MNM

COMMUNICATIONES ARCHÆOLOGICÆ HUNGARIÆ

2022

COMMUNICATIONES ARCHÆOLOGICÆ HUNGARIÆ

2022

Magyar Nemzeti Múzeum
Budapest, 2023

Szerkesztőség
Magyar Nemzeti Múzeum Régészeti Tár
H-1088, Budapest, Múzeum krt. 14–16.

A folyóirat cikkei elérhetők: http://ojs.elte.hu/comarchhung
Kéziratbeküldés és szerzői útmutató: http://ojs.elte.hu/comarchhung/about/submissions

ISSN 0231-133X (Print)
ISSN 2786-295X (Online)

Felelős kiadó
L. Simon László főigazgató

TARTALOM – INDEX

RECENSIONES

LATE BRONZE AGE SWORDS WITH LEADED HILTS FROM HUNGARY

János Gábor Tarbay,* Boglárka Maróti**

Late Bronze Age swords are associated with several technological innovations, one of the lesser-known examples being the casting of lead on the hilt of bronze swords. There are many practical reasons for that, including changing the sword's point of balance, repairing casting defects, and improving the fastening of metal hilts and hilt plates. Some theorise that the addition of lead may even have a ritual explanation. In this study, handheld XRF analyses of three Late Bronze Age (Br C–Br D) flange-hilted bronze swords from river and lake environments in Hungary, Komárom-Szőny-Oil Refinery-River Danube (Komárom-Esztergom County), Lake Balaton, and Gyomaendrőd (Békés County), were carried out. The results of the measurements were used to determine whether the thick, pale, grey residue on the handles of the swords could be identified as lead.

A késő bronzkori kardokhoz számos technológiai újítás köthető, ennek egyik kevésbé ismert példája az ólom ráöntése a bronzkardok markolatára. A jelenségnek megannyi praktikus oka lehet, melyek között említhető a kard súlypontjának megváltoztatása, az öntvényhibák javítása, a fémmarkolatok és nyéllapok szorosabb rögzítése. Egyes elképzelések szerint az ólom hozzáadása még rituális okokkal is magyarázható. A tanulmányban három, Magyarország területéről származó késő bronzkori (Br C–Br D), folyami és tavi környezetben előkerült nyélnyújtványos bronzkard kézi XRF-vizsgálatát végeztük el: Komárom-Szőny-Olajfinomító-Duna folyó (Komárom-Esztergom vármegye), Balaton, Gyomaendrőd (Békés vármegye). A mérési eredményekkel arra kerestük a választ, hogy vajon a fakó szürke színű, vastag lerakódásnyomok a kardok markolatán valóban ólomként azonosíthatók-e.

Keywords: *lead, handheld XRF, swords, point of balance, metalwork and use-wear analysis, Late Bronze Age*

Kulcsszavak: *ólom, kézi XRF, súlypont, készítéstechnológiai és használatinyom-elemzés, késő bronzkor*

Introduction

Bronze Age swords are the results of thousands of years of technological development, accumulated knowledge, innovation, and experimenting by metalsmiths starting with the end of the Late Neolithic. They are the very first archaeologically tangible weapons made solely to kill humans, and as such, were perfected to the very end. A stronger and better weapon is an obvious advantage on the battlefield, and such objects have always been in great demand. Great demand gives birth to even greater creativity and technological progress. In the Late Bronze Age, making a metal-hilted sword required a highly experienced craftsman with advanced metallurgical knowledge or the cooperation of specialists who could cast in two-piece moulds and could master the lost-wax casting technique with a core and different kinds of metal decoration techniques (chasing, repoussé, engraving) and those of edge hardening (cold hammering, annealing). All these efforts went into making swords an even more effective and lethal weapon and an object of prestige desired by many who engaged in the lifestyle of a warrior. The effectiveness of a sword can be improved in various ways, like by adding different proportions of tin to make the blade more resilient or flexible, enlarging or shortening the blade, applying post-casting

▹ Received 27.10.2022 | Accepted 27.02.2023 | Published online 21.09.2023

* Department of Archaeology, Scientific Directorate, National Institute of Archaeology, Hungarian National Museum; H-1088 Budapest, Múzeum körút 14–16, e-mail: tarbay.gabor@hnm.hu; ORCiD: https://orcid.org/0000-0002-2363-7034

** Nuclear Analysis and Radiography Department, Centre for Energy Research; H-1121 Budapest, Konkoly-Thege Miklós út 29–33, e-mail: maroti.boglarka@ek-cer.hu; ORCiD: https://orcid.org/0000-0001-9598-2913

treatment to the blade to make it more resilient, and making the edge razor-sharp to cut through anything that would stand in its way. In the present study, we focus on one phenomenon only: swords with leaded hilts. The analysed examples are three flange-hilted swords from the Prehistoric Collection of the Hungarian National Museum, obtained from sites including Komárom-Szőny-Oil Refinery-River Danube (Komárom-Esztergom County, HU), henceforth: Komárom-Szőny (*Fig. 1, 1*), Lake Balaton (without a more precise findspot, HU) (*Fig. 1, 2*), and Gyomaendrőd (Békés County, HU) (*Fig. 3, 1*).

Catalogue

1. *Sword* (Komárom-Szőny-Oil Refinery-River Danube, 1950.44): Long flange-hilted sword with four peg holes and a straight, narrow blade. Length 861 mm; length (hilt) 89.88 mm; width (hilt) 29.26 – 26.24 – 54.54 mm; thickness (hilt) 10.18 mm; thickness (blade) 27.34 × 6.59 mm; weight 596.3 g (*Fig. 1, 1, Fig. 2, 1A–1B, Fig. 4, D–F*).
2. *Sword* (Lake Balaton, 52.32.75): Flange-hilted sword with six peg holes on its shoulders. It has an oval cross-section emphasised by two outline grooves. The object was welded from three fragments. Length 684 mm; length (hilt) 95.10 mm; width (hilt) 24.26 – 57.40 mm; thickness (hilt) 11.64 mm; thickness (blade) 31.67 × 7.59 mm; weight 554.2 g (soldered) (*Fig. 2, 2, Fig. 2, 2A–2B, Fig. 4, A–C*).
3. *Sword* (Gyomaendrőd, 35.1888): Long, flange-hilted sword with four peg holes and two preserved pegs. The blade has an emphasised central ridge and two outline grooves. Length 556.18 mm; length (hilt) 97.55 mm; width (hilt) 62.69 – 24.44–34.81 mm; thickness (hilt) 9.51 mm; thickness (blade) 34.63 × 7.85 mm; weight 666.8 g (*Fig. 3, 1, 2A–2B, Fig. 4, G–J*).

The three swords

The sword from Komárom-Szőny (*Fig. 1, 1*) was purchased in 1950 from László Barkóczi, who allegedly found it in front of the Oil Refinery in the River Danube (Mozsolics 1973, 181, Pl. 14, 1; Kemenczei 1988, 45, Pl. 18, 189; Szathmári 2005, 157, No. 22). The sword was associated with Type Ia by Amália Mozsolics (Mozsolics 1973, 27) after Ernst Sprockhoff (Sprockhoff 1931, 1–8). Most related finds were classified similarly (Cowen 1956, 56, 58–60; Novák 1975, 16–18; Wüstemann 2004, 20–22; Laux 2009, 101) or as Traun-type (Schauer 1971, 199–121). Later it was reclassified into Tibor Kemenczei's Group A1 and dated to the Br C/Br D (Ha A1) period of the Late Bronze Age (Kemenczei 1988, 44–46). The find was included in the series of the SAM project, which revealed a 9.7 mass percent (m%) Sn content of the weapon, along with As (0.05 m%), Sb (0.05 m%), Ag (in traces), Ni (0.35 m%), and Fe (++) as accompanying elements (Junghans, Sangmeister, Schröder 1974, 294–295, SAM 19687). The Komárom-Szőny sword has analogies among Hungarian swords recovered from a wetland context. A sword was found in the line of the ferry port, approximately 100 metres from the shore of the Lake Balaton at Zamárdi-Szántód puszta (Mozsolics 1975, 9, fn. 30, Fig. 1, 3; Kemenczei 1988, 45, Pl. 18, 191). There are also two stray finds from the western and eastern parts of the country that can be associated with the specimen under study, from Ácsteszér and Mályi (Mozsolics 1973, 28, Pl. 14, 3; M. Hellebrandt 1985, Fig. 1, 1; Kemenczei 1988, 44, 48, Pl. 16, 181, Pl. 18, 187). Only the sword from Nagykanizsa-Alsóerdő ('Br C2–Br D') was found in a grave (No. 1) with uncertain find context (Patek 1968, 60, 132, Pl. 93, 1; Kemenczei 1988, 44–45, Pl. 17, 188). The stray swords from Sommersdorf, Germany, and Praha-Modřany, Czech Republic, can also be related to this weapon (Novák 1975, 16, Pl. 8, 56; Wüstemann 2004, 20, Pl. 6, 36). The sword from Streufdorf was found in a 'double burial' and dated to the Traisbach-Bessunger Wald horizon (Br C/Br C2) (Wüstemann 2004, 22, Pl. 6, 37). There are also a handful of Sprockhoff Ia-type swords from Northern Germany, which may be distant typological relatives of the piece from Komárom-Szőny, such as the ones from Period II (Br B1/Br C2) burial mounds from Westerwanna and Regesbostel, the stray sword from Harsefeld, and the moor find from 'Templin Kr. Burgwall' (Sprockhoff 1930, 66, No. 53, Pl. 1, 3; Laux 2009, 101, Pl. 38, 245–247). It should be noted that lead was also cast on the handle of three specimens (Laux 2009, 101). The sword from a burial mound in Binesminde Klosterhede, Denmark, also represents Period II (Br B1/Br BC2) (Sprockhoff 1931, 5, 60, No. 50, Pl. 3, 1). Two swords from burial contexts in Sonnerup (Period II) (Aner, Kersten 1973, 72–74, Pl. 39, 228.F) and Gerdrup (*ältere Bronzezeit*) (Aner, Kersten 1973, 173, Pl. 100, 475B) can be mentioned as further analogies from Northern Europe. The Traun-type stray sword from Uffenheim may also be related to this specimen (Schauer 1971, 121, Pl. 55, 374). The dating of the Komárom-Szőny sword is not certain because it is an uncontexted individual find. The datable analogies

Fig. 1 1: sword from Komárom-Szőny; 2: sword from Lake Balaton (Hungarian National Museum, Budapest, photos by J. G. Tarbay)
1. kép 1: a komárom-szőnyi kard; 2: a balatoni kard (Magyar Nemzeti Múzeum, Budapest, fényképek: Tarbay J. G.)

Fig. 2 1A–1B: lead traces on the hilt of the sword from Komárom-Szőny; Danube; 2A–2B: lead traces on the hilt of the sword from Lake Balaton (Hungarian National Museum, Budapest, photos by J. G. Tarbay)
2. kép 1A–1B: ólomnyomok a komárom-szőnyi kardon; 2A–2B: ólomnyomok a balatoni kard markolatán (Magyar Nemzeti Múzeum, Budapest, fényképek: Tarbay, J. G.)

of the sword represent the Period II (Br B1/Br C2) and Br C periods. It likely represents the Br C period, or possibly the Br D, as Tibor Kemenczei has suggested (Kemenczei 1988, 44–46).

The archaeological collection of the Hungarian National Museum includes a bronze flange-hilted sword discovered in Lake Balaton (*Fig. 1, 2*) around 1841. This object was classified into the same Type A1 and dated similarly (Br C2/Br D /Ha A1) as the one from Komárom-Szőny by Tibor Kemenczei (Márton 1930, 15, Fig. 8; Kemenczei 1988, 44, Pl. 16, 182; Szathmári 2005, 158, no. 27; Ilon 2011, 236, Tab. 1, 2, Fig. 2, 2). Among Hungarian finds, perhaps the sword from the Zalkod hoard (Br D) is the closest analogy to this specimen (Mozsolics 1985, 216, Pl. 7, 1; Kemenczei 1988, 48–49, Pl. 21, 217). We are also aware of two analogies to this sword without datable archaeological context from Bohemia, the Houška graveyard and Svatý Tomáš (Novák 1975, 16–17, Pl. 8, 55, Pl. 10, 67). One Anneheim-type sword from Davoser See is also a distant relative of the Lake Balaton sword. The difference between the two is in the shape of their handles (Schauer 1971, 126, Pl. 56, 382). Another sword of the same type from 'Jasmund Peninsula' may also be related to the piece from Lake Balaton (Wüstemann 2004, 23, Pl. 6, 40). The sword from the canal of the Thielle/Zihl at Brügg, Switzerland, has a build-up like the Hungarian specimen (Cowen 1956, 58, 121, Pl. 3, 7). The Lake Balaton sword can be dated to the Br D phase based on the chronological position of the Zalkod hoard. Two swords from Northern European Period II (Br B1/Br C2) burials in Bakkebjerg (Aner, Kersten 1973, 6, Pl. 2, 14A) and Søborg (Aner, Kersten 1973, 23, Pl. 15, 91) can also be related to the find from Lake Balaton.

The sword from Gyomaendrőd (Endrőd) (*Fig. 3, 1*) was mentioned in the literature as a stray find (Hampel 1888, 379; Kemenczei 1988, 44, Pl. 17, 184). The find circumstances are described in the inventory book of the Hungarian National Museum. The sword was found during dredging works under Endrőd [Gyomaendrőd] at the 29th incision [of the River Körös], in a depth of ca. 7 metres. This findspot can easily be localised on the 19th-century Cadastral Map of the Habsburg Empire. The exact findspot was located in the northern part of Gyomaendrőd, near Hídfő Street, under the bridge that crosses the Körös River. The circumstances of the discovery of the sword raised the possibility that this weapon was either deposited in the Körös River or placed in a surrounding marshland area in the Late Bronze Age. The flange-hilted sword from Gyomaendrőd (Endrőd) is a stray find that was assigned to the first variant of Tibor Kemenczei's Type A like the Komárom-Szőny sword (Kemenczei 1988, Pl. 17, 184). The overall shape of this sword is not unique at all, as it has many analogies throughout Europe. Despite the similar build-up, the double outline grooves make it somewhat different from other swords of the type. The Budapest-Nagytétény-River Danube sword (Kemenczei 1988, 44, Pl. 17, 183) features similar design. The swords from the Province of Treviso and 'Southern Germany' have identical blade constructions and outline grooves. However, these specimens have six peg holes, and are somewhat more advanced constructions (Bianco Peroni 1970, 59, Pl. 17, 126; Schauer 1971, Pl. 56, 383). Thus, this sword cannot be dated based on its close analogies; it is most likely dated to the Br C/Br D periods, as Tibor Kemenczei has suggested for his first variant of Group A (Kemenczei 1988, 44–46).

Metalwork wear analysis

The three swords were investigated using a Toolcraft microscope camera (Model No. UM039) to identify production-related technological and use-wear traces. To identify modern and prehistoric damage, we relied on experimental archaeological works and use-wear studies focusing on sword combat (Bridgford 2000; Bell 2019; Gentile, van Gijn 2019; Hermann et al. 2020).

The Komárom-Szőny sword showed hammering traces along its hilt. The object's cutting edge was not only heavily damaged by taphonomic processes but also showed characteristic traces of modern combat damage in the form of patina breaks. A fine example is of these is a large V-shaped notch (*Fig. 4, E*). Under a microscope, the tip of the weapon seems to have also been filed (*Fig. 4, F*). Prehistoric use-wear traces could only be observed along the hilt shoulders (*Fig. 2, 1A–1B*). Here, the peg holes showed wear caused by the friction of the pegs. Based on the analysis, the object could be identified as a finished, used product.

The condition of the Lake Balaton sword was far from ideal. According to the analysis, it was soldered from three parts as an old attempt of 'restoration'. Only one production-related technological mark, a hammered cutting edge, could be observed. Microscope images have revealed characteristic traces, such as U- and V-shaped notches (*Fig. 4, A*) and

Fig. 3 1: the sword from Gyomaendrőd; 2A–2B: lead traces on the hilt of the sword from Gyomaendrőd (Hungarian National Museum, Budapest, photos: J. G. Tarbay)

3. kép 1: a gyomaendrődi kard; 2A–2B: ólomnyomok a gyomaendrődi kard pengéjén (Magyar Nemzeti Múzeum, Budapest, fényképek: Tarbay J. G.)

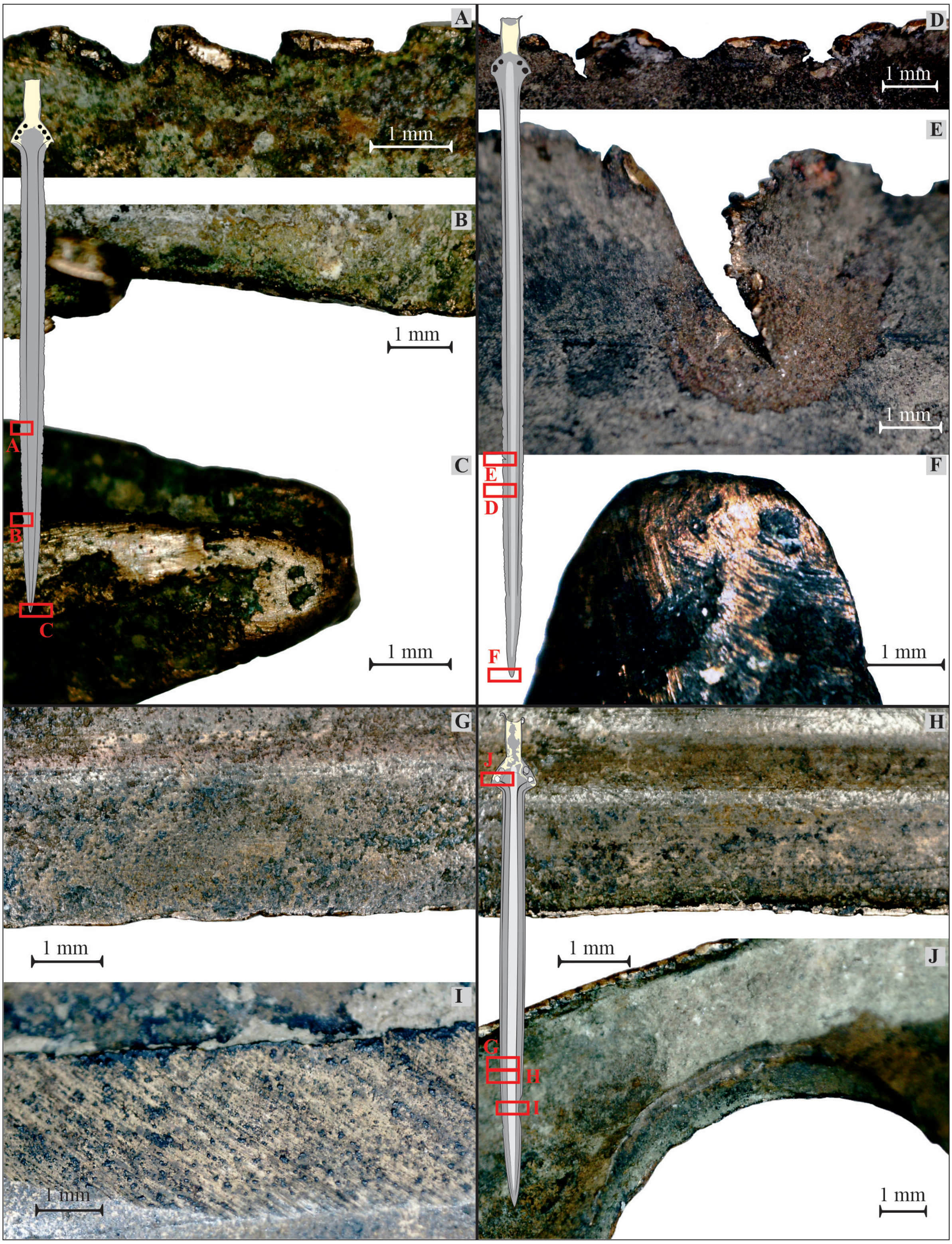

Fig. 4 A–C: sword from Lake Balaton; A: modern V- and U-shaped notches, B: modern chipping, C: modern tip damage; D–F: Sword from Komárom-Szőny; D: notches, E: modern V-shaped notch, F: modern tip damage; G–J: sword from Gyomaendrőd; G: dents, H: curling, I: modern damage caused by dredger vessel, J: peg hole with wear mark (Hungarian National Museum, Budapest, micrographs by J. G. Tarbay)

4. kép A–C: a balatoni kard; A: modern V és U alakú csorbulások, B: modern élforgácsolódás, C: modern hegysérülés; D–F: a komárom-szőnyi kard; D: csorbulások, E: modern V alakú csorbulások; F: modern hegysérülés; G–J: A gyomaendrődi kard; G: élhorpadás; H: élhajlás; I: kotróhajó által okozott modern sérülés; J: kopott szegecslyuk (Magyar Nemzeti Múzeum, Budapest, mikroszkópfelvételek: Tarbay J. G.)

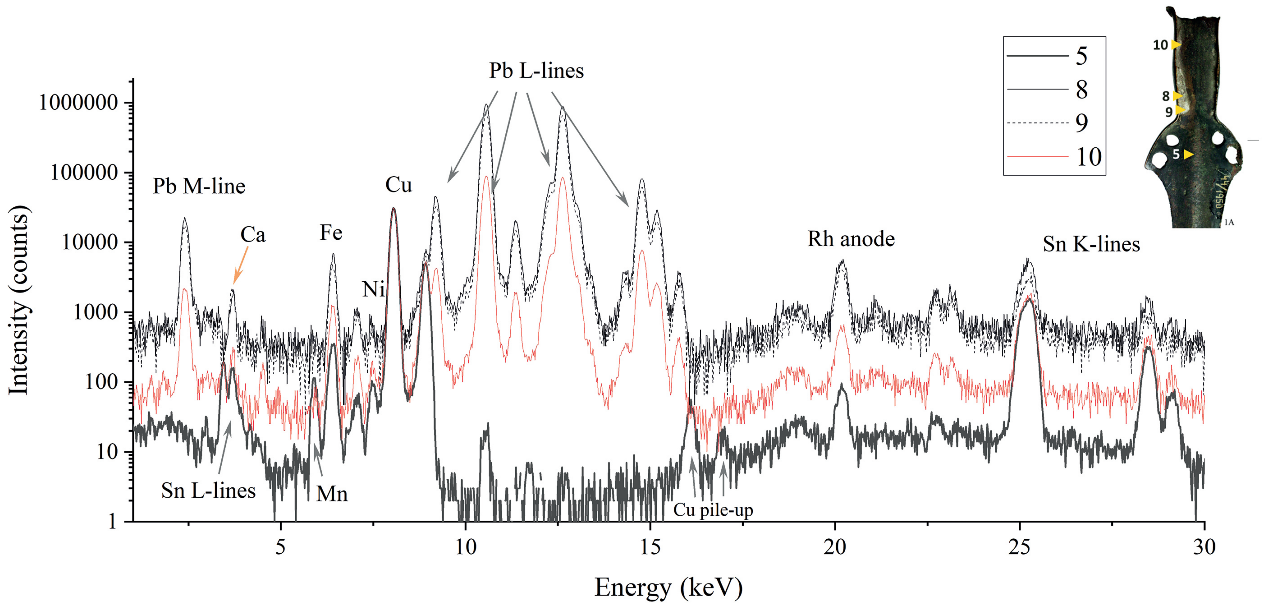

Fig. 5 XRF spectra of the sword from Komárom-Szőny. Elevated amounts of lead can be observed where pale, grey-coloured residue covers the surface of the handle (*Tab. 1; Nos. 8–10*) compared to the cleaned area (*Tab. 1, No. 5*) (the counts in the spectra are normalised to the 8-keV copper peak)

5. kép A Komárom-Szőny lelőhelyről származó kardról készült XRF-spektrumok. Nagy ólomtartalom figyelhető meg a halványszürke lerakódásnyomokkal borított részeken (*1. táblázat, 8–10. mérések*) a megtisztított fémfelületekkel (*1. táblázat; 5. mérés*) összehasonlítva (a spektrumokban a beütésszámok a 8 keV energiájú rézcsúcsra vannak normálva)

chipping related to edge-on-edge contact (*Fig. 4, B*). Tip damage (*Fig. 4, C*) was also observed on the blade. The damages are not covered with patina and were most likely caused by modern fencing.

The sword from Gyomaendrőd has been preserved in fine condition. It shows characteristic traces of a finished product. Hammering impacts were visible on its hilt and along the well-sharpened cutting edge. The peg holes were made by perforation and showed abrasion damage due to use (*Fig. 4, J*). Traces of additional material and the imprint of the organic hilt plates were visible on the hilt (*Fig. 3, 2A–2B*). Micro edge damage (*Fig. 4, G*), curling (*Fig. 4, H*), and a blunt tip were also present, but they were hard to date due to the object having been restored. Their modern origin should not be excluded since the lower part of the blade was heavily damaged by the dredger (*Fig. 3, 1, Fig. 4, I*).

Applied method

Based on the notes in the inventory book of the Hungarian National Museum and visual inspection, no significant chemical treatment was done to the objects. In our study, we aimed to verify the presence of lead in the pale grey substance on the object's surface. Our method of choice was handheld XRF spectrometry as the related device is easy to handle and provides surface compositional results within a minute. The XRF technique is an excellent method for detecting the presence of lead on the surface of bronze objects because its sensitivity increases with the atomic number (for the XRF spectra, see *Fig. 5*).

XRF results

In the case of the weapon from Komárom-Szőny, a Pb content between 38.6 m% and 52.8 m% was detected at various parts of the hilt with pale grey residue (*Tab. 1, 8–10, Fig. 5*), while lead was below the detection limit or only detectable in small amounts (0.06 m%) on other parts of the sword (*Tab. 1, 1–7*). The Sn content was relatively high in the patina: 11.2–11.6 m% and 8.8–14.8 m% Sn were determined in the cleaned surfaces of the blade and the hilt, respectively (*Tab. 1, 1–7*). The result provided by the SAM project, determining a 9.7 m% tin content of the sword's material, is more reliable (Junghans, Sangmeister, Schröder 1974, 294–295, SAM 19687). Accompanying elements like Ni and Fe were also detected in the sword. It must be noted that previous measurements also revealed the presence of As, Ag, and Sb in the sword (Junghans, Sangmeister, Schröder 1974, 294–295, SAM 19687). The sword

Tab. 1 XRF results of the flange-hilted swords with leaded hilts analysed in this paper. Please note that the concentration values measured with the Mining Plus factory calibration setup do not sum up to 100 in the results table. Here, the missing quantities originate from lighter elements (the atomic number equal to or less than 12): Al, Si, P, S, K, and Ca. These elements can be present as contaminants from the environment (soil), their origin requires further investigation.
1. táblázat 1–3, 5–26: A tanulmányban vizsgált ólmos markolatú nyélnyújtványos kardok XRF-eredményei. A Mining Plus gyári kalibrációs beállításokkal végzett mérések esetén a táblázatban listázott eredmények összege kevesebb, mint 100. A hiányzó mennyiségeket ezen mérések esetén könnyű elemek (LE, a rendszám kisebb vagy egyenlő, mint 12), Al, Si, P, S, K, Ca adják. Ezek az elemek az eltemetődési környezetből (talaj) származó szennyezők lehetnek, eredetük további vizsgálatot igényel.

Object	No.	Measured part	Factory calibration	Cu m% ± std	Sn m% ± std	Ni m% ± std	Sb m% ± std	As a.u. ± std	Fe m% ± std	Pb m% ± std	Bi m% ± std	Mn m% ± std
Sword, Komárom-Szőny (1950.44)	1	blade, cleaned	Alloy Plus	**87.6 ± 0.2**	**11.6 ± 0.3**	**0.20 ± 0.02**	*<D.L. (0.065)*	**0.08 ± 0.02**	**0.49 ± 0.05**	*<D.L. (0.013)*	*<D.L. (0.01)*	**0.06 ± 0.01**
	2		Alloy Plus	**88.0 ± 0.2**	**11.3 ± 0.3**	**0.19 ± 0.02**	*<D.L. (0.065)*	**0.11 ± 0.02**	**0.48 ± 0.05**	*<D.L. (0.016)*	*<D.L. (0.01)*	**0.08 ± 0.01**
	3		Alloy Plus	**88.0 ± 0.2**	**11.2 ± 0.3**	**0.23 ± 0.02**	*<D.L. (0.065)*	**0.10 ± 0.02**	**0.46 ± 0.05**	*<D.L. (0.03)*	*<D.L. (0.01)*	**0.06 ± 0.01**
	4	handle, cleaned	Alloy Plus	**83.8 ± 0.2**	**14.6 ± 0.3**	**0.19 ± 0.02**	*<D.L. (0.075)*	**0.11 ± 0.02**	**0.96 ± 0.06**	*<D.L. (0.02)*	*<D.L. (0.014)*	**0.42 ± 0.02**
	5		Alloy Plus	**83.5 ± 0.2**	**14.8 ± 0.3**	**0.17 ± 0.02**	*<D.L. (0.075)*	**0.15 ± 0.02**	**1.05 ± 0.05**	*<D.L. (0.02)*	*<D.L. (0.012)*	**0.47 ± 0.02**
	6		Alloy Plus	**84.7 ± 0.2**	**13.9 ± 0.3**	**0.16 ± 0.02**	*<D.L. (0.071)*	**0.07 ± 0.02**	**0.88 ± 0.06**	**0.06 ± 0.01**	*<D.L. (0.012)*	**0.36 ± 0.01**
	7		Mining Plus	**70.2 ± 0.2**	**8.8 ± 0.1**	**0.15 ± 0.02**	*<D.L. (0.06)*	**0.14 ± 0.02**	**0.99 ± 0.02**	*<D.L. (0.01)*	*<D.L. (0.009)*	**0.59 ± 0.02**
	8	handle, gray	Mining Plus	**1.50 ± 0.05**	**0.92 ± 0.03**	*<D.L. (0.01)*	*<D.L. (0.045)*	*<D.L. (0.2)*	**0.81 ± 0.03**	**52.8 ± 0.7**	**0.33 ± 0.03**	*<D.L. (2.5)*
	9		Mining Plus	**1.90 ± 0.05**	**0.64 ± 0.02**	*<D.L. (0.01)*	*<D.L. (0.045)*	*<D.L. (0.2)*	**0.77 ± 0.03**	**50.2 ± 0.7**	**0.29 ± 0.03**	*<D.L. (2.5)*
	10		Mining Plus	**11.5 ± 0.1**	**2.00 ± 0.03**	*<D.L. (0.02)*	*<D.L. (0.045)*	*<D.L. (0.2)*	**1.20 ± 0.03**	**38.6 ± 0.6**	**0.24 ± 0.02**	*<D.L. (2.5)*
Sword, Balaton (53.32.75)	11	blade, cleaned	Alloy Plus	**80.0 ± 0.2**	**17.3 ± 0.4**	**0.33 ± 0.02**	*<D.L. (0.083)*	**0.36 ± 0.04**	**2.26 ± 0.06**	**0.13 ± 0.01**	*<D.L. (0.018)*	*<D.L. (0.02)*
	12		Alloy Plus	**79.8 ± 0.2**	**17.6 ± 0.4**	**0.32 ± 0.02**	*<D.L. (0.081)*	**0.50 ± 0.04**	**2.10 ± 0.06**	**0.17 ± 0.01**	*<D.L. (0.017)*	*<D.L. (0.02)*
	13		Alloy Plus	**82.3 ± 0.2**	**15.5 ± 0.4**	**0.35 ± 0.02**	*<D.L. (0.077)*	**0.30 ± 0.04**	**1.72 ± 0.06**	**0.14 ± 0.01**	*<D.L. (0.016)*	*<D.L. (0.02)*
	14	handle, cleaned	Alloy Plus	**83.7 ± 0.2**	**14.5 ± 0.4**	**0.33 ± 0.02**	*<D.L. (0.077)*	**0.23 ± 0.03**	**1.38 ± 0.05**	**0.11 ± 0.01**	*<D.L. (0.015)*	*<D.L. (0.02)*
	15		Alloy Plus	**84.4 ± 0.2**	**13.9 ± 0.4**	**0.32 ± 0.02**	*<D.L. (0.072)*	**0.20 ± 0.03**	**1.37 ± 0.04**	**0.09 ± 0.01**	*<D.L. (0.014)*	*<D.L. (0.02)*
	16		Alloy Plus	**84.4 ± 0.2**	**13.7 ± 0.4**	**0.35 ± 0.02**	*<D.L. (0.071)*	**0.22 ± 0.03**	**1.37 ± 0.05**	**0.12 ± 0.01**	*<D.L. (0.014)*	*<D.L. (0.02)*
	17	handle, gray	Mining Plus	**1.40 ± 0.04**	**0.31 ± 0.01**	*<D.L. (0.01)*	*<D.L. (0.045)*	*<D.L. (0.2)*	**1.10 ± 0.03**	**43.4 ± 0.6**	**0.26 ± 0.02**	*<D.L. (2.0)*
	18		Mining Plus	**14.2 ± 0.1**	**5.00 ± 0.05**	*<D.L. (0.02)*	*<D.L. (0.06)*	*<D.L. (0.2)*	**1.60 ± 0.04**	**33.5 ± 0.6**	**0.24 ± 0.02**	*<D.L. (2.5)*
	19		Mining Plus	**3.70 ± 0.04**	**1.10 ± 0.03**	*<D.L. (0.02)*	*<D.L. (0.06)*	*<D.L. (0.2)*	**1.10 ± 0.04**	**36.1 ± 0.6**	**0.25 ± 0.03**	*<D.L. (0.03)*
Sword, Gyomaendrőd (35.1888)	20	blade, cleaned	Alloy Plus	**89.6 ± 0.2**	**9.8 ± 0.1**	**0.35 ± 0.02**	*<D.L. (0.063)*	**0.17 ± 0.01**	**0.29 ± 0.03**	**0.033 ± 0.006**	*<D.L. (0.011)*	*<D.L. (0.02)*
	21	handle, gray	Alloy Plus	**84.1 ± 0.2**	**10.4 ± 0.1**	**0.30 ± 0.02**	*<D.L. (0.08)*	**0.14 ± 0.03**	**2.28 ± 0.05**	**2.37 ± 0.05**	*<D.L. (0.037)*	**0.20 ± 0.02**
	22		Alloy Plus	**67.5 ± 0.2**	**9.6 ± 0.1**	**0.260 ± 0.015**	*<D.L. (0.07)*	*<D.L. (0.1)*	**0.32 ± 0.02**	**22.26 ± 0.14**	*<D.L. (0.11)*	*<D.L. (0.02)*
	23		Alloy Plus	**75.4 ± 0.2**	**11.7 ± 0.2**	**0.28 ± 0.02**	*<D.L. (0.12)*	*<D.L. (0.1)*	**3.28 ± 0.06**	**9.00 ± 0.13**	*<D.L. (0.06)*	*<D.L. (0.035)*
	24	rivet 1	Alloy Plus	**91.7 ± 0.2**	**6.9 ± 0.1**	**0.685 ± 0.015**	**0.33 ± 0.02**	**0.44 ± 0.02**	**0.24 ± 0.02**	**0.11 ± 0.01**	*<D.L. (0.013)*	*<D.L. (0.02)*
	25	rivet 2	Alloy Plus	**91.0 ± 0.2**	**7.8 ± 0.1**	**0.628 ± 0.013**	**0.29 ± 0.02**	**0.33 ± 0.01**	**0.20 ± 0.02**	**0.070 ± 0.008**	*<D.L. (0.010)*	*<D.L. (0.02)*

from Lake Balaton has Pb content between 33.5 and 43.4 m% in the areas covered with pale grey residue (*Tab. 1, 17–19*). On the parts not covered with lead residue, Pb was detected in significantly lower amounts, around 0.1 m%. The XRF analysis also revealed the presence of Sn (13.9–17.6 m%) in the patina and accompanying elements like Ni and Fe (*Tab. 1, 11–16*).

Our measurements on the Gyomaendrőd sword's pale-grey residue-covered parts support the 1909 observations of Sophus Müller, who proposed, based on a photograph, that this sword has a leaded hilt (Müller 1909, 50–51, Fig. 51–52). The lead traces have almost completely disappeared from this sword. XRF measurements were made on those parts where they were preserved in a better condition. The residue traces were so small that the measuring points also included the hilt (*Tab. 1, 21*). High lead content, about 22 m%, was observed on one part of the hilt (*Tab. 1, 22–23*). The Sn content of the sword varied between 9.6 and 11.7 m%. Considering the weapon's bulk Sn content, we find those results (9.6–9.8 m%) more reliable where the sample area was at major modern damage caused by the dredger ship (*Tab. 1, 20*). The accompanying elements detected in this sword's blade were Ni, Fe, and Pb. The XRF analysis has revealed that the two pegs were also made of bronze with an Sn content between 6.9 and 7.8 m%. One contained Co (0.0209 m%), and both had an additional accompanying element, Sb (0.33 and 0.29 m%, respectively). It is possible that the pegs were made of a different material than the sword (*Tab. 1, 24–25*).

In summary, the XRF analysis supported the macroscopic observations that the pale grey residue on the sword's hilt can be identified as lead. It also revealed the alloying element (Sn) and additional accompanying elements such as Sb, Ni, Fe, and Co.

The point of balance

Otto Olshausen was among the very first to identify lead on sword hilts in 1883. He analysed the sword from Rumohrshof aus Alsen. He proposed that lead may have contributed to the better fitting of the hilt into the flanges or originally lead covered the hilt of the bronze sword. Both solutions served to counterweight the blade of the sword, i.e., change its point of balance (Olshausen 1883, 105–107; Olshausen 1884, 535–536). In 1909, Sophus Müller observed the presence of lead on Late Bronze Age Nordic swords. Sophus Müller also reached out to Lajos Márton, and requested a photograph of the Gyomaendrőd (former Endrőd, Békés County, Hungary) sword, which he typologically related to the Scandinavian specimens and called attention to the lead traces on its hilt (Müller 1909, 50–51, Figs 51–52; Márton 1930, 14–16, Fig. 7; Kemenczei 1988, 44, Pl. 17, 184). Another specimen, the sword from Lake Balaton, was added to the list of Hungarian specimens by Lajos Márton some decades later (Márton 1930, 14, Fig. 8). At that time, XRF was not available for checking the macroscopic observations; thus, these observations remained unconfirmed. The new XRF analysis revealed the presence of a significant amount of lead on the studied Hungarian swords in specific areas of the hilts covered in pale residue. The composition of these areas on both weapons differs completely from other parts of the metal hilts. Thus, we can support previous observations on these weapons and enrich the list of known specimens from our research area with new finds.

Swords with traces of lead were observed in different European regions. The best-researched area is undoubtedly Northern Europe. Jens Winther Johannsen mentions a total of 30 bronze swords with leaded hilts from Denmark and Sweden. They were dated between Period II and Period III of the Montelian system, corresponding with the Br B1/Br C2 (Period II) and Br D/Ha A1 (Period III) periods, respectively. This is roughly the same time to which the Hungarian leaded swords can be dated. It should also be noted that the Scandinavian specimens are also mainly Sprockhoff Ia-types (Johannsen 2016, 154, Tab. 1). Swords with a leaded hilt were also reported from Niedersachsen, Germany, mainly from Period II (Laux 2009, 91, 99–102). The filling of the cavity of a metal-hilted sword hilt is also known from a variety of sources. Michał Bugaj and Kamil Kajkowski reported the latest specimen belonging to this phenomenon from Bitów (Bugaj, Kajowski 2019, 358). Harry Wüstemann summarised the specimens known at the time from Austria, the Czech Republic, Denmark, Germany, Italy, Slovakia, and Switzerland in 2004 (Wüstemann 2004, 149, fn. 161).

According to the XRF results, Late Bronze Age Carpathian metalsmiths intentionally cast lead on the hilts of these swords (Márton 1930, 14–16). Considering the regional techno-historical trends, this is an important observation because it means that the presence of lead on swords predates the arrival of the high-leaded bronzes around the Ha A2/Ha B1 and Ha B1 periods (see Liversage, Pernicka 2002; Czajlik 2012, 94–96, 97–98; Tarbay et al. 2021). Craftsmen were aware of this material around the Br C2–Br D not only in Northern Europe (Olshausen 1883, 107) but also in the Carpathian Basin, and used it consciously to enhance swords. It is also possible that lead was extracted and manufactured into ingots even at this relatively early stage of the Late Bronze Age.

What was the advantage of adding lead to the swords' hilts? Authors involved in the discussion of lead on the hilts of flange-hilted swords with organic hilt plates (Germ. *Griffzungenschwerter*) or swords with metal hilts (Germ. *Vollgriffschwerter*) explained the phenomenon in different ways. According to Harry Wüstemann, who mainly discussed metal-hilted swords, the presence of lead in the cavity of this sword type can be explained by four reasons: 1. enhancing the point of balance; 2. improving the attachment of the hilt and blade; 3. repairing; and 4. 'magical meaning' (Wüstemann 2004, 149, fn. 161; Bugaj, Kajowski 2019, 358–360). Also, high lead content measured on sword hilts can hint at modern forgeries, as has been well illustrated by the elemental composition and archaeological analysis of the sword from 'Obišovce' (see Novontá 2014, Pl. 35, F6; Ozdín 2014, 98–103, Tab. 1; Sicherl 2014, 120–121;).

Shifting the weapon's point of balance. Several scholars have raised the possibility that the main reason for adding lead to a flange-hilted sword is to shift the weapon's point of balance from the blade towards the hilt. Thus, by providing a more secure grip on the handle, the swords' manoeuvrability was improved (Driehaus 1961, 28; Thrane 1968, 179; Schauer 1971, 123; Wüstemann 1992, 47; Říhovský 2000, 155; Johannsen 2016, 155–156; Bugaj, Kajkowski 2019, 358–360). Among the different explanations formulated on the subject, we find this scenario to be the most probable, particularly for the specimens under study. In the case of the Komárom-Szőny sword, this can be satisfactorily explained by the dimensions of the object: it has a relatively long and heavy blade and, in contrast, a short and, without lead filling, quite light handle. Adding lead may have been necessary to make this object a functional weapon.

Better fastening. Adding lead to the handle may contribute to the better fastening of the hilt plates or metal hilts and the sword blades. This recognition comes from the X-ray analysis of Bronze Age swords (Olshausen 1883, 106; Bader 1991, 3; Wüstemann 1992, 47; Říhovský 2000, 159; Wüstemann 2004, 149, fn. 161).

Repair. Among numerous studies (e.g., Horst 1989, 100; Wüstemann 2004, 149, fn. 161), Michał Bugaj and Kamil Kajkowski recently argued that in addition to making the weapons more effective by manipulating the point of balance, filling the cavities of metal-hilted swords with lead could also refer to repairing (Bugaj, Kajkowski 2019, 360). In our opinion, this is a plausible scenario if the handle was cast incompletely during manufacturing or damaged during its use-life. However, in most cases, it seems that this practice mainly served to shift the point of balance and stabilise the metal hilt with the blade, as generally, these parts were fastened only by two pegs and hammering.

'Ritual weapons and magic'. Harry Wüstemann proposed in 1992 that magical meaning can be attributed to the casting of lead into metal-hilted swords because lead was a metal with assumed magical potential in ancient societies, and he did not observe combat damages on the Mörigen-type swords he studied (Wüstemann 1992, 47–48; Wüstemann 2004, 149). Bernhard Sicherl further developed this idea by adding, based on antique analogies, that those swords on which practical reasons cannot explain the additional lead may have been associated with the chthonic connotations of lead (Sicherl 2014, 109, fn. 31). Since metalworking and probably all craft activities in prehistory were intertwined with ritual activities, this has always been a possibility. Nonetheless, this is hard to prove by means of archaeology, and even if 'magic' was involved, for instance, in repairing a sword, it served the simple goal of making the sword usable.

The studied Late Bronze Age swords from Hungary fall into the first explanation group, particularly swords like Komárom-Szőny and Gyomaendrőd, which have relatively long blades. Shifting the point of balance near the handle is essential to control such a long weapon in a combat situation.

Conclusions

The three swords can be dated around the Br C/Br D period, and two of them (Komárom-Szőny, Lake Balaton) have connections to Northern European Period II (Br B1/Br C2) weapons. The Gyomaendrőd sword has individual features with a handful of analogies from Hungary, Italy, and Germany. The other two weapons share morphological characteristics with finds from Hungary, Germany, the Czech Republic, Switzerland, and Denmark. The results of the metalwork production and use-wear analysis suggest that the three studied swords were finished products suitable for use as weapons. The microscopic damages along their blade were caused by modern combat or dredging (Gyomaendrőd), while prehistoric use-wear marks caused by abrasion were only present along the peg holes. The XRF measurements confirmed Sophus Müller's and Lajos Márton's observation that the grey residue on the sword hilt from Gyomaendrőd and Lake Balaton is lead (Müller 1909, 50–51, Figs 51–52; Márton 1930, 14, Fig. 8). We also enriched the number of known Hungarian examples by one, as the Komárom-Szőny sword had high lead content in the areas covered by pale grey residue. We believe that the addition of lead manipulated the point of balance in the case of the examined swords, especially the relatively long ones like Komárom-Szőny or Gyomaendrőd.

Acknowledgements

The study has been supported by *The Technology, Use and Manipulation of Weapons from the Late Bronze Age Transdanubia* research program of the OTKA Research Fund. Project no. 134910 has been implemented with the support provided by the Ministry of Culture and Innovation of Hungary from the National Research, Development and Innovation Fund, financed under the OTKA PD funding scheme.

BIBLIOGRAPHY

Aner, E., Kersten, K. 1973: Frederiksborg und Københavns Amt. Die Funde der älteren Bronzezeit des nordischen Kreises in Dänemark, Schleswig-Holstein und Niedersachsen 1. København.

Bader, T. 1991: Die Schwerter in Rumänien. Prähistorische Bronzefunde IV/8. Stuttgart.

Bell, R. D. 2019: A shifting chronology of combat damage. Reassessing the evidence for use and reuse on Irish Bronze Age swords. In: Knight, M. G., Boughton, D., Wilkinson, R. E. (eds.), Objects of the past in the past. Investigating the significance of earlier artefacts in a later context. Oxford, 152–180.

Bianco Peroni, V. 1970: Die Schwerter in Italien – Le spade nell'Italia continentale. Prähistorische Bronzefunde IV/1. München.

Bridgford, S. 2000: Weapons, warfare and society in Britain 1250–750 BC I-II. PhD dissertation, Department of Archaeology and Prehistory, University of Sheffield. Sheffield.

Bugaj, M., Kajkowski, K. 2019: New discovery of a Late Bronze Age sword from Bytów, Pomorskie Voivodeship. In: Przybyła, M., Dzięgielewski, K. (eds.), Chasing Bronze Age rainbows. Studies on hoards and related phenomena in prehistoric Europe in honour of Wojciech Blajer. Prace Archeologiczne Studies 69. Kraków, 349–361. https://doi.org/10.33547/PraceArch.69.16

Cowen, J. D. 1956: Eine Einführung in die Geschichte der bronzenen Griffzungenschwerter in Süddeutschland und den angrenzenden Gebieten. Bericht der Römisch-Germanischen Kommission 36, 53–155.

Czajlik, Z. 2012: A Kárpát-medence fémnyersanyag-forgalma a késő bronzkorban és a vaskorban. Budapest.

Driehaus, J. 1961: Röntgenuntersuchungen an bronzenen „Vollgriffschwertern". Germania 39, 22–31.

Gentile, V., van Gijn, A. 2019: Anatomy of a notch. An in-depth experimental investigation and interpretation of combat traces on Bronze Age swords. Journal of Archaeological Science 105, 130–143. https://doi.org/10.1016/j.jas.2019.02.004

Hampel, J. 1888: A Nemzeti Múzeum régiségtárának gyarapodása 1888 májustól augusztus végéig. Archaeologiai Értesítő 8, 379–381.

Hermann, R., Crellin, R. J., Uckelmann, M., Wang, Q., Dolfini, A. 2020: Bronze Age combat: an experimental approach. British Archaeological Reports International Series 30. Oxford. https://doi.org/10.30861/9781407355719

Horst, F. 1989: Die Stämme der Lausitzer Kultur und des Nordens in der jüngeren Bronzezeit. In: Hermann, J. (ed.), Archäologie in der Deutschen Demokratischen Republik. Denkmale und Funde 1. Archäologische Kulturen, geschichtliche Perioden und Volkstämme. Leipzig–Jena–Berlin, 98–105.

Ilon, G. 2011: Az urnamezős kor bronz depói és szórvány bronzai a Bakonyban és vidékén. A hajdani pápai járás topográfiai munkálataira emlékezve. In: Kővári, K., Miklós, Zs. (eds.), „Fél évszázad terepen". Tanulmánykötet Torma István tiszteletére 70. születésnapja alkalmából. Budapest, 225–242.

Johannsen, J. W. 2016: Heavy metal – lead in Bronze Age Scandinavia. Fornvännen 111, 153–161.

Junghans, S., Sangmeister, E., Schröder, M. 1974: Kupfer und Bronze in der frühen Metallzeit Europas. Katalog der Analysen Nr. 10041-22 000. Berlin.

Kemenczei, T. 1988: Die Schwerter in Ungarn I (Griffplatten-, Griffangel- und Griffzungenschwerter). Prähistorische Bronzefunde IV/6. München.

Laux, F. 2009: Die Schwerter in Niedersachsen. Prähistorische Bronzefunde IV/17. Stuttgart.

Liversage, D., Pernicka, E. 2002: An industry in crisis? Copper alloy impurity patterns near the end of the Hungarian Bronze Age. In: Jerem, E., T. Bíró, K. (eds.), Archaeometry 98. Proceedings of the 31st Symposium Budapest. British Archaeological Reports International Series 1043. Oxford, 417–431.

Márton, L. 1930: Bronzkardjaink markolatának és hüvelyének csontdíszítményei. Archaeologiai Értesítő 44, 14–27.

M. Hellebrandt, M. 1985: Neue spätbronzezeitliche Schwertfunde aus Nordungarn. Acta Archaeologica Academiae Scientiarum Hungaricae 37, 23–31.

Mozsolics, A. 1973: Bronze- und Goldfunde des Karpatenbeckens. Depotfundhorizonte von Forró und Ópályi. Budapest.

Mozsolics, A. 1975: Bronzkori kardok folyókból – Bronzezeitliche Schwertfunde aus Flüssen. Archaeologiai Értesítő 102, 3–24.

Mozsolics, A. 1985: Bronzefunde aus Ungarn. Depotfundhorizonte von Aranyos, Kurd und Gyermely. Budapest.

Müller, S. 1909: Bronzealderens begyndelse og ældre udvikling i Danmark, efter de nyeste fund. Aarbøger for Nordisk Oldkyndighed og Historie II/24. Coppenhagen.

Novák, P. 1975: Die Schwerter in der Tschechoslowakei I. Prähistorische Bronzefunde IV/4. München.

Novotná, M. 2014: Die Vollgriffschwerter in der Slowakei. Prähistorische Bronzefunde IV/18. Stuttgart.

Olshausen, O. 1883: Über Zinngeräthe aus Gräbern und über den Belag der Griffzungen eines Bronzeschwertes mit Bleiweiss. Zeitschrift für Ethnologie 15, 86–110.

Olshausen, O. 1884: Chemische Beobachtungen an vorgeschichtlichen Gegenständen. Zeitschrift für Ethnologie 16, 516–538.

Ozdín, D. 2014: Anhang 2: Chemische Zusammensetzung der Schwerter von Obišovce und Turnianske Podhradie. In: Novotná, M., Die Vollgriffschwerter in der Slowakei. Prähistorische Bronzefunde IV/18. Stuttgart, 98–103.

Patek, E. 1968: Die Urnenfelderkultur in Transdanubien. Budapest.

Říhovský, J. 2000: Die bronzezeitlichen Vollgriffschwerter in Mähren. Pravěk Supplementum 7. Brno.

Schauer, P. 1971: Die Schwerter in Süddeutschland, Österreich und der Schweiz I. (Griffplatten-, Griffangel- und Griffzungenschwerter). Prähistorische Bronzefunde IV/2. München.

Sicherl, B. 2014: Anhang 3: Die Vollgriffschwerter in der Slowakei: Radiographische Befunde. In: Novotná, M., Die Vollgriffschwerter in der Slowakei. Prähistorische Bronzefunde IV/18. Stuttgart, 103–121.

Sprockhoff, E. 1931: Die germanischen Griffzungenschwerter. Römisch-Germanische Forschungen V. Berlin–Leipzig. https://doi.org/10.1515/9783111374956

Szathmári, I. 2005: Folyókból előkerült bronzkori kardleletek a Magyar Nemzeti Múzeum gyűjteményében. – Bronzezeitliche Schwertfunde aus Flüssen in der Sammlung des Ungarischen Nationalmuseums. Communicationes Archaeologicae Hungariae, 143–166.

Tarbay, J. G., Maróti, B., Kiss, Z., Káli, Gy., Szentmiklósi, L. 2021: Non-destructive analysis of a Late Bronze Age hoard from the Velem-Szent Vid hillfort. Journal of Archaeological Sciences 127, 1–25. https://doi.org/10.1016/j.jas.2020.105320

Thrane, H. 1968: Eingeführte Bronzeschwerter aus Dänemarks jüngerer Bronzezeit. Acta Archaeologica København 39, 143–215.

Wüstemann, H. 1992: Jungbronzezeitliche „Vollgriffschwerter" mit Bleifüllung. Arbeits- und Forschungsbericht zur sächsischen Bodendenkmalpflege 35, 39–49.

Wüstemann, H. 2004: Die Schwerter in Ostdeutschland. Prähistorische Bronzefunde IV/15. Stuttgart.

ÓLMOS MARKOLATÚ KÉSŐ BRONZKORI KARDOK MAGYARORSZÁGRÓL

Összefoglalás

A tanulmány a késő bronzkori nyélnyújtványos kardok markolatán megfigyelhető szürkés elszíneződésű „lerakódásokkal" és használati nyomokkal foglalkozik három a Magyar Nemzeti Múzeum gyűjteményébe tartozó bronzkard példáján, melyek lelőhelyei: Komárom-Szőny-Olajfinomító-Duna folyó (Komárom-Esztergom vármegye); Balaton; Gyomaendrőd (Békés vármegye) (Kemenczei 1988, 44–45, Pl. 16, 182, Pl. 17, 184, Pl. 18, 189).

A komárom-szőnyi kard helyi párhuzamokon kívül stilisztikai kapcsolatot ápol németországi, csehországi és dániai fegyverekkel. A párhuzamok jelentős része a II. periódusra (Bz B1/Bz C2) tehető, a Kárpát-medencei darabok valószínűleg a Bz C-re és bizonytalanul még a Bz D-re datálhatók. A Balatonban 1841 környékén talált kardhoz hasonló darabokat Magyarország, Szlovákia, Németország, Svájc és Dánia területén láthatunk. A párhuzamok keltezése hasonló szórást mutat a komárom-szőnyi példányhoz, ezek a kardok a II. periódustól a Bz D-ig datálódnak. A zalkodi fegyverlelet alapján a szóban forgó kard Bz D keltezését tartjuk a legvalószínűbbnek. A lelőhely jól azonosítható topográfiai helyzete alapján a gyomaendrődi kard valószínűleg szintén folyami vagy a Körös folyó mocsaras, ártéri környezetéből származhatott. Ez a fegyver a nagytétényi kardon kívül délnémet és olasz szórványokra hasonlít. Kemenczei Tibor munkája alapján valószínűleg a Bz C/Bz D periódussal hozhatjuk összefüggésbe (Kemenczei 1988, 44–46).

A három kardlelet mikroszkópkamerás vizsgálata alapján elsősorban modern, másodsorban őskori használati nyomokat lehetett elkülöníteni a tárgyak felszínén. A modern sérülések főképpen pengék okozta élcsorbulások, forgácsolódás, horpadások és hajlások formájában jelentkeztek. Egyiket sem borítja patina, ezért jelenlétük arra utal, hogy ezek a sérülések a megtalálást követően keletkeztek, modern „vívás" eredményeként. Őskori használati nyomként mindössze a szegecslyukak kopását azonosíthatjuk. Ez a sérüléstípus két esetben (Komárom-Szőny és Gyomaendrőd) volt megfigyelhető. A kézi XRF-vizsgálat eredményei alapján a kardok markolatán látható különböző vastagságú szürkés lerakódások ráöntött ólomként azonosíthatók. A vizsgálat eredményei igazolják Sophus Müller és Márton Lajos korábbi, makroszkópos megfigyeléseken alapuló hipotézisét, miszerint a gyomaendrődi és a balatoni darab (Müller 1909, 50–51, Fig. 51–52; Márton 1910, 14–16, Fig. 7–8) az ólmos markolatú kardok körébe tartozik. Eredményeink egy tárggyal gazdagítják ennek a technológiai jelenségkörnek az ismert magyarországi példáit Komárom-Szőnyről. Ólmos markolatú kardok a vizsgált fegyverekkel durván egy időben a Bz B1/Bz C2-től (II. periódus) a Br D/Ha A1-ig (III. periódus) jelennek meg a skandináv leletanyagban, illetve feltűnnek Közép-Európa más pontjain is. Harry Wüstemann összegzése alapján az ólom jelenlétét a nyélnyújtványos és fémmarkolatos kardok markolatán a kutatás négyféleképp értelmezi: a súlypont manipulációja; szorosabb nyelezés; javítás; rituálé (Wüstemann 2004, 149, 161. jegyzet). A vizsgált három kard esetében véleményünk szerint a fegyverek súlypontját manipulálhatták, ami különösen a hosszabb pengéjű darabok esetében (Komárom-Szőny; Gyomaendrőd) valószínű, mivel nehezített markolat hiányában a fegyver súlypontja túlzottan a hegy irányába tolódna el, megnehezítve a fegyver forgatását.