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CONTENTS

FRAGMENTED HOARD FROM THE RECYCLE BIN: SZENTES-NAGYHEGY I

János Gábor TARBAY*

The paper revisits an old hoard from Szentes-Nagyhegy (Csongrád-Csanád County, Hungary). As one of the 'workshop hoards' dated to the Ha B1 period, this assemblage provides a case study to elaborate on different casting defect types and the technological classification of hoarded objects associated with metallurgy. Our results suggest that the hoard consists of different types of unusable or unfinished ingots and as-casts, as well as various finished products without observable use-wear traces, and with micro-wear traces or repair marks that suggest heavy wear. Almost all the finds were deposited in an intentionally fragmented state.

Keywords: Late Bronze Age (Ha B1), metallurgy, casting defects, hoards
Cuvinte-cheie: Bronz Târziu (Ha B1), metalurgie, defecte de turnare, depozite de bronzuri

INTRODUCTION

Szentes-Nagyhegy I (Csongrád-Csanád County, Hungary) is a long-known hoard that has been published several times since the end of the 19th century. From time to time, it is worth revisiting such assemblages even after a hundred years, as the artefacts they contain can still provide us with new information about the past lives of Late Bronze Age peoples. Our paper was inspired by the need to understand the technological characteristics of the deposited objects and, through them, the principles of hoard composition. These are questions that both József Hampel and Amália Mozsolics were concerned about, but neither of them has discussed them fully in connection with the Szentes-Nagyhegy Hoard I, leaving us plenty of aspects to elaborate on.[1]

The Szentes-Nagyhegy Hoard I appeared first in József Hampel's paper in *Archaeologiai Értesítő*, where he introduced the new purchases of the Hungarian National Museum (HNM) between April and September 1892.[2] This work described the finds that arrived at the museum and contained drawings of the objects. The hoard was donated to the HNM in 1892 by Sándor Farkas, an amateur archaeologist and pharmacist in Szentes,[3] in three rounds. The first purchase contained solely Late Bronze Age artefacts and was inventoried (Inv. Nos. 1892.31.1–38) as a hoard (IA, Fig. 1–2, Fig. 3/23, 25–32). The other two purchases (Inv. Nos. 1892.43.1–9 and 1892.84.183–186) were brought to the HNM along with objects dated to different periods (IB, Fig. 3/33–40 and IC Fig. 4/41–44). Notes in the 1892 inventory book indicate that these finds belong to the same assemblage. Not much is known from József Hampel's works and the museum's inventory

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1 Hampel 1896, 185; Mozsolics 1985b, 26.

2 Hampel 1892, 372–374, pl. 1.

3 https://www.arcanum.com/hu/online-kiadvanyok/Lexikonok-magyar-eletrajzi-lexikon–7428D/f–7547C/farkas-sandor-nemedi–75531/ (last accessed: 26.04.2024, 8:00).

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book entries about the hoard's circumstances of discovery, and findspot, except for the name of the site: Szentes-Nagyhegy.[4]

This area is a low hill situated on the north-western edge of Szentes City. The Nagyhegy is a multi-period and multi-hoard site, the Late Bronze Age occupation of which is summarized by Gábor V. Szabó in detail. The earliest phase was marked by a Tumulus culture settlement and cemetery dated to Reinecke Br B2/C. Ceramics and metal finds from the site suggest that the occupation continued during the Br D–Ha A1 period.[5] 'Hoard II', and the surrounding hearth and house remains from the vineyard of Mrs. Váczi Imre, are dated around the end of this period.[6] The final stage of the Nagyhegy, Ha B1, is represented only by Hoards I and III. The latter was discovered in the vineyard of Mrs. Sándor Komlósi in 1938 during deep tillage. The composition of Hoard III differs from Hoard I as it consists of metal vessels, sickles, axes, numerous bracelets, and a few ingots.[7]

Following József Hampel's works, the Szentes-Nagyhegy Hoard I appeared in several publications, which were usually concerned with the typo-chronological evaluation of the find.[8] Already József Hampel placed the assemblage to the end of the Bronze Age.[9] In 1955, István Foltiny assessed two axes from this hoard, one undecorated (Fig. 1/5) and one with pseudo-wings (Fig. 1/4), and he dated the latter to the Ha B.[10] In 1968, Wilhelm Albert von Brunn dated this hoard to the Jászkarajenő-Uzsavölgy Phase (Ha A2) based on the pseudo-winged socketed axe, and socketed axes which we classify today as Debrecen and Palotabozsok types (Fig. 1/4–7; 2/13; 3/33).[11] One of Amália Mozsolics's works that she wrote perhaps before 1984, took on the original idea of József Hampel and interpreted the assemblage as a 'foundry hoard' (öntőműhely). At that time, she had been hesitant to decide whether this hoard belonged to her Gyermely horizon (Ha A2) or the Hajdúböszörmény horizon (Ha B1),[12] but later she dated the hoard without doubt to the latter.[13] In 1984, Tibor Kemenczei dated the hoard to "the second phase of the Gáva metal industry", which is roughly similar to Mozsolics's concept; he also briefly discussed the typo-chronological characteristics of several socketed axes and the spearhead (Fig. 1/1–2, 4–9; 2/11).[14] More than a decade later, he listed the Szentes-Nagyhegy Hoard I as an example for Hoard Horizon IVa (Ha B1) based on axes [of Debrecen and Palotabozsok types] (Fig. 1/2, 5, 7–8, 10; 3/33) and a 'late Fuchsstadt- and Jenišovice type' bronze cup, identified a few years back as Spišská Belá type by Pál Patay (Fig. 2/14).[15] Like Tibor Kemenczei, Christopher Pare also dated the Szentes-Nagyhegy Hoard I to a phase ('Depotfundstufe IV') equivalent to Ha B1.[16] By the end of the 20th century, all objects of the Szentes-Nagyhegy Hoard I were presented to the academic community, who agreed on their relative chronology without much debate. Thus the hoard was assigned to phases equivalent to Hermann Müller-Karpe's Ha B1.

4 Inventory Book of the HNM 1892.31, 43, 84; Hampel 1892, 372–374, pl. 1. József Hampel re-published the hoard in 1986. Hampel 1896, 185, pl. 193.

5 V. Szabó 1996, 13, 21–22; V. Szabó 2002, 18–19.

6 Csallány 1939, 58; Kemenczei 1984, 183–184; Mozsolics 1985a, 193; V. Szabó 1996, 22, footnote 33.

7 see Csallány 1939; Mozsolics 1985a, 193; V. Szabó 1996, 22; Mozsolics 2000, 77–78; V. Szabó 2002, 18–19.

8 Notable publications: Csallány 1939, 58; Foltiny 1955, 86, 90, fig. 57/11; 59/1; Patay 1968, 75, fig. 22/23; von Brunn 1968, 47, 55, 292, Tab. 1; Kemenczei 1984, 184, pl. 206/1–22; 207C/1–7; Mozsolics 1985b, 26–28, No. 84, pl. 14/1–5; 16/2; Patay 1990, 55, pl. 39/83; Kemenczei 1996, 61, 84, figs. 31–33; Pare 1998, 360, No. 40; Mozsolics 2000, 76–77, pl. 92; Czajlik 2012, 70.

9 Hampel 1896, 186.

10 Foltiny 1955, 86, 90, 125, fig. 57/11; 59/1.

11 Wilhelm Albert von Brunn discussed the finds from Hoard I and Hoard III together in his statistics. See von Brunn 1968, 47, 55, 292–293, Tab. 1, fig. 4/30, 32–37.

12 Mozsolics discussed the contents of the Szentes-Nagyhegy Hoard I and another hoard, what was later called Szentes area IV (donated also by Sándor Farkas) together, stressing their uncertain attribution. Kemenczei 1984, 183–184, pl. 204–205; Mozsolics 1985b, 26–28, 68, No. 84, pl. 14/1–5; 16/2; Mozsolics 2000, 78–79, pl. 96–97.

13 Mozsolics 1985a, 193; Mozsolics 2000, 76–77, pl. 92.

14 Kemenczei 1984, 77–78, 81–83, 184, pl. 206; 207C.

15 Patay 1990, 55–56, pl. 39/83; Kemenczei 1996, 61, 80, 84, 87, fig. 31–33.

16 Pare 1998, 360, no. 40.

Fig. 1. Szentes-Nagyhegy, Hoard IA.

Fig. 2. Szentes-Nagyhegy, Hoard IA.

Fig. 3. 25–32. Szentes-Nagyhegy, Hoard IA; 33–40. Hoard IB.

Fig. 4. Szentes-Nagyhegy, Hoard IC.

TYPOLOGICAL COMPOSITION

The hoard what we call today Szentes-Nagyhegy Hoard I after Mozsolics and Kemenczei's above-mentioned works contains the following objects: one spearhead with a pronounced midrib (Fig. 1/1), hilt fragment of a flange-hilted sword (Fig. 2/17), Debrecen-type socketed axes (Fig. 1/2–3; 2/13; 3/33; the axe blades on Fig. 2/12 and 3/34 are uncertain), two pseudo-winged socketed axes (Fig. 1/4; 4/42), Palotabozsok-type socketed axes (Fig. 1/5–10; 2/11; 4/41), one perforated sheet (Fig. 2/15), a Máriakéménd-type annular ring (Fig. 3/35), a Spišská Belá-type bronze cup (Fig. 2/14), a sheet metal fragment (Fig. 2/16), a bar ingot (Fig. 2/18–19, Fig. 3/36), a triangle-shaped ingot (Fig. 2/20), plano-convex ingots (Fig. 2/21–22, 24; 3/25–31; 4/43), two unclassifiable cast metal objects (Fig. 3/32; 4/44). Of the forty-four objects, forty-three have been preserved, weighing 11,432.2 g.

The spearhead (Fig. 1/1) belongs to Tibor Bader's Variant B of Group C, which has numerous analogues from the Carpathian Basin to west-Central Europe. Based on two casting moulds from Oşorhei (Br D–Ha A1) and Polgár M3/1 (Ha A2–Ha B1), they were probably produced locally in the Carpathian Basin. Such cast spearheads with pronounced midribs circulated for a long time, during the Late Bronze Age, they occurred mostly between Ha A1 and Ha B1.[17] Of the Debrecen-type axes,[18] only one can be evaluated properly owing to its complete rib motif (Fig. 1/2). This decoration appears on stray-find axes from Austria and Slovakia and hoarded objects from Hungary, Romania and Slovakia dated to the Ha B1.[19] The two sides of the pseudo-winged socketed axe (Fig. 1/4) look different due to technological reasons. One shows a horizontal rib above the wings (Side A) (Fig. 1/4A), and the other lacks this feature (Side B) (Fig. 1/4B). The analogues of the ribbed side are distributed in Hungary, Austria, Bosnia and Herzegovina, the Czech Republic, Slovakia, Romania, Moldova and Poland. The earliest ones can be dated to Ha A1, while most of them were deposited during the Ha B phase, essentially Ha B1 and Ha B2.[20] The ribless Side B

[17] See with further references in Bader 2015, 376, tab. 1/16; Tarbay 2019, pl. 14/28, e–f; Tarbay 2022a, 33–34, fig. 2/1; Tarbay 2023b, 76–77, fig. 1/3.

[18] Dergačev 2002, 174–176.

[19] 'Austria', Boldeşti-Scăeni (Ha B1), Bratislava (incomplete hoard, ca. Ha B1), Kemendollár (Ha B1), Nyírpazony-Újszőlő (Ha B1), Slovakia. See with further references in: Tarbay 2023a, 129–130, fig. 2/2; 13; 14/2.

[20] Tarbay et al. 2023, 93, fig. 8/10. Further analogues are: Belica (Phase II), Ciceu-Corabia (Ha B1/Ha B2), Gemer area (stray find), Guşteriţa II (Ha A1), Hînceşti (stray find), Máriapócs-Páskum (Br D–Ha A1), Martonyi I (Ha B), Pécs area (stray find), Pyhrn (stray find), Şpălnaca II (Ha A1). Novotná 1970, pl. 38/672; Mayer 1977, pl. 82/1134; Petrescu-Dîmboviţa 1977, pl. 148/16; 193/22; Marinescu 1979, pl. 1/6; Vidović

has counterparts in Hungary, Czechia and Slovenia and is dated to the Ha B1 phase in East Hungary.[21] Most of the deposited socketed axes are loopless and have a thin, chisel-like body, thick collar, and an oval cross-section (Fig. 1/5; 2/11; 4/41). These tools, called Palotabozsok type,[22] are local Carpathian axes with parallels from Hungary, northern Croatia, Serbia and Romania. They were present for a long time in the Late Bronze Age material from (Br D)/Ha A1 to Ha B1 but became frequent towards the Ha B1 period.[23] The small ring fragment with lozenge cross-section (Fig. 3/35) was part of a Máriakéménd-type annular ring. Such jewellery is distributed in a large territory between east- and west-Central Europe. Máriakéménd-type rings are usually found in hoards and can be dated between the Ha A1 and Ha B1(Ha B2) periods.[24] Previous research sorted items similar to the bronze cup fragment (Fig. 2/14) into different classes,[25] here we follow the classification proposed by Pál Patay. He determined the object as a Spišská Belá-type cup and dated it to Ha B1. This is a rare type that sporadically appears in the Carpathian Basin (e.g., Spišská Belá, Hajdúsámson).[26] Apart from finished products, the hoard contains different types of ingots[27] cast in regular bars (Fig. 2/18–19; 3/36),[28] triangle (Fig. 2/20)[29] and plano-convex (Fig. 2/21–22, 24; 3/23, 25–31, 37–40; 4/43) shapes.[30]

Analogues to the Szentes-Nagyhegy Hoard I are mostly from the Carpathian Basin but the find shows connections with the northern Balkans, Austria and Moravia as well. Its typological composition corresponds to the tendencies observed in East Hungary, as it shows connections with local hoards there such as Nagyrábé I or Hévízgyörk, and also with Southern Transdanubian assemblages.[31] The hoard contains objects that are characteristic of multiple periods, mainly between Ha A1 and Ha B1 (e.g., spearhead of Variant B of Group C, pseudo-winged socketed axe, Palotabozsok- and Máriakéménd-type rings). The Ha B1 dating proposed by research can be further strengthened with the fine parallels of the Debrecen-type socketed axe No. 2, the analogues of the rib pattern on the A- and B-sides of the pseudo-winged axe, and the dating of the bronze cup.

A DIFFERENT CLASSIFICATION

The true value of a hoard like Szentes-Nagyhegy I lies in the technological character of the deposited objects. József Hampel already identified the Szentes-Nagyhegy Hoard I as a group of objects originating from a foundry (Hungarian 'öntőműhely'). His arguments rested on the content (plano-convex ingots, defective products and incomplete casts) and condition (broken

1989, pl. 4/11; Kobály 1999, fig. 2/4; Almássy et al. 2001, pl. 1.6; Cerna–Topal 2013, fig. 2/1; V. Szabó 2019, fig. 115. The Szentes-Nagyhegy axe has a body similar to the Palotabozsok type, although most socketed axes with these rib patterns are rather squat. Finds with similar form characteristics can be mentioned from the Gemer area, Hradec, Hînceşti, Máriapócs-Páskum, Pyhrn. Novotná 1970, pl. 38/672, 676; Mayer 1977, pl. 82/1134; Almássy et al. 2001, pl. 1.6; Cerna–Topal 2013, fig. 2/1.

21 Belica (Phase II), Doubravice Hill I (Ha B2 – Ha B3), Jevíčko (Ha A1), Lázy, Újszentmargita (Ha B1), 'Moravia/Slovakia', Tiszavasvári (Ha B1), Rátka (stray find), Szentgál (stray find), Trate, Vladislav, Vrhnika-okolica. Kemenczei 1969, pl. 20.7; Vidović 1989, pl. 4/4; Říhovský 1992, pl. 66/943; 65/933–935; Teržan 1995 (ed.), pl. 16/90–91; Mozsolics 2000, pl. 111/6; 112/3; Ilon 2011, fig. 3.6; Vích 2017, fig. 8.2.

22 Dergačev 2002, 176.

23 See with further references in Tarbay 2022a, 36–37, fig. 2/2.

24 See with further references in Tarbay 2022a, 44.

25 Nestor 1935, 51, no. 6; Lindgren 1938, 69, footnote 42; Childe 1948, 195; Patay 1990, 55.

26 Patay 1990, 55–56, pl. 79B; Novotná 1991, 23.

27 No. 44 is difficult to classify. The breakage of the object seems modern. Its entire surface is heavily ground by a modern polishing tool. Its form indicate a cuboid ingot.

28 Mozsolics 1985b, 23–33; Czajlik 2012, 74; Tarbay 2022a, 50.

29 See with further references in Tarbay 2016, 99.

30 A classification of the ingots in the Szentes-Nagyhegy Hoard I were provided by Zoltán Czajlik who sorted a few examples to the Gór type (probably nos. 22–23). According to Czajlik's results, the Gór type has a diameter of 4–5 cm, a total weight of 20–30 g, and it is usually alloyed with tin. Known examples distribute from the Carpathain Basin to France. Mozsolics 2000, pl. 92/18–19; Czajlik 2006, 58; Czajlik 2012, 70.

31 Mozsolics 2000, pl. 62–65; Tarbay 2021; Tarbay 2022b, fig. 5.

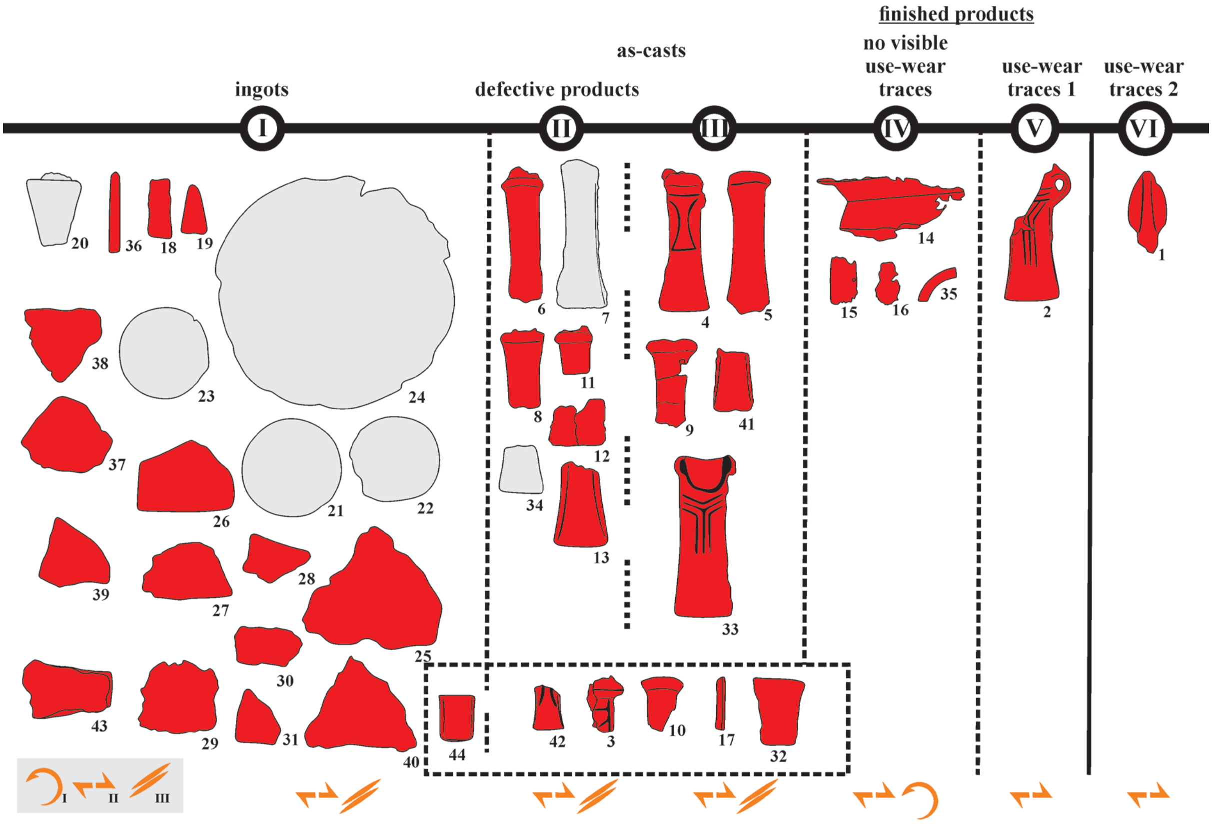

Fig. 5. Selection of Szentes-Nagyhegy Hoard IA–C. I. bending, II. breaking, III. tool impacts; red: broken, grey: complete.

objects, split ingots) of the assemblage.[32] Amália Mozsolics also recognised this pattern and proposed that the Szentes-Nagyhegy Hoard I contains defective products for remelting, a 'casting jet' [triangle-shaped ingot], and round plano-convex ingots.[33] These observations on the nature of this hoard are indeed correct, but there is much to reveal about its composition. During our revision of the Szentes-Nagyhegy Hoard I, the objects were sorted into different technological groups based on production technological and use-wear phenomena on their surfaces: Group I (ingots) – Nos 18–31, 36–40, 43; Group II (as-casts, defective products) – Nos 6–8, 11–13, 34; Group III (as-casts) – Nos 4–5, 9, 33, 41; Group IV (finished products without observed use-wear traces) – Nos 14–16, 35; Group V (finished products with level 1 use-wear traces) – No. 2, Group VI (finished, heavily used products with level 2 use-wear traces) – No. 1 (Fig. 5).[34]

This hoard primarily contains *ingots* (Group I), which dominate the assemblage in quantity and total weight, measuring almost 8.5 kg (8456.4 g). Macroscopic observation was insufficient to decide that these are pure copper or copper alloy ingots, produced during casting from the residue metal in the crucibles. A future elemental composition analysis can provide conclusive evidence on this matter. However, the greyish, silverish surfaces of most ingots and the porous breakage surfaces of some (Fig. 2/24; 3/25) support the latter scenario based on the study of the Budakeszi hoard, which contains ingots with similar colour and surface characteristics.[35] In this hoard, we observed a phenomenon which most probably is lead segregation.[36]

32 Hampel 1896, 186.

33 Mozsolics 1985b, 26, 28, 38. Gábor V. Szabó also entertained the idea that in the area of Szentes, assemblages like Hoard I may be a sign for a local metal distribution centre or place of cult. V. Szabó 1999, 70.

34 Unclassifiable: Nos. 3, 10, 17, 32, 42, 44.

35 see Tarbay–Maróti 2023.

36 Harrison et al. 1981; Hughes et al. 1982.

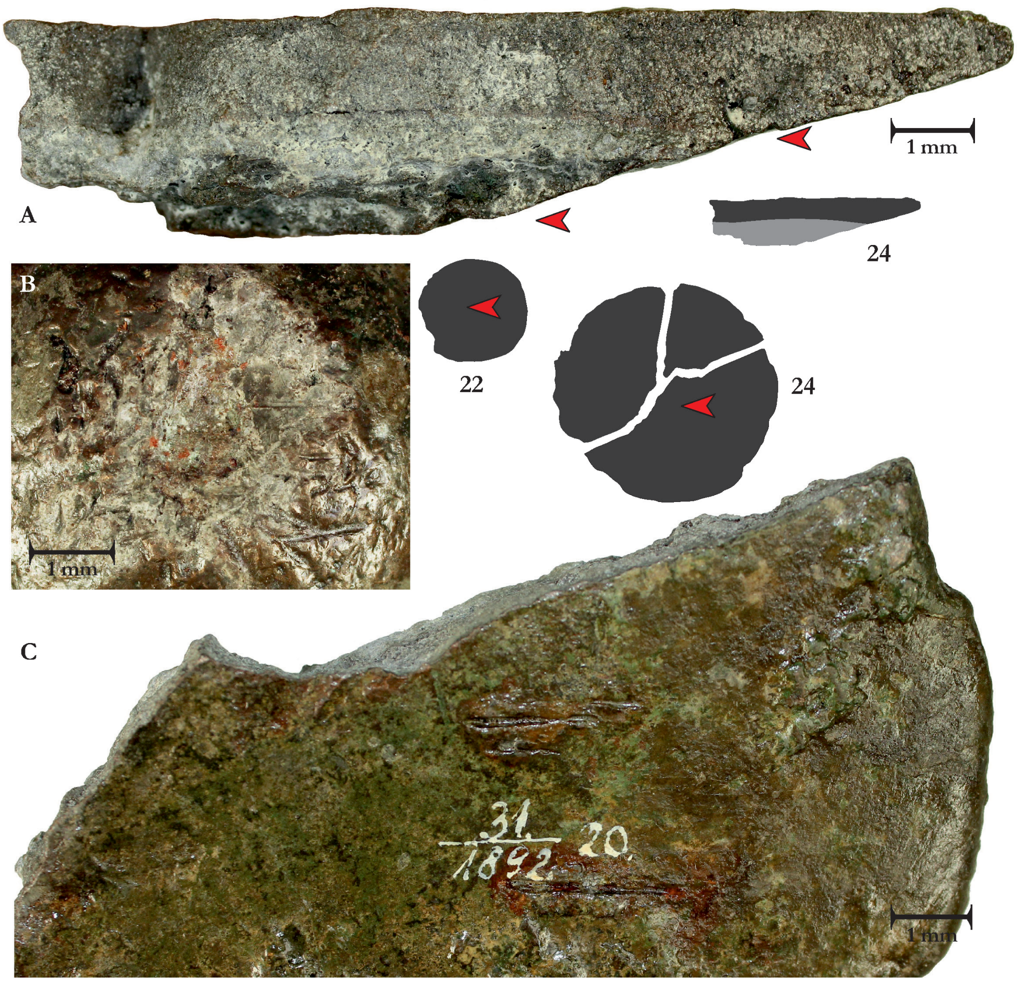

Fig. 6. A. Layers and lead segregation of a plano-convex ingot; B. tool impacts, C. modern tool impacts.

On plano-convex ingots Nos. 21–22 and 24–25, additional layers were visible on the convex sides, which were at the bottom during casting (Fig. 2/21–22, 24; 3/25). These parts have a greyish colour and brittle surfaces, just like corroded lead. The segregated layer is most visible along the modern fracture surface of the largest plano-convex ingot (Fig. 2/24; 6/A). Higher mass percentage of lead in ingots, which is probably the case here, is also characteristic of the Ha A2–Ha B1 and Ha B1 periods, observed in other Hungarian assemblages as well.[37]

A large number of objects are as-casts (Groups II and III). These are objects that have not received essential post-casting treatment,[38] such as the removal of casting seams, repair of casting defects, cold hammering, annealing, grinding, and sharpening of the cutting edges. These objects look nearly the same since they were removed from the casting mould. Within this find group, we differentiate a special category of objects, called Group II, made up of *defective products*. As-casts that received no further post-casting treatment and had several, serious casting defects that prevented their primarily intended function were sorted into this category. Such objects most likely did not leave the foundry and were immediately selected for recycling after casting. In the Szentes-Nagyhegy Hoard I, well-identifiable defective products were socketed axes of Palotabozsok and Debrecen types. However, defects were also observable on other as-casts (Group III) and finished products (Group V), two of which showed traces of use (Group VI). This exemplifies that

[37] Liversage–Pernicka 2002; Czajlik 2012, 94–95, 97–98.

[38] In rare cases, they may receive minimal 'post-casting treatment', such as the removal of casting jets or testing of edges.

Tab 1. Casting defects in the Szentes-Nagyhegy Hoard I.

Objects	**Group**	**Casting defects total**	**Core rising**	**Core shift**	**Flash defect**	**Incomplete castings**	**Porosity**	**Surface shrinkage**	**Solid castings**	**Misrun**	**Mismatch**	**Mould imprints**
			Fig. 7.D	Fig. 8.A, C	Fig. 7.B–C	Fig. 9.A–B	Fig. 10	Fig. 11	Fig. 7.A	Fig. 12	Fig. 13A–B, D–G	Fig. 14
Spearhead 1	VI	2	0	0	0	0	0	1	0	0	1	0
Socketed axe 2	V	4	0	1	1	0	1	1	0	0	0	0
Socketed axe 3	III/IV	2	0	0	0	1	0	0	0	0	1	0
Socketed axe 4	III	4	0	0	0	1	1	1	0	0	1	0
Socketed axe 5	III	3	1	0	1	0	0	1	0	0	0	0
Socketed axe 6	II	4	1	0	1	0	0	0	1	0	0	1
Socketed axe 7	II	4	0	0	1	1	0	1	0	0	1	0
Socketed axe 8	II	3	0	0	0	0	1	1	0	0	1	0
Socketed axe 9	III	1	0	0	0	0	1	0	0	0	0	0
Socketed axe 10	III/IV	2	0	0	0	0	1	0	0	1	0	0
Socketed axe 11	II	4	1	0	1	0	1	1	0	0	0	0
Socketed axe 12	II	3	0	1	0	0	1	0	0	0	1	0
Socketed axe 13	II	3	0	1	0	0	1	1	0	0	0	0
Socketed axe 33	III	2	0	0	0	0	1	1	0	0	0	0
Socketed axe 34	II	5	0	0	0	1	1	1	0	0	1	1
Annular ring 35	IV	0	0	0	0	0	0	0	0	0	0	0
Socketed axe 41	III	1	0	0	0	0	0	0	0	0	1	0
TOTAL			3	3	5	4	10	10	1	1	8	2

the presence of a casting defect does not necessarily make an object a dysfunctional defective product, as Late Bronze Age craftsmen often ignored, tolerated, and repaired these defects.[39]

Casting defects identified on the surface and inside the objects from the Szentes-Nagyhegy Hoard I are core rising (Fig. 7/D), core shift (asymmetry) (Fig. 8/A, C), flash defect (Fig. 7/B–C), incomplete castings (Fig. 9/A–B), porosity (shrinkage or gas porosity) (Fig. 10), surface shrinkage (Fig. 11), solid castings (Fig. 7/A), misrun (Fig. 12), mismatch (Fig. 13/A–B, D–G), and mould imprints (Fig. 14). Recognition of the macroscopic characteristics of these casting defects were essential in the definition of Group II. However, as defects are usually the result of several individual factors or their combination, macroscopic observation is often insufficient to determine the causes of their formulation in an object, only possible scenarios can be suggested. For a more thorough analysis, casting simulations, experimental casting, and 3D imaging, such as neutron imaging, are needed to reveal the internal structure of objects and to quantify the results of the study.[40] Here, a brief description is given of the defects observed on the surface and break surface (inside) of the finds from the Szentes-Nagyhegy Hoard I. This overview does not encompass all Bronze Age casting defects but offers a proper selection of the most typical ones.

Objects intended to be cast hollow, like socketed axes, spearheads, arrowheads, and chisels, became solid due to multiple causes related to the casting core. During casting, *core-rising defects* can occur (Fig. 7D), resulting in the partial or complete ejection of the casting core from the moulds. The Szentes-Nagyhegy hoard provides examples of both partial ejection (No. 11)

[39] Gener 2011.

[40] Tarbay et al. 2021.

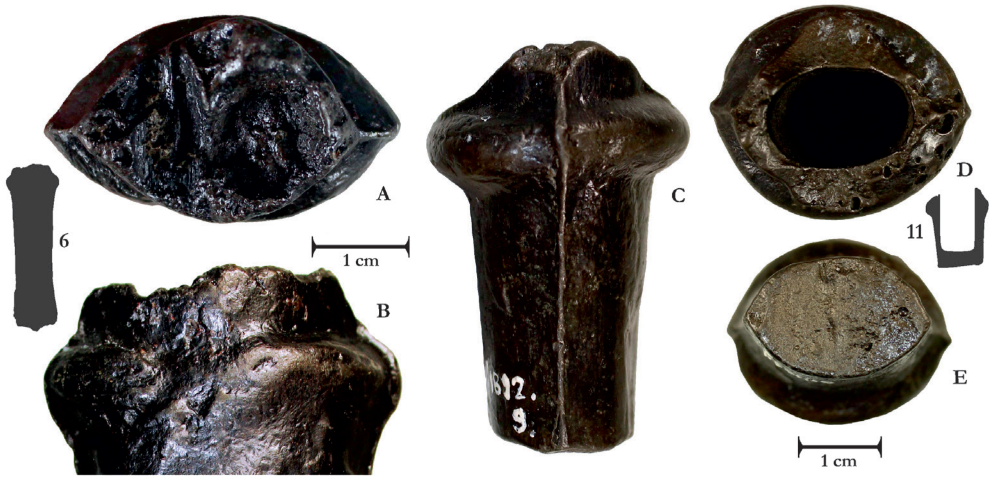

Fig. 7. A. Solid cast; B. Flash defect and shrinkage; C. Flash defect; D. core rising; E. melted break surface.

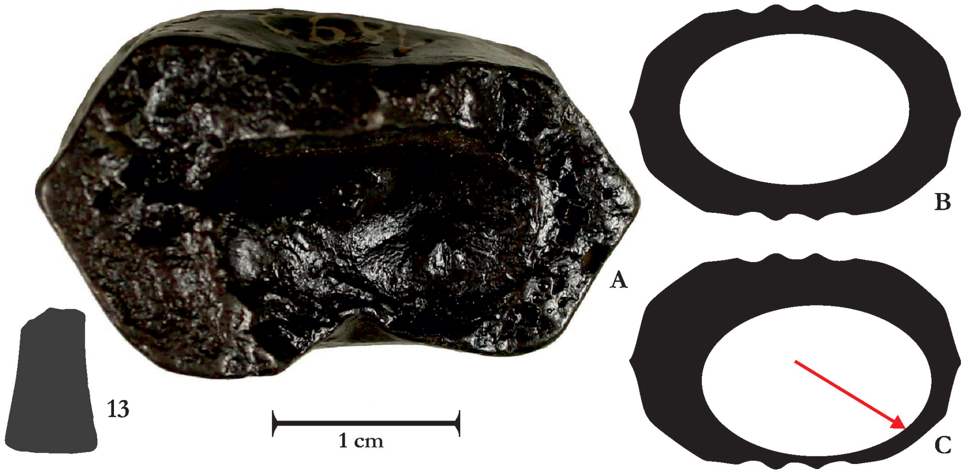

Fig. 8. A. Core shift/asymmetry; B. symmetric socket; C. asymmetry.

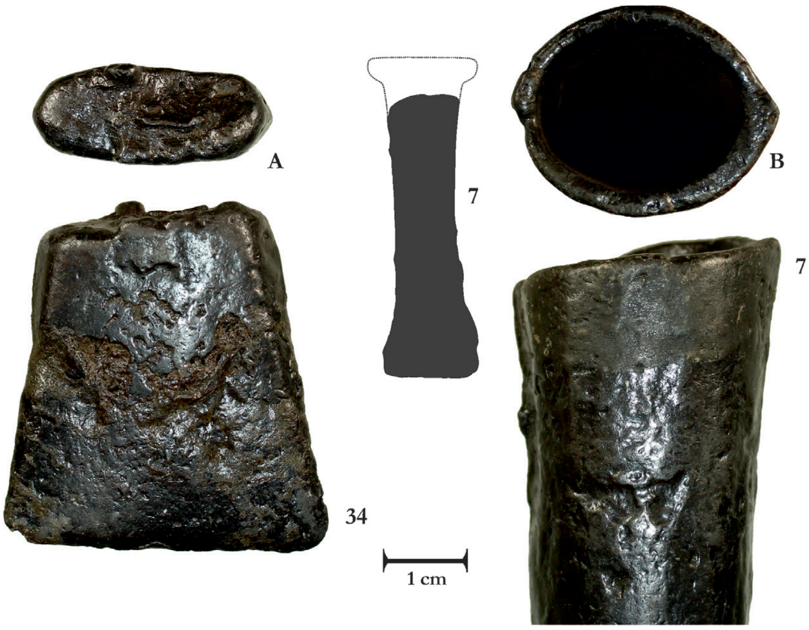

Fig. 9. A. Incomplete cast (axe blade); B. incomplete cast, missing upper part.

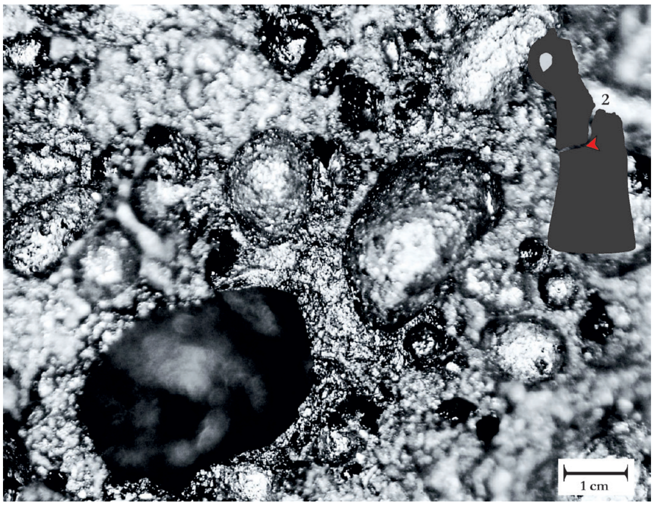

Fig. 10. Porosity.

Fig. 11. A–C. Shrinkage.

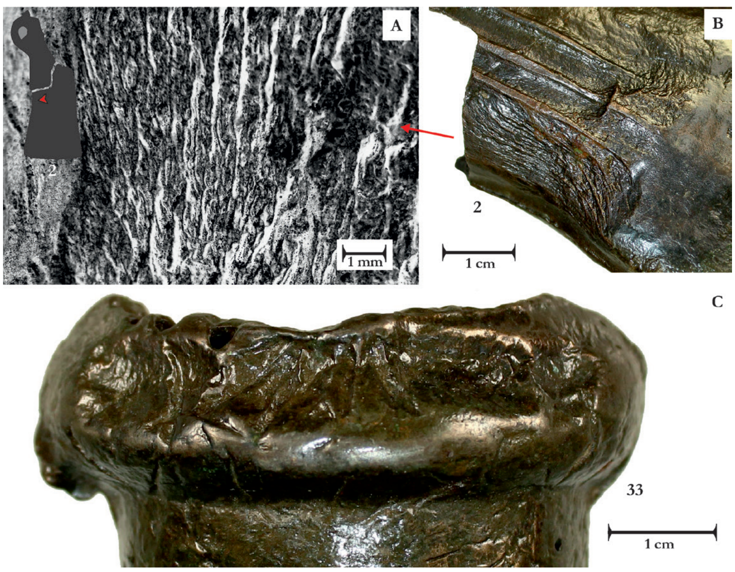

Fig. 12. A. Misrun (Szentes-Nagyhegy IA, No. 10); B–C. Misrun (Jászkarajenő).

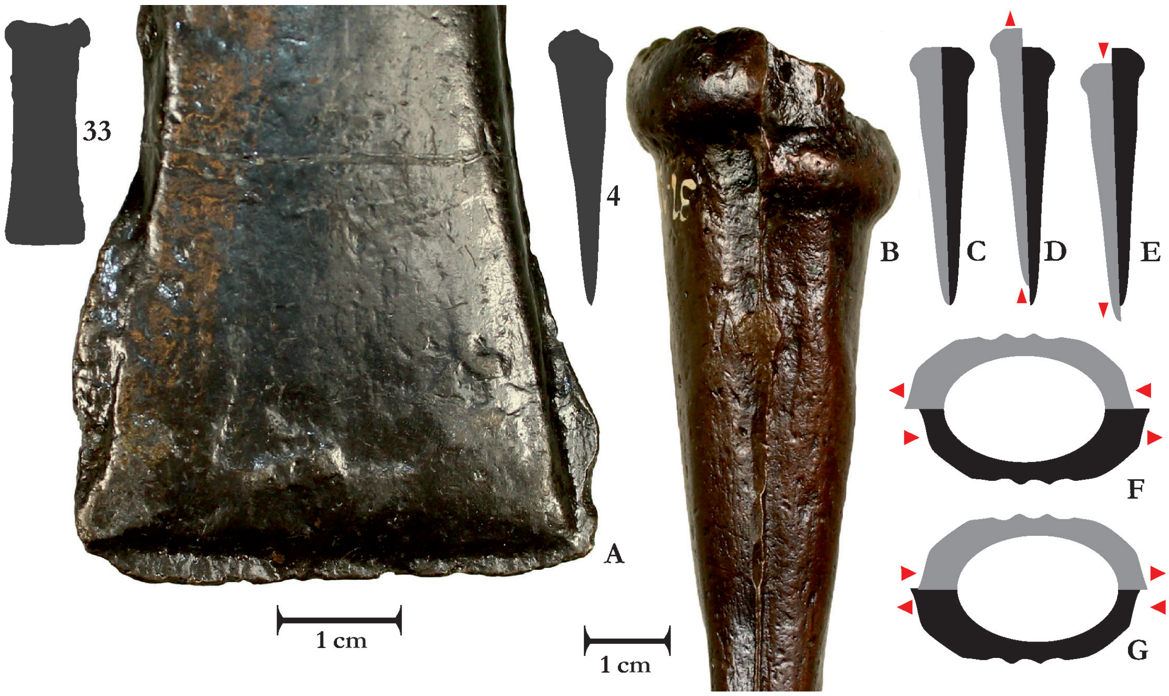

Fig. 13. A, F–G. Horizontal mismatch defect; B, D–E. Vertical mismatch defect; C. Matching halves.

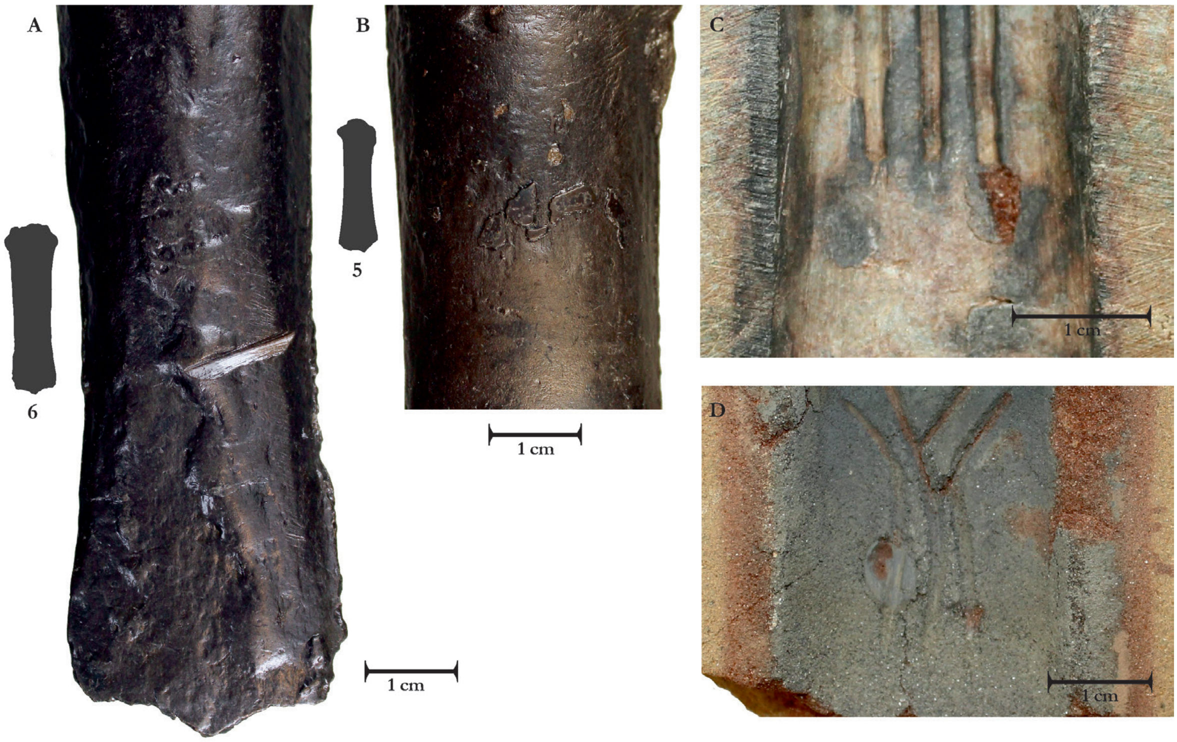

Fig. 14. A–B. Mould imprints; C. Damaged mould negative of a used experimental casting mould.

that caused a too-short socket for hafting, and complete ejection, which led to a *solid-cast object* (No. 6) (Fig. 7A).[41] Analogues of this defect are observed in the Transdanubian Nagydobsza hoard from the same period as the studied ones. Causes of the core rising defect include too-light casting core and improperly pre-heated moulds (or core), which contribute to the formation of gases that result in the ejection of the core. The remedy for this defect is heating the moulds before casting, and the application of a fixing rod, the technical solution of which is observed only on the spearhead (Fig. 1/1), but not the defected Palotabozsok-type axes.[42]

Asymmetric walls of socketed objects indicate the displacement or *shifting of the casting core* during casting, dissimilar negatives, or irregular-shaped casting cores. Consequently, the defect is either predetermined during the production of the mould halves and cores or formulated during the casting process, probably due to a similar reason as a core-rising defect. Due to this asymmetry, one side of the sockets becomes thinner than the other (Fig. 8/C), making the objects less resistant to mechanical stress. The defect is common among all kinds of objects cast with a core, such as spearheads, socketed axes, arrowheads, disc-butted axes, etc.[43] The most extreme example of this defect type is the No. 13 socketed axe, which has a wall less than a millimetre thick on one side (Fig. 2/13; 8/A).

Flash defects usually occur when the two mould halves mismatch. These are typically large casting seams or burrs. Flashes can occur on the rim area of the socketed axes when it becomes a thick projection due to excess metal which partly fills the pour cup of the negative. This kind of flashes are characteristic of the finds from the Szentes-Nagyhegy Hoard I (Fig. 1/5–6; 2/11; 7/B–C). The occurrence of this defect is probably connected to the improper shape of the casting core or its rising during casting. Flashes can be broken off, then their traces can be further smoothed by grinding stones and hammering. There are several reasons behind the formation of flash defects, such as damaged moulds, improperly matching mould negatives or the displacement of mould halves during casting.[44]

Both *misrun defects* (Fig. 12) and *incomplete castings* (Fig. 9) can be characterised by rounded edges. Misruns usually occur as small, round-edged holes on the walls of socketed axes or the blade or handle parts of flanged sickles. The breakage surface of one of the socketed axes from Szentes-Nagyhegy shows a macroscopic trace indicating a misrun (Fig. 12/A). Further characteristic examples are known in the Jászkarajenő hoard (Fig. 12/B–C). An object becomes an incomplete cast when parts of it missing to a greater or lesser extent. For instance, a socketed axe may lack any parts from the smallest (loop, rim) to the larger ones (blade, upper part). A proper example of the latter is the No. 34 socketed axe, of which only the blade part has been cast (Fig. 3/34; 9/A). These defects occur when the metal flowing through the channels does not fuse properly and does not fill the cavity of the mould, leaving incomplete, round-edged surfaces in the casting. In industrial casting, these defects have the same causes: low casting temperature, insufficient melt fluidity, mould defects (faulty pattern, gating system, risers), insufficient metal for casting in the crucible, and an improperly manufactured core. According to Ó Faoláin and Northover, incomplete casting can occur if the mould halves are not pre-heated properly.[45]

Pores on the breakage surface of the castings, and sometimes also on their surfaces are a result of *porosity*. There are two main types of this defect concerning Late Bronze Age castings: gas porosity and shrinkage porosity. Gas porosity usually occurs as globular, almost spherical,

[41] Another explanation is that the object was intended to be solid.

[42] Tarbay 2016, fig. 6/2, 11; 14/12; Tarbay 2018, 245–246; Tarbay 2022a, 56, fig. 3/1.

[43] Mozsolics 1985b, pl. 13/3; Tarbay 2016, fig. 6/3; Tarbay 2018, 246.

[44] Bridgford 2000, 122; Quilliec 2007a, 406; Rajkolhe–Khan 2014, 379, fig. 9; Tarbay 2018, 245; Molloy 2019, 17; Molloy–Mödlinger 2020, 196; Tarbay 2022a, 67, fig. 3/6, pl. 56/A–B.

[45] Mozsolics 1985b, pl. 13/1; Ó Faoláin–Northover 1998, 73; Mödlinger 2011, 13; Rajkolhe–Khan 2014, 377–378, fig. 5; Tarbay 2016, fig. 6/2; Atlas 2017, 35; Tarbay 2018, 246; Tarbay 2022a, pl. 56C; 57D.

round-edged pores in the material. It is caused by metal vapours and gases generated during the casting process, which then allow air and gas inclusions to be formed inside the castings (Fig. 10). Improper drying of the casting moulds and cores can also trigger gas porosity. Shrinkage porosity occurs when the wall of the castings does not solidify simultaneously and the liquid metal used to replenish the shrinkage is not provided. Morphologically, it can be characterised by elongated cavities inside the cast. However, the two types of porosity are hardly distinguishable macroscopically, only advanced analytical techniques such as neutron imaging can reveal their differences. Multiple pores concentrated in one area can transform the casting structure susceptible to fracture. Porosity is quite severe among the axes in the Szentes-Nagyhegy Hoard I. Pores appear both on their surfaces and insides, sometimes in connection with surface shrinkage.In some cases, the socketed axes of the studied hoard were fragmented along these porous areas (e.g. Fig. 1/2, 10; 2/12–13; 3/33).[46]

Surface shrinkage of Bronze Age objects occurs as depressions with irregular outlines on their surfaces (Fig. 11). Ten socketed axes from the Szentes-Nagyhegy Hoard I bear such traces. The most prominent examples are displayed along the narrow side of the No. 2 socketed axe (Fig. 11/A–B), and on the collar of the No. 33 axe (Fig. 11/C). These defects occur when the molten metal shrinks during solidification, and the shrinking of the castings is uneven, causing the collapse of the adjacent skin due to atmospheric pressure. Several causes are known for the occurrence of this defect in industrial casting. For Late Bronze Age products, inadequate feeding and temperature problems with the metal or moulds are the most probable causes.[47] If surface shrinkage is not combined with internal shrinkage, the artefact can fulfill its function but it becomes less pleasing aesthetically for a modern observer. The No. 33 socketed axe with a large depression on its collar and incompletely cast rib patterns is a proper example of this phenomenon.

Mismatch is one of the most common casting defects of objects cast in two-piece moulds. It occurs when the two halves of the mould do not meet, causing a horizontal (Fig. 13/A, F–G) or vertical (or both) shift (Fig. 13/B, D–E) of the cast sides of the casting. Improper matching of the mould halves' negatives and the displacement of the mould halves during casting can contribute to this defect. Mismatches are generally tolerated, ground and hammered away during post-casting treatment.[48] This defect surely can be brought to the extreme, as it happened with the No. 4 socketed axe, the collar of which shifted vertically on each side, offset by centimetres, likely due to the different lengths of the mould negatives (Fig. 13/B). This is not a typical mismatch because the patterns of the axe halves are different. The bronzesmith probably used two pseudo-winged axe mould halves with different styles and sizes for casting, which resulted in this oddly-looking axe.

Mould imprints are formed when the negative of a casting mould is damaged, i.e., parts of the negative are broken off due to use. The mould imprints on the castings became amorphous protrusions on the surfaces (Fig. 14/A–B). In our experience with sandstone and soapstone casting moulds, mould damage reaching the negatives occurs after the first casting, during the removal of the as-cast, when the stone casting mould is heated and the negative becomes more susceptible to fragmentation (Fig. 14/C–D). Perhaps these axes were cast in an already damaged casting mould after the first casting. Mould imprints also do not prohibit the use of the castings, they can be removed by intensive grinding or left untreated.

The casting defects described above are present in different combinations on the defective products of Szentes-Nagyhegy Hoard I. Some defects are so severe that they render these products unusable. Several pieces cannot be

[46] Ersfeld 1990, 18, 20, fig. 14; Born–Hansen 1991, 149, fig. 3; Zhang et al. 1995, 607–609; Armbruster 2000, 68; Bridgford 2000, 52–54, 68, 125; Quilliec 2007a, 406, fig. 8; Quilliec 2007b, 100; Zhao et al. 2009; Binggeli 2011, 17–19; Gener 2011, 121; Rajkolhe–Khan 2014, 378, 380–381; Pola et al. 2015; Atlas 2017, 27–28, 49, 51; Tarbay 2018, 246–247; Tarbay 2022a, pl. 58A.

[47] Atlas 2017, 51.

[48] Mozsolics 1985b, 27, pl. 14/3; Quilliec 2007b, 100; Rajkolhe–Khan 2014, 378–379, fig. 7; Tarbay 2016, fig. 6/1, 5; Tarbay 2018, 245; Tarbay 2022a, pl. 57C.

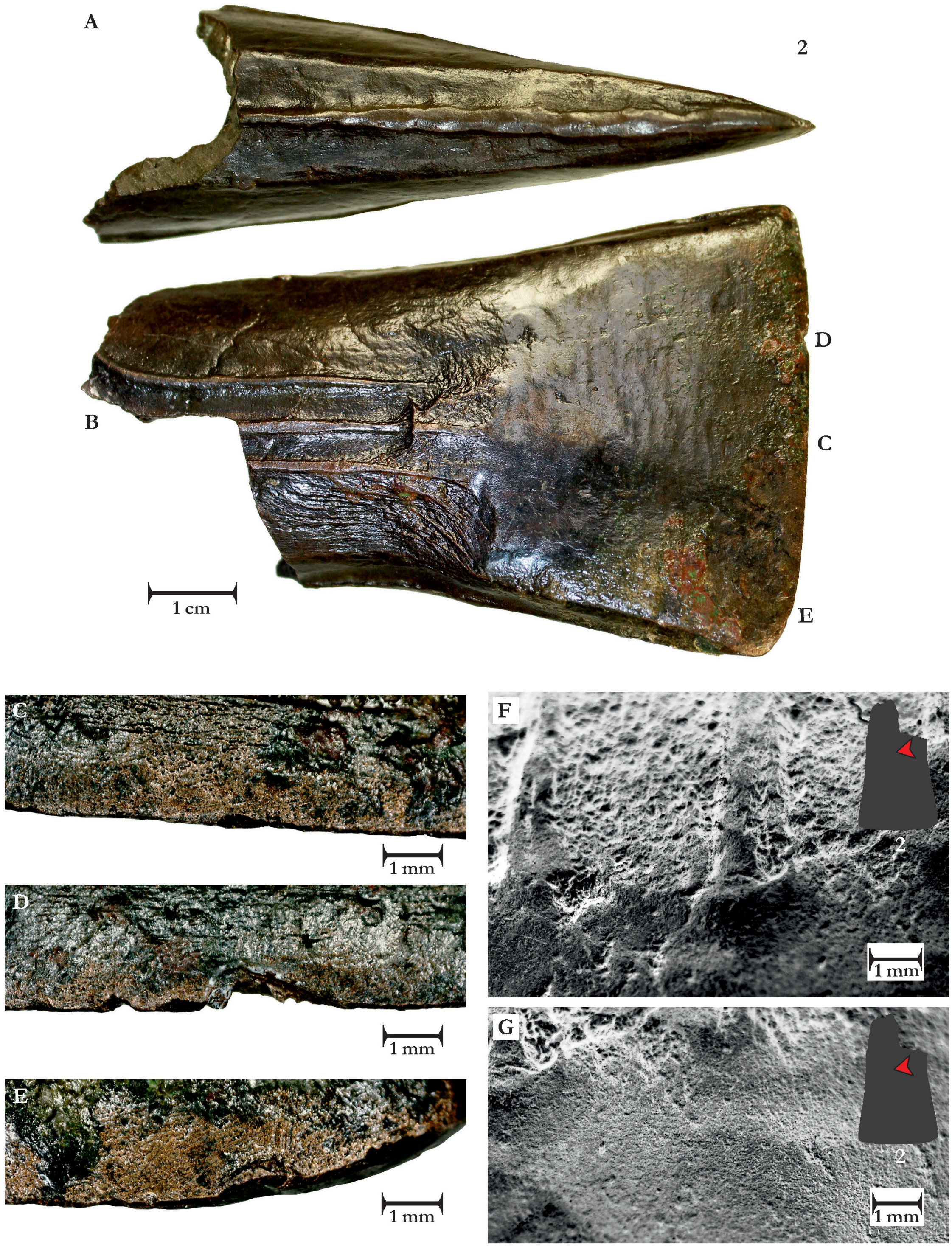

Fig. 15. A. Superficially hammered casting seams along the narrow side of a socketed axe; B. hammered cutting edge; C. dent; D. notch; E. bow; F. the meeting point of the as-cast and hammered surface of a socketed axe; G. the hammered surface of a socketed axe.

hafted because they are only blade parts or their sockets are partially (Fig. 2/11) or completely solid (Fig. 1/6). A few axes have a heavily porous structure that is also visible on their surface (Fig. 1/8; 2/12). If these tools had been used they would surely have broken. The casting quality of these objects is so low compared to other Late Bronze Age products from the eastern Carpathian Basin that it is difficult to imagine them being the products of a professional metalworker who aimed to create usable products. They may be results of technical experimentation with a new alloy, casting techniques, mould or core materials; or they are products of an apprentice who attempted to master the casting of socketed axes in two-piece casting moulds with a core.

The as-casts of the Szentes-Nagyhegy Hoard I belonging to Group III could have become functional products if received post-casting treatment, even if they had minor casting defects (Fig. 1/4–5, 9; 3/33; 4/41; 5). Only the casting jets were removed from these objects, and their casting defects seem repairable and less severe than the ones observed in artefacts of Group II. What makes it hard to differentiate them from the defective products is that the craftsmen decided not to invest further work into finishing them. However, their decisions are difficult to comprehend millennia later. Perhaps a higher aesthetic standard was sought for the objects or it was not worth the effort to invest in the post-casting treatment to transform them ready to use. Furthermore, the minor fractures visible on some of these objects may not be fragmentation in the classical sense, but the results of hammer blows testing the usability and casting quality of the objects, which eventually did not pass the test (Fig. 1/5; 3/33).

The degree of fragmentation also influences technological classification. Technological and use-wear traces are less prominent on smaller objects (Fig. 5/3, 10, 17) than on larger ones. If the objects are complete or the fragments are larger and relevant for the observation of post-casting treatment traces, they can be sorted into the finished product category. We differentiate between three such categories. Finished products without observable use-wear traces (Group IV) are cast items that are in a state of completion and have received all the post-casting treatments required. Use-wear traces are not observable on the surfaces of these objects due to preservation conditions, restoration, or their intentional removal in prehistory. As Horn has pointed out, such an object is not necessarily an unused product; the term only means that traces are not possible to observe on its surface.[49] In our case, the annular ring with a ground surface (Fig. 3/35), the bronze cup (Fig. 2/14), and the folded and perforated sheet metal object (Fig. 2/15) were sorted into this category.[50]

The next two categories are represented by two objects only. Group V includes finished and used products (Fig. 5) that are in a state of completion and have received all the post-casting treatments required. Use-wear traces, generally micro-edge damages, are also observed on their surfaces. The No. 2 socketed axe fulfils these requirements. Despite visible surface shrinking (Fig. 11/A–B), the blade of the case is carefully hammered along the wider sides based on small depressions left by a hammer (Fig. 15/A–B, F–G).[51] Such traces appear to be present along the narrow sides of the blade, but the execution is superficial and technically only flattens the casting seams along this part (Fig. 15/A). The cutting edge also shows lateral striation (Fig. 15/C–D) caused by sharpening. Traces along the object's cutting edge, such as a dent (Fig. 15/C), notches (Fig. 15/D), and a bow (Fig. 15/E), indicate the use of this tool.[52]

The last group (Group VI) consists of finished and heavily used products (Fig. 5) that are in a state of completion and have received all the post-casting treatments required. Use-wear traces, different general traces of abrasion (worn surfaces, dull edges, worn damages), repair traces, and modifications of the initial cast shapes (re-shaped tips, asymmetric or narrow blades, secondary added peg holes, shortened tip/socket) are observed on them. At the moment, it is not possible to determine whether the objects were used for an extended period or if they were used intensively for a short period. No. 1 spearhead is a proper example of such an object (Fig. 1/1). The upper half of the original blade is missing (Fig. 16/A), the tip was probably broken off or became heavily damaged due to repeated thrusting or throwing actions at the

[49] Horn 2013, 36; Horn 2015, 203.

[50] No. 16 sheet metal fragment probably belongs to this category, as it is most likely part of a larger product.

[51] Szabó 2013, 88–90.

[52] Roberts–Ottaway 2003, 126–127, fig. 25; Dolfini et al. 2023.

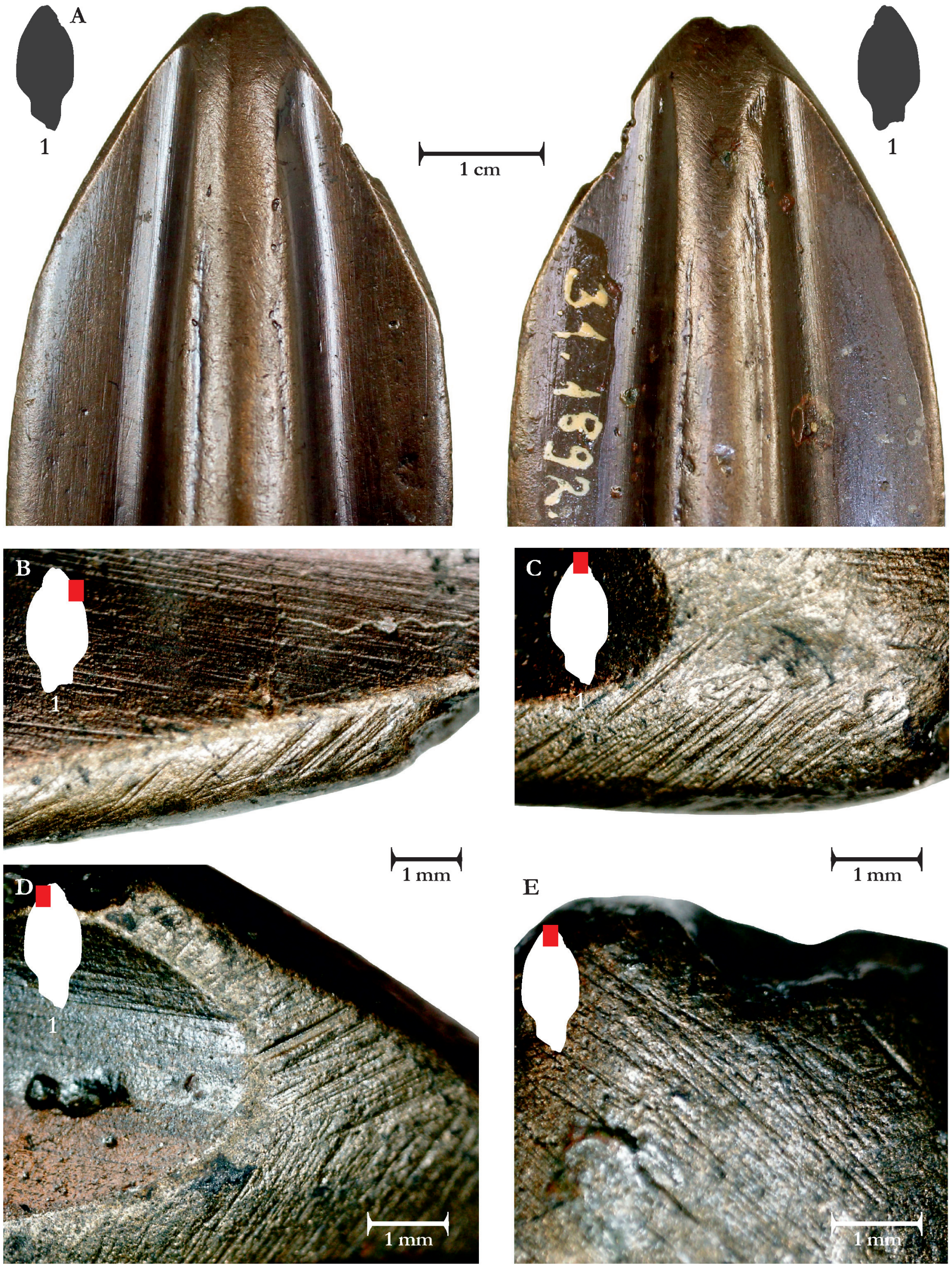

Fig. 16. A. Re-shaped tip; B. rasped edge, grinding traces, worn edge; C–E. rasped, worn edge and tip.

target.[53] At one point, the damaged tip of the spearhead was completely reshaped; the craftsmen formed a new cutting edge and a tip by removing and rasping the damaged part, making the blade significantly shorter. The rounded surfaces along the cutting edges indicate that the spearhead was used after this repair (Fig. 16/B–E). The object's surface shows heavy abrasion, resulting in blurring and almost complete wear of its profiled midrib (Fig. 16/A). This phenomenon suggests that the spearhead had been used intensively and for a longer period before deposition until the object became completely useless for fulfilling its weapon function.

Fragmentation analysis of the artefacts was limited since they were studied in a restored

[53] It is also possible that the missing tip had a higher porosity concentration that weakened the weapon during use and it finally broke off.

state which hindered the identification of modern, post-recovery breakages. Only a few objects, such as the No. 2 socketed axe (Fig. 1/2), the No. 24 plano-convex ingot (Fig. 2/24), and the No. 44 unclassifiable object (Fig. 4/44), showed clearly distinguishable modern manipulation, in the form of clean breakage surfaces devoid of patina (Fig. 6/A, C). It seems that both the large plano-convex ingot and the socketed axe were shattered into pieces. Based on Hampel's published plates, it should have happened around 1892.[54] The surface of No. 44 was completely altered by some kind of modern polishing by a rasping tool (Fig. 4/44). The rest of the objects are fragmented intentionally, probably in prehistoric times, regardless of the technological group to which they belong (Fig. 5). Only a few complete objects remained, two incomplete castings, four plano-convex ingots, and one triangle-shaped ingot (Fig. 5/20–24, 7, 34). The chronology of fragmentation cannot be established with any certainty but several signs indicate that it happened before hoarding. One of the arguments is the technological composition of the hoard. Plano-convex ingots are more likely to be split in the foundry for the remelting process in a reheated state with hammers as described in detail by Bianka Nessel and Daniel Modl.[55] These ingots are easily portable in their original shape but hardly fit into crucibles for remelting. Mishits on the plano-convex ingots, are present in two cases: on the flat side of the No. 24 plano-convex ingot and in the middle of the No. 22 ingot (Fig. 6/B). On the former, the impacts have a different, brighter patina than the rest of the object (Fig. 6/A). The direction of the mishits also corresponds with the modern breakage of the ingot, suggesting that these can be associated with post-recovery fragmentation (Fig. 6/C). The breaks of most objects are sharp without hammer impacts, mishits of chisels or comprehensive deformation on the surface, which morphology suggests the hot shortening technique described by Knight.[56] There are a few exceptions, however. Chisel marks in connection to abandoned breakage are seen on the wider and narrower sides of some axes (e.g., Nos. 4, 6, 8) but their prehistoric or modern origin cannot be determined. These ingots and as-cast objects were likely piled up and fragmented in a metalworker's workshop. In this sense, the as-cast objects also served as a sort of recyclable raw material. Among the finished products, there are various types of fragments, ranging from the smallest pieces hardly resembling the original object (e.g., sword hilt fragment) (Fig. 2/17) to larger fragments like the broken spearhead (Fig. 1/1), the bronze cup (Fig. 2/14), and a split socketed axe (Fig. 1/2). The fragmentation of a few finished products probably served a practical purpose, such as recycling broken ingots or as-cast objects as raw materials. The No. 1 spearhead, used to the limits in its original function, perhaps was prepared for remelting (Fig. 1/1). Besides, the hoard contains objects that were probably broken intentionally in a functional state, like the No. 2 socketed axe (Fig. 1/2).[57] This may be explained by the nature of object selection in hoards. If the object was damaged for a ritual assemblage, only a small symbolic piece would be deposited, while the rest of the object would be retained to be recycled in the workshop of the metalworker.[58]

CONCLUSIONS

As Amália Mozsolics has pointed out, the composition and fragmented condition of this assemblage is not without parallels in the Carpathian Basin, essentially in Transdanubia and the southern Great Hungarian Plain.[59] This makes the interpretation of this assemblage difficult, which is further hindered by the unknown context and the possibly incomplete state of the acquired assemblage.[60] From a technological

[54] See Hampel 1896, pl. 193/1.

[55] Nessel 2014, 405–407; Modl 2019, 375–377, fig. 2.

[56] Knight 2019.

[57] One of the breakage surfaces of this socketed axe is modern.

[58] Tarbay 2022a, 114, 137–138.

[59] Mozsolics 1985b, 24–27; Tarbay 2022a, 146–148.

[60] Late Bronze Age objects were retrieved mixed with other finds on two occasions of the three when parts of the hoard were purchased. In light of these circumstances, the original assemblage was perhaps much larger, and other finds could be left in the findspot or retained by the finders and the original owner.

point of view, Hoard I from Szentes-Naghegy is a collection of potentially alloyed ingots and as-cast objects, some of which were unsuitable for use due to casting defects, while others received no post-casting treatment. Apart from the presence of a few finished and used products, ingots and as-casts dominate the hoard which is also characterized by heavy intentional fragmentation (Fig. 5). Similar selections of objects are known from Ha B1. These are large hoards containing several intentionally fragmented finished and used products, of diverse technological groups. They also appear as other assemblages (e.g., Lovasberény,[61] etc.), or they form hoards with uniform selection preferring metallurgy-related objects, such as the hoards from Csabdi,[62] Kemendollár,[63] Nagydobsza,[64] and Beremend.[65] Additional objects associated with metalwork that the Szentes-Nagyhegy Hoard I is lacking may also appear in them, like casting jets and droplets. In our analysis, these objects would form an individual category, the distinguishable by-products. These 'foundry hoards' would illustrate well the hoarding of practical, recyclable raw materials that were not ultimately used and left *in situ* at metalworking sites. These hoards, however, show recurrent typological patterns besides the technological ones, as if someone realized the same intentional hoard construction idea repeatedly, by selecting objects with similar techno-typological characteristics out of foundry recycle bins. Two Southern Transdanubian assemblages, the Nagydobsza and the Beremend hoards refer to Szentes-Nagyhegy in particular, they display similar technological tendencies on the same type of objects, right down to the smallest selected fragments. Thus, these hoards have the same selection pattern of both the large and small items. They also contain one or two spearheads, a small piece of a flange-hilted sword (Nagydobsza), and a blade fragment (Beremend). They mainly consist of as-cast and defected product axes of the Palotabozsok and Debrecen types and also contain different ingots including triangle, bar-shaped and plano-convex specimens.[66] Information regarding their contexts is meagre, both Nagydobsza and Beremend were found in a pit, the latter at an Urnfield settlement.[67] The *in situ* spatial arrangement of the objects is completely unknown, as well as their location within the sites. We do not know if they were situated in the vicinity of houses as raw material stocks or pits related to casting workshops, or if they were special ritual assemblages carefully arranged and selected directly from casting workshops, most likely by the metalworker. The intriguing similarities in the composition of these assemblages suggest a consciously constructed idea of a hoard. Together with the selection of objects from foundry materials that follow a common concept, these phenomena open up the possibility for a ritual interpretation of this quite mundane collection of hoards.

CATALOGUE[68]

Szentes-Nagyhegy IA (Hungarian National Museum, Inv. No. 31.1892.1–38)

1. **Spearhead** (Group VI): Small spearhead fragment with a leaf-shaped blade, two peg holes and a profiled midrib. O.: shrinkage, mismatch, worn surface, re-shaped tip, broken. L.: 70.03 mm, W.: (b/mr) 32.06×16.12 mm, Th.: (b) 2.02 mm, Wt.: 62.6 g (Fig. 1/1; 15/A–E).

2. **Socketed axe** (Group V): A socketed axe with a thick collar and a loop in two fragments. It is decorated with three horizontal ribs, one Y-shaped rib and two broken ribs below them, on both wide sides. O.: hammered blade, ground, flash, shrinkage, porosity, notch, bow, slightly asymmetric blade, breakage, modern breakage.

[61] Mozsolics 1985a, 144–145; Mozsolics 1985b, 59.

[62] Mozsolics 1985a, 107

[63] Tarbay 2023a.

[64] Tarbay 2016.

[65] Mozsolics 1985a, 95–96; Mozsolics 1985b, 50–51.

[66] Mozsolics 1985a, 95–96; Tarbay 2016.

[67] Mozsolics 1985a, 95; Tarbay 2016, 86–89, fig. 2.

[68] Abbrevations: O. Observations; Group I – ingot; Group II – as-cast, defective product; Group III – as cast; Group IV – finished product, use-wear traces not observable; Group V – finished products with use-wear traces; Group VI – finished, heavily used products, U – unclassifiable into groups; L – Length, W – Width., b/mr – blade-midrib interface, bs – blade-socket interface, r – rim, H – Height, Th – thickness, b – blade, Wt – Weight.

L.: 115.51 mm, W.: (bs) 35.31×23.25 mm, W.: (b) 47.15 mm, Wt.: 254.6 g (Fig. 1/2; 10; 15/A–G).

3. **Socketed axe** (U): A socketed axe with a thick collar. On one side, an incomplete and uncertain rib pattern is visible. O.: incomplete loop, incomplete pattern, mismatch, breakage. L.: 47.77 mm, W.: (r) 40.34×32.59 mm, Wt.: 62 g (Fig. 1/3).

4. **Socketed axe** (Group III): Pseudo-winged socketed axe. One side of the axe is decorated with pseudo wings and two horizontal ribs, while the other lacks horizontal ribs. The object was made by assembling two different negatives. O.: extreme mismatch, incomplete loop, shrinkage, porosity, blade impacts on the body and the cutting edge, breakage. L.: 121.48 mm, W.: (r) 35.84×29.81 mm, W.: (bs) 24.75×14.49 mm, W.: (b) 41.21 mm, Wt.: 216.2 g (Fig. 1/4; 13/B).

5. **Socketed axe** (Group II): Narrow socketed axe with a thick collar. O.: core rising, flash, shrinkage, breakages. L.: 121.27 mm, W.: (r) 26.65×26.86 mm, W.: (bs) 25.75×13.20 mm, W.: (b) 36.23 mm, Wt.: 244.1 g (Fig. 1/5; 14/B).

6. **Socketed axe** (Group II): Narrow socketed axe with a thick collar. O.: solid cast/core rising, incomplete collar, mould imprint, fragmented edge, impacts on the blade and along the narrow sides. L.: 117.28 mm, W.: (r) 37.36×21.34 mm, W.: (bs) 24.52×15.16 mm, W.: (b) 28.88 mm, Wt.: 254.9 g (Fig. 1/6; 7/A–B; 14/A).

7. **Socketed axe** (Group II): Large, narrow socketed axe. O.: incomplete defect, flash, mismatch, shrinkage. L.: 128.49 mm, W.: (r) 34.25×26.61 mm, W.: (bs) 28.85×18.17 cm, W.: (b) 43.68 cm, Wt.: 336.5 g (Fig. 1/7; 9/B).

8. **Socketed axe** (Group II): Upper fragment of a narrow-socketed axe with a thick collar. A jet remains visible on the rim. O.: shrinkage, porosity, mismatch, breakage, tool impact. L.: 68.18 mm, W.: (r) 38.21×26.53 mm, W.: (bs) 27.94×16.83 mm, Wt.: 168 g (Fig. 1/8).

9. **Socketed axe** (Group III): Upper fragment of a narrow-socketed axe with a thick collar. The object is broken into two parts. O.: porosity, breakage. L.: 76.65 mm, W.: (r) 43.79×32.47 mm, W.: (bs) 26.15×14.19 mm, Wt.: 158 g (Fig. 1/9).

10. **Socketed axe** (U): Upper fragment of a narrow-socketed axe. Two broken jet remains are visible on the rim. O.: porosity, misrun, breakage. L.: 47.49 mm, W.: (r) 42.05×32.53 mm, Wt.: 78.7 g (Fig. 1/10; 12A).

11. **Socketed axe** (Group II): Upper fragment of a narrow-socketed axe with a thick collar. O.: porosity, shrinkage, core rising (depth of the socket: 24.89 mm), breakage (melted break surface). L.: 43.35 mm, W.: (r) 33.61×27.53 mm, Wt.: 90.2 g (Fig. 2/11; 7/C–E).

12. **Socketed axe** (Group II): Blade fragments of a socketed axe. O.: porosity, core shift, mismatch. L.: 38.54 mm, W.: (b) 44.64 mm, Wt.: 68.3 g (Fig. 2/12).

13. **Socketed axe** (Group III): Blade fragment of a socketed axe. O.: shrinkage, porosity, core shift, breakage. L.: 73 mm, W.: (bs) 33.83×18.59 mm, W.: (b) 45.77 mm, Wt.: 222.4 g (Fig. 2/13, Fig. 8/A–C).

14. **Bronze cup** (Group IV): Rim fragment of a bronze cup with a straight rim. O.: breakage. 157.20×95.65 mm, H.: 32.49 mm, Th.: 0.20 mm, Wt.: 24.2 g (Fig. 2/14).

15. **Perforated sheet** (Group IV): A large, rectangular sheet with two or more perforations. O.: folding. 40.20×22.50 mm, Th.: 0.47 mm, Wt.: 3.00 g (Fig. 2/15).

16. **Metal sheet [metal vessel]** (Group IV): Metal sheet fragment, probably from the neck area of a vessel. Maybe belongs to No. 14, but refitting was not possible. O.: breakage. 35.61×21.46 mm, Th.: 0.37 mm, Wt.: 1.7 g (Fig. 2/16).

17. **Sword** (Group IV): A hilt fragment of a flange-hilted sword. O.: breakage. 45.43×7.51 mm, Th.: 7.32×8.04 mm, Wt.: 14 g (Fig. 2/17).

18. **Bar ingot** (Group I): Middle fragment of a bar ingot with a triangular cross-section. O.: breakage. L.: 50.76 mm, Th.: 20.48×8.39 cm, Wt.: 44.8 g (Fig. 2/18).

19. **Bar/loaf-shaped ingot** (Group I): Edge fragment of a bar- or loaf-shaped ingot. O.: breakage. L.: 40.48 mm, Th.: 21.56×11.51 mm, Wt.: 41.3 g (Fig. 2/19)

20. **Triangle-shaped ingot** (Group I): A

triangle-shaped ingot with broken jet remains. 64.41×48.97 mm, Th.: 12.32–4.58 mm, Wt.: 138.6 g (Fig. 2/20).

21. **Plano-convex ingot** (Group I): Round and flat, plano-convex ingot with lozenge cross-section. 84.96×83.99 mm, H.: 16.47 mm, Wt.: 547.2 g (Fig. 2/21).

22. **Plano-convex ingot** (Group I): Round plano-convex ingot. O.: layered modern and prehistoric blade impacts. 77.38×73.71 mm, H.: 19.08 mm, Wt.: 452.6 g (Fig. 2/22; 6/B).

23. **Plano-convex ingot** (Group I): Round plano-convex ingot. 74.41×75.28 mm, H.: 12.08 mm, Wt.: 280 g (Fig. 3/25).

24. **Plano-convex ingot** (Group I): Large, round plano-convex ingot in three fragments. O.: modern break, modern blade impacts. 189×205 mm, H.: 20.89 mm, Wt.: 3038 g (Fig. 2/24, Fig. 6/A, C).

25. **Plano-convex ingot** (Group I): A quarter fragment of a plano-convex ingot. O.: Circular imprint on the convex side, breakage. 118×117 mm, H.: 43 mm, Wt.: 1531 g (Fig. 3/25).

26. **Plano-convex ingot** (Group I): Quarter-rim fragment of a plano-convex ingot. O.: breakage. 80.71×61.26 mm, H.: 18.83 cm, Wt.: 353.4 g (Fig. 3/26).

27. **Plano-convex ingot** (Group I): Quarter-rim fragment of a plano-convex ingot. O.: imprint, breakage. 77.01×47.42 mm, H.: 26.93 mm, Wt.: 291.4 g (Fig. 3/27).

28. **Plano-convex ingot** (Group I): Rim fragment of a plano-convex ingot. O.: breakage. 59.96×37.72 mm, H.: 37.75 mm, Wt.: 240.4 g (Fig. 3/28).

29. **Plano-convex ingot** (Group I): Quarter fragment of a plano-convex ingot. O.: breakage. 64.44×61.72 mm, H.: 18.84 mm, Wt.: 149.8 g (Fig. 3/29).

30. **Plano-convex ingot** (Group I): Rim fragment of a plano-convex ingot. O.: breakage. 59.59×31.97 mm, H.: 12.09 mm, Wt.: 96.8 g (Fig. 3/30).

31. **Plano-convex ingot** (Group I): Rim fragment of a plano-convex ingot. O.: breakage. 46.82×35.52 mm, H.: 12.76 mm, Wt.: 80.4 g (Fig. 3/31).

32. **Unclassifiable object** (U): A wall fragment of an unclassifiable object. O.: breakage. 58.28×49.24 mm, H.: 14.44 mm, Wt.: 220.1 g (Fig. 3/32).

Szentes-Nagyhegy IB (Hungarian National Museum, Inv. No. 43.1892.1–8)

33. **Socketed axe** (Group III): Large socketed axe with a thick collar and a broken loop and rim. The object shows traces of blurred rib patterns (1 Y, two side ribs). O.: shrinkage, porosity, mould imprint, breakage. L.: 140.62 mm, W.: (r) 52.55 mm, W.: (bs) 39.50×17.26 mm, W.: (b) 50.33 mm, Wt.: 469 g (Fig. 3/33; 11/C; 13/A).

34. **Socketed axe** (Group II): Blade of an incomplete cast socketed axe. O.: incomplete cast blade, mismatch, shrinkage. L.: 47.32 mm, W.: (bs) 32.31×13.18 mm, W.: (b) 44.56 mm, Wt.: 107.9 g (Fig. 3/34; 9/A).

35. **Annular ring** (Group IV): Fragment of an annular ring. O.: breakage. 42.77×13.14 mm, Th.: 8.53×4.12 mm, Wt.: 7 g (Fig. 3/35).

36. **Bar ingot** (Group I): A half fragment of a bar ingot with a trapezoid cross-section. O.: breakage. L.: 69.15 mm, Th.: 7.81×9.15 mm, Wt.: 28.4 g (Fig. 3/36).

37. **Plano-convex ingot** (Group I): Quarter fragment of plano-convex ingot. O.: breakage. 76.87×61.87 mm, H.: 6.41 mm, Wt.: 113.2 g (Fig. 3/37).

38. **Plano-convex ingot** (Group I): Rim fragment of a plano-convex ingot. O.: breakage. 59.53×60.69 mm, H.: 16.39 mm, Wt.: 175.2 g (Fig. 3/38).

39. **Plano-convex ingot** (Group I): Quarter fragment of a plano-convex ingot. O.: breakage. 61.40×46.61 cm, H.: 14.04 mm, Wt.: 131.1 g. Cl. ingot (Fig. 3/39).

40. **Plano-convex ingot** (Group I): Quarter fragment of a high plano-convex ingot. O.: breakage. 87×70 mm, H.: 39 mm, Wt.: 377 g (Fig. 3/40).

Szentes-Nagyhegy IC (Hungarian National Museum, Inv. No. 84.1892.183–186)

41. **Socketed axe** (Group III): Lower part of a socketed axe with a straight blade. As-cast. Impact at the middle of the cutting edge. O.: mismatch, breakage. L.: 55.81 mm, W (bs) 29.08×16.71 mm, W.: 33.62 mm, Wt.: 135.8 g (Fig. 4/41).

42. **Socketed axe** (U): *'Like the former [No. 41 socketed axe], but its blade is cut off. L.: 3.7 cm, W.: 2.6 cm.'*[69] The object has been lost. On Kemenczei's plate, it is a middle fragment of a pseudo-winged axe (Fig. 4/42).[70]

43. **Plano-convex ingot** (Group I): Slice of a plano-convex ingot. O.: breakage. 75.64×48.39 mm, Th.: 19.59 mm, Wt.: 345.8 g (Fig. 4/43).

44. **Unclassifiable** (U): Edge fragment of a lozenge-shaped rod. O.: modern breakage and grinding. 38.90×29.55 mm, Th.: 8.93 mm, Wt.: 63.6 g (Fig. 4/44).

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ABBREVIATIONS

ActaAntHung	Acta Antiqua Academiae Scientiarum Hungaricae, Budapest
ActaArchHung	Acta Archaeologica Academiae Scientiarum Hungaricae, Budapest
ActaMilMed	Acta Militaria Mediaevalia
ActaMN	Acta Musei Napocensis, Cluj-Napoca
ActaMP	Acta Musei Porolissensis, Zalău
ActaPraehist*A*	Acta Praehistorica et Archaeologica
AnB	Analele Banatului
Angustia	Angustia. Muzeul Carpaţilor Răsăriteni, Sfântu Gheorghe
Antiquity	Antiquity. A Quarterly Review of Archaeology
Apulum	Apulum. Acta Musei Apulensis, Alba Iulia
ArchÉrt	Archaeologiai Értesítő, Budapest
ArchKorr	Archäologisches Korrespondenzblatt, Römisch-Germanischen Zentralmuseum Mainz
ArhMold	Arheologia Moldovei
Banatica	Banatica, Muzeul Banatului Montan, Reşiţa
BAR (I.S./B.S.)	British Archaeological Reports, International Series / British Series, Oxford
BayVgBl	Bayerische Vorgeschichtsblätter
BerRGK	Bericht der Römisch-Germanischen Kommission
BHAUT	Bibliotheca Historica et Archaeologica Universitatis Timisiensis
BMA	Bibliotheca Musei Apulensis
BMusBrux	Bulletin des Musées Royaux d'Art et d'Histoire, Bruxelles
CA	Cercetări Arheologice
CommArchHung	Communicationes Archaeologicae Hungariae, Budapest
Complutum	Complutum. Publicaciones del Departamento de prehistoria de la Universidad complutense de Madrid
Crisia	Crisia. Muzeul Ţării Crișurilor, Oradea
Dacia (N. S.)	Dacia. Recherches et décuvertes archéologiques en Roumanie, I–XII (1924–1948), Bucureşti; Nouvelle série (N. S.): Dacia. Revue d'archéologie et d'histoire ancienne, Bucureşti
DissArch	Dissertationes Archaelogicae ex Instituto Archaeologico Universitatis de Rolando Eötvös Nominatae, Budapest
EphemNap	Ephemeris Napocensis, Cluj-Napoca
EurAnt	Eurasia Antiqua
FI	File de Istorie. Muzeul de Istorie al Judeţului Bistriţa-Năsăud, Bistriţa
FolArch	Folia Archaeologica, Budapest
Germania	Germania. Anzeiger der Römisch-Germanischen Kommission des Deutschen Archäologischen Instituts
HOMÉ	A Herman Ottó Múzeum Évkönyve, Miskolc
JAHA	Journal of Ancient History and Archaeology
JAMÉ	A Nyíregyházi Jósa András Múzeum Évkönyve, Nyíregyháza
JASc	Journal of Archaeological Science
JbRGZM	Jahrbuch des Römisch-Germanischen Zentralmuseums, Mainz
JRA	Journal of Roman Archaeology

JRomMilSt	Journal of Roman Military Equipment Studies
JRS	The Journal of Roman Studies
KuBA	Kölner und Bonner Archaeologica
Marisia	Marisia (V–), Studii şi Materiale, Târgu Mureş
Marisia-AHP	Marisia: Archaeologia, Historia, Patrimonium, Târgu Mureș
MCA	Materiale şi Cercetări Arheologice, Bucureşti
MFMÉ	A Móra Ferenc Múzeum Évkönyve, Szeged
Oltenia	Oltenia. Studii și comunicări. Istorie-Arheologie
OxfJA	Oxford Journal of Archaeology
PBF	Prähistorische Bronzefunde, Stuttgart
ProcPrehistSoc	Proceedings of the Prehistoric Society
PZ	Praehistorische Zeitschrift
RA	Revue archéologique
RadMV	Rad vojvođanskih muzeja (1994- Rad Muzeja Vojvodine)
ReiCretActa	Rei Cretariae Romanae Fautorum Acta, Tongeren
RevBis	Revista Bistriţei, Complexul Judeţean Muzeal Bistriţa-Năsăud
SaalbJb	Saalburg-Jahrbuch. Bericht des Saalburg-Museums
Sargetia (S.N.)	Sargetia. Acta Musei Devensis, Deva
SCIV(A)	Studii şi Cercetări de Istorie Veche (şi Arheologie 1974–), Bucureşti
SlovArch	Slovenská Archeológia, Bratislava
SMIM	Studii și Materiale de Istorie Medie
StComBrukenthal	Studii şi comunicări – Muzeul Brukenthal
SUBB-Historia	Studia Universitatis Babeş–Bolyai, series Historia, Cluj-Napoca
Századok	Századok, A Magyar Történelmi Társulat Folyóírata, Budapest
Tibiscum	Tibiscum. Studii și comunicări. Muzeul Județean Caransebeș
Tisicum	A Jász-Nagykun-Szolnok Megyei Múzeumok Évkönyve
Tyragetia	Tyragetia. The National Museum of History of Moldova, Chișinău
UPA	Universitätsforschungen zur Prähistorischen Archäologie, Bonn
Ziridava	Ziridava (–2012 Studia Archaologica)
ZMúz	Zalai Múzeum. Közlemények Zala Megye Múzeumaiból
ZPE	Zeitschrift für Papyrologie und Epigraphik

MARISIA. ARCHAEOLOGIA, HISTORIA, PATRIMONIUM

With a publishing tradition since 1965, in 2019 the annual of the Mureş County Museum initiated a new series entitled: *Marisia. Archaeologia, Historia, Patrimonium*. The publication provides a panel for new research results in archeology, architecture and material heritage of the history of arts and culture. The studies mainly focus on the inner Transylvanian region that encompasses also Mureş County. Beyond local valuable contributions, the annual aims at a regional and global concern that is relevant for the whole of Transylvania. Among the annual's missions is to provide mutual interpretation of the research results produced by the Romanian and Hungarian scientific workshops. Therefore, the annual articles are mainly in English but based on the field of research and the approached topic studies in German, Romanian or Hungarian are also accepted.

Cu o tradiție din anul 1965, anuarul Muzeului Județean Mureș s-a relansat în 2019 sub titlul *Marisia. Archaeologia, Historia, Patrimonium*. Această publicație se descrie ca o platformă științifică care cuprinde rezultatele cercetărilor în domenii precum: arheologia, arhitectura și patrimoniul material din zona istoriei artelor și a culturii, studii localizate în regiunea centrală a Transilvaniei, din care face parte județul Mureș. In extenso, anuarul își propune să ofere un spațiu unitar contribuțiilor științifice valoroase, relevante din perspectiva geografică a ceea ce înseamnă întreaga regiune a Transilvaniei. Una dintre misiunile publicației este aceea de a oferi tuturor celor interesați spațiul de schimb pentru cele mai noi rezultate din atelierele științifice românești și maghiare. Articolele anuarului sunt scrise în general în limba engleză, existând totodată articole scrise în germană, română și maghiară, în funcție de specificul domeniului și a temei abordate.

A Maros Megyei Múzeum 1965 óta megjelenő évkönyvének 2019-ben útjára bocsátott új sorozata, a *Marisia. Archaeologia, Historia, Patrimonium* elsősorban a mai Maros megyét is magába foglaló belső-erdélyi régió régészeti, épített és tárgyi örökségére, nemkülönben az ezekhez kapcsolódó művészettörténeti, művelődéstörténeti kérdésekre vonatkozó újabb kutatások tudományos fóruma. A lokális perspektíván túl igyekszik kitekinteni a regionális és univerzális összefüggésekre, így a tágan értelmezett Erdély területére nézve is közöl kiemelkedő értékkel bíró tanulmányokat. Küldetésének tekinti a hazai román és magyar tudományos műhelyekben született eredmények kölcsönös tolmácsolását. A dolgozatok nyelve főként az angol, de szakterülettől és témától függően német, román vagy magyar nyelven is közöl írásokat.