelna A. and Osipowicz G. 2024. Made of flint, bone and boar's tusks – burial goods from male Grave No. 2 in Świerszczów (Kolonia) Site 28, Hrubieszów District – attributed to the Malice culture – in the light of traceological analysis. *Sprawozdania Archeologiczne* 76/1, 335-358.

The article presents the results of a traceological analysis conducted on artefacts made of bone, boar's tusks and flint – the only funerary goods discovered in Grave No. 2 at Świerszczów (Kolonia) Site 28, in which an adult male was buried. Despite the lack of pottery vessels that could indicate cultural affiliation, the grave is attributed to the Rzeszów phase of the Malice culture, *i.e.*, the final, Eneolithic, stage of that culture. This attribution is based on ^{14}C dating and on the presence in the grave of artefacts made of boar's tusks and flint burins. Microscopic analysis conducted on the discovered artefacts revealed traces related to their production, use and repair on their surfaces. Most items bear traces indicating their usage in processing soft materials, like siliceous (wild and domesticated) plants and hide. Interestingly, the artefacts with holes for hanging – traditionally regarded as adornments in archaeological literature – were also employed in different activities.

Keywords: Eneolithic, Malice culture, Rzeszów phase, male burial goods, artefacts made of bone, traceological analysis
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INTRODUCTION

Thanks to a recently growing number of Polish archaeologists/traceologists, microscopic use-wear and technological analyses are becoming an increasingly popular method supplementing not only traditional research on the production and use of flint, stone and osseous raw materials that concern their technological and morphological as well as raw material aspects but also studies of the socio-economic and ritual behaviours of prehistoric societies in general. To a great degree, we owe this to Jolanta Małecka-Kukawka, who – along with Małgorzata Winiarska-Kabacińska – was the forerunner of Polish specialist research on functions of artefacts made of siliceous rocks. For over 30 years, she has conducted traceological and experimental analyses of flint inventories discovered at functionally and chronologically diverse sites, mainly dated to the Neolithic (Małecka-Kukawka 1999; 2001; 2017). Her efforts resulted in the publication of the first Polish handbook of use-wear analysis (Korobkowa 1999). She educated at least several researchers of the younger generation, and the research centre in Toruń has become one of the leading institutions specialising in traceological and experimental analyses. We may venture to say that a pessimistic reflection expressed by the distinguished celebrator nearly 20 years ago in the question 'Why has traceology not been developed in Poland?' (Małecka-Kukawka 2005, 66) is just history now, and our country can boast a group of traceology specialists, a community where one can discuss and exchange experiences (as well as collections of experimental materials for comparative studies).

However, the already rich specialist literature still lacks works discussing the results of traceological analyses of materials attributed to the Malice culture (hereinafter: MC). This paper is a step towards filling this void. It presents the results of the first microscopic studies on a set of artefacts associated with the MC discovered in a male grave in Świerszczów (Kolonia), Site 28. The collection consists of semi-products and tools made of flint, bone and boar's tusks (Zakościelna 1988, 9-11; Kadrow and Zakościelna 2009, 224, 225). The discussed site is known in archaeological literature as Świerszczów Kolonia 28, while in the official list of localities, it is referred to as Świerszczów. For this reason, we put the term 'Kolonia' in brackets.

SITE AND FEATURE

The multicultural Site 28 in Świerszczów (Kolonia) is located on the south-western edge of a circular elevation that lies at the base of a loess hilltop on the margin of the valley of the Huczwa River. The central part of the site was divided by a trench dug prior to the construction of a modern road leading from Hrubieszów to the Ukrainian border (Fig. 1). The site was discovered in the spring of 1988 during earthworks on the property of Wacław Suchecki. A feature (clay extraction pit) attributed to the Linear Pottery culture (LBK) was partly damaged at that time. Rescue excavations (1988) resulted in recording the remains



Fig. 1. Świerszczów (Kolonia), location of site 28
(graphic editing by M. Juran and P. Mączyński; base map: 65)

of a multicultural settlement initiated by a community associated with the younger stage of the Music-Note phase of the LBK, with elements of the Szarvas-Érpart style (three settlement features). The subsequent stages of occupation at the site were associated with the classical phase (Ib) of the MC (materials from accumulation layers outside anthropogenic features), the early horizon of the Rzeszów phase of the MC (IIa – two graves), the Mierzanowice culture (two settlement features) as well as the Strzyżów, Trzciniec and Lusatian cultures (materials from accumulation layers outside anthropogenic features), and with a residential building from the 5th-6th centuries AD (Zakościelna 1988a, 9; Zakościelna and Gurba 1993).

The graves from the early Rzeszów phase of the MC were discovered in Features 4 and 5, adjacent to the limit of the excavation trench on the east, *i.e.*, from the side of the edge of an escarp located near the road (Zakościelna 1988, fig. 1). The remains were buried in pits of a circular plan and trapezoidal cross-section. Originally, they were most likely of a utilitarian nature. Grave No. 2 (Feature No. 4) contained remains of an adult male equipped with artefacts made of boar's tusks and bones as well as flint semi-products and tools. In Grave no. 3 (Feature No. 5) a child aged Infans I was buried. Wanda Kozak-Zychman performed both anthropological examinations. The child's grave was equipped with an unornamented pear-shaped beaker (Kadrow and Zakościelna 2009, 224, 225, fig. 49, 50).

Grave No. 2 (Feature No. 4) – at the bottom of the pit with a circular plan and trapezoidal cross-section (diameter at the bottom about 230 cm; depth 80-85 cm) and with uniform dark brown-black fill, archaeologists discovered a skeleton of an adult male. The skeleton was lying in a strongly flexed position on his right side, with his head pointing to the west and face to the south. His back was against the northern edge of the spacious burial pit (Fig. 2). His right hand was under his right cheek. The left hand – resting on his

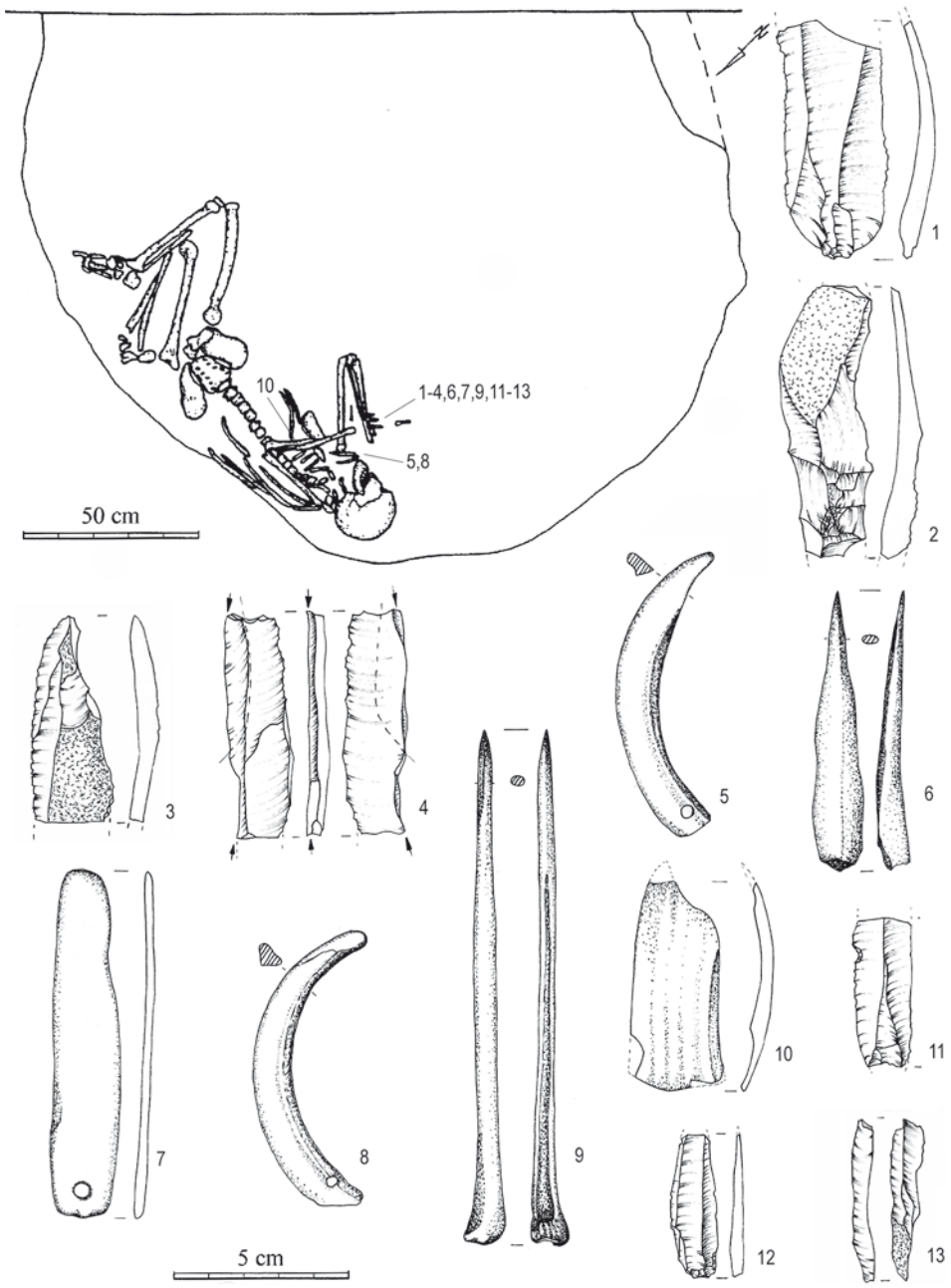


Fig. 2. Świerszczów (Kolonia), site 28. Layout and equipment of grave No. 2
(after Kadrow and Zakościelna 2009, fig. 49, with changes; graphic editing by M. Juran)

right forearm – was holding two spike-like tools and an artefact with an aperture for hanging – all made of bone – as well as seven items made of Volhynian flint. It is possible that all the above-mentioned artefacts were originally in a container/pouch made of organic matter. Near the man's mandible, there were two boar's tusks with holes in their thicker ends. A plaque made of the same material was found between the ribs (Fig. 2).

METHODS

All the artefacts made of flint (seven) and bone materials (six) discovered in the grave were subject to traceological analyses. Two microscopes were used in the research. The evaluation of the state of preservation of the products and preliminary analysis of techno-

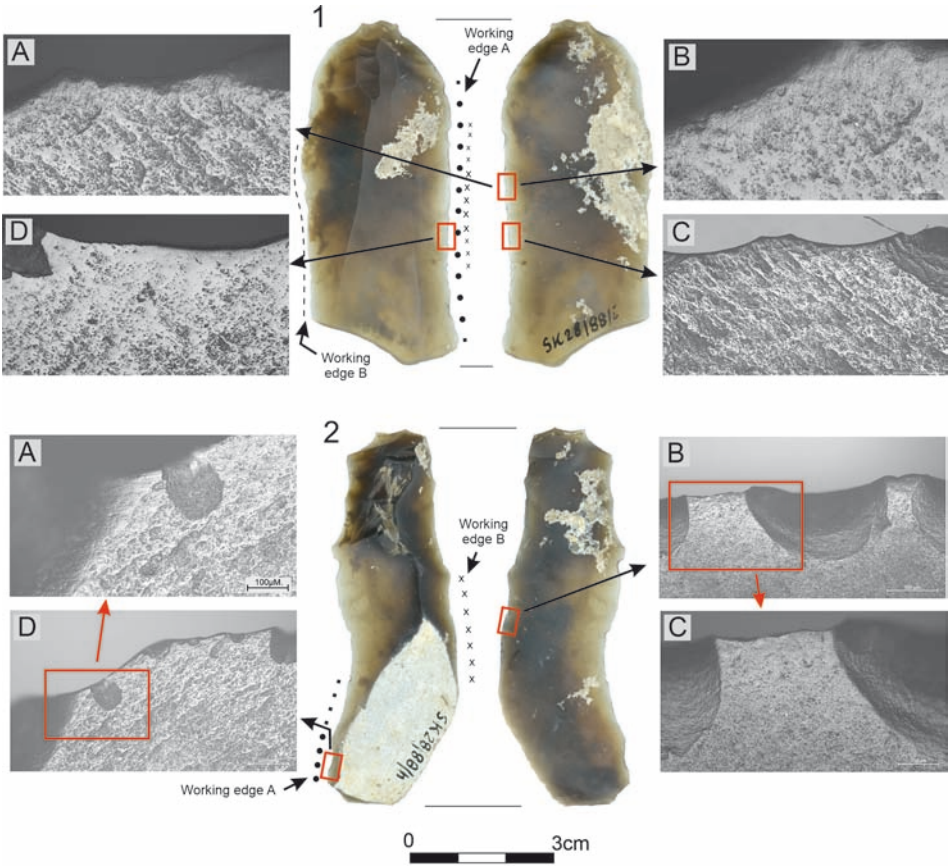


Fig. 3. Use-wear patterns recorded on flint artefacts Nos. 1 and 2 (photos and graphic editing of Figs. 3-10 by G. Osipowicz)

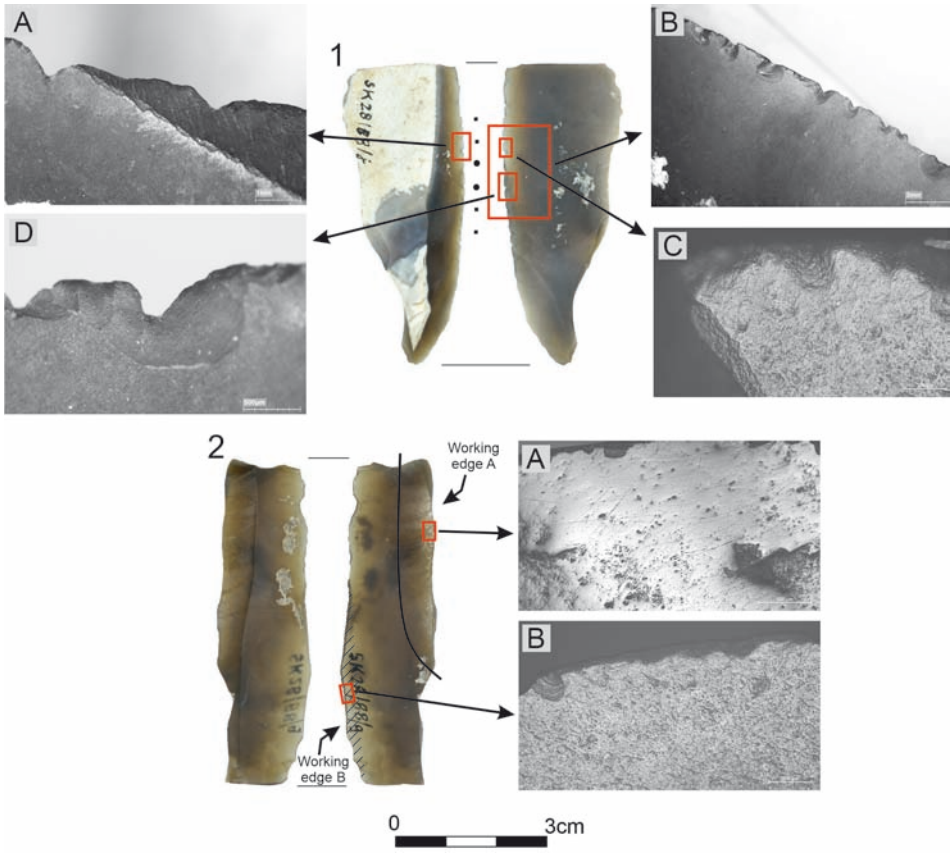


Fig. 4. Use-wear patterns recorded on flint artefacts Nos. 3 and 4

logical and use-wear traces was conducted using an optical Nikon SMZ-745T microscope fitted with a Delta PixInvenio 6EIII camera. This microscope provides a maximum optical magnification of 50×. The equipment was used to take microphotographs presented in Figs. 4: 1A, B, D, 5A-F, I, 6, A, D, F, G, 8C, E, G, 9C, E, F and 10A, D. A metallographic microscope Zeiss Axioscope 5 Vario fitted with an Axiocam 208 camera was utilised in analysing polished surfaces. It provides a maximum lens magnification of 50× (optical magnifications up to 500×) and was used to record the remaining microphotographs presented in this article.

The terminology applied in the traceological studies was based on the conceptual system known from the archaeological literature (*e.g.*, Vaughan 1985; van Gijn 1989; Sidera 1993; Juel Jensen 1994; Legrand 2007; Osipowicz 2010; Buc 2011) and adjusted to the needs and requirements of the conducted analysis.

During the description of the location of wear traces observed inside the perforations created in "typological" pendants, a scheme based on a dial plate was used with specific

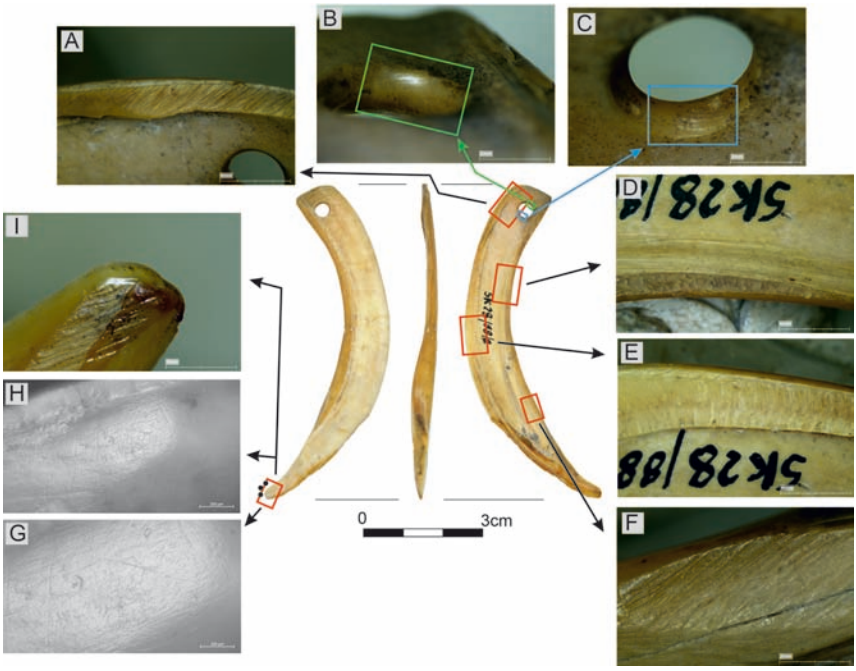


Fig. 5. Technological and use-wear patterns recorded on artefact No. 5 – specimen with a hole, made of a boar's tusk

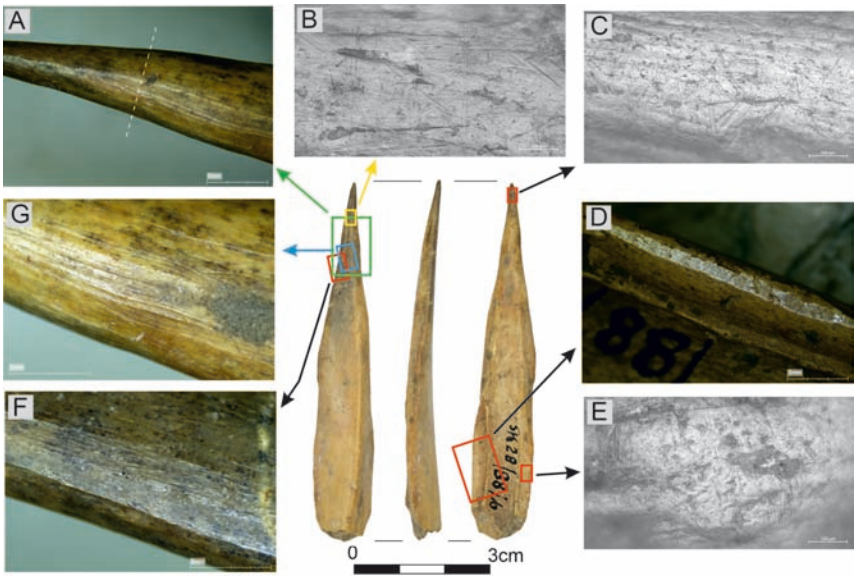


Fig. 6. Technological and use-wear patterns recorded on artefact No. 6 – spike-like tool

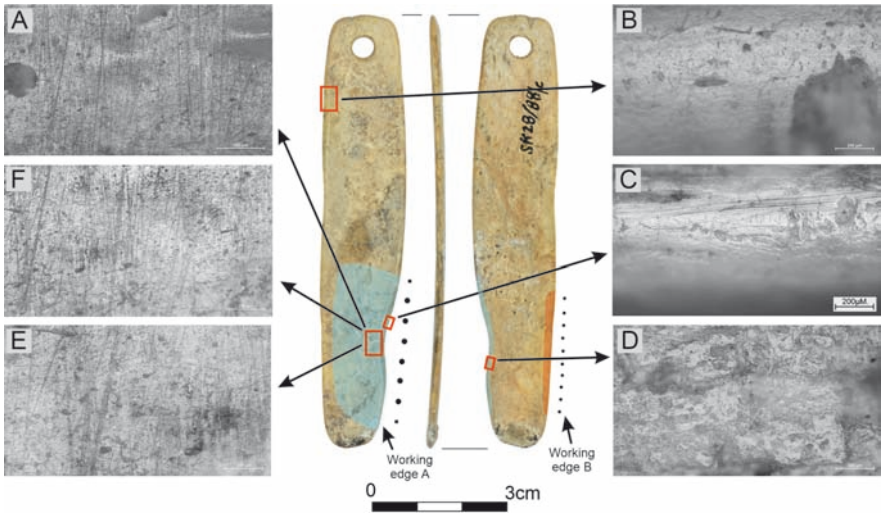


Fig. 7. Technological and use-wear patterns recorded on the rectangular artefact with a hole, made of animal bone (No. 7)

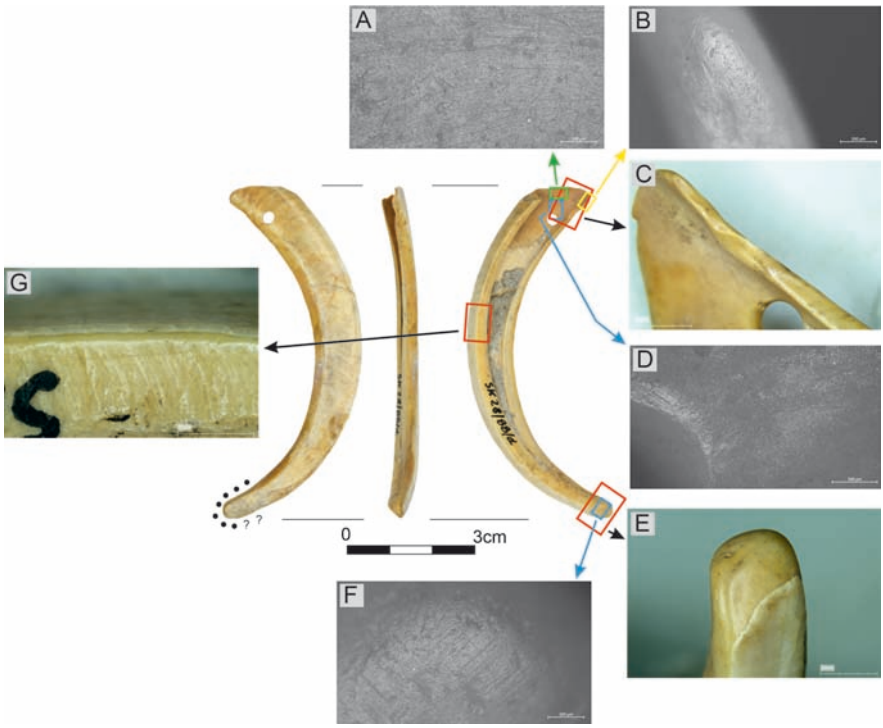


Fig. 8. Technological and use-wear patterns recorded on artefact No. 8 with a hole, made of a boar's tusk

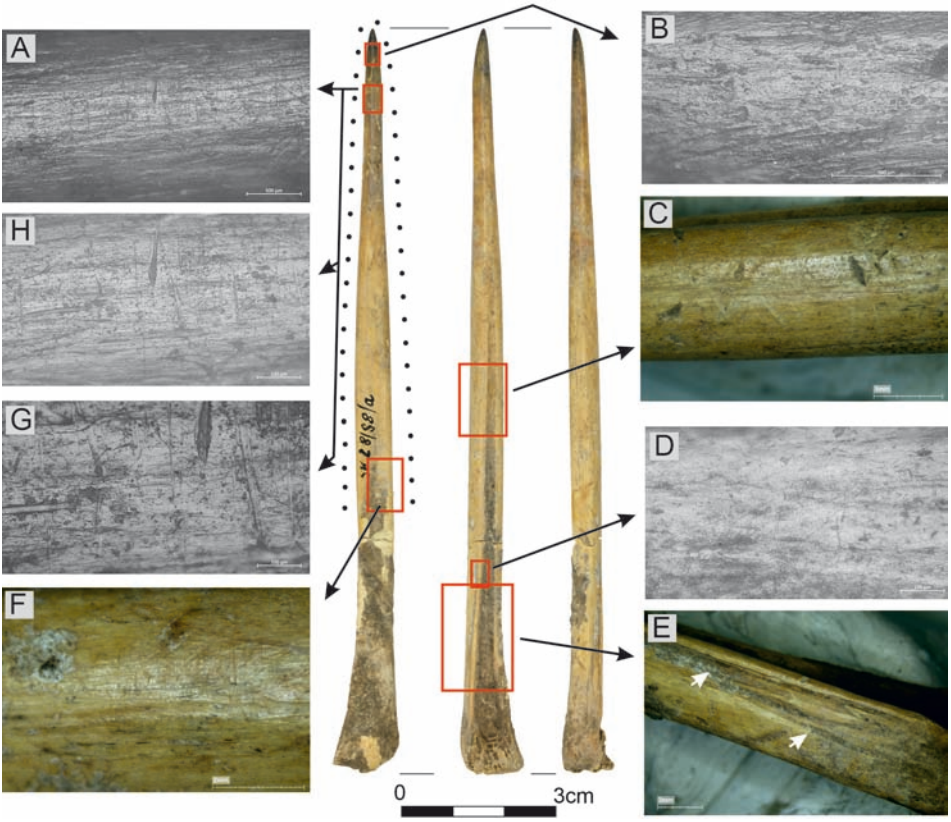


Fig. 9. Technological and use-wear patterns recorded onartefact No. 9, spike-like tool

hours on the dial plate corresponding to the sectors where traces occurred, *i.e.*, sector 1 marked the area between hours 12 and 1, sector 2 – the area between hours 1 and 2, and so on (*cf.* Osipowicz *et al.* 2020).

The research results omit the taphonomic data as the evaluation of the state of preservation of the analysed artefacts indicated that they were well preserved.

To avoid the usage of functionally tinged terms before the presentation of the results of the use-wear analyses, when typologically classifying bone artefacts having a separate tip (point), we refrained from using such terms as 'awl' or 'piercer' in favour of neutral designations like 'spike-like tool' (*cf.*, Jaworski 1990, 61; Makowiecki 2010, 84). A similar procedure was adopted when presenting the artefacts made of boar's tusks, which were not referred to as 'pendants' or 'tools' (as it is generally accepted in archaeological literature, *e.g.*, Wiślański 1966:, 43; Szmyt 1996, 56), but they were described as 'an item made of boar's tusks, with a hole'.

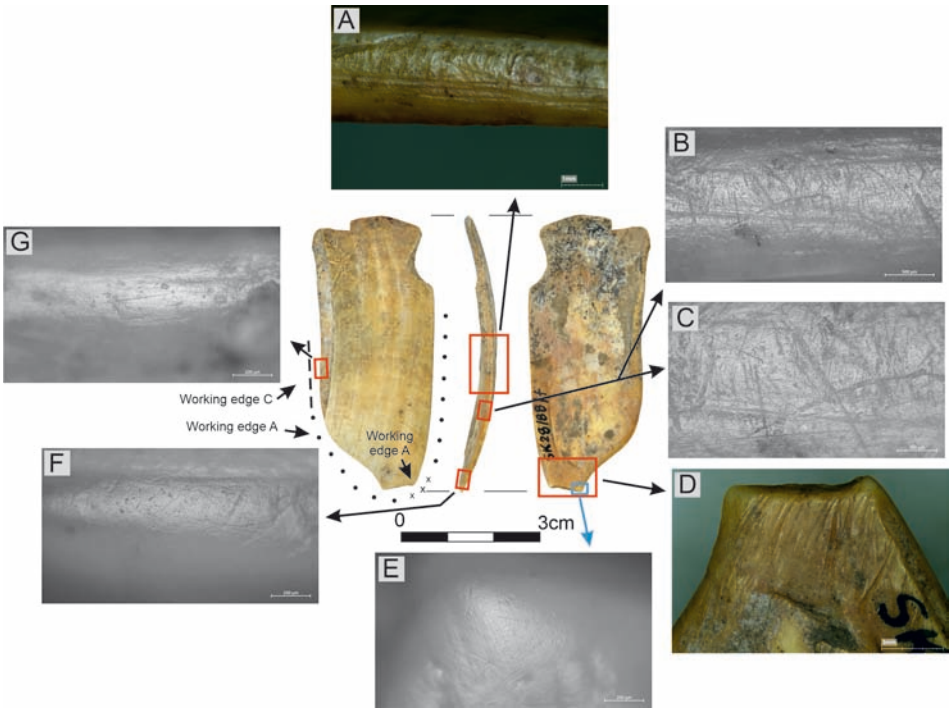


Fig. 10. Technological and use-wear patterns recorded on artefact No. 10, made of a boar's tusk

MATERIALS

The following artefacts were subject to traceological analyses:

1. Flint blade with broken-off tip; prepared butt; lip under the butt; prominent percussion bulb; scars of platform edge trimming; triangular-trapezoidal cross-section; slight longitudinal polish of the left edge on both sides; dimensions: 71 × 31 × 6 mm (Fig. 2: 1).

2. Partially cortical crested flint blade with slightly broken-off tip and broken-off butt; lateral edges having an irregular shape; triangular cross-section; dimensions: 78 × 22 × 7 mm (Fig. 2: 2).

3. Partially cortical flint blade with broken-off proximal part; fine retouch limited to the right edge, near the fracture; chipped left edge with use-wear retouch on the ventral side; triangular-trapezoidal cross-section; dimensions: 59 × 23 × 6 mm (Fig. 2: 3).

4. Flint double burin: on a transverse break + on a transverse burin facet; with extensive sickle gloss on both the ends; dimensions: 64 × 19 × 5 mm (Fig. 2: 4).

5. Artefact made of a boar's tusk, with a hole; dimensions: 81 × 13 × 6 mm; diameter of the hole = 4 mm (Fig. 2: 5).

6. Spike-like artefact made of an animal bone; dimensions: 80 × 14 × 8 mm (Fig. 2: 6).

7. Rectangular artefact with a hole, made of an animal bone; dimensions: 100 × 21 × 3 mm; diameter of the hole = 5 mm (Fig. 2: 7).

8. Artefact made of a boar's tusk, with a hole; dimensions: 78 × 12 × 7 mm; diameter of the hole = 3 mm (Fig. 2: 8).

9. Spike-like artefact made of a halved/split bird bone (?); dimensions: 147 × 8 × 6 mm (Fig. 2: 9).

10. Plaque made of a boar's tusk, with all surfaces smoothened; the tip and base damaged in two places; dimensions: 60 × 26 × 4 mm (Fig. 2: 10).

11. Flint blade with broken-off butt and tip; with a micro-notch on the left edge; diffuse bulb with a scar; platform edge trimming scars; triangular-trapezoidal cross-section; dimensions: 43 × 17 × 5 mm (Fig. 2: 11).

12. Flint blade with broken-off tip; prepared butt; diffuse bulb; platform edge trimming and abrasion scars; dimensions: 42 × 13 × 3 mm (Fig. 2: 12).

13. First series flint burin-spall with a cortical tip; dimensions: 47 × 11 × 5 mm (Fig. 2: 13).

RESULTS

Detailed results of the traceological research with a precise description of the observed technological and use-wear traces are presented in Table 1.

Among the seven analysed flint artefacts, four bear use-wear traces developed to a degree that allows us to interpret their function. Two of them were utilised in processing siliceous plants: one is a sickle insert for harvesting cereals (Fig. 4: 2), and the other was probably employed to cut wild plants (Fig. 3: 1). The latter tool was also secondarily used to scrape hide (with an addition of some abrasive admixture, *e.g.*, charcoal or ochre) and most likely to cut it as well. Hide was also cut with the last flint artefact that bears evident use traces (Fig. 3: 2). Additionally, one of the artefacts shows traces of use (Fig. 4: 1), but its function remains unclear.

The analysed osseous artefacts were used in processing similar organic materials. Three of them were most probably used to work with vegetal material. This group includes both the examined spike-like tools (Figs 6 and 9). The latter specimen is particularly interesting due to its exceptionally long working edge. The rectangular bone artefact with a hole (Fig. 7) is the last artefact utilised in plant processing, possibly in threshing, viz., separating cereal grains from grain ears.

The remaining three bone artefacts (all specimens made of boar's tusks – Figs 5, 8, 10) were probably used in processing hide. Although the nature of the activity remains unclear, it resembled carving/cutting or rubbing. At least one of the tools might have come in contact with material covered with an abrasive admixture.

Distinct traces of hafting or "holding in hand" were observed on most of the analysed flint and bone tools (*cf.*, Table 1).

Table 1. Świerszczów (Kolonia), site 28, grave 2. Results of the traceological analysis of the artefacts (Dots and dashes in brackets indicate the range of traces of use in the drawings)

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
1	Volhynian flint	Blade with broken-off tip section	-	Retouch (both working edges): both sides, half-moon scars, one-step; Polish and linear traces: Working edge A: Type 1 (range • • •): on both sides, glossy, band along the edge; domed and flat topography; smooth texture. At the cutting edge, the polish is slightly linear and connected with single linear traces (black and filled in striations – Fig. 3:1C, D). Type 2 (range x x x): only on the ventral side and tip; perpendicular linear matting with a cratered topography and rough texture (Fig. 3:1A, B). Edge B (range - - -): rounding of the working edge, a polish with a cratered topography, delicately linear.	Edge A: cutting siliceous plants (probably grass or reed); followed by scraping dry hide with an admixture of abrasive material; edge B – possibly used to cut hide	Inv. no. SK28/88/i	Fig. 3:1
2	Volhynian flint	Crested blade	-	Retouch: close/irregular, on both sides, one-step type; feather-terminated scars. Near the tip, at the length of ca. 0.5 cm: multi-step retouch on one side, hinge- or step-terminated scars. Polish: Edge A (range • • •): rounded working edge, linear matting with a cratered topography and rough texture (Fig. 3:2A, D); Edge B (range - - -): matting with a varied character, rounding of the edge (Fig. 3:2B, C)	Edge A – cutting hide; Edge B – probably used	Most of the use-wear damages on edge B were probably caused by hafting (presumably result of holding the tool through a piece of hide). Inv. no. SK28/88/h	Fig. 3:2

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
3	Volhynian flint	Microdenticulate-saw	Retouch forming notches of the microdenticulate (Fig. 4:1B) was done with a hard tool having a triangular cross-section of the working edge with a width of not much more than 100 micrometres (made of metal?) (cf. Fig. 4:1A, D). The retouch is secondary, i. e., it removed earlier damages and is not covered with use-wear traces.	Apparent 'hide' polish with a strictly limited range is recorded on the ventral side, in certain parts - outside retouch scars (Fig. 4:1C). Its origin is unclear. There are no use-wear traces on the dorsal side.	Used	Inv. no. SK28/88/j	Fig. 4:1
4	Volhynian flint	Multiple burin	Burin blows obliterated entirely the original working edge of the tool. It seems that this was their purpose. The artefact was not used afterwards.	Retouch: on edge B, half-moon scars in the tip section; Polish: Edge A: burin negatives do not bear use-wear traces. A glossy polish with flat topography and slightly rough texture can be observed on the preserved part of the working edge. It is associated with linear traces (comet-tails and black striations oriented along the line of the edge – Fig. 4:2A). Edge B: rounding and polish of 'hide-like' characteristics (its range marked with a hachure) (Fig. 4:2B);	Cutting cereals (edge A)	'Hide-like' traces on edge B were caused by hafting. A part of the edge with half-moon scars was already outside the hafting. Inv. no. SK28/88/g	Fig. 4:2

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
Bone artefacts							
5	Boar's tusk	Artefact with a hole	The method of the initial splitting of the raw material is unclear. After the tusk was split, the redundant fragment on the concave side of the specimen was removed by sawing (from the inner side of the tusk) and breaking (Fig. 5D). There are no remains of sawing on the convex side of the specimen - the split surface shows the fracture (Fig. 5E). Both mentioned split surfaces were ground to a great extent, which was complemented with scraping at some places (Fig. 5A, F). The hole in the specimen was drilled (Fig. 5C).	An obvious rounding and bright linear polish is visible at the top of the spike. It is the most distinct at the (concave) processed side of the artefact, where it blurs technological traces (Fig. 5I). The polish has a homogenous (generally flat) topography with regular micro-relief and considerably rounded highest points (Fig. 5G, H). Its texture is smooth. The polish is linked with numerous linear traces, in the form of thin, black and filled-in striations arranged according to the axis of the specimen. In the perforation on the sawed side, in section 1, polish caused by a threaded cord/thong completely blurred traces left by drilling (Fig. 5B).	Cutting/carving soft material (hide?)	The origin of the slanting grooves presented in Figs. 5G, H is unclear (left by grinding?). Inv. no. SK28/88/e	Fig. 5

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
6	Bone	Spike-like tool	The tool was made using a split long bone with an appropriate shape. Processing the tool was limited to correcting one of the split surfaces (by planing) (Fig. 6D). The working edge was initially formed by planing – hence its multi-faceted character – Fig. 6F) – and finished by scraping (Fig. 6G).	Use-wear patterns blurred technological traces at the length of ca. 1 cm from the tip of the spike (Fig. 6A – the extent is marked with a dashed line). The polish damaged mainly the upper parts of the micro-relief. It is bright and has a homogenous (generally flat) topography, regular micro-relief, slightly rough texture and somewhat flat highest points. It is linked with numerous multidirectional linear traces of different characteristics (Fig. 6B, C). In the central part of the tool, a polish with the 'hide-like' characteristics can be observed (Fig. 6E).	Perforator, used to work in organic material, most probably of vegetal character	Observed 'hide-like' traces are probably caused by holding the tool in hand. Inv. no. SK28/88/b	Fig. 6
7	Bone	Artefact with a hole	No technological traces preserved on the surface of the artefact. They were blurred by use-wear damage and post-depositional alterations. The hole in the specimen is of hourglass shape (it was probably drilled).	Edge A (range of the use-wear traces marked with blue): Lower side (contact surface): very invasive, surface polish with homogenous, generally flat topography, regular relief and rough texture. It is linked with numerous hair-like linear traces having uneven edges, which overlap with the lateral edge of the specimen (Fig. 7A, E, F; working edge – Fig. 7C). Upper side (non-contact surface): polish/melting visible only in the upper parts of the relief. Its topography is heterogeneous, the micro-relief is irregular, and the highest points are convex (Fig. 7D). No linear traces. Edge B (the range of the use-wear traces marked with red): traces analogous to the ones present on edge A but of a very limited range (basically, present only on the cutting edge).	Threshing cereals (?)	Edge B was used for a very short time. Damages resulting from holding the item in hand a visible in the central part of the tool and near the hole (Fig. 7B) Inv. no. SK28/88/c	Fig. 7

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
8	Boar's tusk	Artefact with a hole	The method of tusk split is unclear. There are natural surfaces (fractures) on the split surfaces, in places lacking traces of the secondary processing. Processed areas are covered with grinding traces (Fig. 8G). The hole was drilled.	The tip is considerably rounded (Fig. 8E) and covered with bright polish having a heterogeneous (considerably pitted) topography, irregular micro-relief, slightly rough texture and convex highest points (Fig. 8F). It is linked with linear traces, black and filled in striations with multidirectional orientation. The polish is invasive (covers ca. 1 cm of the spike length). In the hole, one can observe rounding and 'hide' matting that blur technological traces. A band of matting runs from here to the base of the specimen (Fig. 8A, D), where (on the edges of the fractures), changes into a more bright, greasy 'hide' polish (Fig. 8B, C). In the central part of the tool, there are traces resulting from holding it in hand (they cover the ground surfaces – Fig. 8G).	The working edge of the specimen had contact with soft material, most probably dry hide (maybe with an abrasive admixture). The character of the performed activity is unclear. It was not drilling holes (rotational movement), but it rather resembled cutting, carving or rubbing (linear movement).	A band of the 'hide-like' traces running from the perforation to the base of the specimen marks the contour of a strap used to attach the tool to a hide 'handle'. This term may refer to different things, e.g., a hide lining of a wooden handle or simply a strap wrapped around the base of the specimen. Inv. no. SK28/88/d	Fig. 8

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
9	Bone	Spike-like tool	The method of splitting the bone is unclear. There are incisions (Fig. 9E – marked with arrows), indicating that the raw material was sawed on the inside, near the articular head. The split surfaces and the spike of the specimen were formed by scraping, most probably with an unretouched blade/flake (Fig. 9C).	The use-wear traces are very invasive – they cover ca. 10 cm of the length of the tool working edge. On the greater part of this area (except the tip of the spike), there is pale linear polish (oriented along the axis of the specimen) with a heterogeneous topography, irregular micro-relief, convex highest points and slightly rough texture. It is linked with linear traces – arranged perpendicular to the edge – of various natures (single, grouped, black scratches, filled-in scratches, grooves, linear bands etc. (Fig. 9A, F-H). On the tip of the spike, the polish is of the same character, but there are generally no perpendicular linear traces (Fig. 9B). In the lower part of the tool (near its base), polish and 'etching' of the surface resulting from holding the specimen in hand was recorded (Fig. 9D).	Spike for processing vegetal material (unclear character of the performed activity). The artefact was used is such a way that its tip punctured the processed material, and then –the tool was turned (like a borer), while pushing it inside the processed material.	Artefact broken in recent times; a great part of its base is covered with contamination. Inv. no. SK28/88/a	Fig. 9

No.	Raw material	Morphological description	Technological traces	Use-wear	Function	Comments	Figure
Flint artefacts							
10	Boar's tusk	Plaque	The method of splitting the material is unclear; only traces of scraping are present on the inner side and concentrate in its upper area (Fig. 10D). Scraping traces are also visible on split surfaces, but here, they are considerably obliterated by strongly developed use-wear changes (Fig. 10A).	Edge A: rounding and polish obliterate technological traces. The polish topography is heterogeneous, micro-relief regular, somewhat rough texture, and the highest points are concave. The polish is linked with perpendicular linear traces (mainly black striations – Fig. 10B, C). In the most worn parts, the polish is completely flat and its texture is smooth (Fig. 10F). Edge B (xxx): topography of the polish is corrugated, and texture is smooth. The polish is associted with perpendicular linear traces (mainly filled in striations – Fig. 10E). Edge C (- - -): polish with characteristics similar to the one visible on more worn fragments of edge A, but the linear traces recorded here are oriented parallely to the line of the cutting edge (Fig. 10G). A polish resulting from holding the specimen in hand or hafting in a leather handle can be seen on the base.	Edge A – scraping soft (possibly vegetal) material. Edge marked as Edge C was used in cutting the same material. Edge B – processing (cutting/carving/ rubbing) soft material, probably hide (?); activity analogous to the one described in the case of the other two artefacts made of boar tusks.	Traces of scraping present on the specimen are largely secondary with regard to the use-wear patterns (they cover them). Nevertheless, the edges of some scratches are covered with a polish, meaning the specimen was still used after scraping. Hence, the discussed activity should be considered as some sort of repair procedure, repeated several times while using the artefact. Inv. no. SK28/88/f	

DISCUSSION

Grave No. 2 from Świerszczów (Kolonia) 28 definitely stands out from over 20 burial features attributed to the MC published so far. No special grave pit was prepared for the interment. Moreover, the burial was not equipped with vessels, viz., the typical burial goods deposited in MC funerary features (Kadrow 2009, tables III and IV). Additionally, burying the man with his head to the west instead of the south, is an aberration from the rules usually followed by the population of this culture. The facts mentioned above were the reason to doubt if the discussed feature was correctly attributed to the MC (Kadrow 2009, 53, 54). Eventually, the absolute dating of Grave No. 2 and nearby Grave No. 3 were decisive in this matter. For both features, ^{14}C measurements were made for samples collected from the respective skeletons. The obtained dates are: Grave No. 2 – Ki-4193 5430±60 BP, Grave No. 3 – Ki 4189 5350±50 BP (Kadrow and Zakościelna 2000, fig. 43). Both results correspond to ^{14}C dates for sites from the Rzeszów Foothills, Sandomierz Upland, and western Lesser Poland (Dębiec and Pelisiak 2008, 136-139, figs 5, 6; Włodarczak 2017, 103, figs 1, 2, 7, 9; Zastawny 2022, figs 9-10; Kadrow 2023, table 1) and fit well into the chronology of already Eneolithic development period of the MC, namely the Rzeszów phase (Kadrow 1996, fig. 19; 2009, 59, 60). The Eneolithic character and chronology of Grave No. 2 are also indicated by the grave inventory, especially the artefacts made of bored boar's tusks- attributes of Eneolithic male graves from South-Eastern and Central Europe (Bognár-Kutzián 1963, 310, 311; Nevizansky 1984, 272; Todorova 2002, 188-189). The burin and burin-spall are equally important in the chronological context of the grave, as they reflect the Eneolithic burin trend (Balcer 1983, 115, 116; Zakościelna 1996, 101-106). The mixed burin (on a truncation + on a break) finds very close analogies at the MC settlement in Werbkowice – dated to the Rzeszów phase (Zakościelna and Gurba 1997, 204) – where this type of tool clearly dominates (Zakościelna 1981, pl. 2. Tables 9-11).

The results of the conducted traceological analyses suggest a considerable functional coherence of the bone and flint artefacts deposited in the analysed grave, which may be of great importance for interpreting the character of activities performed by the buried man during his life. Undoubtedly, he had been a farmer, as indicated by the sickle insert and bone artefacts used (probably) in threshing. He had processed not only domesticated cereals but also wild siliceous plants, which is attested by the character of the use-wear traces present on the second knife for cutting plants (mainly lack of linear traces, including comet-tails – *cf*. Korobkowa 1999, 134). Both bone spike-like tools deposited in the grave had also been engaged in activities linked with processing plants. The character of the wear observed on their surfaces indicates that they had come in contact with soft, not very abrasive material, possibly wet bark, phloem or other vegetal fibres, *e.g*., during the production of baskets or mats. This assumption is corroborated by the length of the working edge of one specimen and the considerably invasive extent of the recorded use-wear patterns. Nevertheless, a definite answer to this question requires adequate experimental re-

search. The results of these studies are engaging in the context of the fact that for most Neolithic tools of this type from Poland, which were subjected to traceological analysis, a connection with hide processing was suggested (*cf.* Osipowicz *et al.* 2014, 2015; Lisowski *et al.* 2017).

Undoubtedly, processing hide had also been essential for the buried man. Quite importantly, he probably had used abrasive admixtures, such as ochre or powdered charcoal, when performing this activity. Ochre was applied in various stages of hide processing, mainly during fleshing and tanning. It was used primarily due to its very good fat absorption and drying properties, as well as its antibacterial and antifungal effect (Mandl 1961; Audouin and Plisson 1982; Wadley 2005; Dubreuil and Grosman 2009; Trąbska *et al.* 2007; Rifkin 2011; Hodgskiss and Wadley 2017; Kościuk 2017). Powdered charcoal (or ash) was added to water in which hides were soaked in the process of tanning, in order to remove fat, meat, hair and epidermis from the hide during the so-called 'wet-scrape process' (van Gijn 1989; Richter and Dettloff 1995; Rašková Zelinková 2011).

We have at our disposal considerable evidence that ochre was used as a substance facilitating hide processing in the prehistoric era. It is identified primarily on working edges of flint tools employed for processing this raw material (Keeley 1980; Solecki *et al.* 2004; Ahlrichs 2015; Wadley 2005; Hodgskiss and Wadley 2017), although it is also occasionally found on working surfaces of macrolithic stone tools used for the very same purpose (Dubreuil and Grosman 2009) or even bone tools (Osipowicz *et al.* 2019).

Technological traces observed on the analysed bone artefacts do not differ from the ones recorded on other Neolithic artefacts made of this raw material discovered in Poland (*e.g.*, Frankiewicz 2013; Osipowicz *et al.* 2014; 2015; Lisowski *et al.* 2015; 2017). One of the flint artefacts bears traces of an interesting technological operation that, as it seems, was aimed at completely blunting the working edge by burin blows. Such procedures, in fact a type of ritual renovation/destruction of tool edges before depositing them in graves, are recorded relatively often in Neolithic materials (Osipowicz 2022 – further literature there).

The presented results of the traceological research contribute considerably to the interpretation of artefacts with a hole through which a cord or thong was threaded. In archaeological literature, there is a convention of treating such products – according to their typological-functional character – as pendants or elements of necklaces and breast-plates – that is body adornments – and they were often discovered near necks or ribcages of buried remains (Bognár-Kutzián 1963, 310, 311; Nevizánsky 1984, 272; Zakościelna 2010, 152). Nevertheless, the results of the traceological research indicate that the rectangular 'pendant' and both artefacts made of boar's tusks were tools used in processing vegetal materials and hide, so they had utilitarian functions and were not, or at least not exclusively, of non-utilitarian nature.

CONCLUSION

The results of the traceological analyses conducted on the bone and flint artefacts from the inventory of Grave No. 2 in Świerszczów (Kolonia) 28 indicated that the buried man (farmer) used them during work associated with harvesting – probably processing both domesticated cereals and wild siliceous plants. Some flint artefacts also played a different role – they were secondarily used to process hide. The items made of bone and boar's tusks had also been used to process plant material and hide. Particularly interesting are the outcomes of the analysis of the rectangular artefact with a hole, as the recorded patterns most likely resulted from threshing. The utilitarian nature of this item and the two specimens made of boar's tusks calls for caution when interpreting objects provided with holes for threading a cord or thong.

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USE-WEAR STUDIES OF THE FUNCTION OF PREHISTORIC WOODEN PRODUCTS, IS IT REALLY POSSIBLE? THE EXAMPLE OF PESTLES FROM SITES IN ŠVENTOJI, LITHUANIA

ABSTRACT

Osipowicz G., Piličiauskas G., Piličiauskienė G. and Skrzyński G. 2024. Use-wear studies of the function of prehistoric wooden products, is it really possible? The example of pestles from sites in Šventoji, Lithuania. *Sprawozdania Archeologiczne* 76/1, 359-380.

The article presents the preliminary results of the traceological analysis of the collection of wooden pestles obtained during excavations of the complex of subneolithic sites in Šventoji in Lithuania. During the studies, an attempt was made to assess the possibility of interpreting the functions of the analysed tools based on the (probably) functional damage visible on them and to verify the hypotheses about the way they were used put forward by the authors of the excavations. The primary goal of the reported research was an attempt to first (preliminary) assess the nature of damage occurring on wooden tools (in this case, pestles) as a result of their use, the possibility of analysing and interpreting these traces (also in the context of post-depositional changes and modifications resulting from the conservation process), and consequently (in general) the possibility of conducting functional analyses of wooden tools dating back to the Stone Age.

Keywords: use-wear analysis, wooden artefacts, Šventoji, dendroarchaeology, pestle, hammer
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1. INTRODUCTION

The traceological (technological and functional) studies of Stone Age wooden artefacts are one of the weaker-developed branches of this method. The singular studies of this type have been discussed just in a few articles and chapters (*i.e.*, d'Errico *et al.* 2012; Caruso Fermé *et al.* 2014, 2015, 2023; Schoch *et al.* 2015; Lozovskaya and Lozovski 2016; Rios-Garaizar *et al.* 2018; Taylor *et al.* 2018; Caruso Fermé and Aschero 2020; Vidal-Matutano *et al.* 2021; Barham *et al.* 2023; Gibaja *et al.* 2023). This situation is due to many factors.

First, prehistoric wooden artefacts, especially those dating to the Stone Age, are extremely rare. For their preservation to this day, favourable soil and hydrological conditions are necessary, including, above all, the constant presence of water. Hence, most of the artefacts of this type come from "wetland" or underwater sites. Examples of this type of deposition environment include sites such as Star Carr in Great Britain (Taylor *et al.* 2018), Tybrind Vig in Denmark (Andersen 2011), Friesack IV in Germany (Gramsch and Kloss 1989), Zurich-Parkhaus Opéra in Switzerland (Bleicher and Harb 2018), Zamostje in Russia (Lozovskaya and Lozovski 2016), Šventoji in Lithuania (Rimantienė 2005), or La Marmotta in Italy (Mineo *et al.* 2023).

The second thing is that wood is a very soft organic material, which means that post-deposition processes modify its surface very fast, destroying the potential technological and functional traces as well. This very often makes traceological analysis of even reasonably well-preserved artefacts impossible.

Last but not least, prehistoric wooden artefacts must usually be subjected to the conservation process immediately after the excavation. The method of carrying out this process is crucial for preserving traces of use and the possibility of conducting traceological research.

All these factors make functional analyses of wooden artefacts extremely rare, which means every scientifically conducted study of this type can be a precious source of information about the economy or (generally) lifeways in the Stone Age (and in prehistory in general).

This article aims to present the first (test) results of traceological research of selected wooden artefacts discovered during the excavations at the complex of prehistoric sites in Šventoji in Lithuania. The primary goal was to answer the question about the possibility of conducting effective and reliable functional analyses of wooden artefacts (in general), but also about the possibility of analysing such products originating from the Šventoji sites specifically (regarding their state of preservation and the impact of the preservatives used on the potential use-wear traces). The research was also aimed at verifying (if possible) the suggestions about the functions of the analysed artefacts made by the author of the excavations in Šventoji. The final goal was to assess the possibility of conducting traceological research on prehistoric wooden products, using the equipment and methodology used to analyse this type of stone and bone products.

1.1. Sites in Šventoji, Lithuania

The archaeological complex of Šventoji in north-west Lithuania consists of about 60 sites as well as many stray finds (*e.g.*, stone and bronze axes), and several amber hoards that have so far been discovered on the swampy Littorina Sea terrace, a ribbon of land running from Palanga to the Lithuanian–Latvian border, 16 km long and up to 2.5 km wide (Fig. 1). The finds are dated generally from the Late Mesolithic to the Late Bronze Age, *i.e.*, 6000-500 cal BC. However, it is mostly famous for its Subneolithic and Neolithic wetland sites that produce astonishing everyday and ritual artefacts and are a fertile ground for interdisciplinary palaeoenvironmental studies in the same way as several other Neolithic Lake regions in the south-east Baltic, *i.e.*, Sārnate and Lubāns in Latvia and Biržulis and Kretuonas in Lithuania. From a coastal perspective, the Šventoji sites could mostly be recognized as part of the circum-Baltic Neolithic seal hunting and fishing community which lived off of the diverse and abundant coastal food resources during 4th – early 3rd millennium cal BC (see Rimantienė 2005; Piličiauskas *et al.* 2012; Piličiauskas 2016; Piličiauskas *et al.* 2017b; Robson *et al.* 2019).

The Šventoji sites are situated on the banks, littoral zones, and beds of former lagoons, delta channels, and rivers. The sites were interpreted as habitation areas, refuse layers, fishing stations, and amber workshops. Large quantities of pottery, as well as wooden and bone fishing gear, were unearthed during the excavations at the wetland sites. Large-scale seal hunting and freshwater fishing was inferred alongside the very sparse and dubious signs of a Neolithic farming economy in the Šventoji region (Piličiauskas *et al.* 2017a). Today the cultural layer has greatly deteriorated owing to ploughing and the drop in groundwater level at most of the habitation sites. However, the bone and wooden artefacts in the waterlogged gyttja of former bodies of water are still in good condition.

Today Šventoji might be considered one of the best archaeologically investigated areas in Lithuania. In addition to extensive test-pitting (c. 5000 m^2), many trenches (>10 000 m^2) have been excavated at the sites with the best preserved artefacts. We will discuss the three Šventoji sites (1, 3 and 23) in more detail below, as the wooden artefacts we have studied were found there.

Šventoji 1 was investigated in 1967-1969, 2010 and 2022 (Rimantienė 2005). Then an area of c. 1900 m^2 was excavated excluding test-pits, mostly at the wetland part of the site. Excavated finds were found in lake gyttja – from 0.5 to 1.7 m deep. However, it is important to note that close to it there was a low sandy hill with plenty of amber and flint artefacts within a ploughed layer (Rimantienė 2005). In places, two horizons were distinguished. The organic materials are well preserved. In the upper horizon (1A), wooden stakes, poles, pine laths, stones, and Neolithic and Subneolithic ceramics were concentrated in a strip only 1-2 m wide and more than 150 m long. Firstly it was assumed that this was a ceremonial enclosure, built on the site of an overgrown lake (Rimantienė 2005). However, today more likely is an alternative interpretation that the shallow water was still

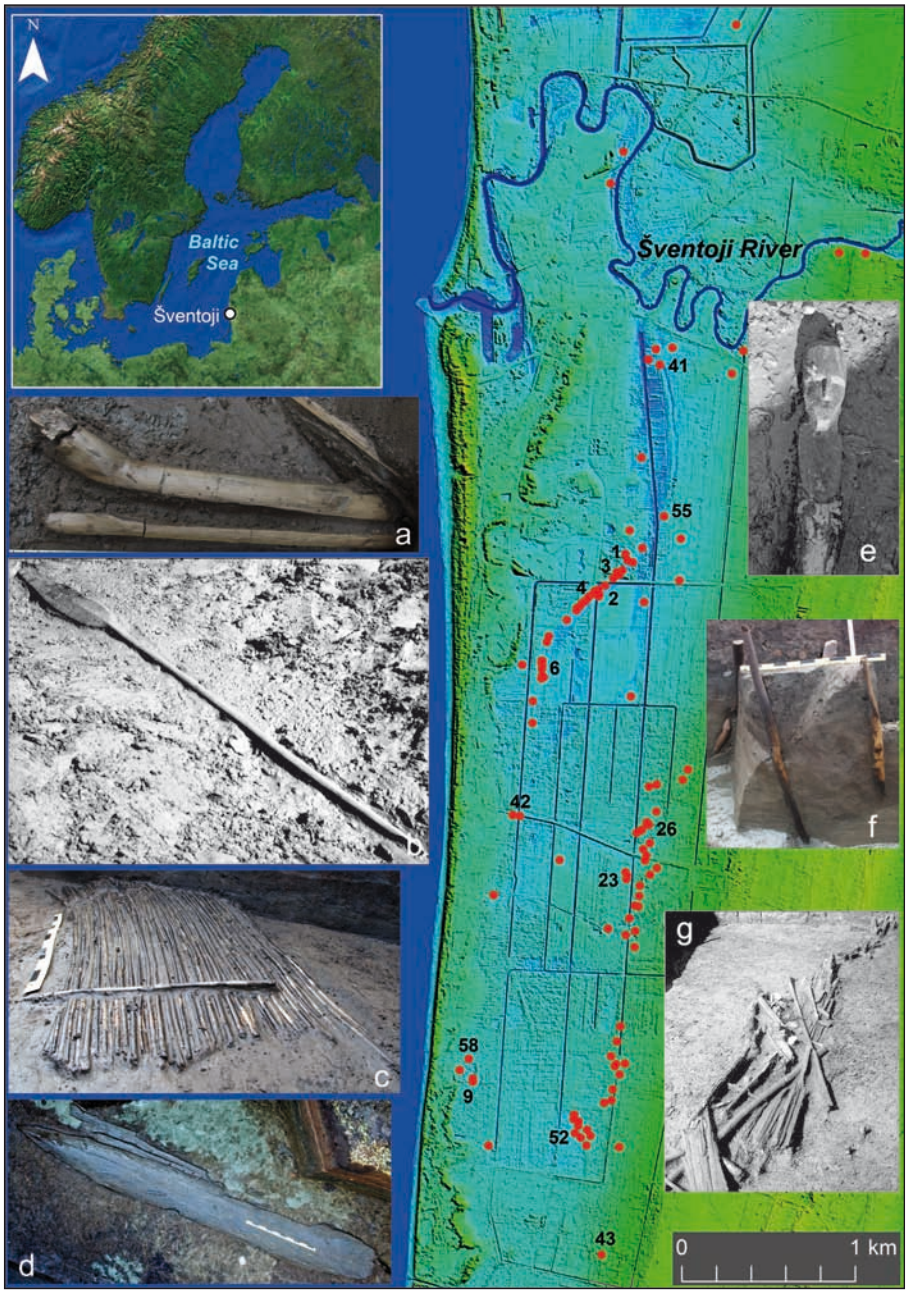


Fig. 1. Location of the Šventoji sites with photos of some wooden artefacts *in situ*: a – leister prongs at Šventoji 4, b – paddle at Šventoji 2, c – a rollable fishing fence at Šventoji 58, d – a dugout at Šventoji 58, e – an idol figure at Šventoji 2, f – piles at Šventoji 55, g – remains of fish weir at Šventoji 1 (Illustration by G. Piličiauskas)



Fig. 2. A selection of wooden artefacts from Šventoji sites: 1, 2 – paddles; 3, 4 – net floats; 5, 6 – sleeves; 7 – shaft; 8, 9 – fragments of wooden vessels/containers; 10, 11 – eel leister prongs; 12 – arrow fragment; 13 – wooden spatula (Illustration by G. Osipowicz and J. Orłowska)

present during the construction of the wooden fence and that it represents a fish weir (Piličiauskas 2016). The site is dated to c. 3500-2500 cal BC.

Šventoji 3 is located 150 m to the SW of Šventoji 1, on the shore and littoral of the erosional channel approximately 50 m wide. It was investigated 1971-1972, 2005, 2007 and 2022 (Rimantienė 2005). The excavations covered an area of 784 m² if not to count numerous test-pits. The finds were found in gyttja, at a depth of 0.5-1.75 m. Organic materials are well preserved including thousands of fish bones. Only Subneolithic pottery was found at Šventoji 3. Typologically and stratigraphically, it corresponds to the Šventoji 4B complex and can be dated to 3100-3000 cal BC (Piličiauskas 2016). Šventoji 3 was used exclusively for fishing during the Subneolithic. A hoard of amber artefacts and pieces of raw material was once found on a higher area adjacent to the site (Rimantiene 1979), but they may have belonged to a later period, possibly 2600-2400 cal BC, when the lake water level had dropped significantly (Piličiauskas 2016).

Šventoji 23 is located on the eastern shore of the lagoonal lake. It was investigated in 1970-1971 when an area of 1268 m² was excavated. The finds were found in peaty gyttja, as well as peaty sand on a higher area, at a depth of 0.4-0.8 m (Rimantienė 2005). Today, unfortunately, the wood has already decayed, but 45 years ago, a large number of various wooden artefacts were found in the littoral sediments. A dwelling area was found further to the east, marked by wooden stakes 5-12 cm in diameter distributed sparsely (Rimantienė 2005). The site is dominated by Late Subneolithic Porous pottery, analogous to the Šventoji 4B and 4A2 complexes. It is of light clay mass, shell-tempered, having numerous drilled holes, decorated with knot, comb and other impressions. Šventoji 23 was initially thought to be one of the latest Šventoji sites (Rimantienė 2005), but the AMS dates of hazelnut shells and hearth charcoal obtained in 2014-2015 show that it is actually contemporaneous with many other Šventoji sites situated in the middle of the same lagoonal lake and dates to 3200-2700 cal BC (Piličiauskas 2016). The site is important for the discovery of isolated human bones belonging to at least 3 individuals – extremely valuable material for isotopic studies (see Piličiauskas *et al.* 2017b, 2022 for results).

The collection of wooden artefacts found at Šventoji sites includes thousands of artefacts and their fragments. Next to the remains of fishing fences (Šventoji 1, 9, 55, 58; Rimantienė 1980; Piličiauskas 2016; Piličiauskas *et al.* 2020a), a dugout boat (Šventoji 58; Piličiauskas *et al.* 2020b), and the most famous artefact from Šventoji, *i.e.*, a statue of a wooden idol (Šventoji 2; Rimantienė 1979), many small objects were discovered here that accompanied the hunter-gatherer-fishermen who used this place on a daily basis. Rimutė Rimantienė, in her book from 2005, mentions at least 530 of them, including: paddles, bark floats, eel leister prongs, bows, arrows, wooden containers, sleeves, hammers, shafts and others (Fig. 1: a-g; Fig. 2).

2. MATERIALS AND METHODS

2.1. Materials

The subject of the analysis reported in this article were five wooden artefacts which, due to their morphological features, can be classified as pestles.

The first one was found at the site Šventoji 1 (inv. no. EM2070: 756; Fig. 3: 1). It is a relatively massive tool, oval in cross-section, with a well-defined handle and macroscopically clearly visible usage damage in the working part. Its total length is 38 cm (the length of the head is 25 cm), and the largest diameter of the working part is about 6.5 cm (diameter of the handle – about 3 cm). No sample was taken from the product for dendroarchaeological research, but the results of analyses carried out earlier for this artefact indicate that willow or alder were used (Rimantiene 2005, 244).

The second tool comes from the Šventoji 3 site (inv. no. EM2132: 384; Fig. 3: 2). It is 24.3 cm long and has a rectangular head with dimensions of 15.3 cm (length) × 6 cm (width in the part without the knot) × 3 cm (thickness). The head is clearly rounded at the top, and there is a large knot at its base. The handle of the tool is well-defined, its cross-section is oval, and the maximum diameter is approximately 2.2 cm. A sample was taken from the specimen for dendroarchaeological research, the analysis of which showed that it was made of ash tree (*Fraxinus excelsior*), which confirms previous findings in this regard (Rimantienė 2005, 346).

The remaining three artefacts were discovered at the site Šventoji 23. All were found almost in the same place (near the hearth), with three more artefacts of this type (Rimantienė 2005, 449). The first of them (inv. no. EM2110: 697; Fig. 4: 1) is a Y-shaped tool, approximately 23.3 cm long, which was most likely made from the branching point of a branch. The head of the specimen has an irregularly oval (sometimes close to rectangular) cross-section. Its length is approximately 13.7 cm, with a width ranging from 5-9.2 cm and a thickness of approximately 5 cm. The handle of the tool is well-defined, round in cross-section and has a diameter of about 3 cm. There are clear depressions visible on both sides of the head (on the wider sides) and in its central part. Dendroarchaeological examination of a sample taken from the artefact showed that it was made of hornbeam (*Carpinus betulus*). This is indicated by the characteristics of the microstructure of the tested wood (Fig. 5: 1). However, this is in contradiction with previous findings which had suggested that the artefact was made of ash (*Fraxinus excelsior*) (Rimantienė 2005, 64, 449).

The second tool from the Šventoji 23 site is similar in form to the specimen described above, but much more damaged (inv. no. EM2110: 696; Fig. 4: 2). Its length is 24.3 cm, of which 14 cm is the head, which is oval in cross-section (width: 5.5-8.6 cm; thickness max. 4.5 cm). The specimen has a well-defined oval handle with a diameter of up to 3.7 cm. As a result of dendroarchaeological analysis of the sample taken from the artefact, it was found that poplar wood (*Populus* sp.) was used for its production. This is confirmed by the

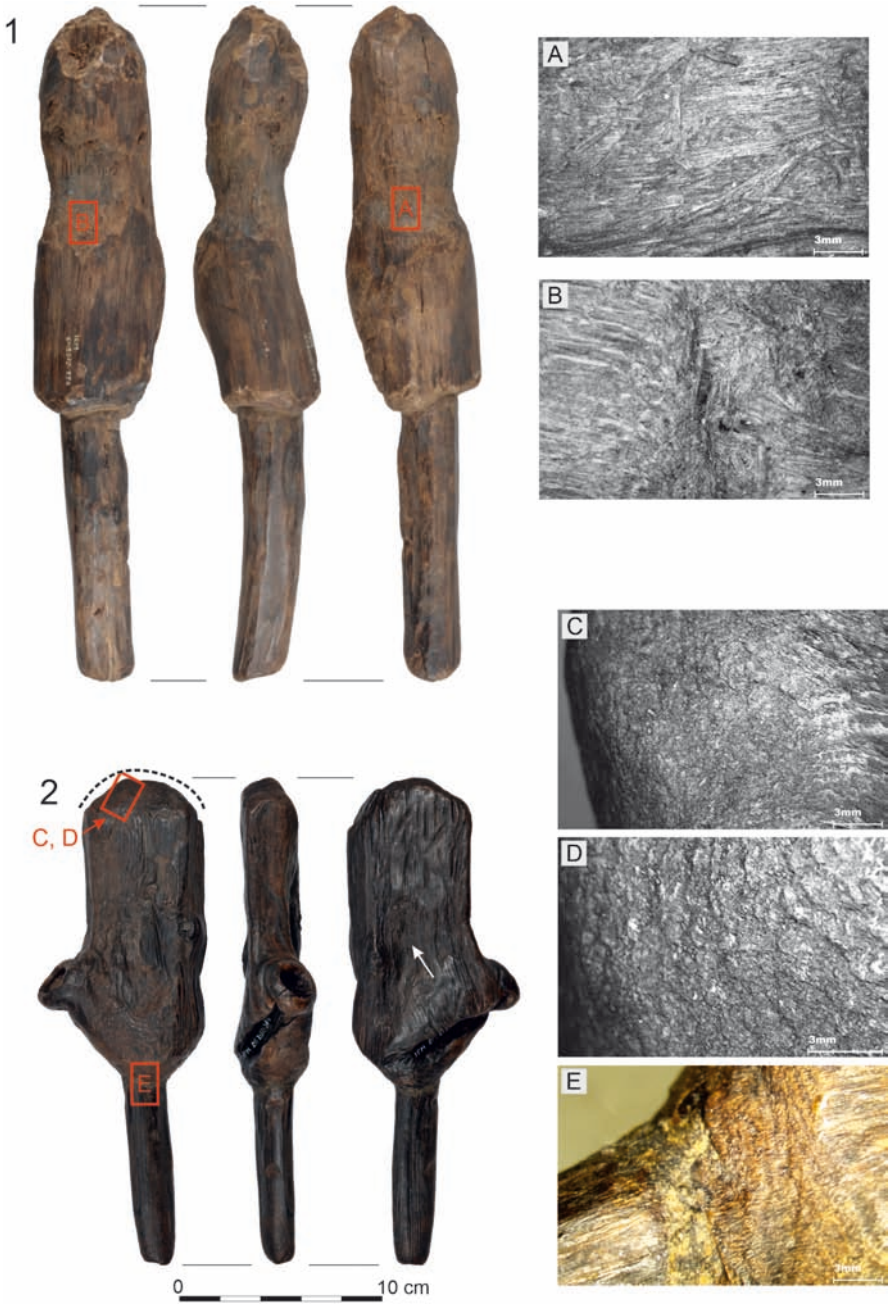


Fig. 3. Pestles that were the subject of the traceological analysis and the examples of technological and possibly usage traces observed on their surface: 1 – Šventoji 1; artefact inv. no. EM2070: 756; 2 – Šventoji 3 artefact inv. no. EM2132: 384 (Illustration by G. Osipowicz)

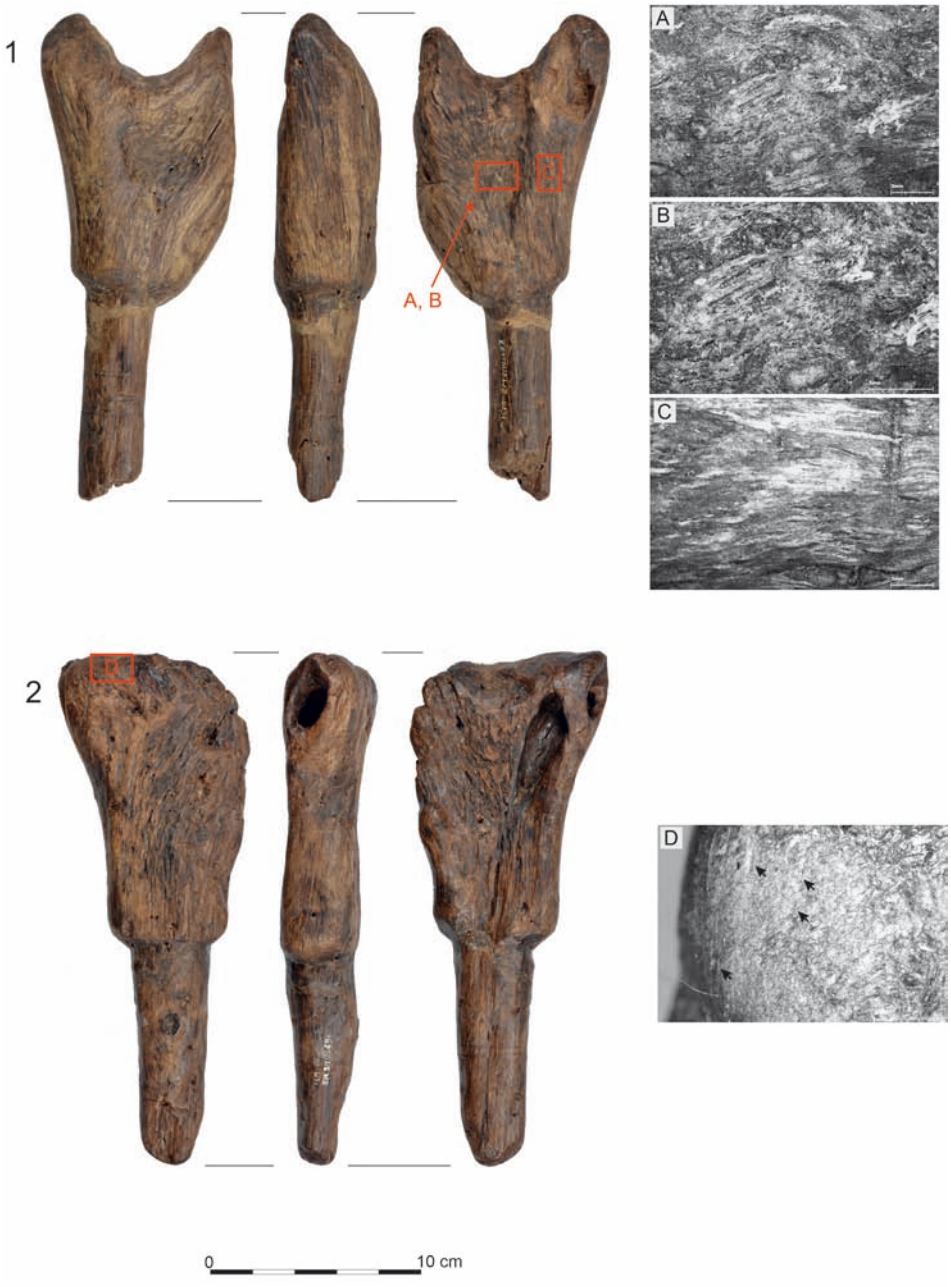


Fig. 4. Pestles from Šventoji 23 site that were the subject of the traceological analysis and the examples of possibly usage traces observed on their surface: 1 – Šventoji 1; artefact inv. no. EM2110: 697; 2 – inv. no. EM2110: 696 (Illustration by G. Osipowicz)

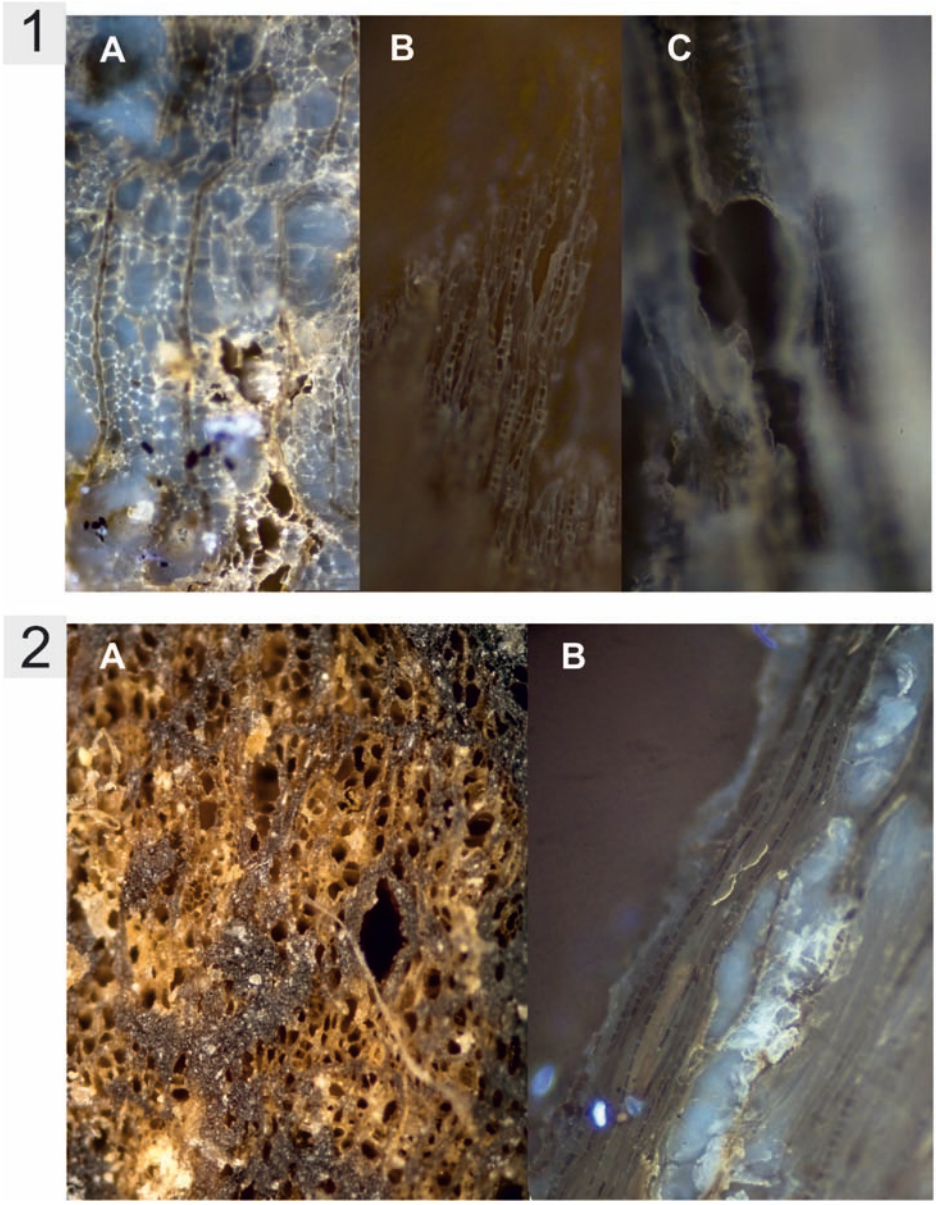


Fig. 5. Results of dendroarchaeological analysis: 1 – Characteristic features of *Carpinus betulus* wood (artefact inv. no. EM2110: 697): A. traversal section with diffuse porous tissue (100×MAG, UV light), B. tangential section with uniseriate rays forming an agregate ray (50×MAG, UV light), C. radial section with simple perforation plate and large pits in ray-vessel intersections (200×MAG, UV light); 2 – Characteristic features of *Populus* sp. wood (artefact inv. no. EM2110: 696): A. traversal section with diffuse porous tissue (50×MAG), B. tangential section with uniseriate, homogenous, long rays (100×MAG, UV light) (Illustration by G. Skrzyński)



Fig. 6. Pestle inv. no. EM 2110: 872 from Šventoji 23 site that was a subject of the traceological analysis (Illustration by G. Osipowicz)

microstructure of the analysed material (Fig. 5: 2). However, this result does not agree with previous findings, which suggested that the artefact had been made of made of ash (*Fraxinus excelsior*) (Rimantienė 2005, 449).

The last tool from the Šventoji 23 site (inv. no. EM 2110: 872; Fig. 6) is analogous to the specimen from the Šventoji 3 site. It has a head whose longitudinal and cross-sections are close to a rectangle, approximately 15 cm long and 6 cm wide. Its maximum thickness is

about 2.7 cm. The total length of the product is approximately 26.6 cm. No sample was taken from the artefact for dendroarchaeological research, but previous analyses indicate that it was made from alder (*Alnus* sp.) (Rimantienė 2005, 449).

The choice of these (and not other) artefacts for the analysis reported here over other similar products found in Šventoji was determined by their relatively good state of preservation.

2.2. Methods

As mentioned in the introduction, traceological research on wooden artefacts has only very recently been begun, and a research methodology that takes into account their specificity has not yet been developed. For this reason, the reported microscopic studies used



Fig. 7. The examples of the use-wear traces observed on the working edges of the experimental tools (Illustration by G. Osipowicz)

the methodology and terminology already developed for traceological studies of stone and bone specimens (*e.g.*, Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Korobkowa 1999; Legrand, 2007; Osipowicz 2010; Buc 2011; Orłowska *et al.* 2023). Of course, they were adapted (as much as possible at this stage of research) to the specificity of the analysis of wooden products.

Two microscopes were used during the research. The assessment of the state of preservation of the artefacts, as well as a preliminary analysis of technological and functional traces present on their surface, was carried out using a Nikon SMZ-745T optical microscope coupled with a Delta Pix Invenio6EIII camera. It allows for optical magnifications of up to 50×. This equipment was used to take the microphotographs shown in Figs. 3, 4 and 7. Additionally both, artefacts and experimental tools were analysed using the Zeiss Axioscope 5 Vario metallographic microscope, which allows obtaining objective magnifications up to 50× (optical magnifications up to 500 ×).

Samples for dendroarchaeological research, the results of which are presented in the article, were collected using an incremental drill, taking cores with a diameter of 5 mm and a length of approximately 10 mm. The samples were contaminated with the substance used to preserve the artefacts, *i.e.*, wax, which was removed by a 5-minute water bath at 100˚C, which was repeated three times. For anatomical analyses, an Olympus BH2 reflected light microscope was used, operating in the magnification range of 50-500×, with the possibility of conducting observations in a dark and bright field. The observations used the phenomenon of lignin fluorescence in ultraviolet light (Donaldson 2013). For this reason, a specially designed UV light source with a frequency of 365 nm was installed in the microscope. This equipment was used to take the microphotographs shown in Fig. 5. For taxonomic determinations, anatomical keys were used (Schweingruber *et al.* 2011, 2013) and a xylological comparative collection. The names of the plants are given in accordance with the botanical nomenclature applicable in Poland (Mirek *et al.* 2002).

2.2.1. Experimental program

The experimental research program carried out for the purposes of these studies was largely based on suggestions made about the functions of the analysed artefacts by the author of the excavation, R. Rimantienė (2005). In the case of the artefact from the Šventoji 1 site, she suggested that it was a stick, maul for driving, beating poles (German: *Holzbleuel*). She based this suggestion on the fact that it was found among elements of a fence, with three more similar artefacts lying nearby – all very worn, with the heads smashed and the shafts broken (Rimantienė 2005, 244). The remaining analysed artefacts were interpreted by the excavator (Rimantienė 2005, 346) as nut shellers, used to crush hazelnuts and/or water chestnuts (*Trapa natans*). The basis for this suggestion were ethnographic analogies and the fact of identifying the remains of a water chestnut on the surface of one of the artefacts (Rimantienė 2005, 449). Additionally, the planned experimental program

included activities that, in the opinion of the authors of this article, could have generated traces analogous to damage of (possibly) usage origin that was observed on artefacts from Šventoji.

Experimental tools were used for the following activities (*cf. Supplementary material*):

1. Debarking of poplar and hornbeam trunks. The experiment was carried out during the first International Camp of Experimental Archaeology, Toruń 2021 (Osipowicz *et al.* 2022). In order to debark trunks intended for dugout canoes, wooden and antler wedges were beaten with two pestles made of ash wood (Fig. 7: A). They were also used in the same way to remove the rotten outer layers of the tree. The duration of the experiment is impossible to determine because the tools were used *ad hoc*, when necessary. However, it was not less than a few hours.

2. Driving wooden pegs into the ground. The experiment was carried out during the first International Camp of Experimental Archaeology, Toruń 2021, but also after its completion, at the Institute of Archaeology of the Nicolaus Copernicus University. A hammer made of pine wood was used to drive sharpened stakes made of different types of wood into the ground to various depths. Also in this case, the exact duration of the experiment is impossible to determine, but it was certainly over an hour.

3. Breaking hazelnut shells. During the experiment, dried hazelnuts placed on a processed trunk of an unspecified tree were broken with a pestle made of pine wood (Fig. 7: D). The experiment lasted approximately 60 minutes.

4. Grinding hazelnuts. The experiment involved crushing/grinding hazelnuts in a small beechwood bowl using a pinewood tool (Fig. 7: G). The duration of the experiment was 30 minutes.

5. Grinding the shells in a wooden container. The experiment was identical to the one described above, except that in this case the shells of the common mussel (*Anodonta anatina*) were crushed (Fig. 7: J).

It was impossible for us to carry out experiments with the processing of water chestnuts (*Trapa natans*) due to the fact that this plant is currently a species found very rarely in the Baltic Sea zone.

3. RESULTS OF TRACEOLOGICAL ANALYSIS

3.1. Artefacts

Traceological research carried out on the described artefacts from Šventoji was significantly hampered by the post-depositional damage present on their surface. Among them, the most important (and most common) include various types of fractures and cracks, rounding and smoothing of the edges, and numerous compression marks resulting from the pressure on the object after its deposition. Changes caused by the applied conservation

process created additional difficulties. One of its results is the thorough cleaning of the surface of artefacts from contamination originating from the context in which they were located, but also (at the same time) from any residues related to their function. The preservative used was largely absorbed by the wood and did not pose a problem during analyses using optical microscopes and low magnifications. However, it made it difficult to analyse possible usage polishes using metallographic microscopes. The conservation process did not have a significant impact on the degree of preservation of impact, compression or abrasion traces, which appear to have been preserved in good condition on the artefacts considered and were the main subject of the following analysis.

Traceological examination of the wooden artefacts in question led to the identification of quite uniform technological traces on their surface in the form of incisions and planing/chopping negatives (Fig. 3: E). At the same time, they showed considerable discrepancies in the characteristics of damage considered being (possibly) usage, visible on individual products. The results of the analysis in this regard are as follows:

In the central part of the head of the tool from the Šventoji 1 site, a large loss of wood fibres is visible macroscopically (Fig. 3: 1). This area should most likely be considered a working surface. Microscopic analysis showed that this loss is the result of strong compression and crushing of the fibres, without any clear traces of their cutting (Fig. 3: A, B). The highly destructive nature of this damage causes the surface topography in this place to be heterogeneous and its relief to be very irregular. No polish or linear traces were found.

In the case of a tool from the Šventoji 3 site, damage of possibly utilitarian origin was observed on the top of its head (Fig. 3: 2 – the range is marked with a dashed line). Its characteristics are different than in the case of the tool from Šventoji 1. The surface topography here is definitely more homogeneous and its relief is quite regular. It also appears to be slightly roughened, with the higher areas of the micro-relief being clearly smoothed and rounded (Fig. 3: C, D). However also in this case, no polish or linear traces were found. Additionally, in the central part of this specimen, on one of the wider sides, a depression was observed, the origin of which could not be clearly explained (Fig. 3: 2 – marked with an arrow). However, it seems to be post-depositional due to the lack of any impact traces in this place.

Depressions, approximately 4 cm in diameter and up to several millimetres deep, were also observed on both sides of the head of the first of the analysed tools from the Šventoji 23 site (Fig. 4: 1). In this case, however, as a result of the microscopic analysis, it was found that these are areas of strong compression and crushing of the wood fibres with a large number of small cracks between them (Fig. 4: A, B). The scope of changes in the structure of the raw material that occurred in these places is confirmed by comparing Fig. 4: A, B with a microphotograph taken just outside the border of one of them, where the course of the wood fibres is very regular and they show no signs of destruction (Fig. 4: C).

On another tool from Site 23 in Šventoji (Fig. 4: 2), changes of perhaps utilitarian origin were observed elsewhere. Most of the surface of this specimen is heavily damaged,

but on the top of its head there are signs of surface crushing, associated with identically oriented (and consistent with the axis of the specimen) single linear traces in the form of shallow linear depressions (Fig. 4: D; the potentially used area is marked with a dashed line; linear depressions are marked with an arrow). The surface topography in this place is homogeneous and the microrelief is quite regular.

The last specimen from the Šventoji 23 site (Fig. 6) did not contain any traces that could be considered potentially due to usage. Its surface is too damaged post-depositionally.

3.2. Experimental tools

The use-wear traces produced on individual experimental tools differ to a large extent. The element common to all of them is the lack of a clear usage polish (it was also not legible when observed using a metallographic microscope).

As a result of experiments involving hitting wooden and antler wedges, in order to debark tree trunks and driving wooden piles into the ground, quite similar use-wear traces was produced on experimental pestles (although the degree of their development was different). All tools show significant crushing and destruction of the wood fibres, which leads to their fragmentation. This results in a significant loss of material in the working zone of the tools. What is important here is the fact that most of the fibres do not show signs of being cut, but of being crushed/broken off (Fig. 7: B). There are also numerous compression traces (irregular depressions) with different characteristics on the working surface (Fig. 7: C). The topography of the working surface is heterogeneous and its micro-relief is very irregular. The difference between pestles used for debarking and those used for driving piles into the ground is that the traces of use on the first type of tools are much less developed. However, it can be assumed that as a result of their use long enough, their characteristics would become identical to those observed on the second type of tools.

The first, macroscopically noticeable result of using a wooden pestle to break hazelnut shells was the creation of an irregular, shallow depression on its working surface with a diameter of about 2.5 cm. Within it, numerous compression traces were observed, including irregular deformations of the tool's working surface (depressions), visible surface cracks and a type of linear traces, *i.e.*, linear depressions with different characteristics and course (Fig. 7: E, F). Compression of the fibres within the working surface of the tool also led to their fraying and a type of peeling/delamination of the wood, consisting in the separation of its layers belonging to different rings (Fig. 7: E). The microtopography of the working surface can be described as homogeneous and the micro-relief is regular.

As a result of crushing/pulping hazelnuts, very faint traces of use were created on the experimental tool. In this case, no significant crushing of the wood fibres or their splitting/breaking was observed. On the working surface, only a slight rounding of the higher parts of the raw material relief and a slight fraying of the fibre ends are visible (Fig. 7: H, I).

A relatively large number of small fragments of ground nuts were pressed into the relief (readable as brown dots in the photos).

Different functional damage was caused by grinding the shells. In this case, a clear crushing and compression of the fibre "terminations" was observed on the working surface, resulting in their splitting and "pressing" into the working surface (Fig. 7: K, L). As a result, it becomes clearly rounded. Its topography is heterogeneous and the microrelief is very irregular. Also in this case, fragments of the processed material pressed deep into the working surface were documented (Fig. 7: K, L – marked with arrows).

4. DISCUSSION

Traces considered as (probably) utilitarian observed on the analysed artefacts and the use-wear damage visible on experimental tools are so well developed that they allow their comparison with each other and verification (at least to some extent) of the hypotheses put forward by the authors of the research in Šventoji regarding the artefacts' functions. However, a certain problem here is (both in the case of prehistoric and experimental specimens) the lack of usage polish, which is one of the basic diagnostic indicators during traceological (functional) analyses of stone and bone products (*e.g.*, Vaughan 1985; Van Gijn 1989; Sidera 1993; Juel Jensen 1994; Legrand 2007; Osipowicz 2010; Buc 2011; Orłowska *et al.* 2023). At this stage of research, it is difficult to say whether its absence is due to the specificity of activities performed with wooden pestles, post-deposition processes (in the case of artefacts), or differences in use-related damage that occur (generally) on wooden tools (although it should be noted here that the presence of usage polish on tools made of this raw material has already been indicated in the literature – *cf.*, Caruso Fermé *et al.* 2014, 2015; Caruso Fermé and Aschero 2020). This problem certainly requires much more multi-aspect studies, especially experimental ones, and cannot be solved at the stage of preliminary research such as that reported in this article.

Apart from this issue, the results of the traceological analysis presented here allow the making of several observations about the functions of the examined wooden products from Šventoji and the possibility of interpreting the (potential) use-wear damage observed on them.

First of all, it should be stated that the traces visible on the artefact from the Šventoji 1 site are very similar to those observed on the tools used to hit wedges during the experimental debarking, and basically identical to those visible on pestles used to drive wooden pegs into the ground. The suggestions of the authors of the research at the site regarding the function of this tool (a stick, maul for driving, beating poles; Rimantienė 2005, 244) therefore seems very likely.

The remaining wooden artefacts from Šventoji included in this study were considered probable nut shellers (tools used to crush hazelnuts and/or water chestnuts; Rimantienė

2005, 64, 346). The use-wear damage caused to a wooden pestle as a result of experimental hazelnut cracking is, to some extent, similar to that observed only on one of them, namely the specimen from the Šventoji 23 site shown in Fig. 4: 1. On this artefact and on the experimental tool, in the central part of the working surface, a shallow depression is visible, created as a result of crushing wood fibres during nut cracking. In both cases, clear compression traces were observed on the working surface, although their characteristics are slightly different. What they have in common is the presence of microcracks in the surface of the raw material. However, the difference is that in the case of the artefact, we basically only observe the crushing of wood fibres, while on the experimental tool we can also see (perhaps even primarily) various types of compression deformations (depressions), which do not significantly affect the structure of the raw material fibres (apart from the fact that lead to their splitting). These discrepancies do not, however, seem to exclude the possibility of using this artefact for cracking nuts, as they may result from raw material factors (the artefact and the experimental tool are made from different types of wood) or morphological factors (the use of morphologically different branch fragments). This problem undoubtedly requires further experimental and traceological research.

In the case of the remaining artefacts from Šventoji, for which the function of nut shellers was suggested, the similarity of the damage visible on them to the use-wear traces created as a result of experimental cracking of hazelnuts was not confirmed. A certain analogy to the linear depressions visible on this experimental tool may be traces of this type observed on the top of the head of the artefact from the Šventoji 23 site, shown in Fig. 4: 2. However, no other types of damage caused to the experimental product were recorded on this specimen, which does not allow it to be associated with nut cracking with greater probability (especially considering the heavy destruction of the specimen). Nevertheless, the surface on which the above-mentioned traces were observed can be considered as probably used.

The potential origin of the traces observed on the top of the head of the artefact shown in Fig. 3: 2 was initially associated with grinding of some material. However, they are not similar to the damage caused by experimental grinding of nuts and shells in wooden bowls. Of course, this does not definitively rule out their utilitarian origin. However, it cannot be ruled out that we are dealing here with a post-depositional modified surface.

As already mentioned in the introduction, prehistoric wooden artefacts, especially those dating back to the Stone Age, are extremely rare archaeological sources. Work on creating a methodology for traceological research adequate to their specificity is ongoing and each subsequent study in this area is valuable. Previous research indicates that it is undoubtedly possible to conduct reliable technological analyses of prehistoric wooden objects (see Caruso Fermé *et al.* 2014; 2015; 2023; Schoch *et al.* 2015; Lozovskaya and Lozovski 2016; Rios-Garaizar *et al.* 2018; Caruso Fermé and Aschero 2020; Vidal-Matutano *et al.* 2021; Barham *et al.* 2023; Gibaja *et al.* 2023). The traces resulting from wood processing using stone tools are in many respects similar to those observed on bone

products, which simplifies analytical procedures because it is possible to use the findings made for them.

The situation seems to be slightly different in the case of use-wear (functional) analyses. Answering the question posed in the title of this article, it can be said that this type of research is most likely also possible, but the traces of use created on wooden objects as a result of their use as tools are specific and in many respects different from those observed on stone and bone products. At this stage of research, in the vast majority of cases, their correct interpretation seems to be very difficult, if not impossible. Improving the situation in this respect undoubtedly requires conducting a large number of experiments, taking into account various types of wood and other variables, the ultimate goal of which will be to create a reliable classification of traces on wooden tools, corresponding to the specificity of the raw material. This is extremely important, because even the traceological studies carried out for the purposes of this article – very preliminary in their profile – indicate that taxonomic and morphological factors may be of key importance for the characterization of traces of use visible on wooden objects. The issue of the formation and characteristic of usage polishes, which could not be identified through the reported research, also seems to be very important here.

A major problem for traceological studies of prehistoric wooden objects is their state of preservation. It is obvious that the possibilities of identifying technological and (especially) use-wear (functional) traces depend on the degree of post-depositional destruction of artefacts. The preservative substances and processes used in the case of prehistoric objects are also of great importance for their readability. Future experimental work should undoubtedly also include studies in this area.

The Šventoji collection seems to be an excellent material for testing the possibility of conducting traceological research of prehistoric wooden objects, because these artefacts are very well preserved, and the conservation process used did not have a destructive impact on many categories of technological and functional traces. However, the interpretative possibilities and limitations resulting from these analyses will become visible only in the future, after more research has been conducted and their application to the results of other analyses conducted in Šventoji.

5. CONCLUSIONS

The studies presented in the article were of a preliminary nature, therefore the conclusions drawn here may still change. However, this type of research should be considered very promising and should therefore be continued, despite the difficulties that we will certainly have to face again and again. Traceological analyses of wooden products can be carried out using equipment and methodology used for examining stone and bone artefacts. The intensification of studies in this area depends solely on the availability of the subject

of analysis, *i.e.*, prehistoric wooden products, and on our willingness. We consider the most important for research in the near future to be multi-aspect experimental studies aimed at replication and precise classification of traces of use created on wooden objects during various activities. In the case of Šventoji, further categories of artefacts should be subjected to microscopic analysis. This may help in assessing the impact of post-depositional processes and conservation on their surfaces and constitute an excellent material for cross-verification of conclusions drawn during experimental research.

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HIDDEN LITHIC TREASURES. RESEARCH PERSPECTIVES ON MUSEUM COLLECTIONS OF NEOLITHIC STONE TOOLS

ABSTRACT

Kufel-Diakowska B., Chłoń M., Bronowicki W. and Borowski M. 2024. Hidden lithic treasures. Research perspectives on museum collections of Neolithic stone tools. *Sprawozdania Archeologiczne* 76/1, 381-403.

Museum collections contain numerous finds that are considered low-quality data and do not attract the proper attention of researchers. The most common reason is the uncertain context of the finds or lack of other precise identification. The main aim of this paper is to increase the scientific value of so-called stray finds. The collection of the Neolithic stone tools from two museums was subjected to multifaceted analysis combined with detailed archival research. The results allowed us to address two important aspects. At the level of objects, the use of microscopic observations proved the complexity and prolonged use-life of the Neolithic tools. At the cultural level, the re-evaluation of stray finds introduces changes in the range of Neolithic settlements in SW Poland.

Keywords: Stray finds, Neolithic, macrolithic tools, archival resources
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INTRODUCTION

Macrolithic tools made from various types of non-flint rocks are the most durable archaeological artefacts, which survived for thousands of years. Stored in scientific and educational institutions, the majority are accidental discoveries. Archaeological context provides information about the provenance of finds and the relationships with each other and with the environment. Nevertheless, lack of context does not mean that artefacts are beyond archaeological interpretation, because all prehistoric objects were part of a cultural process including need, production and use (see Johanson 2006).

The phenomenon of context-less macrolithic tools is a result of human behaviour both in prehistoric and modern times. From the Neolithic to the Iron Age, hoards of stone and metal tools were deliberately deposited outside the prehistoric settlements, or were parts of burial furnishing (Johanson 2006; van Gijn 2010, 184-186; Furmanek *et al.* 2019, fig. 34). Single objects could have been lost by early farmers during expeditions or field works such as preparing land for cultivation and felling trees. Stone tools, mostly those with cutting edge were reused in prehistoric periods (Szydłowski 2017, 121; Kufel-Diakowska *et al.* 2022, 1624). Examples of recycling also come from historic and modern times, until today. According to the documentation stored in the District Museum in Nysa, a battle-axe of the Corded Ware culture found in the village of Skoroszyce in 1968 was being used by children as a toy before it was donated to the Museum.

Long after the Neolithic, stone axes attracted attention and were the objects of beliefs and superstitions due to the raw material and shape. Between the Middle Ages and the 19th century the phenomenon of "thunderbolts" or "thunderstones" spread throughout Central and Northern Europe (Johanson 2009; Kurasiński 2021). Cross-data that confirm this practice come from ethnographic sources and archaeological excavations. Ground stone tools were discovered in medieval and postmedieval residential houses, strongholds, and agricultural buildings. Apart from the protective function they played a role in folk medicine. Axes were used to treat cattle (Kurasiński 2021) or prevent human diseases (Horoszkiewicz 1950).

Although many archaeologists exclude stray finds from their research, they provide valuable scientific data for micro- (object level) and macro-scale (culture level) investigations. The development of archaeometric and statistical methods of study in archaeology contributed to the extensive data gathering and processing. Stone and metal tools are investigated with the use of microscopic techniques to determine the true role of objects in prehistoric society (Baron *et al.* 2020; Hamon *et al.* 2021). All kinds of context-less artefacts complement landscape and demographic studies (Bergsvik *et al.* 2021). In the case of semi-sedentary or nomadic societies, the distribution of stray finds is important. For example, the habitation range of the Corded Ware Culture in SW Poland, due to a low number of discovered and preserved graves, is recognised mostly by the accidental discoveries of battle axes and pottery fragments (among others, see Chmielewski and Romanow 2015).

In this paper, we focus on the research perspectives of macrolithic stray finds. We show that multifaceted analysis combined with detailed archival research is effective for the reconstruction of the life history and circulation of tools that were essential parts of the economic and religious life of past societies.

ARCHAEOLOGICAL COLLECTIONS FROM SW POLAND

In Lower Silesia and adjacent territories, archaeological collections were assembled in museums starting from the beginning of the 19th century. Owing to local historians or private collectors, they were first enlarged, but then impoverished due to various historical events. Many prehistoric artefacts were lost during World War II. The deposit of 25 Neolithic stone axes from "*Hasenberg*" (Ratnowice) found at the beginning of the 20th century is one of the examples known only from the archival notes. In 1945 Poland inherited considerably reduced but still numerous collections that also included macrolithic tools.

Information about the archival finds gathered in German documentation before 1945 was and still is being meticulously translated and verified. This often resulted in rediscovery of the artefacts and new field research. The largest archaeological surface survey program was performed within the "Archaeological Picture of Poland" project (AZP). It aimed to map as many as possible archaeological sites and settlement points. Archival information was very often the basis of this search. In the course of the AZP program, archaeologists were able to verify the possible areas of settlement in the past. Some of them, unfortunately not the ones from the Neolithic, were then excavated.

For this study, we chose two collections of stone artefacts from the museums in SW Poland: the District Museum in Nysa and the Museum of the Silesian Piasts in Brzeg. The selection criteria were the number of objects within collections, the condition of the artefacts and the degree of access to preserved archives, including museum archives, and articles in German journals (*Jahresberichten des Neisser Kunst- und Altertums-Vereins*; *Altschlesische Blätter; Schlesiens Vorzeit in Bild und Schrift*: *Zeitschrift des Vereins für das Museum schlesicher Altertümer*) and books (*e.g.*, Drescher 1932). Two selected collections are characterized by a large number of stone artefacts, often without a specific context – it had either been forgotten, or information was lost during the tumultuous times of the first half of the 20th century. These artefacts are mainly large tools with cutting edges. The majority were accidental discoveries by searchers-amateur archaeologists, teachers, and doctors (for example, U. Weisser, H. Weisser, W. Radig) and German archaeologists (G. Raschke, E. Drescher) before or during WWII. Recent finds come mainly from surface surveys, "private" collections and rescue investigations during agriculture and construction works.

Museums in Nysa and Brzeg have quite rich collections of stone tools initially documented as Neolithic. The assemblage we included in this paper consists of 97 artefacts from the District Museum in Nysa and 10 from the Museum of the Silesian Piasts in Brzeg

Table 1. Collection of stone tools in the District Museum in Nysa (MNa) and Museum of the Silesian Piast in Brzeg (MPŚ): basic classification ([1] Zápotocký 1989; [2] Włodarczak 2006; [3] Glob 1945), site (previous site name/numbers in brackets), references abbreviations (AB-*AltschlesischeBlätter*, JK-*Jahres-Bericht des Kunst- und Altertums-Vereins Neisse*, NZ-*Neisser Zeitung*)

Inv. No. (ID)	Basic Classification	Site	County	Museum Inv. No.	Archival Inv. No.	Chronology	Raw Material	References
308	Shaft-Hole Axe	Siedlec 2	nyski	MNa/A/612	R.30:550	STbK/L-PC	Metabasite	
309	Axe	Goświnowice 4	nyski	MNa/A/4	2378; 17	STbK/L-PC	Metabasite	
310	Shaft-Hole Axe	Trzeboszowice 2	nyski	MNa/A/406	2906; R.1:20	STbK/L-PC	Metabasite	Drescher 1932, 33
311	Axe	Goworowice-Tarnawa 3	nyski	MNa/A/501	3103; R.21:33	STbK	Metabasite	
312	Shaft-Hole Axe	Prusinowice 10	nyski	MNa/A/677		Neolithic	Amphibolite	
313	Shaft-Hole Axe	Słupice 3	nyski	MNa/A/659		LBK/STbK	Serpentinite	
315	Shaft-Hole Axe	Kępnica 6	nyski	MNa/A/7	2360: 15	STbK/L-PC	Amphibolite	
316	Axe	Radzikowice 48	nyski	MNa/A/17	2378; 29	TRB	Basaltoid	AB 1936, 2: 66
317	Shaft-Hole Axe	Lipniki 5	nyski	MNa/A/559	3040; R.140:32	STbK/L-PC	Metabasite	
318	Shaft-Hole Axe	Maciejowice 29 (1)	nyski	MNa/A/568	R.48:43	STbK/L-PC	Serpentinite	
319	Axe	Lipowa 5	nyski	MNa/A/9	2374; 28	Undetermined	Basaltoid	
320	Shaft-Hole Axe	Maciejowice 26	nyski	MNa/A/565	2969; R.842:43; 1842:27	STbK/L-PC	Serpentinite	
321	Shaft-Hole Adze	Siestrzechowice 2	nyski	MNa/A/386	2875; R.58:31	STbK/L-PC	Metabasite	Drescher 1932, 32
322	Shaft-Hole Axe	Lipniki 4 (1)	nyski	MNa/A/560	2977; R.142:32	STbK/L-PC	Serpentinite	
323	Shaft-Hole Adze	Biała Nyska 7	nyski	MNa/A/474		STbK/L-PC	Metabasite	
324	Shaft-Hole Axe	Hajduki Nyskie 1	nyski	MNa/A/299	R.21:43	STbK/L-PC	Serpentinite	
325	Shaft-Hole Axe	Piotrowice Nyskie-Krakówkowice nn (Krakówkowice 2)	nyski	MNa/A/318	R.131:35	STbK/L-PC	Serpentinite	
326	Shaft-Hole Axe	Otmuchów 2	nyski	MNa/A/593	R.134:29	STbK/L-PC	Amphibolite	Drescher 1932, 28
327	Shaft-Hole Axe	Nysa-Górna (Średnia) Wieś 3	nyski	MNa/A/81	3194; 81	STbK/L-PC	Serpentinite	JK 1935, 38:56; NZ 8.04.1937
329	Shaft-Hole Axe	Głębinów 12	nyski	MNa/A/224		STbK/L-PC	Basaltoid	
330	Axe	Goświnowice 2 (3)	nyski	MNa/A/295	R.38:27	STbK/L-PC	Serpentinite	AB 1941, 4/5: 242

331	Axe	Lipowa 6	nyski	MNa/A/10	2373; 18	STbK/L-PC	Serpentinite	JK 1934, 37: 2, 4
332	Axe	Gierów 2	brzeski	MNa/A/491	R.38:61	LBK/STbK	Metabasite	
333	Battle Axe (B1)[2]	Piątkowice nn	nyski	MNa/A/734		CWC	Amphibolite	
334	Shaft-Hole Axe	Regulice nn	nyski	MNa/A/676		STbK/L-PC	Serpentinite	
335	Shaft-Hole Axe	Złotogłowice 21	nyski	MNa/A/23	2367; 8	STbK/L-PC	Metabasite	
336	Shaft-Hole Axe	Kępnica 5	nyski	MNa/A/6	2362	STbK/L-PC	Amphibolite	
337	Shaft-Hole Axe	Bodzanów 6	nyski	MNa/A/245	2570; R.227(4):29	STbK/L-PC	Metabasite	AB 1929, 6: 115; JK 1932, 36:9
338	Shaft-Hole Axe	Złotogłowice 23	nyski	MNa/A/420	R.41:66	STbK/L-PC	Serpentinite	AB 1933, 1: 22
340	Axe	Jędrzychów 4	nyski	MNa/A/5		STbK/L-PC	Serpentinite	JK 1932, 36: 10; AB 1933, 5: 94
341	Shaft-Hole Axe	Ligota Wielka 6	nyski	MNa/A/545	R.23:36	L-PC	Metabasite	
342	Shaft-Hole Axe	Radzikowice 47	nyski	MNa/A/16	2359; 10	STbK/L-PC	Metabasite	JK 1934, 37: 3
343	Shaft-Hole Axe	Chociebórz 4	nyski	MNa/A/487	3161; R.61:38	STbK/L-PC	Serpentinite	AB 1938, 5: 198
344	Shaft-Hole Axe	Grądy 3	nyski	MNa/A/508	3110; R.54:43	STbK/L-PC	Metabasite	AB 1938, 5: 198; JK 1941, 43/45: 79
345	Shaft-Hole Axe (R)[1]	Pakosławice 1	nyski	MNa/A/344	R.28:43	TRB	Serpentinite	AB 1941, 1: 69
346	Axe	Ligota Wielka 9	nyski	MNa/A/541	3002; R.433:32	LBK	Metabasite	Drescher 1932, 24
347	Battle Axe (G1)[2]	Maciejowice 30	nyski	MNa/A/569	R.50:43	CWC	Serpentinite	
348	Shaft-Hole Axe	Lipowa 1	brzeski	MNa/A/24	2365	STbK/L-PC	Basaltoid	AB 1935, 3: 82
349	Shaft-Hole Axe (R)[1]	Biskupów-Łączki Nyskie 7	nyski	MNa/A/323	2689; R.41:38	TRB	Sandstone (Greywack)	AB 1941,3/4: 242
351	Shaft-Hole Axe	Kępnica 4	nyski	MNa/A/316	2684; R.38:38	STbK/L-PC	Amphibolite	
352	Axe	Węża 9	nyski	MNa/A/21	2379; 25	STbK/L-PC	Serpentinite	JK 1934, 37: 5
353	Chisel	Ścinawa Mała 3	nyski	MNa/A/20	2381; 31	STbK	Metabasite	JK 1934, 37: 5
354	Shaft-Hole Axe	Burgrabice 9	nyski	MNa/A/80	3175; 80	STbK/L-PC	Metabasite	JK 1934, 37: 1; AB 1935, 2: 50
355	Axe	Goworowice 8	nyski	MNa/A/505	R.57:43	STbK/L-PC	Basaltoid	
356	Shaft-Hole Axe	Biechów nn	nyski	MNa/A/1	2357; 36	STbK/L-PC	Amphibolite	
357	Shoe-Last Adze (middle)	Malerzowice Małe 2	nyski	MNa/A/577	3054; R.120:35	LBK	Metabasite	AB 1936, 5: 162

Table 1.

Inv. No. (ID)	Basic Classification	Site	County	Museum Inv. No.	Archival Inv. No.	Chronology	Raw Material	References
358	Tool preform	Otmuchów nn	nyski	MNa/A/585	R.191:32	Undetermined	Sandstone	
359	Shaft-Hole Axe	Nowy Świętów nn (Złotogłowice 6)	nyski	MNa/A/417	2891; R.38:36	L-PC	Serpentinite	AB 1936, 7: 230
360	Shaft-Hole Axe	Maciejowice 16	nyski	MNa/A/575	3065; R.49:43	STbK/L-PC	Metabasite	
361	Shaft-Hole Axe (R)[1]	Strobice 2	nyski	MNa/A/395	R.37:107	TRB	Serpentinite	JK 1939, 40/42: 98
365	Shaft-Hole Axe	Brzeg 4 (Location unknown)	brzeski	MPŚ A/I:132	III/148; 1623	STbK/L-PC	Serpentinite	
366	Shaft-Hole Axe (R)[1]	Obórki 2	brzeski	MPŚ A/I:134	III/150; 1617	TRB	Serpentinite	AB 1944, 1: 15
369	Mace (*Geröllkeule*)	Mikolin 3 (Wronów)	brzeski	MPŚ A/I:129	III/145; 1639	Mesolithic	Sandstone (Quartz)	AB 1931, 3: 290
373	Shaft-Hole Axe (Highly modified form)	Brzeg 20	brzeski	MPŚ A/I:198	III/219	TRB	Gabbro	
375	Axe	Prędocin 2 (Kruszyna)	brzeski	MPŚ A/I:82	III/96; 1645	TRB	Serpentinite	AB 1929, 4: 61, 1930, 6: 86, 1934, 4: 305, 1935, 1: 26
376	Axe (*Walzenbeil*)	Stobrawa 3	opolski	MPŚ A/I:131	III/147:1663	Mesolithic	Undetermined Igneus Rock	AB 1935, 1: 27
377	Shaft-Hole Axe	Lubsza 15	brzeski	MPŚ A/I:133	III/149; 1647	STbK/L-PC	Amphibolite	
379	Battle Axe (H2)[2]	Zielęcice 3 (Małujowice)	brzeski	MPŚ A/I:86	III/100; 1626	CWC	Diabase	
381	Axe	Małujowice 2	brzeski	MPŚ A/I:20	III/22; 1644	TRB	Metadiabase	
384	Battle Axe (H2)[2]	Brzeg-Brygidki 2	brzeski	MPŚ A/I:25	III/30; 1631	CWC	Undetermined Igneus Rock	
388	Axe	Burgrabice 4	nyski	MNa/A/2	2383	TRB		JK 1934, 37: 1
389	Battle Axe (I)[2]	Biechów-Godkowice 11	nyski	MNa/A/3	2364; 11	CWC		Drescher 1932, 32

390	Axe	Lipowa 4	nyski	MNa/A/8	2375; 19	TRB		
391	Battle Axe (G2)[2]	Nysa 8 (ul. Orląt Lwowskich)	nyski	MNa/A/13	2368; 13	CWC		AB 1934, 2: 39; JK 1934, 37: 2, 1935, 38: 56
392	Tool preform	Nysa 19	nyski	MNa/A/14	2372; 27	Neolithic		
393	Axe	Przydroże Małe nn	nyski	MNa/A/15	2387; 24	TRB/CWC		
394	Shaft-Hole Axe	Sławniowice 1	nyski	MNa/A/19	2363	STbK/L-PC		JK 1934, 37: 2
395	Battle Axe (H1)[2]	Złotogłowice 20	nyski	MNa/A/22	2358; 12	CWC		
398	Battle Axe (B4)[2]	Wójcice-Otmuchów 26	nyski	MNa/A/213	2181	CWC		
399	Battle Axe (B1)[2]	Wójcice-Otmuchów 26	nyski	MNa/A/217	2183	CWC		
400	Battle Axe (F/H1)[2]	Skorzoszyce 4	nyski	MNa/A/218	2182	CWC		
401	Shaft-Hole Axe	Dziewiętlice 1	nyski	MNa/A/287	R.32:1930	STbK/L-PC		Drescher 1932, 32
402	Battle Axe (D3)[2]	Jegielnica 1	nyski	MNa/A/300	R.5:41	CWC		AB 1942, 3/4: 242
403	Mace	Kamienica 1	nyski	MNa/A/308	R.124:35	Undetermined		
404	Axe	Radzikowice 7	nyski	MNa/A/355	2741; 41:53	STbK		NZ 27.11.1935; Raschke 1941, 17
405	Axe	Sucha Kamienica 1 (11)	nyski	MNa/A/396	R.26:43	TRB/CWC		
406	Axe	Ścinawa Nyska 1	nyski	MNa/A/403a	R.31a:43	TRB		
407	Axe	Ścinawa Nyska 1	nyski	MNa/A/403b	R.31:43	TRB		
408	Handstone	Trzeboszowice 3	nyski	MNa/A/407		Undetermined		Drescher 1932, 33
409	Battle Axe (G1)[2]	Włodary 1	nyski	MNa/A/413	2901: R.108:37	CWC		
411	Battle Axe (B2)[2]	Ulanowice 10 (Otmuchów nn)	nyski	MNa/A/422		CWC		
412	Tool preform	Nysa 20	nyski	MNa/A/468		Undetermined		
413	Battle Axe (I)[2]	Chociebórz 3	nyski	MNa/A/486	3022; R.24:36	CWC		
414	Axe	Goworowice 2	nyski	MNa/A/493	3044; R.19:33	STbK/L-PC		AB 1933, 5: 92
415	Axe	Goworowice 5	nyski	MNa/A/494	3013; R.85:36	TRB/CWC		
416	Battle Axe (I)[2]	Goworowice 16	nyski	MNa/A/495	3074; R.52:43	CWC		
417	Axe	Goworowice-Tarnawa 3	nyski	MNa/A/497	2942; R.20:33	TRB/CWC		
418	Shaft-Hole Axe	Goworowice 1	nyski	MNa/A/500		STbK/L-PC		

Table 1.

Inv. No. (ID)	Basic Classification	Site	County	Museum Inv. No.	Archival Inv. No.	Chronology	Raw Material	References
419	Axe	Goworowice 4	nyski	MNa/A/502	3058; R.132:32	TRB		
420	Axe	Goworowice 6	nyski	MNa/A/504	3051; R.87:35	L-PC		
421	Axe	Goworowice 8	nyski	MNa/A/506	R.53:43	Undetermined		
422	Battle Axe (C1)[2]	Grądy 2	nyski	MNa/A/507	R.88:35	CWC		JK 1936, 39: 35
423	Battle Axe (K)[3]	Grodków 4	brzeski	MNa/A/510	R.60:43	CWC		
424	Axe	Janowa 1	nyski	MNa/A/514	2024; R.38:92	STbK/L-PC		AB 1938, 5: 98
427	Axe	Lipniki 3	nyski	MNa/A/561	2957; R.141:32	TRB/CWC		
428	Shaft-Hole Axe	Maciejowice 27 (1)	nyski	MNa/A/566	R.30:35	STbK/L-PC		
429	Shaft-Hole Axe	Maciejowice 28	nyski	MNa/A/567	R.51:43	STbK/L-PC		
430	Shaft-Hole Axe	Maciejowice 31	nyski	MNa/A/570		Undetermined		
431	Axe	Mikołajowa 2	brzeski	MNa/A/579	R.6:36	TRB		
432	Battle Axe (D2)[2]	Osiek Grodkowski 3	brzeski	MNa/A/583	R.17:39	CWC		Raschke 1941, 20; AB. 1939, 4: 165
433	Axe	Goraszowice-Rysiowice 4 (Rysiowice 1)	nyski	MNa/A/606	R.5:34	TRB		
434	Shaft-Hole Axe	Goraszowice-Rysiowice 3	nyski	MNa/A/608a		STbK/L-PC		
435	Shaft-Hole Axe	Goraszowice-Rysiowice 3	nyski	MNa/A/608b		STbK		
436	Battle Axe (G2)[2]	Starowice 3	nyski	MNa/A/613	R.1:41	CWC		Drescher 1932, 30; AB 1941, 3/4: 241
437	Shaft-Hole Axe	Strzegów 2	brzeski	MNa/A/616	3089; R.41:38	STbK/L-PC		
438	Axe	Wilemowice 2	nyski	MNa/A/627	3041; R.56:43	TRB		AB 1938, 5: 198
439	Battle Axe (R)[1]	Włodary nn	nyski	MNa/A/733		TRB		

(Table 1). We focused thoroughly on the area of two districts – Nysa (n=91) and Brzeg (n=15). One specimen was discovered in neighbouring Opole District. We excluded artefacts from other locations (*e.g.,* Wrocław district) or from "unknown" locations impossible to determine.

The available archaeological materials are only a part of collections gathered before WWII. Following the history of both collections, finds are or were previously stored in other museums, mainly in Racibórz, Bytom, Opole and Wrocław, or even in museums in the Czech Republic and Slovakia. They were moved from one to another at different times, which increased the risk of losing them. Some of them may be still deposited in these institutions without any notifications and marked as "unknown" locations. It is necessary then to cross-reference archival information from all the known places of their deposition to possibly track it back. Many archaeological assemblages were also lost during WWII, either irrevocably destroyed or transported westward to other museums in Germany. We had access to circa 30% of macrolithic artefacts reported by E. Drescher (1932), described as *Steinbeil*, *Steinaxt*, *Pflugschare* or *Steinhacke*. Both in Nysa and Brzeg Museums, much archival information stood the test of time, the same concerns journals and books from before WWII. This enables us to imagine the enormous loss of archaeological material. Nonetheless, after years, it is still possible to connect the artefacts with the archival information. The hoard of 25 stone tools from the village of Maciejowice, Nysa District well-exemplified this possibility (Drescher 1932, 27, fig. 23). Stone adzes from the deposit are described as "lost" in current documentation, but two of them were "discovered" as exhibits in the Archaeological Museum in Wrocław. The artefacts had passed through many hands which resulted in duplication of sometimes erroneous information in further publications and archives. This was the case of an artefact from Nowy Świętów (Germ. *Deutsch Wette* 6). The original German description of the find has not survived. After WWII, it was documented at the Museum in Opole as a find from the village of Złotogłowice. Then, it was transferred to the Museum in Nysa, and the information about the location was duplicated. In the course of searching the old German journals, we were able to re-identify the correct location. Archaeological documentation and publications stored in local and provincial museums before the War were very diligently collected by German researchers. The degree of detail varies. In many cases, only a transfer of the find to the museum is mentioned, in others, the artefacts are richly described, with drawings. With the development of digitization of library collections, access to older German publications is becoming more open to the public.

RESEARCH PROCEDURE

Our research procedure consists of three main steps: identification of the artefact's location, chronological and taxonomic determination, and a reconstruction of the life-cycle of the objects.

The first step in our procedure was to identify the precise location of the find. We tried to establish a relationship between artefacts and already recognised archaeological context (site). We gathered information from the tool itself (inscriptions and marks), museum inventory cards and registers, and archaeological site records cards (KEZA), which had been created in the course of the AZP program. The latter often contain information that authors or researchers have been able to access, including descriptions in the literature, figures and archival documentation. Armed with data we searched German journals and publications to verify and piece together all the snippets of information. The detailed search enabled us to obtain more information about the origin and the context of the finds, in some cases to re-identify the location of artefacts or correct errors in the accessible documentation.

The second step was to re-identify the stone tools from two collections (n = 107), in terms of their chronological and cultural context. They were most often included in the Neolithic sections (80.37%), without any specific, detailed classification (Table 2). In most cases, correct identification was possible based on the characteristic morphometric features of the following parts of the tool: cutting edge, butt (*e.g.,* shape from top, side and front), and body (*e.g.,* cross-section, longitudinal section). The very detailed object analysis enabled us to develop our classification of the macrolithic assemblages from SW Poland. The new division is based also on existing typologies of the stone tools (Geschwendt 1931; Wojciechowski 1981, 57; Chmielewski and Romanow 2015, 44-56) and finds from other areas (Czekaj-Zastawny and Przybyła 2012, 18-24; Machnik 1966, 41-47; Włodarczak 2006, 20-36; Libera and Sobieraj 2016, 411-454) and adjacent countries (Brandt 1967; Šebela 1999; Zápotocký 1989). The largest problem we faced was identifying tool fragments and non-diagnostic, intercultural forms.

Within this step, we conducted spatial analyses performed at an entry level. An open-source Geographic Information System (QGIS version 3.24) was used to investigate the probable settlement range of taxonomic groups of the Neolithic population. We complemented our dataset with information from archival research (including archival records and *Messtischblätten*). We made a compromise between the quality of the acquired data (some of the finds had a general location specified to the level of a town) and the amount of data. We included a total of 681 sites in the maps, grouped into the Neolithic cultures or broadly determined as the Neolithic or the Mesolithic. Kernel Density Estimation (KDE) was used to re-evaluate the settlement patterns. The radius of the centroids in the heat maps was set to 5 km (for all settlement systems) according to a proposed distance in the Neolithic site catchment analysis (see Ullah 2011, Kempf 2020).

Finally, the last step in our procedure was to trace the use-life and circulation of stone tools. We adopted the concept of cultural biography developed by Annelou van Gijn (van Gijn 2010, 11-34). Data from petrographic analysis provided information about the raw material and artefact's cultural provenance. Most of the tools from our collection were unrecognised in terms of the type of rock and possible quarries. It was an important part of the analysis, because, in the Neolithic, people used selected types of rocks for the pro-

duction of edge tools – for example only metabasite in the Linear Pottery Culture and serpentinite not earlier than in post-Linear units (Borowski 2019, 397, 404). The use-wear analysis combined with experimental studies enabled us to examine the life phases of the stone tool's biography. The raw material was identified macroscopically using a Kappameter KM-7 and an Olympus SZX9 stereomicroscope (6.3-114×). Traces of manufacture, use and repair were analysed using a Nikon SMZ25 stereomicroscope (3.15-315×) and a Nikon Eclipse LV100 metallographic microscope (50-500×). To collect referential data experimental studies were performed according to the protocol developed by the Institute of Archaeology of the University of Wrocław as an integral part of the research project titled "*Breaking the code of stones. Economic, social and symbolic meaning of the macrolithic stone artefacts of the Neolithic societies (6th-3rd millennia BC) in SW Poland - biographical approach*".

RESULTS

Chronological identification and spatial analysis

We analysed the collections of artefacts that consist of 107 stone objects, mainly large tools with cutting edges. Most of the tools were made from serpentinite, metabasite and amphibolite, a few from basaltoid. There are also single objects made from gabbro, undetermined igneous rock, greenschist, aplite and erratic sandstone (raw material identification of 60 specimens). In the course of morphometric analysis, we distinguished macehead, axes, adzes, shaft-hole axes, battle axes and chisels (Figs. 1-3) and classified them into the following taxonomic units: the Linear Pottery culture (LBK), the Stroked Pottery culture and post-Linear cultures (STbK/L-PC), the Funnel Beaker culture (TRB), and the Corded Ware Culture (CWC). Moreover, we determined the chronology of two stone objects from Brzeg District as the Mesolithic (Table 2). According to the analogies from Central Europe one of them belongs to the *Walzenbeil* type of Mesolithic axes (Fig. 1: 1), and the second one is a perforated mace-head (*Geröllkeule*) (Fig. 1: 2).

Table 2. Results of re-evaluation of the Neolithic macrolithic tools

	Undet.	**Mesolithic**	**Neolithic**	**LBK/ STbK**	**STbK/ L-P C**	**TRB**	**CWC**	**GAC**	**Total**
Archival (n)	2	0	86	4	8	3	3	1	107
%	1,87%	0,00%	**80,37%**	3,74%	7,48%	2,80%	2,80%	0,93%	
Re-evaluated (n)	7	2	1	6	49	22	20	0	107
%	6,54%	1,87%	0,93%	5,61%	45,79%	20,56%	18,69%	0,00%	



Fig. 1. Examples of the macrolithic tools from the studied collections from the District Museum in Nysa (MNa) and Museum of the Silesian Piast in Brzeg (MPŚ). 1 – Stobrawa 3 (MPŚ/A/I:376), 2 – Mikolin 3 (MPŚ/A/I:129), 3 – Malerzowice Małe 2 (MNa/A/557), 4 – Ligota Wielka 9 (MNa/A/541, 5 – Gierów 2 (MNa/A/491), 6 – Goświnowice 4 (MNa/A/4), 7 – Jędrzychów 4 (MNa/A/5), 8 – Siedlec 2 (MNa/A/612), 9 – Biała Nyska 7 (MNa/A/474), 10 – Siestrzechowice 2 (MNa/A/386). Photo Ł. Melski



Fig. 2. Examples of the macrolithic tools from the studied collections from the District Museum in Nysa (MNa). 1 – Biechównn (MNa/A/1), 2 – Trzeboszowice 2 (MNa/A/406), 3 – Maciejowice 16 (MNa/A/575), 4 – Maciejowice 29 (MNa/A/568); 5 – Bodzanów 6 (MNa/A/245), 6 – Burgrabice 9 (MNa/A/80). Photo Ł. Melski



Fig. 3. Examples of the macrolithic tools from the studied collections from the District Museum in Nysa (MNa) and Museum of the Silesian Piast in Brzeg (MPŚ). 1 – Obórki 2 (MPŚ/A/I:134); 2 – Strobice 2 (MNa/A/395); 3 – Prędocin 2 (MPŚ A/I:82); 4 – Małujowice 2 (MPŚ/A/I:20); 5 – Piątkowice nn (MNa/A/734); 6 – Maciejowice 30 (MNa/A/569); 7 – Brzeg-Brygidki 2 (MPŚ/A/I:25); 8 – Zielęcice 3 (MPŚ/A/I:8). Photo Ł. Melski

We re-identified the chronology of 111 sites (16.3%) from all those marked in the maps (n=681). The re-evaluation included archaeological materials from two collections, archival drawings and archival descriptions. This work had varying degrees of impact on Neolithic cultural groups in the area under study (Fig. 4: A). In the case of the LBK/STbK settlement range, the main cluster located on the border of the Otmuchów Depression and the Niemcza-Strzelin Hills was expanded towards the northwest. The range of the remaining concentrations located on the Wrocław Plain and the Głubczyce Plateau remained the same (Fig. 4: B). We noted significant changes in the settlement range of the STbK/L-PC. Two previously separated concentrations have now been united into one cluster extending over three mesoregions: the Niemcza-Strzelin Hills, the Otmuchów Depression and the Głubczyce Plateau. Additionally, a new cluster was marked in the south, in the Paczków Foreland. Worth noting is the appearance of several sites located to the north, on the Wrocław Plain in the Wrocław Ice Marginal Valley and on the Oleśnica Plain (Fig. 4: C).

The re-evaluation of Neolithic sites changed the main TRB/CWC clusters. In the case of the southern concentration, the previously occupied areas of the Niemcza-Strzelin Hills and the Otmuchów Depression have been combined. As for the northern concentration, a small cluster in the Wrocław Plain joined the concentration in the Wrocław Ice Marginal

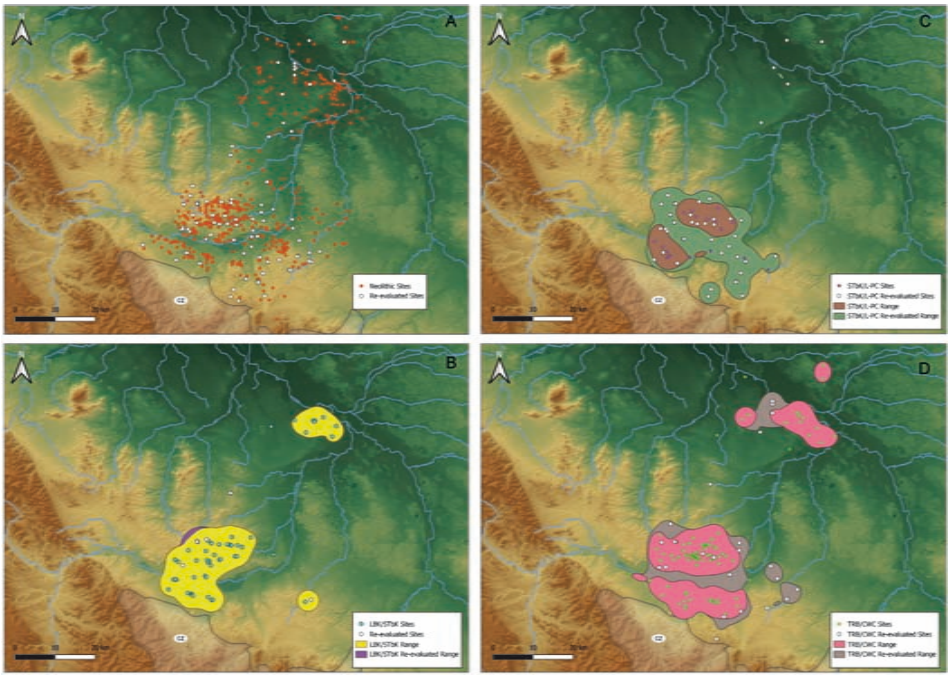


Fig. 4. Settlement range re-evaluation: A – Neolithic sites; B – LBK/STbK sites; C – STbK/L-PC sites; D – TRB/CWC sites. Computer processing by M. Chłoń

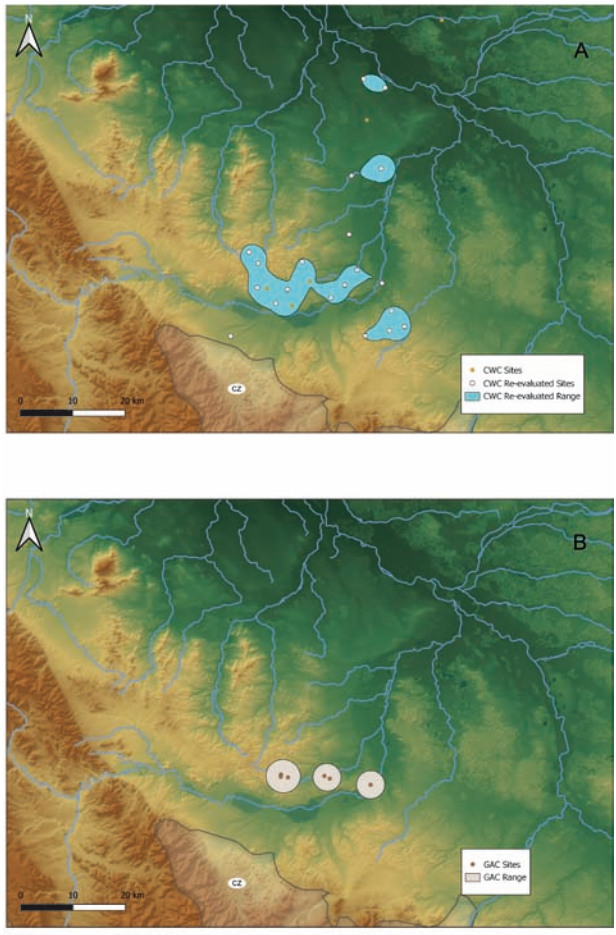


Fig. 5. Settlement range re-evaluation: A – CWC sites; B – GAC sites.
Computer processing by M. Chłoń

Valley. Two new concentrations were identified on the Głubczyce Plateau and on the Niemodlin Plain (Fig. 4: D). More extensive CWC occupation of this area can be proposed after the re-identification of the stray finds; previously, the CWC was recognised only from single accidental discoveries. The largest concentration is recorded at the southeastern border of the Niemcza-Strzelin Hills. Another concentration is located on the border of the Głubczyce Plateau and the Niemodlin Plain. Two smaller ones, on the north, are located on the edge of the Nysa Kłodzka River Valley and on the Wrocław Plain (Fig. 5: A). The range of GAC has not changed. The number of sites was reduced by one. The remaining sites constitute three small neighbouring concentrations in the southern part of the Niemcza-Strzelin Hills and in the Nysa Kłodzka River Valley (Fig. 5: B).

Use-wear analysis

A sample of macrolithic tools was subjected to the use-wear analysis (n=64). The collection included various types of stone tools dated from the Mesolithic to the Neolithic: mace-head, adzes, shaft-hole adzes, axes, shaft-hole axes, battle-axes, chisels and preforms. Surface weathering is the most frequent post-depositional modification of the artefacts, which has an influence on the preservation of grinding traces and traces of primary utilisation. Tools have however a large potential for microscopic analysis, and based on traces, we can reconstruct large parts of their lifecycles.

Most of the analysed artefacts belong to a group of stone tools with cutting edge. They display marks of the final phases of manufacturing: coarse flaking, grinding and drilling holes. In the shaping phase, middle-sized flakes were detached from a pre-form blank. The fragments of negatives are preserved mostly on the butt parts and along the edges of the shaft-hole axes from the STbK/L-PC and CWC battle axes. On the latter ones grinding traces are well-developed (Fig. 6: 1, A), also documented on several metabasite axes and shaft-hole axes (Fig. 6: 2, B). We recorded groups of scratches on the sides and butts of tools. The orientation of linear traces varies on the particular side of the tool: parallel and transverse on upper and bottom sides, transverse on lateral sides and mixed on butts. The drilling phase left a set of traces, consisting of concentric lines inside holes, transverse lines on the edges (Fig. 6: 3, D) and steps inside a hole recorded in some cases. The latter proved that the hole was drilled alternately from both sides.

Traces of use are well-preserved on the axes and shaft-hole axes of the LBK and the STbK/L-PC made from metabasite and serpentinite. Cutting edges display rounding, use retouch, including small and large scars and linear traces perpendicularly and diagonally oriented to the working edge (Fig. 6: 4, E-F). Such types of traces correspond with different activities tested experimentally within the project (Kufel-Diakowska *et al.* 2023). We also observed traces parallelly-oriented to the cutting edge, from sharpening or re-sharpening the edge in the course of the use (Fig. 6: 2, C). Parts of tools opposed to the cutting edge also show marks of repair. Tools made from metabasite were exposed to damage because of the laminar structure of the rock. For example, the upper side of the shaft-hole axe from Maciejowice 16, Nysa district was knapped after half of the surface had split.

Modification of macrolithic tools was a frequent practice of curating in prehistoric times. There are examples of broken shaft-hole axes of the STbK/L-PC and battle axes of the CWC. In these cases, a second hole was drilled closer to a cutting edge and the broken part was ground. In the Neolithic, modifications also included a change in the tool's function. The shaft-hole adze from Biała Nyska 7 and shaft-hole axe from Lipniki 4, both in Nysa district are good examples of secondary use in the Neolithic. Apart from use marks on the cutting edge, tools bear traces of hammering or pecking located on their butts (Fig. 6: 6, G). In the case of adzes and axes of Linear and post-Linear traditions, the re-utilisation of butt ends or broken tools was a common phenomenon (Kufel-Diakowska *et al.*



Fig. 6. Traces of production, use and recycling on the macrolithic tools. 1 – Brzeg-Brygidki 2 (MPŚ/A/I:25), 2 – Goświnowice 4 (MNa/A/4), 3 – Brzeg 20 (MPŚ/A/I:198), 4 – Gierów 2 (MNa/A/491), 5 – Otmuchów 2 (MNa/A/593), 6 – Lipniki 4 (MNa/A/560), 7 – Unknown location (MPŚ/S/I:130), A-B – scratches on grinding surface, C – parallel lines from re-sharpening, D – concentric and transverse traces inside a hole, E – use retouch, F – linear traces from use, G – traces from hammering, H – furrows after use of tools as a whetstone. Photo Ł. Melski (5-7), M. Chłoń, B. Kufel-Diakowska, W. Bronowicki A-H. Drawing N. Lenkow

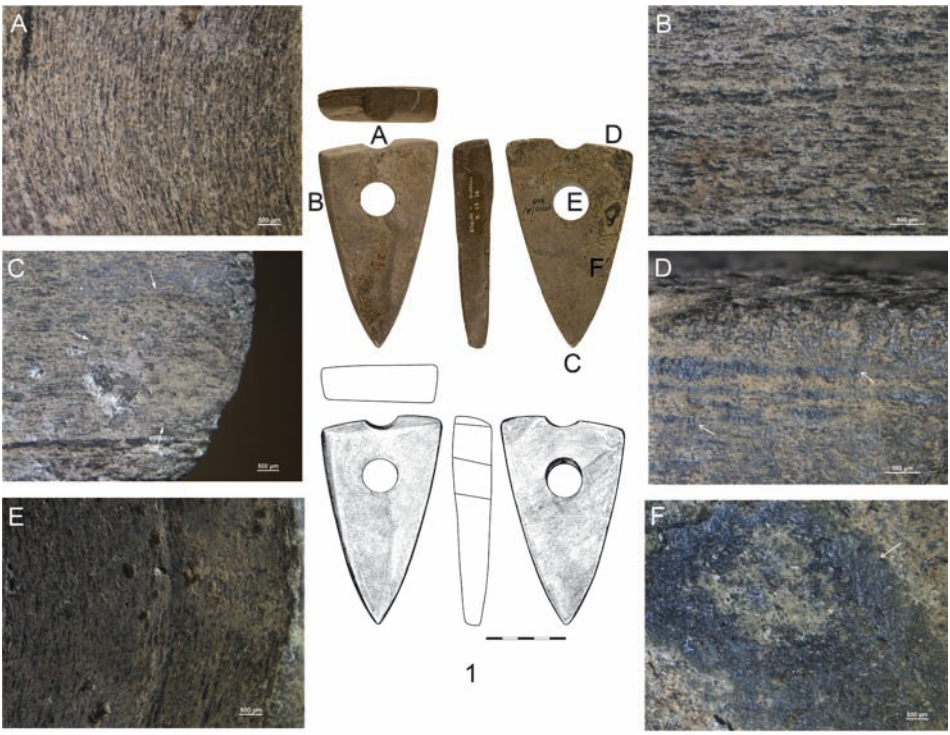


Fig. 7. Traces of production, use and modification on a shaft-hole axe from Ligota Wielka Site 6 (MNa/A/545): A, E – traces of drilling; B, D, F – grinding traces; C – use scar. Photo Ł. Melski (1), M. Chłoń (A-F). Drawing N. Lenkow

2022; 2023). An example of extreme modification is a tool made from metabasite, transformed from a shaft-hole axe to a "handstone" (Fig. 6: 7). Unfortunately, the location of the find was not possible to determine.

Loose finds of stone axes bear traces of modern activity. We observed large edge scars that were not rounded by subsequent use and looked "fresh" (Fig. 6: 5). However, in this case, there are doubts if we are able to match such traces with regular use or if it was accidental damage. More convincing are groups of extensive longitudinal marks, located usually on the lateral sides of thick shaft-hole axes (Fig. 2: 4; 6: H). Lines are deep, have various widths, from narrow to wide, and cover a large part of the surface, suggesting repeatable contact with metal objects. The use of Neolithic tools as whetstones was reported in the German archival documentation. One example of a currently lost stone LBK axe was found by a blacksmith in Goworowice 18 (Germ. *Gauers*) and used as a whetstone 100 years ago. Different types of rocks were re-used for sharpening metal tools, among them soft serpentinite was an eligible rock. A shaft-hole axe from the studied collection – with possible traces of use as a whetstone –was found 7 km away, at the site Maciejowice 29.

The complex result of the multifaceted analysis is illustrated by one of the examples stored in the District Museum in Nysa (Fig. 7: 1). The name of the archival location – "Ellguth: Grottkau" - and artefact number written by a German researcher is visible on one side. *Ellguth* is a German name of present Ligota Wielka in Nysa District. In an archival publication from 1932, Eberhard Drescher (1932) mentions the find of a stone axe at Site no 6, west of the village. This area was densely settled in the Neolithic. Archaeological finds are associated with STbK/L-PC and TRB, assigned on the archival German *Messtischblatt*. The area of the site was positively verified in the current documentation (AZP).

The artefact was made from metabasite from the Bohemian Massif. It underwent many modifications during its use life. According to morphometric and raw-material data, initially, it was a shaft-hole axe associated with the STbK/L-PC. Grinding traces are preserved on the upper and two lateral sides (Fig. 7: B). Drilling traces are preserved inside the original hole (Fig. 7: A). The axe was used for chopping/adzing. This activity produced a use-scar on the cutting edge (Fig. 7: C). Probably in the course of use, the tool broke transversally. Despite the damage, it was not discarded. The broken part was ground (Fig. 7: D), and a second hole was drilled through (Fig. 7: E). Afterwards, the shortened axe was used and broke longitudinally. Again it was not discarded. The split surface was flattened (Fig. 6: F). The new tool was probably in use again and lost in the vicinity of the settlement.

CONCLUSIONS

Multifaceted archaeological analyses combined with the investigations of the archival data and current documentation show that stray finds can generate high-quality data for scientific studies. Accidental discoveries supplement information collected from the excavations. We were able to put macrolithic stone tools into the proper position in the typo-chronological system, and we linked them to particular settlement episodes.

Traces of use showed that the shape and function of large stone objects changed throughout the life cycle, to fulfil needs or keep the traditions of the people who used them in prehistoric periods. We also discovered the signs of long-lasting circulation of the Neolithic stone tools, which included modifications and the uses of tools in modern times. The ethnographic sources provide information about the long amuletic use of axes, treated as "thunderbolts". However, such activity did not leave any traces that can be observed with the microscopic methods of study. The bad preservation of the surface only suggests that tools were not underground. Probably, a shaft-hole found in the ruins of a house in Biechów, Nysa district (Fig. 2: 1) was one example of this phenomenon or just a souvenir kept by the residents. Whereas, we noted traces of other uses that correspond with the information from the archival documentation from the beginning of the 20th century. The problem of when exactly the Neolithic shaft-hole axes were used as whetstones required more detailed investigations and experimental studies.

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MACROLITHIC RETOUCHED BLADES FROM KAŁDUS AND STARE MARZY: FOREIGN TECHNOLOGY AND NEW IDEOLOGY IN THE LITHIC TRADITIONS OF THE TRB COMMUNITIES IN THE LOWER VISTULA REGION

ABSTRACT

Adamczak K. and Sudoł-Procyk M. 2024. Macrolithic retouched blades from Kałdus and Stare Marzy: foreign technology and new ideology in the lithic traditions of the TRB communities in the Lower Vistula region. *Sprawozdania Archeologiczne* 76/1, 405-426.

Over a dozen macrolithic retouched blades or their fragments are known from archaeological sites at Kałdus and Stare Marzy, located in the Lower Vistula region in northern Poland. The context of deposition links these artefacts to the settlements of the younger Funnel Beaker culture, spanning a period of 3650/3500-3300/3100 BC. This article presents and discusses the results of morphological, technological and raw material examinations of the macrolithic retouched blades or their fragments from Kałdus and Stare Marzy and relates them to the lithic industry of the local TRB communities. The results show that the blades were made of high-quality lithic materials sourced from the Polish and Ukrainian Uplands and indicate that their technology is very specific and not rooted in the flintworking traditions of the region. Furthermore, the obtained results suggest that macrolithic retouched blades were charged by the TRB people with a specific function and significance that can be traced beyond the Polish Lowlands.

Keywords: Eneolithic, Funnel Beaker culture, macrolithic blades, Świeciechów flint, Volhynian flint, Jurassic flint

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INTRODUCTION

Polish archaeology has long recognised macrolithic blades as the products of highly specialised lithic centres of the Polish and Ukrainian Uplands that operated in the vicinity of local flint mines (Balcer 1975; 1983; 2002). They were made on massive retouched blades ranging from a dozen to 250 mm in length and 20-35 mm in width (Balcer 1975, 89) and there is a broad consensus that these objects were made with the use of indirect percussion or the lever pressure technique (Migal 2002; 2006b). Macrolithic blades are relatively rare in the region of the Polish Lowlands and are known from settlement and grave

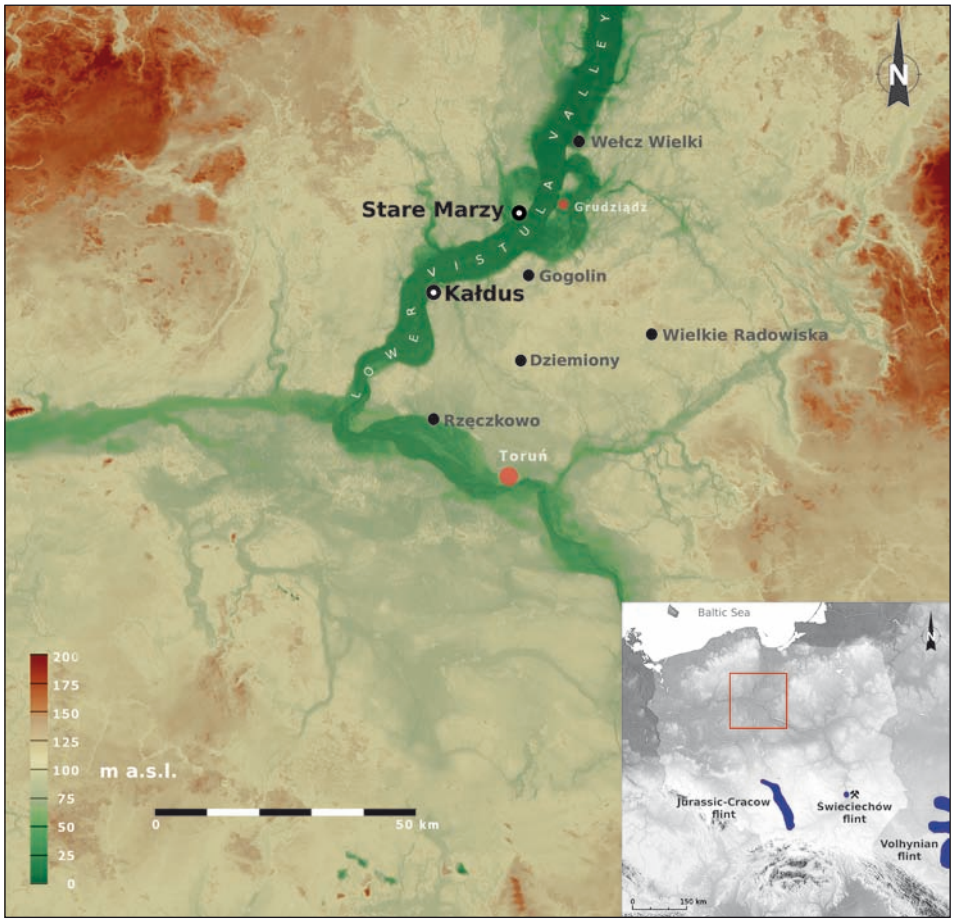


Fig. 1. Map showing the Lower Vistula Valley and the location of archaeological sites at Kałdus and Stare Marzy. The sites from Chełmno land that yielded macrolithic retouched blades or their fragments are also displayed on the map (edited by K. Adamczak; map background: https: //commons.wikimedia.org/wiki/File: Kujawsko-pomorskie_topo.png)

contexts. Lithic studies in this region (Balcer 1981a; 1983; Małecka-Kukawka 1992; 2020; Domańska 1995; 2013; Papiernik 2016; Kabaciński and Sobkowiak-Tabaka 2019) link macrolithic blades and retouched blades to the Funnel Beaker culture (*Trichterbecherkultur*, hereafter TRB) and indicate that these products are imports from remote regions located 300-500 km away from the TRB residences in northern Poland.

While there has been success in providing detailed technological characterisation of macrolithic blades and retouched blades from the Polish Uplands and Lowlands, the issue of significance of these objects has been investigated to greatly varying degrees across these two regions (*e.g.*, Budziszewski 2000; Libera and Zakościelna 2006; Zakościelna 2008; Krzyszowski 2018). There have been attempts to understand macrolithic blades and retouched blades from the Polish Uplands in non-technological terms, for instance, by pointing to a causal link between the appearance of macrolithic tools and the development of the farming economy in Eneolithic Poland (Balcer 1983, 40-43). Attempts have also been made to shed some light on the social and symbolic significance of these artefacts (Budziszewski 2000; Zakościelna 2008). It must however be said that research on macrolithic blades and retouched blades from the Polish Lowlands has not gone much "*(...) beyond the 'industrial' characteristics of lithic material and sweeping generalizations about flintworking*" (Małecka-Kukawka 2009a, 161), meaning that the debate about the significance of macrolithic industry in northern Poland is far from being closed.

In this paper, we therefore present unpublished macrolithic retouched blades from two archaeological sites, Stare Marzy and Kałdus, located in the Lower Vistula region, to determine their morphology, technology and raw material characteristics. The analyses of these objects, aided by the evidence of their use and deposition as postulated by Jolanta Małecka-Kukawka (2009b, 166-168), provide a framework to discuss the significance of retouched blades in the daily life of the TRB Eastern group and help improve our understanding of these objects in the region of Polish Lowlands.

GEOGRAPHICAL AND ARCHAEOLOGICAL SETTING

The Lower Vistula Valley is a geographical macroregion in northern Poland, covering the area of the Vistula Valley between the Toruń-Eberswalde ice-marginal streamway and the Vistula Delta (Kondracki 1978). The region has a length of 120 km and it spread across the Unisław Basin, Świecie-Chełmno Basin and Grudziądz Basin (a width of 8-18 km) as well as narrowings ranging from 3 km to 5 km (Fig. 1). The Lower Vistula Valley has a step-like landform and its ridge is elevated up to several dozen meters above the valley bottom. In its lower course the Vistula is a powerful river and during the Neolithic period it exhibited the features of an anastomosing river and flowed in a wide braided channel with a maximum width of 4 km (Augustowski 1982; Starkel 2001).

The settlement pattern of the Neolithic sites in the Chełmno land – which is part of the Lower Vistula Valley – indicates that the interior of the Vistula Valley was not settled until the colonizing venture of the TRB farmers who spread over large parts of the Lower Vistula Valley and its surroundings, as evidenced by more than one hundred archaeological sites from this area (Kukawka 1991, map 1; Sosnowski 1994, figs 1-5; Kukawka 1997). Five of these sites are known for macrolithic retouched blades and/or their fragments (Gogolin, Kałdus, Stare Marzy, Dziemiony, Wełcz Wielki) (Fig. 1), but only the sites of Stare Marzy and Kałdus have yielded whole macrolithic retouched blades and/or a significant number of their fragments.

STARE MARZY (SITE 5), ŚWIECIE DISTRICT

The site lies on sandy sediments deposited on a kame terrace, 20 m above the flood plain of the Vistula River in the Grudziądz Basin (Chudziak 2002) (Fig. 1). The site was discovered in 1995 and excavated in 1999 during rescue excavations in conjunction with A1 motorway construction works run by the Institute of Archaeology and Ethnology of the Nicolaus Copernicus University (NCU) in Toruń (presently: the Institute of Archaeology). The excavations covered an area of 5,700 m^2 and revealed evidence for settlement activity at the site during an extended timescale spanning the Palaeolithic to the early modern period, including a campsite of the Swiderian culture, a campsite of the Chojnice-Pieńki culture, traces of an LBK settlement, settlements of the TRB and the Globular Amphora cultures, a campsite from the Late Neolithic, a settlement from the Early Bronze Age, a cemetery and a settlement of the Lusatian culture, a settlement of the Pomeranian culture, settlement traces dating to the Wielbark culture, as well as the Early and Late Middle Age and early modern period.

About 2,500 flint artefacts were recovered from the site, most of which date to the Palaeolithic and Mesolithic period. The lithic material was yielded by ten flint scatters ("kshemenitsas") (Cyrek 2002; Cyrek and Sudoł 2009) and cultural layers, and only a few flint artefacts come from pits dating to the Early Iron Age (Słupczewski 2003, tab. 2). There are eight whole retouched blades or their fragments in the assemblage. They were found with no associated material or structures and with no specific spatial distribution, which seems to indicate that they were recovered from a secondary context. However, the retouched blades or their fragments from Stare Marzy can be safely linked by their raw material, morphology and technology as well as lithic traditions of the region to the TRB culture; there was no other material from the site with attributes diagnostic for the TRB flintworking. The TRB residence at the site can be dated by the typology of the ceramics (494 potsherds) to the late Wiórek phase (Słupczewski 2003, 230, 231), which corresponds with the phases IIIB-C and IIIC TRB in Kuyavia (Kośko 1981) and the phase IIIC in the Chełmno land (Kukawka 1991).

THE SITE COMPLEX IN KAŁDUS, CHEŁMNO DISTRICT

The site complex at Kałdus is located on the ridge of the morainic plateau, on the edge of the Lower Vistula Valley, between the Świecie-Chełmno Basin and the Unisław Basin (Fig. 1). Four distinct sites (1-4) are arbitrarily distinguished in Kałdus, covering an area of about 15 ha. The site was first excavated in the 19th century (Chudziak 2003, and refs.) and in 1996, an interdisciplinary research program was started at the site, run by the Institute of Archaeology, NCU in Toruń and covering the entire site complex (Chudziak 2003; Chudziak 2004).

The earliest occupation level recorded in Kałdus can be dated to the Neolithic period and linked to the TRB culture. A few ceramic finds from the site are related to the Linear Pottery culture, the Globular Amphora culture and the Late Neolithic, whereas the younger cultural strata recorded in Kałdus belong to an Early Bronze Age cemetery of the Iwno culture, which was followed by intense settlement activity of the Lusatian and Pomeranian cultures. A few artefacts date to the Roman period. The next layer can be assigned to the Early Middle Ages, when the site of Kałdus became a political centre for the first rulers of Piast Poland (one of the *sedes regni principalis*) and was organised as a stronghold with backup facilities and cemeteries (Chudziak 2003; Bojarski *et al.* 2006). The archaeological record also indicates human activity at the site in the Late Middle Ages and early modern period.

The TRB habitation has been exposed in Kałdus over the entire area of the site, evidenced by numerous domestic and ritual pits, metal hoards and cremation graves (Kaszewski 1979; Adamczak *et al.* 2015; 2021; Kowalski *et al.* 2019; 2020), rendering it one of the largest TRB site in the region, which could operate as a major central-place settlement for the local Eneolithic communities. The available archaeological evidence links the TRB occupation at the site to the classical and late Wiórek phases (Kaszewski 1979; Adamczak *et al.* 2015; Kowalski *et al.* 2020), which corresponds with the younger stages of the TRB in the Chełmno land (Kukawka 2010, fig. 9). The TRB material from the site has not yet been fully analysed and presented, including the flint artefacts.

MATERIAL AND METHODS

Fourteen retouched blades or their fragments were selected for this project (Table 1). Six specimens are from the Kałdus site: four of them were found in cultural layers, while two other artefacts are reported from archaeological features. The largest retouched blade from Kałdus was found in a ritual pit (no. 1186, Site 2), accompanied by a metal hoard, amber, clay and bone artefacts, potsherds and two flint arrowheads (Adamczak *et al.* 2015). There is also an overheated, distal fragment of a retouched blade, which was yielded by a pit (no. 255, Site 4) with burnt bones that can be interpreted as a cremation grave; the

Table 1. Morphological characteristics of retouched blades from Kałdus and Stare Marzy

Id	State of preservation				Lateral edges		Traits of the dorsal surface			Butt			Retouch					Dimensions lenght x widht x thickness	Raw material			Comments				Fig.
		fragment																								
	Fully preserved	Distal	Mesial	Proximal	Regular	Irregular	Regular ridges	Irregular ridges	Cortex	*Lisse*/Plain	Prepared	In the type of en epperon	On one edge	On both edges	Endscraper front	Regular	Denticulated		Świeciechów flint	Creataceous, Volhynian	Jurassic-Cracow	Partly crested blade	Destruction of tip	Polish on edge	Charring	
Kałdus, site 1-4																										
1	x				x		x				x			x	x	x		149 x 29 x 9	x						x	2:1
2		x			x		x							x	x	x		(39)* x 18 x 4	x							2:2
3				x		x	x				x	x		x			x	(52)* x 30 x 5***	x							3:3
4		x			x		x										x	(49)* x 25 x 6	x				x		x	4:4
5	x				x		x				x			x				100 x 51 x **	x						x	4:5
6			x		x		x							x			x	(27)* x 24 x 4		x				x		5:2
Stare Marzy, site 5																										
7	x				x			x			x	x		x		x		136 x 37 x 12	x			x				3:1
8			x		x		x						x				x	(34) * x 30 x 9	x			x				3:2
9	x				x		x				x			x		x		127 x 31 x 9	x							4:1
10		x			x		x		x					x			x	(59) * x 25 x 7	x				x			4:2
11		x					x		x					x			x	(26)* x 20 x 7	x							4:3
12	x				x		x			x				x		x		142 x 33 x 9			x					5:1
13		x			x		x							x			x	(80)* x 27 x 8		x						6:1
14			x		x		x		x				x				x	(63)* x 31 x 7		x						6:2

* length of preserved fragment of a blade; ** blade is missing; morphometric description based on the analysis of a photo of the dorsal face of the artefact; determination of thickness is impossible; *** blade-flake blank revealing traits similar to blades discussed in the paper

pit contained also potsherds and four fragments of an overheated retouched blade. The archaeological site of Stare Marzy produced eight retouched blades that were recovered from cultural layers.

Technological analysis of flint artefacts broadly follows the procedure by Bogdan Balcer (1975; 2002), which involves examining morphological data of blades (surfaces and butts) for relevant information about specific techniques used for the preparation and exploitation of cores.

RESULTS OF TECHNOLOGICAL AND RAW MATERIAL ANALYSIS

Five specimens preserved in complete form, there are also five distal and three mesial fragments. The analysed assemblage includes also one proximal fragment (Fig. 2: 3), which is similar to the blade-flake forms, but shows specific characteristics of the proximal (butt and bulb) part. The artefacts are made from three different types of siliceous rocks: the predominant Świeciechów and Volhynian flint, followed by the Jurassic flint raw material (Table 1). The fully preserved blades and their larger fragments were made from the so-called intentional blades. The analysed artefacts reveal technological traces indicating the use of the pressure technique with a special toolkit: the regularity of the lateral edges and dorsal ridges, the very similar thickness of the products, the maximum width in the proximal part of the blade, the presence of small, repeatable bulbs and a striking angle close to 90 degrees (Clark 2012; Inizan *et al.* 1999, 77; Pelegrin 2006; Pyżewicz 2013, 235-238). The technique of obtaining of macrolithic blades is not completely understood. Likewise, it is difficult to specify the tools or devices used for the production of macrolithic blades and their identification may be hampered when tools produced using a punch are present in the lithic assemblage (Budziszewski and Grużdź 2013; Migal 2006a). However, it seems likely that the small butts of intentional blades known from the TRB flint inventories confirm the use of the pressure technique. This group of blades contains cortical specimens and technical forms of partly-crested blades type with straight side edges and scar ridges as well (Balcer 2002).

The analysis of butts was possible for six artefacts (Table 1). Five specimens from Kałdus and Stare Marzy were made of Świeciechów flint and have butts prepared in a manner typical of the TRB flintworking (Balcer 2002) and indicates that the blades were detached from cores with extensively prepared striking platforms. Butts were carefully formed before detachment of blades, facetted and trimmed by removing micro-flakes and micro-blades. Butts are narrow, the bulbs are not very prominent, whereas the distal parts of the blades are arched and pointed. A single blade from Stare Marzy, made of banded Jurassic-Cracow flint, is noticeable for having a *lisse*/plain butt, which was detached from a core with a plain striking platform, as can be seen in Fig 5: 1.

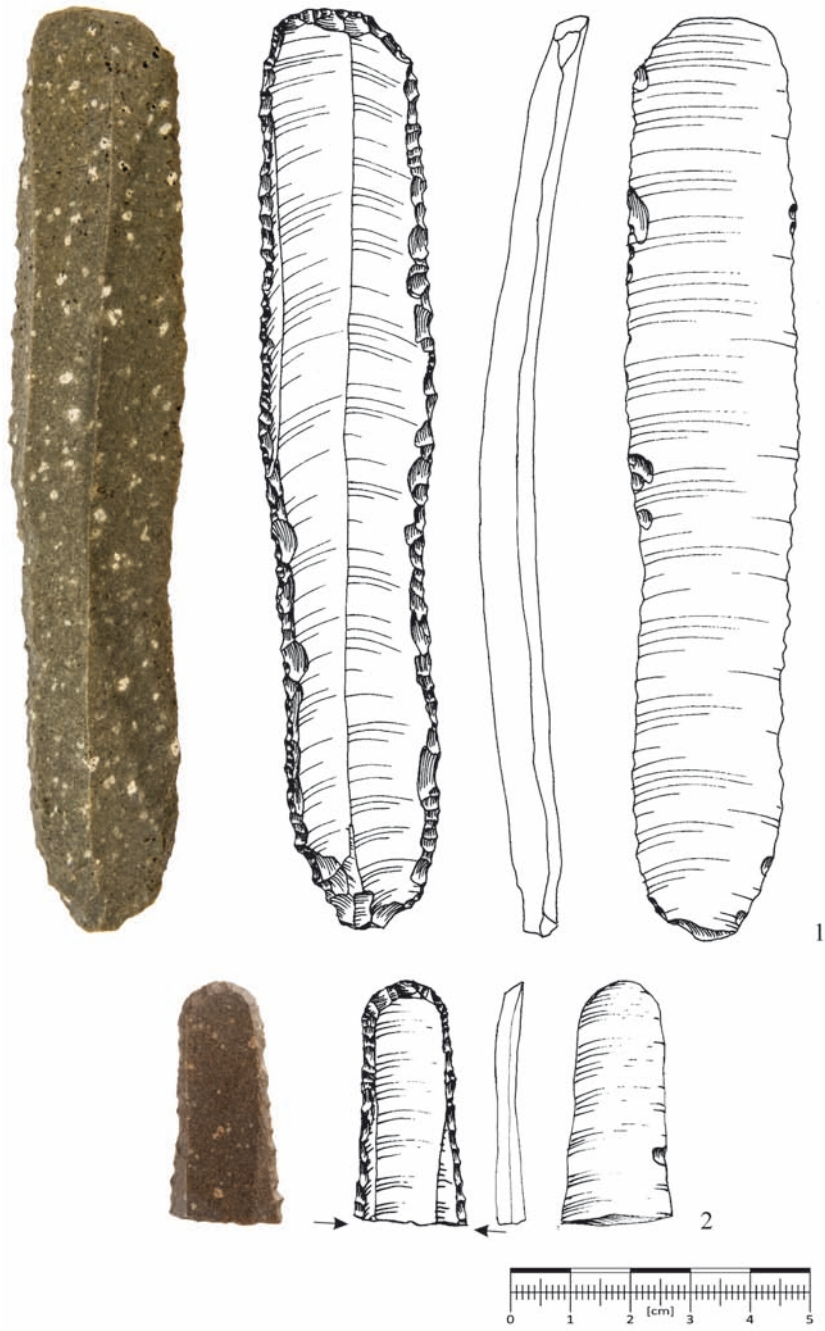


Fig. 2. Retouched blade from Kałdus (1) and its distal fragment with retouched edges and a tip of endscraper type (2) (drawings by M. Sudoł-Procyk; photographs by W. Ochotny)

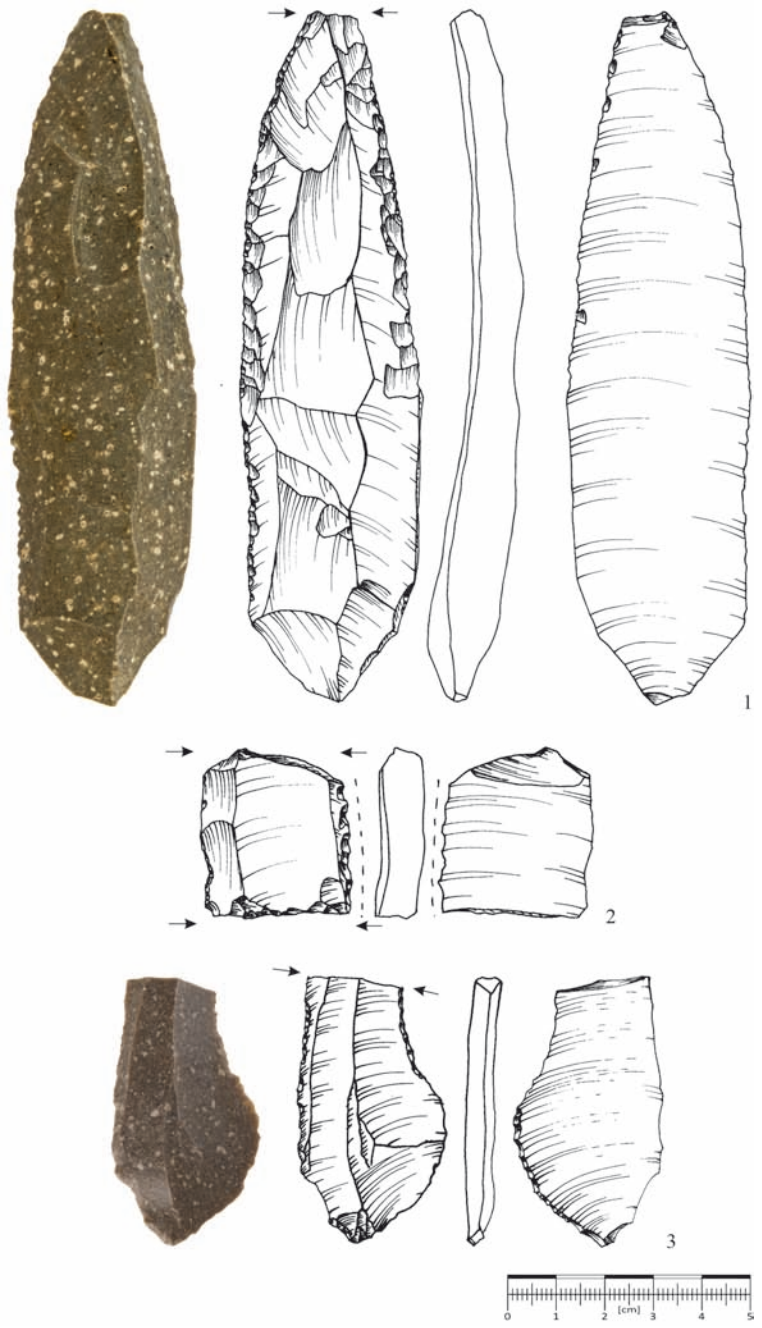


Fig. 3. Retouched blade and fragments of retouched blades from Stare Marzy (1-2) and Kałdus (3) (drawings by M. Sudoł-Procyk; photographs by W. Ochotny)

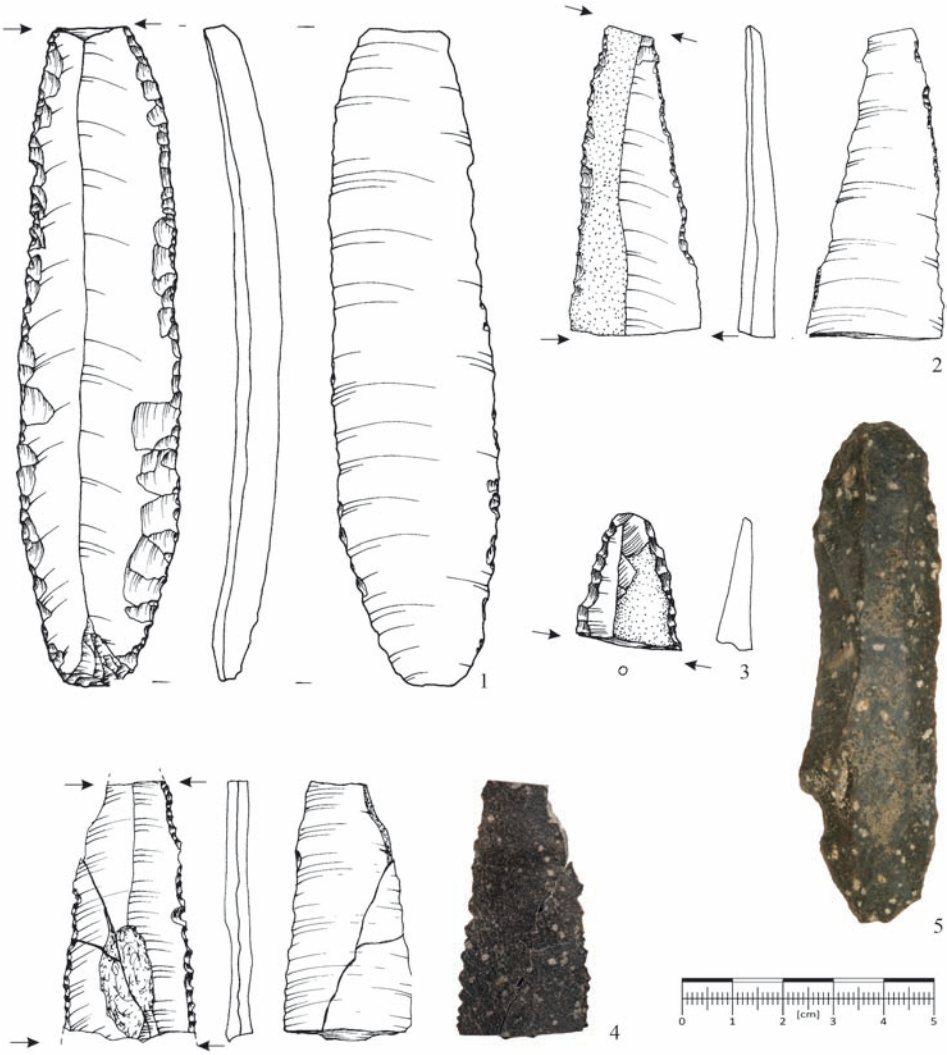


Fig. 4. Retouched blade and fragments of retouched blades from Stare Marzy (1-3) and Kałdus (4-5) (drawings by M. Sudoł-Procyk; photographs by W. Ochotny)

In general, the side edges of the blades are straight and parallel, converging towards their tips, which is typical of intentional blades (Balcer 2002). Only three blade fragments are partially cortical: two of them preserved in distal parts (Figs 3: 2 and 3: 3) and one is a mesial fragment (Fig. 6: 2). All of the blades and their fragments have straight side edges and ridges between scars of previously detached blades, which allowed us to label two additional partly-crested blades as retouched blades (Figs 3: 1 and 3: 2).



Fig. 5. Retouched blade and a fragment of retouched blade from Stare Marzy (1) and Kałdus (2) (drawings by M. Sudoł-Procyk; photographs by W. Ochotny)

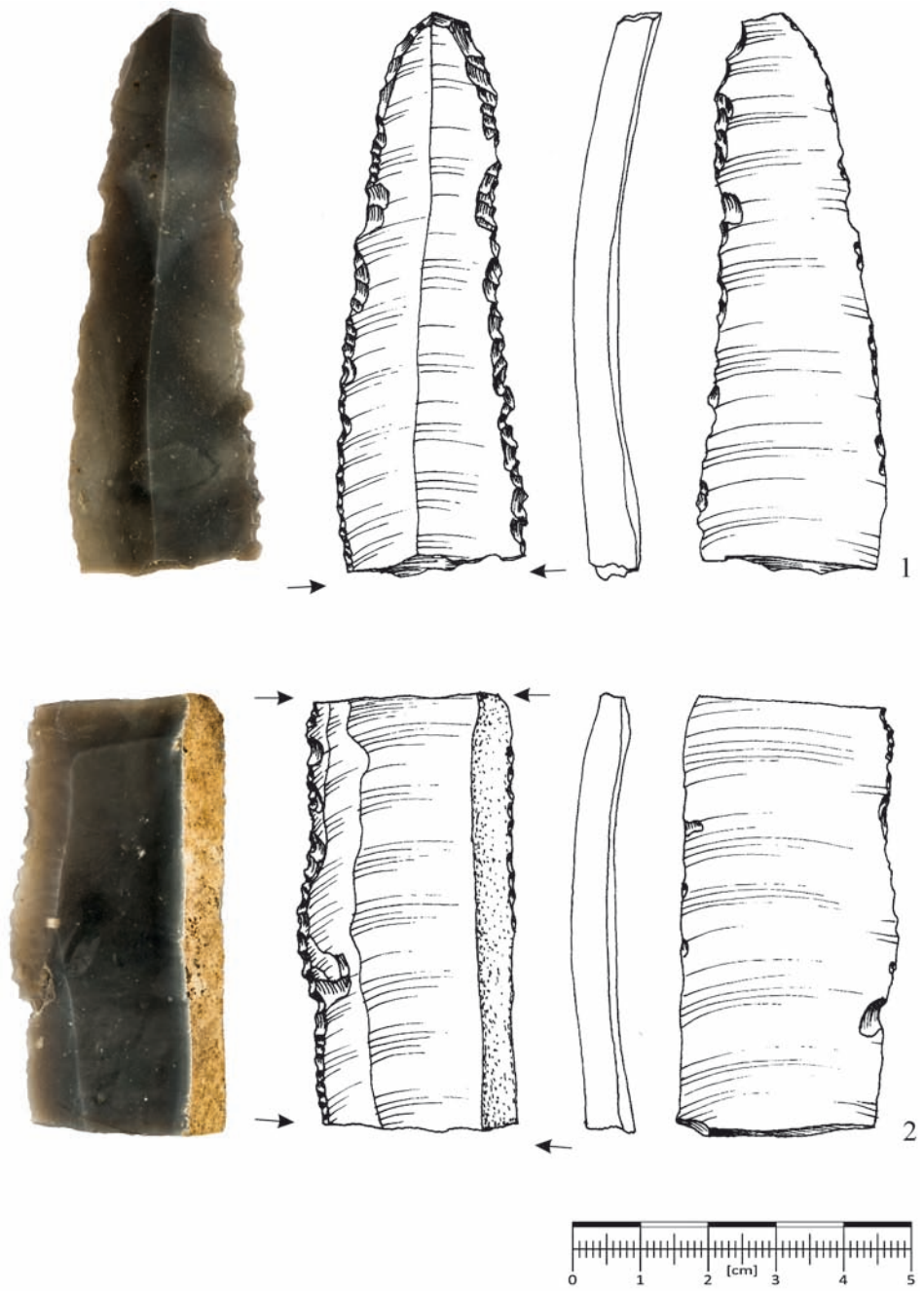


Fig. 6. Fragments of retouched blades from Stare Marzy (1, 2)
(drawings by M. Sudoł-Procyk; photographs by W. Ochotny)

The fully preserved blades from Kałdus and Stare Marzy have the following dimensions: length 100-149 mm, width 29-51 mm, thickness 9-12 mm, which allows us to classify them as macrolithic blades (Balcer 1975, 89; 2002). The remaining fragmented nine blades correspond well in terms of proportions with the fully preserved blades, making it possible to identify the specimens from Kałdus and Stare Marzy as fragments of macrolithic blades. The high number of blade fragments in the assemblage can be explained by the fact that macrolithic blades were more susceptible to damage than short blades (*e.g.*, Balcer 2002).

The analysed blades and their fragments have retouched edges and some of them display use-wear traces (Table 1). Examinations identified the presence of different types of retouch. Aside from continuous regular, semi-step, rarely flat and semi-step retouch, a denticulated retouch was distinguished, which occurred mainly on blade fragments with edges retouched continuously or partially (Figs 3: 2; 4: 4; 5: 2; 6: 1, 2). On Figs 2: 1 and 2: 2 it is clearly visible that the two blades have regular, semi-step retouch covering both edges and the edge of a fracture, which could potentially be taken as evidence for identifying them as endscrapers. The "endscraper front" of these specimens was formed by retouching the edge of a fracture that resulted from the removal of a bending or too thin tip. These technological dealings are evidenced by the preserved tip parts of blades from Kałdus and Stare Marzy. Retouched blades with "endscraper-like" tips are known from the TRB period in Poland, for example at the site of Ćmielów (Balcer 2002). However, typical TRB endscrapers have more massive and specialised endscraper fronts and are usually shorter than retouched blades, suggesting that the specimens shown in Figs 2: 1 and 2: 2 may have been multi-purpose tools used for cutting and scraping (with the edges) as well as scraping, piercing and engraving (with the tips) (Balcer 2002, 69).

MACROLITHIC RETOUCHED BLADES IN THE TRB EASTERN GROUP: CHRONOLOGY, FUNCTION AND SIGNIFICANCE

The appearance of macrolithic blades and flint axes mark the later stage of the TRB flintworking in Poland, which is often summed up as the "metric change". Bogdan Balcer (1983, 122) refers to this period as the "Eneolithic stage" of the TRB Eastern group lithic industry and dates it to the classical and late Wiórek phases and the Luboń phase. This time span for retouched blades seems to resonate well with the macrolithic industry of the Polish Lowlands. Macrolithic blades from this region are chiefly known from the monumental tombs and other types of TRB graves dating to the Wiórek phase (Młynarczyk 1982; Papiernik 2016, 732, fig. 591). The retouched blades in this region are also evident at the TRB settlements of the classical and late Wiórek phases, for example at the sites of Annopol in the Gostyń Lake district or Zarębowo in Kuyavia (Balcer 1983, 157; Papiernik and

Rybicka 2001). There is virtually nothing in the lithic record from Poland to elucidate the nature of TRB flintworking during the Luboń phase and there is no single example of retouched blade that can be linked to the later stage of the TRB Eastern group.

To sum up, the emergence of macrolithic blades to the TRB people of northern Poland dates back to 3700/3600-3100/2800 BC (Kukawka 2010). However, this extended time span can be narrowed by the radiocarbon dates obtained for the settlements of the TRB South-Eastern group that operated as specialised production centres of macrolithic blades made of local Świeciechów flint. The sites "Pieczyska" in Zawichost and the "Gawroniec" hill in Ćmielów can be mentioned here (Balcer 1975; 2002). Modelling of radiocarbon dates from Ćmielów indicates a relatively short time period of 3650-3350 calBC (Balcer 2002; Włodarczak 2006, 39, fig. 10) and broadly similar date with a 2σ range of 3620-3350 calBC comes for the ritual pit (no. 1186) from Kałdus, which yielded the retouched blade made of Świeciechów flint (Kowalski *et al.* 2019, tab. 1, 5) (Fig. 2: 1).

The TRB sites of the Polish Lowlands are usually known for single finds of macrolithic blades, only rarely does their number exceed five specimens, as evidenced by the Volhynian flint deposits from the settlements of Byczyna in Kuyavia and Rożental in the Starogard Lake district (Balcer 1983, 157; Felczak 2020, 163, fig. 63; Małecka-Kukawka 2020, 255, figs 11-13). In this context, the deposit from Stare Marzy is exceptional and invites further discussion. There are no cores and/or their fragments in the geohistorical range of the TRB Eastern group that could have been used for the local production of macrolithic blades. The only exception is a core made of Volhynian flint, which was found by accident at the Starogród site, near Kałdus. There are, however, strong archaeological and technological indications suggesting that the Starogród core was transported to the Lower Vistula Valley region as a ready product and had never been exploited by the local TRB people (Adamczak *et al.* 2019, 185, figs 3, 4). Macrolithic blades and retouched blades in the Polish Lowlands are made of non-local lithic raw material, mostly of Świeciechów flint, and they stand in sharp contrast to the local flint traditions of the TRB Eastern group in the Polish Lowlands. Many prehistorians now agree that retouched blades are entirely the products of highly specialised lithic centres that operated near outcrops of fine siliceous raw materials, for instance at the "Gawroniec" site in Ćmielów (Balcer 2002, and refs.). Therefore, it is reasonable to assume that the TRB people of the Polish Lowlands were unfamiliar with macrolithic blade technology (pressure technique, preparation of single platform cores) and did not attempt to produce retouched blades using either local or non-local flint material, as may be evidenced by the core from Starogród. It is interesting to see this technological disconnection between the Polish Uplands and Lowlands in relation to the contemporary flint axe industry, which widely exploited the erratic flint of much lower quality and saturated these two TRB regions with many examples of flint axes in the second half of 4th millennium BC (Balcer 1981a).

There are basically two different approaches to understanding the possible significance of retouched blades for the TRB people, although they are not mutually exclusive. The first

is focused on economic activities in the Neolithic period and emphasizes the "*(...) rational use of blades, first, as harvesting tools and then, after some technological modifications, as other functional tools*" (Balcer 1981b, 82). Use-wear traces identified on a few retouched blades from the Polish Lowlands support this opinion (Papiernik 2016, 706, tab. 23; Krzyszowski 2018; Winiarska-Kabacińska 2018; the blades from Kałdus and Stare Marzy have not yet been examined for use-wear traces). Studies of lithic assemblages indicate that retouched blades were intentionally fragmented and used to the fullest extent possible, which is a commonplace among the whole regional TRB ecumene of the Eastern group, for instance, at the younger TRB settlements from the Chełmno land: Gogolin, Wełcz Wielki and Rzęczkowo (Małecka-Kukawka 1992, 88, 98, 99, tab. 36, figs 12: 11, 12; 16: 2; 20: 1, 2). Similar evidence of retouched blades fragmentation comes from the sites of Stare Marzy and Kałdus. Furthermore, there are good grounds to assume that after fragmentation, the significance and valorisation of the macrolithic blades was changed: they were still a reservoir of high-quality starting material for effective domestic tools, but at the same time they may have been socially and ritually depleted – and this may be the reason why whole blades, rather than their fragments, are found in the grave and deposit contexts.

Janusz Budziszewski (2000, 276-278), on the other hand, touches upon the socio-cultural and symbolic issues related to the production and use of macrolithic blades. Accordingly, macrolithic blades could have been charged with a socially negotiated meaning and function, and served the Eneolithic communities to mark the high social rank of an individual or group. This pattern of use can be traced to the Tisza River region and eastern Balkans (*e.g.*, Bognár-Kutzián 1972; Lichardus-Itten 1981; Gurova 2013). Furthermore, the widespread and long-distance exchange network of macrolithic blades, which were made of specific and selected raw materials, can be taken as evidence of the increased inter-group and inter-tribal communication and signifies the social agency of these objects (*cf.*, Włodarczak 2006, 58; Małecka-Kukawka 1994). In this regard, Janusz Budziszewski (2000, 278) is right to say that non-economic role of retouched blades can be seen in deposits and votive hoards of the TRB South-Eastern group, which contain whole macrolithic blades that were placed in water reservoirs and graves. This statement was reasserted by Jerzy Libera (*et al.* 2019, and refs.). Also worth exploring is the question of the significance of retouched blades in the funerary realm of the Lublin-Volhynian culture, which preceded the TRB culture in south-eastern Poland (Zakościelna 1994; 2010). Archaeological data indicate that in the later Lublin-Volhynian culture, inhumation burials of adult males were equipped with the most impressive flint retouched blades-daggers that were placed near crucial parts of bodies, such as the chest or head. So, it can be reasonably posited that retouched blades were used in the Lublin-Volhynian culture to signal the high social rank of the buried male in the local community as a warrior-hunter (Zakościelna 2008; Zakościelna *et al.* 2023). It seems very likely that similar understanding of macrolithic blades was adopted in the TRB South-Eastern group in Lesser Poland. To set this argument into context, one should pay attention to the TRB megalithic tombs and graves that yielded a signifi-

cant amount of retouched blades, which is particularly well attested in the Lublin region (Libera and Zakościelna 2006). Furthering this argument, we can assume that the TRB people of the Polish Uplands included retouched blades in their ritual *via* aquatic deposits (Kadrow 1989; Libera *et al.* 2019, and refs.) and funerary activities (Libera and Zakościelna 2006). We now know that these ideas found their way to the TRB ecumene in the Polish Lowlands, where they were echoed by human graves equipped with macrolithic retouched blades made of raw material sourced in the southern Poland and western Ukraine (*e.g.*, Młynarczyk 1982), as well as macrolithic retouched blades that were deposited in local settlements (*e.g.*, Balcer 1983).

POSSIBLE SIGNIFICANCE OF THE RETOUCHED BLADES FROM STARE MARZY AND KAŁDUS

Starting from 3650/3500 BC we can observe how macrolithic blades and retouched blades appeared in the TRB Eastern group and how they were used in ritual, funerary and domestic activities in the region. Good examples of this process can be found at the site of Kałdus, where a tip of an overheated retouched blade-dagger was found in a cremation grave. The same site yielded a pit containing a massive retouched blade made of Świeciechów flint, accompanied by other luxury goods originating from remote regions, including metal weaponry and ornaments, an amber disc and other archaeological finds that indicate the ritual function of the pit. Intentionally fragmented retouched blades from Kałdus can also furnish proof for valorisation of macrolithic blades in the region by showing their domestic and economic use. The apparent accumulation of Świeciechów retouched blades in Kałdus need not come as a surprise. It can be understood through the exceptional status of Kałdus in the cultural landscape of the region (Adamczak *et al.* 2015), which arguably operated as the major TRB central-place and persisted for many generations of local Neolithic farmers. A further example comes from the site of Stare Marzy, which yielded eight retouched blades and their fragments, made of three different lithic materials, rendering it an exceptional assemblage of macrolithic blades in the Polish Lowlands. The topography of the site at Stare Marzy is important to better understand the choice of this place for the deposition of macrolithic blades. The site is located on a tongue-shaped kame terrace cutting into the flood plain of the Vistula River, which may have been a convenient spot in the local TRB landscape (Fig. 1) and was most likely an important communication node of the Lower Vistula Valley (Adamczak 2011, 377). In this context, the deposition of macrolithic blades in Stare Marzy took place at the crossing over the Vistula River, where important communication routes connecting Grupa/Stare Marzy and Grudziądz intersected in the Neolithic (see Fig. 1). Evidence for a similar choice of location for deposits of non-local lithic tools comes from several TRB sites near Toruń (Małecka-Kukawka 1992, 101). Secondly, the retouched blades from Stare Marzy can be material evidence of denoting actions of the TRB

people taking place in special topographical zones with landform obstacles. Archaeological data from Neolithic Poland seems to confirm this pattern. Examples that fit this pattern well include the copper object(s) from Antoniny (Kowalski *et al.* 2016, 197) that were deposited near the Noteć River crossing on the border of Pomerania and Greater Poland region, and copper artefacts from Przysiecz in Silesia (Adamczak *et al.* 2022, 75), which were found near the Prószkowski Potok River.

FINAL REMARKS

The results presented in this study show that macrolithic retouched blades made their appearance in the Lower Vistula Valley—and throughout the Polish Lowlands region – between 3650/3500 and 3300/3100 BC. They emerged as products of highly specialised lithic centres of the Polish and Ukrainian Uplands that operated in the vicinity of local flint mines. At the same time, there is no evidence to suggest that the flintworkers of Polish Lowlands did attempt to produce macrolithic blades using available local flint outcrops, indicating that local lithic industry in the region of northern Poland missed the "know-how" of macrolithic blade production. Taken together, the retouched blades were technological outliers *vis-à-vis* the flint industry in the Polish Lowlands and we have reasons to believe that they were charged with socially negotiated meanings and functions. Evidence also exists that macrolithic blades were a reservoir of high-quality starting material for effective domestic tools. Furthering this argument, we can see the retouched blades as symbol of action that contained both the attributes of a specialised lithic tool as well as prestigious objects with socio-cultural agency. This seems to hold the key to understanding the special status of macrolithic blades in the TRB Eastern group, which is well reflected by the context and content of the retouched blade deposits from Kałdus and Stare Marzy.

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OLD FIND – NEW INFORMATION. HOARD OF LONG FLINT BLADES FROM WĄWORKÓW (SANDOMIERZ UPLAND, POLAND)

ABSTRACT

Mączyński P. 2024. Old find – new information. Hoard of long flint blades from Wąworków (Sandomierz Upland, Poland). *Sprawozdania Archeologiczne* 76/1, 427-443.

Deposits of flint blades have been found in southern Poland for many years. These finds, although rare, due to their nature have aroused the curiosity of many researchers. One such assemblage, consisting of seven macrolithic chocolate flint blades, was discovered in 1958 in the village of Wąworków, Opatów District. In order to understand the reasons for depositing these lithics in the ground and to uncover all the secrets they conceal, the artefacts were subjected to multidimensional research. In the first phase of the studies aimed at analysing and recording the assemblage, a detailed description of the specimens was made, and raw material, technological, and functional analyses were carried out. Then, on the basis of the collected data, an attempt was made to establish their age, cultural provenance, and final interpretation.

Keywords: long blades, chocolate flint, use-wear analyses, Lublin-Volhynian culture, Funnel Beaker culture
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INTRODUCTION

A deposit of seven blades made of chocolate flint, described below, is kept in the Department of Archaeology of the National Museum in Kielce. According to the information available to us, they were discovered by chance in September 1958 while ploughing a field in the village of Wąworków, Opatów District. This unique hoard of flint blades has not yet been studied in detail. Assemblages of this type are relatively rare finds (Fig. 1; see Florek and Zakościelna 2003, 51; Mączyński and Polit 2018, 142). Usually, artefacts deposited in the ground are interpreted as evidence of armed conflicts, during which their owner, in order to save some of his/her property, decides to bury it in the ground. This is, of course, only one interpretation. It is equally probable that the products deposited in the pits may be testimony to the rich spiritual realm and beliefs of ancient communities. If this is the case, they should be interpreted as a remnant of ancient rituals associated with, for example, making offerings to deities or as a foundation deposit (see Kaflińska 2006, 8-10).

To understand the reasons that prompted the last owner of the blades to deposit the hoard, analyses were carried out to establish their chronology and cultural provenance. In addition, a technological and functional analysis was carried out to obtain the broadest possible picture.

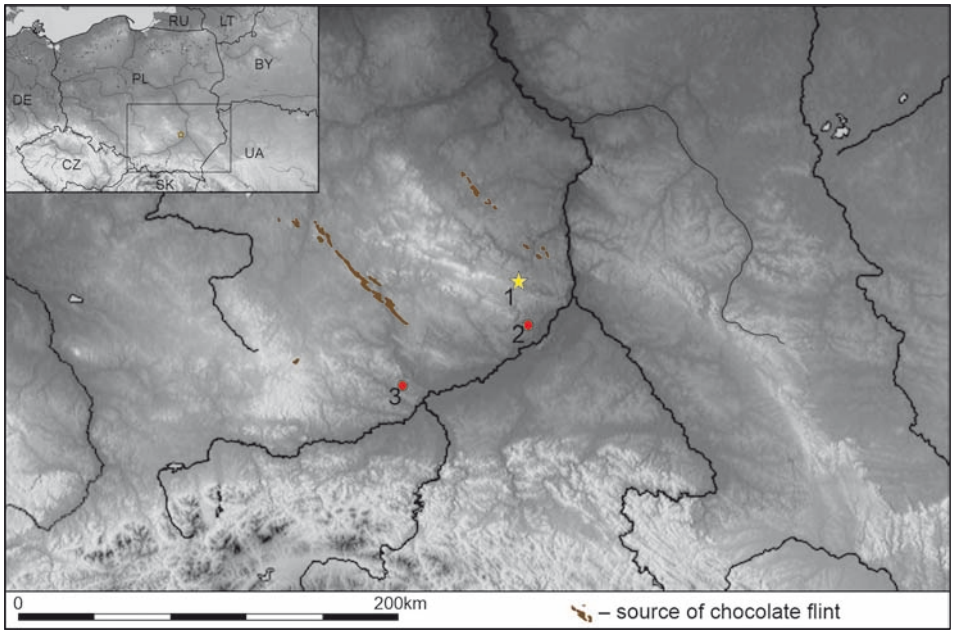


Fig. 1. Map of the deposits containing long flint blades made of chocolate flint:
1 – Wąworków; 2 – Krowia Góra; 3 – Pełczyska.
Prepared by P. Mączyński (after Sudoł-Procyk 2022, fig. 1; base map: https: //maps-for-free.com)

PRESENTATION OF THE MATERIAL

1. Blade with irregularly shaped lateral edges removed from a single platform core. Negative scars of two previously removed blades are visible on the dorsal side, the surface of the left part of the blade is formed by the cortex and a surface created as a result of a thermal crack, slightly curved in the middle part; trapezoidal cross-section; multi-scarred butt (rather faceted); platform edge trimming; mildly prominent bulb. The tip is broken off. The blade can be refitted with blade No. MNKi/A/5666/4 (item 2 below). Dimensions: length: 177 mm, width: 26 mm, thickness: 10 mm; weight: 43 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/3 (Fig. 2: 1, 3; 3).

2. A lengthwise cortical blade with irregularly shaped lateral edges removed from a single platform core, with negative scars on the dorsal surface formed by a previously removed crested blade and fragments of trimming negatives. There are also two visible negative scars formed by the flawed attempts to remove blades. The specimen is slightly bent in the mesial part; trapezoidal/triangular cross-section; multi-scarred (faceted) butt; platform edge trimming?; mildly prominent bulb with a visible bulb scar. The bottom part of the right edge of the blade is damaged by contemporary retouching. The tip is broken off. Dimensions: length: 167 mm, width: 26 mm, thickness: 11.5 mm (the refitting shows that it should be 19 mm longer); weight: 52 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/4 (Fig. 2: 2, 4).

3. Blade with regularly shaped lateral edges removed from a single platform core. Negative scars of three previously removed blades are visible on the dorsal surface. The specimen is bent in the top part; trapezoidal cross-section; butt bearing two negative scars; platform edge trimming and abrasion; mildly prominent bulb. Fragments of a crest are preserved near the tip of the blade. The right edge of the blade is badly damaged by contemporary retouching, the blade is broken into three pieces. The tip is broken off. The blade can be refitted with blade No. MNKi/A/5666/1 (item No. 4 below). Dimensions: length: 163 mm, width: 19 mm, thickness: 9 mm; weight: 33.5 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/5 (Fig. 4: 1, 3).

4. Negative blade with regular lateral edges, removed from a single platform core. Negative scars of three previously removed blades are visible on the dorsal surface. The specimen is bent in the central part; the apical part shows a fragment of a crest, trapezoidal cross-section; butt bearing two negative scars; platform edge trimming, abrasion; weakly distinct bulb with a visible bulb scar. Both edges of the blade are damaged by contemporary retouching forming notches. Dimensions: length: 155 mm, width: 23 mm, thickness: 10 mm; weight: 43.5 g. (the refitting shows that it should be 6 mm longer). Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/1 (Fig. 4: 2, 4).

5. Blade with regularly shaped lateral edges removed from a single platform core. Visible negative scars on the dorsal surface formed by at least two previously removed blades; along the left side of the blade there is a regular cortical surface along its entire length. The

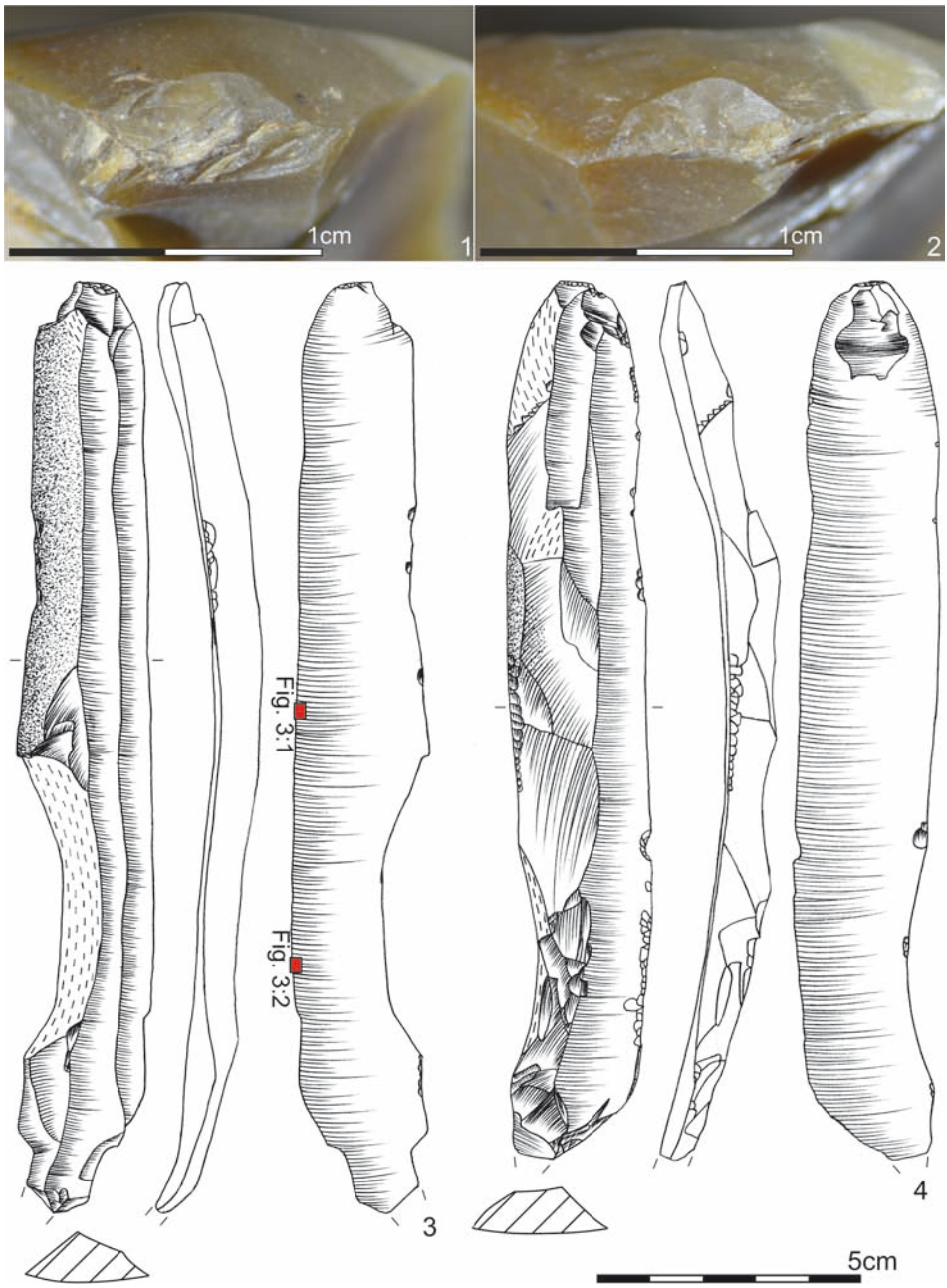


Fig. 2. Wąworków, Opatów District.
1, 3 – Flint blade No. MNKi/A/5666/3; 2, 4 – Flint blade No. MNKi/A/5666/4.
Drawn and photo by P. Mączyński

specimen is bent in the top part; the apical part shows a crest-type correcting retouching, trapezoidal cross-section; multi-scarred butt; platform edge trimming; mildly prominent bulb with a visible bulb scar. The tip is slightly broken off. Dimensions: length: 159 mm, width: 23 mm, thickness: 9 mm; weight: 40 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/6 (Fig. 5: 1, 3).

6. Blade with regularly shaped lateral edges removed from a single platform core. Negative scars of three previously removed blades are visible on the dorsal surface. The specimen is bent in the top part; trapezoidal cross-section; planar butt bearing two (?) negative scars; platform edge trimming; mildly prominent bulb. The blade is broken into two parts. The tip is slightly broken off. Dimensions: length: 156 mm, width: 23 mm, thickness: 11 mm; weight: 43.5 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/7 (Figs 5: 2 and 4; 7).

7. Blade with regularly shaped lateral edges, removed from a single platform core. Negative scars of three previously removed blades are visible on the dorsal surface, in addition, there are visible fragments of trimming negatives on the upper right side and cortical surfaces on the lower part. The specimen is bent in the central part; pentagonal cross-section; enéperon butt bearing two negative scars; platform edge trimming/ abrasion; mildly prominent bulb with a visible bulb scar. The left edge of the blade is damaged by contemporary retouching. The tip is broken off. Dimensions: length: 141 mm, width: 31 mm, thickness: 7 mm; weight: 34 g. Raw material: chocolate flint with visible stripes. Inventory number MNKi/A/5666/2 (Fig. 7).

MORPHOLOGICAL AND TECHNOLOGICAL ANALYSIS

The blades in question are chance finds. Their discovery, which was made during farming activity, negatively affected their state of preservation – four of the specimens show modern damage as a result of contact with agricultural machinery. This was probably also the reason

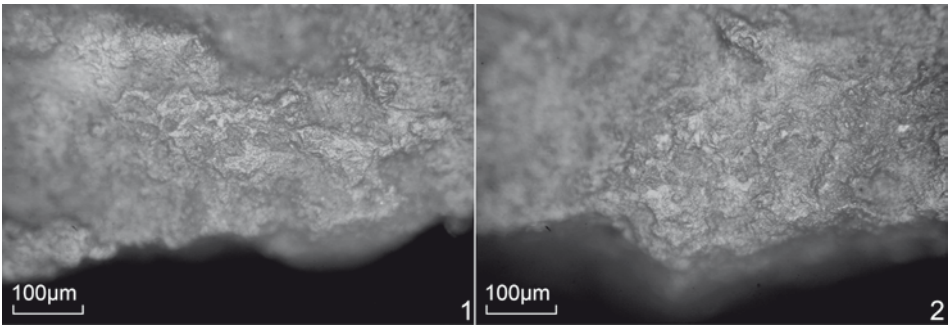


Fig. 3. Wąworków, Opatów District.
1, 2 – poorly developed polish visible on the edge of the blade No. MNKi/A/5666/3.
The origin of the polish is unclear. Photo by P. Mączyński

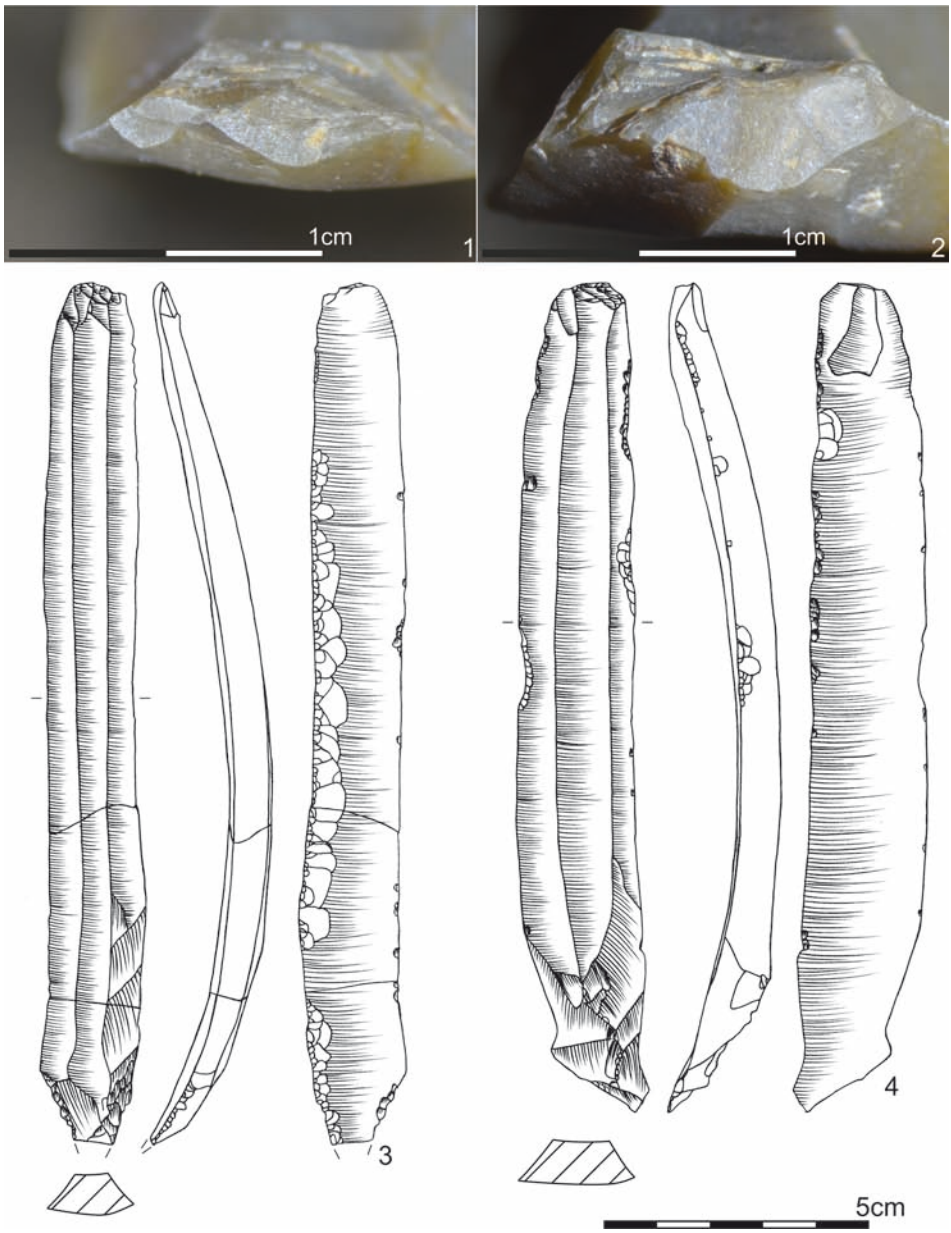


Fig. 4. Wąworków, Opatów District.
1, 3 – Flint blade No. MNKi/A/5666/5; 2, 4 – Flint blade No. MNKi/A/5666/1.
Drawn and photo by P. Mączyński

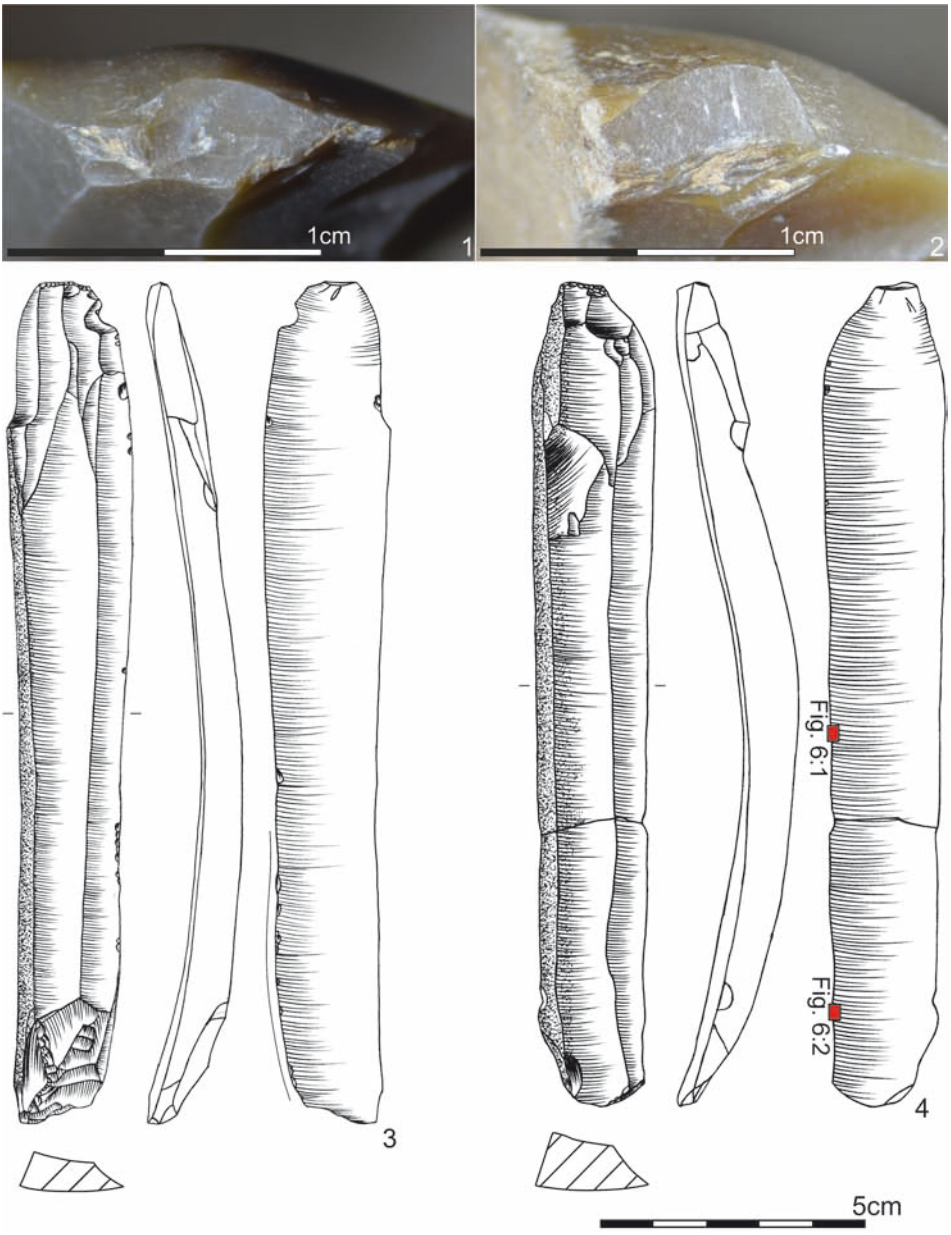


Fig. 5. Wąworków, Opatów District.
1, 3 – Flint blade No. MNKi/A/5666/6; 2, 4 – Flint blade No. MNKi/A/5666/7.
Drawn and photo by P. Mączyński

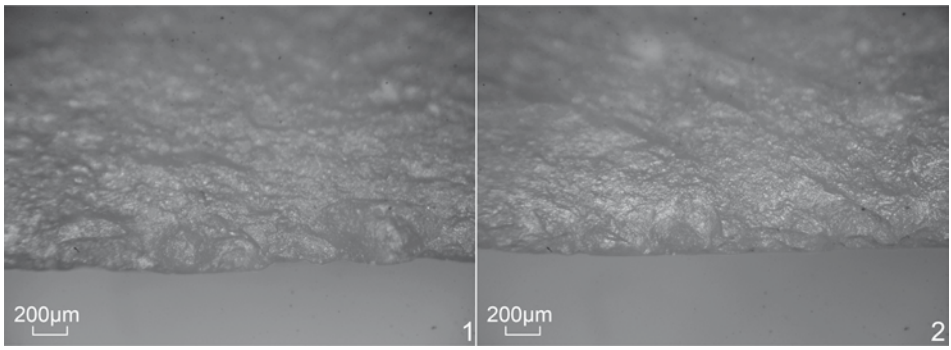


Fig. 6. Wąworków, Opatów District.
1, 2 – retouch visible on the edge of the blade No. MNKi/A/5666/7 interpreted as traces of transport (?).
Photo by P. Mączyński

why two of the specimens were broken into two and three pieces. Also, all blades have a slightly broken tip. Such a frequency may suggest that at least in some cases this was intentional.

Furthermore, all blades have a similar, brown colour with a characteristic striping (Fig. 8). This may be a premise suggesting that at least some of the artefacts were removed from a single lump of raw material. However, this supposition is not reflected in the refittings. Only two matches were obtained. The first refitting concerns two blades removed at an early stage of the core exploitation process, as evidenced by the fragments of the crest negative scars and the cortical surfaces (Fig. 2: 3, 4). Another refitting combines two blades with negatives and cortex surface (Fig. 4: 3, 4).

All the products are characterised by a fairly high degree of regularity and a very similar morphology. Only two of the specimens are an irregular form (Fig. 2: 3, 4). Most of them have relatively parallel sides and ridges (Fig. 4: 3, 4; 5: 3, 4; 7: 2). Their side profiles thin down towards the apex with the greatest thickness usually occurring near the mesial part. On the upper surfaces, the specimens bear traces of previously removed three to five blades. The lateral projection is characterised by an arched profile. The curvature of the majority of the specimens was recorded in the mesial part (Fig. 2: 1, 2; 4: 4; 5: 3, 4; 7: 2), less frequently at the top (Fig. 4: 3). Six specimens have a very fine lip underneath which there are mildly prominent bulbs, in several cases these are partially removed by the bulb scar.

In the course of the analyses, an attempt was made to reconstruct the core exploitation technique used to manufacture the blades. Experimental studies indicate that two different techniques may result in the production of flint forms with parameters similar to the blades discovered at Wąworków. The first one, called the indirect percussion technique, involved applying to the edge of the butt a punch (made usually of bone or antler) that was struck with a stone or wooden hammer. With this type of operation, the core was most likely stabilised between the flintknapper's thighs. In the second technique, the core was immovably put in a grip placed on the ground and the force necessary to obtain blades was

generated by applying strong pressure to the edge of the core's butt using a wooden lever. Due to the similarity of morphological features, distinguishing the indirect percussion technique from the lever pressure technique is sometimes difficult and not always possible (see Inizan *et al.* 1999, 76, 78; Migal 2002, 264; 2003, 61; Pelegrin 2002; 2006, 39-47;

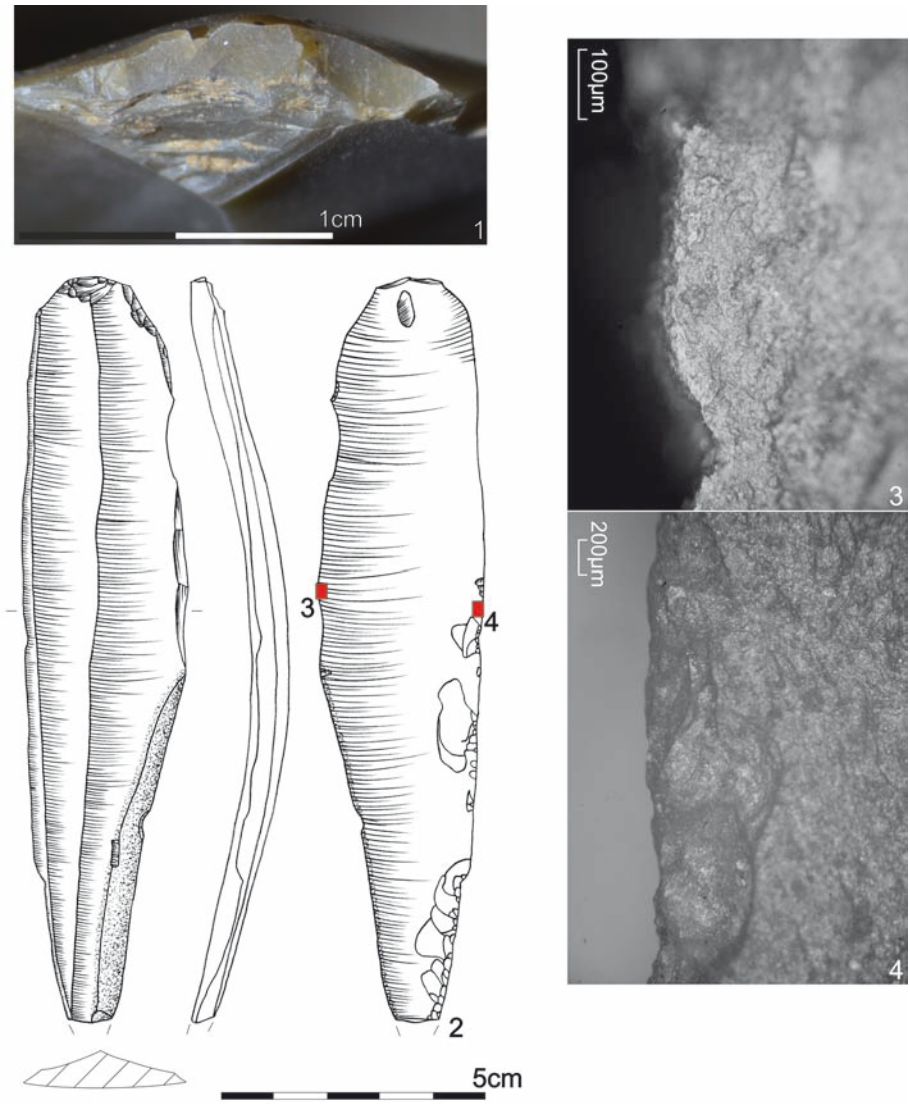


Fig. 7. Wąworków, Opatów District.
1, 2 – Flint blade No. MNKi/A/5666/2; 3 – poorly developed polish visible on the edge of the blade. The origin of the polish is unclear; 4 – retouch visible on the edge of the blade interpreted as traces of damage in transport(?). Drawn and photo by P. Mączyński



Fig. 8. Colour diversity of chocolate flint based on the example of the materials from Wąworków. Photo by P. Suchanek (MNKi)

2012; Budziszewski and Grużdź 2013, 167-169). Furthermore, the rather small sample of available artefacts, consisting of only seven specimens, creates additional uncertainty, as this sample may not be sufficient when analysing technological features.

As indicated above, some of the artefacts from Wąworków have very parallel sides and ridges (Fig. 4: 3, 4; 5: 3, 4). On the one hand, these features bring them closer to the blades obtained by the lever pressure technique. However, all the specimens lack the bending in the apical part typical of this method of obtaining blades. The artefacts are also quite thick. The forms created using the lever pressure technique are usually characterised by a slight curvature and are relatively thin and narrow. Thus, we are unable to attribute these features to the forms from Wąworków.

It is also worth bearing in mind that the chocolate flint has very good knapping qualities and, furthermore, some of the blades have been removed from a core for which a plate-shaped concretion of flint with flat, even sides has been adapted. Both of these features facilitate obtaining long blades with straight edges.

The above-mentioned deliberations do not make it possible to state unequivocally which method was used in the manufacturing of the discussed hoard of blades. However, many of the morphological features observed on the material from Wąworków seem to indicate that probably the indirect percussion technique was used in their production.

USE-WEAR ANALYSIS

Use-wear analyses were carried out using two types of microscope.The applied method of conducting microscopic observations does not deviate from general guidelines for such research (Vaughan 1985, 6, 16; van Gijn 1989, 12, 13; Korobkowa 1999, 15; Osipowicz 2010, 24, 25). In the initial phase of the study, Carll Zeiss SteREO Discovery.V8 equipment providing actual magnification between 10× and 80× was used. Magnification up to 40 times was used in the studies. The microscope was equipped with a dedicated source of cold LED light. The next step of the research involved the observation of artefacts using a Meiji Techno MC-50T apparatus, which is a metallographic microscope capable of much greater magnifications – between 50× and 500× (zoom 50×/ 100×/ 200× was used). The magnification obtained with it enables the free observation of use-wear polish/abrasions and traces in the form of lines. Prior to the analysis, the flint specimens were cleaned with acetone to degrease their surfaces and remove fingerprints.

The study was directed towards the analysis of several aspects. The primary goal was the observations carried out to identify traces related to the use of hafts and wrappings/sheaths. The next stage of the analysis focused on the observation of the surface of the butts in order to identify traces that might indicate the type of raw material from which the tools used in their manufacture were made.

The surface of the artefacts was covered with a bright patina penetrating into the structure of the flint, altering its natural surface. Microscopic observations did not reveal linear traces of use-wear, and very faint weak polish was sometimes recorded, most probably related to the impact of post-depositional processes (Figs 3: 1, 2; 7: 3). On the other hand, multi-step continuous scars were observed on the lateral edges of all blades (Figs 6: 1, 2; 7: 4). This damage was undoubtedly caused by their contact with hard material. These transformations are also covered by patina, suggesting that they were formed as early as the prehistoric period probably before the blades were deposited in their hiding place.

Usually, scars are among the low-distinctive transformations and an analysis based on them alone is not very certain. Nevertheless, it seems that some of them may be of a use-wear nature. They may, for example, have been created during a short-term work. Such a situation is recorded on one edge of blade No. 5. As it seems, this edge may have been used for scraping/shaving hard material, like bone or antler (Fig. 5: 3). What is important, these transformations are not accompanied by linear traces or polish. Unfortunately, the rather limited nature of the traces makes this a rather questionable interpretation. Thus, how can we interpret the scars recorded on the edges of virtually all blades? It seems that these transformations were created during the transport of the blades without due protection (for example the use of a wrapper). Experimental studies have proven that transporting blades in a single container resulted in the formation of numerous scars on the edges of the lithics as the flint blades bumped against each other. We need to bear in mind that the location of the blade deposit is approximately 20 km as the crow flies from the nearest chocolate flint outcrop (see Mazzucco and Clemente 2013, fig. 3: a-d).

Butt surfaces were also examined to identify transformations that occurred during the blade manufacturing process. These analyses, however, do not identify the method used in their production but only allow us to identify the type of material of which the tools used in the process were made, *i.e.*, stone or bone/antler. In addition, there is also the hypothetical possibility of recording traces of copper, which would confirm the use of a copper tool. Unfortunately, no such transformations were registered.

DISCUSSION

So far, apart from the aforementioned assemblage, we know of only two other assemblages of macrolithic blades made of chocolate flint. The first deposit was discovered in the village of Krowia Góra, Site 14, Sandomierz District. It comprises a total of 24 blades, including both fully and fragmentary preserved artefacts (Florek and Zakościelna 2003, 51; Migal 2003; Skakun *et al.* 2008, 429). Six specimens were lost during the discovery of the assemblage. This fact indicates that the originally deposited assemblage was most likely larger. Furthermore, some of the blades forming the assemblage were recovered during rescue work carried out at a later date. The artefacts were not accompanied by fragments of clay vessels that could have contributed new information regarding the dating of the materials. No traces of archaeological features were also recorded (Florek and Zakościelna 2003, 51).

The second assemblage was obtained as a result of a chance discovery in the village of Pełczyska, Pińczów District. It consists of three well-preserved flint blades. As in the case of the discussed assemblage from Wąworków, these finds also have a very poorly documented context of their discovery, and no ceramic material was discovered with them either. Therefore, it is not possible to clearly determine their chronology and cultural provenance (Mączyński and Polit 2018, 150).

It is worth mentioning that for both above-mentioned assemblages of blades – from Krowia Góra and Pełczyska – a use-wear analysis was performed. The materials from Krowia Góra were examined by Natalia N. Skakun for the presence of use-wear transformations. As a result, changes were found on the surface of 18 of the 24 specimens, indicating their use as knives for cutting soft material – like meat (see Skakun *et al.* 2008, 429, 432). The analysis of the flint artefacts comprising the second of the mentioned assemblages did not reveal any functional changes on their surfaces; only the presence of numerous removals along the edges of blades was noted, potentially indicating evidence of damage in transport (Mączyński and Polit 2018, 149).

Unfortunately, due to the chance find nature of the assemblages from Krowia Góra and Pełczyska, we cannot use these finds to date the collection from Wąworków presented in this paper. However, while discussing this issue we can instead rely on general findings related to the use of chocolate flint raw material and long blades by Neolithic communities.

All of the examined flint blades are characterised by their significant dimensions. The size of the artefacts ranges from 141 to 177 mm, prompting their classification as macrolithic specimens. These forms were discovered in the Sandomierz Upland, and the only communities inhabiting this area in prehistory with the sufficient skills and knowledge necessary to produce blades of similar size were the people representing the Lublin-Volhynian culture and the Funnel Beaker culture (Zakościelna 1996, 44; 2008, 578; 2010, 137; Budziszewski 2000, 258, 259; Migal 2006, 398).

The analysis of the differentiation in the use of siliceous rocks provides some information on the attribution of the discussed assemblage to one of these communities. Thanks to its application, we are able to obtain data relating to the raw material preferences of individual Neolithic groups. When manufacturing lithic forms, the people of the Lublin-Volhynian culture primarily used chocolate flint and Volhynian raw material, while at the same time it is worth noting that the use of chocolate flint is typical of communities that inhabited areas to the west of the Vistula River and in the western part of Lublin region (Zakościelna 1996, 19-26; Zakościelna and Libera 2013, 277-283).

At the same time, a very different situation concerning the supply of raw material is observed in flint assemblages associated with the Funnel Beaker culture. The people of this group inhabiting the area of the Lesser Poland Upland relied on the sources of the Volhynian flint, Cracow-Jurassic flint, Świeciechów flint, and striped flint for the production of tools, while artefacts made from chocolate flint accounted only for a small percentage of the lithic material known to us (Balcer 1983, 131; Budziszewski 2000, 258, 259; Libera and Zakościelna 2011, 89-93; Zakościelna and Libera 2013, 283-289). However, it is worth noting that this is typical for this region, because in other areas the situation with the use of raw materials could be different, for example, in the Kujawy area, the people of the Funnel Beaker culture widely used chocolate flint for tool production (Balcer 1983, 123; Prinke and Rachmajda 1988, 118; Domańska 2013, 101; Papiernik 2016).

The presented variation in the use of siliceous rocks does not determine unequivocally the cultural affiliation of the Wąworków blade assemblage. However, the fact that chocolate flint was used may indicate a link to the community of the Lublin-Volhynian culture.

In determining the cultural provenance of the assemblage, the context of the discovery is also important. Usually, discoveries of hoards are interpreted as votive offerings given to deities or as foundation deposits. Their discovery may indicate the special significance of the place where they are deposited. In the case of the communities of the Lublin-Volhynian culture, the deposition of hoards has not been attested in archaeological sources (Florek and Zakościelna 2003, 58). Such evidence of ritual practices is, however, known from the community of the Funnel Beaker culture, which quite commonly deposited hoards consisting of both flint artefacts (axes, long blades), copper artefacts (tools, jewellery as well as raw material), and pottery. So far, several dozen assemblages of this type are known to have been discovered on settlement sites, in funerary contexts or associated with deposi-

tion in water bodies (Kadrow 1988, 27, 30, 32; Libera 2003, 37; Kaflińska 2006, 8-10; Libera and Zakościelna 2010, 91-97; Libera *et al*. 2019, 198; Zakościelna 2022, 414, 416).

If we accept the hypothesis that the creators of the deposit were the people of the Funnel Beaker culture, in such a situation, then the blades made of chocolate flint may have come into their possession as a result of trade exchange, as gifts, or as spoils of war. The hostile attitude of both cultures (at least in some periods and regions) is suggested, among other things, by traces of hostile occupation of the territory, resulting, among other things, in the destruction of Lublin-Volhynian culture funerary features, as evidenced, *inter alia*, by materials from Gródek and Książnice. In both cases, earlier burial pits were destroyed by settlement features of the Funnel Beaker culture (Libera and Zakościelna 2006, 161; Wilk *et al*. 2006, 90, 91).

CONCLUSIONS

In conclusion, we are unable to unambiguously determine the cultural provenance of the analysed assemblage, although its manufacture and deposition in the ground were undoubtedly associated with the activity of Neolithic communities. The choice of chocolate flint raw material as a material for the production of the discussed blades indicates their affiliation with the community of the Lublin-Volhynian culture. This population, however, did not make sacrificial offerings. Such behaviour was practised by members of the Funnel Beaker culture communities. Unfortunately, it is difficult to find an explanation as to how this community could have come into possession of an assemblage of flint blades made from chocolate raw material. It is possible that this occurred through trade exchange or was the consequence of a successful war expedition carried out by the people of the Funnel Beaker cultures into areas occupied by the Lublin-Volhynian culture population. Such or similar interpretations, although currently impossible to prove, seem to explain both the type of flint raw material used and the deposition of blades in the ground.

Regrettably, due to the lack of detailed information relating to the circumstances of the discovery of the hoard, we are unable to unequivocally answer many of the questions we have concerning the artefacts in question. However, in the light of the conclusions obtained, the presented deposit of flint artefacts can undoubtedly be regarded as a unique find on the regional scale.

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ORGANISATION OF ACTIVITIES IN SETTLEMENTS OF THE SOUTHEASTERN GROUP OF THE FUNNEL BEAKER CULTURE. PATTERNS OF USE AND DEPOSITION OF LITHIC ARTEFACTS FROM ZAWARŻA, SITE 2, PIŃCZÓW COMMUNE

ABSTRACT

Oberc T. 2024. Organisation of activities in settlements of the southeastern group of the Funnel Beaker Culture. Patterns of use and deposition of lithic artefacts from Zawarża, Site 2, Pińczów commune. *Sprawozdania Archeologiczne* 76/1, 445-468.

The aim of the study is to provide an insight in the possible modes of use of space and organization of work within the settlements of the south-eastern group of Funnel Beaker Culture (FBC SE) utilizing framework for integrating use-wear of lithic artefacts and intra-site analyses of their deposition patterns. Those analyses concerns Site 2 in Zawarża, Pińczów commune. Excavations on the site spanned from 1959 to 1963, culminating in the uncovering of 58 ares of the site, which equals approximately 60% of its supposed area. This fact along with already published set of data concerning archaeological remains, and short occupation period make it a nearly ideal candidate for testing new analytical approaches. This study utilizes traces of use recorded on 32 of the 119 flint artefacts, as well as the data on their deposition to identify possible functional areas of the site linked to butchering and related practices and other activities such as production or repairing of tools.

Keywords: Funnel Beaker Culture; Eneolithic; lithic analysis; lithic use-wear analysis; spatial analysis
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INTRODUCTION

The site in Zawarża is situated in the eastern part of the loess area of western Lesser Poland within the Nida catchment area. It was discovered in 1959 during a survey conducted in conjunction with research on the Stradów settlement at that time (Kulczycka-Leciejewiczowa 2002, 11). The subsequent excavations of the site spanned from 1959 to 1963, culminating in the uncovering of 58 ares of the site, which, according to A. Kulczycka-Leciejewiczowa, accounted for approximately 60% of the total settlement area. The comprehensive excavation effort led to the registration and examination of 77 archaeological features. Remarkably, only materials related to the South-Eastern group of the Funnel Beaker Culture (FBC SE) were discovered during these excavations. The site's finds inventories encompassed over 8,500 fragments of pottery, comprising complete or nearly complete vessels, more than 2,500 bone remains, 29 bone and antler products, 21 fragments of grinding stones and querns and 119 flint artefacts. Of significance to this study are the flint artefacts, which have been analysed in terms of typology and raw materials by Bogdan Balcer. These findings were incorporated as a dedicated chapter in a monographic publication of the site (Balcer 2002).

SPATIAL ARRANGEMENT OF THE SETTLEMENT

Although over half of the supposed settlement area in Zawarża has been excavated, we have only indirect evidence of its internal structure (Figs 1 and 2). This evidence comes in the form of clusters of archaeological features along with archaeological remains found within them. Based on this evidence, A. Kulczycka-Leciejewiczowa interpreted the site as a single-phase, small settlement characterized by 8-10 houses encircling a central plaza (Kulczycka-Leciejewiczowa 2002, 61, 62; fig. 52, insert). She estimated the locations of these houses by examining the placement of hearths and clusters of storage and waste pits. If this interpretation holds true, Zawarża would be one of the very few FBC sites where such a reconstruction is possible. Among known sites associated with this archaeological culture, those with internal structures that remained undisturbed by later occupation are not numerous. Moreover, the extent of the settlement is rarely known, due to limited scope of excavations. Both these factors contribute to the fact that settlement in Zawarża seems to be better suited to understand functioning of FBC SE communities than large, long-lasting settlements like Bronocice, Site 1, which show intensive occupation spanning over a thousand years, often obliterating earlier plans of arrangement.

Additionally, results of analyses conducted by A. Kulczycka-Leciejewiczowa suggested that the occupation of the site was relatively short, possibly consisting of only one occupational phase. This conclusion was drawn from the observed homogeneity of pottery, similarities in composition of clusters of features, and lack of stratigraphic relations between

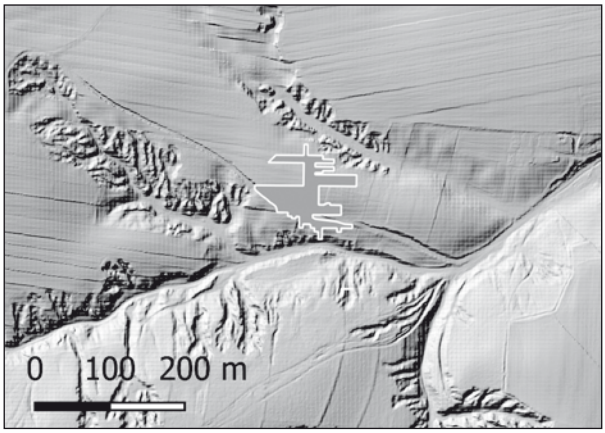


Fig. 1. Zawarża Site 2, Pińczów commune. Localisation of the site in the local topography

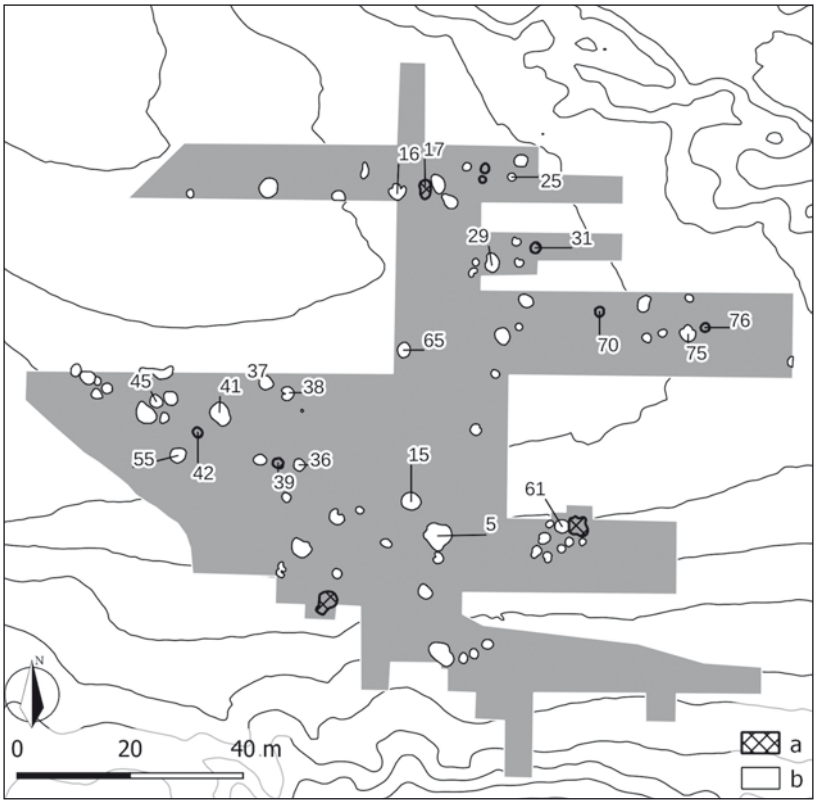


Fig. 2. Zawarża Site 2, Pińczów commune. Plan of excavated area; a – hearths, b – other features, numbers – features mentioned in Table 1. After Kulczycka-Leciejewiczowa 2002, with changes

them, suggesting that newer generations of features were dug during the time of use or, at least, with memories or traces of older ones. The author also suggested that at least some features were filled purposefully, supposing an organised emigration of settlers at the end of the functioning of the site. The precise duration of the site's use is uncertain, as no radiocarbon dating was available at the time of the study. The author estimated approximately 50 years as a probable time of use of the horizontal log constructions, which in her opinion were used for housing. Use of such constructions would explain lack of recorded postholes on the site. Estimated timespan of use of the settlement was also supported by general observations regarding the quantity of archaeological remains, such as pottery, bone fragments and lithics. Unfortunately, the actual timeframe of use of the settlement cannot be verified by radiocarbon dating at this point, as only one determination is available from the site, made on an animal bone from Feature 67 (ICA 15B/0615, 4730±40 BP, calibrated to around 3640-3370 BC; Kruk *et al.* 2018, 39, table 9; 40).

In terms of the spatial arrangement of the settlement, the author's view suggests the presence of several households, each marked by a cluster of features such as storage pits and hearths located inside or near the construction. These households were, therefore, interdependent units organized around the central plaza, with one feature interpreted as a water reservoir (Feature 65). This interpretation resembles the household-based settlement structures of earlier Neolithic societies, as discussed in literature (*e.g.*, Bogucki and Grygiel 2022). Planning at the higher level is also evident in these societies, particularly in the layouts of enclosed sites (*e.g.*, Lublin-Volhynian Culture phase in Bronocice; Kruk and Milisauskas 1985). However, the presence of a plaza in the middle of the settlement has not been confirmed in any of these examples. Planned settlement arrangements are strongly associated with so-called mega-sites of the Cucuteni-Trypillia Culture (*e.g.,* Gaydarska *et al.* 2020 and literature cited there), although the scale of these structures may be comparable only to the largest sites of the FBC SE, such as Bronocice 1, Miechów 3 or Mozgawa 1-3 (Nowak *et al.* 2022). For example, the estimated size of the settlement in Bronocice in phase Br II, which is stylistically analogous to the pottery of Zawarża, equates to 8 hectares with fewer than 200 people (Diachenko *et al.* 2016, 27, table 1), a multiple of the size of the settlement in Zawarża. The closest representation of the circular arrangement of settlements observed in Zawarża comes from the FBC sites in Garbia Basin, Central Poland, such as Andrzejów 2 (Pelisiak 2003, 65, 149-151). Unlike the situation in Zawarża, however, clear traces of hearths were localised in the vicinity of the central plaza, and not in the houses. The site in Andrzejów is also smaller than Zawarża. Altogether, while all elements of internal structure of the analysed site could be tracked back to either contemporary, or earlier ways of organisation of settlements, it is their combination made visible by extensive excavations, that makes Zawarża a unique test object.

The aim of the study is to provide an insight into the possible modes of use of space and organization of work within FBC settlements. The specific question concerns the distinction between the tasks performed near individual households and in spaces that could be

considered communal. The latter possibility was formulated by the original researcher of the site, basing on the observation of central plaza, an area almost free of archaeological features, and surrounded by clusters pits interpreted as remains of households. On the more detailed level, the study aims to create a robust framework for integrating use-wear and intra-site analyses in a way that would develop a better understanding of social and economic patterns of settlement activity in the FBC SE. Such analyses have been attempted for example for the Eastern group of the FBC (Małecka-Kukawka 2001; Pyżewicz 2015; Papiernik 2016; Kabaciński and Winiarska-Kabacińska 2018).

MATERIALS AND METHODS

Functional analysis was performed on the 80 of 119 flint artefacts described by B. Balcer (2002). The omitted specimens were not found in the preserved material. The typological designations by that author were employed during the study, with minor changes. Raw material designations were slightly expanded, particularly to better emphasize the presence of artefacts made from the so-called "type G" Jurassic flint, originating from the Central Kraków-Częstochowa Upland (Přichystal 2009, 93). Additionally, original drawings of the lithic items were used with slight modifications to mark the locations of use-wear traces. The artefacts were categorized into 7 dynamic classification categories, along with indications of the form of the blank or prefabricate used for their production. This step seems to be necessary for interpretation of observed traces, mostly because of specimens bearing multiple wear traces, or modifications (*e.g.*, splintered pieces). This approach is also aimed to provide information about the cycles of production and knapping activity present at the site, which could be compared with other Neolithic and Eneolithic site assemblages. The lithic artefacts had previously been documented and drawn by B. Balcer, and in only a few instances was more intensive cleaning necessary. In these cases, an ultrasonic bath was used. In most cases, rinsing with water to remove accumulated dust and wiping the surfaces with ethyl alcohol prior to observation sufficed. The artefacts have been observed with naked eye and using low magnifications first for marking of potentially used edges and surfaces. On this basis, a description of edge/area shapes, presence of working retouch, polishes and striations were made. For this purpose, a trinocular Nikon SMZ-745T has been used, with magnification range 6.3-50×, with additional use of a Dino-Lite AM4113ZTL digital microscope (20-90x). For the observation, description and documentation of the characteristics of polish and striations, a Nikon Eclipse LV100 metallographic microscope has been used, with magnification range 100-500×. Observed traces were recorded using a form based on characteristics described by Grzegorz Osipowicz (Osipowicz 2010). Observed traces were interpreted in accordance with established methodologies, drawing from the literature (van Gijn 1990; Korobkova 1999; Osipowicz 2010; Rots 2015) and comparisons with the writer's own experimental collection. It should be noted

Table 1. Zawarża Site 2, Pińczów commune.
Artefacts with identified use wear

No.	Feature (depth)	Typological category	Raw material	Fragmentation	Contact material	Activity	Figure
1	36 (100-120 cm)	splintered piece	Jurassic (Kraków)	whole	hide	contact	
2	Loose	ret. flake	Volhynian	whole	hide	cutting	
3	65 (20-40 cm)	cont. ret. blade	Volhynian	apex	hide	cutting	3
4	70 (40-60 cm)	cont. ret. blade	Jurassic (G)	distal part	hide	cutting/ scraping	
5	Loose	ret. blade	Volhynian	whole	hide/meat	cutting	
6	5 (40-60 cm)	ret. blade	Jurassic	whole	hide/meat	butchering	8
7	15 (80-100 cm)	blade	Volhynian	whole	hide/meat	cutting	
8	65 (40-60 cm)	cont. ret. blade	Volhynian	whole	hide/meat	cutting	4
9	41 (60-80 cm)	flake	Jurassic	brekage: apex	meat	cutting	
10	76 (120-140 cm)	backed blade	Jurassic (Kraków)	whole	meat	cutting	
11	76 (140-160 cm)	splintered piece	Jurassic	whole	meat	cutting/ butchering	
12	75 (120-140 cm)	end scraper (double)	Volhynian	whole	bone	drilling	5
13	25 (30-50 cm)	splintered piece	Świeciechów	whole	bone/wood	cutting	
14	70 (20-40 cm)	ret. blade	Świeciechów	mesial part	bone/wood	engraving	9
15	37 (20-40 cm)	flake	Jurassic	whole	plants	cutting	
16	76 (80-100 cm)	flake	Volhynian	whole	plants	cutting	
17	16 (100-120 cm)	ret. blade	Volhynian	distal & mesial part	plants	cutting	
18	5 (80-100 cm)	end scraper	Volhynian	whole	silicous plants	cutting	
19	38 (20-40 cm)	end scraper	Volhynian	brekage: apex	silicous plants	cutting	6
20	38 (80-100? cm)	cont. ret. blade	Volhynian	brekage: apex	silicous plants	cutting	
21	37 (60-80 cm)	axe head	Świeciechów	whole	wood	cutting	9

No.	Feature (depth)	Typological category	Raw material	Fragmentation	Contact material	Activity	Figure
22	16	splintered piece	Volhynian	whole	wood	cutting/ sawing	
23	76 (80-100 cm)	splintered piece	Jurassic (Kraków)	whole	wood	splitting	8
24	39 (40-60 cm)	flake	Jurassic (Kraków)	whole	wood?	contact	
25	61 (20-40 cm)	splintered flake	Volhynian	apex	wood?	cutting/ splitting?	9
26	29 (140-160 cm)	splintered piece	Volhynian	whole	mineral	hitting (strike-a-light)	7
27	17 (40-60 cm)	splintered piece	Jurassic	whole	hard material	cutting?	
28	45 (40-60 cm)	ret. flake	Jurassic (G)	whole	hard material	cutting	
29	5 (40-60 cm)	flake	Jurassic (K)	whole	hard material	cutting?	
30	42	flake	Jurassic (G)	proximal & mesial part	unknown	cutting	
31	31 (40 cm)	flake	Jurassic	whole	unknown	cutting	
32	19 (40-60 cm)	ret. blade	Volhynian	mesial part	unknown	scraping?	

here that the collection comes from the "first-generation" experiments (*sensu* Marreiros *et al.* 2020), with no controlled and serial experiments conducted specially for this study. Therefore, the results of the use-wear analysis are limited at this point to the description of contact materials and performed activities. Interpretation was possible for 32 out of the initial 80 artefacts (Table 1). In the case of the remaining specimens, traces of use were either not present or impossible to interpret due to thermal breakage, mechanical damage, patination, very weak appearance or a mixture of these factors. For 3 of 32 artefacts, only supposed motion could be inferred, with unknown worked material. Furthermore, localisation of Find 2 is unknown. As a result, only slightly more than 1/5 of the whole assemblage (27 out of 119 of lithic artefacts) that could be used in spatial analysis.

While a reduction of database is not limited to this case, quantitative comparisons of this aspect between sites are not easy. Two simple measures were introduced to illustrate this problem: identification ratio (IR) and representativeness of the sample (RS). The former is the number of cases with identified traces (in this case: worked material and motion) per studied specimens, showing how often identifiable traces can be found in given assemblage or collection. The latter is the number of studied lithic items divided by the

number of lithics in the whole site/phase assemblage (*nota bene*, lithics and other materials discovered during excavations are also samples of statistical populations of unknown size). As an example, out of 213 analysed lithic artefacts from Kopydłowo Site 6, use wear has been observed in 32 cases (Pyżewicz 2015, 193). Since the whole lithic material has been analysed, IR would equal about 15% and RS would be 100%. In the case of Sandomierz-Wzgórze Zawichojskie, from 102 analysed lithics found in features, use wear was observed on 65 specimens, but identification of the worked material was possible in the case of 48 of them (Winiarska-Kabacińska 2017, CD, tab. 1). Therefore, IR is about 47%. The RS is, however, much lower, as it consists of less than 4% of the 2701 lithic materials found in the archaeological features (Zakościelna 2017, CD, table 1). The RS is higher, about 32%, in the case of Wilkostowo Site 23/24 (Winiarska-Kabacińska 2015, 323, table 28). However, in this case the RS equals about 31% (103 identified for 330 analysed lithics). In her analyses of the Neolithic site inventories from Chełmno Land, J. Małecka-Kukawka set a typical frequency of "functional tools" in a range oscillating from a dozen to about 40% of lithics (Małecka-Kukawka 2001, 30-50, 84-100; 2012, 146). As can be seen, the value of IR varies, but only in some cases does it exceed 40-50%. A sharp decline in values of RS can be seen in collections and assemblages that are too numerous to analyse. In such cases applied sampling strategies strongly influence the possibility of comparison (*e.g.*, Małecka-Kukawka, Werra 2011; Pyżewicz 2021; Kruk *et al.* 2023, 64). The problem is still more complex if traces of multiple activities are considered. In the classic study of lithic artefact of Beek-Molenseeg by A. van Gijn, about 47% of the selected tools had identified use-wear (van Gijn 1990, 94). However, this study would show that out of 619 PUAs ("potentially used area" marked on artefact) there were only 149 AUAs ("actually used area"), including 32 with unknown worked material (van Gijn 1990, 93, Table 26). The ratio of about 19% of identifiable used areas should be therefore considered as a more representative value for the identification ratio. The materials from Site 2 in Zawarża do not therefore stand out from this background, with an IR value of c. 36% and a RS of c. 67%. The presented examples show that in most cases, the numbers of functional tool may be enough to represent the scope, but not necessarily represent intensity of different activities in the site.

The analysed artefacts were plotted on a plan of the investigated settlement area to visualize the possible locations of different activities. However, no circumstances allowing the use of the so-called 'Pompeian premise' have been discovered during excavations. Therefore, a displacement of materials from the place of its last use need to be taken into account. The model of disposal described by M. Kuna (2015) was used to conceptualise this problem. The data, however, allowed limited insight into deposition processes. Therefore, the utilised model was simplified. Primary and secondary refuse were treated as a uniform category characterised by short circulation in the space of the site, associated with direct and indirect deposition in time close to the last use of features, so at the beginning of formation of fills. Artefacts included in the tertiary refuse are associated with longer circulation around the site and indirect deposition from another cache. In the case of

Zawarża, no external residues (*sensu* Kuna 2015) are recoded under the hypostatised single-phase occupation of the settlement. Therefore, in archaeological features with layered fills, a stratigraphic position in the lowest layers (identified as a fill cones) should be in the closest association with the time of last usage of features. Archaeological material deposited in these layers would therefore be considered as sealed by superimposed layers, and therefore, removed from further circulation (= "short circulation"). In contrast, materials from the upper layers had a greater chance to be exposed to the longer period of circulation between last use and final deposition (= "long circulation"). Materials from features with uniform fills need to be considered as single strata that are equally distant chronologically from the last use of the feature, so they are treated as subjected to a long circulation process.

Used lithics were then assigned to the area of site, according to classification described above. For representation of short circulation deposition area, the outline of the features has been used without additional buffer. For the other materials Thiessen polygons were created around features' centroids to represent possible areas of discard of artefacts before their final deposition in the features fills. Polygons were created in the "Voronoi (Thyssen) polygons" algorithm with 10% buffer in QGIS 3 software. Data on use of lithics was appended to both the layers, and then they were combined. In cases of multiple traces on the artefacts, it was assumed that deposition followed the last recognisable use. Therefore, only these last stages were included in the spatial analysis. Additionally, Voronoi polygons were used to visualise spread of other lithics and pottery fragments.

RECORDED TRACES OF USE

Soft animal tissues

Traces of work on soft animal materials were observed in 11 cases. Those associated with cutting hide were found on two of them (Table 1, 2-3; Fig. 3), with possible another three used either for hide or meat and a fragment of continually retouched blade used for cutting or scraping hide (respectively nos 5, 7, 8 and No. 4; Fig. 4). Traces of cutting meat were found on two artefacts (No. 9-10), a flake and a backed blade. Lastly, two specimens have traces suggesting use in butchering (No. 6 and 11; Fig. 8) and one has unidentified contact with hide (No. 1). In general, mostly blades and blade tools have been used for this purpose, with "raw" or retouched thin edges, although not always straight. Traces of use are sometimes spread along edges and on nearby areas, but in some cases areas of greater intensity are observed, especially on the specimens interpreted as knives and scrapers for hide. The specimens identified as butchering tools had additional "bone-like" traces, occurring in the used areas (Fig. 8) and less localized traces characteristic for meat knives. In addition, traces of contact with soft animal tissues have been recorded on several occasions. In the case of some splintered pieces, these are interpreted as remnants of the arte-

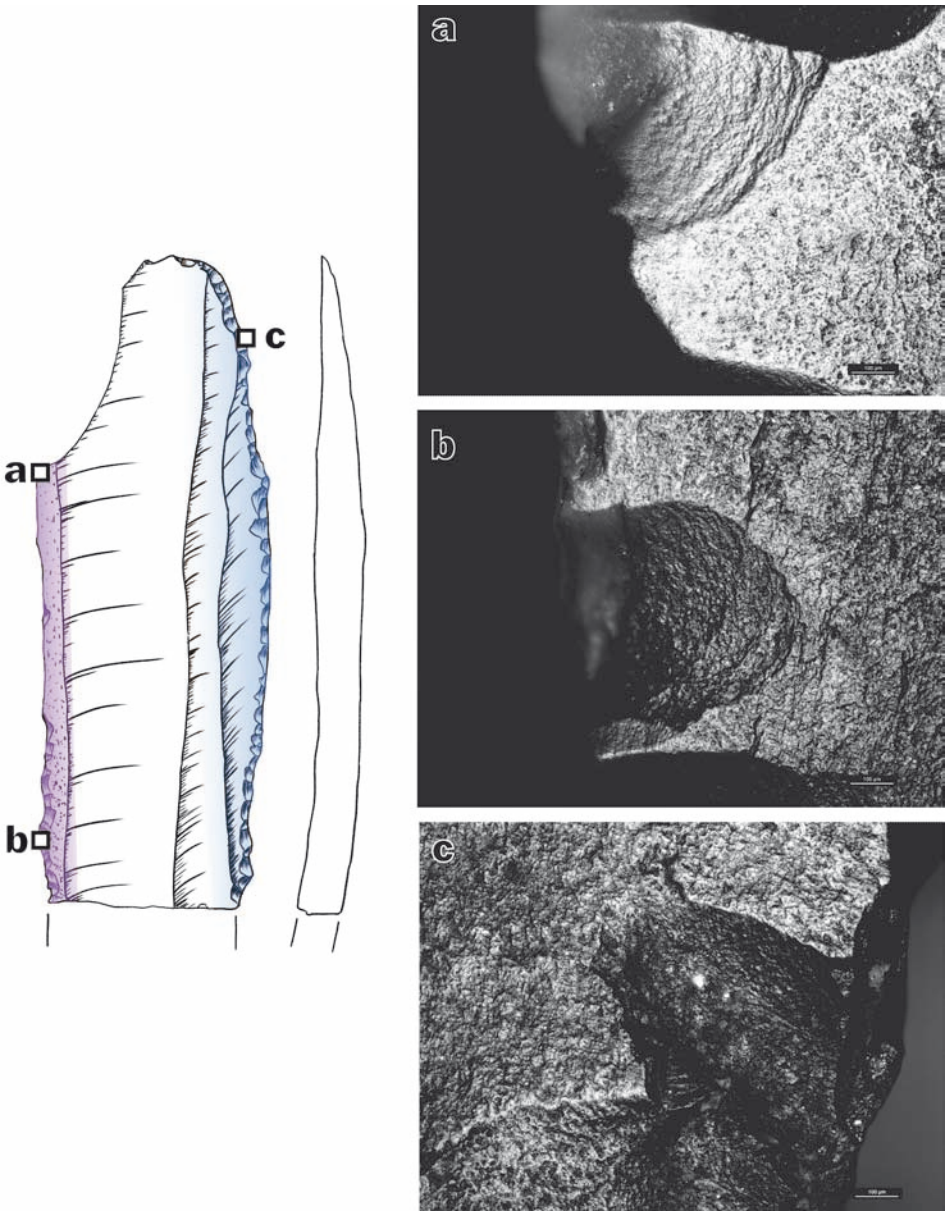


Fig. 3. A distal part of the continuously retouched blade (No. 3, Feature 65); a, b, c – traces of contact with hide; violet area – cutting, blue area – unknown contact. Original drawing after Balcer 2002 with modifications. Original magnification: a, b, c – 100x, objective 10x, scale bar: 100 μm

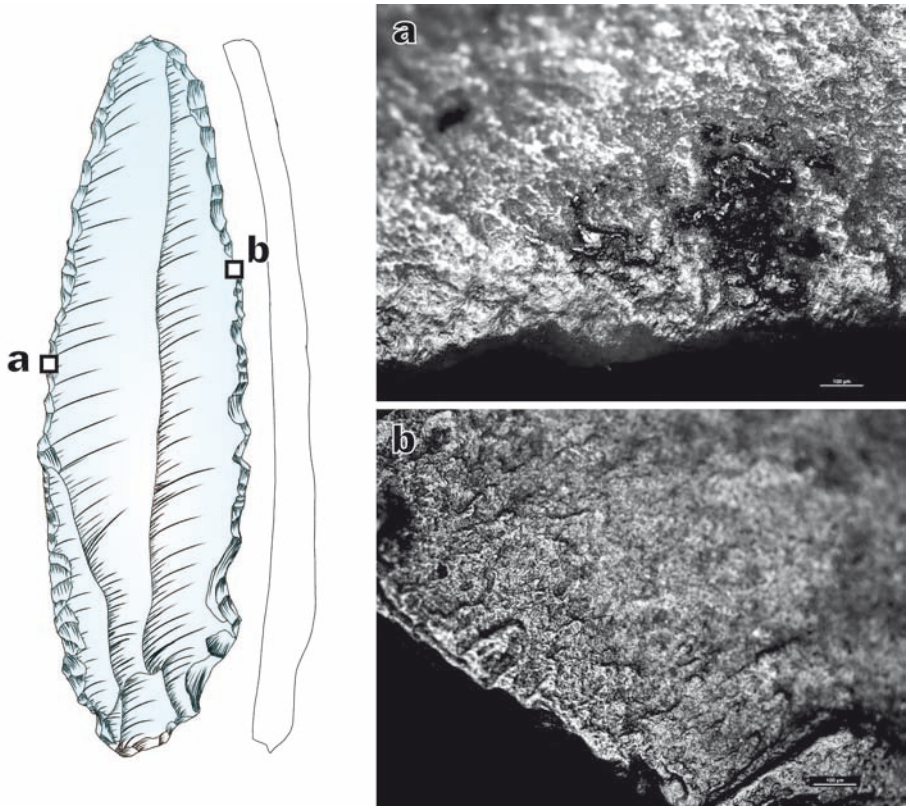


Fig. 4. The continuously retouched blade (No. 8, Feature 65); a, b – traces of cutting meat or hide. Original drawing after Balcer 2002 with modifications. Original magnification: a, b – 100x, objective 10x, scale bar: 100 μm

fact's previous function, as it was in the case of a splintered end scraper, which was subsequently repurposed as a strike-a-light (No. 26, Fig. 7: a). Traces found on its lateral edges may be associated with prehension, but also on the distal end of the specimen there are remnants suggesting some work in hide before the edge was obliterated by bipolar strikes. Traces of both scraping motion and contact with hide are present on the proximal end of a sickle insert, and on its right lateral edge (although, with ambiguous motion indicators; No. 19, Fig. 6: b, c). The specimen was however described by B. Balcer as an end scraper/perforator with broken apex (and this diagnosis seems plausible). Therefore, it is possible that the tool has been worked with in multiple ways during its life history, leaving complicated pattern of use wear. Similarly, there are also traces of directional, scraping-like activity, accompanied by polish, suggesting contact with soft animal tissues on the distal part of a double end scraper (described by B. Balcer as an end scraper/blunt perforator; No. 12, Fig. 5: a). In this case, the piece also shows multiple different stages of uses.

Hard animal tissues

The specimen described above shows traces of movement with the proximal end against organic material, possibly softened bone or antler (Fig. 5: c). This movement was multidirectional, possibly rotary or semi-rotary at approximately right angle to the matetial contacted. This was apparently the last of the functions of the specimen before it was discarded. The hide-scraping end mentioned above might have been used in a separate stage, preceding the "blunt drill" function, but it should be argued, that considerable pressure was probably applied at this edge, leaving some marks on it. It is also probable that retouched notches on the lateral edges of the specimen – made after it was used as a sickle insert – are associated with this activity. In case of another two specimens possibly used for bone/antler, one is splintered piece with edge marked by traces of perpendicular movement with weak traces of cutting hard material, probably bone or hard wood (No. 13). Another one is a mesial portion of a retouched blade, with traces of grooving on the edge

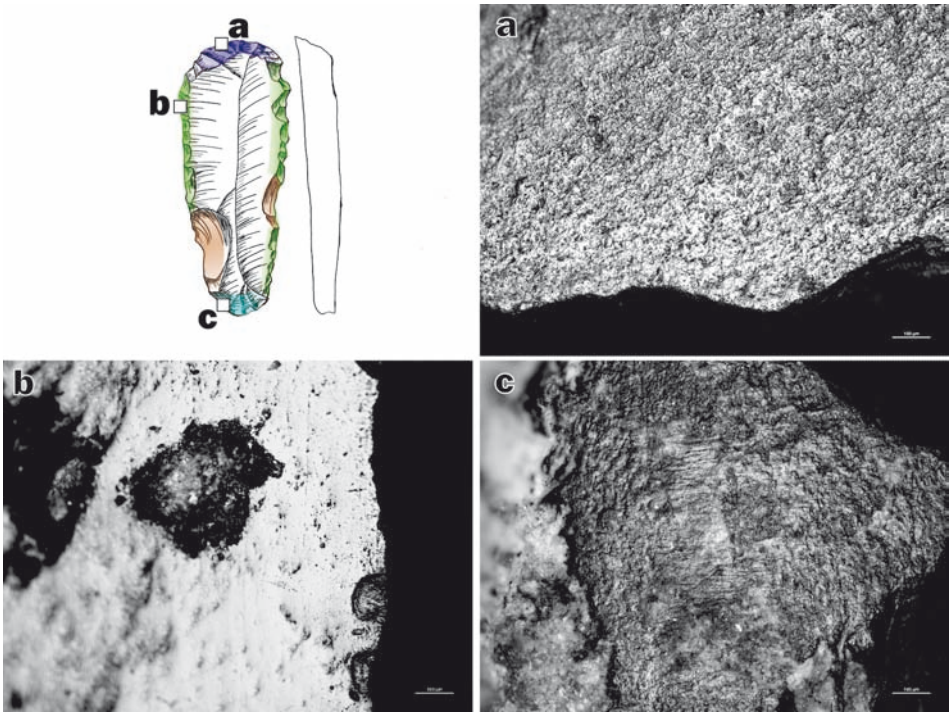


Fig. 5. The two-sided end scraper (No. 12, Feature 75); a – traces of hide scraping (violet), b – traces of cereals cutting (green), c – traces of bone/antler drilling (cyan), brown – negatives free of distinguishable use wear. Original drawing after Balcer 2002 with modifications. Original magnification: a, b, c – 100x, objective 10x, scale bar: 100 μm

broken in a burin-like fashion (No. 14, Fig. 9: c). Three other artefacts have damages on the working edges characteristic of the cutting or splintering of hard material (No. 27-29). The contact material, however, could not be identified.

PLANT-BASED MATERIALS

Activities involving the cutting of soft plant tissues were identified on three artefacts (Table 1, 15-17). They consist of two flakes and a fragment of retouched blade. On the flakes traces are faint and spatially limited. They probably had been used as *ad hoc* tools. The retouched blade has a fairly well developed polish visible on the preserved part of its left lateral edge, more pronounced in the supposed central part of the specimen, in the region of local bend of the original blade. These characteristics are sometimes observed on the tools for splitting fibres. In this case, polish is brighter on the ventral side of the artefact,

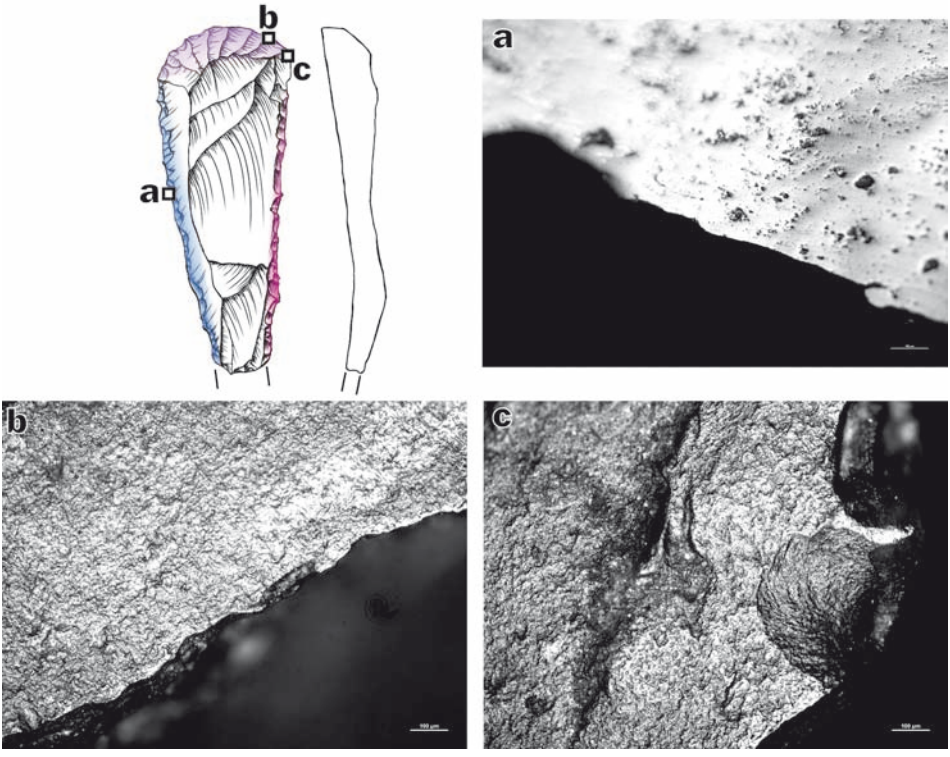


Fig. 6. End scraper (No. 19, Feature 38); a – traces of cereals cutting (blue), b – traces of hide working (violet), c – traces of contact with hide (fuschia). Original drawing after Balcer 2002 with modifications. Original magnification: a, b, c – 100x, objective 10x, scale bar: 100 μm

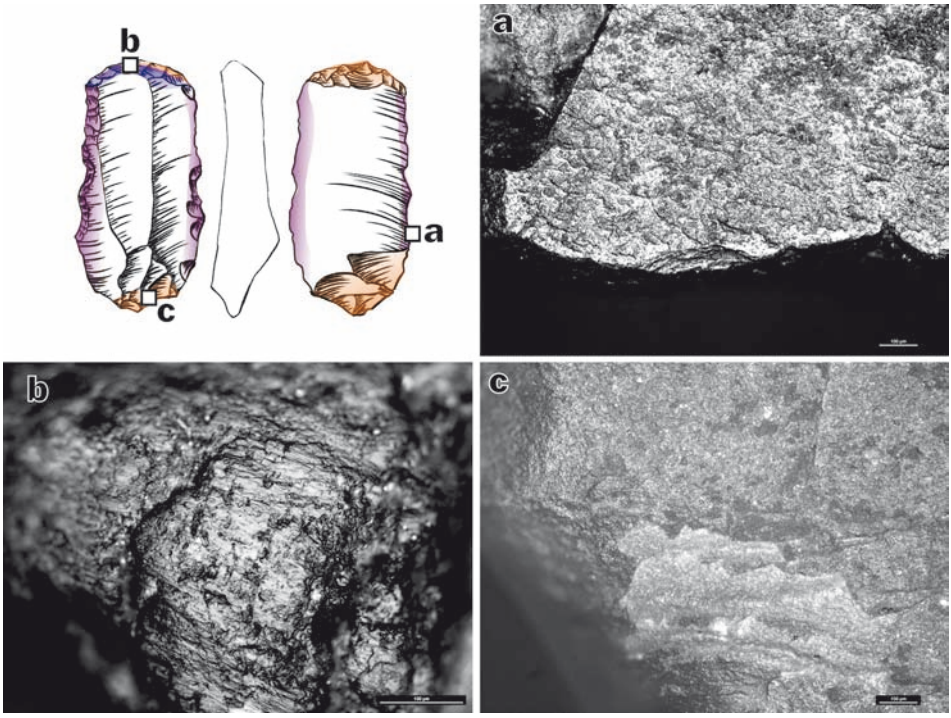


Fig. 7. Splintered piece made on end scraper (No. 26, Feature 29); a – traces of intensive contact with hide (pink), b – traces of striking a spark with mineral material (violet), c – technological traces associated with bipolar technique? (orange). Original drawing after Balcer 2002 with modifications. Original magnification: a, c – 100x, objective 10x, b – 200x, objective 20x, scale bar: 100 μm

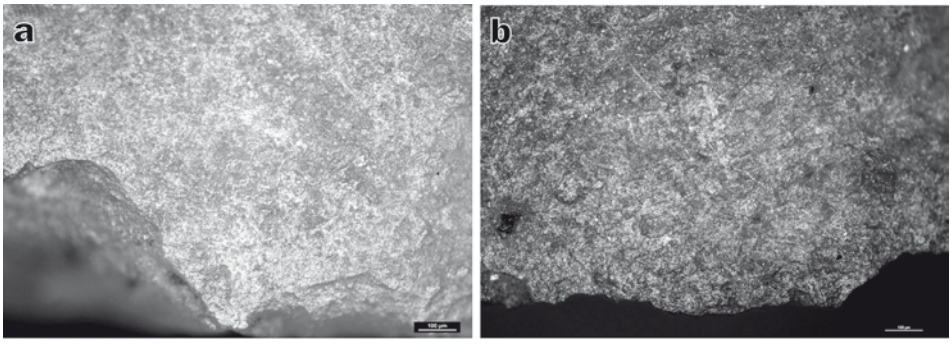


Fig. 8. Traces associated with wood working (a; splintered piece, No. 23, Feature 76) and butchering (b; retouched blade, No. 6, Feature 5).
Original magnification: a, b – 100x, objective 10x, scale bar: 100 μm

although the direction of striations suggest movement diagonal and parallel to the edge instead of perpendicularly, needed for such an activity.

Harvesting tools have been identified in three cases as a final activity (Table 1, 18-20) and on several occasions as a previous stage of use. Two of them are typologically an end scraper and end scraper/perforator with broken apex (No. 19, Fig. 6). The third one is a blade with continuous retouch with broken-off apex. In case of specimen No. 19, it is unknown, as is mentioned before, whether the cutting of cereals was the final stage of use, or if it was later used for hide scraping, since it would seem that larger blades, usually used as sickle inserts were often refurbished for other purposes. Specimen No. 20 was used as double sided insert, with observable "fresh" retouch over part of one edge. Another example, already mentioned, is specimen No. 12, with both retouched lateral edges covered with harvesting polish, and later used as a drill for antler of bone, with possible intermediate stage of scraping hide.

Tools associated with wood working can be divided in two main groups: specialized, planned tools represented by an axe head of Świeciechów flint (No. 21, Fig. 9: a), and tools that require less expertise to produce, such as splintered pieces or just flakes. While traces

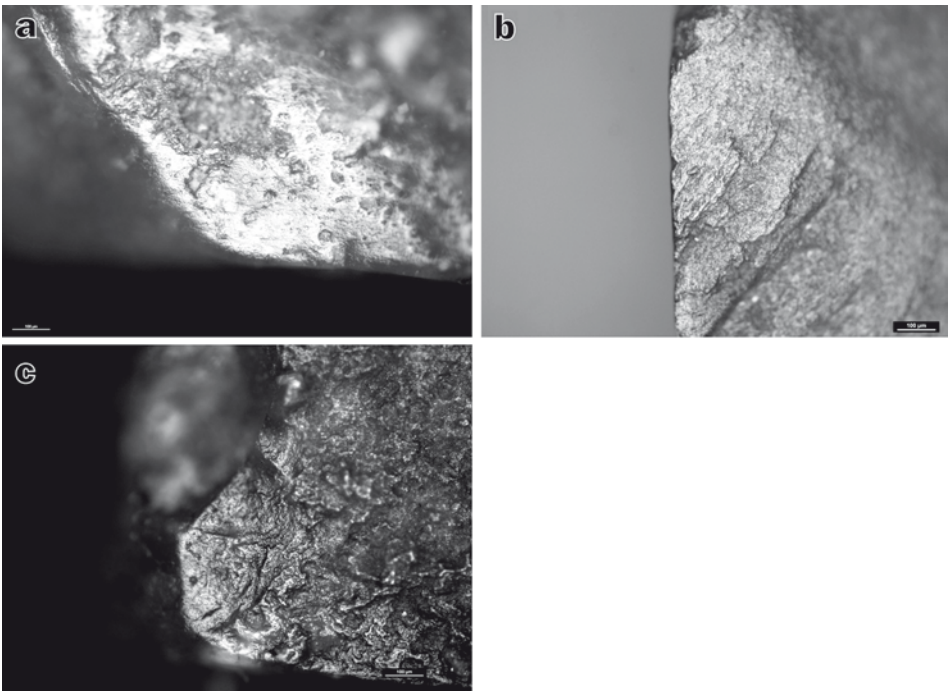


Fig. 9. Traces associated with wood working (a, b; axe head, No. 21, Feature 37 and flake from splintered piece, No. 25, Feature 61) and grooving antler/bone (c; fragmentary retouched blade, No. 14, Feature 70). Original magnification: a, b – 100x, objective 10x, scale bar: 100 μm

on the axe head are well developed in the working and handling area, the other tools were seemingly used in more expedient way. One of the splintered pieces, with traces of a sawing motion, has been made on the retouched blade (No. 22). It is therefore uncertain if the traces belong to the final stage of use. Specimen No. 23 has been used as a wedge in wood, or in similar matter (Fig. 8: a). It is possible, that specimen No. 25 also have been formed in a similar process. The use wear on the latter is, however, less developed (Fig. 9: b).

MINERAL MATERIALS

The only artefact with identified contact with mineral material of a character other than a technological one is the splintered piece strike-a-light mentioned above (No. 27, Fig. 7). Three other artefacts, with unidentified material contact, have wear traces suggesting cutting or scraping motion, usually not observed on the hard, mineral materials.

Deposition patterns

Out of 32 analysed artefacts, only five can be associated with a short circulation process (Table 2). Interestingly, most of them are splintered pieces. These include two specimens made on cortical flakes, one on a negative flake, and last one on an end scraper turned strike-a-light. Above that, only two flakes (one retouched) could be associated with early deposition, while all the typological tools circulated longer before final deposition. A similar

Table 2. Zawarża Site 2, Pińczów commune. Number of artefacts in category (broken down into prefabricate categories) in short and long circulation contexts

Artifact category	**Circulation**		**Sum**
Prefabricate category	Short	Long	
Blade		**1**	**1**
Blade production		1	1
Flake	**1**	**6**	**7**
Preparations	1	3	4
Bipolar technique		2	2
Repairs		1	1
Splintered pieces	**3**	**5**	**8**
Preparations	1	2	3
Flake production	1	1	2
Bipolar technique		1	1
Tools	1	1	2
Tools	**1**	**15**	**16**
Preparations		1	1
Blade production		13	13
Flake production	1	1	2
Sum	**5**	**27**	**32**

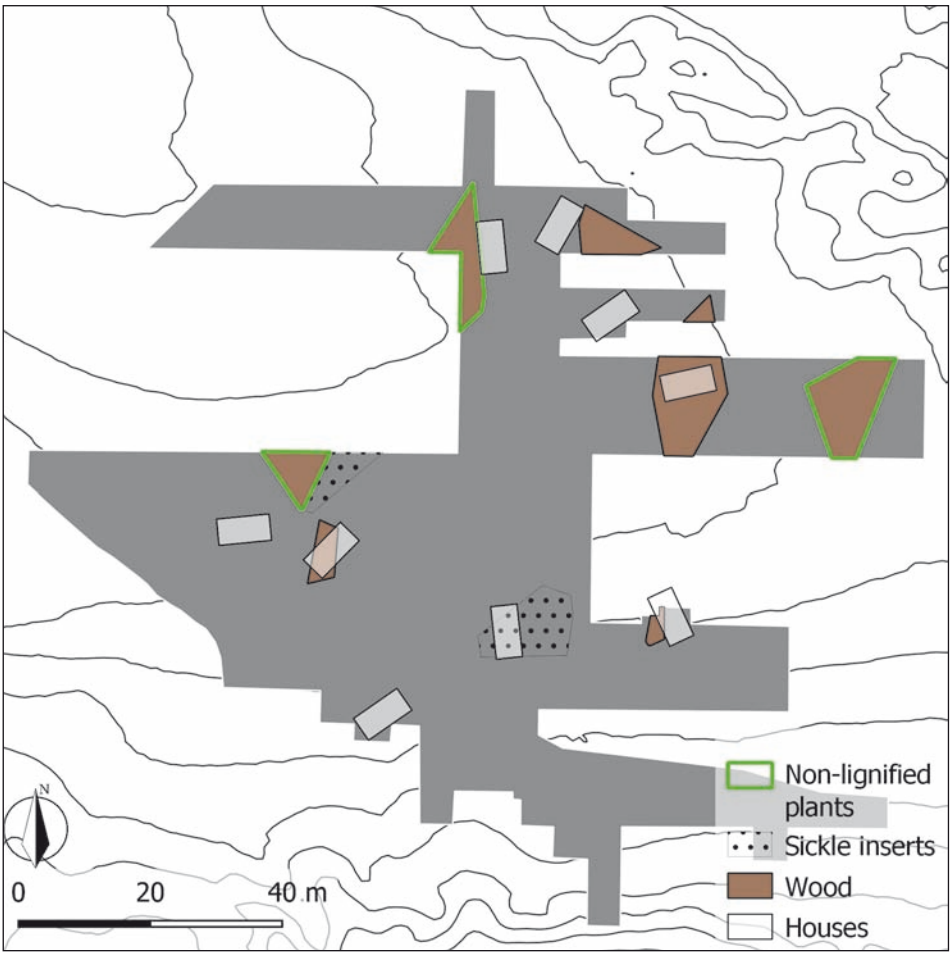


Fig. 10. Zawarża Site 2, Pińczów commune. Thiessen polygons representing deposition areas of tools used for processing plant-derived materials with localisation of supposed housing structures marked

trend can be seen also in the whole set of lithics: less than a quarter of 80 artefacts can be associated with short circulation patterns, in which also splintered pieces and flakes dominate. Moreover, tools in this subset consists of two retouched flakes, fragment of a retouched blade and a flint grinder. This picture would suggest that the users of flint tools executed most of the activities outside of the pits, and that more elaborated tools, and perhaps raw material itself, were not disposed of lightly.

The overall distribution of used lithic materials within the settlement does not exhibit any clear clustering. As depicted in Figures 10 and 11, tools associated with work involving processing animal and plant materials form distinct clusters in the central and western

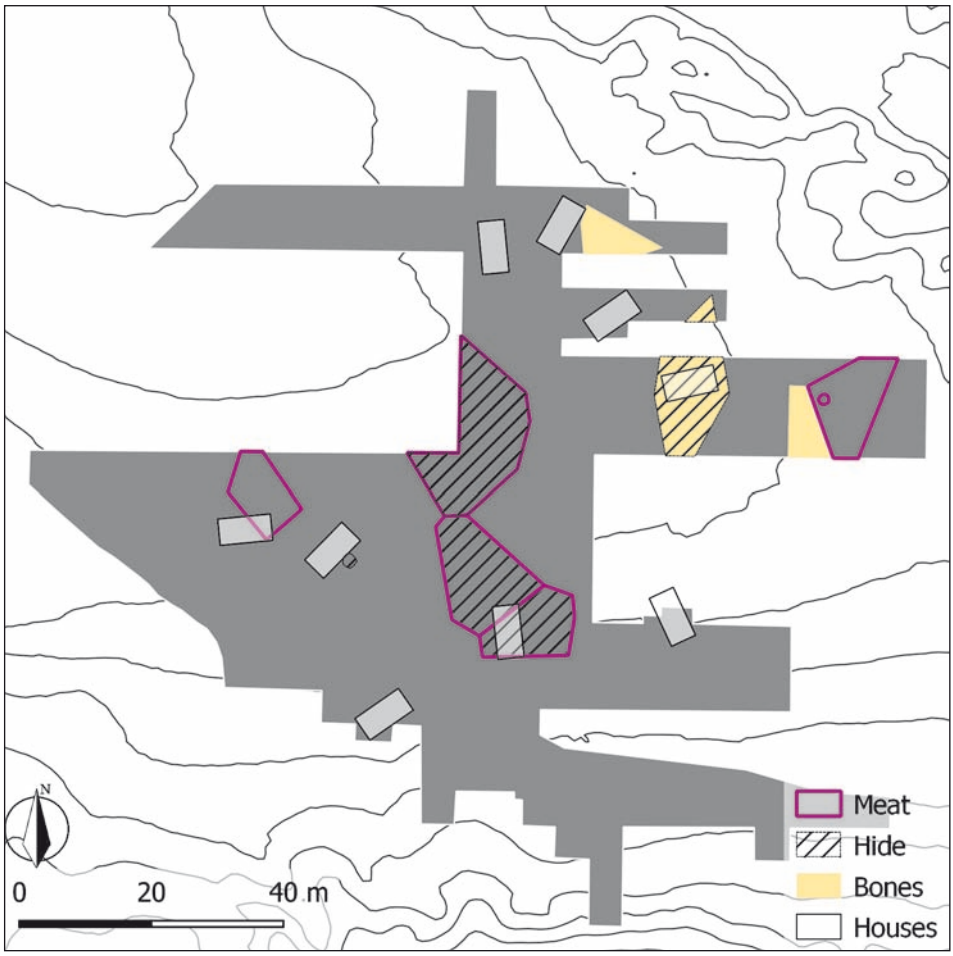


Fig. 11. Zawarża Site 2, Pińczów commune. Thiessen polygons representing deposition areas of tools used for processing animal-derived materials with localisation of supposed housing structures marked

portions of the settlement. However, in the eastern part, these clusters overlap. If the assumed location and concurrent usage of housing structures proposed by A. Kulczycka-Leciejewiczowa are accurate, one might expect household specialization in production within the settlement.

The concentration of pits in the eastern side of the settlement can be interpreted in multiple ways. It could potentially represent a common production area associated with processing animal-based material or a site for waste storage. Supporting the former function is the presence of a hearth (Feature 76) in that vicinity, as well as the presence of tools associated with bone or antler working. Notably, while both animal remains and items

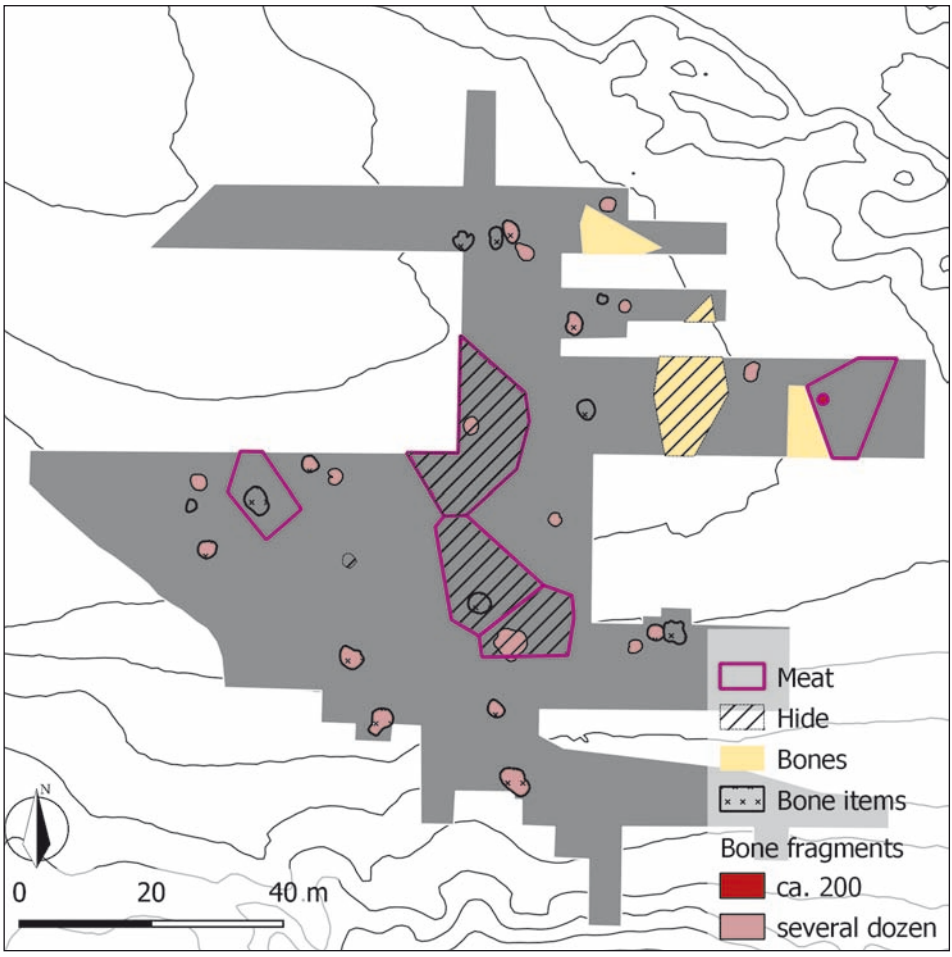


Fig. 12. Zawarża Site 2, Pińczów commune. Thiessen polygons representing deposition areas of tools used for processing animal-derived materials with localisation of features containing animal bones and bone/antler items marked

made of bone and antler are evenly distributed throughout the site, the highest density of bone deposits has been discovered in Feature 76 (Fig. 12). On the other hand, the downslope location of this area, on the opposite side of the ridge and near a small valley, made it ideal for deposition of cumbersome waste. Both of these factors, along with presence of tools used on soft animal tissues suggest that this area might have been used for activities like butchering. Conversely, the western part of the plaza appears to have been associated with "cleaner" activities. While lithics with traces of working on wood and softer plant materials have been uncovered there, two sickle blades were also found. These items were

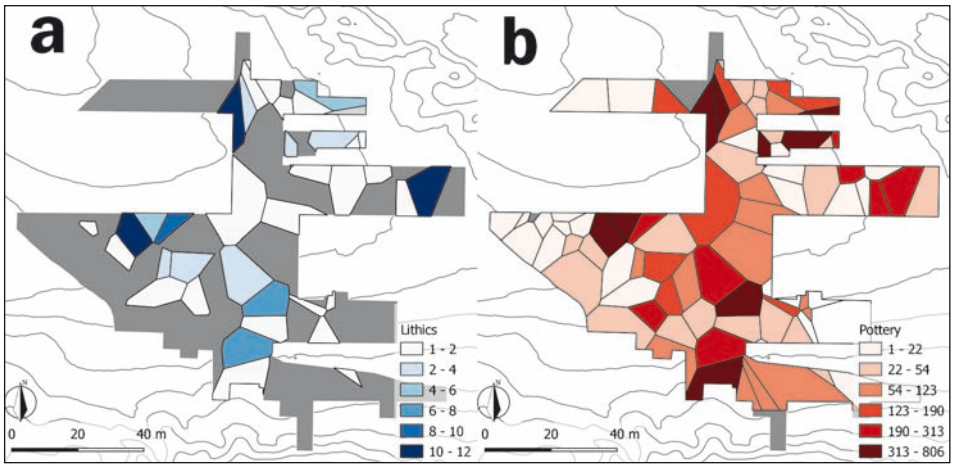


Fig. 13. Zawarża Site 2, Pińczów commune. Thiessen polygons representing deposition areas of lithic and pottery artefacts

likely not used in the centre of the settlement. According to experimental research, sickle blades tend to have a relatively long lifespan (*e.g.*, Osipowicz 2010, 86, 87). Examination of the sickle inserts from Zawarża did not reveal serious damage or blunting; instead, they appear to have undergone modifications aimed at extending their lifespan. Moreover, sickle inserts made from long blades could potentially be repurposed into other tools, as happened in the case of specimen No. 12 and in the case of tools from Bronocice (Kruk *et al.* 2023, 84). Thus, it is plausible that repairs, assemblage or reattachment of blades to handles were conducted in this location. In this area, a higher-than-average number of lithic artefacts have been found, including an axe head – a part of another specialized, composite tool that may have required repairs and maintenance, but serving a completely different function (Fig. 13: a). However, it is important to note that this area also yielded a high concentration of pottery fragments, the use and deposition processes of which are considered independent of the lithics (Fig. 13: b). Therefore, alternative explanations, such as the existence of a waste storage area or a natural catchment area for materials from the upslope region, should also be considered.

SUMMARY

In the lithic material from Zawarża, Site 2, there is an observable tendency to recycle tools. The whole preserved specimens made on larger blades are rare and show clear signs of long use. This applies also to the axe head, that has been used after at least one stage of repairs. On the other hand, flakes and splintered pieces were sometime discarded with no

or only general traces of use, regardless of the used raw material. Also, while tools made on flints from the Kraków-Częstochowa Jurassic Upland are more numerous than from Volhynian and Świeciechów flint, the ratio of tools/artefacts is higher for the latter two (Balcer 2002, tab. 2, 119). This pattern shows that the economic effort was concentrated into obtaining and maintaining specialised tools. The frequency of observed modifications suggest, however, that also other forms were not fully expedient, possibly due to limited flint supplies. Similar tendencies have been observed on the other FBC and FBC-Baden sites in the western Lesser Poland (*e.g.*, Brzeska-Zastawna 2017-2018; Kruk *et al.* 2023, 84). In the general terms, these results support observation made by B. Balcer, that Zawarża was a settlement of flint users, and not producers (Balcer 2002, 127).

The problem of use of splintered pieces as a wood wedges is interesting from the use-wear perspective. While B. Balcer (1975, 130) indicated such possibility, it seems that the traces of such activities are rare – possibly due to the susceptibility of such tools for chipping. In this case study, both splintered pieces and splintered flakes had polish that could be associated with wood working. Although, in conducted experiment of such kind, the wedges (made of chocolate flint) had many more striations of "technological" type, that probably resulted of multiple chipping during the work. Experimental work by W. Migal on the topic suggests, that composition of hammer and anvil makes about as great a difference as flint variety used in the bipolar technique (Migal 1987). In accordance to the mentioned above picture of scarcity of material needed for production of specialised tools such as axe heads and ubiquitous presence of splintered pieces in FBC settlements, more experiments including these products should be conducted.

The results of the analysis of deposition of used artefacts shows that most of the tools can be treated as tertiary refuse (according to Kuna's system), and they were characterised by longer circulation before final deposition. An exception to this rule is, once again, splintered pieces and flakes. On the eastern side of the site, there is a probable area associated with processing animal-based materials. For the exact nature of it, an analysis of the cut marks on the bones discarded there should be included, but traces of work on hides, meat and bones combined suggest a butchering site. In the light of the above discussion, it seems possible that there was some kind of specialised area in the central part of the site, not associated with specific materials, but for example accommodating activities such as repairs of axes or sickles. It would be in accordance with the diversified toolset found in this area. Reconstruction of such workshop areas is a complex task, requiring analysis of multiple chains of processing. At last, it is hard to pinpoint activities related to the housing structures without clear traces of them. It seems that some diversified activities could have occurred in the central plaza of the site, although it clearly overlaps with the portion of the site that has not been excavated – and where other houses should have been to enclose the ring. This fact impedes also an interpretation of the high amount of other archaeological material in this area. On the other hand, in the proximity of some reconstructed houses similarly varied activities have been recorded – most notably in the southern part of the

site (clusters with Features 5, 15 and 36, 39; Fig. 2). This fact would suggest a more household-based economy. Although, also in the model suggested by A. Kulczycka-Leciejewiczowa, such activities would be possible. It is likely that the distribution of pits, fireplaces and other remains, used by this researcher as a proxy, did not in every case relate to houses, but maybe to other structures of economic importance. Even if that is the case, collective processing would be expected in at least some areas of the site – most probably one associated with butchering. This fact does not, however, mean that animal-based economy was more important to the occupants of the settlement, even in combination with the high number of bones in archaeological features. An analysis of the economical profile of the site requires an adjustment for the loss of plant materials, which are preserved only exceptionally. As far as a comparison between number of tools used for processing materials of plant and animal origin can tell, both "branches" of the economy should be considered as having been of roughly equal value. In both groups, curated tools of imported lithic materials can be found as well. The most important thing that the deposition patterns of lithics in Zawarża shows is that the different materials were likely processed in neighbouring or even the same spots in various configurations, suggesting a complex and an intertwined character of the economy.

Acknowledgements

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A SUPERB AXE-HEAD OF G-TYPE FLINT FROM THE VICINITY OF BRONOCICE AS A REASON TO CONSIDER THE PRODUCTION OF MACROLITHIC FOUR-SIDED TOOLS IN THE ENEOLITHIC OF LESSER POLAND

ABSTRACT

Brzeska-Zastawna A., Kufel-Diakowska B. and Zastawny A. 2024. A superb axe-head of G-type flint from the vicinity of Bronocice as a reason to consider the production of macrolithic four-sided tools in the Eneolithic of Lesser Poland. *Sprawozdania Archeologiczne* 76/1, 469-496.

This article presents the study of a unique artefact in the form of a very large trapezoidal axe-head with rectangular section from Słupów, Lesser Poland, against the background of Eneolithic phenomena occurring in the area. The specimen is in the collection of the Archaeological Museum in Kraków since 1929, but has not been discussed until now. It was made by local communities from flint of the G variety, a raw material exploited by Eneolithic groups in western Lesser Poland. The axe-head from Słupów is one of the largest flint axes to have been discovered on Polish lands. This find provokes a broader discussion of the role of local production of macrolithic four-sided forms against a wider background.

Keywords: Eneolithic, Funnel Beaker culture, Funnel Beaker-Baden assemblages, flint axe, microwear analysis

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INTRODUCTION

In 1929, the Archaeological Museum of the Polish Academy of Arts and Sciences (AM PAAS) in Kraków purchased for its collection a flint axe-head (hereafter abbreviated as "axe") discovered in the village of Słupów, located near Bronocice on the Nidzica River in Miechów district. Due to its raw material, dimensions, state of preservation, as well as the area where it was found, it is a unique artefact, but it has not been studied for over 90 years. Although it is hard to believe, the axe from Słupów, one of the largest flint axes to have been discovered on Polish lands, has not been included as a source or comparative material in any study of flint knapping and in works on the Eneolithic in Poland in general. With this publication, we fill this gap by discussing the axe from Słupów in typological, raw material, use-wear and cultural aspects.

Since its addition to the collection, the artefact in question (inv. no. MAK/8513) remains stored at the Archaeological Museum in Kraków (AMK). On the subject of the find from Słupów itself, there is little information in the museum's archival sources (Archives of the AMK). There are just two pieces of information about the artefacts and a list of several bibliographic items, but do not refer to the axe purchased by the AM PAAS. It was only in 2018 that it became an exhibit in the temporary AMK exhibition („From collecting to museology. 160th anniversary of the first exhibition at the Archaeological Museum in Kraków") and an element of the catalogue accompanying this exhibition (photo and brief catalogue note; Liwoch 2018, 68, 69). Recently, information about the artefact discussed here has been included in an online popular science portal titled "Archaeological Atlas of Małopolska" (Atlas 2021), developed by the AMK.

CONTEXT OF THE FIND AND INFORMATION ABOUT THE ARTEFACT

Except for the date of the acquisition of the axe from Słupów by AM PAAS in Kraków in 1929, unfortunately, no further information is known (has not survived) about the circumstances of the purchase of the object, its finder (seller), and, above all, where the axe was discovered in the field. Słupów is a small village located on the border of the Miechów Upland and the Proszowice Plateau, on the right bank of the Nidzica River, at a distance of 2.5 km from the town of Działoszyce and less than three kilometres from Bronocice (Fig. 1). The eastern and northern parts of Słupów are occupied by a floodplain valley of the Nidzica River with numerous fish ponds, while the rest of the area is dominated by a typical upland landscape, with several terrain-exposed loess hills (including the names Mojżeszówka and Grudziec).The area is used extensively for agriculture and is almost entirely deforested. It is drained by only one larger right-bank tributary of the Nidzica River, which flows into the river in the centre of the village. According to the Polish Archaeological

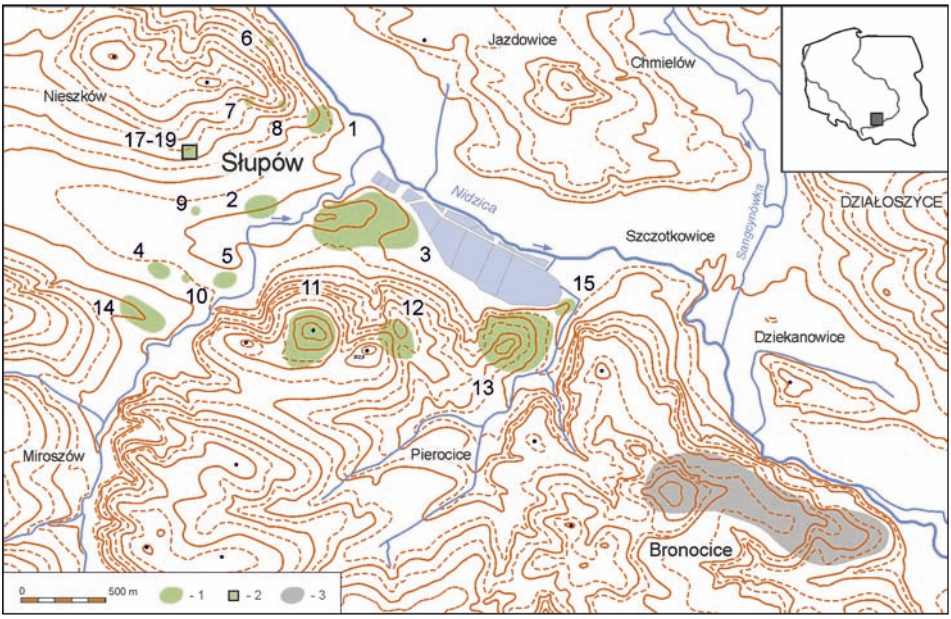


Fig. 1. Distribution map of archaeological sites in the area of Słupów, Miechów district: 1 – sites, 2 – finds without location, 3 – Site 1 in Bronocice. Illustration by A. Zastawny

Record (Polish abbreviation: AZP), twenty archaeological sites are registered in Słupów. Settlement points are located within two AZP areas: 96-59 and 96-60. The axe discussed in the article was given No. 17 in the locality and on the sheet AZP No. 96-59/2 (KESA card by J. Górski and M. Zając), as a stray find, with no known location. This designation is no more than a sequential number. The exact find-spot of the artefact remains unknown.

We know of the first archaeological finds from Słupów thanks to the field activity of M. Wawrzeniecki. At the end of the nineteenth century, he collected a little archaeological material in the fields belonging to this village in the form of "a few fragments of vessels of a very ancient period" (Wawrzeniecki 1898, 56; 1900, 93). These artefacts are not in the collection of the AM PAAS (it is uncertain whether they were stored there at all), but the information about them was repeated in later literature, including Słupów in the list of Neolithic sites on this basis (Kozłowski 1924, 49, 174, fig. 2). In the interwar period, a ceramic vessel was accidentally discovered at an unknown location, interpreted as burial equipment of the Pomeranian culture (Kostrzewski 1922/1924, 42, 43; Nosek 1946, 58). In 1952, surface research in the Słupów area was conducted by T. Lesiak, who discovered tools made from Jurassic flint of the G variety on one of the loess hills (collection of the AMK). The first finds with an established and documented location were obtained only during several field campaigns organised within the framework of the AZP by a team of archaeologists from the Polish Academy of Sciences in 1977-78 (Liguzińska-Kruk 1981),

W. Morawski in 1985, and J. Górski and M. Zając in 1999 (AZP documentation). This work led to the discovery of material primarily of the Bronze Age, of the Mierzanowice, Trzciniec, and Lusatian cultures, with much less numerous Neolithic/Eneolithic finds.

In trying to indicate the presumed site of the discovery of the axe from Słupów, only two sites with Neolithic/Eneolithic material currently known. The first is site No. 13 (AZP 96-60/18), located in the southeastern part of the village, situated on an isolated hill in the fork of the Nidzica River (Fig. 1) and the stream feeding it, flowing through Pierocice (a site located on the border of Słupów and Pierocice, also referred to in the literature as Pierocice, Site 1; Liguzińska-Kruk 1981, 201). During W. Morawski's surface survey in 1985, a fragment of a vessel with Funnel Beaker-Baden (FB-Baden) features was discovered here. The second site is located about 1 km to the west of the above, site No. 11 in Słupów (AZP 96-60/16), located in the part of the village called Grudziec, on the culmination of a loess elevation. An assemblage of several dozen fragments of Neolithic/Eneolithic pottery comes from surface examinations in 1977-1978 (Liguzińska-Kruk 1982, 201). Some artefacts made of type G raw material (among others, a continuous retouched blade fragment), discovered by T. Lesiak in 1952, can also be associated with this site. No excavations have been conducted at any of the sites indicated as potential sites for the discovery of the axe discussed in the article.

The middle basin of the Nidzica River is an area with traces of intensive Neolithic and Eneolithic settlement settlement from phases representing almost all cultural groups, from the Linear Pottery culture to the Corded Ware culture (CWC) (Kruk *et al.* 1996). The upland settlement of Bronocice, Site 1, is located in the centre of this area, with Słupów nearby (Fig. 1). In the settlement region of Bronocice (an area with a radius of 10 km around the site), the most numerous are traces of the Funnel Beaker culture (FBC), BR II-III phases, more than 100 sites (Kruk *et al.* 1996, 28; Kruk and Milisauskas 2018, 10, fig. 1: B).Traces of FB-Baden settlements have also been recorded on a dozen of them, with the main settlements in Bronocice from two settlement phases: BR IV and BR V (Kruk and Milisauskas 2018). During the period c. 3600-2900 BC, Bronocice played a leading role here in both the extensive settlement system of the FBC and the heavily reduced network of the FB-Baden sites (Kruk and Milisauskas 1999). Situated at a distance of three kilometres from Bronocice, Słupów was in the immediate zone of diversified settlement activity of the communities living at the site in Bronocice.

DESCRIPTION OF THE AXE-HEAD AND MANUFACTURING TECHNIQUES

The specimen in question is a trapezoidal flat axe with rectangular section, which regularly expands towards its cutting edge (Figs 2-4). The axe is characterised by unusual symmetry and not much thickness in relation to other dimensions. Its maximum dimensions



Fig. 2. Słupów, Site 17, Miechów district. Axe made from flint of type G. Photo by A. Susuł

are 240 mm long, 101 mm wide, and 32 mm thick. It weighs 1080 g. Other dimensions are: width at its midpoint – 83 mm, side width – 26 mm, thickness at its midpoint – 32 mm, width at the top (2 cm below the edge of the butt) – 60 mm, thickness at the top (2 cm below the edge of the butt) – 23 mm, width of the butt – 55 mm, thickness of the butt – 17 mm. It is made from flint of the G type. Raw material outcrops of the G variety have been identified in the central part of the Kraków-Częstochowa Upland (Pelisiak 2008; Kopacz 2020).

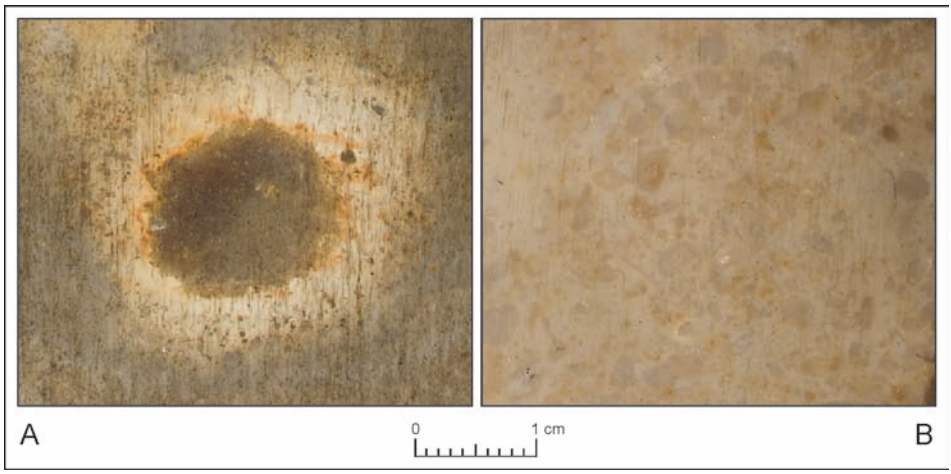


Fig. 3. Słupów, Site 17, Miechów district. Features of G-type flint visible on the surface of the axe: A – brown oval structure framed by a reddish and white matt bands, B – "greasy" spots. Photo by A. Susuł

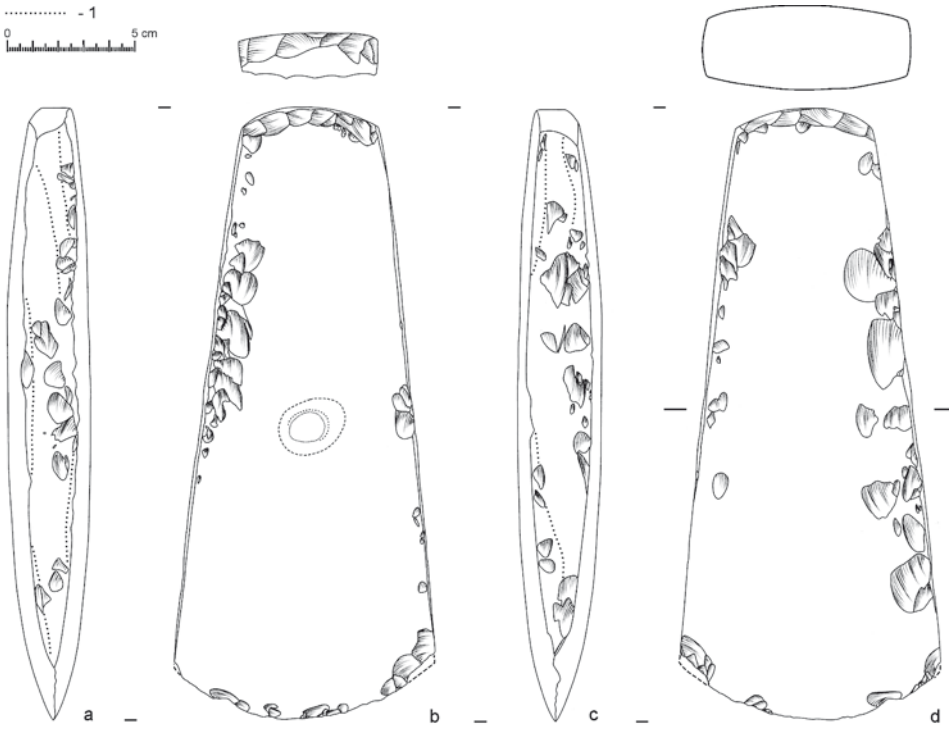


Fig. 4. Słupów, Site 17, Miechów district. Axe made from flint of type G: 1 – zone boundaries ground at different angles, a-d – designations of faces and sides. Drawn by A. Brzeska-Zastawna

It was mainly used for the production of rectangular-sectioned axes and large blades. It is very distinctive, different from other raw materials (Figs 2 and 3). On macroscopic viewing, the G flint is beige in colour and has characteristic "greasy" spots (Fig. 3: B). In the flint mass, sometimes there are structures in the form of an oval brown colour, edged with a white matte band (Fig. 3: A). It is the best locally occurring raw material in the Kraków-Częstochowa Upland, suitable for producing the largest blades as well as durable and large rectangular-sectioned forms, used mainly by the communities of the FBC, FB-Baden assemblages, the Baden culture (BaC) and also the CWC.

The cutting edge is markedly curved and symmetrical with a height of 21-22 mm. The spine plane angle is 70°. On the edge of the blade, damage is visible in the form of small scars. In cross-section, it is rectangular, with moderately convex wider faces (6 mm), and minimally convex, almost flat, sides (2 mm). The sides of the axe were formed centripetally by flaking from both main faces. The surface of the butt has a roughly rectangular outline. The surface of the butt shows traces of faceting, which has been partially smoothed. In plan view, the part at the butt is symmetrically trapezoidal with a convex top. The part at the butt has also been shaped with regular facets (blows in the direction of the cutting edge) visible on both main faces. Flake scars of the axe forming process have been almost completely removed.

The axe was shaped by flaking the so-called "full core" method (for a characterisation of the technology, see for example Migal and Sałaciński 1996), which involves the gradual reduction of the flint nodule in several stages (Vemming Hansen and Madsen 1983), starting with giving it a tetrahedral form, and ending with giving the semi-finished product the final form, with formed cutting edge and butt. In the final stages of shaping, the semi-finished product of this type of axe was precisely aligned using indirect percussion and sometimes a very precise pressure technique (Vemming Hansen and Madsen 1983). The final stage of shaping axes involved grinding main the faces, or all surfaces, including sides – as in the case of the specimen from Słupów. The sides of the axe discussed here were shaped with centripetal flaking from two wide faces, resulting in symmetrical even sides (symmetrical shape in cross-section). The axe bears traces of two major grinding stages. The first stage consisted of wide-surface removal of negative flake scars (and any irregularities), most likely with the support of an additional weight (Madsen 1984), a process that left regular, longitudinal, wide grooves on its surfaces (see also microscopic analysis). The extra weight increased the efficiency of grinding (Madsen 1984), a process more tedious when processing very large axes by hand. The second consisted of giving the final desired form (including symmetrical protuberances), by hand grinding the surfaces at the appropriate angles. In the case in question, the vast majority of scars from the basic axe-forming stage were completely removed in this final process. The grinding procedure, although time-consuming, especially in the case of larger axes (Madsen 1984), was essential for obtaining a damage-resistant blade (Olausson 1983). The resistance of the axe-head was sometimes further increased by performing additional polishing of the area near the



Fig. 5. The axe from Sigerslev Bog. Photo © National Museum of Denmark; after Noble 2017, fig. 3.2.

cutting edge itself. The degree of polishing of an axe (obtaining smooth surfaces) is reflected in its strength when performing work (Olausson 1983), *i.e.*, the greater the degree of polishing and the fewer remaining negatives, the greater the axe's strength and resistance to damage. The edge angle of the axe is 70 degrees, indicating high efficiency in entry into the wood of the blade while maintaining a "safe" angle for cutting edge strength (Olausson 1983). A smaller angle increases the work efficiency of a blade, but then it is more susceptible to damage. In order to maintain the high efficiency of the blade's entry into the wood, while not exposing it to such damage, it was common to make a thinner line on the very edge of the axe-head. The cutting edge of the axe from Słupów bears traces of such flattening of the very end of the cutting edge and resharpening of the blade. Moreover, axes with a curved blade, as in the case of the specimen in question, are more durable than those with a straight blade.

As microscopic analyses (see below) have shown, the axe in question bears traces of use. It is likely that its main function should be related to woodworking. There are also traces that may indicate interaction with the soft material used for binding. The possible kind of hafting of the axe-head from Słupów can be indicated by the example of axe-head finds with preserved shafts from waterlogged regions of the western part of the North European Plain. An example as close as possible in general form and dimensions to the Słupów specimen is a thin-butted polished axe from Sigerslev Bog (Fig. 5, after: Noble 2017, fig. 3.2). The length of the axe-head itself is 21 cm, whereas the preserved handle (not preserved in its entirety; combined measure of fragments) made of ash measures 53 cm (Olausson 1983). In this case, the butt protrudes beyond the shaft.

MICROWEAR ANALYSIS

One of the fundamental questions raised while studying ground flint tools is the functional interpretation of these objects. This should be based on the observation of use-wear traces recorded on tools (Madsen 1984; Rots 2010; Wentink *et al.* 2011; Pyżewicz 2013; Pyżewicz *et al.* 2016). Traces suggest the type of activity performed and category of material processed with a stone tool, relative duration of use, and a hafting method. In the case of the flint axe from Słupów, we discuss two main issues, whether the object was used as a tool *sensu stricto*, or whether it had been produced for a special purpose, and also what kind of hafting and binding method had been applied. Due to the fact that the axe was collected decades ago from a surface site and then stored in the museum, it was necessary to assess the state of the artefact and the influence of its condition the on preservation of microwear.

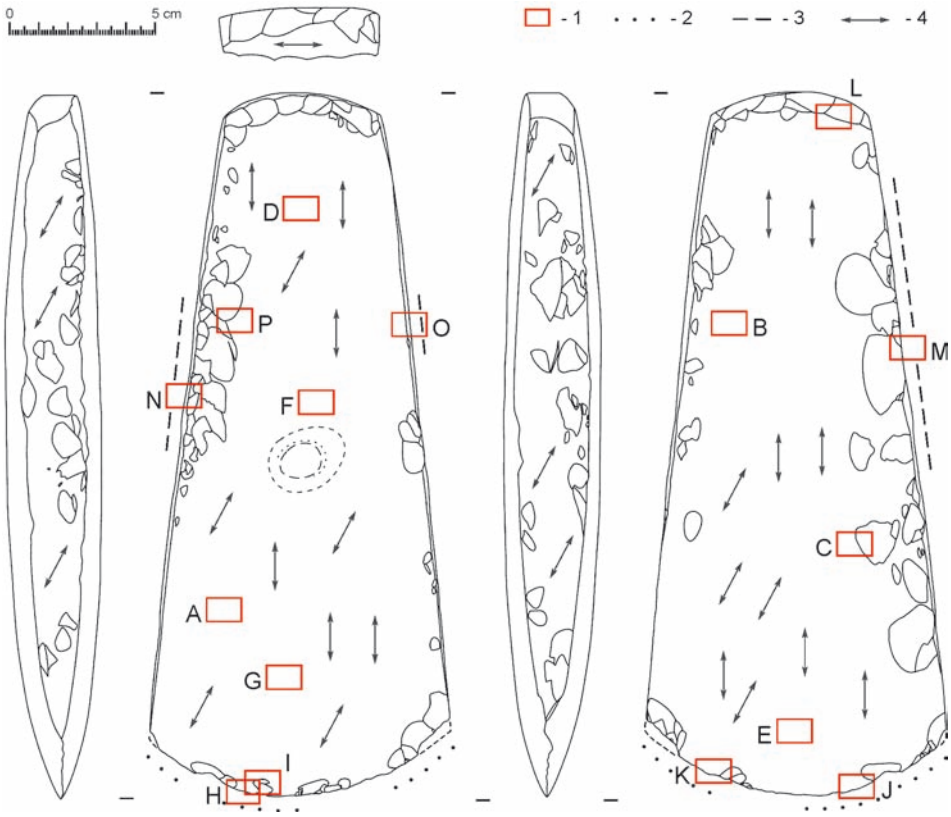


Fig. 6. Słupów, Miechów district. Microscopic observations of the flint axe: 1 – area documented under the microscope (letters correspond with photos on the Figures 7 and 8), 2 -use-wear limit, 3 – limit of a haft/wrapping, 4 – direction of grinding. Drawn by A. Brzeska-Zastawna and B. Kufel-Diakowska

Traces were analysed using two optical microscopes: an Olympus SZX9 stereomicroscope (×6.3-114) for identification of the use retouch and the sequence of the technological traces; a Nikon ECLIPSE LV100 metallographic microscope (×50-500) for identification of use and hafting polish. Prior to the microscopic observations of use-wear, the axe was wiped with acetone in order to remove dirt covering the surface and bottoms of the negatives of technological retouch and use scars. The artefact did not bear any soil remains. Therefore, to prevent the removal of possible microresidues, we decided not to apply a chemical or ultrasonic method of cleaning. Due to the large size of the artefact and the limited working distance of microscopic equipment, especially in case of the microscope with higher magnifications, more detailed observation of microtraces (use polish) located on the cutting edge was not possible. Identification of use-wear traces was limited to observation of mechanical damage of the cutting edge (use scars) and hafting traces.

The artefact is complete and well-preserved. No mechanical damage was recorded with the naked eye (Fig. 6). Under magnification, the surface of the artefact is weathered and "etched" (Fig. 7: A). Alterations are mostly observed on the top parts of the surface relief. Moreover, on one main surface, close to the side surface, there is modern abrasion filled with reddish-brown iron oxide (Fig. 7: B). Similar phenomena are also observed on the very edge adjoining the side surface. These patches of abrasion owe their origin to contemporary activities, such as agricultural machine work, occurring directly in the place of deposition. Remains of ink suggest that the axe was subjected in the past to some kind of labelling (presumably in the museum).

Microscopic observations showed that despite post-depositional changes, traces of manufacture and use of the flint axe are still preserved on the surface of the artefact (Fig. 6). The production process included a few phases. The traces of the initial phase are barely visible on the finished product. Only the bottom parts of the flake negatives relating to the flaking phase are preserved on all four sides of the tool, particularly along the edges and near the butt. We notice the most dense clusters of scars there. The edges of the flaking scars are flattened as a consequence of the next phase, the grinding of all four faces and the butt (Fig. 7: C). Grinding traces are visible in the form of broad or narrow striations thoroughly covering the whole surface of the tool. A similar grinding method and direction of movement were applied to all surfaces. First, both main faces were ground longitudinally. Work with extra weight applied cannot be excluded at this stage of the axe production (Madsen 1984; Pyżewicz *et al.* 2016). Coarse grinding produced broad scratches parallel to the lateral edges, densely distributed on both main faces (Fig. 7: D, E). Then, all four sides and the butt were shaped using fine-grained slabs and probably additional sand (Pyżewicz *et al.* 2016). Different grinding directions were applied, in order to obtain a convex profile of main faces in the cross section. The hand grinding resulted in some separated grinding surfaces on both sides of the axe. This activity produced fine striations diagonally orientated to the main axis, preserved on the side surfaces, over almost the whole area of main surface 1 and about half of main surface 2. Oblique striations from the fine grinding phase

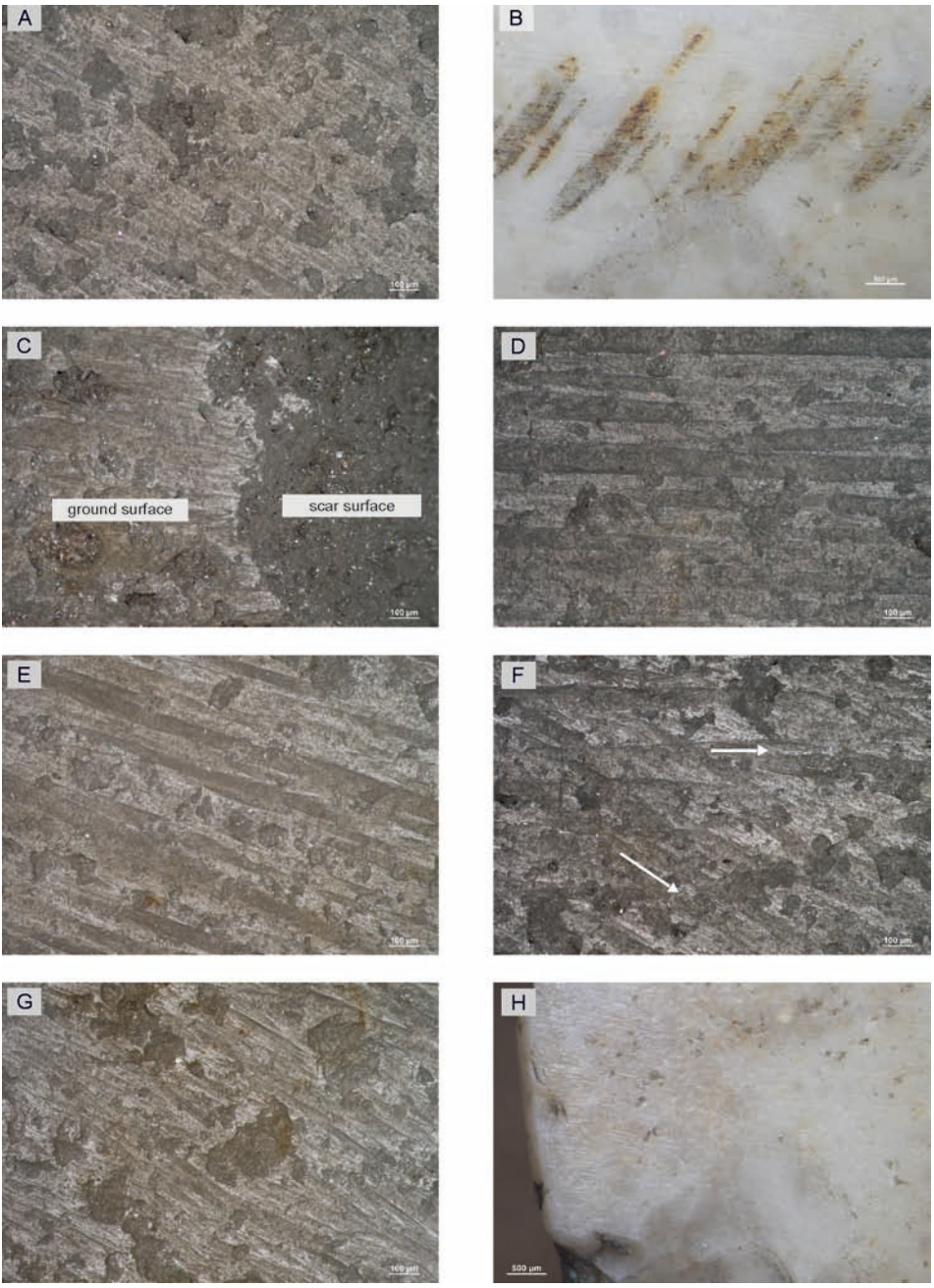


Fig. 7. Słupów, Miechów district. Photographs showing traces on the flint axe: A – weathered surface; B – modern abrasion and reddish-brown iron oxide; C – ground scar's ridge; D-G – grinding traces on the surface; H – grinding traces on the cutting edge. Photo by B. Kufel-Diakowska

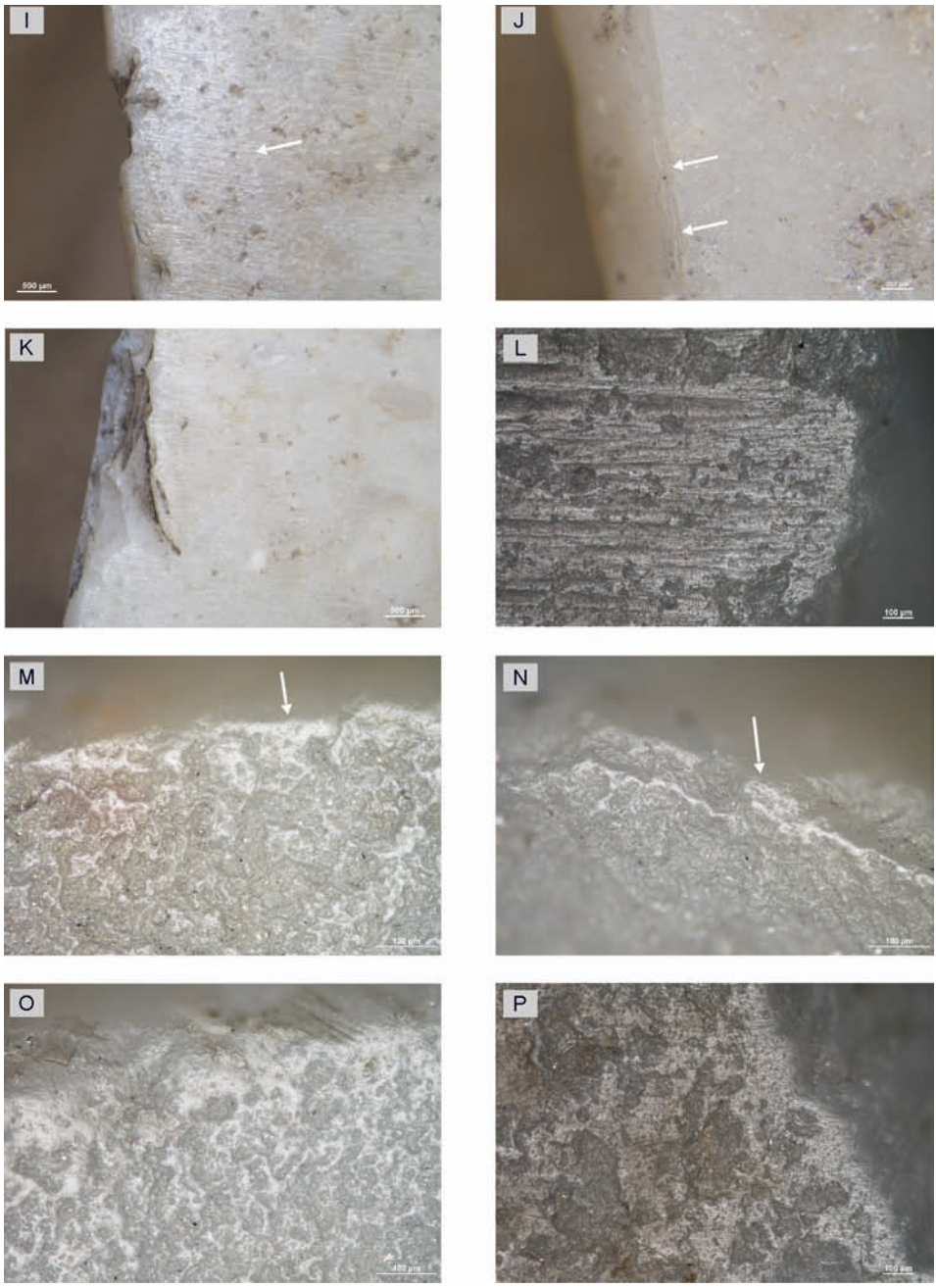


Fig. 8. Słupów, Miechów district. Photographs showing traces on the flint axe: I – grinding traces on the blade; J – flattening of the blade; K – use scars on the cutting edge; L – rounding of the scar's ridge; M-O – "plant" polish and rounding of the lateral edges; P – rounding of the scar's ridge. Photo by B. Kufel-Diakowska

clearly cross the longitudinal furrows produced by coarse grinding (Fig. 7: F, G). The traces of grinding the butt are barely visible. They were most likely smoothened in the course of usage.

There are two separate grinding surfaces along the cutting edge. The first one reaches about 4 mm into the main surface, on each side; the second one is located next to it, but only on one side (Fig. 8: I). Traces of blade re-sharpening (Gijn 2010, fig. 6.8; Januszek and Pyżewicz 2018, fig. 8) are visible as short, fine, densely distributed striations, diagonally and longitudinally orientated to the blade (Fig. 7: H). Moreover, the very edge of the blade was flattened. It is not sharp, but 1 mm thick. The flat surface exhibits fine parallel striations (Fig. 8: J). The traces of use preserved on the cutting edge are secondary to flattening, which excludes the post-use origin of the blade abrasion. We suppose that this deliberate action was performed for the purpose of protecting the blade against mechanical damage. Also, it might be a part of a re-sharpening process.

The blade is densely covered by deep and semi-deep feather- and hinge-terminated scalar fractures. They are distributed in small groups and located on both sides of the cutting edge. Unfortunately, this edge damage was of accidental, post-depositional origin and caused the loss of valuable data on the use of the axe. Some use scars, such as small, step-terminated trapezoidal fractures preserved only on protruding parts of the blade (Fig. 8: K) were produced as a result of chopping of an undetermined material. There is no use polish observed on the cutting edge.

Despite the fact that there are few traces of use on the working edge, marks detected in other parts of the artefact unquestionably suggest that the axe represents long-lasting circulation in the cultural context. First, abrasive traces of grinding the butt have been smoothened. This part of the axe is slightly rounded, including the butt surface and the edges of the negatives from the flaking stage of the manufacture process (Fig. 8: L). Secondly, in the middle part of a tool, three longitudinal edges of the axe are highly rounded and covered by bright reflective polish. This type of gloss suggests contact with plant material (Fig. 8: M-O). The polish extends from the butt part to about two-thirds of the length of the tool, which is clearly visible on one of the edges. Furthermore, the ridges of the flaking scars located close to the longitudinal edges of the axe are also highly rounded and covered by abrasive, short striations, suggesting contact with hide (Fig. 8: P). The traces described here might have been produced by the interaction between the tool and the materials used for fixing a wooden shaft (Pyżewicz 2013). Because of the lack of composite finds from the middle part of Europe, we need to look for the analogies of flint tools fixed in organic hafts from Denmark and the Netherlands (Vang Petersen 2008, fig. 48, 50). In case of the axe from Słupów the shaft must have been solid and made of wood. The axe was inserted into a hole or a deep groove at one of the shaft extremities (lateral tool placement according to Rots 2010, 12). In this case, the flint axe was probably fixed with bindings (using soft vegetal or animal materials). The limit of the traces observed show that the haft reached down about two-thirds of the whole length of the tool.

Based on the microtraces recorded on the flint artefact from Słupów, we can describe this tool as an axe, which might be used for falling trees as well as was engaged in construction works and other activities that required chopping wood. Traces of use are not well developed, though, in case of macrolithic ground tools this is nothing extraordinary (Korobkowa 1999, 140; Pyżewicz *et al.* 2016). Also, the multifaceted process of manufacture, which included the flaking stage, coarse grinding, and fine grinding, as well as two separate phases of blade re-sharpening, represents typical mode of operations. What is unusual is the size of the axe. The length reaches 24 cm. Slightly developed traces in the butt area may suggest rather short duration of work. In this context, the most interesting is well-developed plant polish on the lateral edges of the tool. K. Wentink (2006) interprets a presence of bright reflected gloss on TRB flint axes as a result of a kind of passive action, like wrapping, unwrapping, and transport of the objects, particularly oversized ones (Wentink 2008). This concerns mainly tools retrieved from the contexts of votive offerings, which consist of a few similar artefacts; those of biggest size display no traces of use (Wentink 2008; Wentink *et al.* 2011). Regarded as impractical due to their size and weight, oversized axes are linked to the ideological sphere of life in the past and a ceremonial role in a broad sense (Van Gijn 2010). In the case of the axe from Słupów, the uncertain contextual data prevent from further interpretations concerning the use life and function of a tool.

Due to the large size of the artefact and the limited working distance of microscopic equipment, especially in case of the microscope with higher magnifications, more detailed observation of microtraces (use polish) located on the cutting edge was not possible. Identification of use-wear traces was limited to observation of mechanical damage of the cutting edge (use scars) and hafting traces.

DISCUSSION

Axe dimension

Certainly the sheer size of the axe (24 cm) also draws attention. The specimen surely belongs to the group of the largest flint axes from Polish lands. Among the producers of very large quadrilateral forms, the communities of the FBC come to the fore (Balcer 1983). B. Balcer (2002a) divided the axes of the FBC into small ones, up to 110 mm long, and large ones, over 120 mm long. Among the axes of the FBC associated with the south-eastern production centres, specimens less than a dozen centimetres in length are most common, but there are more large axes compared to other Eneolithic cultural units (Balcer 1975; 1983; 2002a). Also noteworthy are the very large axes from Pomerania coming from the northern production centres of the FBC (Balcer 1983). In addition, there are large, more than 20-centimeter-long axes from Kuyavia, including those representing specimens very similar to the axe discussed here (*e.g.*, Balcer 1983, fig. 27: 4). Interestingly, there is

evidence of the importation of these macrolithic tools into the area of the Eastern Group, made in addition to "south-eastern" and ""northern" raw materials, also those made of Jurassic flint (Balcer 1983, 153), presumably of the G variety. However, this is a separate issue. Small axes dominate in the contexts of other units of the Late and Final Eneolithic, in which quadrifacial axes play a leading role, in the graves of the Globular Amphorae (GAC) and CWC (Balcer 1983; Nosek 1967; Bronicki 2021; Włodarczak 2006; Budziszewski and Włodarczak 2011). Among the GAC axes, as in the case of the CWC, specimens up to several centimetres in size predominate, infrequently exceeding the dimension of 15 cm. Very large axes, more than 20 cm in length, are sporadically found in the context of the GAC. Against this background, specimens exceeding this size definitely stand out, including the exceptional find of an axe from Sadłowice, Opatów district, made of striped flint, a 'model' example of the GAC axes, with a dimension of 23.3 cm, probably from a destroyed grave or graves of this culture (Bajka and Florek 2022). In the graves of the Złota culture, among the less numerous axes from the above-mentioned units, there are smaller axes, about 10 cm long, and those whose length oscillates around 15 cm (Krzak 1976). In other cultural units, the axes are mainly represented by artefacts of settlement character.

From the central and eastern part of Lesser Poland in the context of the FBC, there are relatively many axes classified as large specimens according to B. Balcer (2002a); a relatively large proportion of a non-transformed form exceeds the dimension of 15 cm in length, compared to the axes of other units (Balcer 1975; 1983; 2002a). Among the finds from Lesser Poland linked to the FBC, the most noteworthy are axes made of striped flint, a trapezoidal axe from Ostrowiec Świętokrzyski 1 near Krzemionki, about 23 cm long (Balcer 1983, fig. 21; Migal 1997, fig. 1), ground only at the cutting edge. The specimen is, moreover, very similar to the unfinished axe from Ćmielów from Cluster 1, mentioned by B. Balcer and measuring about 20 cm in length (Balcer 2002a, 34a). Z. Podkowińska (1951/52) determines its length at as much as 25 cm. W. Migal (1997) mentions the largest known axe of the FBC made of striped flint measuring 28 cm in length. The axes listed above represent type A according to Balcer. However, in outline and proportions they assume the shape of an elongated trapezoid with a slightly expanded cutting edge, somewhat different from the types represented by the larger axes associated with Baden settlements. In the BaC, as in the Złota culture, a group of axes measuring about 10 cm and another about 15 cm long are almost equally represented (Brzeska-Zastawna 2020b). They do not exceed the dimension of 20 cm. However, the proportions of some of the fragmented specimens, as well as axes without preserved parts at the cutting edge, indicate that very large axes, originally reaching a dimension of about 20 cm in length, also occurred here, similar to those of the FBC in western Lesser Poland and the FB-Baden assemblages. They are made of locally occurring flint of G variety. Axes made from other raw materials that were brought to the area of western Lesser Poland (*e.g.*, Kraków-Mogiła 62, Zawarża 1, Bronocice 1, Książnice Wielkie 1; Balcer 1983; 2002b; Brzeska-Zastawna 2020a; Kluzik 2010, table VIII: 11; Pipes *et al.* 2018, fig. 5 (right), 6) are generally characterised by small sizes and often a high degree of transformation. The

group of axes produced from locally occurring raw material of the G variety stands out decisively not only in terms of dimensions, but also of morphology. It cannot be ruled out that these differences are due to the later chronology of these finds.

Interpretation, cultural affiliation

The way the specimen was manufactured, shaped, and ground would indicate that the tool in question was associated with the highest degree of specialisation in the production of rectangular-sectioned axes. It is noteworthy that the craftsman had excellent knowledge of the structure and properties of G flint, which had been used to manufacture the tool. Sections where the flint mass of this raw material has light bands and turns brown – these are the weak points of this raw material and places most susceptible to tool damage. In the case of the axe from Słupów, this is visible in the form of a small oval structure left exactly in the central part of the axe-head (Fig. 3: A). In addition to practical reasons, its manufacturer was probably also guided by aesthetic considerations, leaving this distinctive part inside the flint nodule more accurately in this part of the tool. The most spectacular examples of the adaptation of the flint knapper in shaping flint axes in a way related to the structure and colour of the flint nodule that was probably not of a random nature, but allowed achieving an aesthetic, delightful effect, can be identified among the Scandinavian axes (Högberg and Olausson 2007, fig. 35). The best-preserved axes from this raw material are either all made of beige flint mass of raw material G, or a brown transparent fragment encircled with a white band present in the central part of the axe (Słupów, Dodów) or in a part of the butt (*e.g.*, Smardzowice 38, Miechów 3). There are many known examples of broken axes made of this raw material that fractured during use precisely because these weak points were left in the most critical parts, mainly on the cutting edge or at the transition point of the cutting edge part into the middle part of the axe. Examples of this are broken BaC and FBC/FB-Baden axes, like the specimen shown here from the Marchocice 2 site (Fig. 9: B). The most valuable axes in a practical sense were by far those made of G raw material where they were entirely of (or a decided majority of the axe was of) a uniform beige colour. This raw material is a specific variety of the high quality locally occurring flint, the development of the exploitation and use of which is associated with the Eneolithic period in western Lesser Poland, a period of high demand for the raw material, which enabled the production of macrolithic blades and axes (FBC, FB-Baden, BaC, also used in the CWC for the production of axes).

The initiation of the manufacture of flint axes in western Lesser Poland is associated with the emergence of the FBC. The region from which the axe comes belongs to an extremely richly represented settlement region in the Middle/Late Eneolithic, particularly well represented by the FBC and FB-Baden settlements. The greatest development of the Bronocice settlement was in BR Phase IV corresponding, according to J. Kruk and S. Milisauskas, to the first FB-Baden phase (Kruk and Milisauskas 2018), currently dated to

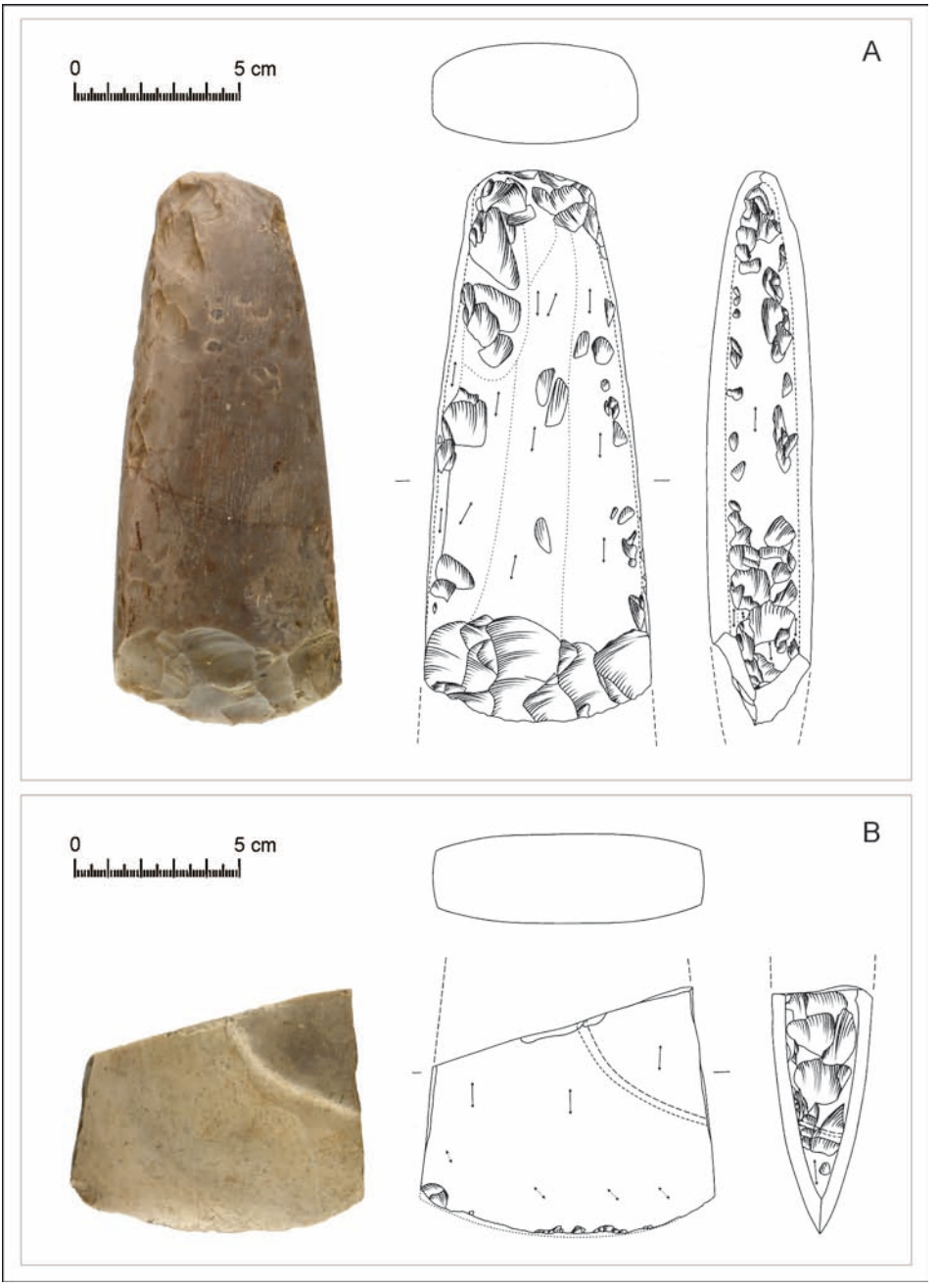


Fig. 9. Axes made from flint of the G variety: A – Baden culture (Wiatowice Site 2, Wieliczka district), B – Funnel Beaker-Baden assemblages (Marchocice Site 2, Miechów district).
Photo by A. Susuł, drawn by A. Brzeska-Zastawna

3350/3300 and 3200/3100 BC (Kruk *et al.* 2018). In particular, a development in the exploitation of raw material of the G variety, accompanied by its distribution to distant areas, is associated with the period of development of the so-called FB-Baden assemblages (Kopacz and Pelisiak 1991; 1992; Pelisiak 2006; 2008). During the period of Baden influence, especially in the horizon in question, there are transformations in these communities that are manifested in material culture, including visible ideological changes (which is, by the way, a broader phenomenon, also visible in other areas of Central Europe). This also coincides with the development of the GAC phenomenon. Only its direct reflection is marked in western Lesser Poland after about 2900 BC, at a time when CWC also appears in the area (Przybyla *et al.* 2013; Włodarczak 2020). This coincides (Zastawny 2015; Kruk *et al.* 2018) with the final stage of the development of the BaC and FB-Baden settlement. Undoubtedly, the period of development of the FB-Baden groups and the Baden culture in western Lesser Poland is a period of dynamic changes, associated with the interaction of several environments, which also affect the nature of lithic inventories, including in the production of forms with a quadrilateral section. This is indicated, among other things, by the strong connections of the Baden and FB-Baden axe groups and their stylistic relationship to the GAC axes, not to mention some related forms of the Złota culture and selected forms from the CWC graves. There is no doubt that these topics require separate research.

The authors associate the artefact in question with the Funnel Beaker traditions, probably to a later period, the so-called FB-Baden assemblages. The characterisation of the unique object discussed here fully corresponds to the tools produced and used within these communities, which, unfortunately, have not been properly studied separately so far. As already submitted, analogous axes made of G-flint come from the FB-Baden (FBC-FB-Baden sequence) and from BaC settlements. It is noteworthy that the discussed group of axes from western Lesser Poland in general refers to axes commonly associated with the GAC (Nosek 1967; Balcer 1983), mainly due to regularity, grinding of all surfaces, small thickness, and trapezoidal regular outline**.** However, these are by no means only features of the GAC axes (*e.g.*, Libera 2009). B. Balcer (1983; 2002a) himself points to examples of axes representing the FBC as flagship examples of this type of axe.

Trapezoidal flat regular, completely polished specimens are considered 'model' specimens from graves of the GAC (Nosek 1967; Balcer 1983). For the most part, these are very regular specimens, flat rectangular and flat in cross-section, trapezoidal or rectangular in shape, and mostly or almost entirely ground (*e.g.*, Bronicki 2021), although a certain group of axes of this unit deviates significantly from this 'model' characteristic (Libera 2009). There are specimens with curved, including asymmetrical, butts, or with a slightly higher blade, or with raised edges of the blade itself, or with grinding covering only selected parts of the axe. In the area of loess uplands in the upper Vistula basin, finds of the GAC are incidental (reports of graves of cist construction – Rosiejów, Kazimierza Wielka, Żurawniki; Wawrzeniecki 1908; Nosek 1967). Single pottery sherds of this culture occurred at Bronocice and Książnice Wielkie (Kruk and Milisauskas 2018; Zastawny and Brzeska-Zastawna

2020). Against this background, the highly spectacular find of a mass burial from Koszyce, dated to 2875-2670 BC, stands out, together with an exceptionally rich cluster of core tools made of striped flint (Przybyła *et al.* 2013). The grave yielded products made from striped flint 'exemplary' for the GAC, among others a small flat trapezoidal axe, including an unfinished form with a straight blade, flat butt and sides. They are characterised by a different grinding method than on the discussed group of large trapezoidal FB-Baden axes. Namely, these axes have traces indicating only hand grinding, without the use of additional support or extra weight (Pyżewicz 2013). Nevertheless, they are among the only finds of certain GAC axes (from an excavated context) from the discussed area (not to mention the axe mentioned by S. Nosek 1967, 190, which, according to his description, was a part of the equipment of a grave with a cist construction from Żurawniki). It is worth mentioning that axes from western Lesser Poland made of flint type G are known to the authors from personal examination, which represent analogous 'model' specimens for this unit, having counterparts among the mentioned group of products (*e.g.*, an axe from Książnice Wielkie 1 near Koszyce; Brzeska-Zastawna 2020a, fig. 2: 1, 202-203; and an almost identical one from Poznachowice Dolne, Myślenice district; AMK collections). Admittedly, the sides are less grounded than the main surfaces, but these are, in fact, features found in all these groups. They are different from the expanded-blade axes of the discussed group of western Lesser Poland axes from the Baden influence period – they are very flat, without the characteristic convexity, have a separated flat butt, and do not have a clearly curved cutting edge. Forms that we would attribute to 'exemplary' specimens of the GAC also occur among other specimens considered by B. Balcer to be typical of the FBC, with reference, for example, to products from the Sandomierz Uplands (*e.g.*, Balcer 2002a).

The problem, unfortunately, is the over-generalisation of these issues and the paucity of studies that focus on these subjects placed in local realities. It would also be appropriate to focus on a set of traits, rather than on individual traits independently, as in practice we find that separately these traits are found in each Eneolithic culture. It should also be noted that the outlined 'model' type of axes (type B) of the so-called Lesser Poland type industry of the FBC according to B. Balcer (*e.g.*, 1983, 142, 272, 273), is not at all the 'model' type of the axes produced in western Lesser Poland. Also noteworthy is the fact that the standpoint of B. Balcer does not take into account the chronological differences, the classical and late FBC units. In a comparison of the axes of the FBC and GAC, B. Balcer (1983) reports that axes of the A variety are less common in the FBC than in the GAC, which is, of course, completely untrue for western Lesser Poland, since type B in its original form is not properly represented here. What is more, axes of the A variety are commonly characterized by a more pronounced expanded blade, often with an outlined convexity of the cutting edge, not to mention the grinding covering most of the axes' surfaces, which distances them from the 'model axe of the FBC according to B. Balcer, and brings them closer to the 'model' axe of the GAC. For the rest, the dissimilarity of these axes was noted by the researcher himself (Balcer 1983, 152), but without giving it further attention.

One should be aware that, as B. Balcer himself put it, the core of the Lesser Poland type industry of the FBC consists of finds from the Sandomierz Upland (Balcer 1983, 149). The assemblages from western Lesser Poland are actually treated as subordinate. In addition, the late FBC groups, including those close to the BaC and GAC assemblages from Lesser Poland, were not given a separate place in his work.

In the discussed group of regular trapezoidal axes of the FB-Baden assemblages and BaC, in their original forms these axes have a convex arched butt and, as a rule, a more clearly outlined curve of the cutting edge and are made of flint type G. This applies to larger specimens; small axes, usually transformed, are characterised by greater morphological variability. Another extremely interesting and – in our opinion – important feature is the occurrence of a group of axes made of G raw material in western Lesser Poland in the BaC and FB-Baden assemblages with ground side-edge rims (the grinding of a straight angle with a "sharp" ridge between the main and side faces, giving the axe in cross-section a more oval or rectangular shape with rounded corners, *e.g.*, the BaC axe presented here from Wiatowice, Fig. 9: A). This is interesting, especially with regard to the opinion that the analogous grinding pattern that occurred on the axe from Miłocin-Kolonia, associated with the FBC burial, from the perspective of J. Libera and A. Zakościelna (2006) is "unprecedented among flint manufacturers of this group of the FBC" and they point to an analogous grinding pattern on only one axe, found with GAC pottery, from Krasne Kolonia, Chełm County. It is likely that in western Lesser Poland we are dealing with another local trend in the period of development, brought along with the Baden influences, and is probably related to Western influences, more markedly manifested in Lower Silesia. Let us remember that the development of these cultural units (the FB-Baden and BaC assemblages), falls within a timeframe from after c. 3350 BC, to c. 2900/2850 BC. A completely separate issue is the occurrence in some burials of the CWC of axes with Middle/Late Eneolithic stylistic traits, including those made of flint G. Nevertheless, attention should be paid to the problem of core tool manufacture in western Lesser Poland, as the local character of this branch of production in the discussed communities to a large extent reflects the cultural changes that took place in communities developing in the 4th and early 3rd millennia BC in this area.

Axes made of G-type flint

Little attention has so far been paid to Middle and Late Eneolithic axes from western Lesser Poland. First, it should be noted that there was a local axe production centre here. They were made mainly from Jurassic G-type flint, outcrops of which have been identified in the central part of the Kraków-Częstochowa Upland (Pelisiak 2006; Kopacz 2020; Přichystal 2013). Workshops have also been identified where axes and large blades were produced near these outcrops (Kopacz, Pelisiak 1988; Pelisiak 2008; Kopacz 2020) but also within large settlements with some production features such as Bronocice, where they

were also being manufactured (Pipes *et al.* 2018). The development of the exploitation of this raw material is associated primarily with the period of Baden influence on the local FBC communities (early identified in fact with the BRIII phase), the FB-Baden complexes (*i.e.*, BR phases IV and V according to Kruk and Milisauskas) and the Baden culture (Pelisiak 2008), parallel to some of the FB-Baden groups. This raw material was also used by representatives of the CWC, who in parallel also targeted the use of K-type flint in local manufacturing. Macrolithic flint products, axes and long blades, made of G flint, were distributed over considerable distances, including the area of Greater Poland, Moravia, the Czech Republic, Slovakia, or Hungary (Pelisiak 2008). They are represented by different types of axes. Among them, we find specimens that are analogous to the large axes of the model examples of the FBC according to B. Balcer (1975, 2002).

The first group of Middle/Late Eneolithic axes made from G flint is represented among the finds from the so-called hoard from Dodów (Kowalski 1963; AMK collection), located quite close to the site discussed in the article. A chisel and three axes came from here, including one thick one of the A variety with an elongated shape and a slightly expanded cutting edge, 18 cm long, and a smaller, flat trapezoidal one. This finds close parallels among the forms of the FBC proper and the classic large axes of the A variety, made from Świeciechów flint from Lesser Poland (Balcer 1975; 2002a). For this group of axes, the grinding mainly covers the faces; the sides are ground less carefully or not at all. An identical specimen of a large axe in unpolished form was found, for example, among the settlement materials from the not so distant Site 3 at Miechów (NCN project 2016/23/B/HS3/00387 carried out under the direction of M. Nowak at Institute of Archaeology of the Jagiellonian University). A morphologically similar specimen, also made of G-flint, comes, for example, from Słupia in the Limanowa district (Valde-Nowak 1988, pl. 8: 1, 3). In this case, the fine grinding covers all surfaces of the axe. It is possible that this type of axe has connotations with the older 'classic' assemblages of the FBC. The question is whether it was also present in the FB-Baden assemblages.

The second group of axes made from G-type flint, of more interest to us here, is represented by trapezoidal specimens of slightly different proportions, less elongated, with a gradually or more markedly expanded cutting edge. They are represented by specimens associated with settlements with the FBC and FB-Baden sequences, such as those from: Marchocice 2 (AMK collection), KsiążniceWielkie 1 (Brzeska-Zastawna 2020a), Miechów 3, Bronocice 1 (Balcer 1983), and the BaC, *e.g.,* from Wiatowice 2, Kraków-Zesławice 21, Kraków-Wyciąże 5, Kraków-Pleszów 17-20 (Brzeska-Zastawna 2020b). They are represented by massive, thicker specimens and flat ones, as in other cultures. These are specimens that have been ground on their entire faces and usually the sides as well. They are very regular, rectangular in cross-section, almost always, however, with a slight convexity, especially of the faces (except in the group of small axes where there are specimens with quite flat sides and main faces). They have a trapezoidal butt with a rounded top. In side view, unless reworked and modified, they have an intermediate shape between wedge-

shaped and lenticular, with the greatest thickness at mid-length of the specimen. The cutting edge is most often curved, sometimes very distinctly so. Large and flat specimens relate more clearly to the Baden horizon. An analogous form to the specimen from Słupów must have been represented by one of the axes from Marchocice (Fig. 9: B), which broke during working at the spot where a flaw occurred. It also has identical grinding marks to those observed on the axe from Słupów. Analogous grinding is also visible on other axes and their fragments of the FB-Baden and BaC axes already mentioned, sometimes preserved only fragmentarily on specimens transformed and ground by hand. Interestingly, the strict standard of this group of large axes is also indicated by their thickness, which is exactly or nearly 30 mm.

Purpose of the item

Unfortunately, as mentioned in the introduction, the exact context of the discovery and the location of the find are unknown. We can only indicate the potential locations from where it came (one of the loess hills in the Słupów area; Fig. 1). The axe from Słupów was undoubtedly an object of value for its users. It is possible that, like the hoard from Dodów (discovered on the slope of a loess hill; Kowalski 1963), it cannot be ruled out that it was deliberately deposited or hidden.

In general, it is noticeable that a large portion of axes from hoards have significant dimensions, larger than axes from settlements and graves, often exceeding 25/26 cm in length (Olausson 1983; Wentink *et al.* 2011). Arguably, extremely long axes with proportions that precluded their practical use and the proportions of which indicate that they had only ceremonial roles or as a symbol of high status should be associated with a special purpose (Nielsen 1977). These include axes of monstrous size, such as the example from Kardyb, probably the longest from northern Europe, which measures 50.5 cm in length! (Sørensen *et al.* 2020). According to some researchers, it is difficult to unequivocally indicate the limit of sheer length, which would indicate their non-utilitarian nature, since it is demonstrable that, depending on the proportions and weight, it is possible to effectively use axes of really large dimensions (Olausson 1983; Sørensen *et al.* 2020). The close relationship between the length of the axes themselves and their purpose is noted, among others, by K. Wentink (2006). In a group of studied axes of the FBC from the northern Netherlands, on specimens over 22 cm in length, no traces indicating practical use of axes and hafting were found, but traces of wrapping and unwrapping of the axes from hoards and the presence of red ochre, often in the region of the cutting edge, testifying to their ceremonial character (Wentink 2006; Wentink *et al.* 2011). According to research (Wentink *et al.* 2011), supported by examples from ethnographic studies, these axes would be kept and hidden and carried long distances, unwrapped and shown only on special occasions, as symbols of special power. Finally, they were deposited in waterlogged places. More than half of the thin-butted axes from hoards of southern Scandinavia were completely ground, but few

show signs of use, and many axes from deposits are unfinished specimens (Midgley 1992). However, it should be kept in mind that not only axes without signs of use were deposited. This is evidenced by finds of deposits of more than one axe, where some have signs of use and some do not (Sørensen *et al.* 2020). The specimen from Słupów bears traces indicating that it may have been used for felling trees, as well as for construction work and other wood chopping activities, which, of course, does not exclude its non-utilitarian function as well.

The axes of the FBC played an important role not only in everyday life, but also in ideology. This is evidenced by axes deposited as burial gifts in megalithic tombs and votive deposits, especially in waterlogged places (Nielsen 1977; Midgley 1992; Sørensen *et al.* 2020; Larsson 2011). Although flint hoards are found throughout the FBC range, the vast majority are from southern Scandinavia and the North European Plain (Midgley 1992). Deposits of flint products are also known in the South-Eastern group of the FBC. There are also examples of axes being deposited as grave gifts. These are undersized forms, they are most often less shapely, with irregular cross sections, and are characterised by varying degrees of grinding (Libera and Zakościelna 2006). There are examples of flint axes constituting a component or the entire cluster of finds linked to the FBC, only some of which can certainly be described as intentional deposits (Libera *et al.* 2019a). Associated with this cultural unit is the custom of storing flint products in hiding places in the territory of the settlements and in separate places, especially those associated with a watery environment also in its south-eastern range (Bronicki 1995; Kadrow 1989; Kaflińska 2006; Libera 2003; Libera *et al.* 2019b; Zakościelna 1997).

SUMMARY

The axe from Słupów should be linked to the Funnel Beaker traditions, most likely from the period of of Baden domination in Lesser Poland, *i.e.*, the so-called FB-Baden assemblages. Unfortunately, the exact context of the discovery of the discussed article is unknown. In addition to analogous specimens from the FB-Baden and BaC settlements, it should be pointed out on the basis of data from Bronocice that the particular period of intensification and development of the settlement falls in the period of 3350/3300-3200/3100 BC, the older FB-Baden phase (Kruk and Milisauskas 2018; Kruk *et al.* 2018). The second phase of the development of the FB-Baden assemblages at this site is placed in the time frame between 3150/3100 and 2900/2800 BC (Kruk *et al.* 2018). The period of emergence and intensification of the impacts of the Baden complex on the Funnel Beaker communities is also combined with a huge intensification in the use of G-type flint. Given the uniqueness of the specimen in question, it cannot be ruled out that the item (after being used for daily work) was hidden in some kind of act of deposition. It is interesting to note that it bears traces of a relatively short period of use, as well as marks of plant polish on the lateral edges of the tool. Such traces may be related to the passive use of axes, their

wrapping, unwrapping, and transportation, merged with ideological functions combined with ideological functions, as in the case of the FBC votive axes (Wentink 2008). Among the closest finds of collective deposits containing axes are the ones from Dodów, only a dozen kilometres away in a straight line from Słupów. All of the items in this find are also made of G flint, and some bear signs of use, as in the case of the votive depots of the northern group of the FBC. It cannot be ruled out that these finds are related to a period of some upheaval or social change. In this context, it is worth noting that large settlements concentrate and traces of defensive structures and strategically located livestock pens are noted on them during the development of the so-called FB-Baden assemblages (*e.g.*, Miechów 3, Marchocice 2, Gniazdowice 1, Bronocice 1; Kruk and Milisauskas 2018; Przybyła *et al.* 2019; Przybyła 2020), from which, by the way, the examples of analogous axe fragments indicated here come. Undoubtedly, the axe from Słupów was an object of value to the communities of the time. There is a possibility that it was deliberately deposited.

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A CONTRIBUTION TO RESEARCH ON THE KNAPPED LITHIC ASSEMBLAGE FROM THE LATE NEOLITHIC SITE OF ALTHEIM IN LOWER BAVARIA

ABSTRACT

Pelisiak A., Saile T. and Dębiec M. 2024. A contribution to research on the knapped lithic assemblage from the Late Neolithic site of Altheim in Lower Bavaria. *Sprawozdania Archeologiczne* 76/1, 497-531.

The lithic artefacts from Altheim, being regarded as essential for the interpretation of the site, have for a very long time attracted attention. Here we concentrate on the discoveries made during the excavation of sections of ditches in 2013-2020. Certain earlier observations were confirmed by the latest excavations, namely the high proportion of arrowheads among the flaked stone tools. A large number of the arrowheads were burnt. Many of them have broken tips, and all the analysed arrowheads with broken tips bear diagnostic impact fractures: step-terminating bending fractures or spin-off fractures specifically in the shape of small fractures on the edge between one surface of the arrowhead and the surface of the fracture of the tip. These suggest an angle of impact of the arrow into a hard surface of about 60°-70°. Broken and burnt arrowheads were found in the solid context of the structures. The context suggest that these arrowheads can be connected with conflict.

Keywords: Late Neolithic, Altheim culture, earthworks, lithics studies, arrowheads, conflict
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1. INTRODUCTION

The earthwork of Altheim in Lower Bavaria makes up the eponymous site of the Altheim culture of the Later Neolithic (4th millennium BC). Excavations carried out in 1914 and 1938 produced a rich inventory of finds, namely pottery, stone artefacts, human skeletal remains and animal bones. Objects made of copper prove the technological innovation of the Altheim population, who were processing metal for the first time. The alignment of the site allows the observation of the movements of the moon and refers to the implementation of astronomical knowledge in architecture.

The earthwork of the (eponymous) Altheim (site) is located north of Landshut in the transition area from the Tertiary hills to the loess-covered high terrace (Fig. 1). Despite their location in the intensively used agricultural landscape of Lower Bavaria, the ditches are still preserved up to a depth of 2 m, especially in the eastern part of the site. However, in the last century alone, about 0.4 m of the feature substance was lost through erosion, as

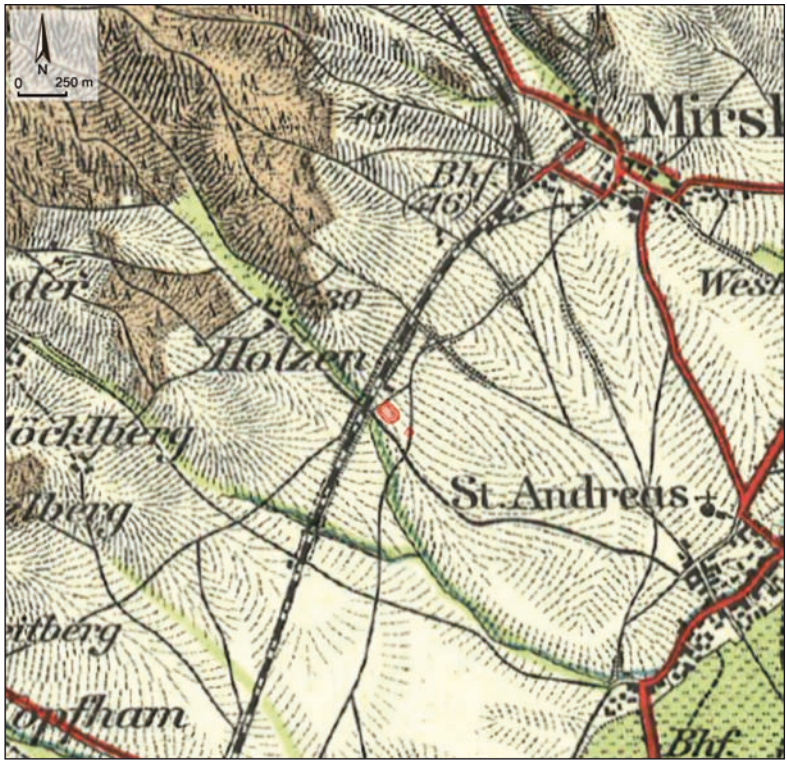


Fig. 1. The two Altheim earthworks on the lower slope of a loess ridge at the exit of the Holzener Tälchen, extending southwestward to the Eichelbach. Map basis: Map of the German Empire 1:100,000 sheet 611 Landshut (1890). Graphic: M. Posselt



Fig. 2. Section of a magnetic image of the landscape on both sides of the Eichelbach with the Altheim I and II earthworks. Graphic: M. Posselt

evidenced by, for example, a comparison of the differences in the profile documentation of the middle ditch between 1914 and 2014 (Saile *et al.* 2021).

A large-scale magnetic prospection of the site on both sides of the Eichelbach stream has yielded evidence of intensive occupation activity (Fig. 2). In the greyscale image, the well-thought-out building scheme of the prehistoric enclosure clearly emerges: aesthetic proportions instead of monumental size (dimensions). The external dimensions of the northwest-southeast oriented complex are about 120 × 90 meters. The enclosed inner space, about 35 m wide and 60 m long, is enclosed by three ditch rings, which are spaced at intervals of 7-10 m (more in: Saile *et al.* 2017).

The two Altheim earthworks are spatially related to each other. The longitudinal axis of the older known structure Altheim I is aligned almost exactly northwest-southeast, as is the line running over both earthworks of the recently discovered earthwork Altheim II.

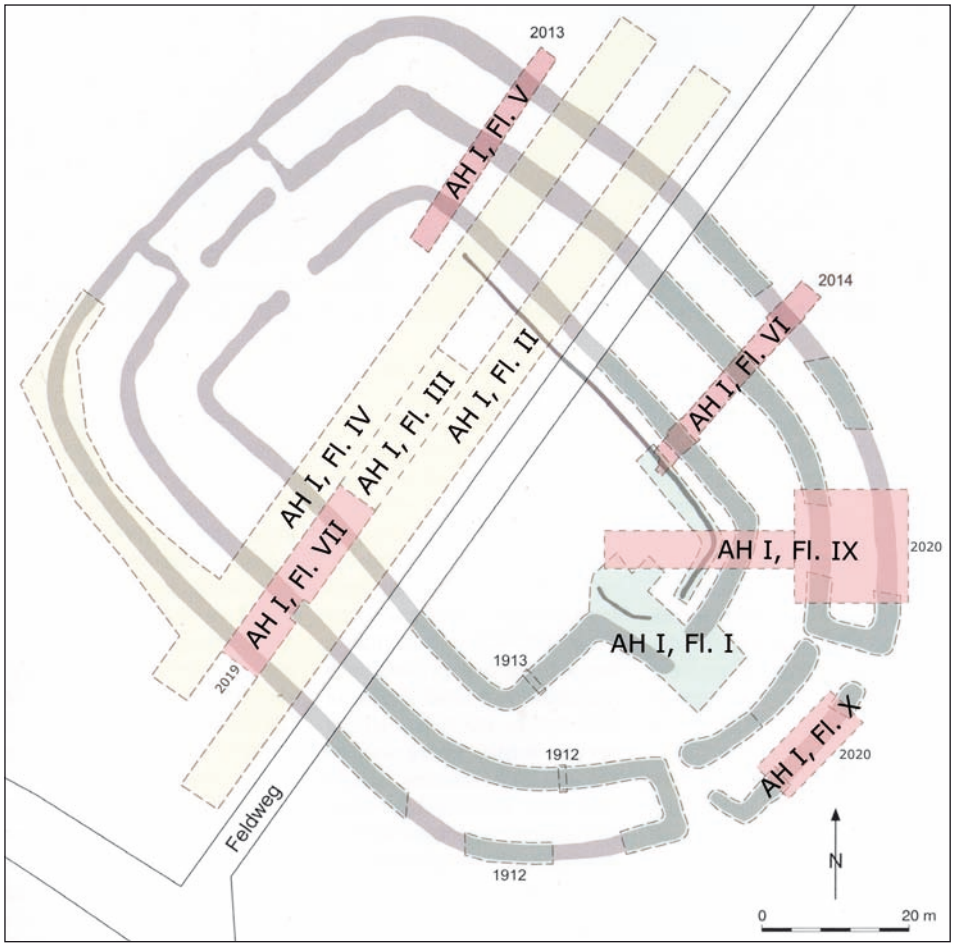


Fig. 3. Interpretative drawing and location of the excavation trenches 1912, 1913, 1914, 1938, 2013, 2014, 2019, 2020

Accordingly, ^{14}C dating on samples of domestic animal bones from Altheim II indicate that the small rectangular enclosure existed at the beginning of the 37th century BC. Dates on samples of cereal grains from the lower backfill layers of the inner ditch of Altheim I suggest excavation at around the turn of the 37th and the 36th century BC. In the 36/35th century the interconnected horseshoe-shaped semicircular ditches were backfilled.

During excavations in 2013, 2014, 2019 and 2020 (Fig. 3), abundant archaeological artifacts were recovered, among them many knapped lithic materials, which are the core of this study. Special attention was paid to the numerous recorded arrowheads.

2. KNAPPED LITHIC MATERIALS

2.1. Altheim I, 2013

2.1.1. Fläche – 1, Befund 1 (Outer ditch)

Only five knapped artefacts were discovered: two chunks, one of them made of Arnhofen Plattensilex (30 mm in diameter), and the other burnt and undefined with respect to raw material (17 mm in diameter); one highly burnt chip; one small fragment of an burnt and crushed undefined tool (size: 14 × 7 × 2 mm); and one burnt and crushed fragment of a probably heart-shaped arrowhead. It has one edge, with the base and the tip damaged. One partly preserved edge and a wing bear regularly retouch on both the dorsal and ventral sides. Length of preserved part – 24 mm, width – 20 mm, thickness – 5 mm (Table 1; Fig. 4: 1).

2.1.2. Fläche – 1, Befund 2 (Middle ditch)

Six knapped artefacts were discovered in Fläche – 1, Befund 2 (Table 1)

End-scraper – 1

One end-scraper made of partly cortical flake from probably Abensberg-Lengfeld chert. The slightly rounded and curved front is prepared with semi-steep and regular retouch; the bulb and butt are damaged; dimensions: length – 36 mm, maximum width – 32 mm, maximum thickness – 9 mm (Fig. 4: 2)

Arrowheads – 4

Items discovered: one burnt small fragment of bifacial arrowhead, made of flake or blade with partly natural one side, one edge formed with regular bifacial retouch, the opposed edge is regularly retouched on one side and jagged, or with fine retouch on the reverse. Maximum length of preserved part, 11 – mm, width – 12 mm, thickness – 3 mm; one burnt fragment of a bifacial arrowhead with one edge preserved and one barb, the opposite edge and barb as well as the tip are broken, the preserved edge, barb and part of the base are regularly retouched on both sides, the tip of the preserved barb is pointed, the concave base is regularly rounded, length of preserved part – 19 mm, width – 17 mm, thickness – 5.5 mm; one slightly burnt fragment of a bifacial tool, probably an arrowhead, made of a cortical flake or blade with broken tip and barbs made of Baiersdorf Plattensilex, cortex covers one side and part of the opposite side, one edge with bifacial regular retouch is almost straight in the central part and is slightly rounded near the partly broken barb, the opposite edge is not preserved, the maximum length of the preserved part is 36 mm, maximum width – 18 mm, thickness – 6 mm (Fig. 4: 3); one burnt heart-shaped arrowhead with a broken tip made of a polished flake, the edges are symmetrical to each other, almost

Table 1. Typological composition of chipped artefacts from Altheim (excavations 2013-2020)

Artefacts	2013, 2014 Altheim I							2018	2018		2019 Altheim I			2020 Altheim I				SUM	% without chips	% of all artefacts
	Fläche 1 bef. 1 (Outer ditch)	Fläche 1 bef. 2 (Middle ditch)	Fläche 1 bef. 3 Inner ditch)	Fläche 2 bef. 1	Fläche 2 bef. 2	Fläche 2 bef 3	Fläche 2 bef 7	Altheim II	AH II, II, 1 No- Kopf. PL 1-12, F-G-H (enclosure)	AH I, VIII, 1, PL. 1, -B-C (pit-house)	Outer ditch	Middle ditch	Inner ditch	Surface, 2019	Outer ditch	Middle ditch	Pit 6			
Chunks	2	---	38	---	---	4	---	---	---	1	---	---	11	1	---	---	1	**58**	**28.43**	**16.11**
Cores	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**1**	**0.49**	**0.28**
Cortical flakes and their fragments	---	---	12	---	---	---	---	---	---	3	---	---	3	---	1	---	---	**19**	**9.31**	**5.28**
Flakes and their fragments	---	---	23	---	1	1	1	---	---	---	---	---	12	---	1	---	---	**39**	**19.11**	**10.83**
Fragments of microblades overheated	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**1**	**0.49**	**0.28**
Cortical blades and their fragments	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	**1**	**0.49**	**0.28**
Blades and their fragments	---	---	---	---	---	---	---	1	---	---	---	---	6	---	1	---	---	**8**	**3.92**	**2.22**
Arrowheads	1	4	10	1	1	---	---	--	---	---	1	2	10	1	3	---	---	**34**	**1.67**	**9.44**
Tools without arrowheads	1	1	13	1	---	1	---	1	1	2	1	---	16	1	1	2	1	**43**	**21.08**	**11.94**
Sum without chips	**4**	**5**	**99**	**2**	**2**	**6**	**1**	**2**	**1**	**6**	**2**	**2**	**58**	**3**	**7**	**2**	**2**	**204**		**56.67**
% without chips	**1.96**	**2.45**	**48,53**	**0.98**	**0.98**	**2.94**	**0.49**	**0.98**	**0.49**	**2.94**	**0.98**	**0.98**	**28.43**	**1.47**	**3.43**	**0.98**	**0.89**			
% of all assemblage	**1.11**	**1.39**	**27,5**	**0.56**	**0.56**	**1.67**	**0.28**	**0.56**	**0.28**	**1.67**	**0.56**	**0.56**	**16.11**	**8.33**	**1.94**	**0.56**	**0.56**			
Chips	1	1	33	--	--	--	--	--	--	87	--	3	27	2	---	2	--	**156**		**43.33**
Total with chips	**5**	**6**	**132**	**2**	**2**	**6**	**1**	**2**	**1**	**93**	**2**	**5**	**85**	**5**	**7**	**4**	**2**	**360**		
% of all assemblage	**1.39**	**1.67**	**36.67**	**0.56**	**0.56**	**1.67**	**0.28**	**0.56**	**0.28**	**25.83**	**0.56**	**1.39**	**23.61**	**1.39**	**1.94**	**1.11**	**0.56**			

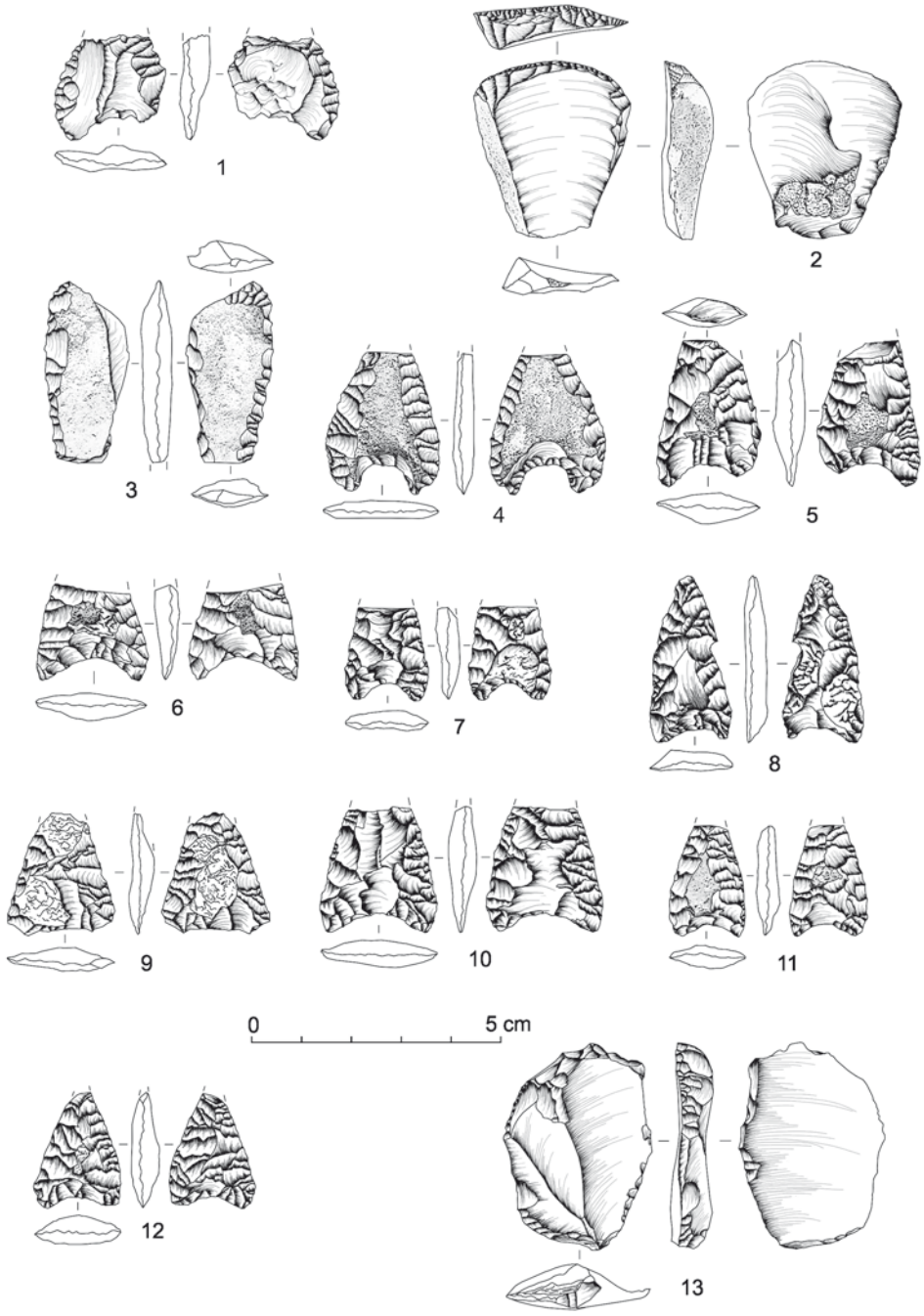


Fig. 4. Lithics from Altheim. Drawings: A. Bardetskyi

Table 2. Altheim, excavations 2013-2020. Typological and raw material composition of chipped assemblage

Category of artefact	Chert of Abensberg-Lengfeld type	Plattensilex of the Baiersdorf type	Chert of the Abensberg-Arnhofen type	Chert from Emmerthal or Hamberg	Tegernheim chert	Thalhof bounded chert	Chert from Herrnsaal	Quartzite	Jurassic chert from Alling	Flintsbach chert	Undefined	Overheated undefined	Sum	% without chips	% of all
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**			
Chunks	---	13	14	1	1	---	---	14	1	---	6	8	**58**	**28.43**	**16.11**
Fragment of core	---	---	1	---	---	---	---	---	---	---	---	---	**1**	**0.49**	**0.28**
Cortical flakes and their fragments	---	12	3	---	---	---	---	---	---	---	---	4	**19**	**9.31**	**5.28**
Flakes and their fragments	2	12	6	1	1	1	---	1	---	2	11	2	**39**	**19.12**	**10.83**
Fragments of microblades overheated	---	---	---	---	---	---	---	---	---	---	---	1	**1**	**0.49**	**0.28**
Cortical blades and their fragments	---	1	---	---	---	---	---	---	---	---	---	---	**1**	**0.49**	**0.28**
Blades and their fragments	---	1	6	---	---	---	---	---	---	---	1	---	**8**	**3.92**	**2.22**
Tools	4	13	11	1	---	1	2	---	---	4	3	4	**43**	**21.08**	**11.94**
Arrow heads	---	20	1	4	2	---	---	---	---	---	---	7	**34**	**16.67**	**9.44**
Sum of artefacts without chips	**6**	**72**	**42**	**7**	**4**	**2**	**2**	**15**	**1**	**6**	**21**	**26**	**204**		**56.67**
% of artefacts without chips	**2.94**	**35.29**	**20.59**	**3.43**	**1.96**	**0.98**	**0.98**	**7.35**	**0.49**	**2.94**	**10.29**	**12.74**			
% of all assemblage	**1.67**	**20.0**	**11.67**	**1.94**	**1.11**	**0.56**	**0.56**	**4.17**	**0.28**	**1.67**	**5.83**	**7.22**			
Cortical chips	---	75	2	---	---	---	---	---	---	---	4	2	**83**		
Overheated cortical chips	---	1	---	---	---	---	---	---	---	---	---	7	**8**		
Chips	3	36	1	1	---	---	---	2	---	---	9	10	**62**		
= Chips	**3**	**115**	**3**	**1**	**---**	**---**	**---**	**2**	**---**	**---**	**13**	**19**	**156**		**43.33**
Total	**9**	**187**	**45**	**8**	**4**	**2**	**2**	**17**	**1**	**6**	**34**	**45**	**360**		
% of all assemblage	**2.5**	**51.94**	**12.5**	**2.22**	**1.11**	**0.56**	**0.56**	**4.72**	**0.28**	**1.67**	**9.44**	**12.5**			

straight in the central part and rounded in the barb part, the tips of the barbs are sharp, the base is concave and almost rectangular in shape, the edges, barbs and base are shaped with bifacial retouch, maximum length of preserved part – 28 mm; maximum width – 23 mm; thickness – 3 mm; size of the notched base: depth – 6 mm, maximum width – 11 mm (Fig. 4: 4), small fractures on the edge between one surface of the arrowhead and the surface of break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°.

Chips – 1

This example is highly burnt.

2.1.3. Fläche 1 Befund 3 (Inner ditch)

The lithic assemblage discovered in Fläche 1 Befund 3 in 2013 comprises the most numeroust group of knapped artefacts. It contains 132 items (Table 1).

Chunks – 38

Chunks constitute one of largest category of lithic items. This group contains 38 pieces of raw material including seven of Baiersdorf Plattensilex (from 12 to 43 mm in diameter, average 23.5 mm), two of Arnhofen Plattensilex (29 and 36 mm in diameter), one of Emmerthal chert (22 mm in diameter), one of Tagernheim chert (29 mm in diameter), thirteen of Quartzite (from 11 to 54 mm in diameter, average 27.25 mm), one of Alling chert (41 mm in diameter), and twelve undefined in respect of raw material (six burnt).

Single platform blade cores – 1

Only one small fragment of a single platform blade core, made of Arnhofen Plattensilex, was found.

Cortical flakes and their fragments – 12

These are numerous but, in most cases, fractured. This group consists of four highly burnt and fractured items; five small fragments of artefacts made from Baiersdorf Plattensilex; and three fragments made of Arnhofen Plattensilex (one of them with one cortical edge, dimension – 21 mm; one fragment of a partly cortical item, dimension 23 mm; and one partly cortical with an edge-like butt and an almost flat bulb, length – 17, width – 16, thickness – 3 mm, one slightly burnt).

Flakes and their fragments – 23

This group contains: five flakes made from Baiersdorf Plattensilex (all preserved as small fragments), three of Arnhofen Plattensilex (one wholly preserved bears an edge-like butt and a distinct bulb, dimensions: length – 26 mm, width – 18 mm, thickness – 6 mm), one fragment made probably of Emmerthal chert, one fragment of flake made of probably Tegernheim chert (length– 22 mm); and one probably of Thalhof chert (with distinct bulb, length – 20 mm, width – 18 mm, thickness – 1.5 mm). Eleven small fragments of flakes have not been classified in terms of raw material. Only three flakes were wholly preserved.

Microblades – 1

There is only one example of a fractured and burnt microblade.

Blades – 1

Only one small distal part of a partly cortical blade, made of raw material similar to Baiersdorf Plattensilex, was discovered.

Chips – 33

Thirty-three chips were discovered in Flache 1 Befund 3. This group contains fifteen cortical chips (four of Baiersdorf Plattensilex including one slightly burnt; four undefined in respect of raw material including two strongly burnt ones), seven of Baiersdorf Plattensilex, one of Emmerthal chert, and 12 undefined with respect to raw material (nine highly burnt).

2.1.4. Arrow heads

Fragment of a highly burnt arrowhead – 1

Only one fragment of a bifacial arrowhead with broken tip and part of one barb, and concave and rounded base was discovered. It is formed by regular bifacial retouch. Maximum length of preserved part – 15 mm, width – 21 mm, thickness – 4 mm. Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°.

Completely preserved arrowhead – 1

One burnt, bifacial arrowhead made of Baiersdorf Plattensilex. It has asymmetrical barbs, one slightly rounded and the opposite one small and rounded. The edges are almost straight; the base is concave and rounded. The tool is formed by regular, bifacial retouch. Maximum length of preserved part – 29 mm, length to the end of the smaller barb – 23 mm, length to the maximum concavity of the base – 25 mm, width – 21 mm, thickness – 7 mm (Fig. 4: 5).

Arrowheads with broken tips – 8

Two of them were made from Baiersdorf Plattensilex. The first one is slightly burnt. The barbs are asymmetrical, with one slightly rounded and the opposite one small and rounded. The edges are almost straight; and the base is concave and rounded. It was formed by regular, bifacial retouch, maximum length of preserved part – 29 mm, length to the end of the smaller barb – 23 mm, length to the maximum concavity of the base – 25 mm, width – 21 mm, thickness – 7 mm. It has tar on the surface of both sides. Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests it broke during bending.

The other arrowhead made of Baiersdorf Plattensilex with a broken tip was formed with regular retouch. Both edges are almost straight and slightly convex in the barb portions. The barbs are a little asymmetrical, one with a pointed end and the other with a slightly rounded end. The base is slightly concave and rounded. Maximum length of preserved part – 18 mm, indentation of the base – 3 mm, width – 22 mm, thickness – 6 mm (Fig. 4: 6).

Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggest a bending break.

Four arrowheads (all are fractured) were made of Emmerthal brown chert.

One has a broken tip, symmetrical slightly rounded barbs, with both edges nearly straight, and a slightly convex base formed by regular, bifacial retouch. Length of preserved part – 19 mm, length to the maximum concavity of the base – 15.5 mm, width – 17 mm, thickness – 4 mm. It bears traces of what is probably tar on the base (Fig. 4: 7). Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°.

Another item (slightly burnt) was formed by regular, bifacial retouch. The edges are slightly convex. The tip and barbs are crushed. The base is slightly concave and round. Length – 33 mm, length to the maximum concavity of the base – 31.5 mm, width – 17 mm, thickness – 4 mm (Fig. 4: 8). Small scars on the tip suggests impact into hard material.

Another arrowhead made of Emmerthal chert is bifacial, almost triangular, partly destroyed, with symmetrical, slightly rounded and partly broken barbs. The edges are straight, and the base is almost straight. The tool was formed by regular, bifacial retouch. Length of preserved part – 24 mm, width – 22 mm, maximum thickness – 5 mm. The tip was broken probably as result of striking a hard surface (Fig. 4: 9).

The last arrowhead made of this raw material has symmetrical, slightly rounded barbs. The edges are almost straight, and the base is slightly concave and rounded. The tool is formed by regular, bifacial retouch. Length of preserved part – 24 mm, length to the maximum concavity of the base – 21 mm, maximum width – 22.5 mm, maximum thickness – 6 mm (Fig. 4: 10). Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°.

Two arrowheads with broken tips were made of Tegernheim chert. One made of a cortical flake is asymmetrical. Both edges are slightly convex. The base is convex and rounded. One barb is sharp, and the other is rounded. It was prepared with regular bifacial retouch. Length of preserved part – 22 mm, length to the maximum concavity of the base – 20 mm, maximum width – 15 mm, thickness – 4 mm (Fig. 4: 11). Small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°.

The other one has rounded barbs, a slightly convex base, and both edges are slightly convex. It was formed with regular, bifacial, retouch. The profile is a little irregular with small convexities on both sides (one of them is located in the bulb portion of the flake or blade from which the tool was made). In the central part of both sides are clearly visible ridges running according to the longitudinal tool axis. Maximum length – 23 mm, length to the maximum concavity of the base – 21 mm, width – 17.5 mm, maximum thickness – 7 mm (Fig. 4: 12).

Small scars on the tip suggests impact into a hard material.

2.1.5. Other Tools

Beside of arrowheads 13 other tools were discovered there (Table 3).

Fragments of undefined tools – 2

Both are fractured and are made of thin plates of Baiersdorf Plattensilex cortical on both sides. Size: 37 × 43 × 4 mm; 24 × 18 × 5 mm.

Flake end-scrapers – 2

One was probably made of Herrnsaal chert and has a rounded and oblique front formed with semi-steep retouch. Both edges are partly retouched on the dorsal face. Length – 41 mm, width – 30 mm, thickness – 7 mm. The other was represented by preserved as a small fragment and was probably made of Abensberg-Lengfeld chert (Fig. 4: 13).

Blades with use retouch – 4

One blade made of Baiersdorf Plattensilex has one cortical edge and the opposite edge with use retouch. The butt is natural, and the bulb is small and distinct. Length – 41 mm, width – 14 mm, thickness in the bulb portion – 7 mm, thickness in the middle part – 8.5 mm.

The proximal part of the second blade (made of Arnhofen Plattensilex), from a single platform blade-core, has one edge partly cortical. The opposite edge is formed by an irregu-

Table 3. Altheim 2013, Fläche 1 bef. 3 (inner ditch). Typological composition of tools (without arrow heads)

Category of artefacts	Chert of Abensberg-Lengfeld type	Plattensilex of the Baiersdorf type	Chert of the Abensberg-Arnhofen type	Chert from Herrnsaal	Sum
	1	**2**	**3**	**7**	
Fragments of undefined tools		2			2
Flake end-scrapers	1			1	2
End-scrapers on cortical flakes					
Backed knife			1		1
Blades wits use retouch		1	2	1	4
Retouched blades		2			2
Cortical plates of Plattensilex retouched		1			1
Cortical plates of Plattensilex with bifacial retouch and glossy polishing		1			1
Sum	**1**	**7**	**3**	**2**	**13**

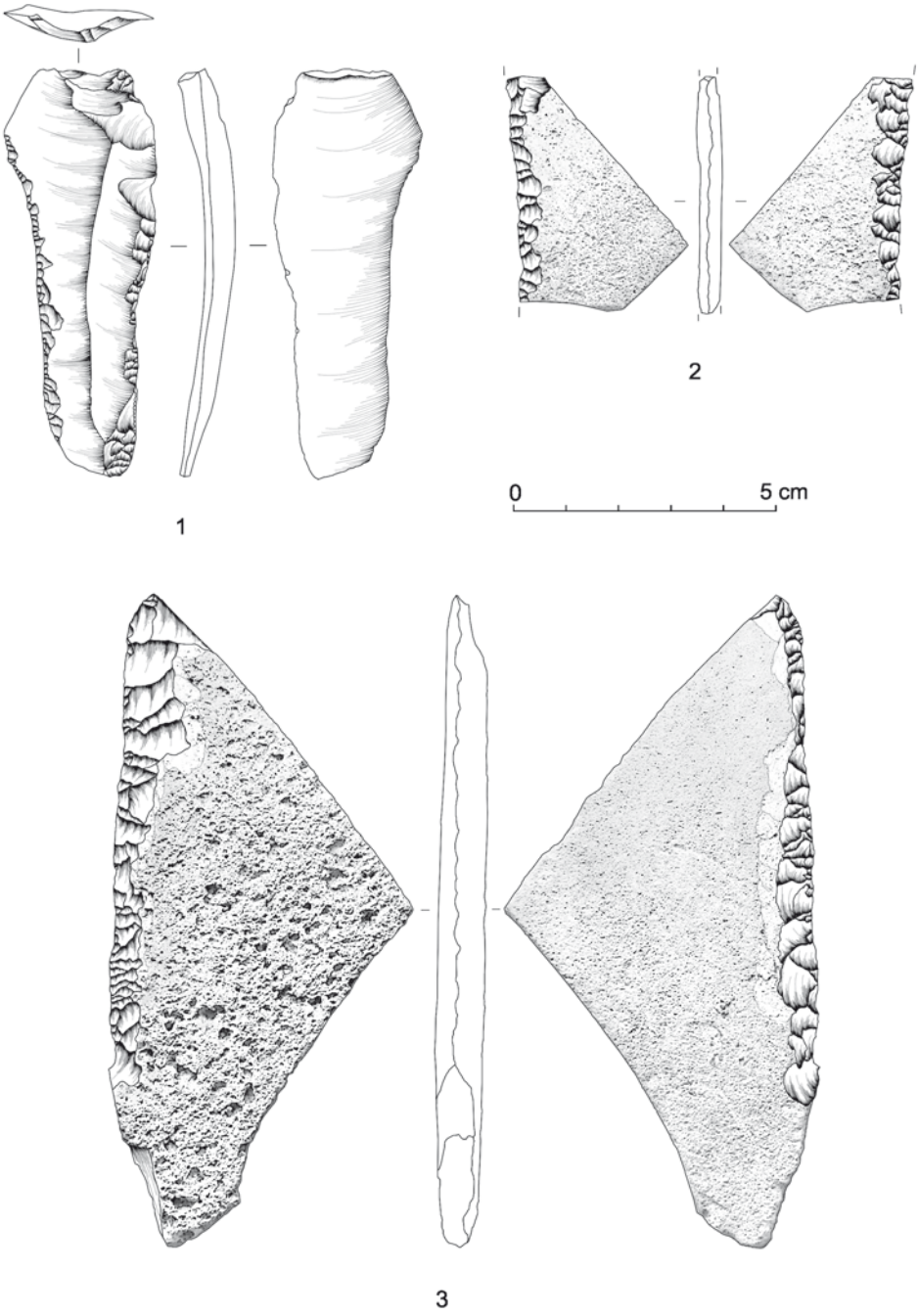


Fig. 5. Lithics from Altheim. Drawings: A. Bardetskyi

lar crack. The edges are regular and parallel. The bulb is almost flat and diffuse; the natural butt and striking platform are large. Edge angle (platform/flaking surface) is about 80°. Length of preserved part – 23 mm, width – 16 mm, thickness in the bulb portion – 5 mm, thickness in the mid portion – 4 mm.

The distal part of the third blade made of the same raw material is preserved. One edge is cortical, and the profile is straight. One edge bears use retouch. Length of preserved part – 28 mm, width – 14 mm, thickness – 4 mm.

The last blade from a single platform blade core (from Herrnsaal chert) is curved in the middle portion and bears use retouch on both edges. Edges are irregular and asymmetrical. The butt is facetted with a clear lip. The striking platform is small, located on the top of semi-conical top of the butt. The bulb is wide and diffuse with a clear ripple. Edge angle is about 80°. Length – 78 mm, maximum width – 28 mm, thickness in bulb portion – 6.5 mm, thickness in middle portion – 6 mm (Fig. 5: 1).

Retouched blades – 2

Both are made of Baiersdorf Plattensilex. One (mesial part) is slightly burnt and crushed with one edge retouched on both the ventral and dorsal sides. Length – 18 mm, width – 21 mm, thickness – 6 mm.

The mesial part of the other partly cortical blade has one edge with flat retouch on the ventral side. Length – 20 mm, width – 22 mm, thickness – 5.5 mm.

Backed knife – 1

Only one was found (made of Baiersdorf Plattensilex). It is a fragment of thin cortical on both sides plate of raw material (length 122 mm, width – 58 mm, thickness – 9 mm) with one edge retouched on both the dorsal and ventral sides (backed knife with natural back) (Fig. 5: 3).

Cortical plates of Plattensilex with retouch – 1

A fragment of thin plate of Baiersdorf Plattensilex, cortical on both sides with one edge retouched on one side. Length – 48 mm, width – 52 mm, thickness – 13 mm.

Cortical plates of Plattensilex with bifacial retouch with glossy polishing – 1

One discovered fragment was made of thin plate of Baiersdorf Plattensilex, cortical on both sides. One edge bears flat retouch on both the dorsal and ventral sides and glossy polishing. Maximum length preserved – 43 mm, width – 32 mm, thickness – 4 mm (Fig. 5: 2).

2.2. Altheim I, 2014

2.2.1. Fläche – 2, Befund 1

Two artefacts were discovered: one bifacial arrowhead made with Baiersdorf Plattensilex with asymmetrical barbs; both edges are slightly convex; the base is convex and rounded; one barb is rounded; the tip is sharp (Table 1). The tool is prepared with regular bifacial

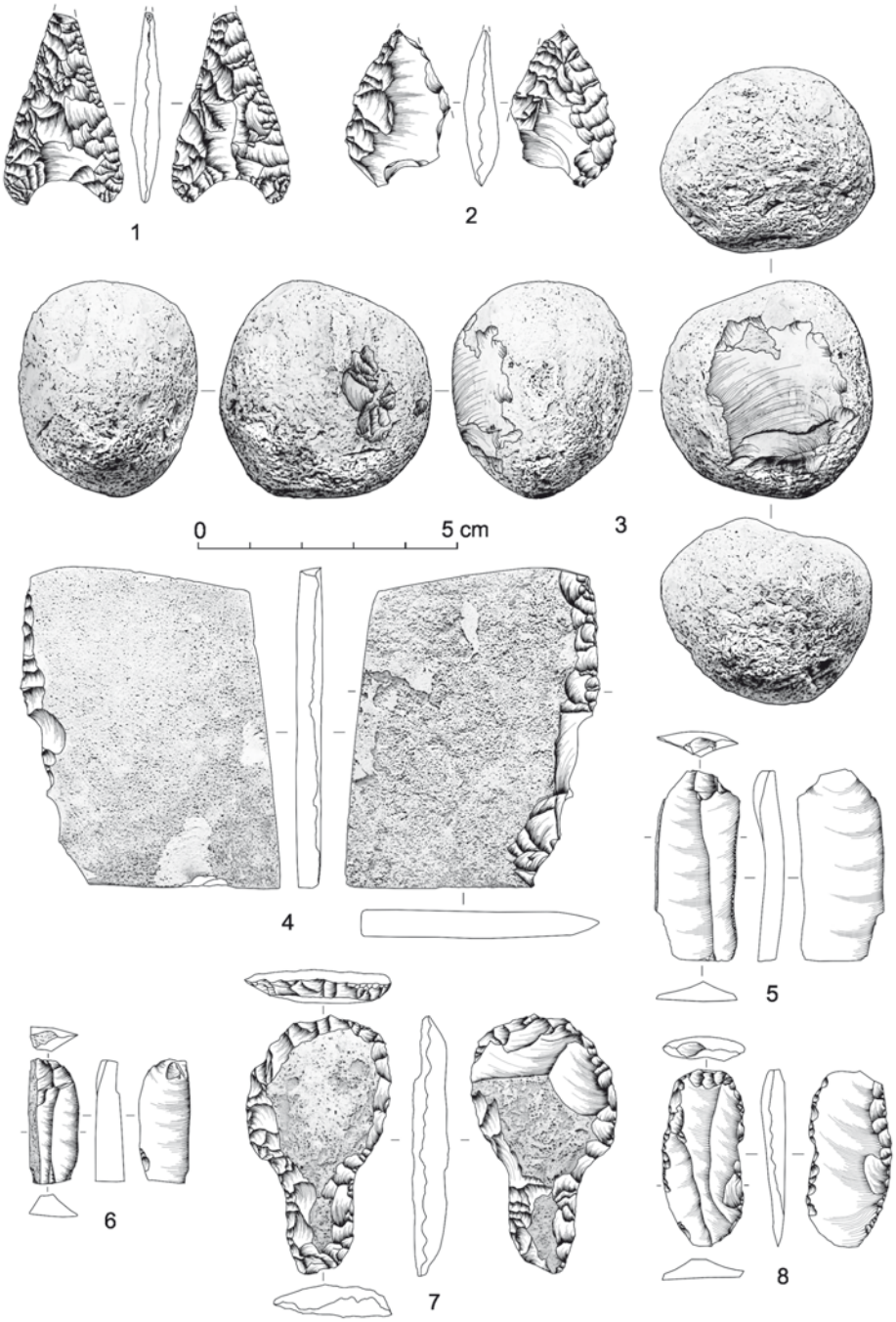


Fig. 6. Lithics from Altheim. Drawings: A. Bardetskyi

retouch. Length of preserved part – 38 mm, length to the maximum concavity of the base – 32 mm, maximum width – 22 mm, thickness – 6 mm (Fig. 6: 1). No traces of use or damage are registered; one spherical nodule of Arnhofen Plattensilex used as a hammer, max diameter 44 mm (Fig. 6: 3).

2.2.2. Fläche – 2, Befund 2

Two knapped artefacts were discovered: one fragment of flake made of quartzite and one burnt fragment of an arrowhead (Table 1; Fig. 6: 2).

2.2.3. Fläche – 2, Befund 3

Six artefacts were found: one chunk made of Abensberg-Arnhofen Plattensilex from Linsberg; one fragment of cortical chert made from Abensberg-Arnhofen Plattensilex from Linsberg; one fragment of flake made of Abensberg-Arnhofen Plattensilex from Linsberg; one fragment of flake end-scraper made of Emmerthal chert; one chunk of Abensberg-Arnhofen Plattensilex from Linsberg; one chunk of undefined raw material (Table 1).

2.2.4. Fläche – 2, Befund 7

Only one fragment of burnt flake was discovered (Table 1).

2.3. Altheim II, surface, 2018

2.3.1. AH II, II, 1 No-Kopf. PL 1-12, F-G-H enclosure

One proximal and mesial part of a regular blade from a single platform blade core, distinct, small bulb, curved in distal part, on the ventral face negatives of two regular blades; one edge bears use micro-retouch and slight gloss, while the opposite one bears slight polishing (traces of hafting?); length – 36 mm, width – 16 mm, thickness – 5 mm (Table 1).

Raw material: Baiersdorf Plattensilex?

2.4. Altheim G-2018 M-2013-1656-3_0

2.4.1. Altheim I pit-house

Ninety-three knapped artefacts made of Baiersdorf Plattensilex were found inside a pit-house (Table 1). There are subdivided as follows: one crushed chunk; three fragments of cortical flakes; one wholly cortified flake with cortical edge-like butt, diffuse bulb with

bulbar scar, straight in profile, length – 18 mm, width – 27 mm, thickness – 3 mm; 87 chips including 71 partly cortical examples; one fragment of thin plate wholly cortical on both sides with one edge with regular bifacial retouch, length – 65 mm, width – 48 mm, thickness (of the plate of raw material) – 5 mm (Fig. 6: 4**)**; one backed knife with natural back made of almost rectangular fragment of thin plate of raw material cortical on both sides, one edge with bifacial retouch and gloss, length – 61 mm, width – 48 mm, thickness (of the plate) – 5 mm.

2.5. Altheim II 2018

Two knapped artefacts were discovered (Table 1): one proximal and mesial part of a regular blade from a single platform blade core, slightly curved in profile, polyhedral butt, distinct bulb, one edge with regular use micro-retouch on the ventral face, length – 36 mm, width – 16 mm, thickness – 5 mm (raw material: undefined) (Fig. 6: 5); and one proximal and mesial part of a partly cortical blade from a single platform blade core probably made of Thalhof chert, butt natural, small distinct bulb with bulbar scar, length – 24 mm, width – 9 mm, thickness – 5 mm (Fig. 6: 6).

2.6. Altheim I 2019 surface

Five knapped artefacts were found on the surface of site Altheim I in 2019 (Table 1): one knapped artefact is made from plate of Baiersdorf Plattensilex, cortical on both sides. It is probably a typical tanged arrowhead or schematic anthropomorphic figurine formed with bifacial sharp irregular retouch (no direct analogy in Neolithic Germany). The artefact consists of two parts: a circular, slightly ellipsoidal "head" 30 mm long and 28 mm wide, and the "tang", about 20 mm long and gently merging with the "head". The maximum length of the artefact is 51 mm, maximum width – 28 mm, maximum thickness – 8 mm (Fig. 6: 7); one distal fragment of a curved blade (truncated piece with crushed front?), length – 36 mm, width – 28 mm, thickness – 1 mm (raw material undefined);

one fragment of a burnt piece of raw material, length 26 mm made of Abensberg-Arnhofen Plattensilex and two burnt chips.

2.7. Altheim I 2019 (outer ditch)

Two artefacts were discovered there (Table 1): one straight blade from a single platform blade core with use retouch on both edges, butt natural and flat, bulb flat, length – 34 mm, width – 16 mm, thickness – 5 mm (raw material undefined) (Fig. 6: 8); and one arrowhead made from Baiersdorf Plattensilex with a broken tip, one edge almost straight, opposite one slightly rounded, base slightly convex, barbs rounded, regular retouch on both sides, length – 20 mm, width – 17 mm, thickness – 4 mm (Fig. 7: 1).

2.8. Altheim I 2019 (middle ditch)

Five knapped artefacts were discovered here: one fragment of an arrowhead with a broken tip and one edge, fragment of preserved edge regularly retouched on both sides, preserved barb is rounded, base also rounded and convex, length – 27 mm, width – 17 mm, thickness – 8 mm (Fig. 7: 2); one bifacial arrowhead cortical on both sides with a broken tip, barbs asymmetrical, one of them sharp, opposite one rounded, one edge almost straight, opposite one slightly rounded in the barbs portion, base convex and rounded, regular retouch on both edges, length – 42 mm, length to the base – 39 mm, width – 16 mm, thickness – 7 mm (Fig. 7: 3); three chips.

2.9. Altheim I 2019 (inner ditch)

85 knapped artefacts were discovered there (Table 1).

Chunks – 11

Three are made from Baiersdorf Plattensilex (length: 14-25 mm), three from Abensberg-Arnhofen Plattensilex (14-35 mm), one from quartzite, and four are crushed and highly burnt.

Chips – 27

Three specimens made of probably Abensberg-Lengfeld chert, fourteen of Baiersdorf Plattensilex, two of Abensberg-Arnhofen chert (one of them is cortical), one of quartzite, one is highly burnt, and six are of undefined raw material.

Cortical flakes and their fragments – 3

This group consists of one cortical flake made of Abensberg-Arnhofen Plattensilex with an edge-like butt, straight in profile, bulb with distinct ripples and bulbar scar, length – 26 mm, width – 32 mm, thickness – 9 mm; and two fragments of cortical flakes made from Baiersdorf Plattensilex (dimensions: length – 24 mm, width – 17 mm, thickness – 5 mm; length – 20 mm, width – 36 mm, thickness – 9 mm).

Flakes and their fragments – 12

Two of them were probably made from Langfeld chert: one preserved as a small fragment and one multidirectional flake with a flat natural butt, straight in profile, curved in the distal part. length – 17 mm, width – 18 mm, thickness – 3 mm; seven examples made of Baiersdorf Plattensilex (one preserved as preserved as a small fragment) constitute the largest group of flakes found there. It contains: one multidirectional flake straight with an edge-like butt, length – 17 mm, width – 23 mm, thickness – 3 mm; one multidirectional flake probably from the edge of a bifacial tool, length – 15 mm, width – 17 mm, thickness – 9 mm; one partly cortical curved flake with an edge-like butt, length 22 mm, width – 25 mm, thickness – 3 mm; one unidirectional flake with a thin butt, length – 17 mm, width – 25 mm, thickness – 3 mm; one fragment of multidirectional flake with a natural butt and diffuse bulb, straight in profile, length – 21 mm, width – 18 mm, thickness – 4 mm; and one unidirectional flake with a polyhedral butt and flat bulb, straight in profile, length – 16 mm,

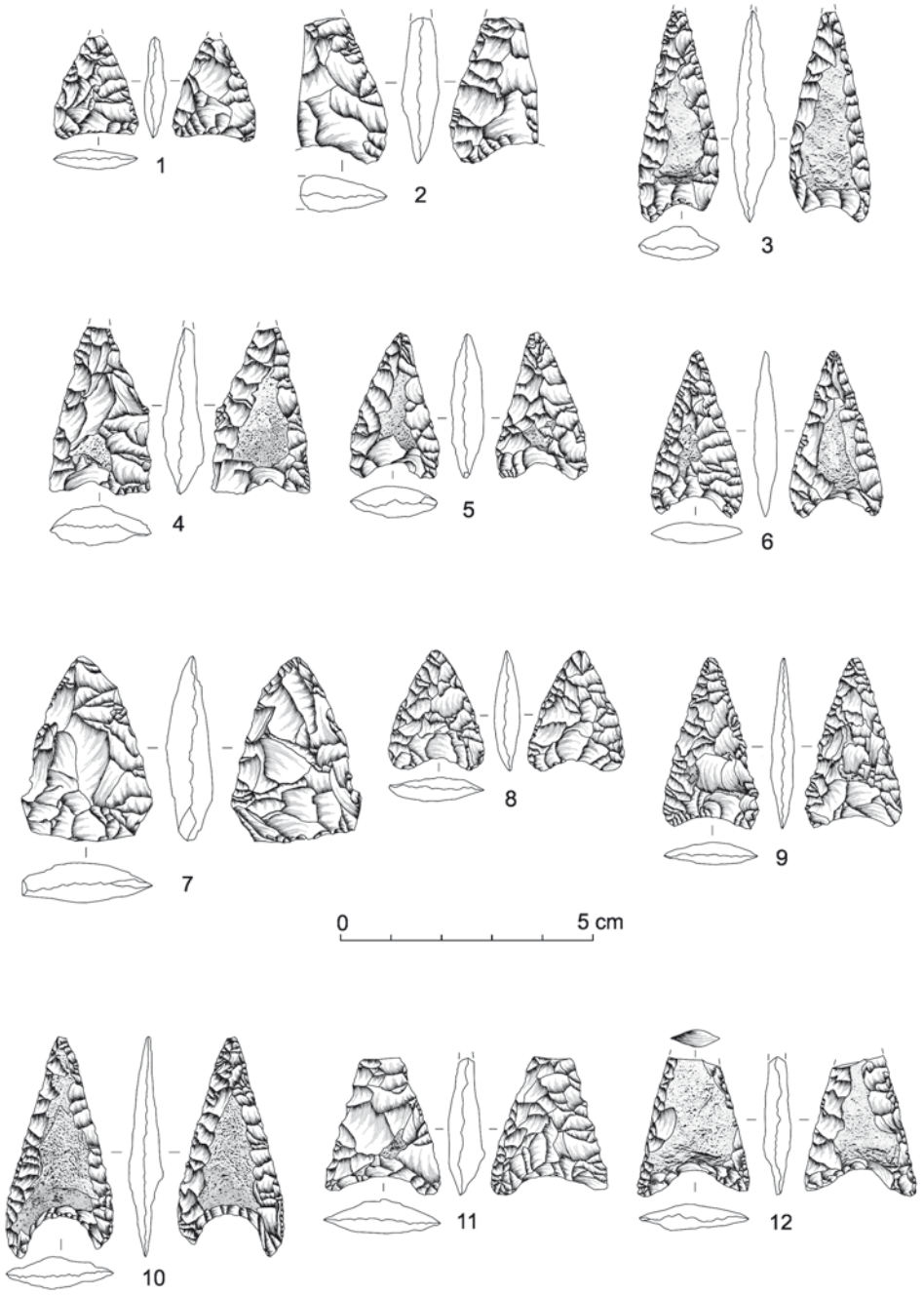


Fig. 7. Lithics from Altheim. Drawings: A. Bardetskyi

width – 28 mm, thickness – 3 mm. Also discovered were two fragments of flakes made probably from Flintsbach chert (length – 21 mm, width – 24 mm, thickness – 6 mm; and length – 53 mm, width – 38 mm, thickness – 8 mm) and one highly burnt flake (length – 23 mm, width – 28 mm, thickness 4 mm).

Blades from single platform cores and their fragments – 6

All six were made from Abensberg-Arnhofen Plattensilex (two small fragments are burnt and undefined with respect to raw material) and all are fractured. This group comprises: one mesial and distal fragment of partly cortical, slightly heated, curved blade, length – 32 mm, width – 11 mm, thickness – 7 mm; one distal fragment of blade from single platform blade core with cortical one edge, slightly burnt, length – 23 mm width – 7 mm, thickness – 3 mm; one proximal and mesial part of a blade with cortical sides and a crushed butt, length – 30 mm, width – 11 mm, thickness (of the plate of raw material) – 8 mm; and two fragments of burned blades.

Arrowheads – 10

All are made from Baiersdorf Plattensilex. Of this one is preserved as a small fragment. Also, one half-product of a bifacial arrowhead is made from a thin plate of tabular chert, both edges and base are irregular, length – 33 mm, width – 20 mm, thickness (of the plate) – 8 mm (Fig. 7: 4).

Six specimens have no signs of damage, This group consists of: one bifacial arrowhead, both sides partly cortical, one edge almost straight, opposite one slightly convex, base rounded and concave, tip sharp, both barbs slightly rounded, regular retouch on both sides, length – 29 mm, width – 18 mm, length to the base – 26 mm, thickness – 7 mm (Fig. 7: 5); one bifacial arrowhead regularly retouched on sides, edges and base, edges slightly rounded, base rounded concave, tip and barbs are sharp, no traces of use, on both sided traces of cortex, length – 33 mm, length to the base – 31 mm, width – 18 mm, thickness – 4 mm (Fig. 7: 6); one bifacial arrowhead with slightly rounded edges, straight base, rounded tip, edges, sides and base irregularly retouched, length – 37 mm, width – 26 mm, thickness – 8 mm (Fig. 7: 7); one bifacial arrowhead, tip and barbs rounded, edges slightly convex and rounded, base rounded and concave, regular retouch on the edges and sides, length – 24 mm, length to the base – 22 mm, width – 19 mm, thickness – 6 mm. No traces of damages (Fig. 7: 8); one bifacial arrow head, tip crushed and slightly rounded, one barb rounded, one sharp, both edges straight, base slightly convex, regular retouch on the edges and sides, length – 33 mm, length to the base – 32 mm, width – 19 mm, thickness – 5 mm (Fig. 7: 9); one bifacial arrowhead cortical on both sides, tip and barbs sharp, both edges almost straight slightly rounded and convex in the base portion, base rounded and significantly concave, asymmetrical sharp barbs, regular retouch on both sides and edges, length – 44 mm, length to the base – 37 mm, width – 21 mm, thickness – 7 mm (Fig. 7: 10).

Two specimens have broken tips and small fractures on the edge between one surface of the arrowhead and the surface of the break of the tip suggests an angle of impact of the arrow into a hard surface of about 60°-70°. One of them has straight edges, the base is

straight slightly rounded and convex, barbs rounded, regular retouch covers the edges, sides and base; length of preserved fragment – 30 mm, width – 22 mm, thickness – 7 mm (Fig. 7: 11). The other one is regularly retouched on both edges and faces, both sides are cortical, tip broken edges almost straight, base is rounded, barbs sharp; length of preserved part – 27 mm, length to the base – 23 mm, width – 22 mm, thickness – 6 mm (Fig. 7: 12).

Tools – 16

Tools constitute a relatively large group of knapped artefacts. Aside from ten arrowheads, 16 lithic tools were discovered in 2019 in the innermost ditch of Altheim I site (Table 4).

Fragments of undefined tools – 2

Both preserved as small fragments, made of Baiersdorf Plattensilex.

Flake end-scrapers – 6

All the flake end-scrapers are made of cortical or partly cortical flakes. They are as follows: one end-scraper made of irregular partly cortical flake from Baiersdorf Plattensilex with front semi-steep, one edge covered with semi-steep retouch on the ventral side, length – 39 mm, width – 23 mm, thickness – 17 mm (Fig. 8: 1); one end-scraper made of a curved, multidirectional, partly cortical flake, semi-steep rounded front partly covers both edges of the flake; cortex with brown coating; length 48 mm, maximum width – 28 mm, thickness

Table 4. Altheim 2019, inner ditch. Typological composition of tools

Artefacts	Platy chert of the Baiersdorf-type	Chert of the Abensberg-Arnhofen type	Thalhof bounded chert	Flintsbach chert	Overheated undefined	Sum
	2	**3**	**6**	**10**	**12**	
Fragments of undefined tools		2				2
Flake end-scrapers	1			4	1	6
Blade end-scrapers	1		1			2
Truncated blade (sickle blade)		1				1
Blade end-scrapers with retouched edge	1	1				2
Blades wits use retouch		1				1
Cortical plates of Plattensilex with bifacial retouch		1				1
Cortical plates of Plattensilex with bifacial retouch and glossy polishing						
Retouched chunk	1					1
Sum	**4**	**6**	**1**	**4**	**1**	**16**

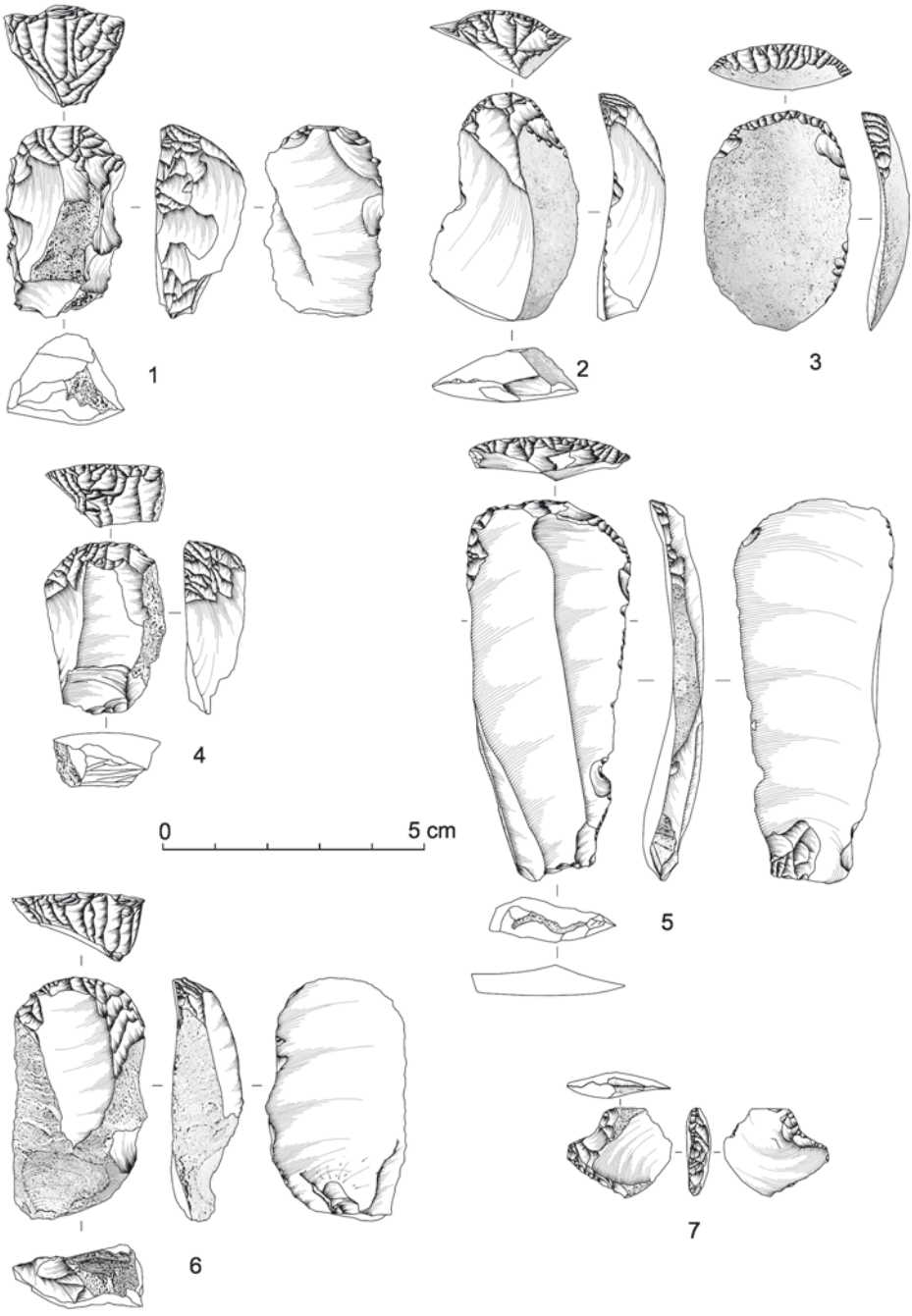


Fig. 8. Lithics from Altheim. Drawings: A. Bardetskyi

– 10 mm (Fig. 8: 2) (raw material: Alling/Thalfoh grey chert? Flintsbach chert?); one end-scraper made on large, partly cortical flake, the rounded and steep front covers one side of a flake and part of the opposite one. length – 63 mm, width – 43 mm, thickness – 20 mm (raw material: Flintsbach chert? Lengfeld chert?); one end-scraper made of wholly cortical flake with edge-like butt, bulb with bulbar scar, the front formed with semi-steep retouch; length – 42 mm, width – 28 mm, thickness – 5 mm (raw material: Flintsbach chert? Lagenfeld chert?) (Fig. 8: 3); one end-scraper made on partly cortical slightly burnt flake, front irregular, steep; length – 33 mm, width – 23 mm, thickness – 10 mm (raw material: Flinsbach chert?) (Fig. 8: 4); one fragment of a burnt end-scraper made of a cortical flake.

Blade end-scrapers – 2

The only two examples are made on blades: one end-scraper made of a regular long blade from a single-platform blade core, significantly curved in the distal portion, burned, butt edge-like, bulb distinct with bulbar scar, front semi-steep regular and slightly asymmetrical covers part of both edges, one edge with use retouch, length 73 mm, width – 27 mm, thickness – 9 mm (raw material: Arnhofen Plattensilex) (Fig. 8: 5); one nosed end-scraper on blade, length – 18 mm, width – 19 mm, thickness – 5 mm (raw material: Baiersdorf Plattensilex (Fig. 8: 7).

Blade end-scrapers with retouched edge – 2

Two specimens were discovered in the innermost ditch in 2020: one slightly burnt end-scraper made of irregular blade slightly curved in the distal part with a cortical edge, steep and regular front covers parts of the edges, one edge with flat edge-type retouch on the ventral face, polyhedral butt, distinct bulb with bulbar scars, length – 48 mm, width – 27 mm, thickness – 12 mm (raw material: Abensberg-Arnhofen Plattensilex) (Fig. 8: 6); one nosed end-scraper made probably on the cortical, distal part of a large blade, front irregular, both sides irregularly retouched on the ventral face, one edge also with flat use retouch on the dorsal face; length – 33 mm, width – 33 mm, thickness 11 mm (raw material: Alling/Thalhof grey chert?) (Fig. 9: 1).

Truncated blade – 1

Only one sickle blade, a truncated piece, made of regular blade, slightly burnt; length – 26 mm, width – 16 mm, thickness – 3 mm (raw material: Abensberg-Arnhofen Plattensilex).

Blades with use retouch – 1

One mesial fragment of regular blade from a single platform blade core has one edge with steep retouch on the ventral side, while the opposite edge has flat retouch on the ventral side and macroscopic traces of use (crushed edge); length – 37 mm, width – 20 mm, thickness – 6 mm (raw material: Abensberg-Arnhofen Plattensilex).

Cortical plates of Plattensilex with bifacial retouch – 1

One fragment of a bifacial tool partly cortical on both sides; length – 23 mm, width – 24 mm, thickness (of the plate of raw material) – 8 mm (raw material: Abensberg-Arnhofen Plattensilex).

Retouched chunk – 1

One retouched chunk partly cortical, max. length – 29 mm (raw material: Baiersdorf Plattensilex)

2.10. Altheim I 2020 (outer ditch)

Seven knapped artefacts were discovered in the fill of the outer ditch (Table 1): one fragment of cortical, straight flake made of Baiersdorf Plattensilex, length – 27 mm, width – 36 mm, thickness – 10 mm; one multidirectional flake made of Abensberg-Arnhofen

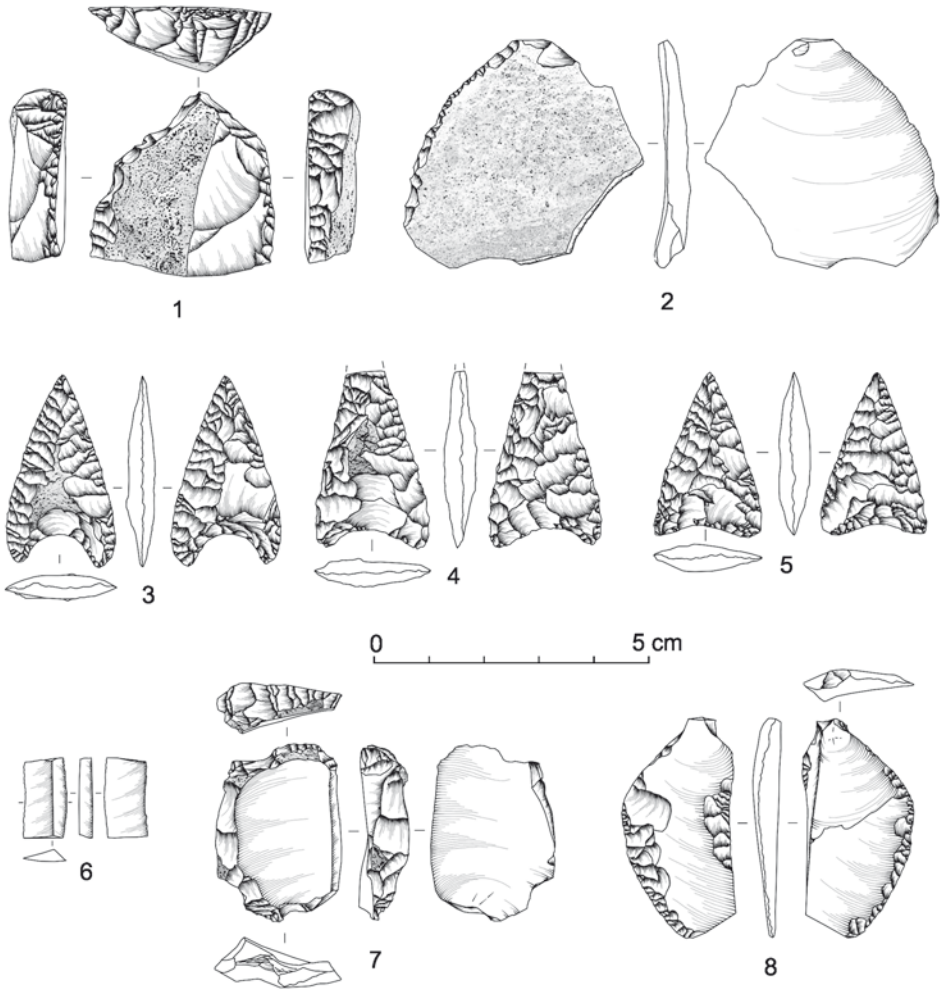


Fig. 9. Lithics from Altheim I. Drawings: A. Bardetskyi

Plattensilex with edge-like butt, flat bulb, straight in profile; length – 19 mm, width – 23 mm, thickness – 4 mm; one mesial fragment of a regular blade from a single platform blade core made probably from Abensberg-Arnhofen Plattensilex; length – 14 mm, width – 8 mm, thickness – 2 mm (Fig. 9: 6); one burnt cortical blade with a flat natural butt, curved in the distal portion, with one edge retouched on the ventral face made from Baiersdorf Plattensilex, length – 44 mm, width – 45 mm, thickness – 5 mm (Fig. 9: 2); one bifacial arrowhead with broken tip, both edges almost straight, barbs rounded, base rounded and convex, regular retouch on both edges and faces, one side slightly cortical made of Baiersdorf Plattensilex; length – 32 mm, length to the base – 29 mm, width – 21 mm; thickness – 6 mm (Fig. 9: 4); one bifacial arrowhead with slightly convex and rounded edges and convex rounded base made from Baiersdorf Plattensilex, one side partly cortical, regular retouch on both edges and sides, tip sharp, barbs are rounded; length 30 mm, length to the base – 29 mm; width – 18 mm, thickness – 6 mm (Fig. 9: 5); one bifacial arrowhead made from Abensberg-Arnhofen Plattensilex, edges almost straight, rounded and convex in a base portions, base concave and rounded, tip and barbs sharp, regular retouch on both faces, one side partly cortical; length – 35 mm, length to the base – 31 mm, width – 19 mm, thickness – 4 mm (Fig. 9: 3).

2.11. Altheim I 2020 (middle ditch)

Four lithic artefacts were discovered in the fill of the middle ditch: one end-scraper with crushed front made from partly cortical flake; length – 31 mm, width – 23 mm, thickness – 7 mm, raw material undefined (Fig. 9: 7); one flake with one edge jagged with a sharp retouch on both edges made from Abensberg-Arnhofen Plattensilex; length – 40 mm, width – 20 mm, thickness – 5 mm (Fig. 9: 8); two burnt chips.

2.12. Altheim I 2020 (middle ditch, pit 6)

One fragment of plate of raw material with negative of detached blade made from Abensberg-Arnhofen Plattensilex; length – 20 mm, width – 18 mm, thickness (of the pate) – 7 mm; one fragment of undefined tool.

3. DISCUSSION

Three hundred and sixty lithic artefacts were discovered during the 2013-2020 excavations in the Altheim Neolithic sites. These finds are made of ten raw materials, all of regional origin (Table 2): (1) Upper Jurassic chert of the Abensberg-Lengfeld-type, Lengfeld, Kelheim district, Bavaria; (2) Upper Jurassic tabular chert (Plattensilex) of the Baiersdorf-type, from Baiersdorf, Kelheim district, Franconian Alb, Bavaria; (3) tabular Upper Jurassic

chert (Plattensilex) of the Abensberg-Arnhofen type, from Linsberg near Abensberg, Kelhein district, Bavaria; (4) Upper Jurassic brown chert from Emmerthal, Emmerthal, Kelheim district, Franconian Alb, Bavaria; (5) Upper Jurassic Tegernheim chert, from Tegernheim, Regensburg district, Bavaria; (6) Jurassic, Upper Kimmeridian-Lower Tithonian/nodular banded chert, banded Thalhof chert, Regensburg district, Bavaria; (7) Upper Jurassic chert from Herrnsaal, Kelheim district, Franconian Alb; (8) Quartzite; (9) Jurassic chert from Alling(?), Regebsburg district; and (10) Flintsbach chert from Flintsbach, Deggendorf district. These raw materials were commonly used in the Neolithic and are thoroughly described in the archaeological literature (see *e.g.*, http://www.flintsource.net/; Althofer, Althofer 2011; Binsteiner 2005; 2013; Brandl *et al.* 2017; Richter 2014; Roth 2008; Underwood 2014). Due to the lack of diagnostic features, some of the artefacts were not specified in terms of raw materials (two groups: 11. Undefined; 12. Highly burnt without the possibility of assignation to a specific raw material).

Ten main typological groups of knapped artefacts were distinguished in the analyzed materials. The statistical analysis of the frequency of individual categories of knapped artefacts was performed on two levels: for the part of the inventory excluding the chips (204 artefacts) and for the whole knapped assemblage (in the further part of the analysis, the percentages without chips will be presented first, and the percentage calculated in relation to the entire inventory will be presented second). The distribution of lithic artefacts across the excavated area is irregular, as is the frequency of artefacts made of different raw materials.

Chunks (pieces of raw material which do not bear traces of flaking or with single negatives of previous detached flakes; some of them, mainly made from Plattensilex, may be parts of damaged tools) constitutes a significant part of the lithic assemblage from Altheim (58 items, 28.43% of knapped artefacts without chips; 16,11% of all the knapped assemblage). Most of them are from Plattensilex (28 items; 13 of the Baiersdorf type, and 14 of Arnhofen type), and quartzite (14 items). Emmerthal and Tegernheim cherts are represented in individual cases. The raw material of fourteen specimens were not recognized. Their maximum diameters do not exceed 100 mm, but most of them are smaller than 30 mm. Most of the chunks were discovered in part of the innermost ditch excavated in 2013.

Only one extremely exploited blade core from Arnhofen tabular chert was discovered in the innermost ditch.

Flakes constitute the largest group (excluding chips) of knapped artefacts in this assemblage of 58 items (28.43%; 16.11%) including 19 cortical specimens (9.31%; 5.28%) and 39 non-cortical specimens (19.11%; 10.83%). Most of the flakes are preserved as fragments, and estimation of their primary size is problematic (the dimensions of the largest fragments do not exceed 23 mm). Their dimensions do not exceed 26 mm, and only one flake made from Flintsbach chert is bigger than the others (53 × 38 × 8 mm). Most of them are from Baiersdorf and Arnhofen cherts, but other raw materials are also represented in this typological group. The relatively numerous flakes have not been classified in terms of raw material. Most of the flakes were discovered in the inner ditch of Altheim I.

All the blades (except one specimen) are fragmented. Except one specimen, all blades are made from tabular cherts, six of Arnfohen type, one of Baiersdorf and one of undefined raw material. Blades are regular in shape, slightly curved in profile, with a flat or polyhedral butt and a diffuse, flat or distinct bulb. Because of fragmentation of the blades, it is difficult to estimate their length. Whole specimens are 41 to 78mm long. Blade widths varied from 7 to 28 mm (average 16.22 mm), and thicknesses from 1 to 8.5 mm, usually 4 to 6 mm (average 5.08 mm). Almost all were discovered in the inner ditch of the site Altheim I. It should be added that almost all the blades bear micro-use retouch visible under 30× magnification, which suggests that they were used as tools. Almost all of the blades were discovered in the part of the innermost ditch excavated in 2019.

Tools constitute a relatively large group of the knapped assemblage from Altheim (43 specimens; 21.08%; 11.94%). Most of them were discovered in the innermost ditch. Nevertheless, tools were also discovered in other part of Altheim sites.

Tools are differentiated with respect to the raw materials used. It is particularly visible in the relatively large group of flake end-scrapers. The flake end-scrapers were made from five different ra materials: On specimen of chert of the Abensberg-Lengfeld-type, two of Baiersdorf chert, of Arnhofen chert there were three specimens of Herrnsaal chert one specimen, and four examples of Flintsbach chert. One specimen was not classified in terms of raw material. Flake end-scrapers have a slightly rounded and curved front formed with semi-steep and regular retouch. They are up to 41 mm long, 32 mm wide and 9 mm thick. In several cases, the edge(s) are partly retouched.

Four end-scrapers were made from blades. One from a regular long blade from Arnhofen Plattensilex is significantly curved in the distal portion, and it has semi-steep regular, a slightly asymmetrical front, and one edge with use retouch (dimensions: length – 73 mm, width – 27 mm, thickness – 9 mm). Another slightly burnt specimen made of the same raw material is made from an irregular blade slightly curved in the distal part. It has steep and regular front and one edge with flat edge-type retouch on the ventral face (length – 48 mm, width – 27 mm, thickness – 12 mm). One nosed blade end-scraper is from Baiersdorf chert (length – 18 mm, width – 19 mm, thickness – 5 mm). Another nosed end-scraper made from the cortical, distal part of a large blade from Thalhof chert has irregular front and both sides irregularly retouched on the ventral face, and one edge with flat use retouch on the dorsal face (dimensions: length – 33 mm, width – 33 mm, thickness – 11 mm. another blade end-scraper bears more or less visible retouch or use retouch on the edge or edges.

Two artefacts typologically refer to truncated pieces (sickle blades?). One, slightly burnt, is made of regular blade of Arnhofen chert (length – 26 mm, width – 16 mm, thickness – 3 mm. The other made of identified raw material has a crushed front (length 36 mm, width – 28 mm, thickness – 1 mm). These artefacts do not find clear counterparts on the sites of the Altheim culture or other cultures of similar chronology. Instead, they are most characteristic of the knapped assemblages of the LBK and younger Danubian cultures (*e.g.*, Dębiec *et al.* 2014, taf. 105, 6; Kadrow 1990; Mateiciucová 2008, 84, 85).

Blades with distinct use retouch and retouched blades (except two specimens) are made from tabular chert from Baiersdorf (5 specimens) and Arnhofen (4 specimens). They are regular in shape, curved, and those made of Plattensilex have one or both cortical edges. They are from 5 to 8 mm thick and from 14 to 28 mm wide. The sizes of the whole specimens made from Baiersdorf chert and Herrnsaal chert are respectively: length – 41 mm, width – 14 mm, thickness – 8.5 mm; and length – 78 mm, width – 28 mm and thickness – 6.5 mm.

Specific forms are specimens made from tabular chert described as backed knives (2 specimens), cortical plates of Plattensilex with bifacial retouch (3 specimens), and cortical plates of Plattensilex with bifacial retouch and glossy polishing (1 specimen). Their function looks unclear: they could have been multifunctional cutting tools or sickle fragments (specimens with glossy polishing).

During the excavations of 2013-2020, 34 arrowheads were discovered on the Altheim site (Table 5): 16 broken, four preserved as small fragments, and 15 whole specimens. The arrowheads are made of flakes or blades also of cortical blank. Some arrowheads made of Baiersdorf-type chert were made of plates of raw material cortical on both sides. They were made of various lithic raw materials: chert of the Baiersdorf-type, chert of the Abensberg-Arnhofen type, Upper Jurassic brown chert from Emmerthal or Hamberg, or Tegernheim chert. Six items were highly burnt. Most of them were made of Plattensilex. Tabular cherts were an especially useful raw material for making arrowheads. Thin plates of Baiersdorf and Arnhofen Plattensilex were a kind of ready-made half-product and a "starting point" for arrowheads. It is not surprising that some arrowheads from Plattensilex were made of plates of raw material cortical on both sides.

The arrowheads differ in size. The lengths of whole specimens varied from 24 to 44 mm (average 34.4 mm). The length of preserved parts of broken arrowheads is from 15 to 42 mm. They are from 12 to 26 mm in width, and from 3 to 8 mm in thickness. The concave bases are up to 6 mm deep. Most of the arrowheads are regular in shape with symmetrical edges and/or barbs, but some are also irregular. One arrowhead is almost triangular. The edges are straight, some specimens have both edges slightly concave or the edges are straight in the central part and rounded in the barbs part. They are regularly retouched on both sides, sporadically on one side. The bases of most arrowheads are concave and rounded, and also rectangular in shape and regularly retouched. Barbs are symmetrical or asymmetrical, sharp or slightly rounded. The tips are sharp, with numerous scars. The edges, barbs and base are shaped with bifacial retouch. Most of the arrowheads were discovered in the innermost ditch. All the specimens in the group of arrowheads found in 2019 are made from Beiersdorf Plattensilex (except one burnt with no assignation to a specific raw material).

Table 5. Characteristics of arrowheads

Location	Length	Length to the base	Width	Thickness	Raw material	Broken tip	Small fragment	Fig.
Excavations 2013								
Fläche 1, Befund 1	24		20	5	12		1	16
Fläche 1, Befund 2	11		12	5	12		1	
Fläche 1, Befund 2	19		17	5,5	12		1	
Fläche 1, Befund 2	36		18	6	2			22
Fläche 1, Befund 2	28		23	3	12	1		24
Fläche 1, Befund 3	15		21	4	12	1		
Fläche 1, Befund 3	29	25	21	7	2			33
Fläche 1, Befund 3	18		22	6	2	1		42
Fläche 1, Befund 3	19	15,5	17	4	4	1		66
Fläche 1, Befund 3	33	31,5	17	4	4	1		65
Fläche 1, Befund 3	24		22	5	4	1		29
Fläche 1, Befund 3	24	21	22,5	6	4	1		31
Fläche 1, Befund 3	22	20	15	4	5	1		32
Fläche 1, Befund 3	23	21	17,5	7	5	1		63
Fläche 1, Befund 3	23	20	17	5	2		1	
Fläche 2 Befund 1	38	32	22	6	2	1		607
Fläche 2 Befund 2	21		22	6	12			
Excavations 2019 and 2020								
2019 outer ditch	20		17	4	2	1		874
2019 middle ditch	27		17	8	2	1		875
2019 middle ditch	42	39	16	7	2	1		876
2019 inner ditch	33		20	8	2			888
2019 inner ditch	29	26	18	7	2			896
2019 inner ditch	33	31	18	4	2			898
2019 inner ditch	37		26	8	2			899
2019 inner ditch	24	22	19	6	2			884
2019 inner ditch	33	32	19	5	2			883
2019 inner ditch	44	37	21	7	2			891
2019 inner ditch	30		22	7	2	1		881
2019 inner ditch	27	23	22	6	2	1		898
2019 inner ditch	27	22	22	6	12			
2020 outer ditch	32	29	21	6	2	1		1246
2020 outer ditch	30	29	18	6	2			1247
2020 outer ditch	35	31	19	4	3			1249
2020 surface	51	28	8	6	2			872

4. FUNCTIONS OF TOOLS. USE-WEAR ANALYSIS

Use-wear analysis is one of the most powerful techniques for the reconstruction of functions of artefacts, and for detecting various types of damage, including breakages (Aldenderfer *et al.* 1989; Grace 1989; Hayden 1979; Hurcombe 1985; Keeley 1980; Kononenko 2011; Korobkowa 1999; Małecka-Kukawka 2001; Owen and Untrath 1985; Pelisiak 2004). Both macroscopic and microscopic observations formed the basis of the analysis. All the artefacts from Altheim were examined using an OLYMPUS SZX16 stereoscopic microscope and an OLYMPUS BX51 optical polarizing microscope using reflected light, employing both low (24X-33X) and high (175X) magnifications.

Fourteen artefacts (excluding arrowheads) were analyzed for microscopic traces of work. Use-wear analyses were performed using a microscope at 300x magnification. Formation of use-wear on lithic tools is a complex and dynamic process. On the examined tools (14 specimens) several kinds of modification were observed: surface modifications; edge scarring (microchipping); scars distributed continuously, irregular in shape, oriented toward the edge perpendicularly or slightly diagonally to the edge, edge striations (long and deep, oriented at a slight angle to the edge); and edge rounding and polishing. These traces suggest various types of working with a soft material, probably soft wood. In the case of cortical plates of Plattensilex with bifacial retouch and glossy polishing of this edge, it is possible that this tool was used for grass cutting, probably harvesting of cereals.

The lithic arrowheads discovered at Altheim in the 2013-2020 field season excavations are whole or broken. Whole specimens are extremely rare. One such artefact bears specific traces of use on the tip (Fig. 4: 8) in a form of small scars on the tip and micro crushes and cracks in the shape of micro flakes detached from the tip of the arrowhead, vertically or almost vertically to the long axis of the arrowheads. Such traces can be linked to the arrow striking a hard tree. The direction of impact of the arrow (arrowheads) was vertical or almost vertical (approx. 80°-90°) to the tree. One arrowhead bears no traces of impact (Fig. 4: 1).

Most of the arrowheads with broken tips bear diagnostic impact fractures: step terminating bending fractures or spin-off fractures (Altorfer and Altorfer 2011; Coppe and Rots 2017; Fischer *et al.* 1984; Gassin 1996; Loi, Brizzi 2011; Kalterborn 1999) specifically in the shape of small fractures on the edge between one surface of the arrowhead and the surface of break of the tip (examples 24, 28, 29, 31, 32, 33, 42, 63, 66). These suggest angles of impact of the arrows into hard surfaces at about 60°-70°. It should be also added that some arrowheads bear cracks as result of burning and/or bending. The lithic arrowheads were attached to the wooden part of the arrows. Their bond with the wooden arrows must have been stable but not very strong. After a hitting the a body, the stone part of the arrow must have stayed inside the body like a bullet.

Arrows with lithic heads were probably used in various ways, some of them also as a weapon (Bye-Jensen 2011, fig. 10). In this regard the famous Ötzi (with a lithic arrowhead recognized in his body) can be suggested as good proof of the "military" use of bows

and arrows tipped with lithic arrowheads (Fleckinger 2003, 45). Other examples come from, for example, the Iberian Peninsula (Márquez *et al.* 2008, fig. 3) and Eulau in Saxony-Anhalt (Meyer *et al.* 2009). The interpretation of some of the lithic arrowheads found in Altheim as archaeological traces of conflict (s) also finds support in the place of their discovery. The vast majority of broken specimens and specimens with characteristic fractures indicating impact into a hard material, as well as whole arrowheads, were recorded in the ditches, mainly in the inner ditch. It should be also noted that not every arrowhead that impacted hard material was necessarily broken or bearing other traces of impact.

5. CONCLUSIONS

In the 2013-2020 excavations at the Altheim site, 360 lithic artefacts were discovered. They have been analyzed on several main levels: context, raw material, typology, and use-wear and damage. The analyzed artefacts are made of several kinds of raw material sourced in the Regensburg and Kalheim regions, mainly Baiersdorf and Arnhofen patular cherts. Tabular cherts from Baiersdorf and Arnhofen were widely used by Neolithic communities which settled areas around the natural sources, but distribution of these raw materials and artefacts made of them covered an area of a radius of hundreds of kilometres from the extraction sites of Baiersdorf and Arnhofen cherts (*e.g.,* Roth 2008; Binsteiner 2005). A relatively large number of lithic artefacts discovered in Altheim are burnt, some to an extent which makes it impossible to identify the raw material used. Plates of tabular cherts were a convenient and useful type of "half-product" for the production of many tools. Plates 3-6 mm thick were used for production of arrowheads, and others for the production of a variety of tools (*e.g.,* sickles, knives, end-scrapers) as well as regular blades.

The vast majority of the lithic artefacts were discovered in the innermost ditch.

Chunks, flakes, arrow heads and other tools are the most numerous in the lithic assemblage from Altheim. Chips are also numerous. A particularly large number of them were found in the "house pit". Aside from the arrowheads, the tools are of a settlement character. They relate to the specimens discovered in the course of previous excavations at this site. The tools are made from various raw materials, but most are from Baiersdorf and Arnhofen Plattensilex. In the tools group (aside from arrowheads) blade end-scrapers (made of various raw materials), retouched blades and retouched tools made from plates of Plattensilex are most frequent. Blade end-scrapers are not numerous. Retouched plates of tabular cherts as well as sickles and knives made of these raw materials are frequently registered on sites of Altheim culture and other cultures in the IV millennium BC in the area of the Alpine Forelands (Reittinger 1968-1970; Brandl *et al.* 2017; Richter and Wild 2018).

The tools discovered in Altheim in 2013-2020 relate to the specimens discovered in previous excavations on this site. End-scrapers and retouched blades are frequent on the settlement sites located on the Alpine Forelands and dated to the Late Neolithic. A damaged

blade truncated piece is an exceptional specimen from this site. Such tools are typical and frequent on sites from the Early and Middle Neolithic. This specimen has no counterpart in the Late Neolithic sites in the Alpine Forelands.

Arrowheads constitute one of the largest group of lithic artefacts found on the Altheim site. Specimens discovered in 2013-2020 are similar in many respects (raw material, size, shape, modifications) to those discovered earlier (Richter 2014; Richter *et al*. 2016; Saile 2019). Most of the arrowheads are made of Plattensilex, but all specimens discovered in the part of the inner ditch excavated in 2018-2020 are made of Baiersdorf Plattensilex. Many of the arrowheads were burnt, and many have broken tips. All the analyzed arrowheads with broken tips bear diagnostic impact fractures: step- terminating bending fractures or spin-off fractures specifically in the shape of small fractures on the edge between one surface of the arrowhead and the surface of fracture of the tip. This suggests an angle of impact of the arrow into a hard surface of about 60°-70°. Broken and burnt arrowheads were found in the strong context of the defence structures. The context of these finds and fractures of the arrowheads resulting from being shot into hard wood suggest a connection with military conflict. It can be also suggested that most of the arrowheads discovered in the ditch were from the arrows of the attackers.

Lithic arrowheads are frequently registered (but varying in number) on other sites located in the Alpine Forelands dated to the fourth millennium BC (Binsteiner 2013). In Altheim, their high frequency compared to other categories of lithic artefacts is noticeable.

In general, the lithic material from the Altheim site relates to other knapped assemblages dated to the 4th millennium BC from the Alpine Forelands. They have numerous analogies in the field of arrowheads, other tools and raw materials used at the sites of Altheim, Cham, Pfyn and Michelsberg cultures (*e.g*., Binsteiner 2013; Kieselbach 2008; Leuzinger 2007; Meixner 2008; Modderman 1977; Underwood 2014; 2017).

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RED DEER ANTLER ARTEFACTS FROM GORDINEŞTI II – ”STÎNCA GOALĂ” AND VYNNYKY-”ZHUPAN”: SHAPE-AND-TRACE FORMATION PROCESSES IN NATURAL, FUNCTIONAL AND DEPOSITIONAL CONTEXTS

ABSTRACT

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The paper scrutinizes the red deer hard tissues from the contexts attributed to the Trypillia Culture's final phases. Having once been reported elsewhere, the objects under study are this time conceptualized in terms of shape-and-trace formation processes, with an eye to incorporating them into research advances under the topic of the late Trypillia transformation, including typological affiliation, radiocarbon dating, archaeoecology, subsistence studies, *etc*. Particular attention is paid to artefacts that lack the overwhelming power of the tiniest wear marks, but do display extensive topographic features of manufacture and use. The formalized shape-and-trace aspects for the antler artefacts are proposed, which are considered to be suitable rather for a morphological than for a morphographic systematization of a prehistoric antler assemblage. An interpretative application of the shape-and-trace approach for the sake of clarification of both past currents in morphogenesis of artefacts and praxis of their use is only possible in a systemic context of knowledge about habitats and lifestyles of the past.

Keywords: Early Bronze Age, Late Trypillia, faunal hard tissues, bone and antler industry, subsistence, adaptation
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INTRODUCTION

The Gordineşti Group represents the latest phase of the Trypillia Culture. Until not too long ago, the economy, sedentism, and subsistence of the Gordineşti Group's population have been among the issues studied on a very limited basis. However, it is the settlement site of Gordineşti II-"Stînca goală" (Dergachev 1980; Rybicka *et al.* 2023a; 2023b) which now constitutes the exception due to the systematic multidisciplinary research. Particularly, subsistence studies have shown that cultivation of cereals with animal husbandry such as cattle, sheep, goat, and, to a lesser extent, pig were the main sources of food supplies for those who lived there (Croitor and Sîrbu 2017; 2019; Rybicka *et al.* 2023b). The protein diet was supplemented with wild fauna (Croitor and Sîrbu 2019). Another significant hill-top location attributed to the Gordineşti Group is in the city of Vynnyky near Lviv in Western Ukraine and the site there is called "Zhupan" (Fig. 1).

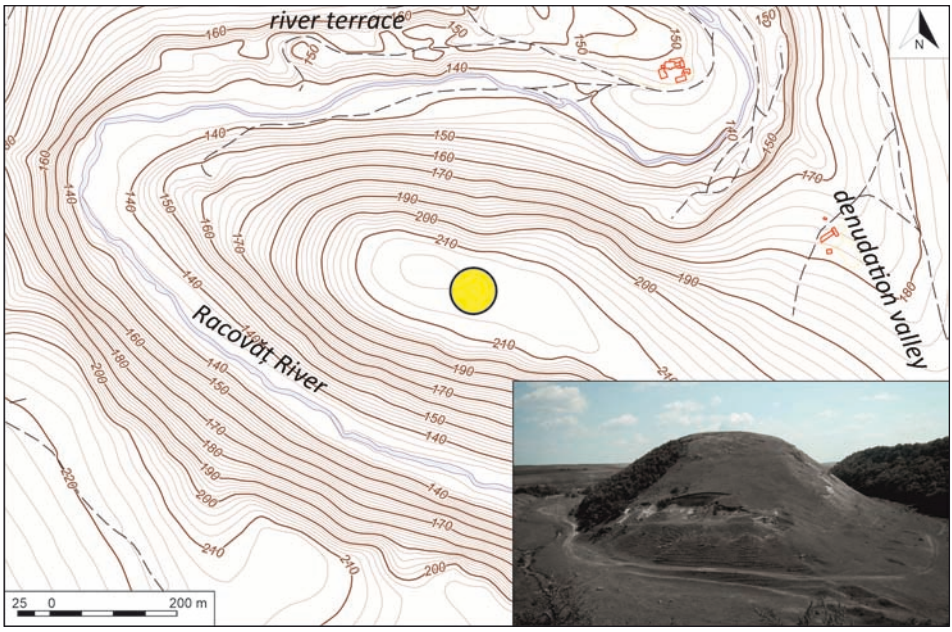
The geographical locations of the sites under study are remarkably diverse and quite distant from each other, yet the sites are nonetheless similar in terms of their affiliation within the same time scale of the late Trypillia Gordineşti Group and the types of landscape they occupy (Figs 1 and 2; Hawinskyj and Rybicka 2021, 15, Fot. 1; Rybicka *et al.* 2023a): these both are situated upon flattened tops of rocky limestone hills called "Bald Rock" (Stînca goală) and "Chieftain" (Zhupan).

Currently, we have a series of radiocarbon-based values at our disposal for the sites under scrutiny. From Gordineşti II-"Stînca goală", a group of twelve ^{14}C dates was obtained, which enables the chronological expanse of the settlement to be outlined within the time range of 3500-3000 cal. BC (Król and Rybicka 2022; 2023). It should be emphasized that no evidence of archaeological cultures other than Trypillia was found in the contexts recovered in Gordineşti. From Vynnyky-"Zhupan", only two samples have been analyzed so far, yet even these two enable the inclusion of the Trypillia settlement features into the cal. BC time range mentioned above (Król and Rybicka 2022).

Both in Gordineşti II-"Stînca goală" and Vynnyky-"Zhupan", there are well-defined and homogenous archaeological contexts such as houses, pits, fortifications, and occupation deposits providing rich samples of faunal hard tissues. The osteoarchaeological research was focused on the osseous records discovered in 2016-2019 (Sîrbu *et al.* 2017a; 2017b; 2019; Sîrbu and Król 2021; Rybicka *et al.* 2023a; Verteletskyi *et al.* 2023).

In recent years, bone and antler artefacts attributed to the Gordineşti Group of the late Trypillia Culture have been subjected to study in terms of raw material structure and use-wear patterns (Pankowski 2019; 2023; Pankowski and Piątkowska-Małecka 2023). At present, there are few other habitation contexts of the Gordineşti Group providing significant data and concepts on manufacture and use of bone, antler and horn artefacts due to use-wear and technological studies.

Among faunal hard tissues in Gordineşti II-"Stînca goală", in addition to the large sample of remains of domestic animals such as cattle, sheep, by the pit, and pig, those of the



A



B

Fig. 1. Location and view of the settlement Gordineşti II-"Stînca goală", Edineț district (A) and view of the site Vynnyky Zhupan, Lviv district (B) (after Król and Rybicka 2023; Hawinskyj and Rybicka 2021)

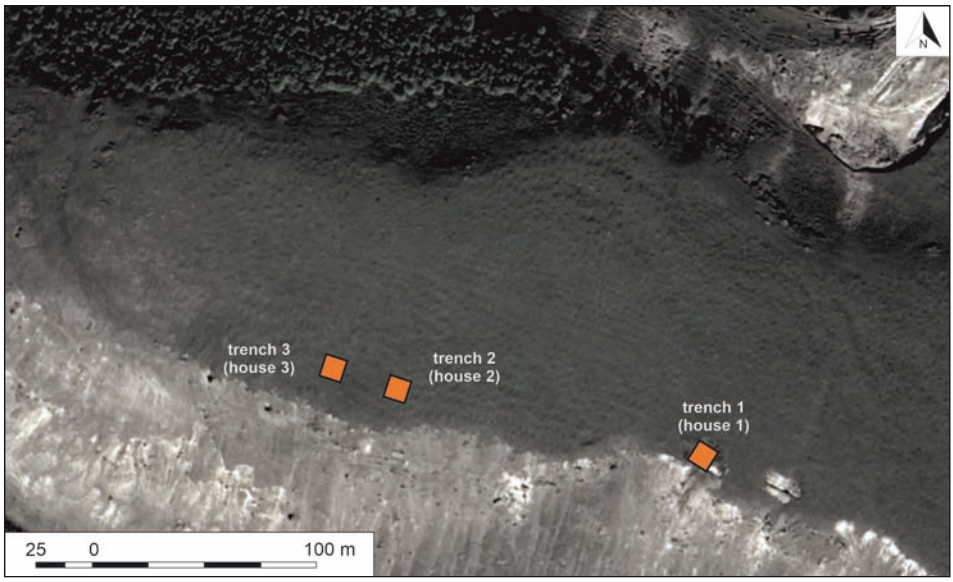


Fig. 2. Gordineşti II-*"Stînca goală"*, Edineț district. Location of the excavated houses (after Król, Rybicka 2023)

wild beasts were identified as well (Croitor and Sîrbu 2017; 2019; Rybicka *et al.* 2023b). The remains of the red deer are of particular interest, since these are represented by both skeletal elements and shed antlers (Croitor and Sîrbu 2017, 216ff; 2019, 153; Pankowski 2023, 53-67). In Vynnyky-"Zhupan", both bone and antler remains of red deer were also reported to have been found (Pankowski 2019, 203; Pankowski and Piątkowska-Małecka 2023, 163-179). The red deer antler industry in Zhupan is only represented by the pit finds of detached pieces of hoe heads (?).

Red deer bones are basically identified as butchering waste and signatures of meat consumption practices, while some antler objects were recognized as documenting manufacture in the form of tools and débitage. In the late Trypillia habitation contexts of Gordineşti, the most remarkable aspect of antler technology is that the natural raw material configurations such as tines, beams and their combinations have been widely reshaped and used for tools, while nothing is known about small pieces elaborately carved from antler cortical tissue (Sîrbu *et al.* 2023, 37, 97, 105, 154, 176, figs 17: 9-12; 3: 1-4, 6; 11: 7; 30: 5, 6, 10; 11: 2, 3). In Gordineşti, according to Sîrbu *et al.* (2023), 19 artefacts of bone and 16 artefacts of antler industry have been found. The latter were roughly classified as adzes, smoothers, a handle, shaft-hole hoe heads, and a shaft-hole sleeve; some antler specimens are interpreted as manufacturing waste, especially when it comes to the curved tips of antler tines. To date, only part of the sample has been subjected to traceological expertise, which, beyond any preliminary considerations, turned out to contain two ambiguous antler objects.



Fig. 3. Gordineşti II-"*Stînca goală*". Red deer antler beam-and-tine shaft-hole object with single side bevel bit: a – left cheek view; b – upper eye view; c – right cheek view; d – lower eye view; e – butt view; f – cutting edge view (photo by the authors)

This paper aims to revisit the samples of red deer antler, raw and worked alike, discovered in Gordineşti II-"Stînca goală" and Vynnyky-"Zhupan", including such instruments as the shaft-hole tool head ('axe head') and the pressure flaker (Pankowski 2023, 57-59) (Figs 3-6). Here, we would like to present some considerations and assumptions concerning



Fig. 4. Gordineşti II-*"Stînca goală"*. Red deer antler tine pressure flaker: a-c – surface aspects; d – hemispherical point view (photo by the autors)



Fig. 5. Gordineşti II-*"Stînca goală"*. Surface aspect of the red deer antler object displaying sawn marks next to the shaft hole (photo by the autors)

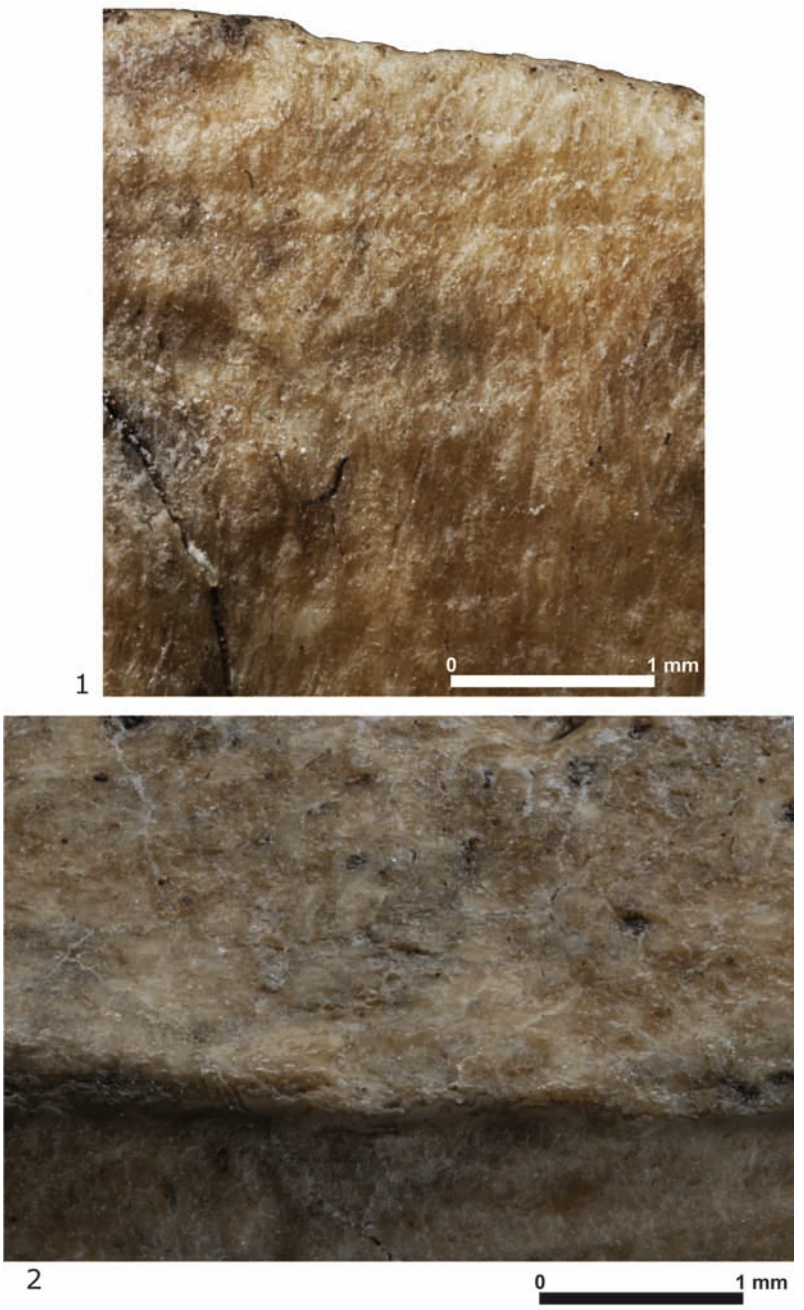


Fig. 6. Gordineşti II-"*Stînca goală*". Surface aspects of the red deer antler shaft-hole object: 1 – convex surface of the bit close to the cutting edge; 2 – frontal view at the cutting edge; the upper half of the picture displays the flatness of the bevelled bit (photo by the autors)

archaeozoological, use-wear and raw material structure studies of the red deer hard tissues from these two sites, with an emphasis on their supply, exploitation, and deposition. What was the special reason to revisit the issue? What is important here is the idea that the instrumentally induced alterations to the natural appearance in antler are all conceptualized as traces/marks of various scales and should therefore be considered within the frameworks of an overall shape-and-trace formation process (morphotraceogenesis) (Giria 2015; Pankowski 2019). From such a perspective, archaeological traceology should operate both with tiniest surface formations, like polish with its special microtopography, linear scratches, *etc*., and with the much bigger loci like flake scars, bevelled areas, facets, clusters of convergent scrapemarks, crater-like boreholes and full-thickness perforations through the spongy and cortical tissues, and the like.

Among late Trypillia humanly modified antler objects there are many that are known to lack well-developed microscopic use-wear evidence, although they do display well-defined surface modifications and shape alterations (Pankowski 2019; 2023). These are the first ones to which we refer our readers, by reproducing the most demonstrative surface conditions (Fig. 6), but not renewing the detailed discussion on topography and research glossary for those surfaces. Here, the macroscopic loci of traceological evidence is revisited most so that more interrelated attributes could be involved in studying type formation processes in antler industries of the palaeometallic epoch.

We also tend to shy away from giving a cursory and therefore superficial essay of the richest experience in systematization of prehistoric bone and antler industries. The variety of the approaches is known and needs comparative theoretical analysis, which has already become a special research trend (*cf*. Beldiman 2001; Vitezović 2016). By hoping that the vocabulary of this paper will coincide exactly with that of the earlier studies, we would risk falling into vain expectations, since here and there the scopes of the concepts may vary greatly, and so do the analytic perspectives, while the historians of the method can dissect, compare and classify them in the due course. We submit the present paper to a volume published in honour of the eminent scholar, Jolanta Małecka-Kukawka, and consider this to be the most appropriate platform for a proposal of the debatable and still emerging conceptual system, as long as the topic's cyclopaedic presentation has not yet been elaborated fundamentally, and a suitable textual space and editorial format have not yet been found.

RESEARCH PRINCIPLES, CONCEPTS, AND TERMINOLOGY

When dealing with the phenomena of humanly induced morphotraceogenesis (artificial shape-and-trace modification) in antler industries, it is advisable to use specialized concepts and terms (Pankowski 2019, 198; 2023, 46, 47). Here, the most useful concepts are *'shape'* and 'surface' with their varieties, and 'trace' ('mark'), that is, a visible sign of the fact that the texture and/or shape of an object were modified by displacing and/or remov-

ing its own substance, or else by applying some foreign substance, to imprint features that may demonstrate the forces and instruments that affected the object.

In the raw materials of hard faunal tissues, with the structural diversity they have, their own proper shapes do exist, and they necessarily contribute to the appearances of artefacts. It happens occasionally that an artefact's proper shape and a natural shape of antler are the same. In some rare occasions, as the integrity of the raw material dissociates beyond antler carving, and its parts enter the manufacture, the raw material proper (own) shapes cannot be called natural.

In technofunctional classification (Pankowski 2017), the increasing intensity, with which the proper shapes in hard faunal tissues have been exploited, is conceptualized in terms of accommodation, modification, and conversion.

Accommodation refers to the use of antler in its whole natural shape (natural accommodation) or else its pieces (partial accommodation) without more alterations previously added in the course of shape-and-trace formation. They are apt, although they were not produced on purpose. But while in use, both kinds of accommodats, like artefacts of the other two technoclasses (see below), wore down to alter their shapes; also, they were cleaned and reshaped. Partial accomodats are in some ways similar to R. L. Lyman's (1984) expediency tools. In A. P. Borodovskiy's (1997) technosystems, natural accomodats correspond to some objects in terms of adapting natural shape of antler, while partial accommodats are parallel to the blanks, in which the natural shape of antler as well as its fragments were used selectively. Red deer antler was taken from special environmental reservoirs and was subject to cutting, chopping and sawing into parts (Choyke 1984, 20, 26, 35; 2005, 141). Being treated this way, the break-resistant material (Borodovskiy 1997, 23, 24; Filippov 1978, 23, 24; Gerasimov 1941, 74; Iziumova 1949, 15, 16) tended to produce shavings, while occasional splinters were few. The manufacturing waste that turned out to be useable tools (van Gijn 2007, 111, Afb. 9) and blanks (Borodovskiy 1997, 83-84), were subjected to handiwork and therefore should be defined differently in technofunctional classification (see below). Among the examples of natural accommodation of antler are hunting trophies from the highland sanctuaries accumulated over the longer term (Kaloev 1971, 258, 265) and, say, offerings associated with the building of prehistoric fortresses (Choyke 2005, 134, fig. 5). Partial accommodation is all in all rare in antler industries.

Modification, in its turn, is the realm of change and use of the given, which preserves either (a) basic structural configurations in toto (natural modification), or (b) selected elements in their organic consistency (partial modification). Unlike the accommodative approach, significant alterations in the course of shape-and-trace formation are required. In A. P. Borodovskiy's technosystems, natural modificats may be found among the artefacts based on natural shapes as a whole, while partial modificats correspond to the blanks obtained from selective use of natural shapes and then transformed by handiwork. In antler industries, natural modificats are, *e.g.*, tools for breaking rawhides, digging, and ore mining (Borodovskiy 1997, 81, 82, pl. 44: 8; 2007, 46, 80). Highly widespread antler tines and

beams modified into hoe heads or, say, shaft-hole axe sleeves, are partial modificats (*cf.* Borodovskiy 1997, 82).

And, finally, conversion means that the raw material is transformed into artefacts by converting whole antlers in the manner that their natural structures only preserved on a restricted basis. The resulted convertats are therefore relatively small. In A. P. Borodovskiy's technosystems, they correlate with extreme loss of the natural shape during the transformation of basic blanks such as the use of expedient fragments or selected pieces produced by controlled cutting and splitting.

Consequently, a proper shape, being a whole or a portion, become an *acquired shape* when worked and used; and as soon as regular blanks may be produced from a whole or a portion, they will be acquired too.

Accordingly, there are two kinds of surfaces within the variability of antler raw material. The one, which is still intact, is a proper (own) surface, with outward proper surface and inward proper surface included. A proper surface, with the antler tissue disclosed, normally produces a series of fractured expanses, *i.e.*, exposed proper surfaces. Manufacture and use, in their turn, produce acquired surfaces; one should not confuse them with the bigger and the biggest among the traces, *e.g.*, percussive flake scars, while acquired surfaces normally display hierarchies of various traces.

On both proper and acquired surfaces, traces of manufacture and use are found, and this is the reason why they are named receptive surfaces. A receptive surface is not another kind beyond the other two, since the receptiveness is a function or a possibility the surfaces may have, for it needs a trace to emerge that we may call a surface truly receptive.

Cumulative (resultant) shape, as well as cumulative (resultant) surface, are newly introduced trial concepts, which will be found below in the text.

In terms of **shapes**, the shape-and-trace formation process in a past functional context can be represented like this:

In raw materials selected		**In artefacts expedient, manufactured, and utilized**	
proper (own) shape	natural shape	natural shape	integral shape resulting from accommodation or modification of the raw material
		acquired shape	
	proper shape's expedient portion	acquired shape	partial shape resulting from accommodation, or modification, or conversion of the raw material

Similar relations in terms of **surfaces** may look as follows:

In raw materials selected			**In artefacts expedient, manufactured, and utilized**	
→ proper (own) surface →	outward surface	← proper exposed surface ←	due to the property of trace-receptiveness:	
			proper, trace-receptive surface	acquired, trace-receptive surface
	inward surface		due to the property of trace-receptiveness:	
			proper, trace-receptive surface	acquired, trace-receptive surface

RED DEER ANTLER INDUSTRY SAMPLE FROM GORDINEŞTI: AN OVERVIEW

The first section of the annotated directory compiles miscellanea of review, introductory and reference nature commonly found in museum inventories and ID cards, and occasionally applicable to various research purposes.

Shaft-hole axe head (Fig. 3): No. 11, 2019, Unit VI, – 0.32 m. Length, mm – 173, head's height, mm – 64, shaft hole diameter, mm – 22, bevelled surface's length, mm – 61 (Pankowski 2023, 57-59, figs. 20-22; Sîrbu *et al.* 2023, 114, 154, fig. 10: D; 30: 10).

Pressure flaker (Fig. 4): No. 10, 2019, Unit VI, cell 71, – 0.3 m. Length, mm – 74.5, hafting diameter, mm – 19.5, working end diameter, mm – 13 (Pankowski 2023, 59, fig. 23; Sîrbu *et al.* 2023, 113, 154, fig. 30: 5).

The following section specifies parallel correspondence between the given – raw material structures – and the ways they were modified (A); the resultant formations are complemented with written descriptions of legacy marks of manufacture (B) and use-wear marks imposed (C). Use-wear marks, following the above, can be both macro- and microscopic.

Shaft-hole axe head

A: raw material selection and modification; an operational sequence is implied to have occurred in the past, but is not emphasized

proper shapes and surfaces (structured)	**acquired surfaces** contributing to the **acquired shape**	axe head elements: **a resultant shape**
main beam (cortex + spongiosa)	●transversal truncating, distally for the bottom sleeve rim and proximally for the top rim (Fig. 3: a-f) ● spongiosa coring (Fig. 3: b, d)	**shaft sleeve**
central/3rd tine (cortex + spongiosa)	● charring and transversal cutting (?); 7°-30° bevelling (Fig. 3: a, c) ●heat hardening? (Fig. 3: c)	**Spike**
beam & tine	cored beam stub & bevelled tine	tube & point

B: manufacture

acquired shapes and surfaces	**shape-and-trace formation**	**shape-and-trace formation topography and geometry**
●beam truncated ●beam stub cored	●circumferential flint filing ●flint cutting and chiselling	● discrete and robust grooving (Fig. 5) ● removal, smooth and hollow (Fig.3: a, c)
●tine beveled*	● solid rock multidirectional abrading, fine-grained particles irregularly located, no sawdust involved**; burning and flint cutting? ●burning?	● low and smooth plane, sharp and clean; longitudinal, transversal and diagonal v-shaped grooves; no clusters of grooves, no extensive polish (Fig. 6)**; black and brown colouration ●black and brown colouration

* Side bevelling specialises tools as axes (shaft-hole adzes) that work best in transversal logging and carpentry; *cf.* van Gijn 2005, 51, fig. 4; Maigrot 2005, 122, fig. 7: 10; Orłowska and Osipowicz 2017, 121-122, 131, fig. 2: a, b.
** *cf.* Christidou and Legrand 2005, 392-394; Orłowska and Osipowicz 2017, 120.

C: trace-receptive surfaces

acquired shapes and surfaces	axe head elements: **a resultant shape**	**shape-and-trace formation topography and geometry**
beam truncated beam stub cored	**shaft sleeve**	
tine bevelled	**Spike**	fine-wavy and smoothly sloped cutting edge (Fig. 6: 1), fine-lumped at its margin (Fig. 6: 2, left), scarce flake scarring and excoriations (Fig. 6: 2, right)*

* Most probably renewed by regrinding, with post-depositional effects added. For well-developed use-wear patterns representing a variability of linear and nonlinear relief textures please see, *e.g.*, Orłowska and Osipowicz 2017, 123-125, fig. 3: A-G, L; 4: B-F, L.

Pressure flaker

A: raw material selection and modification; an operational sequence is implied to have occurred in the past, but is not emphasized

proper shapes and surfaces (structured)	**acquired surfaces** contributing to the **acquired shape**	pressure flaker elements: **a resultant shape**
tine (cortex + spongiosa)	transversal truncating, distally and proximally (Fig. 4) distal end rounding (Fig. 4: d)	**Spike**
Tine	tine truncated and semi-rounded	Point

B: manufacture

acquired shapes and surfaces	**shape-and-trace formation**	**shape-and-trace formation topography and geometry**
tine truncated and rounded*	●proximally: most probably removed by post-depositional breakage (Fig. 4: a, bottom) ●distally: cutting and abrading are most probable (Fig. 4: a, d)	●fracture ● faceted semi-rounded area all around a concentrated working site

* Antler tine pressure flakers are attributed due to sub-rounded or subconical points (Inizan *et al.* 1999, 32, 148, 149; Poplevko 2002; Zhilin 2012, 228-231).

C: trace-receptive surfaces

acquired shapes and surfaces	pressure flaker elements: **a resultant shape**	**shape-and-trace formation topography and geometry**
tine truncated and rounded	**Spike**	eroded and smoothed by post-depositional weathering*

* Antler tine pressure flakers are attributed due to well-visible flint knapping use-wear (Inizan *et al.* 1999, 32, 148, 149; Poplevko 2002; Zhilin 2012, 228-231).

DISCUSSION

In artefactual osteoarchaeology, worked red deer antler studies may produce seminal observations regarding raw material selection, manufacture techniques, and ways of tool use in the past. It appears to be a truism that research like this enables new insights and interpretations concerning antler naturfacts (ecofacts) and artefacts in the ways similar to those applied to the lithic industries studies (Małecka-Kukawka 2001; 2012, 470; 2019).

The overall appearances (cumulative shapes and surfaces resulted from functional contexts in the past) of the pieces of antler selected here may suggest that it is woodworking and flintknapping that should be listed among the purposes and functions of the tools. However, both the macro- and microtraces observed may, in turn, support the fact that we should refrain from insisting on something special which could be ever chopped or dug with the Gordineşti beam-and-tine 'axe head', and it is exactly due to its bit, which even now looks freshly sharpened or refreshed. If we, due to the special conditions of the archaeological record, now and then deviate from making a list of manufacture processes in rural economy and crafts and household activities, then the shape-and-trace formation data constantly inform us about the variability that was expedient technological behaviour in the past. Being perfectly aware of the fact that the following assumption may seem to have little to do with the expertise of real use-wear record, we nonetheless find it useful to note that in the face of a lack of use-wear data, we would risk simplifying the whole picture by classifying the variability of perforated and pointed and bevelled antler objects exclusively as shaft-hole working attachments such as axe heads, mattock heads, hammer heads *etc*. The total lack (or a low density) of expected use-wear patterns resulting from digging soil or chopping wood and the like may indicate that at least some of these artefacts, if not many, may have been used as, say, pegs for holding tents and haystack covers and goat leashes or similar devices. Since the collection of shaft-hole tools from Gordineşti is gradually increasing both in kinds and numbers (Sîrbu *et al.* 2017a, fig. 2: 7; 2019, 109, fig. 12: 11; Croitor and Sîrbu 2017, 217, fig. 1: A), including frontally bevelled varieties, there is still a chance to classify and detail this diversity in due course.

And so, the large-scale traceological evidence provides a sufficient layer of data on cultural formation, diversity, and change in the late Trypillia inventories made of antler. Particularly, the sub-rounded point of the antler tine from Gordineşti (Fig. 4) is an attribute that affiliates the artefact with the 'Tools' group among the 'Instruments' subclass, which, in turn, represents the class of 'Equipment for productive actions' (Pankowski 2023, 62). The same classificatory disposition can be presumed for the shaft-hole beam with its bevelled tine, though one may choose here between a tool's head as such and anything else among 'Instruments', which may seem suitable for other actions than chopping wood or digging ground, just in view of its bevelled end (see above). But most importantly, both the 'flaker' and the 'head' provide regular shape-and-trace patterns and, therefore, typological content, since they represent a special approach of partial modification of antler (Pan-

kowski 2023, 63). A record like this is especially useful with freshly made, refreshed, barely worn, poorly preserved, and alike artefacts.

Red deer evidence in the faunal samples derived from Gordineşti II-"Stînca goală" (Croitor and Sîrbu 2017, 216ff; 2019, 153) and Vynnyky-"Zhupan" (Pankowski and Piątkowska-Małecka 2023, 163-179) provides a substantial material signal of the natural environment within and around those sites. Indeed, in the plant macroremains sample from the fully excavated homestead units at Gordineşti II-"Stînca goală", ash tree and oak were evidenced (Sady-Bugajska 2023, 36, 39), to mark the ecosystem of deciduous forests most probably full of red deer in the late 4th millennium BC.

The very fact that the faunal record from Gordineşti-"Stînca goală" has yielded both red deer antler and artefacts made of it (Sîrbu *et al.* 2019, 109, fig. 12: 9, 10) is, of course, insufficient to prove that the local community was constantly engaged in hunting red deer. Naturally, the presence of antler at the site could well have been a result of gathering activities of the locals who could occasionally scour the area for the valuable raw material in the woods within easy reach of their hill-top village (Pankowski 2023, 63, figs. 36, 37). It is interesting that some detached antler bases and beams and tines in Gordineşti and Vynnyky display tooth marks left by both mice and squirrels. It is not easy to decide with all possible certainty whether every single gnawed specimen is derived from shed or cut antler, though some of them are definitely shed ones (Sîrbu *et al.* 2017a, fig. 2: 8; 2019, 109, fig. 12: 12; Croitor and Sîrbu 2017, 217, 218, fig. 1: B; Pankowski 2019, 203, fig. 22: 1; 2023, 63-67, figs. 29-32, 36, 37). It seems that the past antler gatherers needed to collect antlers as soon as possible during the shedding season before they were devoured by rodents; the latter could nonetheless continue eating various antler objects already in settlement contexts. But after all, both shed antlers and antler artefacts are the things which could have been brought home by the Gordineşti folk from somewhere else or received as gifts or in exchange. However, it is the relative abundance of red deer skeletal bones among faunal remains from the site's occupation deposits (Croitor and Sîrbu 2019, 153) that may clearly suggest that the protein diet has been routinely supplied in Gordineşti with meat and fat of this species, while skeletal elements, antlers, raw hides, tendons, and wool could have been obtained directly from the carcasses of the hunted animals.

Are there many weapons in Gordineşti to signalize red deer -or any other – hunting? Actually, there are only a few of them. There is not enough evidence for the use of ranged weapons such as bow and arrows and spears. It is possible that slings and lassoes or blowpipes were used, but the archaeological record available provides no basis for such a suggestion. According to Ghenadie Sîrbu's personal communication, only two or so flint arrowheads were found in Gordineşti (we probably can observe them after Dergachev 2021, fig. 13: 3, 4), and we do not consider that it is possible that red deer would let humans approach them with flint axes in their hands, any huntsmen using such a weapon would have been skilled tomahawk throwers. It is these flint wedge-shaped 'axe heads' that are especially numerous at the sites of the Gordineşti Group (*cf.* Dergachev 1980, fig. 31: 47, 48; Sîrbu *et al.* 2019, fig.

14; Dergachev 2021, fig. 13: 5, 6), but we still do not have sufficient use-wear evidence to subdivide this conglomerate into real hunting/battle axes and, for example, adzes or mattocks.

Subsistence studies have additional support, given the fact that a perforated red deer tooth was found in Gordineşti-"Stînca goală" (Pankowski 2023, 59-62) and that canine teeth personal ornaments are among principal signatures of the hunting activity and hunting magic among those who made and wore them (d'Errico and Vanhaeren 2002, 211 ff.). Red deer canine decorations as well as bone imitations of them have already appeared twice in burials of the Gordineşti Group, including those from the grave discovered at the eponymous burial ground; in addition to these, a pressure flaker sleeve made of red deer antler as well as red deer bones and skull fragments were reported to be found in the burials of the Gordineşti Group (Dergachev 2021, 46; Dergachev 2022, 290, 294, 297). In riverine areas, such as the Dnister region, red deer hunting near watering spots was commonly practiced in early Trypillia times, providing the abundance of bones in the site deposits (Zbenovich 1980, 98, 100, 141-143; Belan and Logvinenko 1986). From now on, the question for future comparative research can be put as follows: does the red deer hunting specialization of the Chalcolithic settlement in Bernashivka I on the Dnister River (Zbenovich 1980, 141, 142, 144, 149, 150) pose a sort of analogy of the situation that took place in Gordineşti II, already in the conditions of the Early Bronze Age? However, the archaic faunal sample signalizes a good portion of aurochs among game animals, which by no means is the case in Gordineşti.

Unlike Stînca goală, red deer hard tissue remains in Zhupan are few. This place was hardly intended for regular butchering of carcasses, and the dogs didn't feast on food scraps and leftovers here; it was antler tools, pieces of antler, and selected meaty portions that have occasionally been brought there from the foot of the mountain (Pankowski and Piątkowska-Małecka 2023, 163-179). Here, it seems likely enough that the antler specimens just mentioned may represent dry splinters of heavily damaged and poorly preserved tools, given the assumption (Pankowski 2019, 203) that they most probably served as hoe heads when the highlanders dug waste and storage pits through the limestone underlayer, as well as the observations on antler knapping, which is unlikely to have become widespread here and elsewhere in the Late Chalcolithic (*cf.* Kempisty 1958, 136, 137; 1961, 313-316, 317-319), since fresh antler is too tough to be easily knapped.

SYNOPSIS

The above appositely recalls, in particular, that microtraces are not the only thing that traceology focuses on, since it covers the whole shape-and-trace formation process as the morphotraceogenesis, and the smallest ones are only part of a bigger one. The pressure flaker of Gordineşti, for instance, is an almost perfect case of making up for the lack of use-wear microtraces with what is commonly referred to as 'shape'. And yet, S. A. Semenov's

(1970, 6) functional analysis is searching for surfaces displaying at least few well-preserved microtraces of wear, and in case it fails to find them because of heavy antler weathering, then the complementary evidence of the tool's general 'shape' turns into an index evidence. One may even say that there are some well-recognizable 'shapes' that can be linked to the most probable uses. This, of course, is not a reason to skip the microanalysis of surfaces even in cases when nothing useful was found there, as happened in our case. In truth, archaeological traceology is about *complex use-wear patterns* and the ways they relate to the shapes of things. But as we take them ranked, marks of variable size classes must have contributed to the shape, so that for lack of microtraces we should have checked whether some bigger patterns have disappeared; specifically, if linear microtraces of manufacture abrasion have been erased, an abraded facet remains; in case the abrasion was wear, the resulting facet would be a bigger use-wear trace, which remained. And if so, then the prehistoric pit features, like dugout basements and pit-traps (Semenov 1970, 6), will be the large-scale manufacture traces in the ground, though micro-scale traces of their manufacture and use would hardly have been imprinted against the sand and loam for too long.

For those who are looking for the shape formation processes in bone and antler artefacts, and hence typogenesis in unfolding cultural change, shape-and-trace evidence of various ranks is needed, especially considering that the Gordineşti people alternated cutting twigs in the woods with digging fortifications upon the hill; in this regard, the antler débitage from the stony moat-and-rampart area in Gordineşti would be of interest (*cf*. the Zhupan case). Although, of course, loggers, ditchers, and flint knappers must have been aware of green antler as a shatter resistant material. To gain such knowledge, it was enough to look at how the red deer behave and pay attention to the natural wear of the antlers. Burning could be used to enhance and solidify this valuable property, although we tend to presume burning and charring prior to tine bevelling, just to make truncation easier (*cf*. Semenov 1970, 145). In terms of classification, partial modification in red deer antler artefacts is well-distinguishable from among techno-functional approaches (see *Research Principles*...) due to the natural elements of antler routinely used, tines in particular, with some of these left attached to organic carriers, which are main beams. In tool making, unlike antler, spacious cortical tissue blades of tubular bones underwent an overall converting approach, and some were used as expedient chance splinters (*i.e*., via accommodation of parts) (Pankowski 2023, 47-56, 63, 67). The small-sized integral shape in canines is modified for personal ornaments (Pankowski 2023, 59-62, 67, 68).

When it comes to the Chalcolithic and Early Bronze Age in the forest-steppe south of Eastern Europe, it seems to be quite realistic that the red deer bone and antler industry had not yet dispersed into isolated areas of highly specialized bone and antler carving, nor had it been scattered into enclosed cells of use as well as amongst art stylistic trends (as is observed in the Late Bronze and Early Iron Ages in the same region). Specifically, both knapped lithic tools and those shaped of ground stone were used when making antler tools and canine beads, while in the flint knapping, in turn, pressure flakers made of antler tines

were applied, and some antler picks could be of aid in digging holes for pottery and daub clays, various rocks, and minerals. In Gordineşti and Vynnyky, the manufacture and use of red deer antler and bone for both tools and personal ornaments (considering their most relevant and probable purposes, functions, and designs) appear to be quite evenly available to the community's adults and teenagers and at least some kids, with all possible age-class subdivisions and preferences thereof.

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FLINT ARROWHEADS FROM ASSEMBLAGES OF THE CORDED WARE CULTURE: MORPHOLOGY AND FUNCTION – THE EXAMPLE OF THE GRAVE FROM MYDŁÓW (SANDOMIERZ UPLAND)

ABSTRACT

Libera J. and Mączyński P. 2024. Flint arrowheads from assemblages of the Corded Ware culture: morphology and function – the example of the grave from Mydłów (Sandomierz Upland). *Sprawozdania Archeologiczne* 76/1, 555-582.

Flint arrowheads are one of the most common artefact types found in funerary materials attributed to the Corded Ware culture. One of the most numerous assemblages was discovered in Mydłów (on the Sandomierz Upland) in 1990. It was composed of 27 arrowheads deposited in Feature 2. In order to better understand the character of this collection, it was re-examined with the use of new findings concerning the most recent research into Corded Ware flint-knapping across Lesser Poland. To obtain new information, the investigation was considerably enriched with microscopic analyses of the surfaces of the artefacts – conducted to identify potential use-wear patterns on them.

Keywords: flint arrowheads, graves, Corded Ware culture, Sandomierz Upland, use-wear analysis
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INTRODUCTION

Numerous graves discovered across Lesser Poland and attributed to the population of the Corded Ware culture (hereinafter referred to as the CWC) yielded different types of assemblages of portable finds. The literature concerning them is quite substantial, and the most recent, synthetic paper discussing such material found across the upland part of south-eastern Poland presents artefacts discovered in nearly 600 better or worse preserved graves. The most numerous group is the compact Kraków cluster, which contrasts with more scattered groups in the Sandomierz, Lublin and Rzeszów regions (Libera 2022). Flint tools are also frequent finds – although not always present in such graves. The most common ones include axes, retouched blades, scrapers and arrowheads. This article is devoted to the last of these categories of artefacts. They can be described as bifacial points having a nearly triangular shape, formed on relatively thin flakes, with retouch on their entire surfaces or near the edges (sometimes both types are present on the same specimen). Their length can be up to several centimetres. They comprise the most numerous group of artefacts among flint inventories used as burial goods. Their numbers in particular features vary from several to nearly 30 specimens. These materials have been the subject of numerous analyses aimed at their description and classification (Borkowski 1987; Włodarczak 2006; Libera 2022). Work has also been carried out to determine the function of specimens discovered in graves that were considered to have been knives or blades of thrown weapons (for example, Drobniewicz 1979; Winiarska-Kabacińska 2007; 2008; 2019; Boroń and Winiarska-Kabacińska 2014, 218-224; Pyżewicz 2017).

The group of such items from Mydłów, Opatów District (within the Sandomierz cluster) can serve as an example of such a large group (Fig. 1). A systematic surface survey conducted in 1990 within the framework of the Polish Archaeological Record (Polish: Archeologiczne Zdjęcie Polski, AZP) resulted in a discovery of several features exposed in the loess escarpment of a dirt road leading through a gorge (site 37, region 88-70). The rescue research subsequently conducted on the site resulted in exploring several features, *e.g.*, Grave 2 attributed to the CWC. The partially damaged niche of the grave yielded over ten small bones in an unintelligible arrangement, probably belonging to a male about 30 years old. The cultural attribution is corroborated by a set of 26 undamaged arrowheads and a fragment of another arrowhead – a broken off wing. They were scattered, which made it impossible to reconstruct their original arrangement in relation to the skeleton, whose position was also unclear. Another discovery in the same grave were large fragments of a four-handle amphora. Beside them, fine pottery fragments, flint blades and flakes attributed to the Mierzanowice culture (see Bargieł 1990) were found in a stratigraphically unspecified position. Based on sources provided by other grave inventories from southern Poland, we can suspect that the man buried in Mydłów was accompanied by other flint artefacts, which might have been destroyed during the erosion of the sides of the dirt road (see Włodarczak 2006, 66-77). The discussed feature was associated with subphase III of

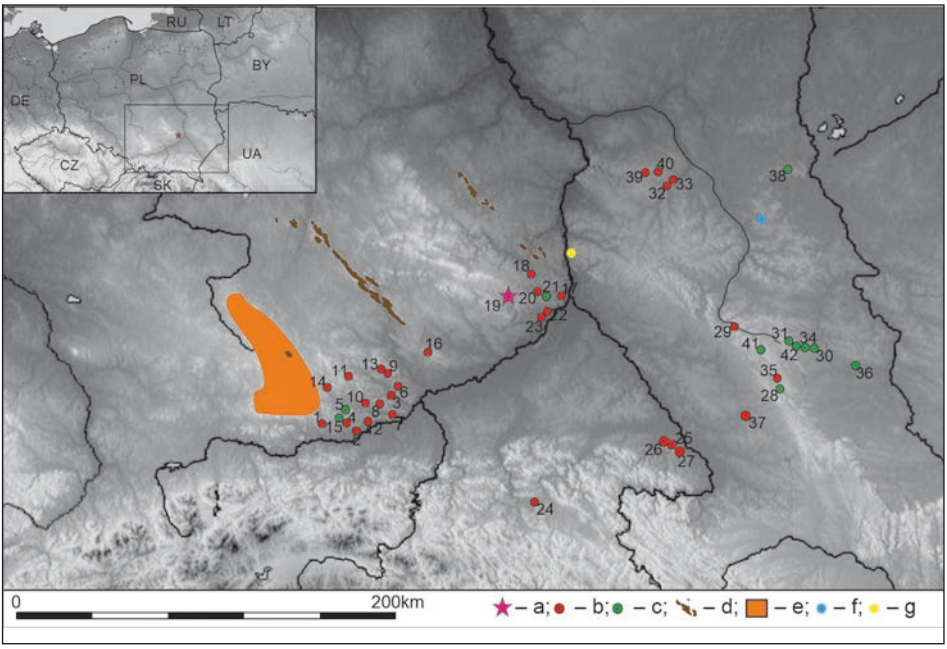


Fig. 1. Location of selected CWC graves with arrowheads from south-eastern areas of Poland (Kraków cluster): 1 – Bosutów; 2 – Igołomia, Site 21; 3 – Kazimierza Mała; 4 – Kocmyrzów, Site 17; 5 – Koniusza; 6 – Krzyż, Site 1; 7 – Książnice Wielkie; 8 – Łękawa, Site 15; 9 – Malżyce, Site 30; 10 – Ostrów, Site 25; 11 – Rosiejów, Site 2; 12 – Rudno Górne, Site 8; 13 – Stradów, Site 1 (currently Zagaje Stradowskie); 14 – Szczepanowice; 15 – Zielona, Site 3; 16 – Żerniki Górne, Site 1; (Sandomierz cluster): 17 – Kichary Nowe, Site 2 (currently Nowe Kichary); 18 – Mierzanowice, Site 1; 19 – Mydłów, Site 37; 20 – No-wy Daromin, Site 20 (currently Daromin); 21 – Wilczyce, Site 10; 22 – Złota, sites „Grodzisko II", „Nad Wawrem" and 6; 23 – Żuków; (Rzeszów cluster): 24 – Bierówka; 25 – Mirocin, Sites 24 and 27; 26 – Rozbórz, Site 42; 27 – Szczytna, Sites 5 and 6; (Lublin cluster): 28 – Brzezinki, Site 1 (currently part of the village Wola Wielka); 29 – Guciów, Site 6; 30 – Hubinek, Site 3; 31 – Klekacz, Site 10; 32 – Lublin-Sławinek, Sites 1 and 2; 33 – Łagiewniki, Site 10; 34 – Łubcze, Site 24; 35 – Łukawica, Site 13; 36 – Machnówek, Site 1; 37 – Młodów-Zakącie, Site 68 (currently part of the village Młodów); 38 – Nieborowa, Site I; 39 – Sługocin, Site 5; 40 – Snopków, Site 18; 41 – Ulów, Sites 3 and 4; 42 – Wierszczyca, Site 29.
Map legend: a – Mydłów; b – location of CWC graves containing at least two arrowheads; c – inventories of CWC with use-wear analysis; d – source of Chocolate flint; e – source of Jurassic sub-Kraków flint; f – Rejowiec flint;g – Source of Świeciechów and Gościeradów flint.
Prepared by P. Mączyński (base map: https: //maps-for-free.com)

the CWC development, which allows us to date it to *ca*. 2500-2300/2200 BC (Włodarczak 2006, pl. 65: 15-19; 127).

The subject of the present consideration is the set of arrowheads discovered in Mydłów (Sandomierz Upland), in Grave No. 2, analysed in the context of similar inventories from closed assemblages located within the range of the CWC settlement in Lesser Poland (Fig. 1). The assemblage in question has previously been analysed (description and classification) carried out by Barbara Bargieł (2009). Nevertheless, in order to better understand the

character of this collection of arrowheads, we need to have a new look based on recent findings concerning CWC flint-knapping, and taking into account the results of microscopic research aimed at identifying potential use-wear patterns on their surfaces.

MORPHOLOGY

With respect to the metric and morphological features of the discussed artefacts, the most numerous group are arrowheads having a nearly triangular frontal outline, with slightly convex edge (in the case of two-thirds of the collection) or straight edges, base cut at nearly a right angle (two thirds of the collection), or arched and symmetrical sides (all but two specimens). The studied assemblage does not include classic heart-shaped arrowheads, but several artefacts have somewhat arcuately undercut sides. Based on the metric values and proportion between the length and maximum width, it was observed that the most numerous group are rather small and heavyset items. Only three artefacts can be considered as slender. Their extreme dimensions are: height of 13-23 mm, width of 9-14 mm, thickness of 2.5-4 mm, and the average results are respectively 18 mm – 12 mm – 2.7 mm. Their masses vary from 0.2 to 1.1 g, with the average of 0.4 g (Bargieł 2009, pl. 1).

They were made of relatively thin blanks in the form of flakes or scaled flakes, which had been retouched on both sides with flat or semi-steep retouch near their edges and sometimes with quite fine correction retouch. There are also examples of both retouch types on a single specimen. Certain specimens have retouch negatives in the form of pseudo-troughs, whereas in others they are in the shape of (pseudo) serrations. In most cases, the tips of the arrowheads were formed in the bulb parts of the employed blanks. Only some of the arrowheads have their tips on the opposite side. Generally speaking, their shapes do not differ from the forms of the points discovered in CWC graves and analysed by Wojciech Borkowski (1987, 156ff) and Jerzy Libera (2022, 70ff).

METHODOLOGY

The use-ware analysis was performed with two types of microscopes. In the early stage of research, stereoscopic equipment by Carll Zeiss (SteREO Discovery.V8), was used. It is capable of producing real magnifications from 10 to 80 times (zoom no greater than 50 was used). The microscope was employed together with a dedicated source of cold LED light. The next step was the observation of arrowheads using the Meiji Techno MC-50T equipment. It is a metallographic microscope which allows for much larger magnifications: 50-500x (magnifications of 50×, 100×, 200× was used).

The microscopic analysis was aimed at identifying several types of use-wear traces. The first category were modifications that might have been caused by using the arrowheads as

elements of projectile weapons (Fischer *et al.* 1984; Nowak and Osipowicz 2013; Wolski and Kalita 2015). We also focused on recording patterns that may attest to keeping the arrowheads in a quiver. The use-wear traces were identified based on archaeological literature and experimental research conducted by the author. Because of the fact that flint arrowheads were not used as autonomous tools, but they were attached to arrow shafts, stress was also put on the possibility of finding remains of adhesives that might have been used in fixing them (see Bąbel 2013a, 114, 115; 2013b, ryc. 41: 11; 205: 1-14; 206: 1-11; Budziszewski *et al.* 2016, ryc. 17, 405).

RESULTS OF USE-WEAR ANALYSIS

Altogether, 26 arrowheads were analysed (Table 1). The last item found in the assemblage, the broken off wing of a further arrowhead was not available. The examined items were very well preserved, and their surfaces were not covered with patina, but carbonate residues (which did not influence the quality of the research) were detected on several specimens (Fig. 2: 1, 7, 8; 3: 3; 4: 1, 5; 1, 8; 6: 4). It is also worth noting that linear traces were discovered on the surface of one of the specimens, but the accompanying residues of metal suggest that it is modern damage (Fig. 2: 4). It is also worth noting that during the

Table 1. Results of use-ware analysis of arrowheads from Mydłów

No.	Morphology	Results of use-wear analysis	Fig.
1	Triangular arrowheads with concave base (with a broken tip and wings)	Use-ware traces no observed	Fig. 2: 1
2	Triangular arrowheads with concave base	Use-ware traces no observed	Fig. 2: 2
3	Triangular arrowheads with concave base	Use-ware traces no observed	Fig. 2: 3
4	Triangular arrowheads with concave base (with a broken wing)	Use-ware traces no observed	Fig. 2: 4
5	Triangular arrowheads with concave base (with a broken tip and wings)	Use-ware traces no observed	Fig. 2: 5
6	Triangular arrowheads with concave base	Use-ware traces no observed	Fig. 2: 6
7	Triangular arrowheads with concave base (with a broken wing)	Use-ware traces no observed	Fig. 2: 7
8	Triangular arrowheads with concave base (with a broken wing)	Tip – weak developed traces of contact with soft material (transport in a quiver)	Fig. 2: 8, 10
9	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver)	Fig. 2: 9, 11
10	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver)	Fig. 2: 12, 13

Table 1.

No.	Morphology	Results of use-wear analysis	Fig.
11	Triangular arrowheads with concave base (with a broken wing)	Tip and wings – traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of wing	Fig. 3: 1-4
12	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver)	Fig. 3: 5, 6
13	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver)	Fig. 3: 7, 8
14	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver). Traces on the tip are more intense	Fig. 4: 1, 2
15	Triangular arrowheads with concave base (with a broken tip and one wing)	Tip (slight broken) and wings – weak developed traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of tip. The chronological position of the fracture on the wing is unclear	Fig. 4: 3, 4
16	Triangular arrowheads with concave base	Tip and wings – weak developed traces of contact with soft material (transport in a quiver)	Fig. 4: 5, 6
17	Triangular arrowheads with concave base	Tip and wings – traces of contact with soft material (transport in a quiver)	Fig. 4: 7, 8
18	Triangular arrowheads with concave base (with a broken wings)	Tip and wings – traces of contact with soft material (transport in a quiver). Most likely use-wear traces also covering the broken part of wing	Fig. 5: 1, 2
19	Triangular arrowheads with concave base (with a broken wing)	Tip and wings – traces of contact with soft material (transport in a quiver). The chronological position of the fracture on the wing is unclear	Fig. 5: 3, 5
20	Triangular arrowheads with concave base (with a broken tip)	Tip (slight broken) and wings – traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of tip	Fig. 5: 4, 7
21	Triangular arrowheads with concave base (with a broken wing)	Tip and wings – traces of contact with soft material (transport in a quiver). Use-wear traces also covering the broken part of wing. Tip – well developed traces, wings – weak developed traces	Fig. 5: 6, 8, 9
22	Triangular arrowheads with concave base (with a broken tip)	Tip (slight broken) and wings – traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of tip	Fig. 6: 1, 2
23	Triangular arrowheads with concave base (with a broken wing)	Tip and wings – weak developed traces of contact with soft material (transport in a quiver). The chronological position of the fracture on the wing is unclear	Fig. 6: 3, 5
24	Triangular arrowheads with concave base	Tip and wings – well developed traces of contact with soft material (transport in a quiver)	Fig. 6: 4, 7, 9
25	Triangular arrowheads with concave base (with a broken tip)	Tip (slight broken) and wings – traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of tip	Fig. 6: 6, 8
26	Triangular arrowheads with concave base (with a broken wings)	Tip and wings (slight broken) – traces of contact with soft material (transport in a quiver). Traces also appeared on the broken part of wings	Fig. 7: 1, 2

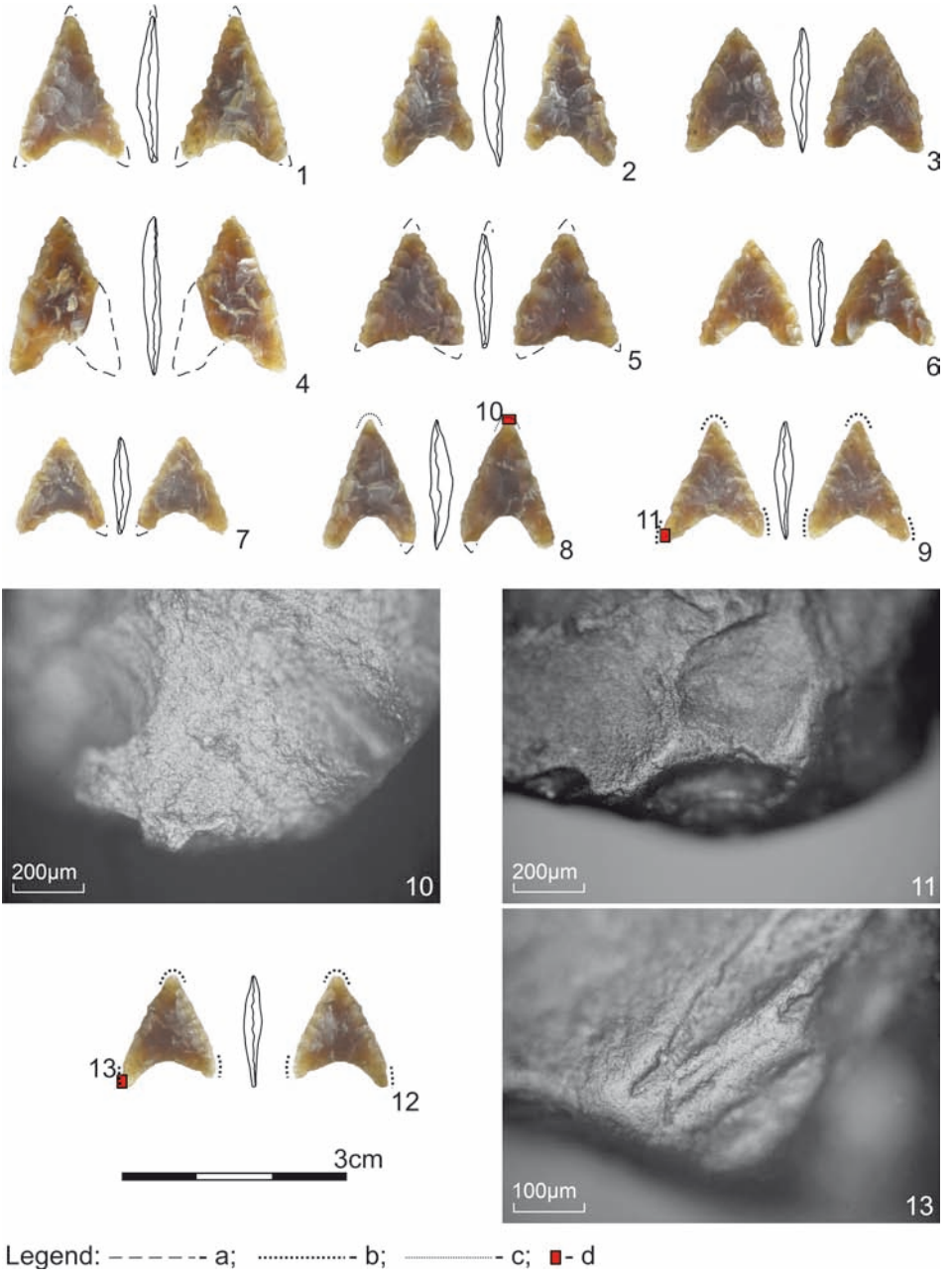


Fig. 2. Arrowheads from Mydłów. 1-9, 12 – arrowheads; 10, 11, 13 – use-wear traces created during contact in a quiver. Legend: a – reconstruction of arrowheads; b – well-developed use-wear traces; c – poorly developed use-wear traces; d – place where the photograph was taken. Photo by P. Mączyński

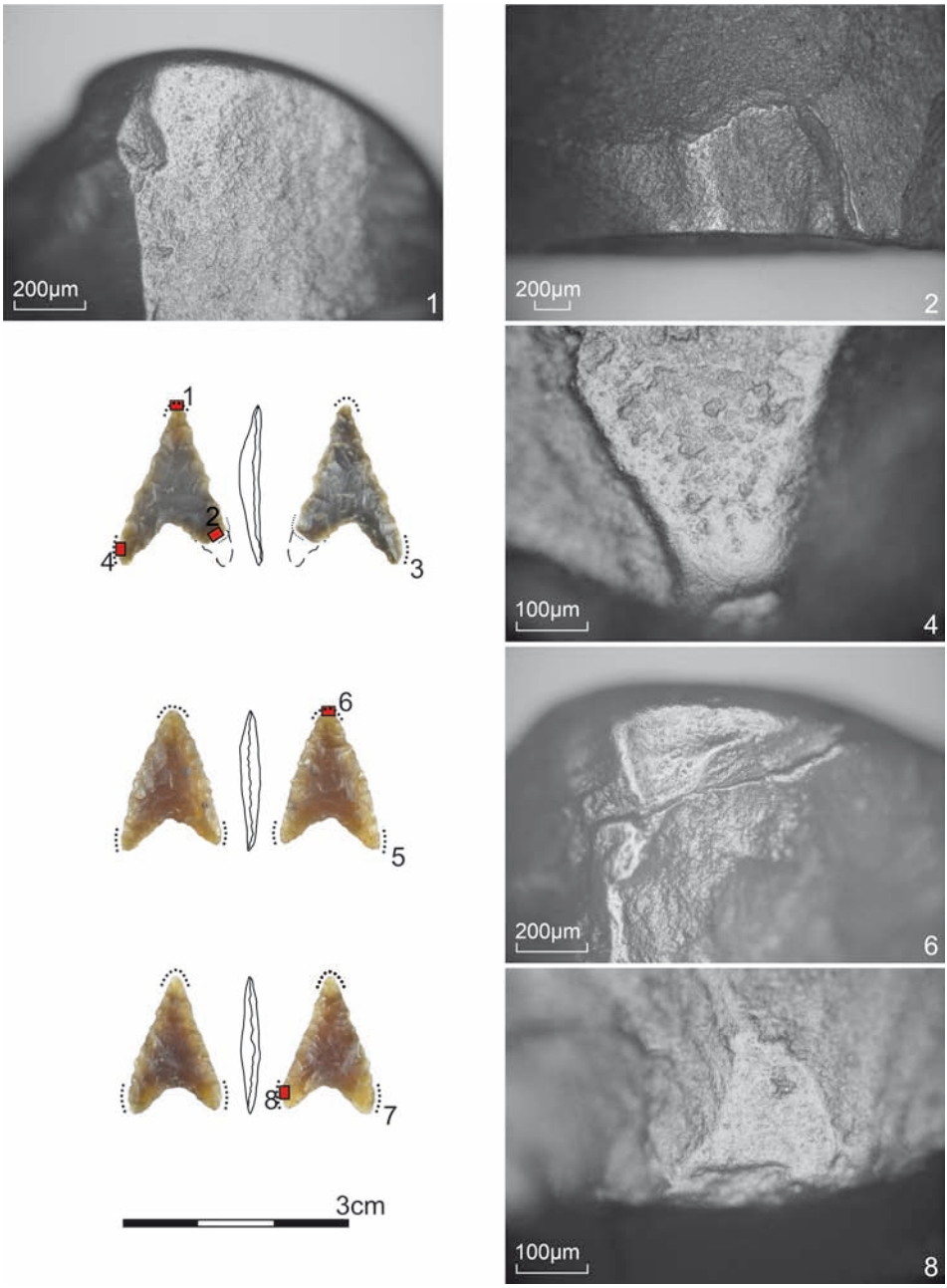


Fig. 3. Arrowheads from Mydłów.
3, 5, 7 – arrowheads; 1, 2, 4, 6, 8 – use-wear traces created during contact in a quiver.
Photo by P. Mączyński

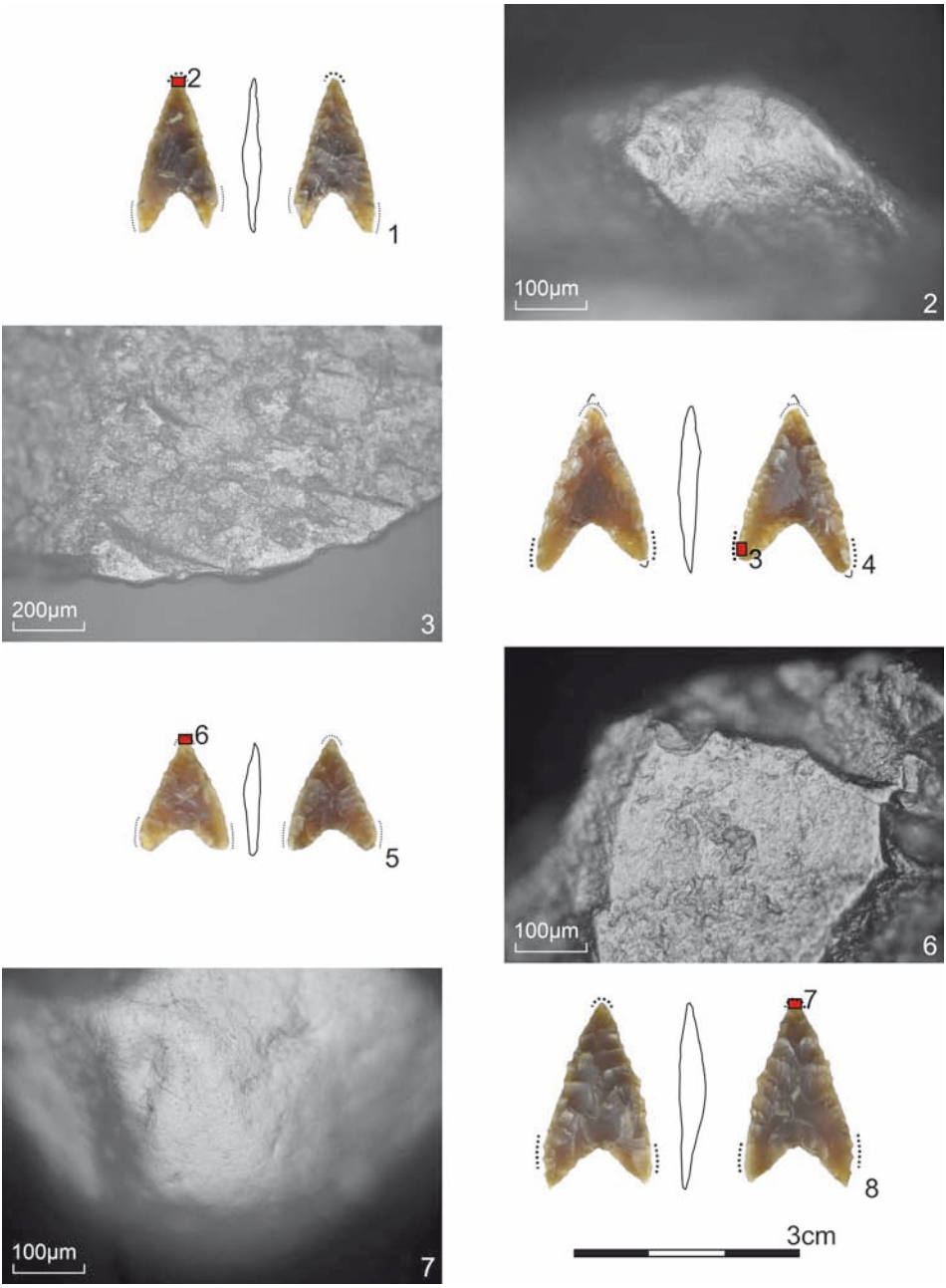


Fig. 4. Arrowheads from Mydłów.
1, 4, 5, 8 – arrowheads; 2, 3, 6, 7 – use-wear traces created during contact in a quiver.
Photo by P. Mączyński

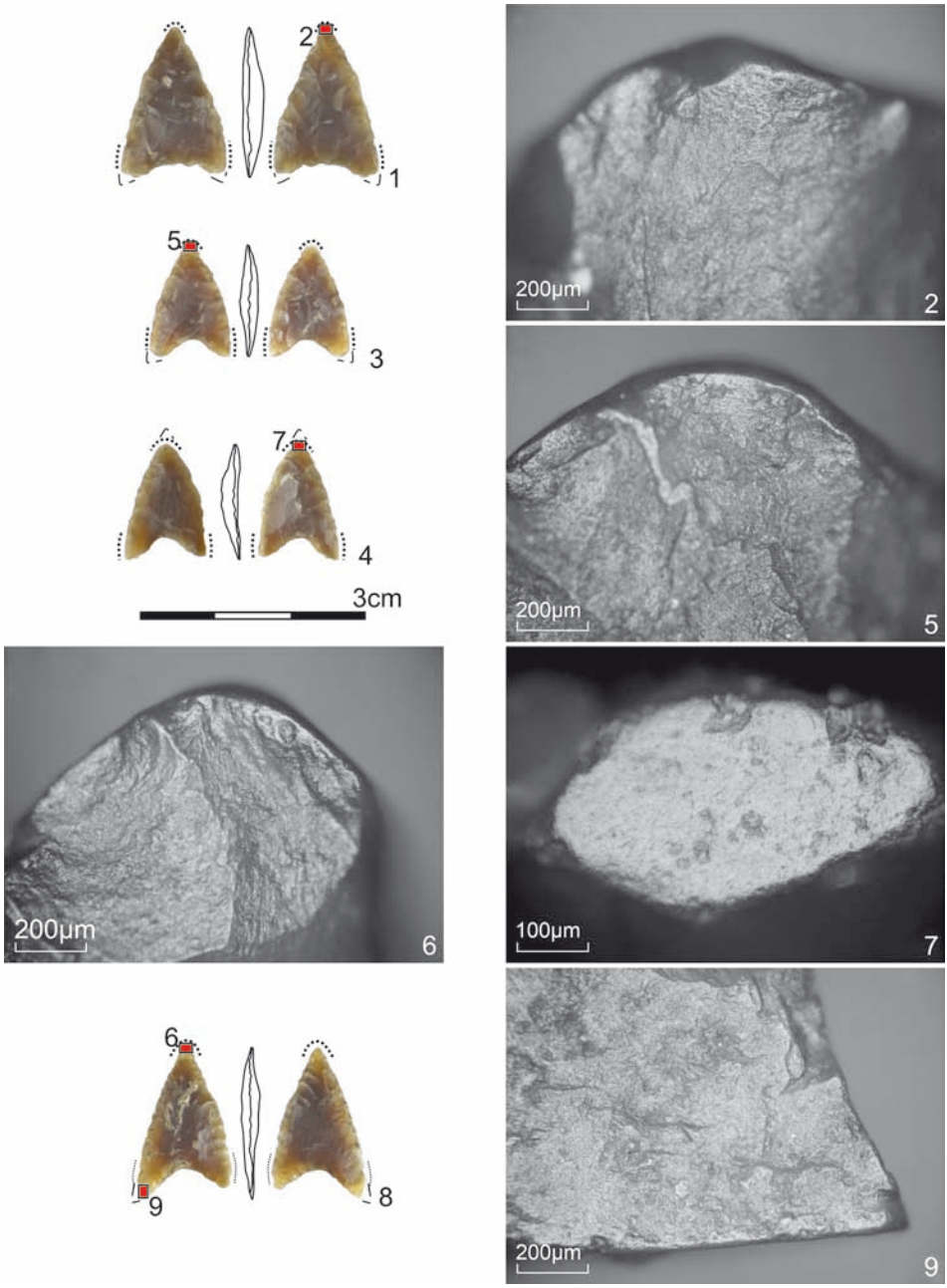


Fig. 5. Arrowheads from Mydłów.
1, 3, 4, 8 – arrowheads; 2, 5, 6, 7, 9 – use-wear traces created during contact in a quiver.
Photo by P. Mączyński

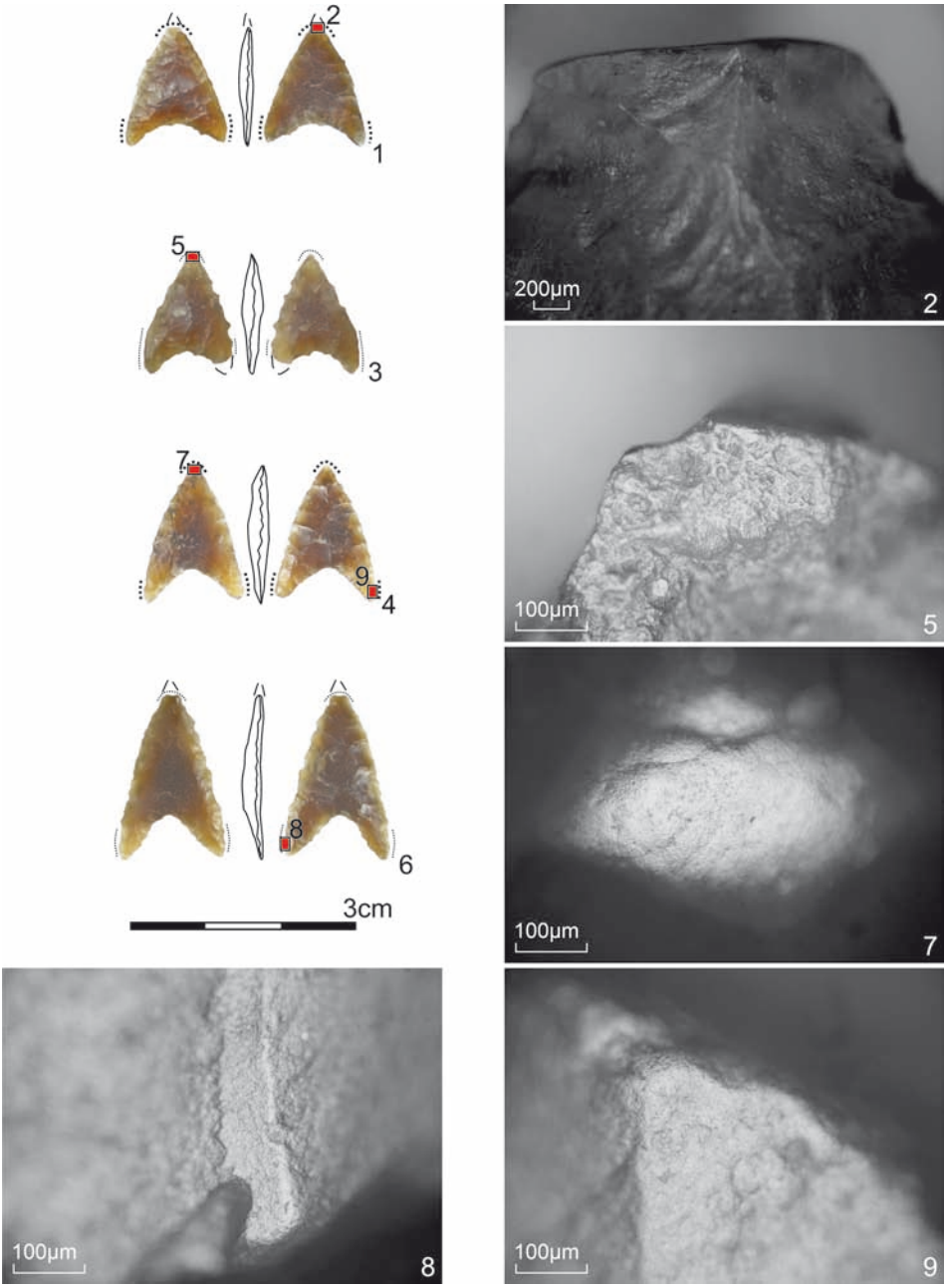


Fig. 6. Arrowheads from Mydłów.
1, 3, 4, 6 – arrowheads; 2, 5, 7-9 – use-wear traces created during contact in a quiver.
Photo by P. Mączyński

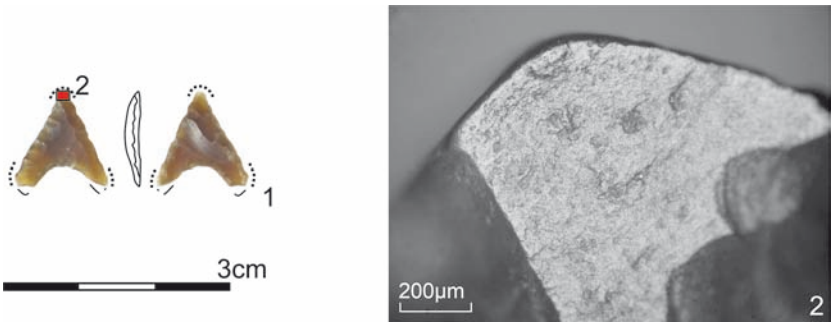


Fig. 7. Arrowheads from Mydłów.
1 – arrowhead; 2 – use-wear traces created during contact in a quiver.
Photo by P. Mączyński

observation, no traces of adhesives used to attach the arrowheads to the shafts, such as wood tar, were found on the surfaces of the arrowheads.

In the first stage, the analysis was aimed at identifying patterns that would indicate keeping the arrowheads in a quiver or some other container. Such traces usually consist of polishing and abrasions of the surfaces that came into contact with a quiver. In triangular and heart-shaped specimens, such surfaces are the protruding parts of the arrowheads – usually external edges of the sides and tips. As a result of the conducted analysis, the above-described patterns were detected on 19 arrowheads (Fig. 2: 8, 9, 12; 3: 3, 5, 7; 4: 1, 4, 5, 8; 5: 1, 3, 4, 8; 6: 1, 3, 4, 6; 7: 1), and the remaining lacked visible use-wear traces (Fig. 2: 1-7).

In the next part of the research, attention was paid to the possibility of detecting damage resulting from using the arrowheads as projectile elements. Nevertheless, such patterns were not discovered. Still, it should be mentioned that traces of this type are only rarely formed. They usually are created as a result of an arrow hitting a hard target; hitting soft materials probably would not have left any identifiable traces, thus their absence cannot be considered as an indicating that arrowheads were not used.

We need to bear in mind that several specimens had broken off tips and wings, but not characteristically enough to be treated as evidence of archery activities. What is interesting, most of the fractures were smoothed, which suggests that the damage occurred as a result of keeping the arrowheads in a quiver or earlier, at the stage of shaping or hafting these artefacts (Fig. 4: 4; 5: 4, 7-9; 6: 1, 2). The same applies to strongly damaged specimens. An example is arrowhead with a broken off wing, whose fracture is covered with abrasions resulting from storing it in a quiver (Fig. 3: 2, 3). This indicates that even strongly damaged, but still usable, specimens were used as points having a value that was equivalent to the unbroken ones.

FLINT ARROWHEADS IN CWC SETS FROM LESSER POLAND

Graves containing sets of arrowheads (more than two specimens) were discovered in all four CWC clusters from Lesser Poland. We know about 490 specimens, which makes almost 42% of the total number of flint artefacts discovered in grave pits (Table 2). They were found in the Sandomierz region – 188 specimens in 15 graves (nearly 12.5 specimens in one feature on average; the greatest number – 29 – found in Wilczyce, Feature 15), in the Kraków cluster – 158 specimens in 21 features (over 7.5 in one feature on average; the greatest number – 16 – found in Koniusza, Grave 3). Similar collections of arrowheads were discovered both in the Lublin region (75 in nine features; eight on average; the greatest number – ten specimens in Młodów-Zakącie) and in the Rzeszów region (72 in 13 features; 5.5 on average; the greatest number – ten specimens in Mirocin Site 24, Grave 110) (Libera 2022, 70ff.).

Most often, arrowheads discovered in a single place near a skeleton are interpreted as remains of arrows deposited in a quiver or in a bundle. In the latter case, we cannot rule out the possibility that they were kept in an organic container (sack). The locations of arrowheads in relation to skeletons are different – they could have been placed next to the head (Żerniki Górne, Grave 128; Mierzanowice, Grave 81); near the arms (Mierzanowice, Grave 94); back (Książnice Wielkie; Zielona; Mirocin, Graves 50 and 54; Szczytna, Barrow I, Grave 4; Lublin-Sławinek); ribcage (Nieborowa); pelvis (Igołomia; Koniusza; Ostrów; Rosiejów; Mierzanowice, Graves 100, 200 and 209; Żerniki Górne, Graves 132 and 133; Mirocin, Grave 110; Rozbórz); lower limbs (Malżyce, Barrow 2, Grave 10; Mierzanowice, Grave 199; Mirocin, Grave 110); feet (Łagiewniki; Mirocin, Grave 360). Sometimes, arrowheads were recorded at a considerable distance from the buried individuals. Such situations are completely different from cases of discovering single arrowheads in different parts of a skeleton or in its nearest vicinity – within the outline of a buried body, *e.g.*, in the ribcage (Malżyce, Barrow 2, Grave 10), arm (Mierzanowice, Grave 94), pelvis (Mierzanowice, Grave 200), ribs (Szczytna, Barrow 1, Grave 56), as well as near the thigh (Zielona) or shank (Mierzanowice, Grave 100).

Grave 2 from Nowy Daromin is a separate case. In this feature, single arrowheads were discovered in three different places: under the right clavicle and right hand as well as near the feet. Another example is Grave 15 from Złota 6; besides three arrowheads found between the ribs, there was also another one near the knee. These locations may suggest the cause of death of the buried individual. In several cases, arrowheads co-occurred in both places, *e.g.*, several arrowheads near the lower limbs and one in the ribcage (Malżyce, Barrow 2, Grave 10), next to the pelvis with a separate specimen near the shank (Mierzanowice, Grave 100), near the pelvis and lower limbs with two arrowheads between the femurs (Mirocin, Grave 110). In materials from Zielona, archaeologists found 10 arrowheads, out of which seven were grouped behind the back of the buried man, and three others were

Table 2. List of graves from the CWC from the Małopolska region containing at least two arrowheads

No.	Site, No.; municipality	Kurgan, grave/ feature	Type of grave/ feature	Sex	Age	Number of arrowheads: type of flint	Location at the skeleton	Presence of flint flake	Phase (Włodarczak 2006)	References
Kraków cluster										
1	Bosutów, No. 1; Zielonki	3	niche grave?	M	?	3 V?	„from the side”	-	IIIB	Krauss 1960, 63
2	Igołomia, No. 21; Igołomia-Wawrzeńczyce	3*	niche grave	M	?	9?	„near the arm”	-	?	Włodarczak 2020, 97 and next
3	Kazimierza Mała; Kazimierza Wielka	70	niche grave	?	?	3?	?	-	IIIB	Włodarczak 2006, 167, tabl. 40
4		79	?	?	?	15?	?	-	IIIC	Włodarczak 2006, 167, tabl. 40
5	Kocmyrzów, No. 17; Kocmyrzów-Luborzyca	5	niche grave	F, M, Ch	?	8?	?	-	IIIA	Włodarczak 2006, 167, tabl. 40
6	Koniusza; Koniusza	3	niche grave	M	*maturus*	16: 12 C, 3 J? 1 S	between the spine and pelvis – disorderly arranged	38 C	IIIB	Tunia 1979, 49-51; Drobniewicz 1979
7	Krzyż, No. 1; Czarnocin	2*	niche grave	-	-	8 C	the skeleton was not discovered	-	III	Tunia 1997, 184 and next
8	Książnice Wielkie; Koszyce	II (5/2)	niche grave	M	?	3 J	behind the back	-	IIIA	Machnik 1964, 344-345
9	Łękawa, No. 15; Kazimierza Wielka	4	?	-	-	7, 6 C, 1 radiolarite	the skeleton was not discovered	-	IIIB	Tunia 1999, 173 and next
10	Malżyce, No. 30; Czarnocin	kurgan 1, 2	niche grave	?	?	6?	?	-	IIIB	Włodarczak 2006, 169, tabl. 40
11		kurgan 2, 10	niche grave	M	*maturus*	9: 6 C, 3 J	near the lower limbs (8), within the chest (1)	10 J	IIIB	Jarosz *et al.* 2009

12	Ostrów, No. 25; Proszowice	18	niche grave	M	*maturus*	4 C	near the pelvis	-	IIIB	unpublished research P. Jarosz, J. Libera and P. Mączyński
13	Rosiejów, No. 2; Skalbmierz	kurgan E, 35	niche grave	?	?	13: 9 J, 4 S	near the pelvis	-	IIIB	Reyman 1948, 73 and next
14	Rudno Górne, No. 8; Igołomia-Wawrzeńczyce	21	niche grave	M	*maturus*	4?	?	-	III	Włodarczak 2020, 99
15	Stradów, No. 1 (currently Zagaje Stradowskie); Czarnocin	4a	niche grave	M	?	8?	?	9 J	IIIB	Włodarczak 2006, 171-172
16	Szczepanowice; Miechów	3/VIII	niche grave	F, M, 2 Ch	*adults*, *infans* II	3?	?	-	IIIB	Gomułka and Hałuszko 2017, 26
17	Zielona, No. 3; Koniusza	3	niche grave	M	*maturus*	10: 8 J? 1 C, 1 Cr/E	behind the back (7), within the chest (2), near the head (1)	9 J	IIIA	Włodarczak 2004; Winiarska-Kabacińska 2007; 2008
18	Żerniki Górne, No. 1; Busko-Zdrój	85	niche grave?	2 M	?	4: 3 C, 1 S	at the feet	-	IIIB	Kempisty 1978, 78-82
19		128	niche grave	M	*maturus*	3 C	at the head	-	IIIB	Kempisty and Włodarczak 2000, 76 and next
20		132	niche grave	M	*maturus*	5: 3 C, 1 S, 1 J	behind the pelvis	-	IIIB	Kempisty and Włodarczak 2000, 86,87
21		133	niche grave	M	*iuvenis*	3: 2 C, 1 J	behind the pelvis	-	IIIB	Kempisty and Włodarczak 2000, 87,88

Table 2.

No.	Site, No.; municipality	Kurgan, grave/ feature	Type of grave/ feature	Sex	Age	Number of arrowheads: type of flint	Location at the skeleton	Presence of flint flake	Phase (Włodarczak 2006)	References
Sandomierz cluster										
22	Kichary Nowe (currently Nowe Kichary), No. 2; Dwikozy	26	niche grave	?	?	10?	?	-	IIIAB	Włodarczak 2006, 172, tabl. 40
23		29	niche grave	?	?	12?	?	-	IIIB	Włodarczak 2006, 172, tabl. 40
24	Mierzanowice, No. 1; Wojciechowice	81	?	M	?	11 C	near the head		IIIB	Uzarowiczowa 1970, 202 and next.
25		94	?	M	?	4, 3 C, 1?	the skeleton was very poorly preserved, at the feet (3), in the bone mass of the right arm (1)	-	IIIAB	Uzarowiczowa 1970, 207,208
26		100	?	M	?	9 C	behind the pelvis (8) – arrowheads oriented in one direction, at the right lower leg (1)	-	IIIB	Uzarowiczowa 1970, 208-210
27		199	?	M	?	13 C	at the knees – tip of arrowheads turned towards feet	5 (15) C[1]	IIIAB	Uzarowiczowa 1970, 213,214
28		200	?	M	?	3 C	at the pelvis under the sacrum	-	IIIAB	Uzarowiczowa 1970, 214,215
29		209		M	*adultus*	7, 5 B, 2 C	behind the pelvis		IIIB	Bąbel 1979, 76
30	Mydłów, No.37; Iwaniska	2*	niche grave?	M?	*adultus*?	26 + one pice C	scattered (post-deposition?)		III	Bargieł 1990; 2009

31	Nowy Daromin (currently Daromin), No. 20; Wilczyce	3	?	M?	?	3: 2 C, 1 Bu	under the right collarbone (1), under the right hand (1), at the feet (1)	7: 4 C, 1 S, 2?	IIIB	Antoniewicz 1925, 250-252
32	Wilczyce, No. 10; Wilczyce	15	niche grave	-	-	29: 12 T, 10 C, 7 Cr/E	the skeleton was not discovered	69: 57 S, 8 J, 4 Cr/E	II	Boroń and Włodarczak 2019; Winiarska-Kabacińska 2019
33	Złota, „Grodzisko II"; Samborzec	15	niche grave	M	?	8 C	various places in niche	46: C	IIIB	Krzak 1958, 353 and next.
34		16	niche grave	M	?	4: 2 C, 1 S, 1 V	various places in niche	-	IIIB	Krzak 1958, 357-359
35	Złota, „Nad Wawrem"; Samborzec	90	?	?	?	7: 6 C, 1 S	?	-	IIIB	Machnik 1966, 236
36	Złota, No. 6; Samborzec	15	?	M	*maturus*	4: 3 C, 1?	between the ribs (3), at the knee (1)	-	IIIB	Florek and Zakościelna 2006, 43 and next
37	Żuków; Samborzec	1(2)	pit grave	M	adult	21: 19 J, 2 S	near the knees	-	IIIB	Marciniak 1960, 47-49
Rzeszów cluster										
38	Bierówka; Jasło	kurgan B, 4a	central grave	-	-	6 J	the skeleton was not discovered	-	II	Gancarski and Machnikowie 1990, 114,115
39	Mirocin, No. 24; Przeworsk	50	niche grave	M	*maturus*	8, 6 V, 1 S, 1 Br	behind the back	15: 12 V, 3?	IIIB	Machnik *et al.* 2019, 13 and next
40		54	niche grave	M	*maturus*	6: 4 V, 2 C	near the torso	-	IIIB	Machnik *et al.* 2019, 20 and next
41		110	niche grave	M M	*maturus* (No I) *maturus* (No II)	14: 6 V, 4 C, 2 J, 1 G, 1 radiolarite	near the pelvis and in the lower limbs (9), between the femurs (2); for the rest there is no further data	49:18 V, 14 Cr/E, 10 C, 2 G, 1 S, 4?	IIIB	Machnik *et al.* 2019, 34 and next

Table 2.

No.	Site, No.; municipality	Kurgan, grave/ feature	Type of grave/ feature	Sex	Age	Number of arrowheads: type of flint	Location at the skeleton	Presence of flint flake	Phase (Włodarczak 2006)	References
42	Mirocin, No. 27; Przeworsk	360	niche grave	M, F	*senilis* (M) *maturus* (F)	8: 5 V, 2 C, 1?	in the area of man's feet	-	IIIB	Machnik *et al*. 2019, 58 and next
43	Rozbórz, No. 42; Przeworsk	2006	pit grave	M	*iuvenis-adultus*	8: 6 Cr/E, 1 S, 1 C	near the pelvis	-	II	Ligoda and Podgórska-Czopek 2011, 217 and next; information P. Jarosz
44	Szczytna, No. 5; Pawłosiów	220	niche grave	2 M	*maturus* (No. I) *maturus-senilis* (No. II)	7, 4 V, 2 C, 1?	various places in niche and entrance corridor; near the head of individual II (1), in the bone retention zone (2), beyond skeletons (4)	5: 3 C, 2 S	IIIB	Hozer *et al*. 2017, 19 and next
45	Szczytna, No. 6; Pawłosiów	kurgan I, 4	niche grave	M	*adultus*	5: 4 C, 1?	behind the back	40: 31 V, 9 C	III	Hozer *et al*. 2017, 38 and next
46		kurgan I, 56	niche grave	M	*adultus*	3 V	between the ribs		III	Hozer *et al*. 2017, 51 and next
Lublin cluster										
47	Guciów, No. 6; Zwierzyniec	kurgan IX	central grave	-	-	8, 5 V, 3 R – two clusters	the skeleton was not discovered	-	IIIC?	Jarosz 2018, 67,68

48	Lublin-Sławinek, No. 1-2; Lublin	2*	?	?	?	5, 2 S, 2 C, 1 Cr/E	between the ribs	-	IIIB	Polańska 2016, 310-315
49	Łagiewniki, No. 10; Niemce	lower	pit grave	?	*maturus*	5: 4 C, 1 V	near the feet (3+1), near the head (1)	-	IIIB	Kubera and Zawiślak 2016
50	Młodów Zakącie (currently Młodów), No. 68; Lubaczów	*	?	-	-	10 V	the skeleton was not discovered	11 V	III	Machnik and Pilch 1997
51	Nieborowa (part of Łowcza-Kolonia), No. I; Sawin	-	pit grave	?	?	7: 5 V?, 2 Cr/E	negative after the skeleton; near the chest	-	IIIB	Boroń and Winiarska-Kabacińska 2014
52	Sługocin, No. 5; Jastków	1	central grave	-	-	3: 2 C, 1?	the skeleton was not discovered	111 C	III	Bienia *et al*. 2016
53	Snopków, No. 18; Jastków	118	pit grave	-	-	5: 2 B, 2 C, 1 Cr/E	the skeleton was not discovered	5: 4 C, Cr/N	III	Borowska *et al.* 2016, 297 and next
54	Ulów, No. 3; Tomaszów Lubelski	kurgan I, 95/1	central grave	-	-	6 V?	the skeleton was not discovered	-	?	Niezabitowska-Wiśniewska 2008, 81; Pyżewicz 2017
55	Ulów, No. 4; Tomaszów Lubelski	kurgan II	central grave	-	-	6?	the skeleton was not discovered	-	?	Pyżewicz 2017

* – destroyed features or partially recognized; F – female; M – male; Ch – child; B – Banded flint; Bu – burned flint; C – Chocolate flint; Cr – Cretaceous flint; E – Erratic flint; G – Gościeradów flint; J – Jurassic sub-Kraków flint; R – Rejowiec flint; S – Świeciechów flint; T – Turonian flint; V – Volhynian flint.

1 There is no consistency in the description of the grave (Uzarowiczowa 1970 – on the page 213 gives information „5 flake", while in the inventory description on the page 214 lists them "fifteen").

found near the skeleton (two near the ribcage and one in the place of the unpreserved skull) (Włodarczak 2004, 318; Winiarska-Kabacińska, 2007, 173, fig. 5). In several features, it was observed that skeletons had been dislocated post-mortem, which undoubtedly might have disrupted the original arrangements of the deposited artefacts. Grave 220 in Szczytna can serve as an example. Bones of two individuals – as well as the arrowhead assemblage – were discovered in different parts of the niche and the entrance corridor. As a result, a single arrowhead was found near the head of individual II, and two others occurred in the place where the bones were lying. Another four specimens were found outside of the skeletons (Hozer *et al*. 2017, 21ff.). In several cases, the locations of the discovered arrowheads in relation to the skeletons were very vaguely indicated (*e.g*., Bosutów, Grave 3; Mirocin, Grave 54; Złota 'Grodzisko II', Graves 15 and 16; Szczytna, Grave 220). In nine features, no buried remains were found. We have no data on skeletons and locations of arrowheads in another eleven graves.

The most common raw material used in the production of arrowheads in the four clusters was chocolate flint, making 38.7% of the whole collection (out of 494 specimens). Volhynian and Jurassic sub-Kraków flints were used to a moderate degree (14.9% and 11.7% respectively). Cretaceous and erratic flints were even less popular (6.1%). Świeciechów and unspecified grey Turonian flint were employed in similar quantities. Striped flint (1.4%), radiolarite, limestone and Dnistr flint were extremely seldomly used.

Unfortunately, we do not know the weight of the majority of the arrowheads included in the discussed sets. In the case of more numerous series, such measurements were taken for the specimens from Mydłów and Mirocin, Grave 360. In the former case, the specific weights of the specimens grouped in the collection of 26 arrowheads vary from 0.2 to 1.1 g (average weight of 0.4 g; Bargieł 2009, 199, tabl. 1). On the other hand, each of the eight artefacts from Mirocin weighs between 0.3 and 0.8 g (Libera 2022, 147).

More than ten features contained great amounts of half-products: minute flakes (often fragmented) and, less frequently, scaled flakes. Their presence was recorded within all the clusters (in different quantities, from several to 111 specimens): in the Kraków group (Koniusza, Grave 3 – 38 specimens; Malżyce, Grave 10 – 10 specimens; Zagaje Stradowskie, Grave 4 and Zielona, Grave 3 – 9 specimens in each), in the Sandomierz cluster (Wilczyce, Grave 15 – 69 specimens; Złota 'Grodzisko II', Grave 15 – 46 specimens; Mierzanowice, Grave 199 – 15 (?) specimens; Nowy Daromin, Grave 3 – 7 specimens). In the Rzeszów cluster (Szczytna, Grave 4 – 40 specimens; Mirocin, Grave 110 – 49 specimens, Grave 50 – 15 specimens), in the Lublin cluster (Sługocin – 111 specimens; Młodów-Zakącie – 11 specimens) (*cf*. Libera 2022, figs 17, 34, 44 and 59).

Numerous arrowheads were discovered especially in niche graves of the Kraków, Sandomierz and Rzeszów regions, but they did not occur in the Lublin cluster, where they were found only in central and pit graves. In the development of the CWC, arrowheads in closed assemblages appeared as early as in phase II (2700-2550 BC). Nevertheless, they became more frequent in later times, especially in subphase IIIB (2500-2300/2200 BC),

at the end of which they ceased to appear (cf. Table 2). Their occurrences are associated with richly equipped male graves, which usually contained weaponry represented by flint arrowheads and axes, as well as battle-axes, sometimes made of materials other than flint (*cf.* Włodarczak 2006, 143ff.).

In general, the morphological and metric features of the arrowheads from Mydłów, Grave 2, are not different from the properties of similar artefacts from the Sandomierz region and the other three clusters. Such features as deeply incised bases and quasi-serrated lateral edges can be found on many points discovered across all of the above-mentioned clusters (see Libera 2022, figs 13, 32, 42, 57). It is possible that the flint blades and flakes discovered in Mydłów were also elements of assemblages. Arrowheads co-occurred with flake blanks in numerous closed assemblages across the entire area of the CWC settlement (*cf.* Table 2). Also this phenomenon is considered as an indication of eastern influences. Their appearance should be linked with phase II of the development of this culture (Wilczyce, Grave 10) and its continuation in phase III (*cf.* Włodarczak 2006, 73).

FLINT ARROWHEADS IN THE FUNCTIONAL VIEW

Use-wear analysis as a method of studying flint artefacts has been known for several decade (Vaughan 1985, 3). It is currently one of the standard techniques. The technique gives very interesting results when it accompanies examination of materials representing different contexts – settlements, hoards and graves. However, some of the most intriguing results can be obtained when studying the functions of flint artefacts found close to buried individuals, because they not only allow us to learn about how they were used, but also better understand the character of burial gifts (see, for example, van Gijn 2010, 144-149).

Materials associated with the CWC were discussed in a series of studies aimed at analysing use-wear patterns. Still, because of the character of such sets, most of them were limited to presenting results of analyses conducted on materials from particular graves or small cemeteries (Drobniewicz 1979; Budziszewski *et al.* 2008, 48-53; Winiarska-Kabacińska 2007; 2008; 2019, 89-97; Boroń and Winiarska-Kabacińska 2014, 218-224; Włodarczak *et al.* 2016, 42, 43; Baron *et al.* 2018, 174-178; Pyżewicz 2017; 2022, 168; Skłucki *et al.* 2021, 182-184). A considerable part of previously analysed assemblages included arrowheads from the following localities: Koniusza, Dąbrowa Biskupia, Nieborowa, Wilczyce 10, Ulów 3 and 4, Zielona 3, Żuków. This issue was more extensively discussed by Grzegorz Osipowicz, who focused on a series of arrowheads from the Sokal Ridge and Eastern Roztocze (such sites as: Brzezinki, Site 1; Hubinek, Site 3; Klekacz, Site 10; Łubcze, Sites 24 and 25; Łukawica, Site 13; Machnówek, Site 1 and Wierszczyca, Site 29), but they were somewhat modest collections containing one or two arrowheads (Osipowicz 2022). Jointly, the use-wear analysis was conducted on 109 arrowheads. This group was complemented with the 26 chocolate flint arrowheads discovered in Mydłów that are the topic of this paper.

Such a number of analyses allows us to draw some broader conclusions concerning the ways of using arrowheads. Still, it should be stressed that due to the considerable time period during which the analyses were performed and different attitudes of the researchers to particular examinations, there are certain differences in interpretations, resulting from employing different methodologies and equipment as well as depending on knowledge and attitudes of particular scholars. In many cases, researchers recorded patterns indicating abrasions on the edges of the wings and/or on the rounded tips of the examined specimens (Drobniewicz 1979; Budziszewski *et al*. 2008, 48; Winiarska-Kabacińska 2007; 2008; 2019, 89-97; Boroń and Winiarska-Kabacińska 2014, 218-224; Włodarczak *et al*. 2016, 42, 43; Pyżewicz 2017; 2022, 168). The same applies to the materials from Mydłów, where such traces were discovered on 19 arrowheads (Table 1). These traces were interpreted as resulting from chafing against the walls of a container made of some soft material. In the case of the discussed artefacts, we suspect that it was a quiver. Grzegorz Osipowicz thinks differently. He suggests that the traces detected on the artefacts from the Sokal Ridge might have been a result of protecting the arrowheads glued to the shafts by placing them in rigid sheaths made of leather. He assumes that they were tubular and their diameters were similar to the widths of particular arrowheads (Osipowicz 2022, 224). There are two other inventories that require more profound analyses. The first of them, examined by Barbara Drobniewicz, is an assemblage composed of one retouched blade and 16 arrowheads, *'the tips of the first 14 points are polished to different degrees'*, another two were not covered with use-wear traces. Despite a different interpretation proposed by the scholar – that the artefacts might have been used as knives (Drobniewicz 1979, 91, fig. 1: c-e) – it appears that in fact the patterns recorded on the arrowheads should be interpreted as a result of keeping them in a quiver (likewise Budziszewski and Tunia 2000, 122, further literature there). Also, the results of microscopic observations of the materials found in Zielona require a commentary. Seven specimens were covered with use-wear patterns (abrasions on the tips and/or wings). The traces were interpreted by the author of the research as a result of processing hide or employing lithic technologies (Winiarska-Kabacińska 2007, 173, fig. 7; *cf*. 2019, 89, 90, fig. 6: 1).

In most cases, researchers conducting analyses did not record patterns indicating that the arrowheads had been used as projectile points. The same conclusions were drawn in the case of the materials from Mydłów. Only one scholar performing microscopic analyses discovered traces that might have been caused by using an examined arrowhead as a projectile element. The specimen in question was discovered in Wilczyce, where the apex of one of the 29 examined arrowheads was characteristically broken off (Winiarska-Kabacińska 2019, 89-90, fig. 6: 2a-d). Due to the lack of use-wear traces on the arrowheads, it is also difficult to interpret the specimens discovered where bodies were supposedly located. Because of the lack of use-wear patterns on their surfaces, the obtained results might indicate that none of the discovered arrows had been used as projectiles. Still, we should bear in mind that this state of affairs may be the result of the way in which patterns

are formed on arrowheads. Generally, traces indicating that an arrowhead was used as a projectile element are recorded rather seldomly and greatly depend on how hard targets were. In the case of hitting soft targets, there are fewer chances of recording use-wear traces on an arrowhead. This is why it appears that lack of such traces cannot be considered as an indication that the arrows were not used, even though it is probably true for many of them. We have to remember that deciding whether an arrow was to be used once or many times was to a great degree a matter of an individual choice.

Then, how can we interpret the remaining arrowheads that were not covered with use-wear patterns? Most probably, most of the artefacts discovered near buried individuals were deposited by the people preparing the burials, who did this according to their material possibilities and prevalent burial practices. We can assume that artefacts discovered in graves (especially arrowheads) were used by the buried individuals during their lives, or they had belonged to the people preparing a burial. Arrows discovered in clusters had probably been kept in quivers, but some artefacts that do not have characteristic abrasions might have been placed in quivers much later. It is possible that some of such arrows were made specifically for the funeral. Some artefacts might have been connected with the deaths of the buried individuals. Such assumptions can be tentatively drawn for specimens discovered near bones (theoretically within the body). Still, it is worth stressing that such locations might have been linked with ritual practices or caused by intermingling materials by roots or rodents. Finding an arrowhead lodged directly in the bones of a buried individual would be direct and certain confirmation the assumption that it was related to the cause of death (see Flohr *et al.* 2015). Nevertheless, so far, no such artefacts have been discovered in CWC materials. Unfortunately, because of the considerable numbers of potential interpretations, it is often impossible to decisively answer the above-presented question. Still, the only type of information that can be confirmed is the fact that the arrowheads without visible traces of keeping them in a container were later added to the quiver of their owner during his life, or after his death – by the people preparing the burial.

CONCLUSION

The collection of 27 specimens, consisting of chocolate flint arrowheads discovered in Mydłów, is one of the largest that has been discovered in the area of the Polish lands. The only larger assemblage is that from Wilczyce, which includes 29 arrowheads.

The inventory from Mydłów is functionally diverse. It includes specimens with use-wear patterns on their surfaces – which indicate that they were kept for a long time in a quiver – as well as those without such traces, which allows us to suspect that they were added to the rest some time later.

The presence of artefacts in the grave bearing intense wear traces indicative of carrying in a quiver suggests that these set of arrowheads were not specifically prepared for burial

purposes (at least not all of them). This observation is consistent with the results of analyses of other (CWC) grave inventories, where artefacts with use-were traces also recorded.

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FLINT ARROWHEAD FROM A HOARD IN PAPOWO BISKUPIE, CHEŁMNO DISTRICT: COMMENTS ON THE DISCUSSION ON THE SACRAL FUNCTION OF LITHIC ARTEFACTS FROM THE TURN OF THE IRON AGE

ABSTRACT

Gackowski J. 2024. Flint arrowhead from a hoard in Papowo Biskupie, Chełmno district: comments on the discussion on the sacral function of lithic artefacts from the turn of the Iron Age. *Sprawozdania Archeologiczne* 76/1, 583-600.

The article presents a flint arrowhead from Papowo Biskupie, Chełmno district. Hoards from this place and many loose metal finds are interpreted as votive offerings deposited in the water. Numerous objects made in bronze are accompanied by abundant non-cremated human bones unearthed there. The archaeological site is dated back to a period from about 1000 to 400 BC. A traceological analysis of the flint arrowhead showed that it had never been used, and that it found its way into one of the hoards on purpose as an element of a set of many artefacts that were deposited with in a birch bark container. Therefore, it probably served a purpose similar to that attributed to flint artefacts discovered in Lusatian-culture cremation graves. The provenance of the arrowhead can be determined in the context of Scythian-style ornaments that were reaching Kuyavia and Chełmno Land, as they have been found more and more often in the Lusatian culture in the area of Tarnobrzeg.

Keywords: flint arrowheads, votive hoards, Lusatian culture, Later Bronze Age, early Iron Age
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INTRODUCTION

At the beginning of 2023, in Papowo Biskupie, in arable land that occupies the site of a now-vanished lake, numerous accumulated prehistoric objects from the Bronze Age were encountered. The artefacts were discovered by members of the Kuyavian-Pomeranian History Finders Group who were conducting a field search with metal detectors in Chełmno district with the consent of monument protection authorities. In terms of landscape, this space was (and partly still is) distinguished by bigger or smaller ribbon lakes and kettle lakes. At present, most of the latter are peat bogs used for agricultuiral purposes and it was within one of those peat bogs the spectacular discoveries were made. The findspot was within the area of a post-lake depression situated southeast of the central buildings of Papowo Biskupie. Here, several assemblages holding hundreds of bronze objects were identified, but there were also many artefacts made of bronze that were found outside the distinct assemblages of such items (Fig. 1). The latter are most likely remnants of similar hoards that comprised exclusive metal artefacts. Other finds included many non-cremated human bone remains (remains of extremities, bases of skulls, mandibles).

In one of these hoard deposits (No. 2/2023) a flint arrowhead was encountered (Fig. 2). The mentioned assemblages can be interpreted – in line with the classification of this kind of finds adopted in archaeology – as hoards deposited in the ground or water for various reasons (Blajer 2001, 16, 17; Maciejewski 2016, 16). Given the fact that many artefacts have been revealed in the vast space of the former reservoir about 20 hectares in area, allowing us to interpret it as a prehistoric location where valuable goods were deposited in the depths of the lake, frequently and cyclically rather than on a one-time basis. The uniqueness of the find soon echoed in the media, named by journalists and amateurs of relics of the past the "field of bones", "treasure field", "votive peat bog", or "holy lake" (for example, Popkiewicz 2023; Willma 2023, 1, 3; Zdziebłowski 2023). For the purpose of this paper, we further refer to this place using the last of the listed names, as termed in the title and the body of the first scientific publication on this interesting discovery (Gackowski *et al.* 2024).

One should bear in mind that Papowo Biskupie made its way into the archaeological literature as a place where a hoard of bronze products was found in the second half of the 19th century. In the year 1876 (or somewhat earlier), the peat bogs at the shore of the lake near Papowo Biskupie revealed a hoard comprising 13 items made in bronze (Undset 1882, 116). These included ornaments in the form of ring ornaments of the neck and extremities made using multiple rods: eight neck-rings preserved in entirety and one damaged, five greaves including four shaped in sheet steel. Furthermore, the hoard involved one pin with a spiral plaque and three bronze disks with a perforation (*phalerae*). In the literature so far, the above-mentioned ornaments made of sheet steel are considered to have probably come from east-Pomeranian bronzeworking smelters and should be dated to the turn of the younger phase of the early Iron Age (Lissauer 1887, 79; Semrau 1917, 5, 23; Kostrze-

wski 1958, 230, 298; Chudziakowa 1974, 81, 124, 125; Blajer 2001, 364; Gackowski and Kowalski 2019, 230). The find is stored in the collection of the District Museum in Toruń (Chudziakowa 1974, 124). At present, it is unclear whether the hoard unearthed in the second half of the 19th century was found in the post-lake area of Papowo Biskupie where so many metal artefacts have been recently encountered, or whether it had been found at some distance.

THE FLINT ARROWHEAD

The artefact bearing a bifacial retouch was made in tan-coloured Baltic flint. Its triangular shape is quite indistinctive from the base of a short solid tang (Fig. 1). In terms of morphology and size, the arrowhead from Papowo Biskupie (6.3 cm long at the maximum width of 2.3 cm) can be linked to a group of blades with triangular tips whose tang has the shape of a somewhat indistinctive short shaft. For this type of form seen in arrowheads and small bifacial points, Jerzy Libera suggested a similarly determined type, subtype, and



Fig. 1. Papowo Biskupie (Site 82, AZP 35-43: 291, Hoard no. 2/2023). Flint arrowhead (photo by W. Ochotny)

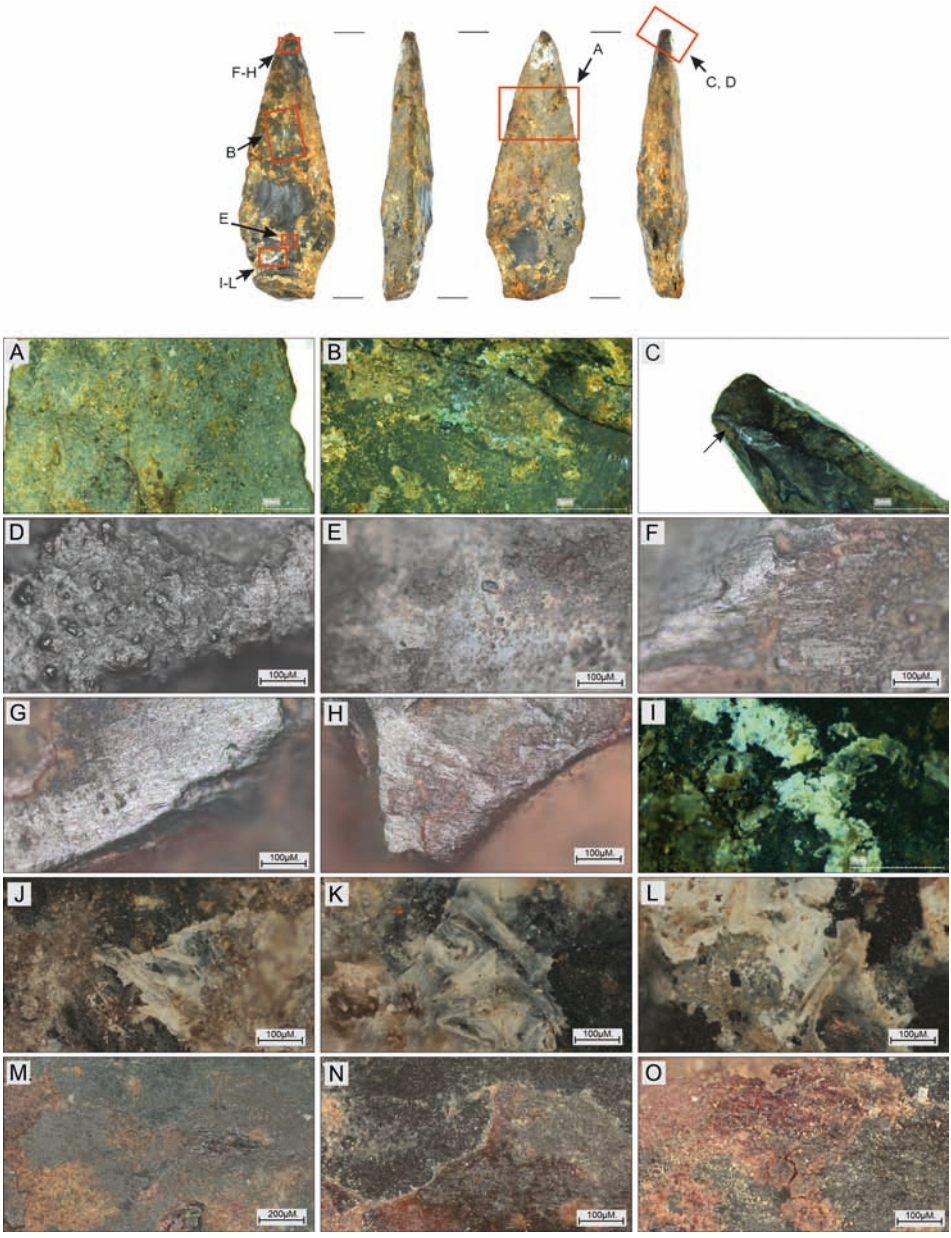


Fig. 2. Papowo Biskupie (Site 82, AZP 35-43: 291, Hoard no. 2/2023). Microscopic imaging of selected areas of the artefact (A: area contaminated with a mineral substrate /sand/); B: contamination with metal oxides; C-E: traces of technological processes in the form of abrasion and polish; F, G: traces of technological processes in the form of polish; H: traces of resin; I-L: traces of a fibrous substance (traces of an adhesive?); M-O: traces of resin (photographs in various areas of the artefact).
Edited and photographed by G. Osipowicz

variant BA I: 1 (Libera 2001, 26, 27, 32, 33). In terms of function, it is difficult to unequivocally interpret this artefact. The item bears a resemblance to small (Trzciniec-culture?) bifacial points employed as insets in polearms, such as in Guciowo, Zamość district (Libera 2001, 90-92, tables 7, 8, 17). However, it is worth stressing here that in terms of form and size (though not in terms of the choice of raw material), the specimen from Papowo Biskupie is clearly similar to the bifacial blade from the Lusatian-culture settlement in Zagroda, Chełm district (Kłosińska 2019, 216, fig. 1: 3).

The surfaces of the artefact bear numerous mineral contaminants of a post-depositional context (Fig. 2: A) and traces of oxidised metals. The formation of the latter is a result of the flint arrowhead leaning pressed against bronze artefacts (Fig. 2: B). The first specialist examination of the object showed the absence of typical "postimpact" traces that would have suggested that the arrowhead had been used as an element of a throwing weapon (Osipowicz 2023). The researcher added that on one of the lateral edges of the blade, in the tip area, on a section about 0.7 cm long, the surface is clearly and visibly rounded and dimmed (Fig. 2: C, D), which is a trace of technological treatments related to correcting the line of the lateral edge by means of grinding and not retouching. The surface of the tang bears a clear mirror polish of a flat topography called bright spots (Fig, 2: E). It was formed as a result of hafting. On the blade surface a linear polish oriented long axis-wise was identified (Fig. 2: F, G). These traces were formed as a result of the object being slid into a sheath made using an organic material (most likely wood). They are readable also on the residues (some kind of resin? – Fig. 2: H) present in that same area, which serves as evidence of their primary and not secondary (post-depositional) origin. In turn, on the base of the object there are visible remains of some white material, most likely an organic substance similar to hide/bone. At high magnification, one can see that this substance is made by fibres of unspecified type (Fig. 2: I-L). This can be a residue of an adhesive (resin?) used for fitting the specimen into the wooden haft (Fig. 2: M, O). On the surface of the artefact, traces of grinding and not retouching were observed on the lateral edge, which is recorded on many bifacial points not earlier than late Neolithic (Osipowicz 2023).

THE OBJECT IN THE CONTEXT OF THE METAL ARTEFACTS AND ORGANIC REMAINS AT THE SITE

The arrowhead was found in one of the hoards containing a numerous group of bronze objects. It was found among them and it is beyond doubt that it was made part of this deposit on purpose. All the identified artefacts were accumulated in a very small area, which suggests that they had been put into a container and then meticulously packed and hidden. Palaeobotanical studies conducted for organic macro-remains preserved in this hoard deposit (that is, present between the objects) and on its immediate edges show that this container was most likely made using the bark and wood of the birch, and lined with moss



Fig. 3. Papowo Biskupie (Site 82, AZP 35-43: 291, Hoards no. 2/2023; 3/2023). Some of the metal objects made in bronze (photo by W. Ochotny)

on the inside. Both the hoard of bronze products involving the flint arrowhead and the other deposits of metal products were deposited in the shallow lake (Gackowski *et al.* 2024, 2, 3).

The metal artefacts with whic the flint arrowhead was deposited include, primarily, ring ornaments (for the neck and upper and lower limbs), as well as elements of equine harness (*phalerae*; Fig. 3: D) from the end of the Bronze Age and the beginning of the Iron Age. These two distinctive groups of items are in many cases interregional products, but also objects of allegedly Pomeranian and, in a broader context, Norse provenance. In the latter group, attention is drawn to necklaces, multicoil bracelets (Fig. 3: A, F), elements of layered necklaces of multiple bronze and glass beads (threaded between spacer beads) with additional numerous cast pendants in the shape of a fish tail (Fig. 3: B, C), which are well reflected in the craftsmanship of the mentioned Pomeranian and Norse regions (Sprockhoff 1956, 9, 26, Taf. 26: 1; 72: 9; Bukowski 1998, 291-296; Gackowski *et al.* 2024, 2-6). They are also found at archaeological sites distant from Pomerania and Chełmno Land, for instance, in settlements, graves, and hoards in the Upper Oder basin, in the Czech Republic, and in Bavaria, dated back to the Later Bronze Age and the beginning of the Iron Age (Kossack 1954, 175, Abb. 26: E; Michalak 2011, 39; Hüttel 1981, 135, Taf. 36: 8-10).

In many areas of the "holy lake", also in the hoard that the flint arrowhead comes from, nail-shaped temple rings were unearthed (Fig. 3: E). The latter are, again, ornaments that

show the style of steppe nomads encountered in the vicinity of the Bydgoszcz-Fordon meander of the Vistula (Gawlik 2007, 231, 232; Garbacz-Klempka *et al.* 2017).

THE HOARD FIND IN THE LOCAL SETTLEMENT SPACE

The numerous metal products that have been recently unearthed in the post-lake terrain of Papowo Biskupie are a spectacular trace of settlement activity of the local Lusatian-culture community; however, it is not the only one that has been encountered in this area. The fact that bigger or smaller groups of people of this culture were inhabiting it is evidenced also by other finds, mainly ceramic vessels from the end of the Bronze Age and the early Iron Age revealed on the borders of the southern and southeastern parts of the subglacial trough that existed there, filled with the waters of the lake near Papowo Biskupie in its northwestern area.

Lusatian-culture source materials have been found on both sides of the mentioned depression of the trough, from Żygląd to the area near Skąpe and Kucbork (Fig. 4). The edges of the settlement microregion are defined by a series of archaeological sites, both

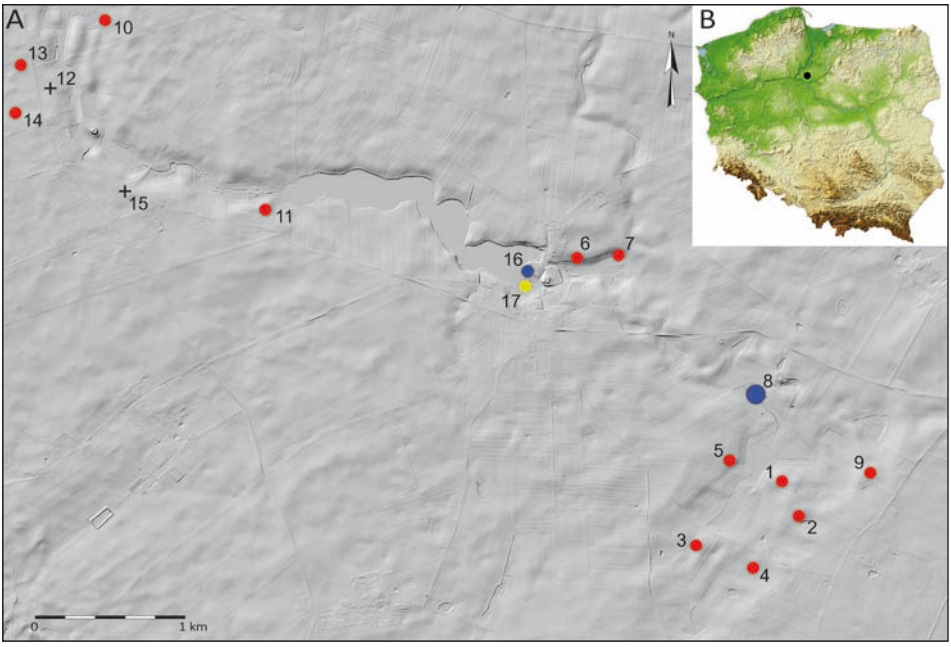


Fig. 4. Archaeological sites in the area of the trough of the lake near Papowo Biskupie (A) and the location of Papowo Biskupie Site 82 (B) (based on Gackowski J. 2012; edited by W. Ochotny).
Key: 1-11, 13, 14 – traces of settlements; 12, 15 – cremation grave fields; 8 – "holy lake" (Papowo Biskupie, Site 82); 16, 17 – find of an unspecified location (16 – hoard of bronze artefacts, 17 – copper nugget)

remains of dwelling structures, cremation cemeteries, hoards and loose finds (Gackowski 2012, 144-146). In its northwestern part, attention should be paid to settlement points at Storlus (Site 6), Żygląd (Sites 2, 12, 13), and Papowo Biskupie (Sites 14 and 15). In turn, in the southeastern part of this settlement zone, the vast majority of traces of settlement activity were preserved around a biogenic depression running across the terrain of Skąpe and Kucbork. Residential areas were founded near small water bodies, covering their shores and nearby peninsular protrusions. This is most evident in Papowo Biskupie (Site 2), Kucbork (Sites 2, 4, 14, 15), and Skąpe (Site 4). In the northern part of the microregion there are two cremation grave fields of the Lusatian-culture communities discovered in the area of Żygląd. For one of them (Site 11), the source data is quite laconic, whereas in the other (Site 26), over 120 cremation graves and even one or a few places where cremation was conducted have been identified (Rembisz 2009, 69-80; Gackowski *et al.* 2021, 235-242).

The microregion can be linked to two metal finds. One of them is the above-mentioned hoard of over ten bronze objects from Papowo Biskupie. The other one, from Żygląd, is a copper nugget linked to the settlement of Lusatian-culture people (Dąbrowski 1997, 170).

FLINT ARTEFACTS IN THE SETTLEMENT AREA OF THE LUSATIAN-CULTURE CHEŁMNO GROUP

Until the commencement of broader-scale excavation works at several Lusatian-culture sites, flint products linked to this taxonomic unit had been known solely from surface surveys. One can safely assume that the postulated association of these artefacts with the Later Bronze Age and the early Iron Age is debatable, to say the least (Dąbrowski 1997, 74-76, map 14). Likewise, compiled works summarising the issue of the presence and use of flint in the Lusatian culture failed to address the materials from Chełmno Land (Malinowski 2000; Dąbrowski 2016). Therefore, it is worth mentioning that over the last three decades, more numerous flint series were obtained from two settlements that were subjected to excavation studies, namely, an open settlement in Ruda (sites 3-6), Grudziądz district, and a defensive settlement in Mirakowo-Grodno (Site 6), Toruń district, as well as a cremation grave field in Żygląd (Site 26), Chełmno district.

The series of flint objects from Mirakowo-Grodno consisted of several hundreds of artefacts. Analyses involved as many as 264 items. The results obtained from the study of this assemblage show dominance of Baltic flint with a noticeable contribution of Pomeranian flint and a few instances of chocolate flint. In terms of morphology, flakes are dominant, but the group of blades and cores is quite noticeable. Among typological tools, attention is drawn to blade scrapers and flake scrapers, flake endscrapers, blades, and retouched flakes, burins, perforators, as well as one trapezoidal inset (Gackowski and Osipowicz 2013, 180-184). In terms of typology and morphology, the assemblage of the analysed

flints shows a series characteristic of the Stone Age. Most likely, these are materials found in the vicinity of the settlement by its contemporary inhabitants that were perhaps re-used. Only single artefacts (flake endscrapers) are reminiscent of Zele-type truncated knives (Gac-kowski and Osipowicz 2013, 186). Although the author of the traceological analysis Grzegorz Osipowicz identified the categories of functional tools and the ways in which they were practically used, such as for working wood, hide, or antler, he was sceptical when it comes to linking these artefacts to the age of metal (Osipowicz 2009, 157-200).

Another 129 artefacts made in Baltic flint and, to a small extent, also chocolate flint come from Lusatian culture settlement pits in Ruda, Chełmno district. In the assemblage, there is prevalence of splintered piece cores and scaled pieces, flakes, and production waste, as well as blade-flake cores and blades. The few implements recorded involved single burins, scrapers, perforators, as well as two bifacial point forms. The author of this publication argues that the flint products from that site should be linked to the craftsmanship of the local settlement group of the Lusatian culture or, alternatively, that it was using older products (from the Stone Age) found near the settlement (Rembisz-Lubiejewska 2017, 48, 50, 51).

Likewise, the provenance of tens of flint artefacts unearthed at the Lusatian-culture cremation grave field in Żygląd, Chełmno district, remains unclear. Counting over 120 cremation graves and a few cremation sites, this necropolis is dated back to the early Iron Age (Gackowski *et al.* 2021). Although in spaces between burials, splintered pieces, flakes, chips, and a single serrated tool were found, due to their typological and chronological evaluation, paired with the fact that cinerary urns were dug into older layers (from the Later Stone Age and the beginning of the Bronze Age), one cannot convincingly link the manufacturing of these artefacts to the settlement stage of the cremation necropolis (Rembisz 2009, 70).

THE SACRAL FUNCTION OF FLINT

Despite the above-mentioned issue of the provenance of these objects, the fact that flint artefacts were unearthed at the burial site in Żygląd is consistent with the interpretation of their intended ritual-ceremonial presence in many Lusatian-culture graves of the younger Bronze Age and the early Iron Age noted in the literature (Dąbrowski 1997, 74; 2009, 204, 216, 221; 2016, 226, 227). Though the specimen from Papowo Biskupie does not come from a necropolis, I still believe that its cultural meaning can be interpreted in a similar manner – a topic I take up again further in the text – the fact that the flint arrowhead was put in one of the hoards of metal objects drowned in the "holy lake" of Papowo Biskupie may mean there is a connection.

The view concerning the intentional employment of flint under as a material of particular sacral importance during burial ceremonies of the people of the Lusatian culture was most fully addressed at the 1994 Warsaw conference titled "Z badań nad krzemieniarstwem epoki

brązu i wczesnej epoki żelaza/Studies of Flint-Mining and Flint-Working in the Bronze and early Iron ages" (Lech and Piotrowska 1997). Back then, the problem of the "symbolic presence" of flint at burial sites was touched on by several speakers (Balcer 1997, 310-314; Gedl 1997, 215-224; Krzyszowski 1997, 249-256; Kurgan-Przybylska 1997, 239-245; Lech H. & J. 1997, 111, 112; Mogielnicka-Urban 1997, 277-287; Piotrowska 1997, 259-273). Although the tendency to interpret flint in graves as archaeologically detectable elements of the "religious doctrine" of that time was reflected in subsequent publications (Mogielnicka-Urban 2000; Piotrowska 2000; Kłosińska 2012, 150, 151; Wilczyński 2014, 232; Lech, Piotrowska and Werra 2015, 226; Dąbrowski 2016, 226), there were also voices that expressed some scepticism as regards such assessments, which according to some prehistorians were premature or even impossible to be scientifically substantiated (Malinowski 2000, 129-131; Libera 2006, 202, 203; 2018, 109-112; Libera and Zakościelna 2020, 554-555). Similar critical views were appearing in the literature before the Warsaw conference (Kobusiewicz 1988, 81).

Regardless of whether they were older than the Lusatian-culture settlements or they had been made by the people of this taxonomic unit, the ritual-ceremonial purpose of flint products found in graves is often based on premises from the field of religious studies, linguistics, or ethnology, and even ethnography, emphasising the ceremonial and thus also metaphysical relationship of siliceous rock with the essential attribute of cremation, that is, fire (Mierzwiński 2012, 59; Woźny 2013, 121; 2014, 227-231; also, *cf*. Kowalski 2017, 225). Other authors add that in the past, the placing of flint in cremation graves could have been an element of resurrective and apotropaic magic (Kłosińska 2012, 151).

DISCUSSION AND CONCLUSIONS

Though the specimen from Papowo Biskupie does not come from a necropolis, I still believe that its cultural meaning can be interpreted in a similar manner. It made its way into one of the hoards of bronze objects and together with them, it was drowned in the shallow "holy lake"; most likely, it was shallow enough for the valuable objects deposited in it to remain visible to the locals. Therefore, it seems that there must have been a social norm in place prohibiting the retrieval of votive objects from the lake. According to the radiocarbon dating performed for the human bone remains that lie in the present-day peat bog of the former "holy lake", the period in which they were deposited is estimated at from c. 1000 to 400 BC (Gackowski *et al.* 2024, 2, Fig. 1B). In turn, the metal artefacts unearthed in that place so far belong to a somewhat shorter chronological horizon (particularly its lower limit), which for now can suggest that the deposition of humans as part of an offering (as evidenced by the mentioned bones) could have been taking place in a time preceding the votive drowning/deposition of precious metal objects. This kind of behaviour involving "human sacrifice" is consistent with the tradition of the Norse cultures, and, in

somewhat younger times, also those of German and Celtic communities (Rembisz 2011; Kowalski 2017, 209; Beek *et al.* 2023). The presented interpretation of the human remains from Papowo Biskupie requires further investigation; however, should it be confirmed in the course of further research at that site, it would be the first such case to be recorded in Poland – obviously, aside from the find of the so-called Girl of Drwęcko, Olsztyn district (La Baume 1940, 17-22). One should bear in mind, though, that the Chełmno group of the Lusatian culture is known in Europe for unearthed finds of non-cremated human remains, albeit offered in inhabited places and not earlier than the turn of the Iron Age (Bukowski 1995; 1996; Gackowski 2011; Beilke-Voight 2015). Attention should be paid to one more fact. The coinciding presence of female ornaments and horse harness elements (primarily *phalerae*-type disks) is typical of hoards of similar items very often deposited in lakes (Blajer 2001, 288; Jeremicz 2007; Szczurek and Kaczmarek 2022, 153-159). The tendency to make frequent depositions of hoards of this type of composition in standing water reservoirs has been repeatedly confirmed for the Late Bronze Age and the early Iron Age (*cf.,* Blajer 2001, 254). In this sense, the object from Papowo Biskupie is somewhat consistent with the common norm of ritual behaviours manifested in such a way. However, its uniqueness lies in that in Poland, no location of ritual deposition of valuable tangible goods that would be this large has been discovered. Importantly, , similar archaeological features of 'cult' nature are not numerous elsewhere in Europe either (Kossack 1999, 183, Abb. 113; Jeremicz 2007, 220; Heske *et al.* 2013, 308–337). The flint arrowhead found its way into the hoard dated back to the early Iron Age in the period when "Pontic cultural models" were reaching the Lower Vistula region (that is, the Kuyavia-Chełmno area) recorded, among other things, based on the presence of nail-shaped temple rings, (Trybała-Zawiślak 2019, 209-210). As mentioned above, use-wear traces have been recorded on neither the surfaces of the triangular blade nor its edges, which could indicate that having been made and equipped with a shaft of some sort, the artefact might have been stored in a sheath (perhaps something similar to a quiver) and in this 'non-used' state, it was placed in an organic container together with metal artefacts. Cases of valuable items made in organic materials (wood, including bark, fabrics, or hide), serving ritual purposes, are known in the literature (Jeremicz 2007, 214, 215; Maik and Rybarczyk 2016, 29, 30; Kowalski 2017, 183-188).

In the source materials of the Lusatian culture, it is exceptionally rare to find flint bifacial pints manufactured by the communities of that taxonomical unit deposited in graves. Despite being unearthed in cremation grave fields (*e.g.*, in Laski, Kępno district, or Śmiardowo Krajeńskie, Złotów district), single specimens, albeit of a much earlier provenance, tend to be interpreted as products found and re-used (Kobusiewicz 1988, 80). The planigraphy of this type of artefacts rather dates the centres in which they were made to much earlier periods than the younger Bronze Age and the early Iron Age in southeastern regions (Libera 2001, 77-89). However, it is worth mentioning and also stressing that in that area, there are records of bifacial blades very similar to the specimen from Papowo

Biskupie allegedly produced and utilised by the Lusatian-culture people (Kłosińska 2019, 216, fig. 1: 3). In turn, the state of research conducted so far on arrowheads bearing tangs allows one to assume that both the Lusatian-culture people (especially those of the 'Tarnobrzeg' variant), and the Wysocko culture neighbouring to the east most likely manufactured them and used them (alongside metal and antler arrowheads) until the end of the early Iron Age (Libera 2001, 91, 92, 131; Gedl 2014, 133-136, Taf. 34; Krzemiński 2017, 16, 17). As mentioned above, there is little doubt as to whether the flint arrowhead in question was placed in one of the hoards and deposited in the shallow waters of the "holy lake" just like other sets of bronze products. The fact that many ornaments, including those of south-eastern provenance in the form of nail-shaped temple rings have been unearthed can suggest that this flint artefact made its way from there to the region of Papowo Biskupie together with them. Nonetheless, one cannot rule out the possibility that it was made locally (perhaps based on foreign models); after all, the above-discussed presence of flint at archaeological sites of the Chełmno group of the Lusatian culture is a fact indicated in the excavated sources.

As yet, co-occurrence of flint and metal artefacts has not been recorded in Lusatian-culture hoards with the exception of the small heart-shaped arrowhead linked somewhat uncertainly to the deposit in Niewierz, Szamotuły district (Fogel 1979, 124; Blajer 2001, 326). This makes the Papowo specimen and the context of its deposition an exceptional find. I believe that the blade discussed here was rather unlikely to have been used as an element of a projectile weapon, although it might have been intended to serve this function formally and originally. Most likely, this object (aside from a number of other ones found submerged in the lake) could have served a unique role for the local community that can be placed in the category of ritual-votive behaviours. In this sense, its value, not utility value but the ritual one, could have been similar to the magical functions of the flint placed in cremation graves.

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UNUSUAL TRANSFORMATIONS OF SICKLE-SHAPED KNIVES MADE OF OŻARÓW FLINT

ABSTRACT

Budziszewski J. and Pyżewicz K. 2024. Unusual transformations of sickle-shaped knives made of Ożarów flint. *Sprawozdania Archeologiczne* 76/1, 601-614.

Three raw materials played the greatest role in the flintworking of the Samborzec group of the Mierzanowice culture. Chocolate flints were used to make small arrowheads, banded flints were used to make bifacial axe blades, sickle-shaped knives were made from Ożarów flint. The latter were systematically transformed during their use, changing their shape and size. When the blade reached a length of about 11 cm, it could not be shortened any further. However, it was then also not possible to convert the specimen into some other core tool. For this reason, the conversion of sickle knives into other tools was something of an exception. Among the materials from the Małopolska Upland are only two flat bifacial axes made from fragments of damaged sickle-shaped knives from the Ożarów flint. These will be analysed in detail. The creation of these tools was possible due to unusual damage to the sickle-shaped knife (Samborzec) or was due to difficulties in obtaining good quality flint (Majkowice).

Keywords: Samborzec group of the Mierzanowice culture, flint sickle-shaped knives, flat bifacial flint axes, Ożarów flint

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Two approaches have been present in the study of prehistoric flintwork for years. One treats the discovered inventories in a static way and, by classifying flint products that comprise them, attempts to reconstruct the structure of the assemblages (Ginter and Kozłowski 1990). The other treats inventories in a dynamic manner in an attempt to reconstruct the *chaîne opératoire* leading to the state found during the discovery of the items (Schmid 2022). In this second approach, it is extremely important to understand the transformations that individual flint pieces underwent during their use. This concerns both the transformation of individual tools in the course of their gradual wear and tear, as well as radical changes transforming the specimen into a completely different tool. The two approaches above can be complementary. They can also lead to an opposing understanding of the materials under study, as was the case, for example, with Middle Palaeolithic scrapers (Dibble 1995). In such considerations, core tools must play a special role. Typically, they are sizable and naturally lent themselves to repeated modifications as the working edges wore out during use.

In the presented paper, we conducted studies based on the concept of *chaîne opératoire*. Using this approach, we had the opportunity to interpret the ways of using selected core tools – lithic axes and bifacial sickle-shaped knives, as well as traces of repairs and changes in their use among the societies of the Mierzanowice culture. We paid special attention to two bifacial axes made from fragments of damaged sickle-shaped knives made of Ożarów flint. A morphometric and traceological analysis of these two specimens was carried out. Microscopic examinations were carried out using standard research methodology. The detailed microscopic analysis was conducted with the digital microscope Keyence VH-Z100R, with a range of magnifications from 50× to 1000×. Before the examination, tools were cleaned with pure acetone. The observations were focused on the macro- and microscopic traces related to the usage and hafting – areas of polish, linear traces, micro-flakescars, fractures, and rounding. The results of analysis were compared with the experimental reference base stored at the Faculty of Archaeology, University of Warsaw.

The community of the Samborzec group of the Mierzanowice culture inhabited a relatively small area of the Sandomierz Upland and the Nida Basin in the first half of the second millennium BC (Kadrow and Machnik 1997, 83-102; Włodarczak 2017, figs 1 and 2). One of the most striking manifestations of its economy was an extremely complex system of flint management (Budziszewski 1991, 194-198; 2020, 270, 271). It was based on rich deposits of flint from the northeastern Mesozoic margin of the Świętokrzyskie Mountains. The greatest role was played by three raw materials used in a manner selected according to their technical properties. Chocolate flint was used for mass production of flakes used to make small arrowheads (Borkowski 1987, 161-167). Banded flint was used to make bifacial axe blades (Machnik 1967, 73; Klekot 1988). Sickle-shaped knives, on the other hand, were made from Ożarów flint (Budziszewski 1980; Libera 2001, 161-167). In addition, the flint inventory is notable for massive scrapers made from large, often cortical flakes of the first

series, obtained during the preparation of the core tools described above (Machnik 1967, 69, 70, pl. 9). Of course, there were times when individual raw materials were used in other ways (Grużdź 2020; Migal 2022), but the tools made in this way never exceed 25% of the known forms and are usually noticeably less. The scale of flint manufacturing in the Samborzec group of the Mierzanowice culture is evidenced by the fact that remnants of manufacturing activity from this time seem to occur at all of the now-known chocolate and banded flint mining sites in the northeastern Mesozoic margin of the Świętokrzyskie Mountains, and most of them were created only at this time.

Axe blades made of banded flint were produced in two types (Machnik 1967, 73; Klekot 1988; Bąbel 2013, 101-103) – either massive, thick specimens (Fig. 1: 1) or flat sub-triangular axes (Fig. 1: 2). This differentiation probably – as in the late Neolithic – corresponds

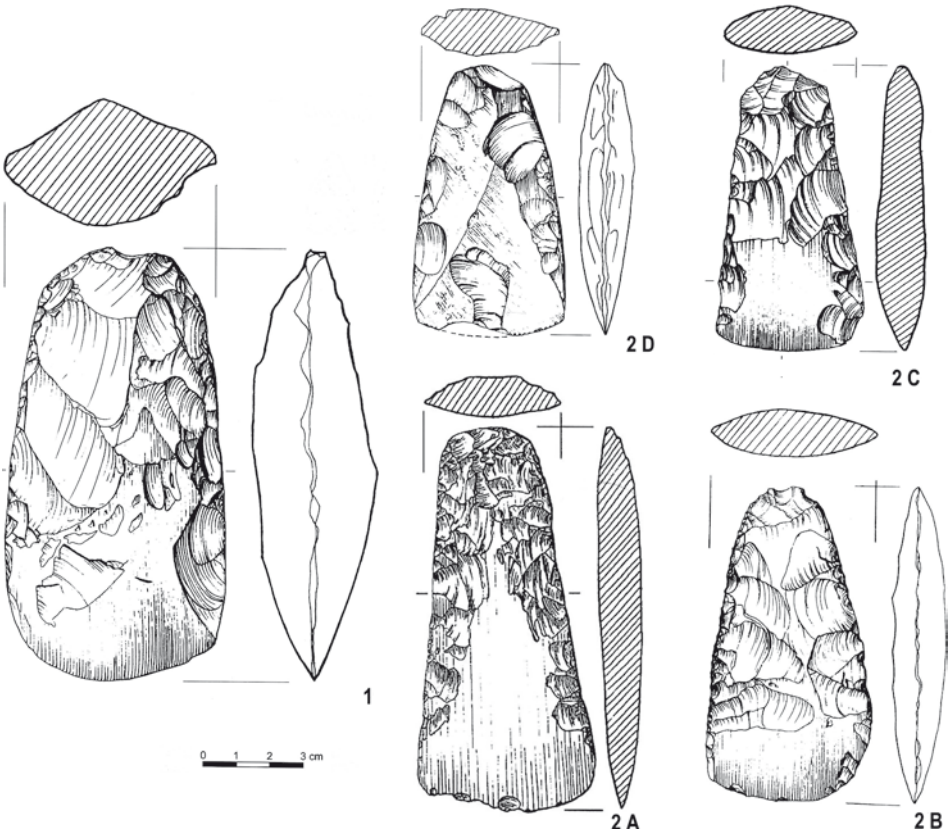


Fig. 1. Bifacial axe blades of the Samborzec group of the Mierzanowic culture made of banded flint. 1. Massive, thick specimen (Mierzanowice, Site I, Grave 27); 2. Flat sub-triangular axes (2A. Mierzanowice, Site I, Grave 55; 2B. Mierzanowice, Site I, Grave 28; 2C. Złota, „Nad Wawrem" site, Grave 255; 2D. Mierzanowice, Site I, Grave 42). After Bąbel 2013b

to the two ways in which the flint blade was hafted – either as a heavy axe mounted in a massive haft or as a light tool with the blade mounted in a knee-shaped handle (Winiger 1981; Suter 1993). Flint axe blades were damaged in the course of use (Jørgensen 1985, fig. 52-55), after which they were repaired, which usually changed their parameters (Budziszewski and Włodarczak 2011). Repairs may have slightly altered the shape of the specimen (Fig. 1: 2B) or may have shortened the entire form, changing its proportions slightly. In the case of flat sub-triangular blades, the original select forms reach a length of 10.0-11.5 cm, and the width of their blades is 5.0-6.0 cm (Fig. 1: 2A). The length of most specimens of this type is between 8.0 and 10.0 cm, and their blades are 4.0-5.0 cm wide (Fig. 1: 2C, 2D). In contrast, the length of the smallest specimens oscillates between 6.0 and 7.0 cm, and their blades are between 3.5 and 4.5 cm wide. The maximum thickness of all specimens is similar and is usually between 1.0 and 1.5 cm (Klekot 1988; Bąbel 2013, 101-103). It seems that a length of about 6 cm and a blade width of 3.5 cm set a limit below which it was impossible to embed this type of flint blade in a haft. Flint blades could have been embedded in lightweight knee-shaped holders in two ways: parallel to the helve as an axe, or perpendicular to it as in adze. The latter way seems to predominate in materials from the Neolithic lake dwellings (Suter 1993). An important contribution to the discussion of this issue could come from the study of the micromorphology of flint blades, determining the degree of their asymmetry in cross-section, which should be more pronounced in the case of adzes. Unfortunately, such analyses have not been conducted so far. Nor have detailed traseological studies of these tools been conducted. Thus, we are left with the conjecture that such tools, regardless of their method of blade fitting, should have been used for many *ad hoc* household activities, including wood or meat processing.

Bifacial sickle-shaped knives were usually produced from the Turonian flint exploited in a single mining field – "Za garncarzami" in Ożarów, Opatów County (Brzeziński 2020). Their form is reminiscent of specimens found in the Early Bronze Age over a wide area from Volhynia in Ukraine to the Netherlands. The artefacts from Małopolska have already been classified in detail several times. Most recently, this was done by Jerzy Libera, who divided them into two varieties – wide-topped and sharp-topped, in each of which he distinguished three sub-varieties, each of which had two classes – slender and stocky. Sickle-shaped knives made of Ożarów flint, appear in 10 of the 12 classes so defined. On the other hand, they dominate two of them – slender or stocky "wide-topped specimens with the working edge slightly convex or straight" (Libera 2011, 161-163). A statistical analysis of shape carried out by Kamil Serwatka a few years ago, which consisted of calculating the allometric coefficient, showed that the above diversity of sickle-shaped knives is probably related to the stages of advanced processing, mainly the transformation of the working edge subject to successive sharpening (Serwatka 2020). This process caused the originally straight working edge (Fig. 2: 1) to become more and more concave while moving toward the middle, thickest part of the tools (Fig. 2: 2-4). There must also have been more fundamental reworking, shortening the tool after the most common damage consisting of the tip

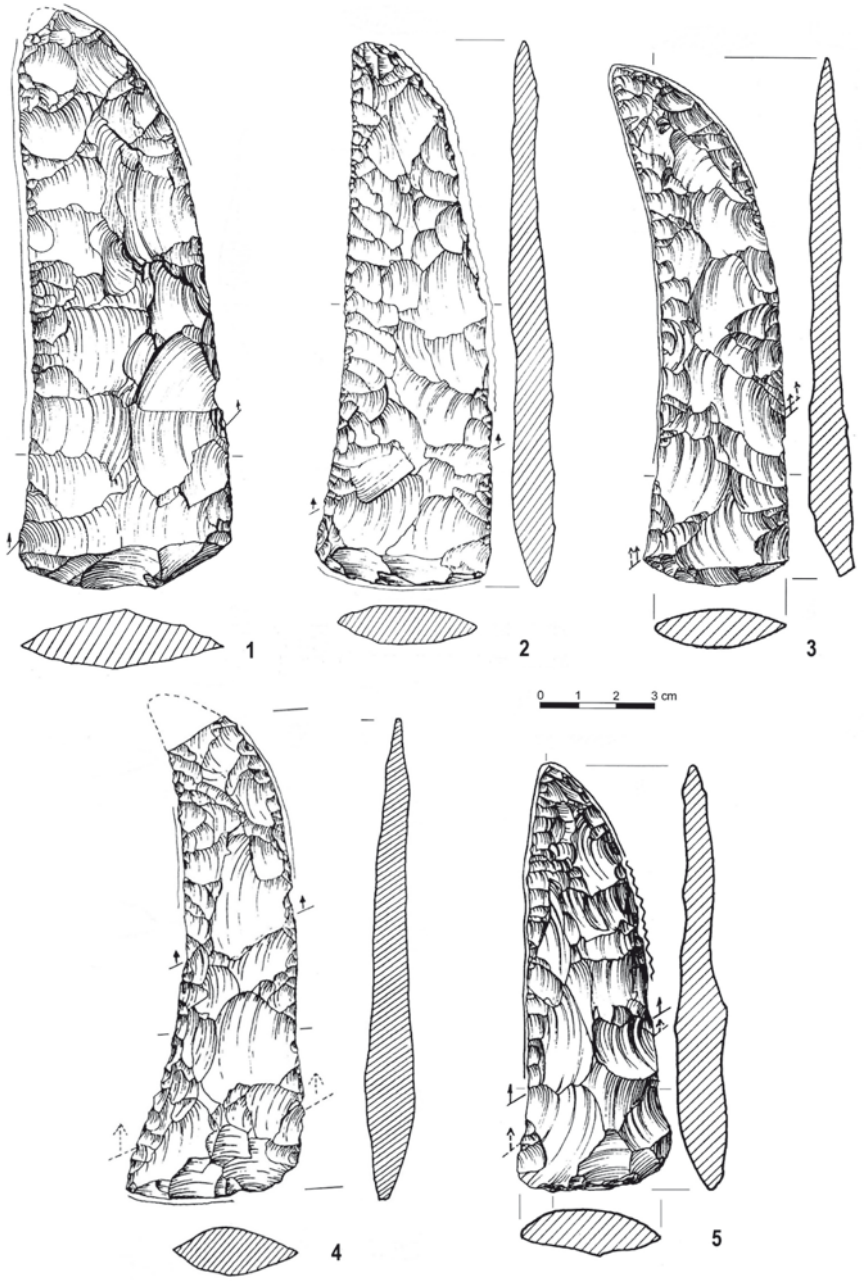


Fig. 2. Sickle-shaped knives of the Samborzec group of the Mierzanowice culture made of Ożarów flint showing different stages of processing: 1. Mierzanowice, Site I, Grave 6; 2. Mierzanowice, Site I, Grave 143; 3. Złota, „Nad Wawrem" site, Grave 25; 4. Mierzanowice, Site I, Grave 155; 5. Złota, „Nad Wawrem" Site, Grave 39. After Bąbel 2013b

breaking off (Fig. 2: 5). As a result, although the most impressive blades of this type reach a length of 15-16.5 cm, most are noticeably smaller. It seems that the limit below which a tool furnished in the standard manner could not be used effectively is a length of about 11 cm. Tools of this type have been repeatedly studied traseologically, beginning with pioneering work in the late 1970s (Bąbel and Budziszewski 1978; Balcer and Schild 1978a; 1978b; 1980) and continuing with professional analyses of recent years (Grużdź *et al.* 2017). The results of traseological studies of sickle-shaped knives made from Ożarów flint are today complemented by analyses of similar forms from the area of the neighbouring Strzyżów culture (Pyżewicz and Grużdź 2019; Wolski 2020; Hyrchała *et al.* 2022) and formally similar artefacts more distant chronologically and spatially (Van Gijn 1988; 2010; Baron and Kufel-Diakowska 2013). In light of all these studies, the thesis that the most common and intense traces visible on their surface are "mirror-like" polishes resulting from their use in the reaping of plants containing silica, probably cereals, is not in doubt today. At the same time, intense scuff marks are visible on the tops of several specimens made of Ożarów flint (Mierzanowice, Site 1: Graves 62, 143, 185), individual forms of the Strzyżów culture from Raciborowice-Kolonia (Wolski 2020, 109-111, fig. 23-2, 24-2), as well as some younger tools from the Dutch sites (Van Gijn 1988), which are interpreted as the effect of contact between the tool and the soil. Their interpretation is still quite doubtful. The most convincing attempts are made to connect them with the cutting of turf for construction purposes (Van Gijn 2010, 193-195), but reliable hypotheses in this regard require solid experiments. This is all the more important because, although traces of this type are extremely rare, they appear over large areas and a considerable time. Thus, it can be thought that they conceal some important information about the economy of Bronze Age communities. The surface of sickle knives also preserves clear traces left by the tool handles. Thus, we have no doubt what parts of the flint blades were in them (Bąbel 2013b; Pyżewicz and Grużdź 2019, fig. 4). On the other hand, there is no basis for a full reconstruction of the handles. It can be expected that they were straight along the axis of the flint blades (Bąbel and Budziszewski 1978, fig. 8), or curved according to the old proposal of S. N. Bibikov (1962, fig. 14; Bąbel 2013a, fig. 41).

Among the materials from the Małopolska Upland are two flat bifacial axes made from fragments of damaged sickle-shaped knives from the Ożarów flint (Fig. 3: 1, 2). The first comes from Pit 99 discovered in 1964 at the settlement of the Mierzanowice culture in Samborzec, Sandomierz District (Kamieńska 1966, 324, fig. 2; Kamieńska and Kulczycka-Leciejewiczowa 1970). In this pit, in addition to a rich ceramic inventory (Kamieńska 1966, fig. 1, 3), a scraper made from a massive flake of Ożarów flint was discovered (Machnik 1967, pl. IX-5), as well as five fragments of flakes – two of Ożarów flint (Machnik 1967, pl. IX-3), one of chocolate flint, one of Jurassic-Cracow flint and one of a raw material of unknown provenance. The flat bifacial axe made of Ożarów flint is 10.1 cm long, has a blade width of 4.6 cm, a maximum thickness of 1.4 cm, and a weight of 75.2 g (Fig. 4: 1). So, the

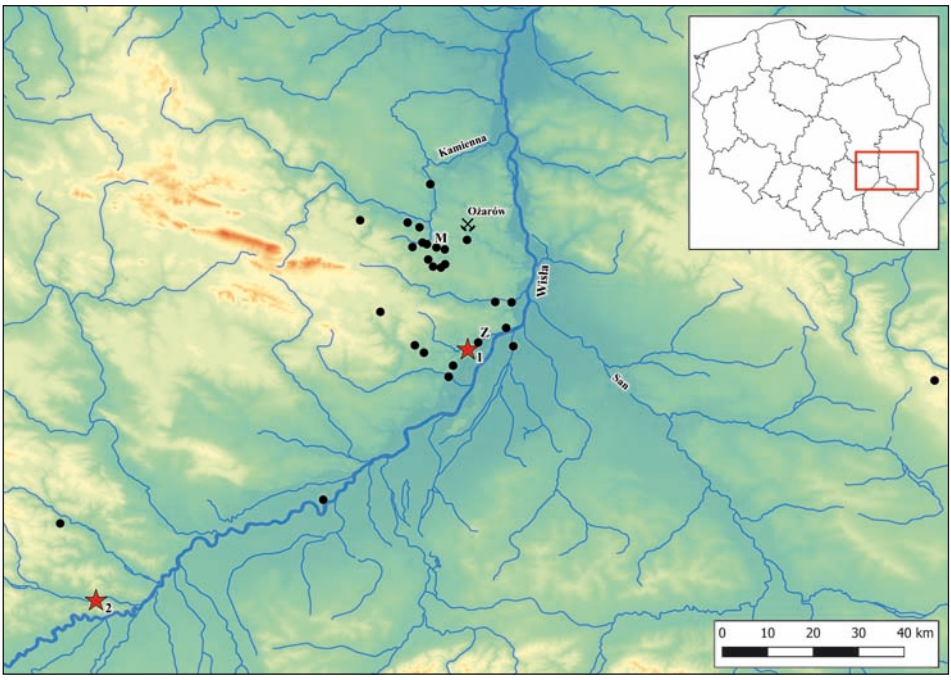


Fig. 3. Location of finds of flat sub-triangular axes made from sickle-shaped knife fragments: 1. Samborzec, Sandomierz County; 2. Majkowice, Proszowice County. The black dots mark the finds of sickle-shaped knives made of Ożarów flint (M – Mierzanowice, Opatów County; Z – Złota, Sandomierz County), while the mining emblem marks the location of the mining field "Za garncarzami" in Ożarów, Opatów County. Drawn by Michał Szubski

dimensions place it among the largest select blades of its kind. It was made from a large fragment of the apex of a sickle-shaped knife bearing not very intensive traces of work.

Traces of use are located on the extensive surfaces of the "old negatives" on both sides of the tool. They appear in the form of highly visible polishes, with a "mirror-like", flat character (Fig. 4: 3). Within them, there are numerous linear traces arranged obliquely relative to the symmetry axis of the tool. The morphology of the traces indicates that they were created while cereals were being cut. Their location – on fragments of negatives, created earlier than those forming the edges of the tool, indicates that they are related to the use of the tool before its transformation into an axe. A new form of the tool was created by modifying the sickle-shaped knife, with a not very precise retouch. To form a relatively symmetrical bottom of the axe, the arched edge and area around the tip of the knife had been modified. The specimen was finished with careful grinding of the slightly asymmetric, flat-convex axe blade and both side edges (Fig. 4: 1). Linear traces created during grinding, which are located near the blade are arranged parallel to the axis of symmetry of the axe, while in the further part, they are less regular and are arranged towards both sides

(Fig. 4: 4). This indicates at least two stages of grinding the axe. The sides of the axe blade are damaged with extensive flakes. There are no traces of use on these surfaces. However, on the preserved fragment of the axe blade, there are areas of polish visible on both sides of the tool. Their morphology (brightness, flat nature) indicates that they were most likely created during woodworking (Fig. 4: 2). Numerous linear traces appearing within the polished area are arranged parallel to the working edge and appear mainly on one side of the tool. These data indicate that the axe blade was most likely mounted perpendicular to the handle. There is one more type of trace left on the surface of the axe, which is related to the hafting. These traces appear in the form of rounding and abrasion of protruding parts (mainly ridges), accompanied by polishing, which in some places resemble that formed during contact with a skin (Fig. 4: 5). Hafting traces were noted in the middle and lower parts of the axe. Most likely, at least some of them were created during the use of the axe, but it cannot be ruled out that some of the hafting traces are remnants of an earlier stage of use of the specimen in the form of a sickle-shaped knife.

The second of the presented axes comes from an accidental discovery in the village of Majkowice, Proszowice County (Fig. 3: 2), that is, from an area far from the Ożarów flint deposits and outside the settlement range of the Samborzec group of the Mierzanowice culture. The flint blade has a length of 5.6 cm, a preserved blade width of 3.7 cm, a maximum thickness of 1.1 cm, and a weight of 26.5 g (Fig. 5: 1). Such dimensions place the specimen between the smallest forms, close to the limits for this type of tool. The axe was made from a small tip fragment of a sickle-shaped knife with clearly visible traces of use.

Despite the areas of polish visible to the naked eye, detailed use-wear analysis was somewhat difficult due to the effects of post-depositional factors. They appear in the form of a shiny patina covering the entire surface of the tool. However, the identification of the traces related to the use of the tool at the sickle-shaped knife stage was not a problem. Clear traces of cereal cutting have been preserved. They appear (analogously to the example described above) in the form of areas of polish with a "mirror-like" and flat character (Fig. 5: 3, 4). Within it, there are linear traces arranged obliquely to the symmetry axis of the specimen. They appear on "old negatives" on one of the sides of the axe and go deep into the surface of the specimen. The tip of the sickle-shaped knife was knocked off earlier – during use, and then it was slightly modified with careless retouching, which largely eliminated its typical asymmetry, and then it was further used. A new form of the specimen was created by modifying the slightly asymmetric, flat-convex axe blade and both side edges with careful grinding (Fig. 5: 1). Linear traces associated with grinding are arranged at a slight angle to the edge of the axe blade (Fig. 5: 2). After transforming the tool into an axe, the specimen was used again. Some uncharacteristic areas of polish visible on the edge of the axe blade have been preserved (Fig. 5: 2), but due to the presence of a patina, it is impossible to determine the type of organic raw material that was processed. During the use of the specimen, its blade was extensively damaged and numerous negatives of chips, flakes, and cracks are visible. It should be added that hafting traces have been

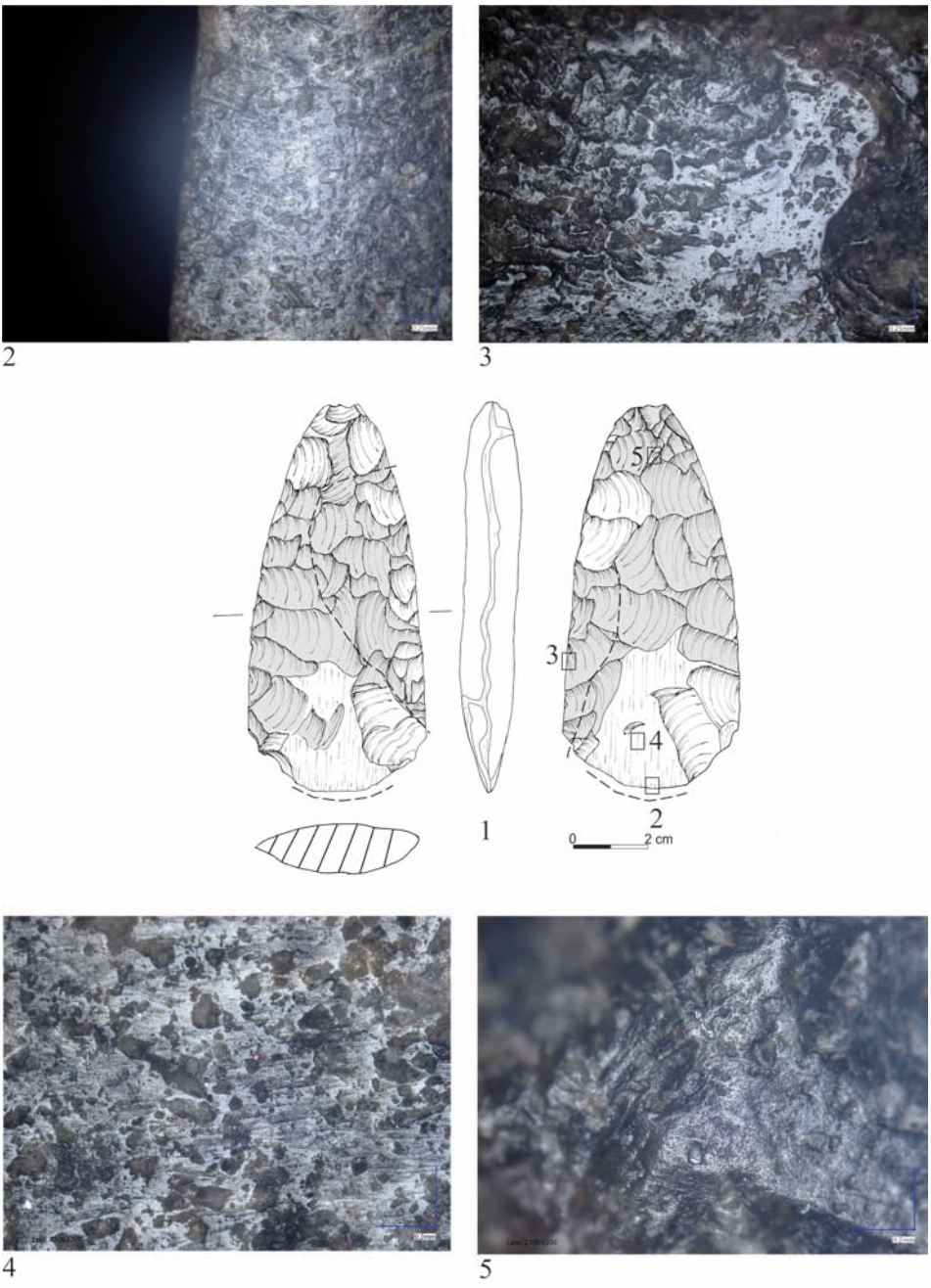


Fig. 4. Samborzec, Sandomierz County, Pit 99. 1. Flat sub-triangular axe made from a fragment of a sickle-shaped knife (drawn by Agnieszka Dziedzic). 2 – use-wear traces related to woodworking; 3 – traces of cereals cutting; 4 – grinding traces; 5 – hafting traces (photos by Katarzyna Pyżewicz)

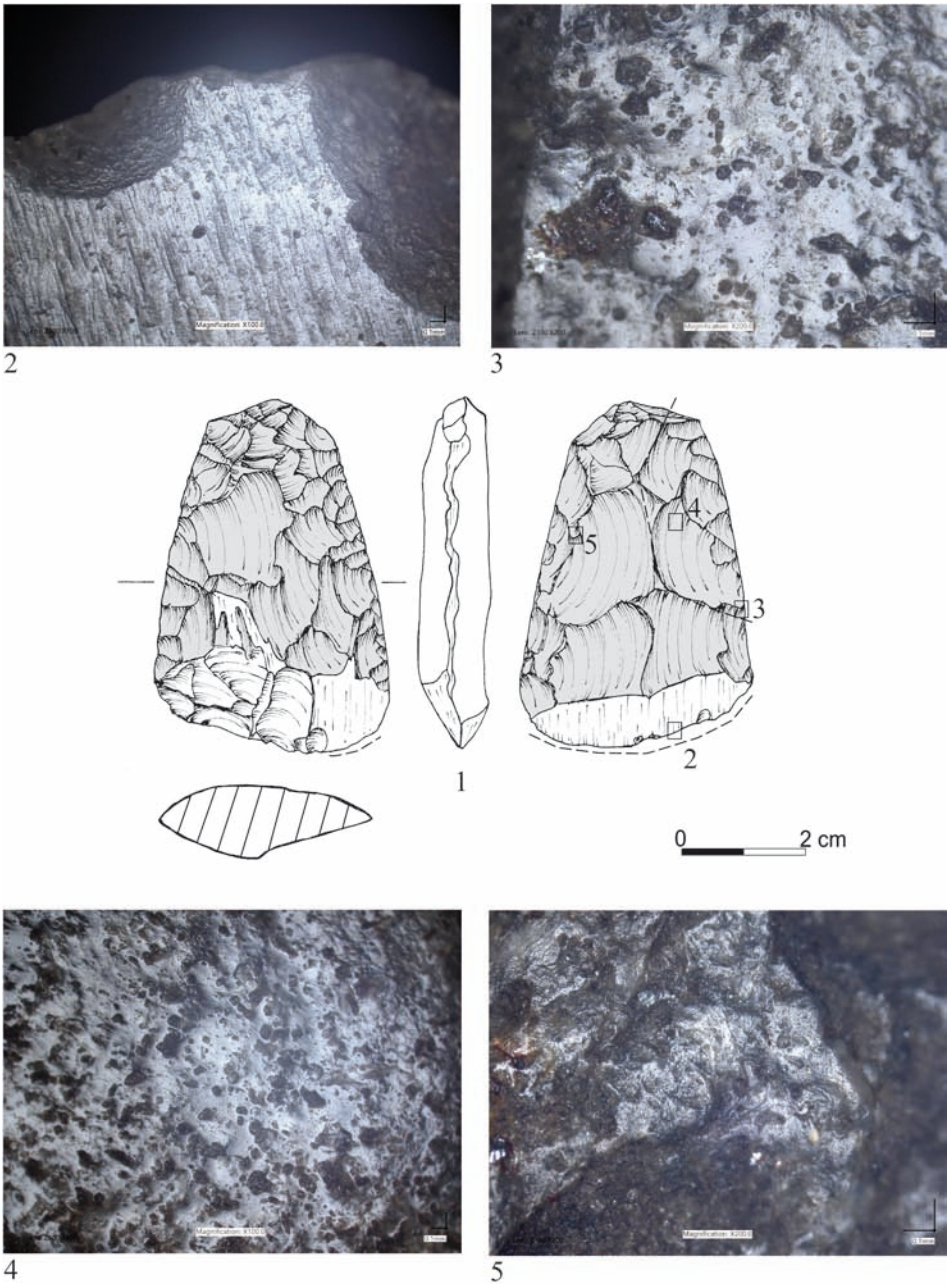


Fig. 5. Majkowice, Proszowice County. 1 – Flat sub-triangular axe made from a fragment of a sickle-shaped knife (drawn by Agnieszka Dziedzic); 2 – grinding and use-wear (?) traces; 3-4 – traces of cereals cutting; 5 – hafting traces (photos by Katarzyna Pyżewicz)

preserved on the tool. They are located in the middle and proximal parts of the axe. They occur in the form of rounding, abrasion, and polishing of protruding parts (Fig. 5: 5). These marks were formed during contact with soft organic material (skin, plants?), but due to the previously mentioned post-depositional factors, the type of raw material cannot be determined with certainty. Also, there are visible concentrations of iron oxides on the surface of the tool, which are probably the result of the destruction of the axe by modern agricultural tools.

The flint blades of sickle-shaped knives wore out through progressive re-sharpening of the working edge. The most common accident disrupting this process was the breaking off of the tip of the tool. Re-sharpening was then done, shortening the entire tool. This process could not be continued when the blade reached a length of about 11 cm. It seems that it was then no longer possible to transform it into some other core tool. For this reason, the reworking of sickle-shaped knives into other tools was something unique. So far, the only reshaping that changed the form and function of sickle-shaped knives were small atypical daggers also used for (ritual?) fire-making (Pyżewicz and Grużdź 2019, 453, fig. 6). The artefacts described above show that it was also possible to transform broken sickle-shaped knives into flat bifacial axe blades used in standard economic activities. The metric relationships between the tools of the two groups are such that axe blades made from broken sickle-shaped knives could even have been among selected specimens of tools of the new type. This was possible in the case of an unusual breakage of the sickle-shaped knife near the end of the holder. However, the case from Majkowice, where the broken-off tip of the knife allowed the making of a small axe blade, close to the limits for this type of tool, seems more likely. Not insignificant in this case may have been the distance from deposits of good quality flint raw material.

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SHIFTING TECHNIQUES IN PERFORATING ANIMAL TEETH AND METAL OBJECTS. SOME EXAMPLES FROM EARLY BRONZE AGE CONTEXTS

ABSTRACT

Baron J. and Nowak K. 2024. Shifting techniques in perforating animal teeth and metal objects. Some examples from Early Bronze Age contexts. *Sprawozdania Archeologiczne* 76/1, 615-628.

This paper addresses shifting techniques between manufacturing two types of raw materials. On the one hand, they are copper-based alloys that were processed in the Early Bronze Age (c. 2300-1600 BCE) only by a few craftspersons, and, on the other hand, well-known and commonly processed animal hard tissues. At least one technique we observed on the metal objects originates from those of working with animal hard tissues, while the other one can be found in already published evidence. Application of techniques known from bone and antler processing in metallurgy indicates cross-craft communication and learning processes.

Keywords: Animal teeth, metallurgy, daggers, halberds, Early Bronze Age
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1. INTRODUCTION

The first metal objects in today's Poland were made primarily of copper and are dated to the 5th millennium BCE (recently Mozgała-Swach 2019, with further references therein). In the Central European Bronze Age, starting around 2300 BCE, we observe increased evidence of metallurgy, primarily based on processing copper-based alloy. Although in the Early Bronze Age (the EBA), the applied technology seems to have continued Neolithic and Eneolithic traditions (*e.g.*, Kienlin 2013, 415, 516), after that period, the copper-based metallurgy became commonly known in many communities, in particular in today's western Poland. To process mostly imported raw materials used in metallurgy, a specific toolkit, knowledge, and designed devices were necessary, and they were operated by individuals, some of whom may be called specialists (*e.g.*, Costin 1991). Manufacturing similar objects was based on successful communication and efficient knowledge transmission among makers (Jordan 2015, 4) about technological requirements and choices (Hosler 1994, 3). Similar shapes and patterns also occurred in multiple types of raw materials (*e.g.*, Biehl and Rassamakin 2008). Danish flint swords and daggers imitating the metal weapons or formally matching ceramic and wooden vessels from the Alpine lake sites can illustrate the shifting of shapes and functions between available and/or desirable raw materials. That, however, required knowledge of both of them or communication between specialists in various crafts. This phenomenon – the inter-craft communication (*e.g.,* Choyke 2008) – occurred locally and globally.

This paper addresses shifting techniques between manufacturing two types of raw materials. On the one hand, they are copper-based alloys that were processed in the EBA (c. 2300-1600 BCE) only by a few craftpersons, and, on the other hand, well-known and commonly processed animal osseous tissues. We argue these two types of raw material were processed by makers familiar with working hard materials, and when needed, they applied already-known techniques to the new material. In this case, learning was based on their own experience or as a result of inter-craft, intra-site communication. For the sake of the study, we focused on only one technique, perforating.

A perforation is a hole in a solid material made by various techniques, such as scraping and grooving, drilling, piercing, or punching (Gwinnett and Gorelick 1998). Such artefacts have been common in archaeological evidence since the Palaeolithic (*e.g.,* Wilczyński *et al.* 2014). Objects of various raw materials have been perforated to be hung, hafted, or attached. Perforations enable the manufacturing of composed items or musical instruments. Perforated ceramic strainers were used in cheese manufacturing. Depending on the hardness of the processed material, the holes were made with different tools and techniques at various operational chain stages, from punching holes in soft clay vessels to drilling through nearly finished stone axes.

2. MATERIALS AND METHODS

To analyse perforating techniques, we examined seven objects: three made of metal and four made of animal teeth. They come from EBA contexts in Western Poland: a metal hoard from Muszkowo, a settlement pit from Bytomin (today Bytnik), and two graves from Grębocice and Milejowice (Fig. 1).

Two objects made of wild boar tusks were found in a grave of six individuals (three adults, three children) furnished with four vessels of the EBA chronology (Łesiuk 2013). One specimen was complete, and the other was broken at both ends (Fig. 2: a). The perforated object is 88 mm long, 20 mm wide, and 2 mm thick.

A plate made of a wild boar tusk comes from an EBA settlement pit at Bytomin (Markiewicz 2016). The specimen is 63 mm long and 19 mm wide (Fig. 2: c) and, according to the results of use-wear analysis, was attached to a leather object: a costume or a helmet (Markiewicz and Diakowski 2016).

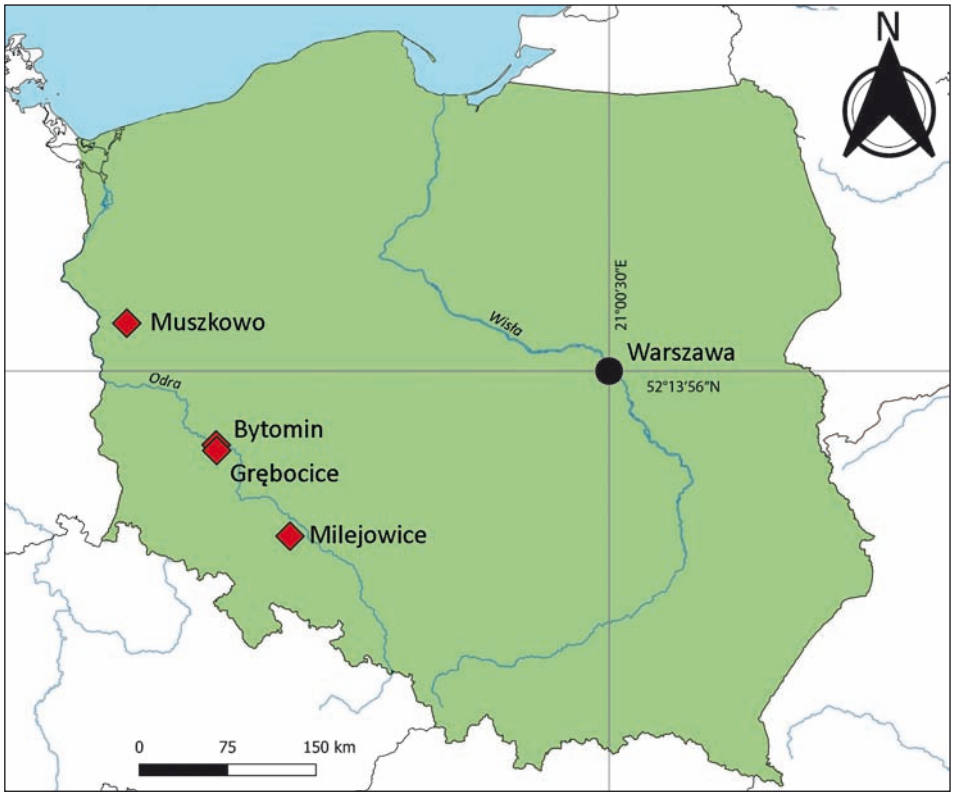


Fig. 1. Map showing locations mentioned in the text.
Source: GUGiK https://www.gov.pl/ and https://dane.gov.pl/



Fig. 2. Perforated objects made of animal teeth;
a, b – Grębocice; c, d – Bytomin (today's Bytnik); e-g – Milejowice. Source: a – Łesiuk 2013, c – Markiewicz, Diakowski 2016, e – Kopiasz 2004, with modifications. All microscopic photos by J. Baron

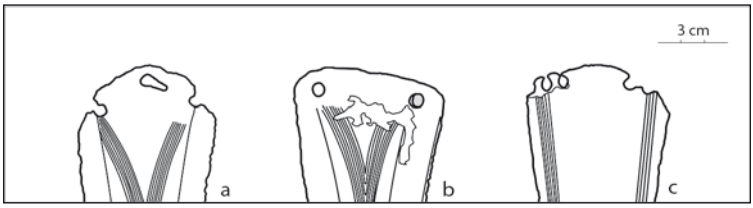


Fig. 3. Perforated metal objects from the hoard at Muszkowo;
a, c – daggers (inv. no. 4 and 6), b – halberd blade (inv. no. 5). Drawn by J. Baron

In an adult woman's grave at Milejowice in SW Poland, a necklace of 14 dog canines was found. It was the only grave good, so no direct indicators of chronology are present, but the burial was situated in an EBA cemetery, so we may assume a similar chronology (Kopiasz 2004, 40, 41). The necklace was placed on her neck; today, 12 teeth are preserved enough to be analyzed (Fig. 2: e).

The metal specimens we examined are two daggers and one halberd blade from an EBA deposit found in 2022. The collection is the subject of a detailed study that has not yet been published, and we decided not to share the full images. The first item (inventory no. 4) is a decorated dagger that is 236 mm long and 59 mm wide at the butt (Fig. 3: a). Its weight is 203.1 g. The second object (inventory no. 5) is a blade with an oblique terminated butt initially part of a halberd (Fig. 3: b). The extent and shape of the halberd's original hilt is represented by a different patina and reaches 17 mm from the blade base. The object is 214 mm long and 64 mm wide and weighs 200.6 g. The last specimen (inventory no. 6) is a fragment of a dagger decorated with grooves along the edges (Fig. 3: c). This part is 81 mm long and 59 mm wide and weighs 110.7 g.

All the artefacts studied here come from contexts representing the Únětice tradition, supported by the style of pottery and metalwork (Muszkowo, Grębocice, and Milejowice), supplemented in one case by the ^{14}C dating (Bytomin: Markiewicz and Diakowski 2016).

Microscopic observations and documentation were made using a Nikon ShuttlePix P-400R digital microscope at the Laboratory of Conservation and Archaeometry, Institute of Archaeology, University of Wrocław in Poland. The surfaces of metal objects were not subject to any conservation work or cleaning before analysis.

3. RESULTS

The tusk from the grave at Grębocice was 2 mm thick and perforated with a flint tool, leaving deep, semi-spiral marks (Fig. 2: b). They are not parallel to the surface, so the perforation was made with short rotational movements, suggesting free-hand drilling.

The plate from Bytomin was also drilled with a flint tool from both sides, making an hourglass-like cross-cut (Markiewicz and Diakowski 2016, fig. 9). Most of the drilling was

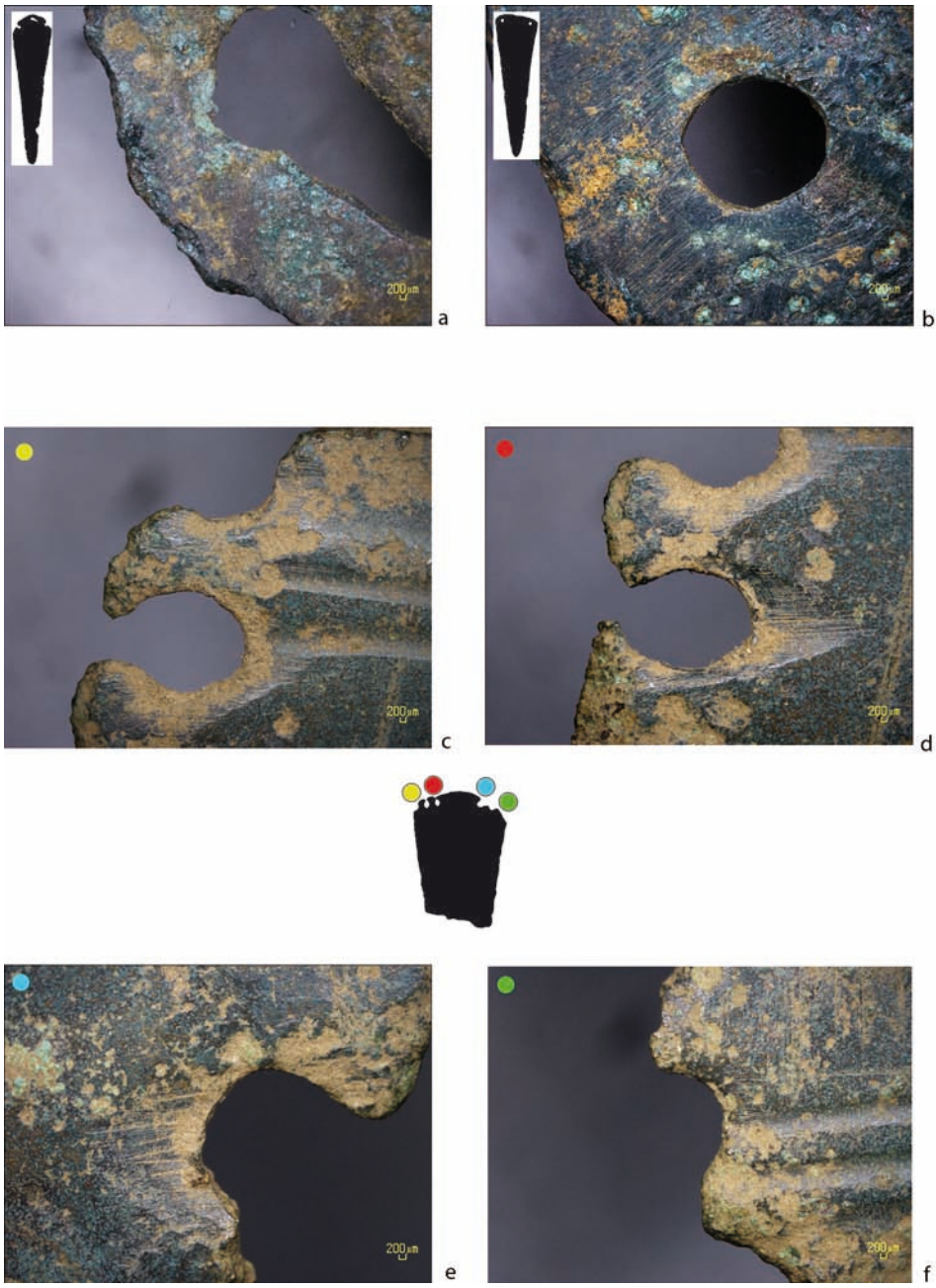


Fig. 4. Perforated metal objects from the hoard at Muszkowo;
a – a keyhole-shaped miscast in dagger no. 4; b – traces of polishing on halberd blade no. 5; c-f – abraded spots around the perforations on dagger no. 6. Photos and drawings by J. Baron

done from the ventral side (Fig. 2: c). The perforation mouth is much wider on that side and has characteristic steps, although most were smoothed by intense use (Fig. 2: d).

Among all 12 teeth from the necklace, we focused on two teeth representing different techniques of perforation. One tooth was perforated with a drilling tool and sand, which left deep spiral traces on the cylindrical hole's walls (Fig. 2: f). The other specimen was prepared before perforation (Fig. 2: g). Its surface was first abraded to less than 1 mm and then polished. The perforation wall is, therefore, less than 1 mm high, and no traces of drilling techniques were observed.

Dagger no. 4 has one central rivet hole and two side holes spaced evenly at two edges (Fig. 3: a). The central opening is fully preserved (*i.e.*, closed) and has the shape of a 5 mm wide and 12 mm long keyhole. Most likely, it was initially designed to be a round perforation with a diameter of c. 5 mm, and the long elongated shape is a miscast. The two side holes were round, partially open, with original diameters of c. 5 mm. Most of the surface was covered with a thick patina, and only some traces at the central hole were visible (Fig. 4: a). There are traces of polishing along the object's longer axis. The miscast of the central rivet hole shows the openings were cast.

The next object (no. 5) has two rivet holes placed at the two sides of the blade base, 6 mm from the edge (Fig. 3: b). Both are of a regular round shape of c. 5 mm in diameter, and a metal rivet is still present in one of them. The shape and smooth edges of both openings suggest they were cast. The multidirectional striations prove the surface around the hole was carefully polished, probably to remove casting defects such as flashes (Fig. 4: b). The upper left part of the opening bears traces of modification with a small and sharp tool.

In object no. 6, five holes were made in two groups of two and three located at both edges of the dagger base (Fig. 3: c). They are broken off, and we assume that initially, there were three holes in each group. Their shapes and surface treatment suggest a different perforation technique than in objects 4 and 5. Two holes on the left side were oval-shaped, 4 mm wide and 5 mm long (Fig. 4: c-d). The openings are situated in centres of lentil-shaped spots abraded with a stone tool, leaving a series of parallel striations. They suggest deliberate thinning of the object before perforation by punching, proved by a thin protrusion of extruded metal forming a lip along the hole edge (Fig. 4: d). In the second group, one of the holes is of quadrilateral shape with a protrusion on the edge, also suggesting a punching technique (Fig. 4: e).

4. DISCUSSION

The four tooth items we studied are made of similar raw materials but represent different perforation techniques observed even in the items composing the same necklace from Milejowice.

The perforations of two teeth of various thicknesses, 2 mm (Grębocice, Fig. 2: b) and 5 mm (Milejowice, Fig. 2: f), have cylindrical walls. Objects with tubular openings have

been evidenced since the Stone Age (*e.g.*, Gál 2011; Pratsch 2011; Orłowska and Osipowicz 2021), and experiments show that such shapes do not necessarily indicate the use of metal drills, as sometimes suggested (Diakowski 2019, 365). Metal drill bits are absent in EBA assemblages, and similar openings can be made by bone, wooden, and flint drill bits (Orłowska 2015; Gurova and Bonsall 2017, fig. 12.7). The circular striations on the walls of the holes are made by sand applied to make the drilling more efficient (Orłowska 2015, 3). Irregularly spaced short traces on the tusk from Grębocice also suggest using a hand tool instead of a bow drill (Venditti *et al.* 2023, 13, 14).

The plate from Bytomin represents a typical example of cross-drilling with a flint borer known from many prehistoric sites of various chronologies (*e.g.*, Diakowski 2019, fig. 6; Osipowicz *et al.* 2019, fig. 5: g; Gál and Bondár 2022). The perforation has an hourglass cross-section and a wide opening on the ventral side. That may reflect the shape of the drilling bit and/or the operating angles. It also can suggest deliberately widening the mouth from one side to make operating a drilling tool easier. Widening of openings by scraping off part of the compacta layer, although originated from the Stone Age, is also standard in the EBA evidence (*e.g.*, Kneisel 2010, Taf. 4: 22; Przybyła and Jędrysik 2018, fig. 8; Diakowski 2019, ryc. 6: a, b; Baron *et al.* 2024).

The last tooth was thinned before the perforation to obtain a flat, thin surface before making the hole. Perforating thin and flat surfaces enabled more significant control over a drilling tool and increased the risk of breaking the whole object if the pressure was too heavy. This mixed technique of scraping and drilling is considered typical for the Stone Age (*e.g.*, Wilczyński *et al.* 2014, fig. 4; Fontana *et al.* 2020; Osipowicz *et al.* 2020, fig. 3).

Making rivet holes in daggers and swords was done in different ways. As pointed out by Schwenzer, they were either manufactured during casting or in the post-cast process (Schwenzer 2004, 172). Interestingly, in the case of dagger casting moulds (*e.g.*, from Skočice, Czech Republic: Novák 2011, 132, Taf. 407: 706), the rivets' location is not marked, and the upper part of the blade is smooth. In casting rivet holes, the metallurgists used small ceramic cores carefully mounted in the casting mould (Armbruster 2000, 108). When pouring the mould with metal, they limited the metal flow and allowed the hole to form. Finds of this type of casting moulds with the cores are scarce; however, the use of this method may be evidenced by holes preserved in the negatives of sword casting moulds (*e.g.*, Wennungen, Germany: Jarecki and Volker 2000, Abb. 7), in which the ends of the cores were stabilized in an appropriate position.

As indicated by observations of sword-casting moulds and specimens preserved in their raw state without traces of further processing, the manufacturing of rivet holes could also have taken place differently. One possibility was to cast a full sword tang without marked holes. Holes were then made in the solid metal in the post-production process. In this case, the casting moulds do not have marked spots for future rivet holes (*e.g.*, Heilbronn-Nekckargartach, Germany; Piverone, Italy: Overbeck 2018, 104, 105, Taf. 11-13; Bianco Peroni 1970, 72, Taf. 25), and raw casts are characterized by a solid handle without

holes (*e.g.*, Bingen, Germany: Schauer 1971, 215, Taf. 106: 659, 660). This solution is analogous to the early bronze daggers discussed above.

Another method of producing rivet holes was to mark the rivet holes' location in the casting mould's negative. The casting moulds are characterized by protrusions in place of the handles, corresponding to later rivet holes.

During casting, bulges in the mould's negative resulted in corresponding recesses in the handle. This technological solution allowed for obtaining places of smaller thickness – dimples, which could then be drilled or punched out more quickly. This technique was most likely used in the case of most Late Bronze Age swords from Ireland and is identified, for example, on raw sword casts from Ballycroghan, Ireland (Ó Faoláin 2004, 86; fig. 5: 7A).

The metal items we studied were perforated to be hafted: objects 4 and 6 as daggers and object no. 5 as a halberd. Based on the archaeological and iconographic evidence (*e.g.*, Horn 2014), there were two different types of hafts for daggers and halberds, but the number and distribution of rivets varied considerably even within objects of similar sizes and morphology (Branigan 1967, graph B). The daggers were hafted with their long axes parallel to the usually short handles. The halberd blades were usually hafted to a much longer handle at a right angle. To ensure durable hafting, the rivet holes must have been placed at some distance from the blade butts; otherwise, they would easily break off even at moderate pressure. This distance can also be estimated by the extent of variant patina as in object no. 5 or from examples cited in the literature (*e.g.,* Horn 2014, Abb. 132: f). Breaking off the rivets is the typical damage observed on bronze tools and weapons that could not be easily repaired (*e.g.*, Jones and Quinnell 2013; Horn 2014, 182-184, Abb. 111; 2017; Horn and von Holstein 2017). Even in this small collection, the rivet holes were preserved on the daggers and the halberd blade in different ways, indicating different pressure directions during the use.

Although obtained from the same context of the exact same chronology, the metal blades represent different perforation techniques. They vary in distribution, number, shape, and size of rivet holes. In objects 4 and 5, the holes have regular circular shapes and similar sizes of c. 5 mm in diameter. At least in the case of object 4, we know the rivet hole was cast, proved by the miscast. They occur frequently at rivet holes in many types of tools and weapons (*e.g.*, Baron *et al.* 2019, Pl. 13, 17; Petriščáková *et al.* 2020, fig. 3/3; Mittermair 2022, fig. 5: a).

The distribution and morphology of the openings were, therefore, designed before casting. Some recent experiments showed that both copper and bronze objects could have been drilled probably with a pump- or bow-drill and with a flint-tipped drill-bit (Bell 2016, 27). Both strategies reflect the makers' knowledge about and skills in hafting finished objects, even if this was not done by metallurgists but other craftspersons, as evidenced in ethnography (Rowlands 1971, 211).

In the case of dagger no. 6, the holes vary in shape and distribution. All the perforations are located right at the dagger base and prove that the rivets were broken off. One

group consists of oval and the other one of possibly rectangular holes. Protrusions along the openings' edges suggest they were punched out of the already cast object. The surface was prepared by abrasion, probably done by a stone tool to improve perforation control. Punching the rivet holes instead of casting indicates repair and secondary riveting, as can be noticed elsewhere (*e.g.*, Horn 2014, Abb. 127; Perucchetti *et al.* 2020, fig. 3). The new holes were punched probably too close to the base edge, and during the use, the rivets broke off again.

After the rivet holes were ready, the next stage was attaching a perforated haft. The main impact in this case would be directed to a rivet head and a metal or organic haft (*e.g.*, Nowak 2020, fig. 4). Traces of hammering or imprints of the rivet heads would not be observed on the blades because they had no direct contact with rivet heads. We argue, therefore, that widened mouths of openings noted in the literature are not rivet-derived wear (*e.g.*, Tarbay 2019, fig. 18.1) but a post-cast treatment of the cast holes or traces of drilling (Bell 2016). Some extra material, casting seams, or irregular edges must have been removed to fit the blade with rivets. The technique of widening the opening (*e.g.*, Tarbay 2019, fig. 10.1; Mittermair 2022, 7b) would, therefore, be similar to what we observe on the plate from Bytomin and on other published items made of bone and antler (*e.g.*, Diakowski 2019, fig. 6).

At least one technique we observed on the metal objects originates from working animal hard tissues. The widening of the openings by rotational movements to finish the rivet holes was not observed in our collection of metal objects. However, in the literature, there are many analogies of application similar technique to what we observed on the plate from Bytomin. Scrape-and-drill techniques have been standard in manufacturing tooth pendants since the Stone Age and were applied as a secondary riveting of repaired blade no 6. The metal dagger need not necessarily have been renewed by the metallurgist. It could have been manufactured elsewhere and brought to the place of use. It seems that it was fixed by someone skilled in working with other materials, and his/her knowledge was applied to repair a broken metal item.

CONCLUSIONS

This short study shows that the manufacturing of objects that we consider similar can involve a variety of technical solutions. If they were composite items and hafting was required, it could have been done in different ways depending on the craftsperson's skills, experience, and knowledge of processing other raw materials. Making the rivet holes in metal objects could have been both planned before casting and performed in already cast or broken items.

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OSSEOUS ARTEFACTS FROM THE CHURCH OF ST JAMES IN TORUŃ AS A SOURCE OF INFORMATION ON THE PRODUCTION AND USE OF EVERYDAY BONE OBJECTS IN POLAND FROM THE 14TH TO THE 18TH CENTURIES

ABSTRACT

Sulkowska-Tuszyńska K. and Orłowska J. 2024. Osseous artefacts from the Church of St James in Toruń as a source of information on the production and use of everyday bone objects in Poland from the 14th to the 18th centuries. *Sprawozdania Archologiczne* 76/1, 629-656.

The article presents the results of typological and traceological analyses that involved seven objects made of osseous raw materials found around the church of Saint James in Toruń. Owing to technological analysis, it was possible to reconstruct the methods applied for working osseous materials by craftsmen of past times, whereas the analysis of use-wear traces allowed us to formulate conclusions regarding the function of the examined specimens. The objects were compared to other analogous finds in an attempt to recreate the techniques used for making them, the context in which they were used, and the role they could have played in the past.

Keywords: Osseous artefacts; traceological analysis; late medieval times; modern era; Poland; St. James's Church in Toruń

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1. INTRODUCTION

Archaeological-architectural studies carried out in cities-living organisms of the past – provide information on the beginnings of settlements, the buildings, the architecture, and the culture. These data are unique and not included in any chronicles. Discoveries made in the vicinity of churches, once surrounded by cemeteries, yield vast knowledge about the spiritual culture and burial rites, about the past of cities, towns, and their inhabitants in the Middle Ages and in the modern era. Among the abundance of ceramics, bits of bricks, tiles or vessels, other items of everyday use are unearthed immediately adjacent to churches; of these, well-preserved objects made of osseous raw materials are usually a rare find.

Toruń – a Hanseatic city in Pomerania, was founded in 1233. This swiftly growing organism prompted the Teutonic Knights to establish another one, the New City of Toruń, right beside it as early as in 1264. This New City had more to do with craftsmanship than the wealthier, trade-oriented Old Toruń did.

In the years 2008-2020, the area near the church of St James served as the site of archaeological-architectural studies conducted by the Institute of Archaeology, Nicolaus Copernicus University (UMK), during which the beginnings of the architecture and the stage of construction were identified; unearthed graves provided perspective for learning about the funerary culture, while various artefacts offered insight about the material culture. As a result of discoveries and expert analyses, it has been proven that right after the founding of the New City (after the year 1264), a brick parish church was erected. After a relatively short time, its chancel had been destroyed due to unknown reasons, and consequently, in 1309, a cornerstone was laid for a new chancel supported by the stone foundations of the previous church. Although the elegant structure with diagonal buttresses and slender staircases was finished in the mid-14th century, eight more chapels and an antechapel were added over time until the beginning of the 16th century (Sulkowska-Tuszyńska 2022).

Currently, this church has been regarded as a pearl of the Gothic architecture of the whole of Pomerania due to its slender shape, the charming beauty of the detailed brickwork, inscriptions and the polychrome decoration in the interior (Fig. 1). From about the turn of the 14thcentury to the mid-19th century, and in some cases to the early 20thcentury, the surroundings of the church served to bury the dead inhabitants of Toruń. In the past, this necropolis was not only a resting place and a haven of peace for passers-by but also a busy area on the road; through the quarter of the city where the church was located, one could reach the market square from the northern suburban area, as well as go towards the Old City of Toruń, and further to the harbour on the Vistula River.

In the course of the archaeological-architectural studies around the church of St James, the parish church of the former New City of Toruń, a unique collection of items made of osseous materials was unearthed. They were once objects of everyday use, employed by the inhabitants of Toruń between the 14th and the 18th centuries. These objects come from

cemetery layers disturbed by subsequent burials. Burials were distributed around the entire structure in 7-15 layers (!). The cemetery area served as a meeting place, a trading site, a refuge, and even a dumping ground for waste. The objects subjected to analysis were not grave offerings; they were not intentionally placed in burial pits. These were everyday accessories, likely lost or abandoned for various reasons.

The article shows the results of the typological and traceological studies of these items. The fundamental objective of the presented analysis was to seek to interpret technological



Fig. 1. A – View of Toruń in 1641 according to a work by Matthaus Merian with the location of the church of St James marked (white arrow); B – Toruń, St James church (Source: Wikipedia; B: church of St. James in 2011. Photo by Kapitel, CC BY-SA 4.0); C-E – St James church. Views from different sides (Photo by W. Ochotny)

procedures performed in the course of the manufacturing of the described artefacts, as well as to try to determine the ways in which they were used, that is, their purpose and the contexts in which they could have been used in the past. In the conclusions, the results of the conducted analyses were confronted with the most recent knowledge on the occurrence, chronology, manufacturing methods, and ways of using analogous products in Poland and in Europe, in the late medieval times and in the modern era.

2. MATERIALS

The total number of archaeozoological objects amounts to nearly 300 fragments, primarily consisting of small broken pieces of post-consuption waste. Bone objects with traces of processing constituted only about 5%. In addition to those presented in the article, there were, for example, several bone plates – probably production waste from buttons (diameter 6-10 mm). For the purpose of the presented study, seven objects were subjected to a detailed analysis. Below are brief summaries for each of the analysed artefacts:

Sleeve (inv. no. IZW- 59/13)

An object in the form of a narrow and quite long sleeve (11 mm in diameter, 7.3 cm long), empty inside, with remains of a corroded pin (?) at one end. The analysed specimen is covered on its entire surface with unevenly situated omnidirectional grooves (Fig. 2: 1). It is preserved entirely, with the edges at both ends slightly chipped. At two points along the axis, up to three-quarters up, two cracks are visible. The sleeve was found on the south side of the church close to its west corner, near the gate at St. Jakob Street (see the planigraphy of the place where the bone and antler items were found, Fig. 2). It was made of a long metatarsal bone of a small ruminant, such as sheep/goat. The item can be dated back to a broad time bracket between the second half of the 16thcentury and the first half of the 17thcentury.

Osseous knife handle (inv. no. IZW-21/10)

An osseous knife handle with a perforation right by the slightly broadened and rounded end (7.5 cm long, 1-2 cm wide). The object is preserved in its entirety, with a fragment of a broken iron tang of the blade. The visible iron heads of rivets are corroded. Found by the north corner of the monastery building, close to the corridor that links it to the church (Fig. 2: 2). Made of antler of an animal from the family *Cervidae* (Cnotliwy 1973), using two flat parts on the inside, and slightly curved on the outer surface. The handle has been dated to the 15th-16th centuries, approximately.

Gaming piece (inv. no. IZW-63/13)

An osseous gaming piece in the shape of a truncated pyramid (28 by 28 by 11 mm), of a milky-cream colour, meticulously crafted and strongly polished on the side walls and on the bottom. Each of the four side walls bears four circular depressions (1 by 2 mm), and one on the upper one, which is horizontal. The edges of the square base were emphasised with lines. About 80% of the object is preserved; its two corners are damaged. Unearthed

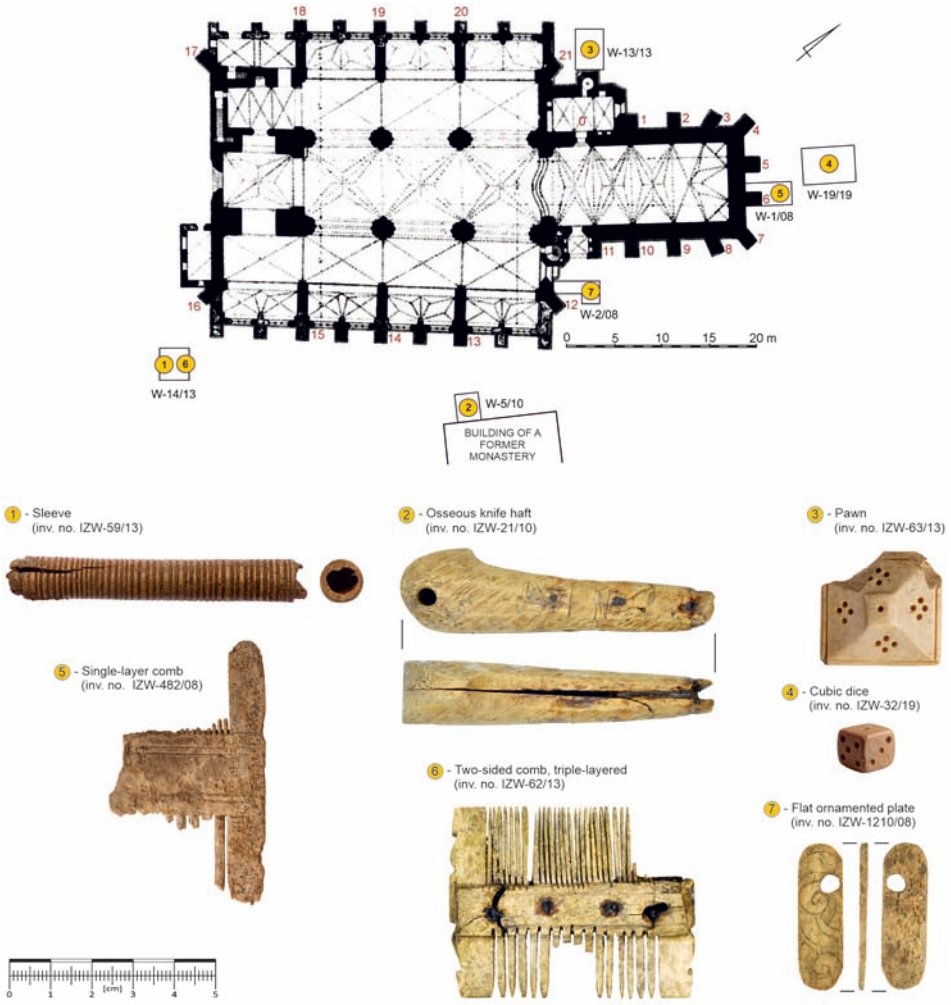


Fig. 2. Top: Toruń, church of St James. Plan after O. Freymuth with an additional marking of the buttresses (Freymuth 1981, 49) and find spots of the analysed artefacts. Bottom: artefacts analysed in the presented study (Photo by W. Ochotny)

by the sacristy, in a layer from about the 17th century (Fig. 2: 3). Made of a long bone, most likely that of a large mammal. The piece can be dated back to the 16th-17th century.

Cubic dice (inv. no. IZW-32/19)

A cubic gaming dice comprising six flat square walls of equal size (8 mm large). The surface of the specimen is polished and meticulously crafted. Preserved in its entirety, found close to the east wall of the cemetery near the gable end of the presbytery, in a layer of burials from about the 18th century (Fig. 2: 4). Since the bone material has been highly processed, it was not possible to identify it.

Single-layer comb (inv. no. IZW-482/08)

A two-sided comb (originally rectangular?), with a row of wider teeth on one side and a row of narrower ones, situated more densely, on the other side. On both surfaces in the central part, there is an ornament made of double straight lines. A feature that makes it stand out is the milky-grey colour of the raw material. Only a small fragment has been preserved (about one-eighth of the entire object) with only several broken teeth. Found right next to the east wall of the chancel, in the layer of burials from about the 18th century (Fig. 2: 5). The material the presented comb is made of is consistent with the structure of the dentine of the incisor tooth of an animal from the family *Elephantidae*. This structure is characterised by the presence of cracks in the form of a characteristic relief called the feather pattern (Locke 2014; fig. 5: F). The structure of the comb and the context of its unearthing allow one to date it to about the 17th-18th centuries.

Two-sided composite comb, triple-layered (inv. no. IZW-62/13)

The comb is made of three plates. The large plate is rectangular (5.8 by 5 cm), clad on both sides with two narrow bone strips (5.8 by 1.2 cm) This is a Hilczerówna (1961) type I, group III BG comb. The object was found by the southwestern corner of the church, in the layer of burials from before the year 1557 (Fig. 2: 6). It has been preserved almost in its entirety, with minor parts chipped; it has iron rivets, rusted. The archaeological-zoological analyses suggest that it was crafted using the antler of an animal from the family *Cervidae* (Locke 2014); most likely, it was the antler of the red deer (Cnotliwy 1973). The structure of the comb and the raw material it was made of suggest that it could be dated rather to the 15th century.

Flat ornamented plate (inv. no. IZW-1210/08)

A small cream-coloured plate (3.5 cm long, 1 mm thick) with rounded corners. One of the surfaces of the plate is adorned with a floral ornament with a slanted chequered motif.

The plate bears a large perforation (4 mm) asymmetrically located by one of the sides. Preserved in its entirety, with a shiny outer surface. The item was unearthed on the line of the corridor linking the monastery and the church, below the level of the floor laid after 1667 (Fig. 2: 7). The oldest building of the Cistercian-Benedictine monastery (from the 13th/14th century) was located approximately 20 metres south of the lateral portal of the chancel. When Catholics regained their church from Protestants after 110 years in 1667, the nuns immediately erected a corridor connecting the church with the monastic complex upon their return. Until the 18th century, additional monastic buildings were constructed to the southeast of the chancel (Sulkowska-Tuszyńska 2022). The ornamented plate was situated in a layer interrupted by several burials (G-6/08, G-8/08, G- 9/08), dated to the second or third quarter of the 17th century. It was made of an unknown, thin bone. Due to the high degree of 'working', it is difficult to determine whether it was a flat bone or a long bone. The object could have been used closer to the turn of the 16th and 17th centuries or in the first quarter of the 17th century.

3. METHODS

The results of the studies presented below are based on objectives developed in the traceological and archaeological literature concerning techniques for working bone and antler (for example, Żurowski 1963; Olsen 1984; MacGregor 1985; Jaworski 2012).

The taphonomical observations were made according to relevant literature (*e.g.*, Olsen and Shipman 1988; Fisher 1995; Madgwick 2014; Fernandez-Jalvo and Andrews 2016; Senyane *et al.* 2023) concerning artefacts made of bone and antler.

The traceological analysis of the artefacts was conducted using a Nikon SMZ-745T microscope-computer set fitted with a Delta PixInvenio 6EIII camera. This equipment provides magnification of the lens up to 12.6× (the actual magnification of up to about 120x) and computer digitalisation and processing of optical images. This set was employed to make most of the microphotographs used in the figures. The analysis of the polish was conducted using a Zeiss Axioscope 5 Variomicroscope fitted with an Axiocam 208 camera. The microphotographs made using this set are shown in Figures 4: N, 5: G-I, 6: K, L, 8: C, M-O, and 9: E.

The observed traces were analysed concerning their location, morphology and distribution on the artefacts' surface. The observed use-wear traces were verified by comparative analyses of micro-wear traces observed on experimental bone and antler products from former experiments that can be found in the Institute of Archaeology NCU in Toruń.

The applied traceological terminology was based on a terminology system that exists in the subject literature (*e.g.*, Korobkova 1999; Legrand 2007; Christidou 2008; Buc 2011; Orłowska 2016), which has been adapted for the purposes and requirements of the conducted analysis.

4. RESULTS OF THE TRACEOLOGICAL ANALYSIS

The state of preservation of the products subjected to the analysis varied. Some objects were preserved fragmentarily, and their surfaces were additionally eroded (among others, the fragmentarily preserved comb of ivory). Nevertheless, the state of preservation of the artefacts did not influence the analysis conducted or the identification of the observed technological and functional traces.

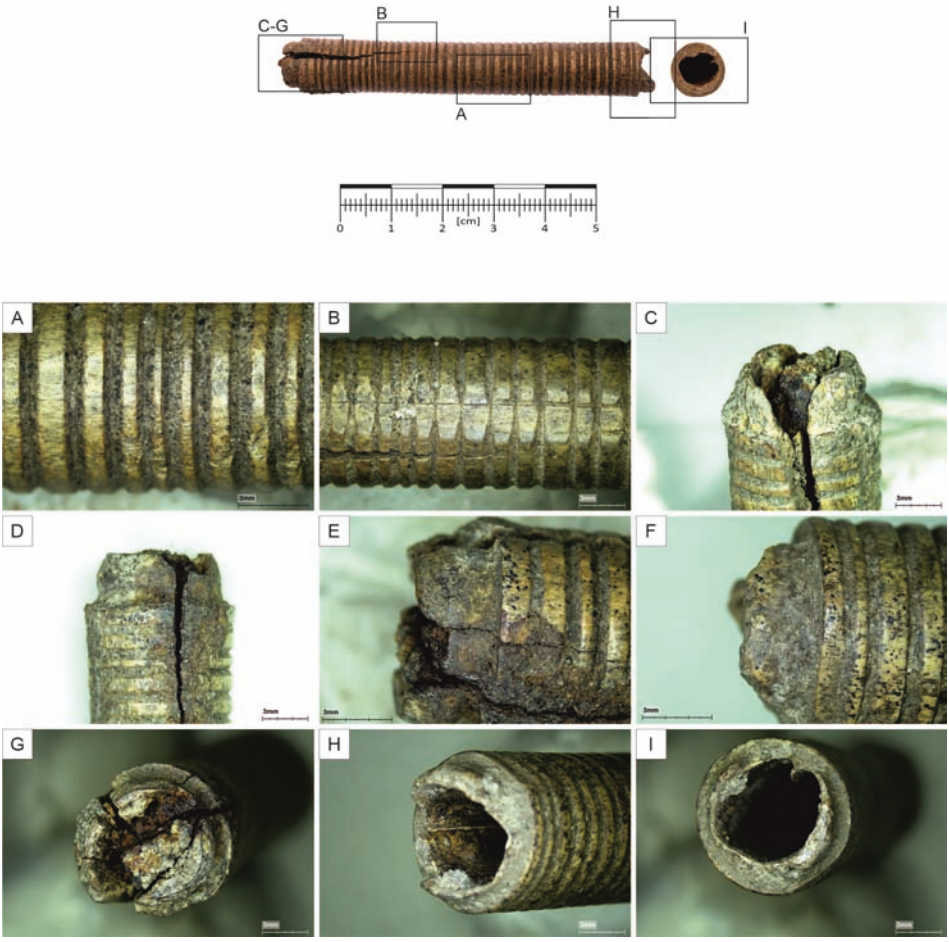


Fig. 3. Top: analysed sleeve with marked sites of microphotographs taken. Bottom: examples of the technological traces discovered on the artefact

Sleeve

The object was made using a small, long bone with a preserved empty medullary cavity. The entire outer surface of the artefact is covered with omnidirectional V-shaped depressions about 1 mm wide and less than 0.3mm deep at intervals of about 1-1.5 mm (Fig. 3: A, B). The observed traces are well preserved and have a readable inner linearity that runs along the side walls of the discussed depressions. These traces were made with a lathe-like tool. The entire surface in question has been smoothed, with the edges of spinning slightly rounded and polished. The visible polished, smooth surface could be caused by both the intentional working process and the use of the object (handling, transport). Inside one of the ends of the item, there are preserved remains of corroded iron (Fig. 3: C, D, E, G). This part of the artefact is also cracked. The opposite end of the object is empty inside, while its interior is the natural structure of a bone marrow cavity (Fig. 3: H, I).

Antler knife handle

The handle comprises two pre-worked fragments of antler, interlocked (Fig. 4: A) and fixed together with three metal rivets about 2mm wide (Fig. 4: B). Originally, between the antler pieces, there likely was the tang of the knife whose corroded remains are well-readable at about two-thirds of the length of the artefact (from the blade side). The entire object was meticulously crafted. Importantly, traces visible on the surfaces of the artefact prove that it was given its final form after the discussed components had been combined in one – here, traces of whittling are preserved, which was done to distinguish an edge protruding subtly at the base of the specimen (Fig. 4: C), and also right by the blade (Fig. 4: A). This treatment resulted in, among other things, subtle undulating nature of the surface in that area and poorly-preserved remains of incisions. Next, the specimen was scraped over. The remains of this treatment are preserved in several areas (Fig. 4: G, H), though they are best-readable on the bottom of the handle. Aside from the traces of whittling and scraping, the surface of the artefact bears clearly-legible, subtle V- and U-shaped cuts (Fig. 4: I). These traces are best visible on the lateral surfaces of the handle, closer to the base. These are most likely traces left by the use of a metal file. Likewise, the hole visible by the base of the specimen was made when the handle scales had already been attached with rivets (Fig. 4: D, E). Importantly, inside this hole, there is a well-visible mistake made by the craftsman during the drilling, namely, the lack of overlapping of the drilled perforations, which is evident at one of their ends (Fig. 4: F). Between the rivets, there are visible cuts, made intentionally albeit quite carelessly, oriented perpendicularly to the long axis of the artefact (Fig. 4: J, K L). The tip of the protruding edge seen at the base is clearly rounded (Fig. 4: M) and polished, which suggests that this part of the object was in contact with a soft material. The polish is accompanied by delicate multidirectional and also more parallel striations that run along the axis of the product (Fig. 4: N).

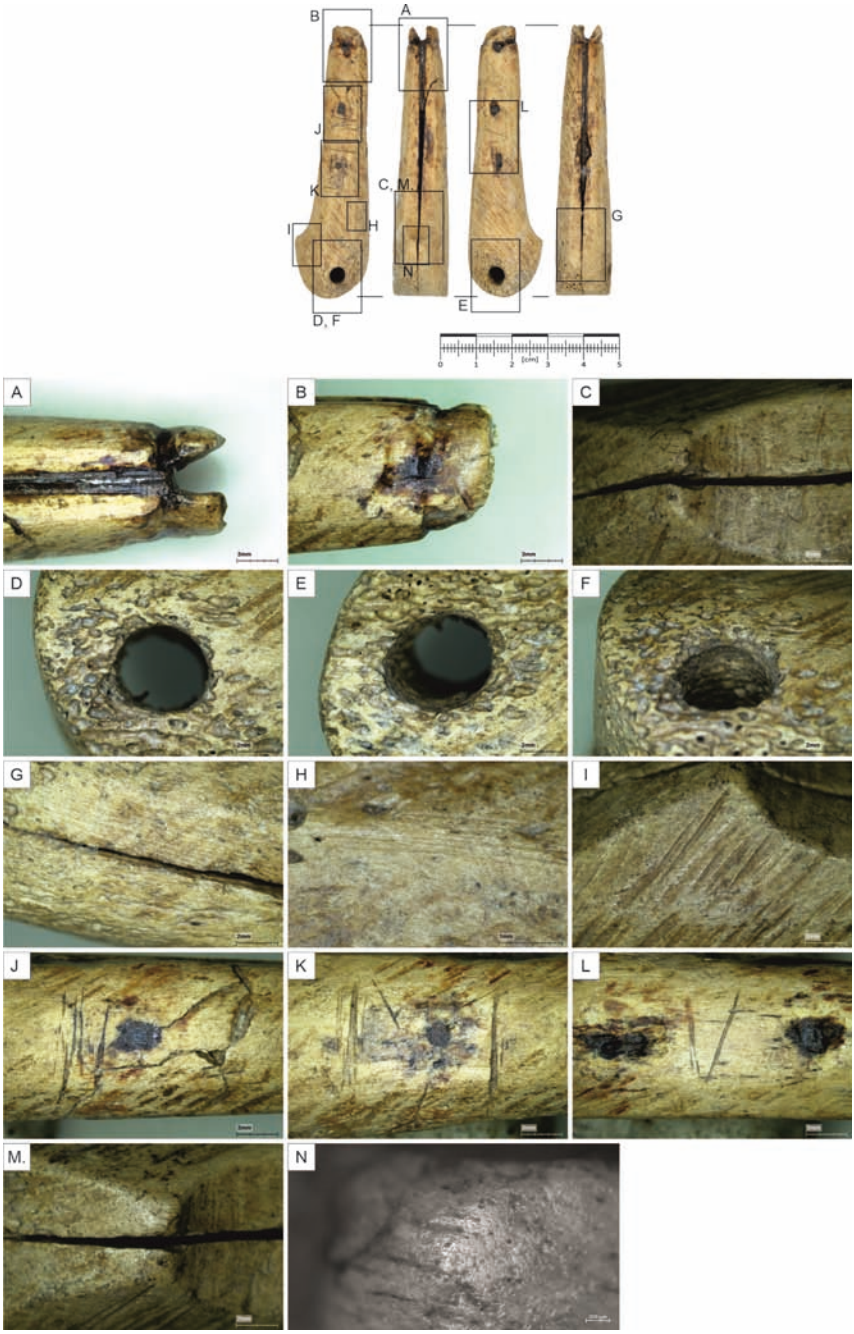


Fig. 4. Top: Osseous knife haft with sites of microphotographs taken marked. Bottom: examples of the technological (A-M) and use-wear (N) traces discovered on the artefact

Gaming piece

The artefact subjected to analysis was made with much care to detail. Right by the lateral edges of the item, in some areas, there are well-readable traces of cutting the gaming piece out of a bone (Fig. 5: A). The edges of the object on the upper side were emphasised all around with a carved straight line 0.5mm wide (Fig. 5: B, C). These lines have a square cross-section and are about 0.5mm deep. Inside the cuts, there are linear traces visible (Fig.5B). By the corners of the gaming piece, in areas where the carved lines cross one another, one can notice which line is secondary to another (Fig. 5: C). On this item one can distinguish four distinctive, trapezoidal walls. On each of them, four circular marks were drilled, about 1mm in diameter (Fig. 5: D). The visible 'pips' have straight inner walls and seem to comprise two levels. The drill used for making them must have been flat and come with a type of a pre-blade, resulting in this cross-section of the pips. On one of the walls, next to a group of four pips, there is a visible trace after a subtly initiated drilling that was then stopped (Fig. 5: E). The surfaces that constitute the upper planes of the specimen are heavily smoothed. In some areas, one can see remains of the preliminary shaping of the object, most likely by means of sawing or whittling the bone surface off. Nonetheless, these traces are poorly legible, as they have been almost entirely destroyed by polishing (Fig. 5: E, G). Despite the polish, some areas show readable traces related to the forming of the square tip of the gaming piece with one central pip (Fig. 5: F). The bottom side of the gaming piece is flat. It is worth noting that the polish seen on the upper part of the specimen varies significantly from the polish observed on the bottom side. The former is flat and bright. It is accompanied by a series of multidirectional, subtle linear traces. There are also well-readable micro-pits (Fig. 5: H). As for the bottom side, the situation is different – the entire surface seems ragged, cut with deep, multidirectional striations. The polish is more matt and covers only the upper surfaces of the bone (Fig. 5: I).

Cubic dice

The analysed dice have six flat rectangular faces with carved-out marks in the system of 7. The edges and the corners of the cube are rounded. The entire surface of this object is smooth and polished (Fig. 6: A-F). The mentioned 'pips' are about 1 mm in diameter each. They are slightly conical in cross-section (Fig. 6: H). In some cases, the pips show a well-readable inner structure (Fig. 6: G), which allows one to distinguish a deeper central point, a slight bump, and, again, a circumferential depression immediately next to the wall of the pip. The morphology of the drilled marks is consistent with the 'pip motif'. The pips are made scrupulously, though if they appear on a face of the dice in a higher number, some lack of manufacturing precision can be noticed, which shows as an asymmetrical arrangement of the pips to one another, as in the case of the central pip on the face bearing five drilled marks (Fig. 6: E), or differences in their depth, which in some cases compromises

the readability of the applied type of drill (Fig.6: I). The polish visible on the surface of the dice is flat, bright, with multi-directional linear traces (Fig. 6: K). In the case of the polish observed on the corners of the dice (Fig. 6: J, L), it seems more matt.

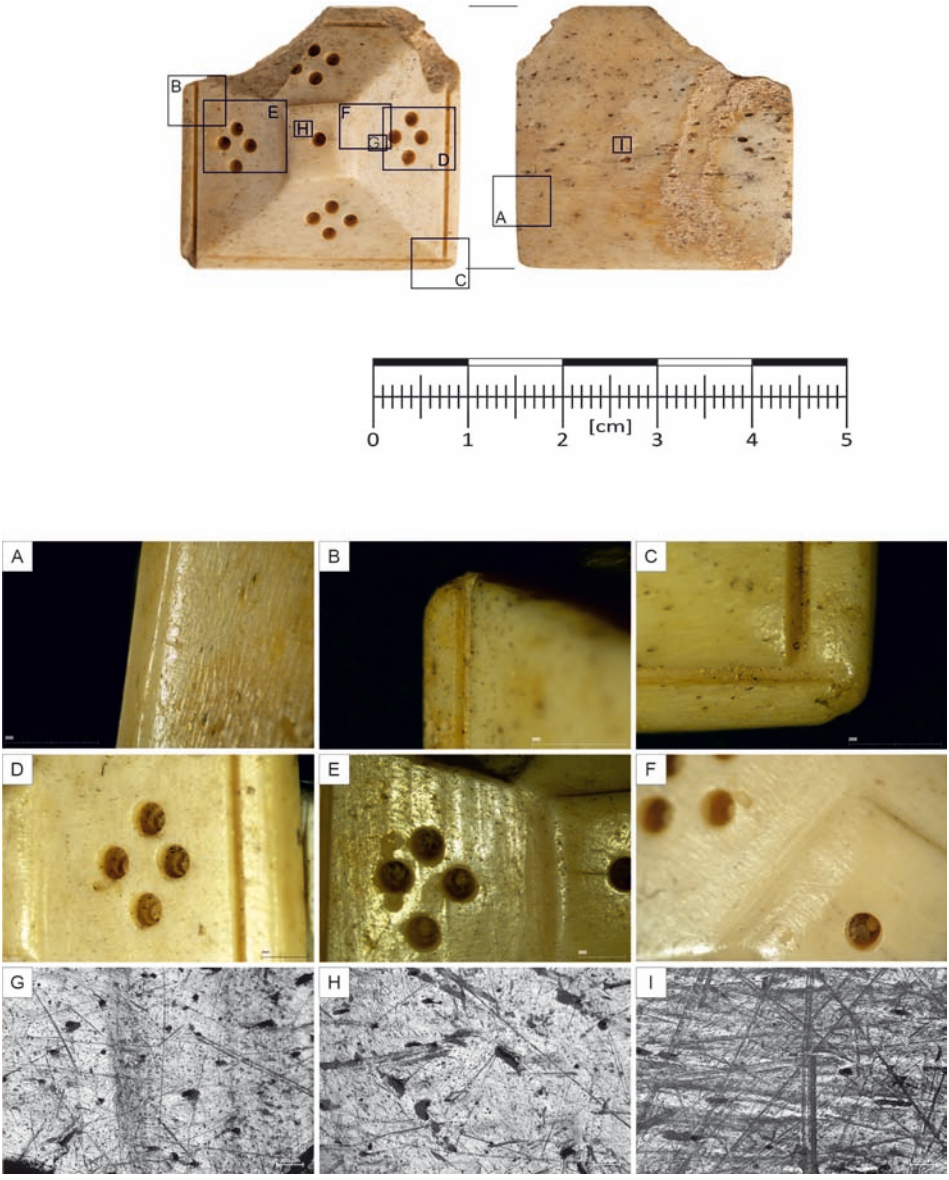


Fig. 5. Top: gaming piece with sites of microphotographs taken marked.
Bottom: examples of the technological (A-F) and use-wear (G-I) traces discovered on the artefact

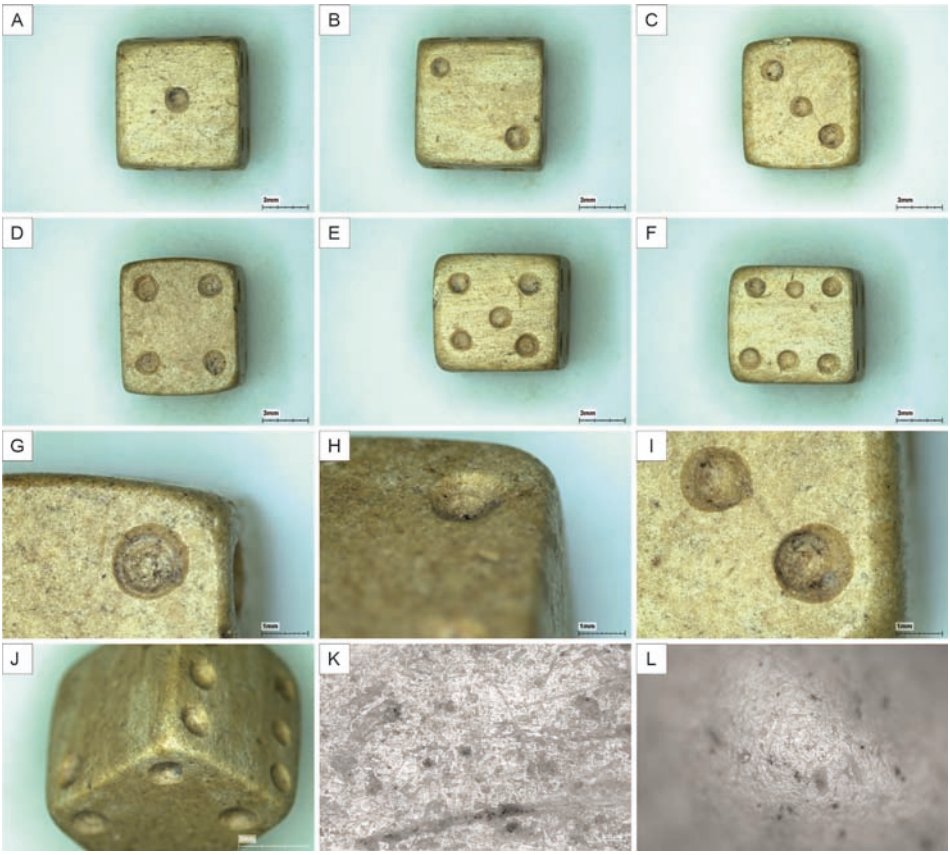


Fig. 6. Cubic dice.
Examples of the technological (A-J) and use-wear (K, L) traces discovered on the artefact

Single-layered comb

The presented object is the most poorly-preserved one of all the analysed items. On its highly eroded surface, traces related to the preliminary working of the bone plate that serves as the basis for the comb were identified. In this case, the preserved damage occurred in the form of parallel linear streaks of various widths, running at a small angle across the entire length of the preserved object (Fig. 7: A, B). These traces are most likely related to cutting a plate of a desired thickness out of a bigger fragment of osseous material with a metal saw. The surface of the object is adorned on two sides with longitudinal carved lines (Fig. 7: A). Additionally, though most of the teeth were destroyed, the comb still bears traces of preliminary sawing of the plate using a saw about 0.3 mm wide, in order to form individual teeth (Fig. 7: C). As mentioned in the part that presents the artefact,

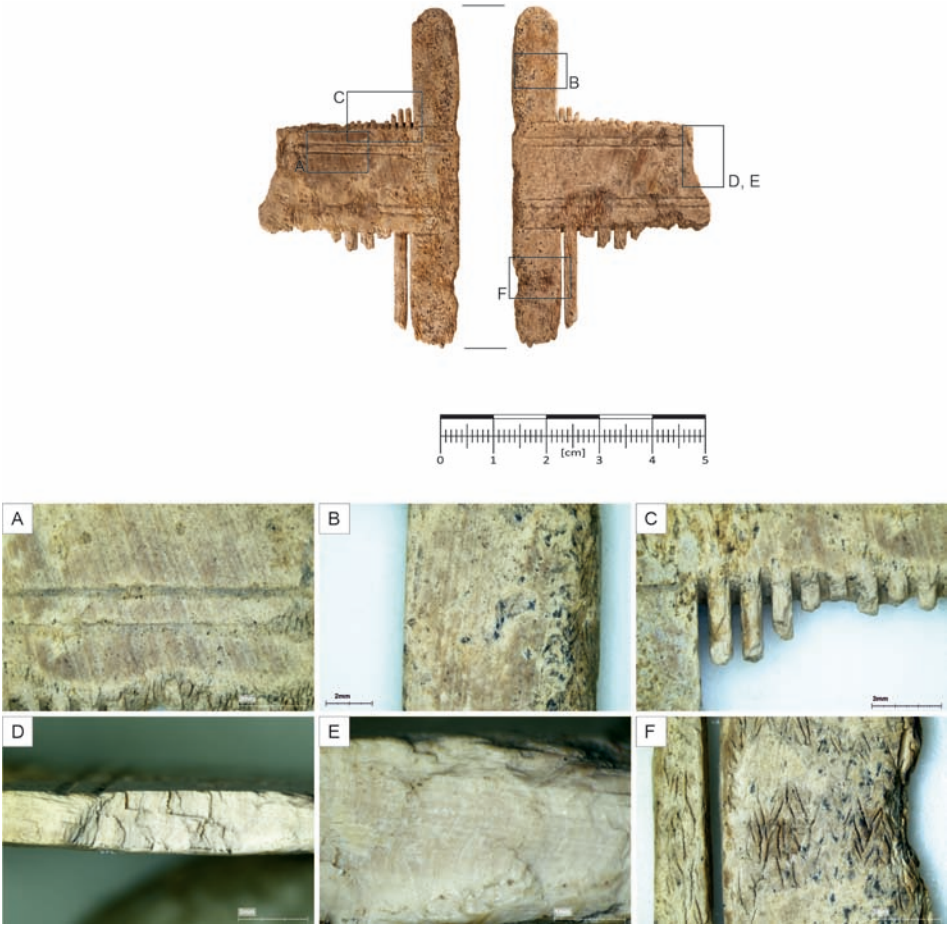


Fig. 7. Top: single-layer comb with sites of microphotographs taken marked.
Bottom: examples of the technological (A-C) traces discovered on the artefact and close-ups of the details of the tusk structure (D-F)

it was most likely made of elephant ivory. Figs. 7: D and E show delamination typical of this raw material, whereas Fig. 7: F presents characteristic cracking and relief referred to as the feather pattern.

Double-sided comb, triple-layered

The profile of the analysed comb clearly shows that it is composed of three bone plates (Fig. 8: A). The entire surface of the central plate was meticulously ground (Fig. 8: B). Traces of this procedure are readable in the form of a series of striations that cross one

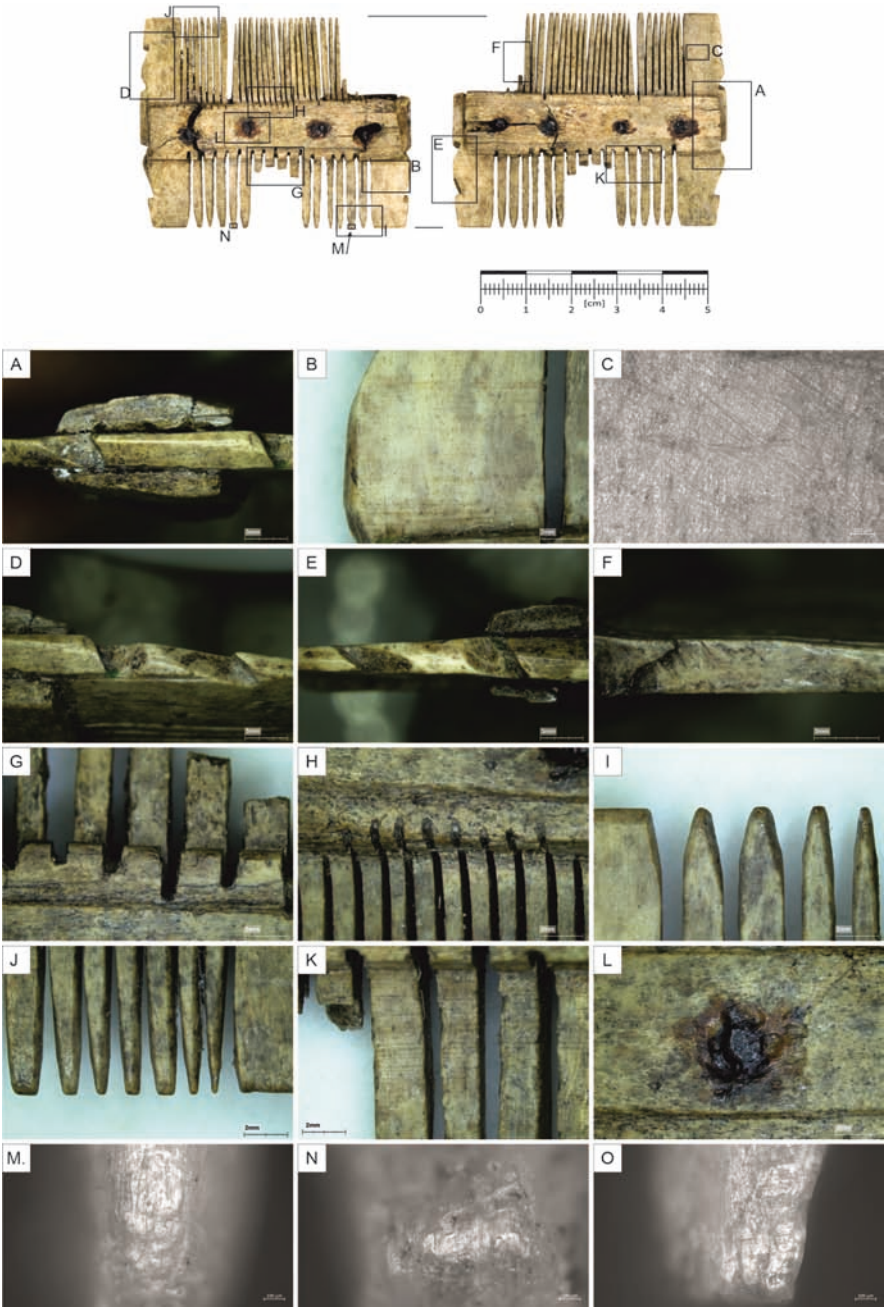


Fig. 8. Top: double-sided comb, triple-layered with sites of microphotographs taken marked. Bottom: examples of the technological (A-L) and use-wear (M, N) traces discovered on the artefact and the use-wear traces formed on an experimental antler comb used for combing hair (O)

another almost perpendicularly (Fig. 8: C). On both lateral edges, the large plate was adorned with three cuts (Fig. 8: D, E) made by pre-sawing of the mentioned edges at a small angle. Traces of this procedure are well-readable as a series of linear streaks that run parallel to one another. On one side of the large central plate, 15 thick teeth were cut with a significant spacing, whereas on the opposite side, 30 thin ones were made, situated close to one another. They were formed by means of pre-sawing of the osseous plate that constitutes the central element of the comb at a small angle (Fig. 8: F). Importantly, the mentioned sawing was done at the moment when all the three elements of the comb had already been fixed to one another. This is evidenced by the pre-sawing of the cladding seen on each side of the object (Fig. 8: G, H). The ends of individual teeth (on both sides of the comb) were additionally filed, making their ends sharper (Fig. 8: I, J). The surfaces of the teeth were additionally ground and scraped near the cladding (Fig. 8: K). The entire three-piece structure was fixed together using four iron rivets 3-4 mm in diameter (Fig. 8: L). The ends of the teeth in the analysed comb are highly rounded and polished. The analysis of the use-wear traces of this item has shown that the observed polish is best developed on the tips of the teeth and that the degree of the polish is marginal (about 4 – 6 mm). The observed use-wear traces are greasy and cover the surface, while their topography is relatively flat. The polish is accompanied by a series of striations parallel to one another, oriented along the long axis of the teeth (Fig. 8: M, N). These traces were compared to the use-wear traces formed on an experimental antler comb used for combing hair and proved identical (Fig. 8: O).

Flat decorated osseous plate

The plate subjected to the analysis is of a small size, made of a thin bone. It is rectangular in shape with rounded corners and is richly ornamented on one side. The other side, which was originally the inner surface of the bone, was only ground. The item has an intentionally made perforation (Fig. 9). On the lateral edges of the object, there are preserved traces of sanding (Fig. 9: A). The perforation made in the plate is irregular (about 4mm in diameter). Its outline obliterates the decoration seen on the plate surface; it was made after the ornament was formed. A visible series of chips in the bone, fine and flat, on both sides of the perforation suggest that it was widened on both sides (Fig. 9: B, C). Within the perforation area, traces were observed in the form of a surface smoothing and rounding of its edges focused closer to the plate edge; it occurs on both sides of the object (Fig. 9: D). The analysis of the visible smoothing made using a metallographic microscope confirmed the presence of a well-developed polish of a smooth topography (Fig. 9: E) accompanied by a series of fine, multidirectional linear traces. The morphology of the observed polish suggests that a string made of a soft material was threaded through the perforation; this could have been a leather thong. The upper surface of the pendant (covered with the ornament) is flat and slightly polished, with numerous legible, omnidirectional

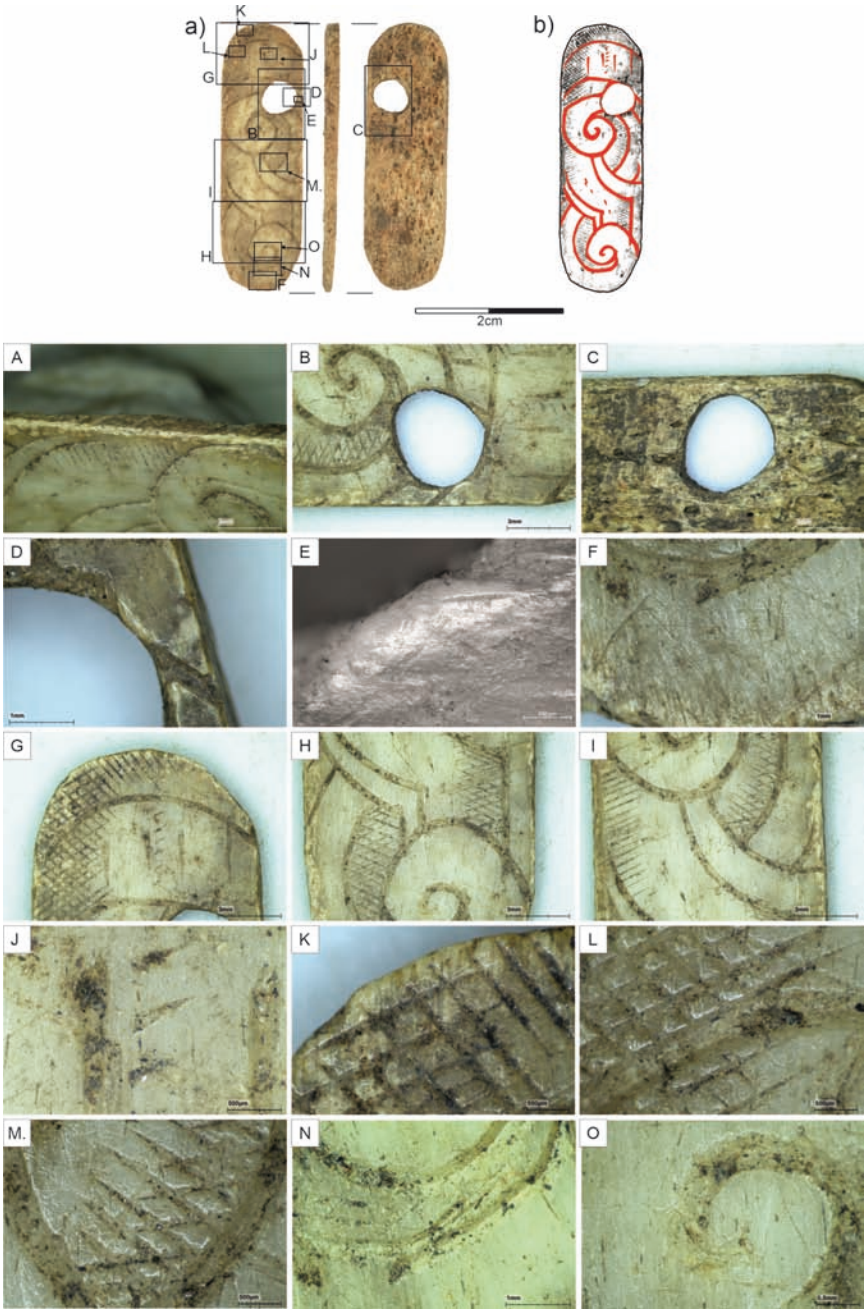


Fig. 9. Top: flat ornamented plate with sites of microphotographs taken marked (a), and schematic representation of the floral ornament visible on the artefacts (b). Bottom: examples of the technological (A-D, F-O) and use-wear (E) traces discovered on the artefact

striations (Fig. 9: F). These traces can be partly related to the sanding and polishing of this part of the object.

As mentioned, the artefact is covered with a rich ornament. Here, one can distinguish two basic motifs (Fig. 9: G-I), namely, a series of fine cuts that are a type of hatching (Fig. 9: b) – the motif marked in black) and distinctive, unquestionably wider and deeper lines (Fig. 9: b) – the motif marked in red), along with accompanying short incisions in the shape of an elongated, acute-angled triangle (Fig. 9: J). In many areas, the incisions that are part of the hatching start at a close distance to the edge of the plate (Fig. 9: K), whereas others seem to be continued further. It is difficult to unequivocally state what the sequence in which specific elements of the decoration were made was. However, it seems that the ornament made of the wider lines was formed once the hatching had been made. This is supported by the fact that the lines that form it cross the mentioned hatching, obliterating its elements (Fig. 9: L, M). Despite the high precision with which the entire object was crafted, in some areas, one can notice traces suggesting that it was necessary to correct specific lines of the ornament (Fig. 9: N, O). As for the lines that form the hatching, they are V-shaped in cross-section, whereas the lines that form the motif made up of wider incisions are more U-shaped.

5. DISCUSSION

The results of the conducted traceological analyses allow the reconstruction, at least to some extent, of the technological procedures carried out in the course of the manufacturing of the items made of osseous materials found during the archaeological-architectural studies conducted around the church of St James in Toruń. Due to the high degree to which the bone raw material was processed, it has been impossible to recreate in a fully reliable manner the initial manufacturing stages, that is, the stage in which blanks were obtained and later formed into the end products. The very process of making the analysed items seems standardised and consistent with the bone-working techniques known from other late medieval or modern contexts in Poland (*e.g.,* Jaworski 2012).

The technological traces observed on the first of the analysed artefacts (the sleeve) confirm the use of foot-powered (treadle) lathes for working bone. The cuts made on the sleeve were intended, most likely, to prevent it from sliding out of one's hand. Its intense use as a handle is evidenced by the highly developed polish and the rounding of the entire surface. The metal fragment preserved inside of the sleeve suggests that it was a shaft for fixing the metal shaft of a small tool or utensil such as a knife, a burin, a two-pronged fork, a spoon for cleaning the ears, or various implements employed by a barber or a surgeon.

Sleeve-shaped lathe-turned handles are rarely found and published. In Wrocław, in the 11th-13thcentury, they were made of antler and used as burin handles (Jaworski 1999). In the 13thcentury, smooth sleeves of unidentified purpose (8.5 cm long) were used in Elbląg

within a tenement house area. In the years 1346 – 1516, narrow, sleeve-shaped handles with grooves were known in the area of the butcher's shambles in Gdańsk as handles of small knives (1.5 – 1.8 cm in diameter, handle length of 8.5-10.5 cm; Marcinkowski 2003, 332, fig. 1-5; Kasprzak 2018, 458, fig. 5 – 3462, 3499; Trawicka 2018, fig.11-3257).

The traces of treatments preserved on the scales of the antler knife handle performed in the course of forming the product in question are evidence of the complex nature of the entire process. This object was made using two longitudinal osseous plates cut with a metal saw out of a compact inner layer of antler. The two parts of the cladding were fixed together, with the flat surfaces facing each other. Once the perforations had been done, both parts of the cladding and the shaft were fixed together using three iron rivets by putting them in the front half of the handle and flattening them out, perhaps on an anvil. The technological traces observed on the surface of the artefact prove that it was given its final shape after the mentioned elements were fixed together. The handle of the object was profiled on the bottom side by cutting it off with a sharp knife, whereas on the end part of the shaft, a perforation was drilled, 5 mm in diameter (drilled on both sides, with the drilling that was shallower visibly offset in relation to the deeper one). Additionally, on the lateral surfaces of the haft, closer to the base, a series of parallel V- and U-shaped cuts were observed. It is difficult to determine unequivocally whether they are remains of previous technological procedures, such as the use of a metal file intending to form both elements of the haft, or whether it is a treatment intended to 'beautify' the object. Apart from the fact that the entire surface of the haft is smoothed, it was observed that the tip of the protruding edge visible at the base is noticeably rounded and polished. The damage observed on its surface is most likely a result of the object being held in the user's hand or being in contact with a leather sheath. Most likely, the handle was part of a kitchen/personal knife carried on a string or leather thong, which was suspended from something. The cut from the bottom side is characteristic of kitchen knives, as it prevents the object from sliding out of the user's hand. Such forms were universal, serving for cutting and chopping.

Similar knife handles, additionally adorned with an ornament consisting of pips, are known from Toruń from the period after the demolition of the castle of the Teutonic Knights in 1454 (Chudziakowa and Kola 1974, 110, table 32: 13, 66). It is likely that such knives were used in Toruń in the 14th century and in the first half of the 15th century before the demolition of the castle. In Gdańsk and Elbląg, knives of this kind (7-9, 12 cm long, blade from 10 to 15 mm wide), meticulously crafted, with ornamented handles, made of bone, antler, or wood, were associated with personal knives or table knives and used from the end of the 14th century to the mid-16th century (such forms of shafts have not been observed in early medieval layers, see Norska-Gulkowa 1985, 265-276). In the Netherlands, they were known in the first half of the 17th century. Similar, yet much longer knives (10-12 cm) were used in the Middle Ages in the castle in Puck, referred to as kitchen knives (Marcinkowski 2003, 333, fig. 1-6; Michalik 2007, 56-58, fig. 7: 5, 8: 3; Gomoliszek 2016, 391-393, 435-440; knives no. 44, 46, 49; Rembisz-Lubiejewska 2021, 358, cat. 93, 95).

The square gaming piece was cut out of a bone plate, probably using a metal saw. The next step was cutting the redundant material off at a small angle and obtaining the form of a truncated pyramid. On each trapezoidal side wall, four circular marks were made with a compass and on the top one, which is rectangular, only one was made. Along the base of the gaming piece, four lines were carved separately along each of the four edges. The entire object was smoothed and polished. In the course of the microscopic observation, a significant difference was noticed between the traces visible on the upper side of the gaming piece and those seen on this base. The damage on the lower side clearly shows that the gaming piece was in contact with a hard surface and was moved, which suggests it was used.

Analogous gaming pieces with rectangular bases served for playing board games in both medieval times and the modern era. Some of them were perforated, most likely so that they could be hung on a string or thong. In Gniewkowo near Toruń, in the second half of the 16th century, a gaming piece of this kind, with a perforation, probably made in a specialist workshop, was used in the premises of what was likely an inn – a wooden house heated with a ceramic stove. In Opole, Wrocław, the Czech Republic, in various castles, in tenement houses of Elbląg and Lidzbark Warmiński, such pyramidal gaming pieces were used in the mid-12th century, yet more often in the 13th-15th century (Norska-Gulkowa 1985, 256, fig. 13; Konczewska 2010, 249-252; Nawrolska 2014, 189, fig. 178; Koperkiewicz 2014, Fig. 3: 1i; Sulkowska-Tuszyńska 2018, 126, cat. 82, 84). These kinds of artefacts are sometimes interpreted as chess pieces moved on the board or pawns used for board games. The different numbers of cut marks and pips, as well as the lines made them diverse and were related to the rules of a given game (Borkowski 1995, 102).

Interesting observations were made owing to the analysis of the cubic dice. These small items were usually made of the metatarsal bones of cattle, less often of antler, amber, or glass. After cutting out square-shaped strips with a hand plane or a saw, most likely, only a higher number of pips were marked on their faces since it was easier to form the marks on a wall of a strip using a vice. It was only after a strip had been cut into smaller cubes that single pips were added onto the walls of the dice. The pips were marked in various ways depending on the applied tool which left different traces. On the dice from Toruń, they were likely made using a metal compass. This is evidenced by the presence of a deeper central point in each of the pips, followed by a subtle bulge and, further to the outside, an omnidirectional depression close to the wall of the perforation. The origin of the visible smoothing and polish on the surface of the dice is difficult to interpret clearly – it might be caused by overlapping traces of intentional polishing of the object, or due to the way in which it was stored, as well as polish caused when it was used.

Tiny cubic dice (sporadically 5-6 mm large, usually 7-15 mm large) were highly popular in the Middle Ages. They were marked using various systems. Aside from the system of 7 (the sum of pips on the opposite faces was 7), in Hanseatic cities, including Elbląg and Kołobrzeg, dice were made using the North European marking system where the sums of pipes were 11-7-3 (Rębkowski 1997, 238-239; Nawrolska 2014, 290, fig. 292). They served

solely for starting board games or, alternatively, the dice alone were used in a game. Cubic dice are known from many cities and suburban areas, from gathering places, and in the premises of private property; they were used in inns, hospitals, and lost at cemeteries. They were unearthed on passageways, squares, and city streets. In Toruń, such dice were found near the church of St James in hospital premises (unpublished) and the suburbia of Chełmno (the cemetery by the church of Saint Lawrence, a group burial of seven people dating from the second half of the 16thcentury to the 17thcentury), where a dice with a metal ring were considered grave goods. In Gniewkowo near Toruń, a tiny die (7 mm) was lost in an inn (second half of the 15thcentury – the 15th/16thcentury), while in Lidzbark Warmiński, a quite large (20 mm) ceramic dice was lost (?) by someone close to the town hall (Górzyńska *et al.* 2011, 27, fig. 12: c; Koperkiewicz 2014, 94, fig. 3: 1e; Sulkowska-Tuszyńska 2018, 126-127, cat. no. 83). Cubic dice were found in Pomerania, Masovia, from Greater Poland to Lesser Poland and Silesia; from Wolin, Kołobrzeg, Słupsk, Gdańsk, and Elbląg, through Toruń, Sandomierz, Racibórz, all the way to Nysa, Bardo, Opole, Krakow, and other cities. In Wrocław, over ten of these objects have been unearthed in various areas of the city, the majority of which were found in layers from the 13th- 14thcentury. In some cases, they were accompanied by production rejects that serve as evidence that they were made locally. They were manufactured for one's personal use and at workshops; older ones were made more often of antler, while later ones – of cattle bones. The oldest cubic dice in Silesia are dated to the turn of the 11thcentury. The most numerous dice identified in various regions come from the 12th-14thcentury. Cuboidal dice are interpreted as counterfeits. Since the 16thcentury, dice were losing popularity in favour of card games, yet in some cities, they were still in use in the 18thcentury and even after that (Borkowski 1999, 187; Adamczyk 2009, 85, fig. 5; Konczewska 2010, 247-249; Fonferek *et al.* 2012, photo no. 74; Romanowicz 2013, 216-217, fig. 1; Kołyszko 2014, 168, fig. 164; Nawrolska 2014, 290, fig. 292; Gomułka 2018, 1027-1030).

Of the two analysed combs, one specimen is single-piece but double-sided. Combs of this type were made of different raw materials – antler, domesticated cattle horn sheath, or the plantar wall of cattle metatarsal bones (Jaworski 2012), and also from ivory (Chmielowska 1971, 87). The analysed comb is preserved fragmentarily. The way in which it was manufactured is most likely consistent with the techniques applied in medieval craftsmen's workshops (*e.g.,* Chmielowska 1971, 28-32). Despite its compact form, the presented comb is a unique specimen due to the material of which it was made. It was made of ivory, that is, a raw material that was hard to access even in the modern era and, most likely, expensive. Combs made of ivory were used mainly in the 5th -12th century in the area of the elite European centres of that time, from Sweden to North Africa and the coast of the Black Sea. And again, from the 14-15th century onwards, when elephant ivory became accessible again with transmission from Flanders and French merchants. One comb of this type, made of ivory and richly ornamented, single-layered yet one-sided, was found in Poland, in Ostrów Lednicki, close to Poznań, in an old residence of the first Piast rulers,

next to a wooden church, where it was most likely used in the mid-11th century (Górecki 2000,13, 41). The area closest to Poland, where such combs were used was in Czechia in the 10th century and in Lund, Sweden. In the modern period, during the 17th and 18th centuries, the production of ivory combs was noted in many places in Europe. Amsterdam was a centre for the production of such combs, and it served as a training ground for their craftsmen. The production, which flourished from the 16th to the 18th century, began to decline after this period (Rijkelijkhuizen 2009, fig. 6, 8). These modern combs were typically not as elaborately decorated as those from the medieval period. Combs made of ivory, similar to the one found in Toruń, were used in the modern period, for example, in the castles in Latvia (Āboltiņš 2019, fig. II-2) and in elite circles in Lithuania (Luik *et al.* 2018). The artefact found in Toruń confirms the widespread use of ivory as a material in various European regions, especially in the 17th and 18th centuries. Richly ornamented ivory combs, referred to as liturgical combs, were used prior to the commencement of a liturgy, near the *sacrum,* when a priest was cleansing himself spiritually, which involved cleansing the mind and the hair by combing it (Chmielowska 1971, 87). The comb from Toruń was deposited by the chancel, about 30 m away from the sacristy, between graves. Aside from the specific material of ivory, this artefact is not similar to early medieval liturgical combs. It cannot be ruled out, however, that before the commencement of the Holy Mass, a priest was using such a comb.

The other of the analysed combs is a double-sided, triple-layered type. In such combs, the basic material was deer antler and the metatarsal and metacarpal bones of cattle. In Poland, antler working developed in the early medieval times, particularly in Pomerania (see Cnotliwy 1973). The process of making the analysed comb was more complex than in the case of the single-piece specimen. The starting point for the craftsman was obtaining proper semi-finished products in the form of antler plates. Such plates were usually obtained as a result of dividing (by means of sawing) the antler into sections of a proper size, removing the *spongiosa* (the spongy inner part of the antler) and dividing it further into pieces of a proper size. The technological traces observed on the comb prove that the surface of each plate was meticulously ground. Then, the plates were fitted and fixed to one another with iron rivets. The next step was to cut the teeth using a metal saw. The traces identified on the ends of the teeth prove that the comb was used for grooming hair.

Analogies for the comb unearthed in the church of St James in Toruń are provided by, among others, triple-layered combs known from Elbląg and Kołobrzeg, which, likewise, had profiled sides. Albeit not common, this feature was known at the end of the 13th century until the beginning of the 15th century. In Gdańsk, such combs with a pit ornament were used in the butcher's shambles in the 13th-14th centuries. Undecorated, triple-layered combs fixed with rivets were known in the monastery in Strzelin in the late medieval period. Wooden combs replaced combs of osseous materials in the modern era (Marcinkowski 2004, 500-505, fig. 1.1. and fig. 3-4; Wywrot-Wyszkowska 2016, table 57-22; fig. 31-6; Kasprzak 2018, 458, fig. 5; Sulkowska-Tuszyńska 2018, 127, catalogue – no. 85, p. 193; Marciniak-Kajzer 2020, 366-368).

The last analysed object, the small osseous plate with ornament is characterised by highly meticulous craftsmanship. The ornament visible on the surface was made with a sharp metal tool used for the gradual cutting of the plate surface. In many areas, traces were noticed that evidence a necessary correction of the lines of the ornament. Due to the high precision and the details, the visible ornament was most likely made using a magnifying glass. The perforation made in the plate seems inconsistent with the precision and the orderly nature that characterises this product. Microscopic analysis has shown that it was formed after the ornament had been made, as it partly obliterated the latter. However, what is more important, on the edges of the perforation, a use-wear polish was observed, the morphology of which suggests that a string made of a soft material, probably a leather thong, was threaded through it. It seems that the object itself could have originally served as a subtle cladding of some flat surface, which, after ending up as a single plate, was reused as a pendant of some sort (a talisman?) due to the excellent artistry. The beautiful decoration on this small plate could have evoked the desire to own it and keep it close.

A close relationship regarding the style of decoration visible on the plate is evident in art from the turn of the 17th century to about the year 1630, among other examples in the sacral art of Kraków, such as the fashionable ferrule ornament with a Moresque design (Czyżewski and Walczak 2022, 80-89, 177, 183, 196-200, fig. 47-51, 143, 146, 148-155).

Nevertheless, small plates made of materials such as bone or mother-of-pearl were also used to decorate hand firearms. Some military muskets were richly adorned with bone plates. In the collection of the District Museum in Toruń (inventory number MT/B/279), there is a long musket, likely crafted in a gunsmith's workshop in Toruń in the second half of the 16th century. It is inlaid with a floral motif and covered with plates depicting half-figures under arcades. On the side of the stock, there are rectangular bone plates (5-6 × 1.2 cm) with an engraved pattern of diagonal mesh. Circular holes, typically asymmetrical to the plates' axis, with a diameter of 3-6 mm, were used to insert hooks connecting the barrel to the stock. On the barrel, on one side of the stock, there could be two to three such hooks, for which openings must have been made in the bone overlays. On firearms used in Polish territories, similar to the plate found in Toruń, there were overlays on the so-called "cieszynki" – wheel-lock rifles used in the first half of the 17th century, manufactured in Cieszyn and Toruń. Oval plates with a length of 3-4 cm adorned the stock and butt of Cieszyn rifles. Some hunting rifles were also decorated with small oval plates featuring a sinuous ornament (Kobielski 1975, 133, 134; Żygulski 1982, 286-287, fig. 320, 322; Skóra and Strzyż 2012, 291, 292, fig. 6). The resemblance to the "Toruń plate" can also be seen on bone overlays of short German wheel-lock pistols, referred to as "puffer," produced in the 1570s-1590s in Saxony and Thuringia (Schulz *et al.* 2009, 20, 21, 28, 29). Bone overlays with holes for hooks, decorating rifles and short pistols (puffers), were crafted in specialised gunsmith's workshops, such as those in Stralsund, in the second half of the 16th century (Radohs and Ansorge 2014, 194, 195). Similar motifs are found on wheel-lock pistols, including puffer-type pistols, used during military conflicts in the second half of the 16th

century and the 17th century in Latvia and Estonia (Haak and Rannamäe 2012, 311, 313, fig.15-1-4; Āboltiņš 2022, 174, fig. 12; 189, fig. VI-10).

The described ornamented plate from Toruń was found in a layer between graves on the former cemetery before a narrow corridor connecting the church with the monastery, which was built in this place soon after 1667. The cemetery itself was located close to numerous roads leading from the northern suburbs to the Vistula riverside and from the west towards the east to the Old Town. Here, Toruń residents would lose various items, coins, decorations, game accessories, and even stone cannonballs driven into the ground next to the chancel. Therefore, it seems highly likely that the tiny plate adorned some musket or other firearm, perhaps used during the Swedish aggression on Toruń in 1629. It might have detached from a pistol during the fights with Swedish musketeers, who were storming the city gates from the north (Dybaś 1994, 146-151), near the church of St. James. Over time, it became a pendant. This is just one of many possible suggestions.

CONCLUSIONS

The conducted studies are the first traceological analysis carried out in such detail of osseous objects unearthed in the course of archaeological-architectural analyses carried out in the surrounding of the church of Saint James in Toruń. Owing to the conducted analyses, it was possible to identify many significant traces related to the ways in which the analysed items were produced, and, more importantly, in some cases, it was possible to confirm that they had been used. The dice, the gaming piece, the knife, the sleeve, the combs, and the ornamented pendant were used in the area of Toruń between the 14th and the 18thcenturies. Most likely, they were once lost, perhaps right after a game was finished or during a walk across the cemetery and, later, when the graves were being dug or filled, they ended up in the grave pits. It is unlikely that they were put inside the graves intentionally, though this possibility cannot be ruled out. These items show not only that such objects were in use in the area in question at the specified time, but they also evidence the level of craftsmanship and the use of osseous raw materials over the course of several hundred years. The game accessories show that there was a fondness for amusement and gambling, while everyday items speak to us through the marks left on them over time due to wear and tear. Following the conducted traceological studies, various activities and the tools used, as well as the context in which they were used, have been partly deciphered. It should be expected that further research in this respect will bring us even closer to various aspects of the life of late medieval and modern Toruń.

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REVIEWS AND SHORT REVIEW NOTES

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(Review) Janusz Kruk, Tomasz Oberc, Kathryn M. Hudson and Sarunas Milisauskas, *Neolithic Flint Technology at Bronocice (4th millennium BC)*. Kraków 2023: Institute of Archaeology and Ethnology. Polish Academy of Sciences, 314 pages, 33 tables, 55 figures, 37 plates, ISBN: 978-83-66463-78-3

The Neolithic site of Bronocice, situated on the western loess uplands of Małopolska, holds a particularly significant position on the archaeological map. Prior to the more recent commencement of research before highway construction, the spatial scope of investigations conducted there had no counterparts in post-war Polish archaeology (except for the sites in Olszanica and Iwanowice, which were examined as part of the same international project). As a result of excavations at this impressive site between 1974 and 1978, a vast array of diverse archaeological artefacts and ecofacts were obtained, along with information on the natural environment and both natural and anthropogenic transformations thereof.

The Neolithic site of Bronocice has been the subject of monographic publications, numerous papers, conference presentations, post-conference publications, and various commemorative works. Materials from Bronocice have served as the basis for studies dedicated to various aspects of the life and activities of Neolithic community, including economy, social organisation, demographic estimates, and various forms of human-environment interaction and their outcomes. The discovery of the depiction of a wagon on one of the vessels earned well-deserved international acclaim. Findings regarding the dating of the settlement in Bronocice serve as an important reference point for research into Neolithic chronology and cultural changes in the 4th and 3rd millennia BC.

The discussed work represents the long-awaited introduction of comprehensive information on the lithic industry of the Neolithic communities in the area into the scientific literature. It consists of several sections divided into unnumbered chapters and subchap-

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ters, totalling 314 pages. The core of the work focuses on the lithic industry of the Funnel Beaker Culture and the lithic industry of the Funnel Beaker-Baden phases. Complementing this are 32 tables, 43 figures embedded within the text (photographs of lithic artefacts, charts), and 37 plates featuring illustrations of archaeological material. The work is written in English, but concludes with a condensed version in Polish. An integral part of the book is the Appendix authored by Piotr Mączyński and Sarunas Milisauskas, entitled "The Results of the Functional Analysis of Flint Artifacts from the Fortified Settlement of Lublin-Volhynian Culture at Bronocice", accompanied by one table and 12 figures containing schematic drawings of lithic artefacts with marked locations of microscopic analyses and photographs of use traces.

Tables 16 and 17 serve as condensed databases of lithic artefacts from phases BR I-V, representing the Lublin-Volhynian Culture, Corded Ware Culture, and Trzciniec Culture. Table 16 contains information on 3634 artefacts, including their chronology, raw material, location details (specific section of the site where each artefact was discovered, object number, and depth), while Table 17 provides information on a significant (essential) set of 940 lithic materials. This includes typological classification, location, state of preservation, dimensions, cortex coverage (if applicable), weight, and, for end-scrapers, the angle of front inclination. Both tables are presented in two formats: printed, as a separate chapter, and digital, as MS Excel spreadsheets. As noted by the authors (p. 8), this facilitates the use of these materials and helps verify the findings presented in the book. Importantly, it greatly facilitates the comparison of lithic production data from Bronocice with materials from other sites.

The introduction to the main part of this book consists of two short chapters addressing the issues of the work and providing basic information about the Bronocice site. Subsequently, details are presented regarding the selection criteria for materials for analysis (excluding items with a diameter smaller than 1 centimetre) and the quantities of specimens discovered in various sections of the site (Table 3). Information is also provided on the number of lithic artefacts discovered in different sections of the site from successive phases of the Bronocice settlement (Table 4, 5, Fig. 4, including materials from the Lublin-Volhynian Culture, Corded Ware Culture, and Trzciniec Culture). Chronological and spatial contexts are analysed with respect to materials classified into four basic typological groups (pre-treatment, hammerstones, typological tools, blanks, debris, and atypical utility artefacts). The chronological assignment pertains to dating within phases BR I–BR V. Spatial contexts include: 'cellar', 'waste pit', 'other features', 'ditch', and 'burial'. Nearly half of the lithic materials come from two pits mainly containing waste from flint workshops. These inventories, from Features 2-Bd and 1-B8, are analysed separately. Such an organisational scheme is applied to describe materials from successive chronological phases of the settlement at Bronocice (Fig. 5; Tables 6, 7, 8, 9, 10). Additionally, the frequency of materials from various typological groups in features from phases BR I-BR V (excluding materials from Pits 2-Bd and 1-B8) is presented in Tables 11, 12, 13, 14, 15. An

important, albeit not extensive, part of the work consists of considerations regarding the utilised flint raw materials and their procurement locations. The authors highlight the fundamental importance of Jurassic flints from the central (Jurassic flint variety G) and southern parts of the Kraków-Częstochowa Upland, with significant variability observed in both groups. Complementing these are artefacts made from Świeciechów and Volhynian flints, while specimens made from radiolarite and obsidian are rare. The authors emphasise the difficulties in identifying the raw material components of the material, caused by factors such as patina or layers of calcite deposited on the surface during post-depositional processes.

A detailed discussion of lithic technology begins with a chapter featuring a typological analysis. The materials have been classified into two sets: the real set (actual), comprising 3624 artefacts (Table 16), and the essential set (943 artefacts, Table 17). These sets exclude materials from the workshops in Pits 2-Bd and 1-B8, which are discussed separately. The analyses are preceded by a presentation and justification of the assignment of materials to the first or second set, as well as a characterisation of specific forms (flake functional tools). The materials were analysed within several typological-technological groups, considering the context of artefact deposition, the raw materials they were made from, morphometric characteristics, and chronology. A similar analytical scheme was applied to all lithic artefacts from Bronocice. The first group includes pre-treatment types, pre-cores, cores, and axe roughouts. Splintered pieces, numerous at the Bronocice site (particularly during the Funnel Beaker-Baden phase), were analysed separately. Nearly half of the lithic artefacts are made from Jurassic flint variety G. According to the authors, the high frequency of this group of artefacts has practical justification. As they write (p. 40), "...the re-use of old tools was probably less trouble than trekking even the 50 km to the nearest Jurassic G sources".

The category of retouched tools encompasses all tools formed by retouching discovered at the Bronocice site. Individual types were analysed in the commonly used sequence in lithic material studies, including end-scrapers (numerous in Bronocice, mainly blade forms), burins, truncated blades, retouched blades, arrowheads (only seven specimens were discovered at the Bronocice settlement), perforators and claws, drills and blunt drills, side-scrapers and scrapers, notched and denticulated tools, multiple function tools, and undefined tools. Core tools were identified as a separate category, within which axes, chisels, and picks were placed. Graphic representations illustrate the size statistics of individual tool types in a clear manner (Figs 13, 14, 16, 18, 20). Spectacular pre-core and characteristic tools are presented in some excellently executed photographs (Figs 12, 15, 17, 19). Size categories of axes are included in Table 18, along with the frequency of axes made from different raw materials assigned to the successive chronological phases of Bronocice (Table 19). The next analysed group of lithic artefacts is represented by functional tools. Here, forms with and without retouch but with use-wear traces were classified and separately discussed, starting with flake forms and then blade forms. Chronological assignment, raw material characteristics, and information on the size of functional tools are

complemented by relevant tabular presentations. The typological analysis concludes with a discussion of tools and technical waste.

Special attention was given to the specific materials from two features with changing functions: Pit 2-Bd dated to phase BR III and Pit 1-B8 from phase BR IV. In both pits, materials from flint workshops located nearby were discovered, with 5763 specimens in the former and 3698 in the latter (these items were found not in their original deposition place, but in a secondary deposit). As noted by the authors, the possibilities for inference are limited, but it is possible to determine what was done in the workshops and what raw material was used. In the first pit, mainly remnants of production and repairs of four-sided axes made from Jurassic flint variety G were discovered, while the second pit features more diverse workshop material, also in terms of raw material, although items made from Jurassic flint variety G and waste from the production and repair of four-sided axes also dominate in Pit 1-B8. Tables 26, 27, 28 contain information on the distribution of materials within the fills, as well as typological and raw material characteristics.

The next part of the work concerns research on the function and use of lithic tools. Microscopic analysis was performed on 50 artefacts from phases BR I–BR V of the Bronocice settlement (Table 30), with 41 artefacts being assigned a function. As noted by the authors, this sample size is too small to draw conclusions regarding chronological and spatial variability, but it is sufficient to observe significant functional diversity among the analysed forms. In the analysed artefact assemblage, the following tools were identified: for processing meat and leather (scrapers, perforators, knives), for working with bone and antler (drills, chisels, burins), for working with plants (sickle inserts, knives, saws), for working with mineral materials, and arrowheads. The analysed artefacts are illustrated in Figures 23-41, which include carefully executed drawings of the artefacts with marked locations corresponding to the microscopic work traces depicted alongside the drawings. Importantly, the captions for the images include information about the magnification used. Discussions on the functional aspect are complemented by observations on tool modifications and wear traces. The summary of this part of the study includes presentations of simplified *chaines operatoires* schemes illustrating the use of lithic tools in the economy of Neolithic communities from Bronocice.

The chapter "Flint in Neolithic Settlements at Bronocice" offers an extensive summary of considerations regarding lithic technology at this site. It begins with compilations (Table 31) concerning lithic raw materials recorded in the inventories from Bronocice, and a few pages later, a typological-chronological compilation of lithic materials from this site (Table 32). Here, information regarding all Neolithic phases at the Bronocice site (BR I-BR V, L-VC, CWC) and materials from the older Bronze Age (Trzciniec Culture) is included. The authors formulate significant conclusions regarding the cognitive value of this category of archaeological materials and various limitations in inference. They note that only 1.7% of the site has been excavated. They highlight the results of geomagnetic surveys conducted in 2020 and 2021, which revealed a large number and high density of features. This

demonstrates the truly modest (though numerically impressive) pool of source materials from excavations conducted at this site compared to the vast quantity of Neolithic features and movable sources lying in unexcavated areas. They emphasise that this observation calls for caution when formulating general conclusions.

Important findings concern the typology and chronology of lithic materials, utilised raw materials, and flint processing in the settlements at Bronocice. Workshops were discovered in settlements from phases BR III, BR IV, and, as the authors suggest, they may have also functioned in phase BR V. However, the domestic final processing or repair of lithic tools was common. Regarding the sources of raw materials, particular attention is directed towards Jurassic flint variety G, the location of its outcrops, places of extraction, and workshops in the regions of material procurement. The quintessence of the summary is the characterisation of lithic production of Neolithic communities from Bronocice, formulated in eleven points.

Every work concerning Bronocice, especially monographs, is a significant archaeological event. Without a doubt, the publication of "Neolithic Flint Technology at Bronocice (4th millennium BC)" falls into this category. The academic community has received comprehensive information about an important economic and social aspect of Neolithic production. Despite various criticisms raised in the work, it is undeniable that the materials from Bronocice largely define the image of lithic technology in the Funnel Beaker Culture and the Funnel Beaker-Baden communities, not only in the western loess uplands of Małopolska. On the other hand, as the authors of this monograph point out, the conclusions presented do not exhaust the issues surrounding lithic technology at Bronocice.

"Neolithic Flint Technology at Bronocice (4th millennium BC)" is not only a highly important summary of the existing research on Neolithic lithic technology from the settlements at Bronocice. In my opinion (and I believe the authors share similar intentions), it also serves as an opening for future, perhaps already planned, research into this sphere of activity within the Funnel Beaker and Funnel Beaker-Baden communities from this prominent Central European Neolithic site.

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