DATE LIST



New radiocarbon dates from the Bronze Age Tiszafüred-Majoroshalom site (Eastern Hungary)

János Dani^{1,2}, Anikó Horváth³, Anett Gémes^{4,5}, Kristóf Fülöp⁶, Tamás Szeniczey⁴, János Gábor Tarbay⁷, Magdolna Vicze⁸, Ashley McCall⁹, István Futó³, Anna Szigeti^{1,3}, Mihály Molnár³, Mario Novak^{4,10}, Klára P Fischl⁶, Gabriella Kulcsár⁶, Géza Szabó¹¹, Edit Mester¹², László Palcsu³, Viktória Kiss⁶, István Major³* and Tamás Hajdu⁴*

¹Department of Archaeology, University of Szeged, Egyetem utca 2, 6722, Szeged, Hungary, ²Déri Museum, Déri tér 1, 4026, Debrecen, Hungary, ³International Radiocarbon AMS Competence and Training Center (INTERACT), HUN-REN Institute for Nuclear Research, Bemtér 18/c. 4026 Debrecen, Hungary, ⁴Department of Biological Anthropology, Institute of Biology, Eötvös Loránd University, Pázmány Péter sétány 1/C, 1117, Budapest, Hungary, ⁵Salisbury Zrt. Tartsay Vilmos utca 14. H-1126 Budapest, Hungary, ⁶HUN-REN Research Centre for Humanities, Institute of Archaeology, Tóth Kálmán u. 4, 1097, Budapest, Hungary, ⁷Department of Archaeology, National Institute of Archaeology, Hungarian National Museum, Hungarian National Museum Public Collection Centre, Múzeum krt. 14-16, 1088, Budapest, Hungary, ⁸Department of Innovation and Experimental Archaeology, National Institute of Archaeology, Hungarian National Museum, Hungarian National Museum Public Collection Centre, Múzeum krt. 14-16, 1088, Budapest, Hungary, ⁹Independent researcher, Dublin, Ireland, ¹⁰Laboratory for Evolutionary Anthropology and Bioarchaeology, Centre for Applied Bioanthropology, Institute for Anthropological Research, Ljudevita Gaja 32, 10 000 Zagreb, Croatia, ¹¹Wosinsky Mór Museum, Szent István tér 26, 7100, Szekszárd, Hungary and ¹²Kiss Pál Museum, Tariczky sétány 8, 5350, Tiszafüred, Hungary

Corresponding authors: János Dani; Email: drdanij@gmail.com, István Major: Email: imajor@atomki.hu and Tamás Hajdu; Email: tamas.hajdu@ttk.elte.hu

Received: 22 October 2024; Accepted: 30 October 2024

Keywords: Bronze Age; radiocarbon; Otomani-Füzesabony culture; Tiszafüred-Majoroshalom; Tumulus culture

Abstract

In this paper we present new AMS radiocarbon dates from the Bronze Age cemetery of Tiszafüred-Majoroshalom excavated between 1961 and 1972. The cemetery provides crucial information on the cultural development and chronology of the Bronze Age Otomani-Füzesabony and the Tumulus cultures of Eastern Central Europe, in addition to the transition between the Middle and Late Bronze Age (approx. 1500 BC) in the Great Hungarian Plain.

Introduction

The Tiszafüred-Majoroshalom site (Eastern Hungary) was excavated between 1961 and 1972 as a part of a rescue project related to the construction of the Tisza II power station (Csalog 1962, 1965a; Hajdu 2012; Korek 1973; Kovács 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973a, 1973b, 1975). During this campaign a total of 1006 Bronze Age burials were discovered: 2 cremation burials of the Hatvan culture, 622 inhumation burials of the Otomani–Füzesabony culture, and 382 inhumation and cremation burials of the Tumulus culture. T. Kovács has published the archaeological results of the Tumulus culture cemetery (Kovács 1975) and material of some graves from the Otomani–Füzesabony cemetery in several papers from Majoroshalom (Kovács 1973c, 1977, 1979, 1982a, 1982b, 1982c, 1984, 1988, 1990, 1992), and from other sites in proximity, such as Fertőihalom (Akasztódomb) and Kenderföldek (Csalog 1965b; Kovács 1975). However, the complete Middle Bronze Age cemetery of Majoroshalom has yet to be published. The stable isotope results are being published in a separate paper (Cavazzuti et al. in preparation).

^{*}These authors jointly supervised this work: Tamás Hajdu and István Major.

[©] The Author(s), 2024. Published by Cambridge University Press on behalf of University of Arizona. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted re-use, distribution and reproduction, provided the original article is properly cited.

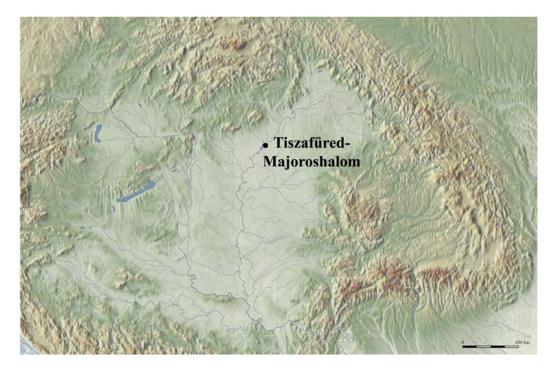


Figure 1. Localization of Bronze Age site Tiszafüred-Majoroshalom (Hungary).

The Tiszafüred-Majoroshalom cemetery is linked to the Bronze Age tell-settlement of Tiszafüred-Ásotthalom (Figure 1). This cemetery is located about 600–700 m south of the tell-settlement, which has been researched by Hungarian archaeologists for about 150 years from 1879 (Milesz 1903, 1904). The Ásotthalom tell is situated on the southern edge of the marshy floodplain bounded by the former meander of the river Tisza (this river bend was probably cut off and slowly filled in prehistoric times). The use of the Bronze Age site complex was started at the end of the Early Bronze Age (around 2100/2000 BE; Hatvan culture), formed by Majoroshalom, Ásotthalom, and other nearby smaller cemeteries (Fertőihalom/Akasztódomb and Kenderföldek), and continued during the Middle (Otomani-Füzesabony culture) and Late Bronze Age (Tumulus culture), until 1300 BC.

50 years after the excavations of the Majoroshalom site, we are now able to publish 44 AMS radiocarbon dates originating from 44 inhumation burials. Out of these 44 dates, 31 represent the Otomani-Füzesabony culture while 13 represent the Tumulus culture. The aim of our study is to provide a strong chronological base for future archaeological studies with an updated and ever-expanding dataset.

Material and methods

All samples were taken from human bone material curated by the Hungarian Natural History Museum (Budapest, Hungary). A fundamental criterion for the selection was that the chosen grave should be intact and clearly identifiable based on both the archaeological and the bioanthropological documentation. Another important criterion was that we tried to select based on the archaeological data (grave goods and burial rite), whereby the sample set was relatively proportionally representative of the whole population.

In addition, since the burials of the two cultures are not superimposed (with only some exceptions), a typology-based relative chronology was used to ensure that the selected graves cover the whole length

of the use of the Middle Bronze Age cemetery of the Otomani-Füzesabony culture. Furthermore, we chose samples from graves of the earliest possible phase of the LBA Tumulus culture in order to clarify the chronology of the Middle to Late Bronze Age transition.

All the skeletal remains were selected and prepared at the INTERACT laboratory of the HUN-REN Institute for Nuclear Research (ATOMKI) in Debrecen, Hungary (Molnár et al. 2013a, 2013b), following a modified version of the Longin method (Longin 1971), which can be found in detail elsewhere (Brown et al. 1988; Pearson 2013; Pearson et al. 2007). Briefly, bone samples were demineralised in 0.5 M HCl until pliable. The samples were then gelatinised with a HCl solution at 75°C for between 24 and 48 hours. The remaining sample material was filtered using Ezee filters and freeze-dried. After sealed tube combustion of ~5 mg freeze-dried gelatin with MnO₂ reagent, the liberated CO₂ was purified and graphitized using sealed tube graphitization method and pressed into aluminium targets (Janovics et al. 2018; Rinyu et al. 2013). The AMS measurement of the samples was normalized to the NIST oxalic acid (oxalic acid standard, SRM-4990C), while the background of the measurements was determined using graphitized fossil CO2. The average blank value was subtracted from each 14C date. In parallel with the actual samples, laboratory background and standard bone samples were prepared and measured, and all unknown age results were corrected for these as well (Major et al. 2019; Molnár et al. 2012). The final radiocarbon age results were calibrated using the IntCal20 calibration curve and the online program OxCal (Bronk Ramsey 2009; Reimer et al. 2020).

Results

In this study, we present the results for radiocarbon dating of archaeological samples from Tiszafüred-Majoroshalom site (Table 1) and the short archaeological description of the graves from which the samples were taken (see below).

The numbering of the finds in the case of published burials does not always follow the publication data. We used the original excavation numbering, where possible, of the grave goods.

Abbreviations in descriptions below: bd: bottom diameter; d: depth; dm: diameter; db: diameter of the belly; dp: diameter of the pedestal; fh: fragmented height: fl: fragmented length; h: height; hd: diameter of the head; l: length; m: measurements; n/a: no data; pd: diameter of the pedestal: rd: rim diameter: rh: reconstructed height: rrd: reconstructed rim diameter; t: thickness; w: width

Grave descriptions

Grave B12

Inhumation burial of an adult male (30–39 years old). The S-N (192°) oriented skeleton was placed in a flexed position on its right side. In front of the legs were placed a bowl (1), a jug (2) and a mug (3). Grave pit: n/a.

Grave B54 (Kovács 1995, Abb. 1/A, 2-3)

Inhumation burial of an adult male (20-29). The S-N (168°) oriented skeleton was placed in a flexed position on its right side. A bowl (8) and a mug within it (7) were placed behind the legs. One jug (6) was laid in front of the legs with another in front of the pelvis (5). An axe with its shaft covered with bronze plate (1) was laid in the area between the arms and legs in front of the pelvis, with its head to the north and its edge to the east. One pin (2) was on the elbow, and the fragments of other pins (3-4) were around the pelvis. One of these pins was previously defined as an awl. Grave pit: n/a

Table 1. ¹⁴C dating of samples from Tiszafüred-Majoroshalom Bronze Age site. *Hajdu (2012)

						Radiocarbon		
				Estimated		date	Calibrated date	
		Inventory	AMS ¹⁴ C measur-	age		(year BP)	(2 a)	
	Grave no.	number	ing ID	$(yrs)^*$	Sex^*	(10)	(year BC)	Sample
Otomani-Füzesabony	B12	68.134.10.	DeA-36138	30–39	Male	3270 ± 18	1620–1460	Cranial fragment
culture	B54	68.134.35	DeA-31087	20–29	Male	3429 ± 34	1880–1620	Thoracic vertebral
								arch
	B69	68.134.50.	DeA-36283	35–44	Male	3282 ± 22	1620-1500	Cranial fragment
	B112	71.6.4.	DeA-36150	2-4	ı	3329 ± 20	1670-1520	Cranial fragment
	B114	71.6.6.	DeA-36133	30–35	Male	3421 ± 20	1870–1850	Rib fragment
							1770–1630	
	B115	71.6.7.	DeA-31088	30–39	Male	3422 ± 33	1880 - 1620	Rib fragment
	B136	71.22.7.	DeA-36156	40-44	Male	3431 ± 22	1880–1630	Rib fragment
	B146	1	DeA-36135	3-4		3385 ± 19	1740–1620	Long bone
								fragment
	B159 III		DeA-42311	16–18	1	3347 ± 29	1880–1620	Metacarpal
	D19	68.133.5.	DeA-36434	9–10	1	3334 ± 22	1690–1530	Cranial fragment
	D34	68.133.20.	DeA-36148	25–29	Female	3357 ± 20	1740–1540	Rib fragment
	D37	68.133.23.	DeA-36273	25–35	Male	3352 ± 23	1740–1540	Cranial fragment
	D41	68.133.26.	DeA-36271	35–49	Male	3326 ± 21	1670–1510	Rib fragment
	D48	68.133.31.	DeA-36278	15–18	Male	3420 ± 23	1870-1850 1770-	Sphenoid bone
							1620	fragment
	D49	68.133.32.	DeA-36267	12.5 - 13.5		3299 ± 21	1620-1510	Cranial fragment
	D56	68.133.38	DeA-31089	45–54	Male	3368 ± 34	1750–1530	Cranial fragment
	D76	68.133.51.	DeA-36284	50–59	Male	3462 ± 23	1880–1690	Rib fragment
	D77	68.133.52.	DeA-36269	20–24	Female	3388 ± 21	1750–1620	Rib fragment
	D104	68.133.74.	DeA-36140	30–39	Male	3341 ± 18	1730–1530	Mandible fragment
	D106	68.133.75.	DeA-33615	8-10		3355 ± 21	1740–1540	Sphenoid bone
								fragment
	D113	68.133.82.	DeA-36281	50–59	Female	3285 ± 22	1620-1500	Cranial fragment
	D117	68.133.87	DeA-36274	20–39	Male	3368 ± 22	1740–1540	sphenoid bone
								fragment

Otomani-Füzesabony culture	D123 D136 D155	69.5.3. 69.5.14. 69.5.32.	DeA-36147 DeA-36268 DeA-31483	35–39 40–59 14–16	Female Male —	3359 ± 19 3375 ± 21 3412 ± 28	1740–1540 1750–1560 1870–1850	Rib fragment Cranial fragment Sphenoid bone
	D240	70.4.74.	DeA-42310	25–29	Male	3422 ± 31	1740–1520	rragment Rib fragment
	D267	71.5.4-5.	DeA-31484	8 ; 4 ;	1 ;	3346 ± 29	1740–1530	Rib fragment
	D284	71.5.22.	DeA-36136	35–49	Male	+1 -	1630–1520	Mandible fragment
	D783	/1.5.25.	DeA-53614	18–19		3313 ± 21	1030-1310	ranetal bone fragment
	D304	71.5.40	DeA-31485	15–19	1	3426 ± 29	1880-1620	Rib fragment
	D305	71.5.41.	DeA-36265	6-8	l	3433 ± 23	1880–1630	Rib fragment
Tumulus culture	C107	68.135.32.	DeA-33617	25–29	Female	3224 ± 20	1530–1430	Rib fragment
	C154 (141)	69.4.1.	DeA-36151	25–35	Male	3211 ± 19	1510–1430	Metatarsal
	C165 (152)	69.4.7.	DeA-36270	30–39	Male	3186 ± 21	1500–1420	Metatarsal
	C173 (160)	69.4.10	DeA-36266	18–19	Female	3011 ± 21	1390–1130	Rib fragment
	C174 (161)	69.4.11.	DeA-36272	25–29	Female?	3076 ± 21	1420–1270	Sphenoid bone fragment
	C191 (174)	69.4.15	DeA-36275	40-44	Male	3140 ± 21	1500-1310	Rib fragment
	C265 (240)	71.23.1.	DeA-31487	30–34	Male	3167 ± 29	1510–1390 1340–1320	Sphenoid bone fragment
	C281 (256)	71.23.8.	DeA-33618	16–19	1	3072 ± 20	1410–1270	Scapular fragment
	E10-11 (291)	68.136.3.	DeA-36154	40–55	Male	3137 ± 19	1500-1310	Atlas fragment
	E16 (294) E24 (301)	68.136.8. 68.136.11	DeA-33619 DeA-36130	45–49 30–34	Male Male	3147 ± 20 3128 ± 20	1500–1320 1450–1300	Rib fragment Sphenoid bone
	E31 (308) E62 (330)	68.136.13 70.5.6.	DeA-36134 DeA-36145	5–6 25–29	— Male	3115 ± 19 3068 ± 18	1440–1300 1410–1270	Rib fragment Rib fragment

Grave B69

Inhumation burial of a male (35-44). The SE-NW (152°) oriented skeleton was placed in a flexed position on its right side. A mug was placed (1) in front of the skull. A bowl (2) with a mug (3) within it were found in front of the pelvis. Grave pit: d. -112 cm.

Grave B112 (Kovács 1982a, Abb. 4/1-5)

Partly disturbed inhumation burial of a child (2-4). The S-N (170°) oriented skeleton was placed in a moderately flexed position on its right side. A mug was (1) at the feet. Another mug was excavated (2) in the S-E corner of the burial pit. In the middle of the grave there was a pin (3) found. Near the east wall of the burial pit, there were bronze spiral beads and two faience beads (4). Two gold hair rings (5-6) were laid around the temples. Grave pit: d. -103 cm.

Grave B114

Inhumation burial of a male (30-35). The S-N (175°) oriented skeleton was placed in a moderately flexed position on its right side. A jug (1) was placed in front of the pelvis. A pot (2-3), a jug (4), and a bowl (5) were found at the legs. A bronze pin was put near the bowl and the legs (6). Grave pit: d. -152 cm, l. -186 cm, w. -88 cm

Grave B115 (Kovács 1995, Abb. 1/B, 4-6)

Inhumation burial of a male (30-39). The S-N (172°) oriented, incomplete skeleton was laid in a flexed position on its right side. The bones were in anatomical order. A bowl (18) was at the feet, jugs were placed in front of the legs (16-17), a mug was over the head (13), and a pot (14-15) was laid in front of the pelvis. A fluted axe (1) was found in front of the skull. Two shaft-hole axes (2-3) were superimposed on each other at the presumed height of the arms with the edge facing east. Fragments of a bronze plate covering the shaft of the Tiszafüred type axe were found in front of the pelvis (6). A bronze pin (4), a triangular dagger (5), and a whetstone (12) were found at the place of the ribs. Fragments of bronze spiral tubes (7) and a gold "Lockenring" (19) were laid around the pelvis. Pieces of two pins (8-9) and a chisel (10) were put on the legs. Another chisel (11) was found in the bowl (18) at the feet. One mug (13) was next to the skull, and two jugs (16, 17) were in front of the legs. Grave pit: d. (16) cm.

Grave B136

Inhumation burial of a male (40–44). The S-N (170 $^{\circ}$) oriented skeleton was laid in a flexed position on its right side. A jug (1) and a pot (2) were placed in front of the legs. A bowl was found (4) at the feet with a mug (3) within it. Grave pit: d. -128 cm, l. -180 cm, w. -140 cm.

Grave B146 (Kovács 1982a, Abb. 5)

Inhumation burial of a child (3–4). The N-S (343 $^{\circ}$) oriented skeleton was laid in a flexed position on its left side. A pin was found on the skull, while a bowl (1) and a mug (2) were in front of it. A second mug (3) was placed in front of the pelvis to the east. Between the two mugs on the photo there were pebbles (12). Several bronze objects (4–11) and a few faience beads (6) were laid between the face and the two mugs. Grave pit: n/a.

Grave B159

Inhumation burial of a juvenile (16-18). The N-S (320°) oriented, slightly flexed skeleton was laid on its left side. A bronze hair ring (1) was on the right temple, two pins (2-3) were on the left shoulder, and

pierced animal teeth (4) near the left hand. A jug (5) was laid on the neck, and a bowl (6) with a mug (7) within it at the pelvis. Grave pit: d = 150 cm, d = 180 cm, d = 180 cm.

Grave D19

Inhumation burial of a child (9-10). The N-S oriented (180°) skeleton was laid in a flexed position on its left side. Hands pulled tightly under the face, while the legs are barely bent. A jug was in front of the pelvis (1). Next to it, a miniature vessel (2) was found. Grave pit: d. -70 cm.

Grave D34

Inhumation burial of a female (25-29). The N-S (352°) oriented skeleton was laid in a flexed position on its left side. Left hand raised in front of the face, right upper arm on the ribs, the forearm bent on the left elbow. A small mug was placed (1) close to the left elbow. Two pins (2) were laid near each other in front of the face. Grave pit: d. -90 cm.

Grave D37

Inhumation burial of a male (25-35). S-N (185°) oriented skeleton. Upper body was laid rather supine, but with the face right to the east. The hands were raised on the upper body, the feet were also raised to the east. East of the pelvis, there were two mugs (2-3) and one jug (1) close to each other. Grave pit: d. -122 cm.

Grave D41

Inhumation burial of a male (35-49). The N-S (3°) oriented skeleton was laid in a flexed position on its left side. A pin (1) was found at the right shoulder. A bowl was placed (2) at the right elbow and a small pot (3) was south of it. Fragments of a mug (5) and another mug (4, 6) were put to the feet. Grave pit: d. -122 cm.

Grave D48

Inhumation burial of a male juvenile (15-18). The S-N (178°) oriented skeleton was laid in a flexed position on its right side. A bowl (3) was laid in front of the pelvis under the elbows, a jug (1) was placed in front of the face and a mug (2) was on the lower arms. In the photo, a fragmented mug (4) is also visible at the feet. Grave pit: d. -140 cm.

Grave D49

Inhumation burial of a child (12.5-13.5). The N-S (360°) oriented skeleton was laid in a flexed position on its left side. A bowl (1) was placed in the bend of the knee and a mug (2) was put next to the bowl. Grave pit: d. -130 cm.

Grave D56

Inhumation burial of a man (45-54). The S-N (170°) oriented skeleton was laid in a flexed position on its right side. There was a bowl (1) in front of the legs. A mug (2) was placed at the knees. Grave pit: d. -110 cm.

Grave D76

Inhumation burial of a man (50–59). The S-N (176°) oriented skeleton was placed in a flexed position on its right side. A decorated bowl (2) and a handled mug (3) were placed behind the legs, while the small mug (1) was located at the left wrist. Grave pit: d. – 116 cm.

Grave D77

Inhumation burial of a woman (20–24). The N-S (0°) oriented skeleton was laid in a flexed position on its left side. The arms are raised in front of the face. Two mugs (1–2) were placed at the feet. Grave pit: d. – 116 cm.

Grave D104

Inhumation burial of a man (30–39). The S-N (150°) oriented skeleton was placed in a slightly flexed position on its right side. A broken jug (1) was put behind the skull. In front of the face, a bowl (2) was placed upside down with a pot (3) on top of it. A dagger (4) was laid on the right upper arm with a whetstone (9) under it. A mug (5) tilted over was in front of the belly. One pin was found on the left knee (6) and one above the feet (7) and two fragments of a further pin (10) was placed above the right collarbone. A fragmented stone blade (8) was discovered above the feet. Grave pit: d. – 90 cm.

Grave D106

Inhumation burial of a child (8-10). The S-N (110°) oriented skeleton was placed in a moderate flexed position on its right side. A mug (1) was placed at the feet. Grave pit: d. -82 cm.

Grave D113

Inhumation burial of a female (50-59). The N-S (360°) oriented skeleton was placed in a strongly flexed position on its left side. A mug (1) was behind the skull. Grave pit: d. -145 cm.

Grave D117

Inhumation burial of a male (20-39). The S-N (190°) oriented skeleton was placed in a flexed position on its right side. The vessels were in front of the legs. The jug (1) was closest to the knee, followed by the bowl (2) with the mugs (3-4) within it. Grave pit: d. -85 cm.

Grave D123

Inhumation burial of a female (35-39). The S-N (174°) oriented skeleton. The upper body was laid on the back, the head was turned to the left, the legs also raised to the left, and the arms crossed on the chest. A bowl (2) was in front of the face with a mug (1) within it. Another mug was at the pelvis (3). Grave pit: d. -100 cm.

Grave D136

Inhumation burial of a male (40–59). The S-N (180°) oriented skeleton was placed in a flexed position on its right side. The right arm was raised in front of the face and a bowl (1) was laid upside down on top of it. The left arm was bent over the pelvis. Grave pit: d = 45 cm.

Grave D155

Inhumation burial of a juvenile (14–16). The N-S (334 $^{\circ}$) oriented skeleton was placed in a flexed position on its left side. At the back of the skull, a jug (1) was found, and a bowl (2) was also placed above it. Grave pit: d. – 66 cm.

Grave D240 (Kustár et. al 2020)

Inhumation burial of a male (25-29). The S-N (175°) oriented skeleton was placed in a flexed position on its right side. A small mug was placed at the right elbow. Grave pit: d. – 125 cm.

Grave D267

Inhumation burial of a child (3-4). The S-N (165°) oriented skeleton was placed in a flexed position on its right side. Based on the excavation diary, the ceramics were placed around the abdomen. The documentation shows the fragments of a mug (1) below the elbows. The bowl (2), however, does not appear in the photo and the drawing only indicates its number. Grave pit: d. -190 cm.

Grave D284

Inhumation burial of a man (35-49). The S-N (170°) oriented skeleton was placed in a flexed position on its right side. Grave goods were placed at the feet. Based on the objects and tags found in the storage room, a bowl (1) with a small mug (3) inside and another mug (2) make up the burial ensemble. Grave pit: d = 110 cm.

Grave D 285

Inhumation burial of a juvenile (18–19). The N-S (360°) oriented strongly fragmented skeleton was placed in a flexed position on its left side. The bones were in anatomical order. A small mug (1) was put in front of the face. The bronze pins (2–3) were on both side of the mug. A button was found south of those artefacts. Grave pit: d. – 65 cm.

Grave D 304 (Kovács 1979, 68, footnote 41-42)

Disturbed inhumation burial of a juvenile (15-19). The N-S $(340^{\rm e})$ oriented fragmented skeleton was placed in a flexed position on its left side. The bones were in anatomical order. A mug (3) wit a bowl (2) within it was near the legs. A gold plate fragment (1) was put into the mug. A bronze awl (4) and a stone blade (8) were found at the knees. Bronze pins (6-7) and spiral tubes (5) were located around the chest and shoulders. Grave pit: d. -125 cm.

Grave D 305

Inhumation burial of a child (8-9). The N-S (338°) oriented skeleton was placed in a strongly flexed position on its left side. A bowl (7) and a mug (6) were found around the knees. One armring was on each forearm (4-5). Two pins and spiral tubes (1-3) were also found at the left hand. A shell bead (8) with an unknown position was also found. Grave pit: d. -125 cm.

Grave C107 (Grave 102 – Kovács 1975, 16, Pl. 10/102)

Disturbed inhumation burial of a female (25-29). The NE-SW-oriented (45°) skeleton was placed in a flexed position on its left side. An amphora (1) and a bowl (2) were placed around the legs. Their exact position is unknown due to the disturbance of a Migration Period grave. A mug (3) was placed near the head. Two bronze pins (4-5) laid on the shoulders and one pin (6) partly under the skull. Two bronze bracelets were on each wrist (7-10) and four rings (11-18) were put on each hand. A bronze button (19), several spiral tubes (20-25), beads (26-29), and a tooth pendant (30) were found on the chest. Grave pit: d. -150 cm.

Grave C154 (Grave 141 – Kovács 1975, 20, Pl. 12/141)

Disturbed inhumation burial of a male (25-35). Only the pelvis and some leg bones were in situ. The position of the NE-SW-oriented (n/a) skeleton cannot be reconstructed. An amphora (1) was placed at the feet and a mug (2) was put inside it. Grave pit: d. -65 cm.

Grave C165 (Grave 152 – Kovács 1975, 21, Pl. 13/152)

Inhumation burial of a male (30–39). The W-E-oriented (252 $^{\circ}$) skeleton was placed in a flexed position on its right side. One mug (1) was placed behind the head. Grave pit: d. – 95 cm.

Grave C173 (Grave 160 - Kovács 1975, 23, Pl. 15/160)

Inhumation burial of a female (18-19). The NE-SW-oriented (28°) skeleton was placed in a flexed position on its left side. One mug (1) was placed at the feet. A bronze button (2) was found next to the neck, partly under the skull. Five pendants were laid on and under the right shoulder (3-7). Two bronze bracelets were on each lower arm (8-9). Altogether 12 pieces of rings decorated the fingers and at least one spiral ring decorated the toes (10-22). Two bronze rings (23-24) were found next to each other under the skull. Grave pit: d. - 115 cm.

Grave C174 (Grave 161 – Kovács 1975, 23, Pl. 15/161)

Inhumation burial of a presumably female individual (25-29). The NE-SW-oriented (28°) skeleton was placed in a flexed position on its right side. One mug (1) was placed at the feet. Two bronze rings (2-3) were put on the right hand's fingers. Bronze spiral tubes (4-15) and shell beads (16-19) were scattered on the chest. One bronze ring (20) was found under the skull and one among the feet (22). Grave pit: d. -115 cm.

Grave C191 (Grave 174 – Kovács 1975, 24, Pl. 17/174)

Inhumation burial of a male (40–44). The SW-NE-oriented (240°) skeleton was placed in a flexed position on its right side. One mug (1) was placed at the feet. A bronze axe (2) was found behind the skull. A decorated bronze pin (3) was laid on the right shoulder and a bronze awl (4) was on the left humerus. A bronze dagger (5) was uncovered on the right side of the pelvis and the point of another dagger (6) together with a flint tool (7) on the left side of it. The position of a small bronze ring (8) is unknown. Grave pit: l. -228 cm, w. -100 cm, d. -200 cm.

Grave C265 (Grave 240 – Kovács 1975, 28, Pl. 23/240)

Inhumation burial of a male (30–34). The S-N-oriented (180°) skeleton was placed in a flexed position on its right side. A bowl (1), a pot (2), and a jug (3) were put on and around the legs. Grave pit: $d_{1} = 134$ cm.

Grave C281 (Grave 256 – Kovács 1975, 29, Pl. 24/256)

Inhumation burial of a juvenile (16-19). The SW-NE-oriented (256°) skeleton was placed in a flexed position on its right side. A bronze pin (1) was found on the chest. There were several jewels on both arms. A bronze bracelet (2) and four bronze rings (5-8) were put on the left arm, while on the right arm, two bronze bracelets (3-4) and two bronze rings (9-10) were uncovered. The position of one bronze ring (11) is unknown. Grave pit: d. -128 cm.

Grave E10-11 (D55-56) (Grave 291 – Kovács 1975, 31, Pl. 27/291)

Inhumation burial of a male (40-55) and a child (2-3). The W-E-oriented (257°) male was placed in a flexed position on its right side. The child was laid close to the male in the same position and orientation. A small pot (1) was placed behind the pelvic bone of the child. Grave pit: d = 60 cm.

Grave E16 (D53) (Grave 294 – Kovács 1975, 31-32, Pl. 28/294)

Inhumation burial of a male (45–49). The W-E-oriented (260°) skeleton was placed in a flexed position on its right side. A bowl (1) was placed upside down at the knees and a mug (2) was located close to the right elbow. Grave pit: d = 120 cm.

Grave E24 (Grave 301 – Kovács 1975, 32, Pl. 28/301)

Inhumation burial of a male (30–34). The NE-SW-oriented (56°) skeleton was placed in a flexed position on its left side. The grave pit was partially dug on top of a Füzesabony culture burial (D95). There were no finds in the grave. Grave pit: d = 100 cm.

Grave E31(Grave 308 - Kovács 1975, 33, Pl. 29/308)

Disturbed inhumation burial of a child (5-6). The bones are scattered in one half of the grave without anatomical order. Due to this relocation of the bones, the original position and orientation of the body is unknown. Similar to the bones, the grave goods also were in a secondary position. A mug (1) and one pendant (3) were found in the refill of the grave pit. Next to the human remains, an amphora (2) was laid on its side. Two more bronze pendants (4-5), one bronze ring (6), and the fragment of a bronze spiral tube (7) were scattered among the bones. Grave pit: 1 - 140 cm, w. -68 cm, d. -132 cm.

Grave E62 (Grave 335 – Kovács 1975, 34, Pl. 31/335)

Disturbed inhumation burial of a male (25-29). The W-E-oriented (260°) skeleton was placed most likely in a flexed position on its right side. Only the upper body is preserved. Bronze tweezers (3) were found behind the skull. A mug (1) was put at the right elbow. A bowl (2) was also uncovered in the uppermost layer of the grave refill. Grave pit: l. -150 cm, w. -80 cm, d. -110 cm.

Authors' statement. Every author contributed to the study conception and design. Material preparation, data collection and investigation were performed by János Dani, Anikó Horváth, Anett Gémes, Kristóf Fülöp, Tamás Szeniczey, János Gábor Tarbay, Magdolna Vicze, Ashley McCall, István Futó, Anna Szigeti, Mihály Molnár, Mario Novak, Klára P. Fischl, Gabriella Kulcsár, Géza Szabó, Edit Mester, László Palcsu, Viktória Kiss, István Major and Tamás Hajdu. The manuscript was written by János Dani, Kristóf Fülöp, Ashley McCall, Anna Szigeti, Klára P. Fischl, Viktória Kiss, István Major and Tamás Hajdu and every author commented on previous versions of the study. All authors read and approved the final manuscript.

Funding. The study was supported by the grants of the Hungarian Research, Development and Innovation Office [project number: FK128013; K146290], the Bolyai Scholarship and the Distinguished Guest Scientist Fellowship of the Hungarian Academy of Sciences and by the New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund (ÚNKP-23-5-ELTE). Project No. KDP-2023-C2321722 and KDP-2023-C2284509 have 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 2023-2.1.2-KDP-2023-00002 funding scheme.

Competing interests. The authors declare no competing interests.

References

Bronk Ramsey C (2009) Bayesian analysis of radiocarbon dates. *Radiocarbon* **51**(1), 337–360.

Brown T, Nelson D, Vogel J and Southon J (1988) Improved collagen extraction by modified Longin method. *Radiocarbon* **30**(2), 171–177.

Cavazzuti C, Horváth A, Gémes A, Fülöp K, Szeniczey T, Tarbay G.J, McCall A, Gamarra Rubio B, Vicze M, Bárány A, Pető Á, Magyari E.K, Darabos G, Futó I, Molnár M, Lisztes-Szabó Zs, Molnár E, Gál E, P. Fischl K, Kulcsár G, Szeverényi V, Szabó G, Mester E, Dani J, Palcsu L, Kiss V, Major I and Hajdu T. In preparation. Multi-isotope and archaeobotanical analyses reveal significant change in mobility and diet around 1500 BCE in Eastern-Central Europe.

Csalog Z (1962) Tiszafüred-Majoroshalom (Kom. Szolnok, Kr. Tiszafüred). Archaeologiai Értesítő 89, 259.

Csalog Z (1965a) Tiszafüred-Majoroshalom (Szolnok m., tiszafüred j.). Régészeti Füzetek Ser. I. 18, 23.

Csalog Z (1965b) Tiszafüred-Fertőihalom (Szolnok m., tiszafüred j.). Régészeti Füzetek Ser. I. 18, 22.

Hajdu T (2012) A bronzkori Füzesabony- és Halomsíroskultúra népességének biológiai rekonstrukciója (Biological Reconstruction of the Bronze Age Füzesabony- and Tumulus Grave Culture Populations). PhD dissertation, Eötvös Loránd University, Budapest, 135 p.

Janovics R, Futó I and Molnár M (2018) Sealed tube combustion method with MnO2 for AMS 14C measurements. Radiocarbon 60(5), 1347-1355.

Korek J (1973) A Tisza II. régészeti leletei. A Damjanich János Múzeum Közleményei 33, Damjanich János Museum, Szolnok Kovács T (1965) Tiszafüred-Ásotthalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser I. 18, 22.

Kovács T (1966) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 19, 25.

Kovács T (1967) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 20, 25.

Kovács T (1968) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 21, 18. Kovács T (1969) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 22, 23.

Kovács T (1970) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 23, 19.

Kovács T (1971) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 24, 17.

Kovács T (1972) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 25, 22.

Kovács T (1973a) Tiszafüred-Majoroshalom (Kom. Szolnok, Kr. Tiszafüred). Archaeológiai Értesítő 100, 260–261

Kovács T (1973b) Tiszafüred-Majoroshalom (Szolnok m., tiszafüredi j.). Régészeti Füzetek Ser. I. 26, 20–21.

Kovács T (1973c) Korai markolatlapos bronztőrök a Kárpát-medencében. [Frühe Bronzedolche mit Griffplatte im Karpatenbecken.] Archaeológiai Értesítő 100, 157–166.

Kovács T (1975) Tumulus Culture Cemeteries of Tiszafüred. Régészeti Füzetek Ser. II. 17. Magyar Nemzeti Múzeum, Budapest. Kovács T (1977) A bronzkor Magyarországon. Hereditas, Budapest.

Kovács T (1979) Középső bronzkori aranyleletek Magyarországról (Mittelbronzezeitliche Goldfunde aus Nordost-Ungarn). Folia Archaeologica 30:55-75.

Kovács T (1982a) Einigeneue Angabenzur Ausbildung und inneren Gliederung der Füzesabony-Kultur. In Hänsel B (Hrsg.), Südosteuropazwischen 1600 und 1000 v. Chr.

Kovács, T (1982b. Die terminologischen und chronologischen Probleme der frühen und mittleren Bronzezeit in Ostungarn. In Aspes A (Hrsg.), Ilpassaggio dal neoliticoall'età del bronzonell'europacentrale e nellaregionealpina. Problemicronologici e terminologici. Attidel X Simp. Int. Neol. EtàBronzo in Europa, Lazise-Verona 8-12 aprile 1980 (Verona 1982). Museo Civico di Storia Naturale, Verona, 153-164.

Kovács T (1982c) A mezőkomáromi és tiszafüredi nyéltaréjos bronzcsákányok. (Nackenkammäxte von Mezőkomárom und Tiszafüred). Communicationes Archaeologicae Hungariae 2, 31–46.

Kovács T (1984) Füzesabony-Kultur. In Tasić N. (Hrsg.), Kulturen der Frühbronzezeit des Karpatenbeckens und Nordbalkans. Balcano-Pannonica, Sonderausgabe 22. Balkanološki Institut SANU, Beograd, 235–255.

Kovács T (1988) Review of the Bronze Age settlement research during the past one and a half centuries in Hungary. In Kovács T and Stanczik I (eds), Bronze Age Tell Settlements of the Great Hungarian Plain I. Inventaria Praehistorica Hungariae 1. Budapest: Magyar Nemzeti Múzeum, 17-25.

Kovács T (1990) Eine bronzezeitliche Rarität: Askos mit menschlichem Gesicht von Tiszafüred und seine südöstlichen Beziehungen. Folia Archaeologica 41, 9–27.

Kovács T (1992) Bestattungssitten der Füzesabony-Kultur und das Gräberfeld von Tiszafüred-Majoroshalom. In Meier-Arendt W (Hrsg.), Bronzezeit in Ungarn. Forschungen in Tell-Siedlungenan Donau und Theiss. Museum für Vor- und Frühgeschichte – Archäologisches Museum, Pytheas, Frankfurt am Main, 96–98.

Kovács T (1995) Auf Mitteleuropa weisende Beziehungen einiger Waffenfunde aus dem östlichen Karpatenbecken. In Hänsel B (Hrsg.), Handel, Tausch und Verker im bronze- und früheisenzeitlichen Südosteuropa. Prähistorische Archäologie in Südosteuropa 11. Südosteuropa-Gesellschaft, München-Berlin, 173–185.

Kustár Á, Hajdu T, Fülöp K and Kiss V (2020) Arcok a bronzkorból. Határtalan Régészet 3(3), 30–33. https://epa.oszk.hu/03200/ 03255/00015/pdf/EPA03255_hatartalan_regeszet_2020_3.pdf

Longin R (1971) New method of collagen extraction for radiocarbon dating. *Nature* 230, 241–242.

Major I, Futó I, Dani J, Cserpák-Laczi O, Gasparik M, Jull AJT and Molnár M (2019) Assessment and development of bone preparation for radiocarbon dating at HEKAL. Radiocarbon 61(5), 1551–1561.

Milesz B (1903) A tiszafüredi múzeum gyarapodása az 1902-ik évben. Archaeologiai Értesítő 23(3), 296-297.

Milesz B (1904) A tiszafüredi múzeum 1903. évi gyarapodása. Archaeologiai Értesítő 24(3), 285–288.

Molnár M, Rinyu L, Janovics R, Major I and Veres M (2012) Az új debreceni C-14 AMS laboratórium bemutatása (Introduction of the new AMSC-14 laboratory in Debrecen). Archeometriai Műhely 9, 147–60.

Molnár M, Janovics R, Major I, Orsovszki J, Gönczi R, Veres M, Leonard AG, Castle SM, Lange TE, Wacker L, Hajdas I and Jull AJT (2013a) Status report of the new AMS ¹⁴C sample preparation lab of the Hertelendi Laboratory of the Environmental Studies (Debrecen, Hungary). *Radiocarbon* **55**(2–3), 665–676.

- Molnár M, Rinyu L, Veres M, Seiler M, Wacker L and Synal H-A (2013b) EnvironMICADAS: a mini ¹⁴C AMS with enhanced gas ion source interface in the Hertelendi Laboratory of Environmental Studies (HEKAL), Hungary. *Radiocarbon* **55**(2–3), 338–344.
- Pearson J (2013) Human and Animal Diet as Evidenced by Stable Carbon and Nitrogen Isotope Analysis. Los Angeles: Monographs of the Cotsen Institute of Archaeology, University of California at Los Angeles.
- Pearson J, Buitenhuis H, Hedges R, Martin L, Russell N and Twiss K (2007) New light on early caprine herding strategies from isotope analysis: A case study from Neolithic Anatolia. *Journal of Archaeological Science* **34**(12), 2170–2179.
- Reimer PJ, Austin WEN, Bard E, Bayliss A, Blackwell PG, Bronk Ramsey C, Butzin M, Cheng HR, Edwards L, Friedrich M, Grootes PM, Guilderson TP, Hajdas I, Heaton TJ, Hogg AG, Hughen KA, Kromer B, Manning SW, Muscheler R, Palmer JG, Pearson C, van der Plicht J, Reimer RW, Richards DA, Scott EM, Southon JR, Turney CSM, Wacker L, Adolphi F, Büntgen U, Capano M, Fahrni SM, Fogtmann-Schulz A, Friedrich R, Köhler P, Kudsk S, Miyake F, Olsen J, Reinig F, Sakamoto M, Sookdeo A and Talamo S (2020) The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0–55 cal kBP). *Radiocarbon* **62**(4), 725–757.
- Rinyu L, Molnár M, Major I, Nagy T, Veres M, Kimák Á, Wacker L and Synal H-A (2013) Optimization of sealed tube graphitization method for environmental ¹⁴C studies using MICADAS. *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* **294**, 270–275.