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FIELD SURVEY AND MATERIALS

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THE METALWORK HOARD FROM CZARKÓW, GLIWICE DISTRICT, SILESIAN VOIVODESHIP: DISCOVERY CONTEXT, ELEMENTAL COMPOSITION, AND WEAR ANALYSIS

ABSTRACT

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The Czarków hoard, discovered accidentally in 1875, probably during agricultural work, comprised 21 bronze artefacts and ceramic vessel fragments, presumably the original container. The assemblage includes socketed axes of Lusatian and Middle Danubian types, a tanged sickle, and a spearhead.

Metallurgical analysis indicates the use of tin bronze with low tin and trace levels of arsenic, antimony, nickel, silver, and lead. Both local and non-local artefacts share similar metal compositions.

Use-wear and manufacturing traces confirm that all axes underwent finishing and use, with evidence of blade hammering and socket edge modification, particularly on the Lusatian types. Transverse grinding traces suggest resharpening prior to deposition.

Comparative studies date the hoard's inventory to the Late Bronze Age HB2-HB3 phases (*ca*. 1000-750 BC).

Keywords: Bronze Age, Metalwork Hoard, elemental data, use-wear
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INTRODUCTION

The Lusatian Urnfield cultures are characterised by a distinctive set of features that define its archaeological identity (*e.g.*, Kaczmarek 2017). Similarities in ceramic and metal artefact assemblages, economic practices, construction methods, funerary rites, and symbolic behaviours enable delineation of the territory inhabited by communities associated with the Lusatian Urnfield culture.

Within the Lusatian urnfields, a range of regionally specific bronze artefacts emerged, including socketed axes and knobbed sickles characteristic of the Lusatian tradition (*e.g.*, Gedl 1975, 59; 1985, 128; 1995, 49; Kuśnierz 1998, 25). Among the most emblematic metal objects are Lusatian-type socketed axes, typically featuring a loop and vertical rib decoration (Sprockhoff 1950, 77). Researchers working on Lusatian Urnfield assemblages frequently encounter Czarków-type socketed axes. Despite their prevalence, the eponymous hoard from Czarków has not yet been the subject of a comprehensive study or publication.

This article presents new research findings concerning this significant metal deposit associated with the Lusatian Urnfield cultures. We discuss the history of the hoard's discovery and present the results of detailed analyses of its inventory. Particular emphasis is placed on the Lusatian socketed axes of the Czarków type, including aspects of their production technology, the selection of metal alloys used in their casting, and the artefacts' biographies, as reconstructed through wear analysis.

Our results allow us to include the Czarków hoard within the research on metal hoards and their deposition during the Late Bronze Age.

MATERIALS

The Czarków Hoard: Two Similar but Divergent Accounts of Its Discovery

The hoard from Czarków, Gliwice District, Silesian Voivodeship (Fig. 1) was discovered in 1875, and details regarding its find were published relatively soon thereafter (Kuschel 1881; Mertins 1896, 362-365). In the academic literature, the hoard appears under at least four different names: der Verwahrfund von Ottmuchow, Tost-Gleiwitz (present-day Otmuchów), Langendorf (present-day Wielowieś), Scharkow (present-day Czarków), and Czarków (in Polish-language publications). These variations reflect shifts in cadastral boundaries prior to the Second World War, as well as the significant changes in national borders and place names that occurred in the post-War period. The name Scharkow continues to appear in post-war German-language publications (*e.g.*, Sprockhoff 1950, 128; von Brunn 1968, 304), further contributing to the ambiguity surrounding the hoard's provenance.

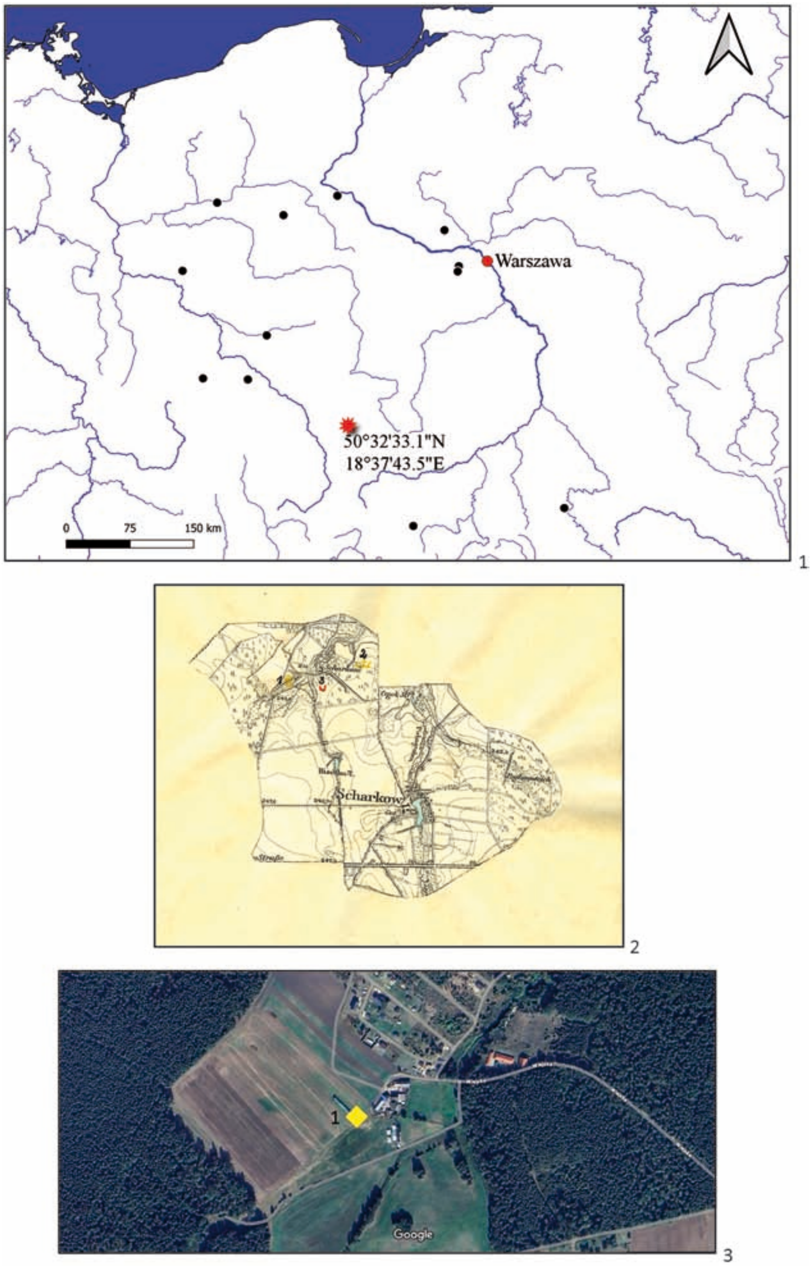

Fig. 1. Location of the Czarków hoard: 1 – On a contemporary map of Poland marked with an asterisk. Black dots mark the sites with elemental analysed socketed axes mentioned in the text, 2 – On the archival *Messtischblatt* map from the collection of the Upper Silesian Museum in Bytom, 3 – An approximate location marked on the contemporary Google map file

Two slightly differing versions of the circumstances surrounding its discovery exist. Moreover, discrepancies are evident in both the reported location and the composition of the deposit across various sources in the literature and archival records.

According to the earliest accounts (Kuschel 1881, 35, 36, with commentary signed 'D. R.'), the hoard was discovered by chance on a dirt track leading to an arable field. In brief, the finder, an employee named Franz Zientek, reported that on 18 June 1875, he noticed a shiny object protruding from the ground in the middle of a rural track. Using a wooden stick, he easily extracted four objects. On 22 June 1875, he returned to the site with the landowner, Mr Gollor, and together they excavated a further 17 objects. According to their report, these items were found at a depth of approximately 20 cm (8 Zoll). In the same location, approximately 15 cm deeper (6 Zoll lower), fragments of a grey ceramic vessel were also uncovered. The report notes that the road in question had previously passed through woodland, which was subsequently converted to arable land (Kuschel 1881). The commentary accompanying the original account specifies that the hoard comprised 21 artefacts in total, and that 17 of the socketed axes originated from a single casting mould.

A similar description was published some years later by Mertins (1896), who also noted that the hoard, referred to as the Ottmuchow hoard, was donated by Gutsbesitzer Kuschel of Langendorf (present-day Wielowieś) to the Museum Schlesischer Altertümer in Breslau (modern-day Wrocław).

A differing version of the hoard's discovery was later published by Seger in 1936, under the name *Scharkow, Kr. Tost-Gleiwitz* (Seger 1936, 143, 144). This account is based on a field report by Otto Hanske, a museum technician and preparator, who visited the site and interviewed the landowner in 1935. According to the second version of events, Franz Zientek – this time identified as a trader (Händler) – was walking behind a plough during agricultural work carried out by Freigärtner Gollarz in his field, when the plough suddenly unearthed four objects. Zientek retrieved them and, upon seeking advice in a nearby town (Kruppamühle, now Krupski Młyn in the Silesian Voivodeship, Tarnowskie Góry District), was informed that the finds were prehistoric artefacts and that further items were likely to remain at the site. Subsequently, Zientek and the landowner returned to the field and excavated the remaining objects.

Based on the above-cited sources, it can be reasonably concluded that the hoard from Czarków was discovered by chance on 18 June 1875 and further explored by non-specialists – namely Mr Zientek and Mr Gollor – a few days later, on 22 June 1875. The assemblage, which included 19 socketed axes, one sickle, and one spearhead, had been deposited at a shallow depth (ca. 20 cm) within a ceramic vessel. Given that the four axes were discovered first, it may be inferred that the uppermost layer of the hoard consisted of this category of artefact. As Seger (1936, 144) notes, however, it remains challenging to reconstruct the hoard's original composition with certainty.

THE INVENTORY OF THE HOARD – A LONG HISTORY

Most of the aforementioned sources agree that the inventory of the Czarków hoard comprised 21 objects: 19 socketed axes, one spearhead, and one sickle. However, there is some inconsistency in the historical record. Notably, Kaleffe (1888) refers to the hoard from Langendorf, but mentions only the sickle and the 19 socketed axes, omitting any reference to the spearhead.

Interestingly, both H. Kurtz (1929) and H. Seger (1936) refer to a total of 21 artefacts in their respective texts; however, the accompanying plate – identical in both publications – depicts only 20 objects. These include 16 socketed axes of the Lusatian type, two socketed axes of the Middle Danubian type, one sickle, and one spearhead (Kurtz 1929, 32, 33 and unnumbered plate; Seger 1936, pl. 13: 3).

In subsequent years, Sprockhoff referenced the Czarków hoard (referred to as Scharkow) in his publication 'Lausitzer Tüllenbeil', in which he catalogued only 16 socketed axes of Lusatian type (Hauptform) within the assemblage (*cf.*, Sprockhoff 1950, 128). In later post-War literature, while the correct total number of artefacts in the hoard – 21 items – is often acknowledged, illustrations typically depict only 20 specimens. This discrepancy is evident, for example, in Gedl (1962), where a photographic reproduction of Seger's (1936, pl. 13: 3) plate, previously published by Kurtz (1929, unnumbered plate), is reused. The omission of one axe in the visual documentation raises the question of why Kurtz – and subsequently Seger and other authors – excluded a single specimen from their respective presentations of the hoard.

The apparent discrepancy in the number of Lusatian-type axes associated with the Czarków hoard can be clarified through archival records and a note in Arndt's 1925 publication. Arndt explicitly states that of the 17 Lusatian-type socketed axes identified initially, one was held in the collection of the Museum zu Beuthen (today the Upper Silesian Museum in Bytom), while the remaining specimens were deposited in the Museum Schlesischer Altertümer in Breslau (present-day Wrocław; Arndt 1925, 36). This explains the omission of a single axe from the photographic documentation reproduced by Hans Seger (1936) and later by Gedl (1962), as it was housed separately from the primary assemblage and thus probably unavailable during the preparation of those publications.

The most comprehensive and up-to-date assessment of the current composition of the Czarków hoard is provided by Kuśnierz in the volume 'Prähistorische Bronzefunde' dedicated to socketed axes (Kuśnierz 1998). On page 33, Kuśnierz records 16 Lusatian-type socketed axes from Czarków, corresponding to the initially documented number of this type of artefact in the hoard. Notably, he identifies one of these axes – inventory number 7092 – as being housed in the collections of the Upper Silesian Museum in Bytom. However, it is catalogued there under the incorrect provenance of Wielowieś (formerly Langendorf) (Kuśnierz 1998, 33; pl. 11:176; pl. 50 with complete inventory of the hoard).

Readers of this article may understandably wonder why we have devoted such extensive attention to the history of the discovery and inventory of the Czarków hoard. We do this in our defence. Namely, the Czarków hoard, given to us for research, contains 20 artefacts (excluding the aforementioned axe, number 7092). The current museum numbering is continuous (B.801/4054:58-B.820/4073:58), which is why our vigilance was somewhat 'lulled', even though we knew from the beginning that number 7092 was missing. Based on the archival numbering preserved on the surfaces of the axes (see Fig. 2), axe no. 7092 should be positioned between B.801/4054 (old no. 7091) and B.802/4055 (old no. 7093). However, we did not pursue this discrepancy immediately, assuming that either the archival numbering was erroneous or, more likely, that the missing axe had been irretrievably lost shortly after the hoard's discovery. Thanks to Kuśnierz's research, we now know the axe was not lost, and we assure our readers that we will revisit the matter of axe no. 7092 in a future publication, where additional information will be provided.

The Czarków Hoard – A Summary

The Czarków hoard consists of 21 metal artefacts (Figures 2 and 3) and was initially deposited within a ceramic vessel that unfortunately has not survived; nothing more is known about it. As previously noted, the vessel was not retrieved at the time of discovery in 1875. The hoard comprises two Middle Danubian-type socketed axes with stepped cutting edges ('Tüllenbeile mit abgestuftem Schneidenteil', Kuśnierz 1998, 17, 18), seventeen Lusatian-type socketed axes of Czarków type (Kuśnierz 1998, 33), one tanged sickle featuring a rib parallel to the back ('Zungensichel mit einer Rückenparallelen Rippe'; Gedl 1995, 80), and one spearhead with a triangular blade ('Lanzenspitze mit dreieckigem Blatt'; Gedl 2009, 56). The detailed characteristics of these artefacts are presented in Table 1.

The relative chronology of the Czarków hoard has been addressed in several studies, and we would like to briefly summarise these viewpoints. J. Kuśnierz (1998, 20), citing sources such as von Brunn (1968, 304), suggests that the hoard should be dated to HaB1, at the end of the IV Bronze Age Period, or, at the latest, to the transition from the IV to the V Bronze Age Period. Kuśnierz points out (1998, 41) that all the Lusatian socketed axes from the Czarków hoard belong to variant A, i.e. the oldest variant of the Czarków type. M. Gedl, drawing on the analogy of the sickle found in the hoard, assigns it to the V Bronze Age Period (Gedl 1995, 82), while also dating the spearhead to the transitional phase between Period IV and V or the early V Bronze Age (Gedl 2009, 56). W. Blajer, on the other hand, dates the hoard to HaB2-B3, *i.e.* the V Bronze Age Period (*ca.* 1000-750 BC; Blajer 2001, 20, 342).

Fig. 2. Inventory of the Czarków hoard, excluding axe no. 7092 (photo: W. Szołtys)

Fig. 3. Inventory of the Czarków hoard, except axe no. 7092
(photo: W. Szołtys)

METHODS

The chemical composition analyses

Chemical analyses were performed on all the artefacts from the Czarków hoard to determine the elemental composition and separate possible raw material groups. Metal samples were obtained using a micro-drill and HSS drills with a diameter of 1-2 mm. Samples were taken from the least visible place. In the case of axes and spearheads, it was the inside of the socket, and in the case of the sickle, on the flat side in the middle of the length. In the first step, the patina layer was removed with a drill. Then, changing to a new drill, a hole was drilled to obtain the required amount of metal core. The obtained material was collected in Eppendorf polypropylene containers. The operation was repeated, each time changing the drill to avoid contamination of the samples. The sampling spots have been restored and are barely visible to the naked eye.

The chemical composition was determined at the Polish Geological Institute – National Research Institute in Warsaw using a Cameca SX-100 electron microprobe analyser (EPMA). Drilling chips or small pieces weighing approximately. 0,01 g per sample was mounted in epoxy resin on 1-inch-diameter discs. Samples were polished with water-free diamond paste (to avoid oxidation) and then carbon-coated to obtain electrical conductivity. Analytical conditions of the microprobe were set to 15kV of accelerating voltage and 20 nA beam current for major elements (Si, Al, S, Cu, Fe, Sn) and 200 nA for trace elements (Zn, Ni, Co, Cd, Ag, Pb, Au, Se, As, Sb, Mn, Bi, Hg). The diameter of the electron beam (spot size) was set to 10 µm. Due to the variable composition at the µm-scale, approximately 15 areas were analysed per sample, each lasting 20 minutes. The following standards were used, and corresponding X-ray lines were used: Si Kα Wollastonite, Al Kα Orthoclase, S Kα Arsenopyrite, Cu Kα Cu metal, Sn Lα Cassiterite, Ag Lα Proustite, Sb Lα Stibnite, Bi Mβ Bi metal, Pb Mβ Galena, Zn Kα ZnS, Se Lβ ZnSe, As Lβ FeAsS, Ni Kα Pentlandite, Co Kα Skutterudite, Fe Kα Haematite, Au Mα Au metal, Mn Kα Rhodonite, Cd Lα CdS, Hg Mα Cinnabar.

Wear analyses

Wear analysis represents an effective method for examining the surfaces of metal artefacts, particularly for distinguishing between treated and untreated surfaces and for classifying objects according to their use-wear status, such as used, unused, repaired, or fragmented. The methodological foundations of this approach have been extensively discussed in the literature (Gutiérrez Sáez and Lerma, 2014; Dolfini and Crellin 2016; Molloy *et al.* 2016; Sych *et al.* 2020). Its limitations and new perspectives have recently been highlighted in Polish and international literature (*e.g.*, Caricola *et al.* 2022; Kasprowicz 2022; Nowak and Sych 2024).

Metalwork wear analyses of copper-alloy axes, as well as related experimental studies conducted in recent years, have considerably expanded our knowledge of these objects, both in terms of production technology and use (Kienlin and Ottaway 1998; Roberts and Ottaway 2003; Dolfini *et al.* 2023; Nowak *et al.* 2023).

The artefacts from the Czarków hoard were subjected to microscopic analysis to identify surface traces associated with both production and use. The primary objective of this examination was to determine whether the objects may have been deposited following a specific pattern related to their condition, such as evidence of wear, repair, or fragmentation. Observations were conducted using a portable Dino-Lite digital microscope and a Zeiss Stemi 2000-C stereomicroscope, equipped with a Delta Optical DLT-Cam PRO 2MP digital camera. The analyses were conducted post-conservation. It is worth noting that the hoard was discovered in 1875, and the post-depositional history of the artefacts – including their treatment and storage prior to museum acquisition – remains partially undocumented.

RESULTS AND DISCUSSION

Elemental composition

The literature indicates that, based on similarities in shape and dimensions, the majority of Lusatian-type socketed axes in the Czarków hoard could have been cast in a single mould (*e.g.*, Mertins 1896, 362, 363; Kuśnierz 1998, 33). All the Lusatian-type axes are typologically analogous variants. Their dimensions and weights are also similar, with some slight differences (Table 1). The average weight is 218 g, of which 9 axes weigh between 210 and 220 g. Three axes are lighter (195-208 g), and five weigh >220 g (222-247 g). The Lusatian-type axes are usually much heavier than the Middle Danubian axes. The lengths of the axes are also basically similar, as 15 axes measure 113-119 mm. Only two are shorter (7092 – 111 mm; B.803/4056 – 114 mm). Slight differences in the weight and length of the artefacts may be related to casting defects – holes in the surfaces (as in the case of axe no. B.803/4056, weighing 205 g) or broken off fragments, as in axe no. B.811/4064 weighing 195 g or a different level of surface treatment, hammering, which could slightly lengthen the artefacts. Axe 7092 clearly stands out from the rest of the collection. With a relatively high weight (235 g), it is the shortest item (111 mm).

As outlined above, the Lusatian-type socketed axes display close similarities in form and dimensions, suggesting a high likelihood that they were produced using the same casting mould, or, at most, from two or three nearly identical sets, possibly derived from a single model (in case of the ceramic and metal moulds) employed for their manufacture. The objective of the elemental composition analyses was to characterise the alloying components employed in the production of these artefacts and to evaluate whether the Lusatian-type axes could have been cast from a single metal batch during one production cycle.

Table 1. Characteristics of the Czarków hoard inventory: L – Lusatian axe type; MD – Middle Danube axe type. The archival inventory numbers are visible in Figures 2 and 3. Weights (g) and some dimensions (mm) as cited in Kuśnierz 1998, 17, 33; Gedl 1995, 80; Gedl 2009, 56

Inv. No.	Item	length	blades' width	width in the middle part	sockets' depth	sockets' diameter (outside)	sockets' diameter (inside)	weight
B.801/4054	Axe [L]	117	42	25	82	38	19	215
B.802/4055	Axe [L]	115	40	25	8	36	17	208
B.803/4056	Axe [L]	114	40	25	82	37	21	205
B.804/4057	Axe [L]	116	40	24	80	37	20	218
B.805/4058	Axe [L]	116	39	25	81	37	18	216
B.806/4059	Axe [L]	117	40	25	82	38	19	215
B.807/4060	Axe [L]	115	39	25	81	37	17	218
B.808/4061	Axe [L]	117	43	20	75	37	20	210
B.809/4062	Axe [L]	115	38	23	68	38	18	247
B.810/4063	Axe [L]	116	41	25	81	37	19	230
B.811/4064	Axe [L]	113	40	24	79	37	20	195
B.812/4065	Axe [L]	115	40	25	80	37	18	228
B.813/4066	Axe [L]	115	39	24	83	37	18	222
B.814/4067	Axe [L]	119	42	24	81	37	20	215
B.815/4068	Axe [L]	115	40	24	80	37	18	220
B.816/4069	Axe [MD]	105	53	25	50	32	11	166
B.817/4070	Axe [L]	117	42	24	82	38	21	214
B.818/4071	Axe [MD]	109	58	25	50	33	13	152
B.819/4072	Spearhead	98	34	-	-	22	6	65
B.820/4073	Sickle	128	31	18	-	-	-	61
7092	Axe [L]	111	-	-	-	-	-	235

Furthermore, the study aimed to assess potential compositional relationships between locally produced artefacts and those of non-local (imported) origin, as such correlations may reflect shared metallurgical sources or recycling practices.

The chemical analyses revealed that the artefacts from the Czarków hoard were manufactured from a copper-based alloy intentionally containing tin – *i.e.*, tin bronze. The alloy also contains varying trace concentrations of arsenic, antimony, nickel, bismuth, and lead (Table 2), elements commonly associated with prehistoric bronze metallurgy and copper ore deposits used (*e.g.*, Pernicka 1999).

The group of Lusatian-type socketed axes from Czarków shows a relatively wide variation in tin (Sn) content (Table 2). Four specimens exhibit a particularly low tin concentration, not exceeding 1% (0.41% to 0.68%). Such values may reflect the tin loss through volatilisation during repeated melting and casting cycles (*e.g.*, Kuijpers 2008, 25). The

Table 2. Chemical composition (EPMA): L – Lusatian type of axe; MD – Middle Danube-type of axe. Results are in weight%: values in italics are below the limit of detection; results for Au and Zn in all the samples are below the detection limit. The table presents selected measured elements

Inv. Number	Artefact type	Cu	Sn	As	Ni	Ag	Sb	Pb	Bi	Co	Fe
B.803 4056	Socketed axe [L]	97.52	0.61	*0.08*	*0.08*	*0.04*	0.47	*0.04*	*0.02*	*0.01*	0.10
B.807 4060	Socketed axe [L]	97.10	0.41	0.15	0.19	0.44	0.81	*0.01*	*0.00*	*0.01*	*0.02*
B.809 4062	Socketed axe [L]	96.94	0.68	0.49	*0.05*	*0.02*	0.30	*0.00*	*0.00*	*0.00*	*0.02*
B.817 4070	Socketed axe [L]	97.39	0.48	0.28	0.13	*0.08*	0.75	*0.05*	*0.02*	*0.01*	*0.02*
B.801 4054	Socketed axe [L]	96.29	1.11	0.21	0.18	*0.08*	0.43	0.41	*0.00*	*0.02*	0.21
B.802 4055	Socketed axe [L]	96.02	1.87	0.15	0.20	0.21	0.97	*0.04*	*0.01*	*0.01*	*0.02*
B.806 4059	Socketed axe [L]	96.78	1.31	0.10	*0.08*	*0.07*	0.77	*0.02*	*0.01*	*0.01*	*0.03*
B.808 4061	Socketed axe [L]	94.21	1.43	0.73	0.14	*0.08*	0.66	*0.00*	*0.01*	*0.02*	0.16
B.810 4063	Socketed axe [L]	96.41	1.48	0.13	0.15	*0.08*	0.60	*0.05*	*0.01*	*0.03*	*0.05*
B.811 4064	Socketed axe [L]	95.48	1.37	0.24	0.12	*0.07*	1.42	*0.02*	*0.01*	*0.02*	*0.09*
B.813 4066	Socketed axe [L]	92.41	1.10	0.15	*0.02*	0.10	2.99	0.42	*0.03*	*0.01*	*0.02*
B.805 4058	Socketed axe [L]	94.80	2.72	0.16	*0.09*	0.09	0.89	*0.02*	*0.01*	*0.01*	*0.05*
B.814 4067	Socketed axe [L]	95.23	2.01	0.38	*0.07*	0.05	0.98	0.15	*0.02*	*0.01*	0.19
B.815 4068	Socketed axe [L]	96.04	2.35	*0.07*	*0.01*	*0.03*	0.66	*0.09*	*0.03*	*0.00*	*0.03*
B.804 4057	Socketed axe [L]	94.37	3.63	0.16	0.12	*0.04*	0.61	*0.03*	*0.01*	*0.01*	0.13
B.812 4065	Socketed axe [L]	93.66	3.88	0.12	0.12	*0.06*	0.56	*0.05*	*0.01*	*0.01*	0.15
B.816 4069	Socketed axe [MD]	93.40	2.81	0.22	0.10	0.11	1.39	0.17	*0.02*	*0.01*	0.10
B.818 4071	Socketed axe [MD]	94.93	2.62	0.19	0.11	*0.09*	1.21	0.20	*0.02*	*0.01*	0.10
B.819 4072	Spearhead	90.84	4.89	0.32	*0.04*	0.10	2.93	*0.01*	*0.03*	*0.01*	*0.07*
B.820 4073	Sickle	93.25	4.42	0.16	0.12	*0.08*	1.00	*0.01*	*0.00*	*0.02*	0.25

most significant subset comprises axes with low tin content (n = 7), ranging from 1.10% to 1.87%. A further three axes display moderately elevated tin levels of 2.01%-2.72%, while two specimens contain higher concentrations, exceeding 3% (3.63% and 3.68%, respectively).

The Middle Danubian-type socketed axes are characterised by a relatively consistent tin content of 2.62-2.81%. The highest tin concentrations within the entire assemblage were identified in the spearhead (4.89% Sn) and the sickle (4.42% Sn), distinguishing these artefacts from the rest of the hoard.

The concentrations of other trace elements – including arsenic (As), antimony (Sb), nickel (Ni), silver (Ag), and lead (Pb) – which typically occur as natural impurities in the copper ore used for smelting, are generally low across the assemblage, but there are visible differences. These elements are considered indicators of the original copper source, as their concentrations are largely unaffected by metallurgical processes such as remelting (Pernicka 2015, 254), unlike tin, which can be diminished by repeated thermal treatment.

Arsenic content is generally minor, averaging 0.22%, with trace levels noted in two artefacts (0.08% As in B.803/4056 and 0.07% As in B.815/4068). Lead and bismuth contents mostly fall below the detection limit of the analytical method employed, with slightly elevated Pb values observed in samples B.801/4054, B.813/4066, B.814/4067, B.816/4069, and B.818/4071. Silver concentrations are consistently low across the assemblage, averaging 0.10%. In fifteen artefacts, Ag content falls within the trace range (0.02-0.09%), while the remaining samples exhibit slightly higher values (0.10-0.44%). Among the analysed elements, antimony shows the most significant variability and reaches the highest concentrations recorded among the suite of natural ore-related impurities. The average Sb content across the assemblage is 1.02%. Elevated values were noted in two Lusatian axes (1.42% Sb in B.811/4064 and 2.99% Sb in B.813/4066), two Middle Danubian type axes (1.39% Sb in B.816/4069 and 1.21% Sb in B.818/4071), the spearhead (2.93% Sb in B.819/4072), and the sickle (1.00% Sb in B.820/4073).

The foregoing data confirm that the artefacts from the Czarków hoard were produced from tin bronze characterised by a relatively low tin content and a generally low level of natural ore impurities. The exception is the increased level of antimony in six artefacts – two Lusatian axes, two Middle Danubian type axes, the sickle and the spearhead.

To assess compositional similarities and identify potential correlations or distinctions within the assemblage, the concentrations of trace elements – specifically arsenic (As), silver (Ag), nickel (Ni), and antimony (Sb) – were plotted on double-logarithmic scatter diagrams (Fig. 4). The diagrams reveal a cluster of artefacts sharing comparable levels of Ni, As, and Ag, suggesting a degree of homogeneity in the metallurgical raw materials used in their production.

The majority of the analysed artefacts from the Czarków hoard form a coherent compositional cluster, characterised by low to very low nickel concentrations and consistent Ni/Ag, Ni/As, and Ni/Sb ratios (Fig. 4). This compositional group encompasses a substantial

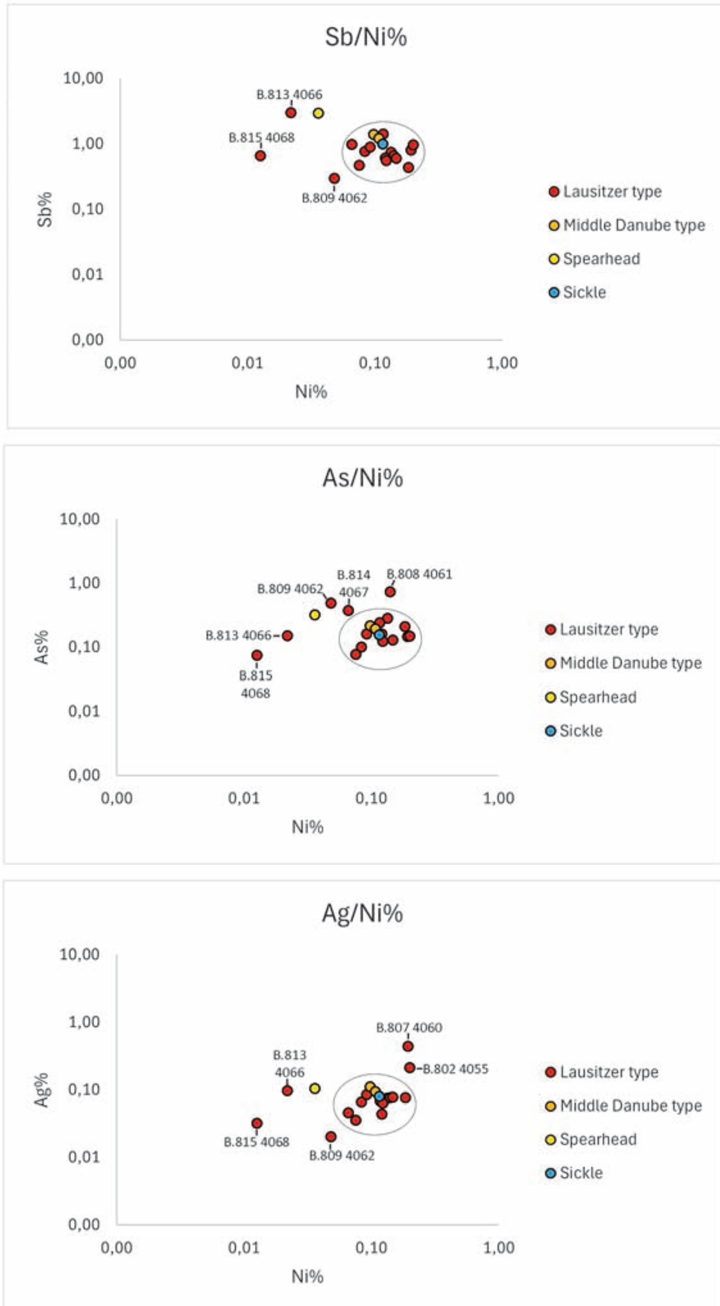

Fig. 4. Double logarithmic diagrams illustrating a distinct cluster of artefacts, both stylistically local and foreign, with comparable values for antimony-nickel, arsenic-nickel, and silver-nickel ratios

number of Lusatian-type socketed axes, as well as both Middle Danubian axes and the tanged sickle. A small number of artefacts deviate from this primary cluster. These include several Lusatian-type axes and the spearhead. Notably, spearhead no. B.819/4072 exhibits the second-highest antimony concentration within the assemblage, while its nickel content falls below the range observed in the leading group. Two Lusatian axes – B.813/4066 and B.815/4068 – consistently fall outside the defined cluster across all comparative diagrams. Axe B.815/4068 displays the lowest concentrations of both nickel and arsenic among the artefacts, whereas axe B.813/4066, while having the second lowest nickel content, possesses the highest recorded antimony concentration (Fig. 4).

Chemical analyses of trace elements facilitate the comparison of artefacts within the assemblage and, ideally, allow the identification of initial clusters that may indicate a shared metallurgical background and/or familiar raw material sources (Gavranović *et al.* 2021). The results of the elemental analysis of the Czarków hoard artefacts suggest that the majority of the Lusatian-type axes were manufactured from a similar base metal. Interestingly, items of foreign origin – namely the Middle Danubian axes and the tanged sickle – also fall within this compositional group.

It remains plausible that both local and non-local axes were produced at their respective production sites using metal derived from a common source. However, these findings may also provide indirect evidence for the recycling of imported objects. It is conceivable that foreign artefacts were reworked into locally styled objects, such as Lusatian-type axes. This transformation of foreign objects into local forms could be supported by the higher tin content observed in the Middle Danubian axes (B.816/4069, B.818/4071) and the sickle. Nonetheless, this pattern is not definitive and further detailed research is necessary to explore this hypothesis in more depth.

Based on published data and information from the available literature, we have endeavoured to correlate the elemental data obtained for the Czarków hoard with those of socketed axes discovered in Poland, spanning from the HA1 phase to the end of the Bronze Age and the beginning of the Early Iron Age (HB2-HC). The results are presented in double logarithmic diagrams in Figure 5.

The distinct cluster of artefacts from the Czarków hoard shows a correlation with assemblages from hoards such as Rosko, Brudzyń, Karmin IV, and the axe from Cierpice, particularly in terms of comparable trace element contents, notably antimony-nickel and arsenic-nickel ratios. These hoards, dated primarily to the Late Bronze Age (HB2-HB3), exhibit similarities in elemental composition. However, the Czarków assemblage diverges from older hoards, such as those from Nowa Górna, Paszowice, Falejówka, Wilamowice, and Gole (HA1-HB1). The lack of correlation is most evident in the antimony-nickel comparison, where, for example, artefacts from Nowa Górna, Wilamowice, and Gole are characterised by a low antimony content. At the same time, the Falejówka axe displays a high level of this element. In the arsenic-nickel comparison, only a subset of the objects aligns with the separated group (Fig. 5).

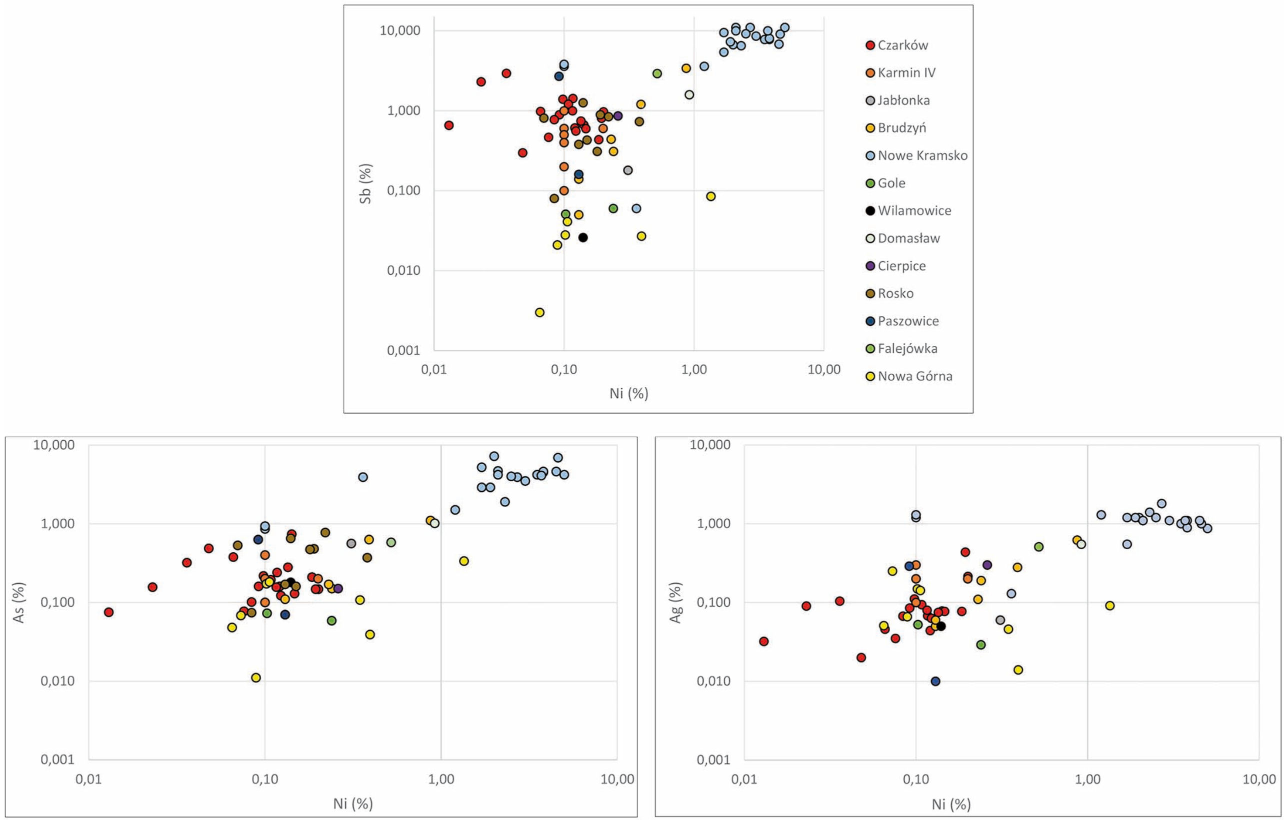

Fig. 5. Trace element correlation for selected socketed axes discovered in Poland (HA1-HC), compared with the results for the Czarków hoard (whole assemblage). The legend applies to all graphs. Elemental data are from: Sałat *et al.* 2006; Biborski 2017, table 1; Garbacz-Klempka *et al.* 2018, Table 1; Baron *et al.* 2019, table 5; Kowalski and Garbacz-Klempka 2019, table 2; Garbacz-Klempka and Kowalski 2020, table 1; Orlińska 2020, table 1; Blajer *et al.* 2022, table 1; Gackowski *et al.* 2023, table 1; Nowak *et al.* 2023; Gan 2024, table 2

A compact cluster, distinct from the rest, is evident in the assemblage from Nowe Kramsko (Fig. 5). Dated to HB2-HB3, it clearly indicates the use of a different metal type for the production of local axes. This metal is marked by a high concentration of impurities in the alloy, including antimony (up to 11%), arsenic (up to 7.2%), silver (up to 1.8%), and nickel (up to 5%). Notably, both Lusatian-type and Middle Danubian axes were crafted from this alloy.

In the case of several artefacts from Czarków, as well as axe no. 15 from the Karmin IV, axe no. 6 from Brudzyń, axe no. 19 from the Paszowice deposit, the antimony level reaches 1-2% or more, while the silver and arsenic content is low (Baron *et al.* 2019; Garbacz-Klempka and Kowalski 2020; Nowak *et al.* 2023). Differences in the content of elements such as antimony, arsenic, silver and bismuth indicate the use of different types of copper ores to produce the copper from which these objects were cast. Artefacts with very low antimony, arsenic, silver and bismuth contents come from smelting chalcopyrite ores, while those with elevated levels of these elements come from fahlore ores. The best example of the use of fahlore ores in axe production, among others, in the Late Bronze Age is the hoard from Nowe Kramsko (Kowalski and Garbacz-Klempka 2019).

Typical copper from chalcopyrite ores, such as those from the Mitterberg, Kelchalm, or Mauk outcrops, has very low impurity contents, while fahlore ore from mines such as Schwaz-Brixlegg contains significant impurities (*e.g.*, Lutz and Pernicka 2013; Tropper *et al.* 2019). For example, the average antimony content in fahlore copper raw material is 6.7 mass%, compared to 0.02 mass% in chalcopyrite (Grutsch *et al.* 2019). In the case of the artefacts we examined from Czarków, the elevated antimony levels are remarkable, with most cases falling within the levels indicated above. The elevated antimony content for six artefacts, including two Lusatian-type axes, two Middle Danubian-type axes, a sickle, and a spearhead, combined with low silver and arsenic content, is also engaging. This may indicate the use of 'diluted fahlore copper' in the production of these artefacts, *i.e.*, a metal derived from mixing metal from fahlore and chalcopyrite ores or from smelting copper from mixed polymetallic ores (Grutsch *et al.* 2019). The frequently cited research by Grutsch *et al.* (2019) indicates that this type of metal is abundant in the Late Bronze Age, which corresponds to the chronology of the Czarków hoard.

Finally, it is worth noting the variation in tin content. While this may seem overly simplified and obvious, it cannot be conclusively stated that a single pattern of tin addition was used across Lusatian urnfields. However, a noticeable trend emerges: older artefacts (from sites such as Nowa Górna, Gola, and Jabłonka) often contain higher tin levels, ranging from 10% to 17%. In contrast, contemporaneous and younger artefacts, such as those from Czarków, Karmin IV, Nowe Kramsko, and Cierpice, typically have lower tin content, usually around 1-3%, and rarely exceeding 5%. The Rosko and Brudzyń hoards stand out, as their examined axes (analysed with the ARL 3460 emission spectrometer for Rosko and ED-XRF Spectro-MIDEX for Brudzyń) show tin levels of 7-11% and 6.3-9.5%, respectively, with one Brudzyń sample containing 3.2% tin.

The reduction in tin content in artefacts dating to the Late Bronze Age is a noticeable phenomenon, but the cause remains unclear. Hypotheses have been put forward regarding a decline in tin transport, which could also have influenced the return to fahlore deposits, rich in elements that, to some extent, could compensate for the tin shortage (Grutsch *et al.* 2019; Baron *et al.* 2020). Experimental studies show that using a high-tin bronze alloy for axe production significantly improves the durability of the object when working with wood compared with using low-tin bronze (Dolfini *et al.* 2023; further literature therein). Therefore, the use of low-tin bronze (minimum 0.41% Sn, maximum 3.88% Sn in the case of Lusatian-type axes in the Czarków hoard) in the production of axes does not appear to have been dictated by a deliberate action aimed at obtaining a product with ideal parameters. The axes were likely made from a low-tin alloy due to the aforementioned shortages of raw materials and limited access to tin. Our research hypothesis assumed that imported artefacts, containing higher levels of tin, could have been fragmented and added to tin-poor bronze to enhance its functional value. In the case of Czarków, this could have been true for axes with very low tin content. However, several Lusatian axes have tin levels similar to or even higher than those found in the Middle Danubian axes, which instead rules out the possibility of fragmentation and the addition of tin-rich fragments to a tin-poor alloy. This, instead, suggests the remelting of entire artefacts to produce new, locally stylistic ones.

Metalwork Wear Analysis

We have analysed all of the objects from the Czarków Hoard (excepting for axe 7092) for wear and divided them into the following categories associated with different stages of their 'lives':

- Production traces related to the casting process, such as casting seams, porosities, shrinkage cavities, or surplus material,
- Preparation for use, mainly actions performed to remove casting evidence and shape the objects, such as regular striations from grinding and hammering marks,
- Use-related wear connected to the direct usage of objects, such as striations on the cutting edges, blunting, chipping of blade tips, asymmetry of the body and the blade, fractures, and breakages.

We also identified a separate category for modern traces, associated with sampling, as well as corrosion, which hinders observation. The results of our observations are presented in detail in Table 3.

The casting seam is present on all 16 socketed axes; in ten cases, it has been removed from the blade sides, and in three, it has been additionally hammered. Traces of diagonal grinding are also present in these parts (Fig. 6: 1). Metal shrinkage cavities were observed on five objects, mainly in the central part of the blade. Material deficit in the form of holes is present on eight objects, mainly on the body below the loops (on two objects)

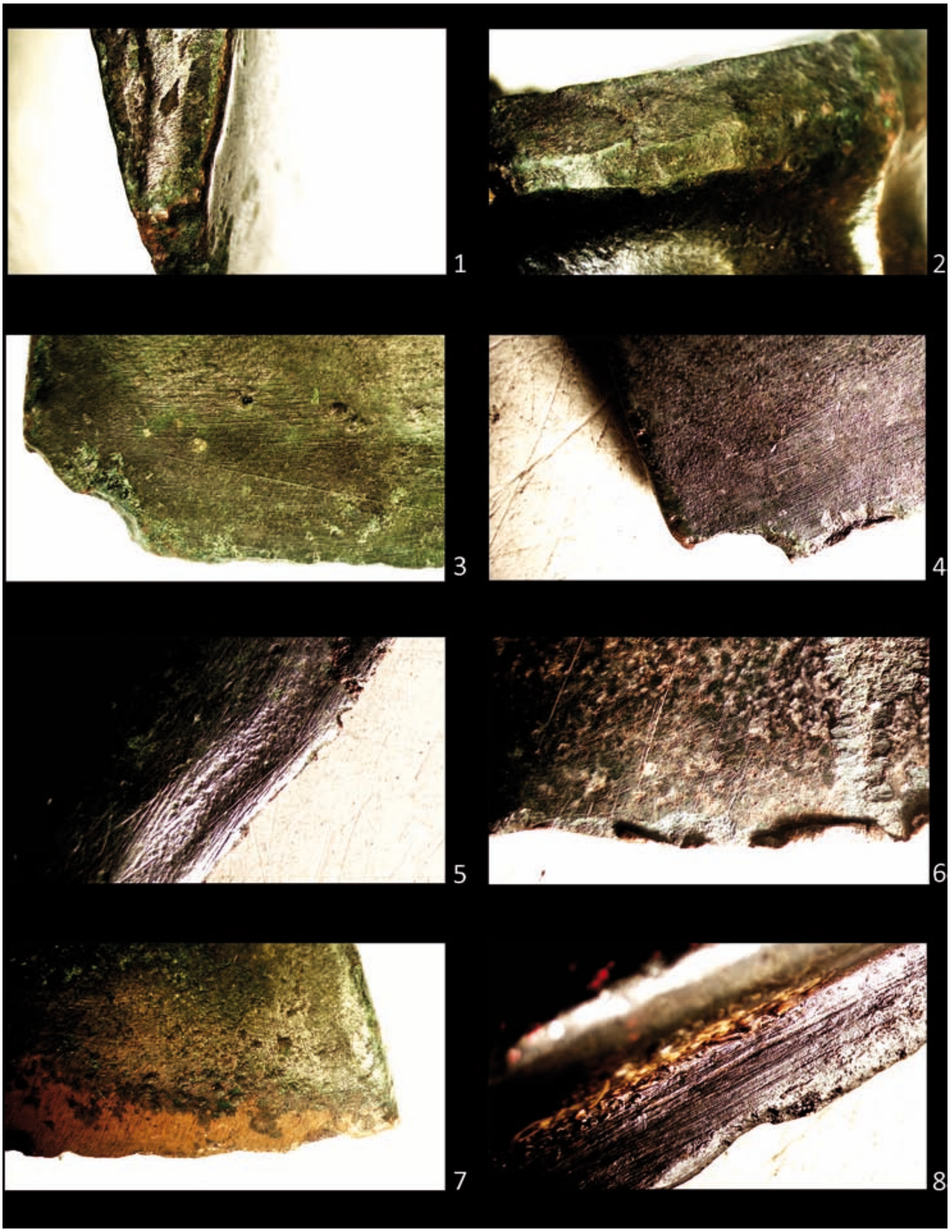

Fig. 6. Manufacture and use-wear traces observed on the artefacts from the Czarków hoard:
1 – worn casting seams on the side of the axe with traces of diagonal grinding; 2 – traces of hammering the edge of the socket; 3-4 – broken edge of the blade and transverse striations (grinding); 5 – minor diagonal striations and fractures in the edge of the blade; 6 – wrapped metal of the edge of the blade; 7 – regular diagonal striations accompanied by worn patina and exposed metal core as a result of modern activities; 8 – striations on the spearhead and fracture of the leaf (photo: K. Nowak, prep. D. Sych)

Fig. 7. Traces of hammering observed on the blade, side and socket on the Axe no. B.809.4062 from the Czarków hoard (photo: K. Nowak, prep. D. Sych)

Fig. 8. Traces of the modern use of Axe no. B.811.4064, indicated by the lack of patina and a visible metallic core – a blunt blade resembling the edge of a narrow hammer (photo: K. Nowak, prep. D. Sych)

and in the socket area (on six objects). Porosity from casting on sockets has been recorded on three axes.

Traces related to preparation have been recorded on all 16 objects. On ten axes, hammering marks were recorded around the socket rim area (Fig. 6: 2) and on six on the blade (Fig. 7). Parallel striations associated with grinding were observed in 12 cases, mainly around the blade area (Fig. 6: 3, 4). However, it must be noted that other finishing processes, such as polishing or corrosion, can obscure both hammering marks and grinding striations.

Use-related wear is present on eleven socketed axes. One of the most common types of damage is chipping of one or both blade tips, which occurred six times (Fig. 6: 3, 4). It is also possible that the chipping is related to the activities associated with fragmenting the axes. Blunting of the tip was observed in one case. Parallel striations on the blade, which could be the result of use and (re)sharpening, were recorded on three objects. A fracture of the blade tip was recorded once. Breakage of the socket and central part of the cutting edge occurred once too (Fig. 6: 5). In one case, the metal on the blade tip was folded (Fig. 6: 6). Only one of the socketed axes displays an apparent asymmetry of the blade from intense use and (re)sharpening in the past. As with grinding and hammering, some use-related wear can be obscured by patina and corrosion concretions. Wear patterns observed on the axes are consistent with timber working (Kienlin and Ottaway 1998; Roberts and Ottaway 2003; Dolfini *et al.* 2023; Nowak *et al.* 2023). However, the possibility of working with other materials cannot be excluded.

Modern traces can usually be recognised by the lack of patina or a different patina colour (Fig. 8). Drilled holes from sampling inside the socket, in the upper part, are barely visible in 15 cases. In four instances, unpatinated striations were recorded, probably from modern cleaning (Fig. 6: 7). Other modern damage includes chipping of blade tips in four cases, as well as notches in another three, blunting of the cutting edge in three, and flattening of the cutting edge in one.

Two socketed axes of Middle Danube type from the assemblage exhibit casting evidence in the form of residual casting seams and short fills on the sockets. One of the axes is distinctly asymmetrical, likely due to past (re)sharpening and use. The cutting edge of the second axe appears to have been cleaned, making it difficult to determine whether the visible traces are original or the result of later interventions.

The tanged sickle with a rib exhibits a single casting-related feature, a short fills on the tang. Pronounced striations running in various directions suggest that they were formed during the (re)sharpening process. The presence of a folded cutting edge and micro-notches indicates wear consistent with intense past use.

The socketed spearhead displays use-related wear in the form of notches and longitudinal striations on the blade from (re)sharpening (Fig. 6: 8). However, the cutting edges are affected by corrosion, making it uncertain whether some of the observed damage resulted from post-depositional processes.

Table 3. Results of use-wear analyses

Inv. No.	Production	Preparation	Use-wear	Modern traces	Add Inf
B.801:58/4054	**Casting Seams** preserved on both sides. **Deficit Material** two holes in the body below the loop.	**Grinding** striations on the blade, oblique to the cutting edge (partially obliterated). **Hammering** of the blade (more visible on the sides).	N/A	N/A	**Corrosion** Cutting edge heavily corroded.
B.802:58/4055	**Casting Seams** preserved on both sides, removed from the blade.	**Hammering** of the blade (more visible on the sides) and socket's rim. **Grinding** striations on the blade parallel to the cutting edge.	**Chipping** one of the blade's tips.	**Sampling** hole inside the socket (preserved).	**N/A**
B.803:58/4056	**Casting Seams** preserved on both sides. **Deficit Material** hole in the socket. **Porosity** on the socket.	**Hammering** of the blade (on the sides more visible).	N/A	**Striations** perpendicular to the cutting edge. No patination on the cutting edge points to modern origin. **Chipping** one of the blade tips. **Blunting** of the blade edge. **Removing of patina** cuttng edge **Sampling** hole inside the socket (preserved)	
B.804:58/4057	**Casting Seams** preserved on both sides, partially removed from the blade and hammered. **Casting** shrinkage cavity in the middle of the blade (obliterated).	**Grinding** striations on the blade parallel to the cutting edge (front, back and sides). **Hammering** of the blade and the socket's rim.	**Chipping?** one of the blade's tips.	**Sampling** hole inside the socket (preserved)	

B.805:58/4058	**Casting Seams** preserved on both sides, removed from the blade. **Deficit Material** hole in the socket.	**Hammering** of the blade (more visible on the sides) and socket's rim. **Grinding** parallel striations on the blade.	**Chipping** one of the blade's tips.	**Chipping** one of the blade's tips. **Blunting** of the blade's edge. **Sampling** hole inside the socket (preserved)	**Corrosion** Cutting edge heavily corroded.
B.806:58/4059	**Casting Seams** preserved on both sides, removed from the blade. **Deficit Material** irregular hole in the socket. Shape suggests it has been also cracked.	**Hammering** of the blade and the socket's rim.	N/A	**Sampling** hole inside the socket (preserved)	**Corrosion** Cutting edge heavily corroded
B.807:58/4060	**Casting Seams** preserved on both sides, removed from the blade. **Casting** shrinkage cavity in the middle of the blade (obliterated). **Porosity** on the socket.	**Hammering** of the blade (on the sides more visible) and socket rim. **Grinding** striations on the blade parallel to the cutting edge.	**Strations?** Oblique to the cutting edge (near edge) - resharpening?	**Notches** on the cutting edge **Sampling** hole inside the socket (preserved)	
B.808:58/4061	**Casting Seams** preserved on both sides, removed from the blade. **Casting** shrinkage cavity in the middle of the blade.	**Hammering** of the blade (front, back and sides). **Grinding** striations on the blade, parallel to the cutting edge.	**Blunting** of the blade's tip.	**Sampling** hole inside the socket (preserved)	**Corrosion** Cutting edge heavily corroded

Inv. No.	Production	Preparation	Use-wear	Modern traces	Add Inf
B.809:58/4062	**Casting Seams** preserved on both sides, removed from blade.	**Hammering** of the blade and the socket's rim. **Grinding** striations on the blade, parallel to the cutting edge	**Asymmetry of the cutting edge** due to use and (re)sharpening.	**Sampling** hole inside the socket (preserved)	**Corrosion** Cutting edge heavily corroded
B.810:58/4063	**Casting Seams** preserved on both sides, removed from the blade.	**Hammering** of the blade and the socket's rim.	N/A	**Notches** on the cutting edge **Sampling** hole inside the socket (preserved)	**Corrosion** Cutting edge heavily corroded
B.811:58/4064	**Casting Seams** preserved on both sides, removed from the blade. **Deficit Material** one hole in the socket.	**Grinding** striations on the blade, parallel to the cutting edge. **Hammering** of the blade (almost obliterated).	**Chipping** one of the blade's tips.	**Striations** perpendicular to the cutting edge. No patination on the cutting edge points to modern origin. **Flattened** cutting edge. **Chipping** one of the blade's tips. **Sampling** hole inside the socket (preserved)	It is difficult to distinguish modern traces from prehistoric ones **Elemental composition** EMPA
B.812:58/4065	**Casting Seams** preserved on both sides, hammered on the blade. **Casting** shrinkage cavity in the middle of the blade. **Deficit Material** two holes in the socket.	**Hammering** of the blade and the socket's rim.	N/A	**Striations** perpendicular to the cutting edge (modern resharpening?). No patination on the cutting edge points to modern origin. **Sampling** hole inside the socket (preserved)	**Elemental composition** EMPA

B.813:58/4066	**Casting Seams** preserved on both sides, removed from the blade.	**Grinding** striations on the blade parallel to the cutting edge. **Hammering** of the blade and the socket's rim.	**Chipping** one of the blade's tips. **Fracture** one of the blade's tips. **Striations** irregular (perpendicular and oblique to the cutting edge).	**Sampling** hole inside the socket (preserved).	**Corrosion** Cutting edge heavily corroded. **Elemental composition** EMPA
B.814:58/4067	**Casting Seams** preserved on both sides. **Deficit Material** hole in the socket. **Casting** shrinkage cavity in the middle of the blade. **Porosity** on the socket.	**Hammering** of the blade (on the sides more visible).	**Striations** oblique and perpendicular, erased by transverse striations (grinding/sharpening) near the cutting edge.	**Chipping and blunting** one of the blade's tips. **Sampling** hole inside the socket (preserved)	**Elemental composition** EMPA
B.815:58/4068	**Casting Seams** preserved on both sides, removed from the blade.	**Hammering** of the blade and socket's rim. **Grinding** striations on the blade parallel to the cutting edge.	**Breakage** part of the socket. middle part of the cutting edge.	**Notch** may be modern due to lack of patination. **Sampling** cut for metallography(?); hole inside the socket (preserved).	**Elemental composition** EMPA
B.817:58/4070	**Casting Seams** preserved on both sides, removed from the blade. **Deficit Material** hole in the socket.	**Hammering** of the blade and the socket's rim. **Grinding** striations on the blade parallel to the cutting edge (highly obliterated by obligue striations).	**Chipping** one of the blade's tips.	**Sampling** hole inside the socket (preserved)	**Elemental composition** EMPA

Overall, the socketed axe assemblage from the Czarków hoard displays fairly uniform wear patterns related to its production, preparation, and use. Most casting traces were only partially removed through grinding and hammering, sufficient to ensure the tools' functionality, while aesthetic considerations appear to have been secondary. The tools were either minimally used or regularly maintained in the past, as suggested by the limited damage observed on their cutting edges. However, some traces of wear may have been obscured by corrosion or conservation processes (Sych *et al.* 2020). All Lusatian-type axes underwent plastic working (hammering) to enhance the hardness and durability of their blades, intended for demanding tasks such as timber work. These procedures caused deformation of the lower blade sections, whereas the upper parts of the axes remained largely unmodified. Macroscopic observations reveal a high degree of similarity among these axes in the shape of the upper socket, loop, and ornamentation. Notably, a recurring concavity is visible on one side of most Lusatian-type axes, located just below the ornament (Figs 2 and 3). This feature may result from insufficient molten metal volume during casting or from design errors in the pouring system. In terms of manufacturing quality, the axes are well-made and fully functional, aside from isolated casting defects in the socket or loop areas. Some blades exhibit distinct damage, particularly at the edges, including broken tips. This is observed in several Lusatian-type axes and one Middle Danube-type axe. Additionally, broken loops are present on the Middle Danubian specimens. Damages are likely due to intentional fragmentation, possibly related to deposition rather than use. Transverse striations, commonly located in the lower blade sections, suggest that many axes were sharpened shortly before deposition, imparting or restoring their functional properties just prior to being buried. This supports the interpretation that these were usable tools, deliberately removed from circulation and placed into the ground.

CONCLUSIONS

One of the main types of Lusatian socketed axes was named after the hoard from Czarków. The research presented in this article contributes to a deeper understanding of the hoard, offering valuable data on the deposited artefacts and their individual biographies.

The Czarków hoard comprises a significant assemblage of metal artefacts from the Late Bronze Age. It was discovered accidentally in an agricultural area and, according to the discoverers, included 21 artefacts deposited within a ceramic vessel, which has not survived to the present day. This study is the first to examine in detail the circumstances of the hoard's discovery. Beyond typological and chronological classification, the metal objects discovered in 1875 have not previously been subjected to detailed elemental or metalwork-wear analyses.

Our research indicates that the artefacts were manufactured from tin bronze with a low tin content and in many cases similar levels of impurities (As, Ag, Ni, Sb). The elemental composition and correlations among specific elemental ratios (Sb-Ni, As-Ni, Ag-Ni) suggest that some typologically local artefacts – Lusatian-type socketed axes – and stylistically foreign objects may have been produced from a similar alloy, probably from copper of common origin. However, this cannot be conclusively confirmed with the analytical methods used. Our next step will be to conduct stable lead isotope analysis (using Multi-collector Inductively Coupled Plasma Mass Spectrometry – MC-ICP-MS) to determine the source of the copper, which will allow us to draw more specific conclusions about the metal's origin.

A highly plausible, though still open, hypothesis is that foreign artefacts may have been recycled to produce the stylistically local axes. Such a practice would not have been exceptional in prehistory. The cargo of the Langdon Bay shipwreck in the United Kingdom contained objects dated to the Middle Bronze Age (1300-1100 BCE). Most belonged to types typical of northern France and southern England, or to types unknown on the British side of the Channel. It is presumed that the metal was transported as complete objects and fragments and subsequently remelted according to local patterns (Garrow and Wilkin 2022, 26-218). Should this hypothesis be confirmed by the study of further assemblages, it could be suggested that locally-styled axes, such as those from the Czarków hoard, had the capacity to contribute to the construction of both personal and collective identity.

The similarity in the dimensions and weights of the objects, which may indicate casting using the same mould, implies deliberate selection, a conclusion further reinforced by their chemical composition. Moreover, the alloy used to produce the axes was not optimal for everyday tasks in terms of physical properties. This may have resulted from either tin shortages or limited casting expertise. It must also be considered that we may be projecting modern scientific expectations onto past societies, and that such factors may not have been as crucial to them as they appear to us.

Detailed wear analysis has enabled the reconstruction of the production process and an assessment of the functionality of the artefacts. All exhibit evidence of casting in a bivalve mould and finishing by hammering. They also show traces of use, such as notches on the cutting edge, transverse striations, and (re)sharpening striations. These used axes, and in some cases partially restored (via grinding), were withdrawn from circulation for reasons known only to those responsible for their deposition. Wear traces, both production- and use-related, are comparable to those observed on socketed axes of the Czarków type from other contemporary hoards, such as Karmin I-IV (Baron *et al.* 2019).

Observations from both specialist analyses and experimental studies clearly demonstrate that axes – not only those of the Late Bronze Age but also earlier examples – were versatile tools, a kind of Swiss Army knife of their time. They had the capacity to transform the landscape, being used both for clearing woodland and for more precise work with wood, bone, and antler, underlining their ability to transform matter. The literature also suggests their use in metallurgy as anvils (Fregni 2014, 69). Nor should it be forgotten that axes were among the finds from the battlefield on the River Tollense – palstaves have been identified at this Late Bronze Age site in Germany (Inselmann *et al.* 2024). This allows us to argue that they were also successfully used as weapons.

The picture that emerges is of axes as objects with capacities to transform matter and the landscape, to inflict violence, and to contribute to the creation of identity. This renders them truly exceptional and important for prehistoric communities and makes the Czarków hoard itself even more significant than previously thought.

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