ZIRIDAVA

STUDIA ARCHAEOLOGICA

35

2021

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STUDIA ARCHAEOLOGICA

35
2021

Editura MEGA
Cluj-Napoca
2021

In Romania, the periodical can be obtained through subscription or exchange, sent as post shipment, from Museum Arad, Arad, Piata G. Enescu 1, 310131, Romania.
Tel. 0040–257–281847.

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Layout: Francisc Baja, Florin Mărginean, Victor Sava

ISSN 2392–8786

Editura Mega | www.edituramega.ro
e-mail: mega@edituramega.ro

Contents

REVIEWS

Seeking Opportunity: Mobility and Transmission of Innovation in the Chalcolithic

Astrid Vicas

Abstract: This paper integrates recent data about health status, nutrition, and autosomal DNA to sketch a narrative of mobility linked to the spread of metallurgical competency in the Chalcolithic. The outlook suggested is that mobility may have been tied to the pursuit and transmission of skills. The mobility of a subgroup affiliated with Bodrogkeresztúr Culture could present an early case of migration of the skilled and be placed in the context of early developments of specialization. The pursuit of skills might also explain the phenomenon of the disintegration of tell settlements of the Great Hungarian Plain in relation to the attraction of the most active metallurgical network of the time, which was centered on the Lower Danube Valley.

Keywords: Bodrogkeresztúr; mobility; migration; early metallurgy; Lower Danube Valley.

Introduction

This paper provides material intended to support a broader project on early, tacit conceptions of excellence, which it associates with practices of complementary cooperation in the context of near-pristine specialization in productive societies. The sketch proposed outlines how one of the earliest metallurgical networks, perhaps the most active of its time, expanded its influence by attracting individuals from neighboring communities that then disseminated metallurgical know-how further west in small-scale migration movements.

The issue of interest is the transmission of metallurgical know-how rather than the dissemination and distribution of copper, and sometimes gold, artifacts in the fifth millennium BCE. Metallurgical know-how is here understood to include knowledge of ores and ore preprocessing, fuel production, pyrotechnical technology needed for melting, smelting, and casting copper, and also the production of refractive ceramics required for these operations. Activities such as cold and hot forging that do not call for metallurgical knowledge are referred to as metalworking. Metalwork and metal objects had reached the Middle Volga as early as the middle of the fifth millennium BCE[1]. Metal objects were concurrently present in Central Europe[2].

Nevertheless, metallurgical know-how was exceptional. By the early third millennium BCE, metallurgy is more widely distributed. In the fifth millennium BCE, it was not. The earliest regional development of metallurgy is attributable to Vinča communities[3]. Most of the sites associated with Vinča Culture end around the 47th century BCE[4]. Regionally, after the demise of Vinča communities, metallurgical know-how appeared only among the Lower Danube Valley inhabitants belonging to the Kodžadermen-Gumelnița-Karanovo VI cultural complex. Thus, after the 47th century BCE, the source of metallurgical know-how must have rested in this complex of communities and later evolving communities to their west associated with Sălcuța Culture, which was in part derived from Gumelnița Culture[5]. A significant development in the fifth millennium BCE is that metallurgical know-how, and not just metal objects or metalwork, was successfully acquired by some communities originating in the Great Hungarian Plain. A further notable development is that some of their descendants brought metallurgical capabilities westward.

The occasion for writing this paper was prompted by the recent availability of information about individuals associated with Bodrogkeresztúr Culture. The narrative outline frames facts

1 Peterson *et al.* 2016, 293, with references to the literature.
2 Scharl 2016.
3 Radivoiević, Rehren, 2016.
4 Borić 2015, 163.
5 Pătroi 2010.

about diet, health status, and autosomal DNA in the context of two processes that P. I. Roman 1971 had proposed. The two processes are the transformative impact of contact with cultures affiliated with the Lower Danube Valley zone of influence, including Sălcuța Culture, on some of their neighbors to the northwest, now seen as Roman had, as aspects of a Tiszapolgár/Bodrogkeresztúr continuum[6], and the ongoing presence of descendants of Bodrogkeresztúr Culture within the intra-Carpathian area[7]. A third process, which Roman could not have foreseen, is added to the first two. The third development is a small-scale migration of metallurgically-competent individuals originating in the Urziceni Bodrogkeresztúr communities bringing their know-how westward into northern Italy.

The first process can be assumed to have occurred sometime before 4250 BCE, a date frequently quoted to mark the cessation of activity in settlements of the core area of metallurgical innovation in the Lower Danube Valley. The last two would have occurred in the wake of that event.

In a fourth section, the paper will propose the hypothesis that the first process that Roman had seen can be placed in a regional context, which would relate the beginnings of the disaggregation of Great Hungarian Plain tell settlements to the pull of the Lower Danube Valley metallurgical network prior to the sudden cessation of the latter**.** It is suggested that this phenomenon might afford an additional explanation of the increased mobility of communities in the Great Hungarian Plain.

This paper offers for consideration that data of an apparently restricted nature can yield clues helpful to drawing broader inferences. The ultimate purpose of the project, of which this paper is a building block, is to bring out connections between facts and concerns of a wider, philosophical nature about how what has become a concept of virtue ethics, excellence, could have been tacitly construed in societies experimenting with near-pristine specialization. Thus, the project is part of a broader reflection on the human significance of the Chalcolithic.

Process 1: People on the move in search of skills

It appears that the core of the Lower Danube Valley metallurgical network was centered on an underlying physical web of interconnected lagoons[8]. There is agreement that the sudden abandonment of Lower Danube Valley settlements in this network occurred around 4250 cal BCE[9]. More recent dating allows one to get a sense of possible sequences of interactions between the Lower Danube Valley inhabitants, communities to their immediate west, and communities of the Great Hungarian Plain. Reviewing some of these dates is a first step to situating the interactions between the Lower Danube Valley and areas to its northwest.

The individual in grave 43 at Varna, known for its spectacular gold and copper grave goods, is dated 4550–4406 cal BCE. Dates are also available for other individuals that belong to the Kodžadermen-Gumelnița-Karanovo VI complex and for which there is autosomal DNA. They are from Varna, Smyadovo, Sushina, and Dhuyunitsa in Bulgaria and range from 4711–4530 cal BCE to 4337–4246 cal BCE [10]. These dates are in keeping with those for the Gumelnițan settlement at Pietrele that was part of the lacustrine network, which range from 4600 to 4240 cal BCE[11]. Dates from a burial at Măgura Gumelnița are 4461–4263 cal BCE[12].

Gumelnița and Sălcuța communities overlapped temporally and geographically around the Olt River[13], west of the core metallurgical zone. 4361–4070 cal BCE is the range given for an individual from Sălcuța Culture further west, buried in Lepenski Vir[14].

The latest dates for Tiszapolgár and Bodrogkeresztúr communities of the Great Hungarian Plain place the first around 4385–4161 cal BCE and the second between 4325–3930 cal BCE. They overlap

6 Siklósi, Szilágyi 2021, with references to and commentary on the older literature.
7 Roman 1971, 100–101.
8 Benecke *et al.* 2013; Hansen *et al.* 2015; Hansen *et al*. 2019.
9 Reingruber 2015, 314.
10 Allen 2021.
11 Benecke *et al.* 2013, 181; Hansen 2012, 273, 283.
12 Lazăr *et al.* 2017, 166–167.
13 Pătroi 2010.
14 Hofmanová 2016, Table 8.

so closely that they are more recently described as styles rather than distinct cultures[15]. These are the Great Hungarian Plain communities associated with metallurgy.

Given the dates available, there can be no doubt that the source of metallurgical know-how rested in the core Lower Danube Valley network. Sălcuța communities, which continued developing after the core metallurgical network ceased to function, are likely to have been the most direct source of transmission of metallurgical know-how to communities from the Great Hungarian Plain[16]. Information on dates for Tiszapolgár communities in Romania is not yet available. However, the dates for the Tiszapolgár site of Male Raškovce in Slovakia, 4340–4240 cal BCE[17], are consistent with those for the Tiszapolgár sites of the Great Hungarian Plain in S. Siklósi, M. Szilágyi 2021 and D. Diaconescu 2014. The latter provides a range of 4326–4235 cal BCE for the last stage of Tiszapolgár Culture[18].

Gold and copper metallurgy are thought to be closely connected, the first being dependent on skills acquired for processing copper[19]. Siklósi, Szilágyi 2021 date the appearance of heavy copper tools and gold ornaments in the Great Hungarian Plain to around 4350 cal BCE[20]. The dates of the Urziceni Bodrogkeresztúr necropolis, from which there are autosomal DNA samples, fall within the range of the Great Hungarian Plain Bodrogkeresztúr sites. The necropolis is dated around 4300–4000 BCE[21], which places it in temporal proximity to the cessation of the core metallurgical network of the Lower Danube Valley.

Stable isotope values for humans and their food sources show that neither the Great Hungarian Plain Bodrogkeresztúr nor the Lower Danube Valley communities of the Chalcolithic practiced transhumant pastoralism[22]. Faunal analyses of the Gumelnița communities show that inhabitants engaged in mixed farming rather than large-scale, specialized pastoralism[23]. The point is reinforced in other studies, such as the settlement at Pietrele, where the economy shifted from a reliance on cattle during the Neolithic to diverse food sources, including fishing and hunting, during the Chalcolithic, a pattern in keeping with developments in other settlements of the Lower Danube Valley[24]. The same can be said of Sălcuța communities, although they have not been studied as intensively. Their resource base also included crop cultivation, animal husbandry, hunting, and fishing[25].

A similar pattern of resource use characterized the Bodrogkeresztúr communities of the Great Hungarian Plain. Quite a few studies converge in showing that the animal husbandry they practiced was integrated with plant cultivation[26]. They were more mobile than their Neolithic-era predecessors, but not in the sense that specialized pastoralists are. Instead, they formed smaller units organized into hamlets. It is thought that they probably interacted more intensely with neighboring households to spread out the risk of subsistence failure[27].

What can be inferred about the nutrition of the Urziceni Bodrogkeresztúr samples currently available is consistent with J. I. Giblin's studies of nutrition and mobility of the Middle Copper Age in the Great Hungarian Plain. Indeed, Urziceni 39, a female buried with an unretouched obsidian blade[28], has carbon and nitrogen stable isotope values compatible with those found for the Bodrogkeresztúr-era individuals of the Great Hungarian Plain[29]. Thus, one can infer similar nutrition patterns.

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15 Siklósi, Szilágyi 2021, 619.

16 This statement will be qualified toward the end of the section.

17 Brummack 2015, 8. Brummack notes that the synchronism between Tiszapolgár and Bodrogkeresztúr cultures implies that differences that were formerly explained chronologically call for a social interpretation. See Brummack 2015, 11.

18 Diaconescu 2014, 233.

19 Leusch *et al.* 2015, 371.

20 Siklósi, Szilágyi 2021, 625.

21 Szücs-Csillik, Virag 2016. These are also the dates given in Marciniak *et al.* 2021 for individuals in graves Urziceni M 10, M 12, M 13, M 21, M 31, M 37, M 41, M 48, M 51, M 60, M 65a, M 68, and M 70. The dates for individuals M 27 and M 56 in Harney *et al.* 2021b are 6300–6050 BP. For M 16 the dates in Allen 2021 are 4331–4076 cal BCE; for M 48, 3761–3645 cal BCE. The dates for M 39 in Chmielewski *et al.* 2021 are 4230–4095 cal BCE (68.2%).

22 Giblin 2011, Appendix A; Giblin *et al*. 2013; Honch *et al.* 2013.

23 Balasse *et al*. 2015; Bălășescu *et al.* 2005.

24 Benecke *et al.* 2013.

25 Radu 2002, 38.

26 Giblin *et al*. 2013; Hoekman-Sites, Giblin 2012.

27 Giblin 2011, 109; Giblin *et al*. 2013, 237; Hoekman-Sites, Giblin 2012, 525.

28 Boroneanț *et al*. 2018, Table 2.

29 Chmielewski *et al*. 2021, Table 1; Giblin 2011, 241.

While one would need stable isotope studies of Bodrogkeresztúr individuals in more locations in Romania[30], there is little expectation that their form of life was very different from those of the people of the Lower Danube Valley, areas to its west, and the Great Hungarian Plain. They would have been agropastoralists consuming a variety of foods and not specializing in transhumant pastoralism. This is significant because specialization in the husbandry of large-animal domesticates has implications for social organization and the emergence of inequality in the strict sense[31]. Marks of social distinction can be noted in burial practices among Chalcolithic communities, including those of the Lower Danube Valley, the Urziceni Bodrogkeresztúr, and the Tiszapolgár in southeast Slovakia[32]. Nevertheless, social distinction is not tantamount to social inequality in the strict sense, which requires an organization suited to imposing exclusive control of access to resources needed to make a living.

Dietary analyses, where available, have not turned evidence to support either one of the societies consistently restricted foods to preferred categories of individuals. Giblin 2011 could not support dietary distinctions between males and females in relation to differences in grave goods among the Bodrogkeresztúr communities of the Great Hungarian Plain[33]. She could also not find differences between males and females in terms of variability in strontium isotope values[34]. The variability in stable isotope values for carbon and nitrogen among individuals of both sexes is attributed to population mobility. N. Honch *et al*. 2013 could not conclude in favor of social stratification in dietary practices related to grave goods in what were expected to be the most stratified communities of the Lower Danube Valley, who buried their dead in the Varna necropolis. Even the strontium isotope values for the occupant of the richly endowed Grave 43 in Varna I lie within the range of variation of individuals from Durankulak[35].

Grave goods and height estimations paint an overall positive picture of how well the Urziceni Bodrogkeresztúr individuals were thriving. Animal offerings in the Urziceni graves are similar to those in Bodrogkeresztúr sites of the Great Hungarian Plain[36]. The Urziceni food offerings were choice cuts, which, according to G. El Susi 2018, suggests that the communities that buried their dead in the Urziceni necropolis were prosperous[37], since they could afford to withhold consumption of desirable foods for ritual purposes. They seem to have been taller than people from the Lower Danube Valley that date from between 4679–4450 cal BCE to 4448–4260 cal BCE[38], which might signal improving health conditions.

Health status indicators are available for some of the individuals buried at Urziceni. They tend to support El Susi's assessment. Some grave occupants were tested for porotic hyperostosis, cribra orbitalia, and linear enamel hypoplasia, skeletal indicators of non-specific stress[39]. Overall, Urziceni individuals appear relatively healthy. Burial with what some may have considered prestige items does not necessarily correlate with better health. Urziceni 12, a male buried with an object described as a copper dagger, suffered from porotic hyperostosis, which signals ongoing health problems into adulthood. Urziceni 48, a male buried with a damaged obsidian blade[40], did not, although he had linear enamel hypoplasia, indicating adverse health conditions in childhood. Males do not seem to have been privileged over females with respect to health outcomes. Urziceni 41, a female buried with Spondylus beads, gold ornaments, and an animal food offering[41], had no adverse health condition.

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30 Luca 1999 and Luca 2000 provide repertories of Bodrogkeresztúr sites. A list of sites might also be extracted from the corpus of metal finds of the Chalcolithic in Mareș 2002, 171–336. Sava 2015 lists and discusses Bodrogkeresztúr and late Bodrogkeresztúr finds, sites, and graves in the Lower Mureș/Maros area, 201–213.

31 Borgerhoff Mulder *et al*. 2010; Gurven *et al*. 2010.

32 For the latter, see Govedarica 2004, 283–285.

33 Giblin 2011, 263, 268; Giblin 2011 provides information on grave goods.

34 Giblin 2011, 196.

35 Honch *et al*. 2013, 159–160.

36 El Susi 2018; Giblin 2011, Appendix A, 325–327.

37 El Susi 2018, 641.

38 For data on height estimates, see Marciniak *et al*. 2021, Supplementary Table S1. Included are Urziceni M 10, M 12, M 13, M 21, M 26, M 31, M 37, M 39, M 41, M 44, M 48, M 51, M 60, M 65a, M 68, and M 70. The Lower Danube Valley-related individuals of the Chalcolithic are from Smyadovo and Sushina.

39 Marciniak *et al*. 2021, Supplementary Table S10 for health indicators. Included are all the individuals in the previous footnote with the exclusion of M 26, M 39, and M 44.

40 Boroneanț *et al*. 2018.

41 For Spondylus beads, see Mărgărit *et al*. 2020; for some of the gold ornaments, see Gindele *et al*. 2014; for animal food offerings, see El Susi 2018.

Mobility can be assessed by means that complement isotope studies and examine segments of unrecombined alleles transmitted from parents to offspring. Urziceni 48 seems to be descended from mating groups — as D. Anthony employs that term[42] — that were not closely related. Neither his recent nor distant ancestors were closely related since his genome does not show reduced genetic variation[43]. That can be due to his ancestors being drawn from a large population or increasing parent/offspring dispersal[44]. The two possibilities are not mutually exclusive. The suggestion of increasing parent/offspring dispersal would confirm what is known about Bodrogkeresztúr mobility from strontium isotope analyses.

Lower Danube Valley inhabitants had the advantage of accelerated development due to the more strongly connected character of their network, which incorporated both tell and flat settlements. Even further inland, theirs was a waterborne culture, in which interaction was facilitated by a web of riverine and lacustrine settlements[45]. The Bodrogkeresztúr communities had their own form of interconnectedness. However, it was between households and hamlets, a pattern detectable in isotope values that had apparently developed in the Great Hungarian Plain in the transition from the Late Neolithic and accelerated in the Late Copper Age[46]. The dating of this pattern is consistent with the current dating of the beginning of the process of abandonment of tells in the Great Hungarian Plain to around 4500–4450 cal BCE[47], which antedates the formation of Sălcuța Culture.

A more recent tally of sites attributed with a high degree of certainty to Tiszapolgár Culture bearers in Romania raises the number to 161 sites[48]. That number can be compared with an older tally of 250 Tiszapolgár sites, of which only 17 were in Romania[49]. Merging the two sets of sites reveals three lines of advance into the intra-Carpathian area following the courses of the Someș, the Mureș, and the Timiș-Cerna[50]. More sites may be uncovered in the future. The currently detectable pattern shows a direction of movement away from the Great Hungarian Plain toward the southeast.

There is as yet no stable isotope and DNA information about Tiszapolgár Culture bearers in Romania that might enable a finer-grained picture of the interaction between Great Hungarian Plain Tiszapolgár groups venturing away from the Great Hungarian Plain and the source of metallurgical know-how, which could only have come from the southeast, from Sălcuța or perhaps Gumelnița culture bearers. Nevertheless, the genomes of some relevant populations and proxies are available, allowing one to surface evidence of contact. The results rely on measures of covariance in allele frequency differences between populations[51].

The samples available are genomes of individuals from Early Tiszapolgár Culture from Pusztataskony Ledence 1, Tiszapolgár Bodrogkeresztúr Culture from Törökszentmiklos, Road 4, and Bodrogkeresztúr Culture from Urziceni, of which Urziceni 48 has the highest coverage. There are no samples from Sălcuța and Gumelnița cultures, but there are samples from the Kodžadermen-Gumelnița-Karanovo VI complex from various locations in Bulgaria, which are grouped as Bulgaria Chalcolithic[52]. These southeastern individuals serve as a proxy for the populations of higher priority for testing gene flow to Tiszapolgár or Bodrogkeresztúr communities.

The result is that for the Tiszapolgár and Bodrogkeresztúr individuals buried in locations in the Great Hungarian Plain, the hypothesis of gene flow from communities related to the Lower Danube Valley area of influence is rejected. However, it is not rejected for some of the Urziceni Bodrogkeresztúr individuals, Urziceni 48 and 16 (Appendix, Section 1, Table 1). Thus, ancient autosomal DNA can contribute to elucidating the supposition that contact with communities to the southeast was a factor in

42 Anthony in press 2020, 12, 18. The concept of a mating group allows one to make a distinction between genetic relations among individuals and the sharing of material culture.

43 Ringbauer *et al.* 2020, Supplementary Information.

44 Ringbauer *et al.* 2020, 8.

45 Benecke *et al*. 2013, 177–181. Hansen 2015, 283–284.

46 Giblin 2011, 191.

47 Siklósi, Szilágyi 2021, 622.

48 Diaconesu 2009, 89–119.

49 Bognár-Kutzian 1972, 237–240.

50 The relevant maps are Diaconescu 2009, Map 3, 319 and Bognár-Kutzian, supplement entitled “The Sites. The Groups.”

51 Each genome, from which data is drawn, encapsulates information from several hundred genetic ancestors. The inference in Raghavan *et al.* 2013 that western Eurasians and Native Americans share ancestry was supported by information from only one individual, from Mal’ta, dated 22621–22171 cal BCE.

52 See the Appendix for a full list of the samples, their labels, dates, and burial location.

the transformation of some of the Tiszapolgár Culture bearers into the Bodrogkeresztúr variant. The genetic information yields an additional line of evidence supporting the hypothesis that some establishment of kinship relations in the genetic sense accompanied the transfer of metallurgical know-how.

Nevertheless, one cannot infer that the transfer of metallurgical competence necessarily followed lines of genetic kinship relations, since the hypothesis of gene flow from southeast communities that were metallurgically competent is rejected for some of the Urziceni Bodrogkeresztúr individuals, Urziceni 27 and 56 (Appendix, Section 1, Table 1).

A further issue is the probable source of this southeastern admixture. The assumption is that it is of Sălcuțan origin, Gumelnița Culture bearers being too remote geographically and temporally. Nevertheless, Sălcuța Culture was in part derived from Gumelnița Culture[53]. Communities of both cultures overlapped in the area of the Olt River. C. N. Pătroi 2006b believes that the westward movement of Gumelnița communities into the area of the River Olt and partial withdrawal into the hilly zones of Muntenia was due to pressure from steppe cultures, whose C-type pottery makes its appearance in the area[54]. The bearers of Sălcuța Culture are thought to have been pushed westward for the same reason[55].

C-type pottery in the Lower Danube Valley has been found not only in Carcaliu, Hârșova, and Năvodari but also Pietrele[56]. Moreover, the presence of individuals from the Pontic-Caspian steppe occurs quite early. The circumstances of their burial make it unlikely that they indicate a resurgence of hunter-gatherers local to southeastern Europe. Burials combining trepanation and red ochre or rust-colored burnt wall-plaster substituting for red ochre appear in Smyadovo and Sushina. All three individuals in a triple burial, grave 24 in Smyadovo, show trepanation. Two of the three trepanned individuals are dated 4457–4343 cal BCE and 4494–4348 cal BCE. The grave was filled with burned rust-red wall plaster. A trepanned individual from burial 18 in Smyadovo is dated 4550–4450 cal BCE. That grave was also filled with rust-colored burnt wall plaster[57]. The Sushina burial, for which there is some autosomal DNA, is dated 4446–4258 cal BCE and also presents a combination of trepanation and red ochre[58].

The combined ritual was not characteristic of communities of the Lower Danube Valley. However, burials with trepanation and red ochre appear in south Russia on the east coast of the Sea of Azov. They are found in Tuzluki, dated 4450–4341cal BCE, and Vertoletnoe pole, dated 4899–4724 and 4899–4724 cal BCE[59]. Thus, it appears that the presence of individuals from the Pontic-Caspian steppe in the Lower Danube Valley antedated or was coeval with a westward movement that gave rise to the formation of Sălcuța Culture.

A factor leading to contact between Tiszapolgár and Sălcuța communities is the westward movement of the latter. According to A. Radu 2002, the points of contact were in the Timiș-Cerna corridor, the southernmost line of advance of the Tiszapolgár communities in the intra-Carpathian area mentioned above. The sites that have received most attention, Băile Herculane-Peștera Hoților, Cuptoare-Sfogea, and Slatina-Timiș, are located in that corridor[60]. The most likely source of copper ores with which Sălcuța communities would have been familiar before spreading further westward is in the not-too-distant location of Baia de Aramă, in which evidence of slag was found[61]. Merging sites occupied by Tiszapolgár and Sălcuța culture bearers as indicated in Diaconescu 2009 and Pătroi 2018[62] leads to similar conclusions to Radu 2002 and Pătroi 2006a. An area which encompassed access to ores known

53 Pătroi 2010; Pătroi 2013.

54 Pătroi 2006b, 16.

55 Roman 1971, 100; Roman 1973, 66; Pătroi 2006a, 100; Radu 2002, 7.

56 Georgieva 2018, 99. Voinea 2005, Appendix 4, 138. The appearance of C-type potttery in the area is dated to the Gumelnița A2 stage, the chronological limits of which, according to Bréhard, Bălășescu 2012, Table 1, are 4300–4000 cal BCE.

57 Chohadziev 2016.

58 Sample I2426_published, in Allen 2021.

59 Gresky *et al.* 2016, Table 1. There is also evidence of trepanation in an individual in burial 10, Neolithic burial site of Vasylivka 2 in the Dnieper-Azov area. Some of the skeletons in the site were also covered in red ochre. See Mathieson *et al.* 2015, Supplementary Information, 40–41.

60 A. Radu 2002, 191–192.

61 Pătroi 2006a, 95.

62 See Map 3 Diaconescu 2009, 319 and the map of settlements and finds of Sălcuța Culture in Oltenia in Pătroi 2018, Plate 2, 68.

to Sălcuța Culture bearers and which was also accessible to Tiszapolgár Culture bearers, that is, the Timiș-Cerna corridor, was quite possibly the area of first contact.

Nevertheless, some elements of material culture appear unresolved and could imply that direct Gumelnițan influence might not be ruled out at the early stage of contact. As S. Šiška 1964 had noted, the gold artifacts in Tibava suggest a strong southeastern influence. However, gold Sălcuțan artifacts have yet to be found[63]. To this one can add that the Gumelnițan figure of the human/bird hybrid is clearly expressed in two of the Moigrad pieces attributed to Bodrogkeresztúr Culture, whereas it is only schematically found in Sălcuțan contexts[64]. Perhaps some direct Gumelnițan contribution at the earliest stages of contact with Tiszapolgár communities cannot, for the moment, be entirely ruled out.

Whatever uncertainty remains, some of the Urziceni Bodrogkeresztúr, among whom gold items are well attested, had ancestry from a southeastern source, currently proxied by individuals from Lower Danube Valley settlements in Bulgaria. The Bodrogkeresztúr represented by the communities that buried their dead at Urziceni were thriving, prosperous, and mobile. Their predecessors had been open to establishing relations beyond close kin, which may have been instrumental in acquiring metallurgical competence.

Process 2: Continued Urziceni Bodrogkeresztúr-like presence in the intra-Carpathian area

Roman 1971 suggested that a more thorough merging of the Bodrogkerestúr and Sălcuța cultures occurred in a time frame that can now be situated after the cessation of the Lower Danube Valley core network. A pottery style featuring applied handles or Scheibenhenkel, which he thought was inspired by metal-working techniques, is offered as an indicator of the merger[65]. More recently, a workshop featuring the manufacture of gold artifacts in Cheile Turzii has been attributed to the Bodrogkeresztúr and Bodrogkeresztúr-Scheibenhenkel horizon[66].

The Cheile Turzii Late Bodrogkeresztúr layer is dated to between 4100–3900 cal BCE[67]. This site is singled out because it was subject to various analyses. Diversified use of resources continues to characterize its Late Bodrogkeresztúr-era occupants, just as it characterized earlier Tiszapolgár, Bodrogkeresztúr, Sălcuța, and Gumelnița communities. Their diet appears to have been varied. It relied on cereal cultivation and animal husbandry but also on the products of fishing and hunting. Evidence of foddering argues against their practicing the kind specialized transhumance characteristic of pastoralists[68].

It can be surmised that metallurgically competent, Bodrogkeresztúr-derived groups that remained in the intra-Carpathian area carried on living a similar life to their predecessors. But they made personal decorative items from locally available freshwater shells instead of the Mediterranean-sourced Spondylus that had adorned the deceased at Urziceni[69], perhaps an indication that trade with regions further south had been disrupted with the cessation of activity of the Lower Danube Valley core metallurgical network. Nevertheless, obsidian continued to be sourced from southeast Slovakia, just as it had been for the Urziceni grave goods[70].

There is no DNA of individuals from applied-handles sites in Romania or cultures from later periods, such as the intrusive Cernavodă or the subsequent Coțofeni. One can nevertheless establish that the hypothesis that individuals from Early Bronze Age Maros Culture have Urziceni 48-like admixture is not rejected[71]. However, the hypotheses that they have Tiszapolgár, Bodrogkeresztúr, or Baden admixture from sites in Hungary are rejected (Appendix, Section 2, Table 2a). These results suggest that,

63 Pătroi 2010, 10.

64 For a rendering of the human/bird motif from the site of Gumelnița, see Dumitrescu 1925, Figure 64/13. For the stylized version of this motif in Sălcuța Culture, see Pătroi 2013, Figure 24/1; it is from Piscul Cornișorului.

65 Roman 1971, 116. For Roman's map of relevant sites see Roman 1971, 33.

66 Lazarovici *et al*. 2015, 325, 342.

67 Lazarovici *et al.* 2015, 340.

68 Biagi, Voytek 2006, 184; Ciută 2009, 174; Nisbet 2009, 169–170.

69 Sakalauskaite *et al*. 2019; Mărgărit *et al*. 2020.

70 Biagi, Voytek 2006, 180; Boroneanț *et al.* 2018.

71 For this reason, it is unlikely that Early Bronze Age Maros, as a whole, would be primarily descended from a Bell-Beaker or Early Bronze Age Danubian, central European source, although the steppe admixture in Early Bronze Age Maros

even around 1866–1619 cal BCE, the dates for the most recent among the Maros samples, Urziceni-like derived populations were still present in the western vicinity of the intra-Carpathian area. It also suggests that one would eventually need to test the hypothesis of a duality between Late Baden gene flow to the west and whatever developed in the intra-Carpathian area. Given archaeological information, relevant populations would be Coțofeni and succeeding communities in the intra-Carpathian area, which are currently unsampled.

There is some information from a location east of the intra-Carpathian area that could be relevant. Samples from Iron Age, western Scythians in Glinoe, Republic of Moldova dated as late as the second-century cal BCE, are available. They represent individuals belonging to confederations of warriors who, because of their high mortality rate, replenished their numbers by drawing on local populations[72]. For this reason, information about their admixture might offer indirect clues about some of the local populations.

The Moldova Scythians are very diverse, so only a subset of them relevant to assessing gene flow from Tiszapolgár, Bodrogkeresztúr, or Baden communities is included. The hypotheses that Moldova Scythian 192, 197, 300, 305, and 311 have Urziceni 48-like admixture are not rejected (Appendix, Section 2, Table 2b). The hypotheses that they have either Tiszapolgár Hungary or Baden Hungary admixture are rejected (Appendix, Section 2, Tables 2d, 2e). For some of these Moldova Scythian individuals, the hypothesis that they have Bodrogkeresztúr Hungary-like admixture is not rejected. This is the case for Moldova Scythian 305. Moreover, the result for Moldova Scythian 197 comes close to the threshold of non-rejectability (Appendix, Section 2, Table 2c). Thus, retaining only cases in which there is no ambiguity, some of the Moldova Scythians, Moldova Scythian 192, 300, and 311, might signal the presence of Urziceni 48-like admixture to the east of the intra-Carpathian area into the Late Iron Age.

Combining results suggests that it would be reasonable to examine the hypothesis that populations with Urziceni 48-like admixture continued to be present in the intra-Carpathian area. A further examination of this issue would be helpful in gaining a fuller understanding of the relations among succeeding populations currently identified by pottery styles. But, again, the issue cannot be pursued for lack of samples.

Process 3: Westward, small-scale migration of the metallurgically competent

A belief shared for some time is that the earliest westward spread of metallurgy into Central Europe and North Italy originated somewhere in the Carpathians[73]. It was thought that the transmission occurred through contiguous contact or information sharing between adjacent communities. A drawback of that view is that metallurgical know-how is not transmitted by information sharing but by direct participation in a long chain of operations that need to be mastered in order to produce copper artifacts. Experimental archaeology has highlighted that many of these operations call for face-to-face activity conducted by participants engaging jointly in complementary actions[74]. Thus, while contiguity can explain the diffusion of copper artifacts, the same cannot be said for the acquisition of know-how.

Relevant to the issue of the transmission of metallurgical know-how is the finding that gene flow from some Urziceni Bodrogkeresztúr samples to Remedello Chalcolithic individuals, who belonged to the first metallurgical culture of northern Italy, is not rejected (Appendix, Section 3, Tables 3a and 3b). It is evidence for a migration of Urziceni-like individuals in a group or groups sufficiently large to leave an impact into the late fourth and early third millennium BCE, since the Remedello samples on which the inference is based are dated 3483–3107 cal BCE and 2908–2578 cal BCE (Appendix). This result lends support to those who believe that early metallurgy spread through groups of individuals rather than by solitary male metallurgists, either acting on their own or under the sponsorship of warrior elites[75].

Moreover, while the hypothesis that there was gene flow from an Urziceni 48-like source to

would likely originate in Central Europe. The suggestion that Early Bronze Age Maros is derived from Lower Austria or Burgenland is in Bertemes, Heyd 2015.

72 Łukasik *et al*. 2017, 608.

73 Strahm 2005; Strahm 2007; Dolfini 2013.

74 Heeb 2014, 49.

75 Kienlin 2016; Rowlands 1971; Wailes 1996.

individuals from Chalcolithic Remedello Culture is not rejected, one can reject the hypotheses that there was such gene flow from Tiszapolgár or Bodrogkeresztúr communities in Hungary, given the samples available (Appendix, Section 3, Table 3a). These results mirror those concerning the genetic affinity of the Iceman, dated 3484–3104 cal BCE, who was found in an area relatively close to Brixlegg, a site at which early evidence of metallurgy in Austria has been detected. In the case of the Iceman, one can reject the hypothesis that there was gene flow from Tiszapolgár or Bodrogkeresztúr communities in Hungary. But that is not the case for gene flow from an Urziceni 48-like source (Appendix, Section 3, Table 3a). Nevertheless, not all Urziceni individuals had descendants who participated in migration. Gene flow from Urziceni 27 to Remedello Chalcolithic individuals is rejected (Appendix, Section 3, Table 3b).

Close kinship relations could have bound members of the migrating metallurgically competent community or communities, but not necessarily so. One might have imagined that metallurgical know-how was jealously guarded by Urziceni community members for which southeastern ancestry is plausible, given that metallurgical know-how must have first been acquired from a southeastern source. However, the hypothesis that there was gene flow to Remedello Chalcolithic individuals from descendants of an individual like Urziceni 56 is not rejected, although one can reject that Urziceni 56 had southeastern admixture (Appendix, Section 3, Table 3b and Section 1, Table 1). That would be in keeping with the Bodrogkeresztúr communities buried in Urziceni being open to creating ties with people not closely related to them, an inclination that several generations of mobility would have inculcated.

Whatever the kinship status of members of the migrating metallurgical communities was, results for Iron Age individuals from northern Italy, which date from 900–800 BCE to 600–200 BCE (Appendix), confirm that these communities must have been large enough to have left their mark on populations north of Rome into the Iron Age. Again, one can reject the hypotheses of gene flow from Tiszapolgár or Bodrogkeresztúr Hungary to Republic-Age individuals north of Rome. One can also add that the hypothesis of gene flow from Late Baden Hungary to Republic-Age individuals north of Rome is rejected. However, the hypothesis that gene flow occurred from an Urziceni 48-like source is not rejected (Appendix, Section 3, Table 3c).

That it is plausible Remedello Chalcolithic individuals have Urziceni Bodrogkeresztúr-like admixture has two implications. First, it confirms that the source of the westward spread of metallurgical know-how was from the Carpathians. Second, it suggests that the spread did not occur merely by word-of-mouth or exchange of artifacts among adjacent communities occupying territory between northwestern Romania and northern Italy, which would, for the most part, have belonged to the Lengyel or Epi-Lengyel horizons.

The closest communities to northern Italy were Lengyel-related. However, Lengyel communities in Transdanubia exhibited a decline attributed to a reduction in stone resource exploitation. A drop in population and decline in stone production is further attributed to the impact of the Copper Age[76]. Nevertheless, it is unlikely that the drop in stone implement production was due to replacement with copper production.

Recently, L. Papac *et al.* 2021 have found a resurgence of Körös Hunter-Gatherer introgression in Epi-Lengyel communities, which they date to around the 47th to the 44th centuries BCE[77]. Hunter-gatherer resurgence appears to be a notable factor in the evolution of central European populations before the advent of Corded Ware Culture bearers. However, hunter-gatherer social organization is not germane to production practices with a long *chaîne opératoire*, as is the case in metallurgy. There were copper objects in Lengyel and Epi-Lengyel culture burials, but despite discussions of Late Lengyel culture as a participant in copper production[78], the evidence is hard to come by. There do not seem to be finds of metallurgical activity. It does not appear likely that Lengyel-related communities were either a source or direct transmitters of metallurgical know-how.

Nevertheless, the path leading westward and eventually into northern Italy must have traversed

[76] Regenye 2020.

[77] Papac *et al.* 2021, 4 of 17.

[78] Scharl 2016, Table 2 refers to Kovács 2013, Table 1; Siklósi 2004, Table 3; and Zalai-Gaál 1996. The relevant information in Zalai-Gaál 1996 is in Tables 2 and 3. The referenced information confirms finds of copper rings and bracelets, and copper beads. There is no reported evidence of slag, prills, crucibles, blowpipes, or tuyères in Transdanubian sites in the sources mentioned.

an area rich in ores, without which metallurgy cannot be practiced until long-distance exchange networks are established to procure raw materials. The mountain ranges of Slovakia have suitable ores, and, in the late fifth and early fourth millennia, there are signs of metallurgical activity throughout Slovakia distributed along a trajectory that forms an arc reaching down into Austria, all in areas occupied by Lengyel or Lengyel-related communities.

Although hammer-axe and hammer-adze finds often lack a context of discovery, their distribution gives a broad indication of the area of operation of people who could have been involved in the spread of metallurgical know-how. The pattern of the combined spread of Székely-Nádudvar, Szendrö, and Handlová type axes, for instance, follows an arc that is parallel to and overlaps with the mountainous areas of Slovakia[79]. Marked axes, especially, are distributed in this north and northwestern area[80] and appear to be characteristic of Tiszapolgár and Bogrodkeresztúr groups[81]. Szendrö and Székely-Nádudvar axes are thought to belong to the late fifth millennium, while Handlová axes are dated to the end of the fifth millennium[82].

The path formed by the distribution of these axes could be related to the course of the River Hron, which flows into the Danube and offers accessibility to copper ores in neighboring mountain ranges in Slovakia[83]. M. Schreiner *et al.* 2012 associate Chalcolithic-era evidence of casting and smelting at Handlová, Nitriansky Hrádok, Slovenské Pravno, and Sucha nad Parnou with this corridor of access, which linked the sites at which signs of copper metallurgy were found to the most likely sources of ores at Spania Dolina, Poniky, and L'ubietová[84].

S. Scharl 2016 identifies the spread of metallurgical know-how to Central Europe as Phase II of the process of transfer of innovation. It encompasses finds of crucibles in Austria and Bohemia. The sites in Austria, Bisamberg, Oberpullendorf, and Keutschacher See, date to around the 41st century BCE for the first two and between 4100 and 3700 cal BCE for the third[85]. Moreover, B. Höppner *et al.* 2005 report dates of 3960–3650 cal BCE (68.2%) for green copper minerals mixed with baked clay and charcoal found in the Mariahilfbergl settlement in Brixlegg[86]. Finally, A. Dolfini 2013 estimates the spread of metallurgical know-how to Italy to have occurred sometime in the last quarter of the fifth millennium BCE[87].

The result that Urziceni-type gene flow to Remedello Chalcolithic individuals is plausible provides an answer to a puzzle generated by the collection of finds of metallurgical activity by tying them to the westward path taken by metallurgically competent groups originating in the intra-Carpathian area. It had been generally agreed that metallurgical know-how came from somewhere in the Carpathians, but who the agents of change were was not known. A reasonable, default assumption is that the mediators were from adjacent regions occupied by Lengyel-derived communities. Nevertheless, transmission at early stages, in the fifth millennium, requires face-to-face contact in apprenticeship arrangements. That gene flow to Remedello Chalcolithic individuals from an Urziceni Bodrogkerezstúr source is not rejected suggests that contiguity is not always the right answer. Traces of metallurgical activity in areas from which ores are accessible are consistent with a path metallurgically competent migrating communities needing ores in order to exercise their skills would have taken.

The migration from metallurgically competent Urzceni Bodrogkerezstúr communities probably collected groups of individuals, male, female, adult, and children, some of whom were related, but all of whom, if able-bodied, would have been needed to carry out ongoing support and metallurgical activities from scratch since they were heading into areas where none of the required complementary products and competencies were present. These competencies, which we might take for granted, included everything from knowing how to produce heat-resistant ceramics to preparing the large amounts of fuel needed, not to mention seeking out, collecting, and preprocessing ores. Attempts to

79 Heeb 2014, Maps 21, 31, and 3.
80 Heeb 2014, Fig. 77.
81 Heeb 2014, 94.
82 Heeb 2014, 72–73.
83 Schreiner *et al*. 2012, Fig. 1.
84 Schreiner *et al.* 2012, 355, 357–360. The authors attribute metallurgical knowledge to local, Lengyel-derived communities, such as the Brodzany and Ludanice groups.
85 Scharl 2016, 12–13, including references to the literature.
86 Höppner *et al*. 2005, 299.
87 Dolfini 2013, 29.

reproduce copper tools with Chalcolithic-era technology in experimental archaeology drive this point home effectively.

There is no evidence that conquest or population replacement occurred on the way. There does not seem to be archaeological evidence of migration, which is why archaeologists attributed the spread of metallurgy westward to adjacent and local communities. Once one knows what to look for, expectations about what is findable may change. Whichever way the migration occurred — it might not have been a single event— the displacements were not a matter of controlling territories and their occupants but finding opportunities to practice a set of skills.

Reconsidering mobility and disaggregation

The mobility of the agropastoralists of Copper Age Eastern Hungary has been described as an effect of their reorganization from tells to smaller habitation units. This reorganization is explained in terms of a gain in agricultural productivity in smaller units compared to massed living in tells. The smaller units are variably described as households or hamlets. Increased productivity in smaller units is characterized as an effect of the privatization of storage and consumption of the products of agricultural labor. The idea is that there is a greater incentive to increase production if the products of labor are privatized. Mobility is factored in as a way of insuring against subsistence failure by maintaining relations with other households [88]. Strontium isotope analyses have brought out the reality of mobility. They also support that mobility was not tied to adopting a specialized form of pastoralism.

However, the idea that the disaggregation of tells in the Great Hungarian Plain to households or hamlets and increased mobility were brought about by adopting a policy of privatization of food storage and consumption relies on literature about privatization that illustrates an opposite trend. In archaeology, the shift from a social organization in which food is pooled to one in which privatization of food storage develops was used to explain changes in settlement organization from the Natufian and Pre-Pottery Neolithic A to the Pre-Pottery Neolithic B[89]. In ethnography, the privatization of food consumption among the !Kung and its impact on the organization of living space were described to have occurred as the !Kung gradually abandoned foraging in favor of farming concurrently with being drawn into a market system of exchanges[90].

In both cases, the privatization of food resources is a descriptor of an intensified transition away from foraging. It is not particularly tied to increased mobility. If anything, it would be tied to decreased mobility implied by a definitive shift away from foraging. The tell inhabitants of the Great Hungarian Plain were not foragers. Thus, what set off the process of tell disaggregation and increased mobility in the Great Hungarian Plain is still an open question.

One might suggest that both social reorganization and mobility in the Great Hungarian Plain could have been tied to the pull of the neighboring Lower Danube Valley metallurgical network. The attraction of better opportunities for exchanges, technological innovation, and a variety of social roles in complementary activity might have been stronger than allegiance to the local tell system. The latter disaggregated as individuals and subsets of tell communities pursued greater opportunities offered by the Lower Danube Valley network of exchanges. The dates seem to fall in place, as the beginning of the disaggregation of the tell system in the Great Hungarian Plain, by around 4450 BCE[91], corresponds to the period of the florescence of the Lower Danube Valley core metallurgical network and antedates the formation of Sălcuța Culture. The time frame is also coeval with the appearance of individuals from the Pontic Caspian steppe among Lower Danube Valley settlements. The Lower Danube Valley was a pole of attraction for communities both to the west and the east.

On the northwestern edge of this pole of attraction, those who would have been especially active in setting up ties with the Lower Danube Valley network could have been Tiszapolgár communities described as eventually adopting the Bodrogkeresztúr style. A key to developing relations with the Lower Danube Valley network and the Sălcuța communities that bordered it to the west would have been initiating and maintaining reciprocal exchange agreements at the local level. Such agreements

88 Hoekman, Giblin 2012, 524–525.
89 Flannery 2002, 421.
90 Kranton 1996b, 844.
91 Siklósi, Szilágyi 2021, 622.

become stronger and self-sustaining the more frequently they are exercised. Repeated interaction allows parties involved to assess mutual reliability and honesty and plan for future interaction[92].

Without the need to resort to a system of laws, self-enforced agreements could have been facilitated by the fact that groups of individuals from the Lower Danube Valley, Sălcuța communities, and communities to the northwest had similar ways of making a living. They were all agropastoralists exploiting diversified resources. They probably all spoke languages derived from western Anatolian that may have still been mutually understandable[93]. The shared iconography of symbolic figures suggests shared explicit beliefs and tacit outlooks. Certainly, the Bodrogkeresztúr communities borrowed their iconography, such as the gold ring idols and human/bird hybrids, from the Lower Danube Valley complex of cultures.

These communities probably also had similar rituals to reduce disagreements and control aggression. Some kinship relations for transferring metallurgical know-how are likely to have formed, although relations instrumental to building the trust needed to transfer know-how might also have had the nature of "fictive" kinships[94]. The creation of enduring relations would have required extended periods of providing favors or gifts[95]. The favors on the side of those pursuing apprenticeship might have been in the form of labor-intensive support tasks.

The burgeoning process of building links with the Lower Danube Valley core network, probably through its western extension among Sălcuța communities, was interrupted by the sudden cessation of function of the core network. As a result, the process of reconfiguring the Great Hungarian Plain settlement system looks like it had no connection to anything going on outside of it. It becomes difficult to fathom why social organization in the Great Hungarian Plain would have reverted to smaller units. Placing it in the context of an interrupted process that had broader regional linkages could provide some rationale for the process of disaggregation and increased mobility that accelerated with the formation of the Tiszapolgár/Bodrogkeresztúr continuum.

Conclusion

Given the dates for metallurgical activity in the Lower Danube Valley and the time lag in the appearance of metal objects among Tiszapolgár and Bodrogkeresztúr communities, it should now be accepted that the source of metallurgical competence was ultimately in the Lower Danube Valley. In striving to acquire metallurgical skills, some communities east of the Tisa were transformed by their contact with Sălcuța and, perhaps, Gumelnița communities. They or their descendants became the vector through which metallurgical know-how eventually spread northwest of the Great Hungarian Plain and into northern Italy. These migrants were related to or descended from Urziceni Bodrogkeresztúr-like individuals.

Their displacements would have involved small communities, not just individuals. They would have included kin but not been limited to them. In their migration westward, these small-scale communities, who would have needed to be self-sustaining, are likely to have included diverse individuals who could fulfill the various roles required for all stages of metallurgical production since host communities could not have been relied upon to have the requisite know-how.

These developments reveal something that was perhaps a novelty in the fifth millennium BCE or at least infrequent, that is, a small-scale movement of individuals seeking to acquire technological proficiency in a first stage and then, in a later stage, a small-scale migration of the technologically proficient searching for avenues to exercise their skills. In neither case was the movement tied to occupying land or gaining control of its occupants. These individuals and communities belonged to a period that saw an increase in complementary activities necessary for specialization. One should put early metallurgists in the context of such complementary coordination and attendant broadening of social roles and opportunities.

The Urziceni-like agropastoralists associated with Bodrogkeresztúr Culture were descendants of what are perhaps among the earliest skill-seeking migrants known to us. Descendants of some

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92 Kranton 1996b, 832.

93 "Anatolian" in this sense has no association with the Indo-European family of languages.

94 Kranton 1996a, 225.

95 Kranton 1996a, 226.

Urziceni Bodrogkeresztúr-like individuals were also perhaps among the earliest migrants associated with the exercise of a skill. They are interesting because they allow us to tell a story of how metallurgy spread out of an area in which it had thrived earlier, probably in decentralized and local interaction with metallurgically competent individuals and communities of the Sălcuța and perhaps Gumelnița cultures. That some Tiszapolgár/Bodrogkeresztúr communities acquired metallurgical competence is, in itself, a remarkable development. In fifth millennium BCE Europe, mastery of metallurgical practices appears not to have spread eastward from the Kodžadermen-Gumelnița-Karanovo VI horizon, despite ample opportunities for doing so. Individuals of the Pontic Caspian steppe were locally present among Kodžadermen-Gumelnița-Karanovo VI communities since the middle of the fifth millennium, yet metallurgy does not appear in the Pontic Caspian steppe with any certainty before the early third millennium BCE[96]. Westward, traces of metallurgy appear to mark the migration path of a metallurgically active community rather than native activity. Thus, a further issue to examine, which is outside the purview of this paper, is what could have been the social-organizational factors specific to Gumelnița, Sălcuța, and Tiszapolgár/Bodrogkeresztúr communities that enabled them to acquire and transmit metallurgical skills but were not present at the time in the Pontic-Caspian steppe or Central Europe.

Finally, it is possible to think of settlement fragmentation in the Great Hungarian Plain as part of a broader process. It might have been a phase in the reorganization of settlements in the Great Hungarian Plain into new population centers in relation to the Lower Danube Valley metallurgical network. The communities originating in the Great Hungarian Plain had started out as consumers, not producers of metal artifacts. A reorganization in relation to the Lower Danube Valley might, if the process had not been cut short, have led to a more efficient transfer and adoption of new technologies and eventually enabled the formation of regional centers that could participate in a broader intra-Carpathian network for sharing resources and know-how. What was left of this interrupted process was a migration of some of the metallurgically skilled community members, their descendants eventually bringing their know-how further west, while others chose to continue their activity in the intra-Carpathian area.

Much more detail could be filled in if there was more data with which to work. But even with what is available, one can get a glimpse of a period in European prehistory, the importance of which still calls for further reappraisal.

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96 Peterson *et al*. 2016, 294.

APPENDIX

The purpose of this Appendix is to provide a summary of results on which claims concerning individuals/populations in the paper are based.

All individuals/populations and their labels are from a curated dataset, V42.4, the dataset current at the time of writing, available at https://reich.hms.harvard.edu/allen-ancient-dna-resource-aadr-downloadable-genotypes-present-day-and-ancient-dna-data. The exceptions are two individuals from Harney *et al*. 2021b, here labeled Urziceni 27 and 56.

For inferences concerning relations among populations, the software used was *qpWave* version 410, setting allsnps: YES and *qpAdm* version 810, allsnps: YES, in *AdmixTools*.

f_4 statistics measure the covariance of allele frequency differences between populations[97]. *qpWave* computes multiple f_4 statistics that capture allele frequency differences between populations of interest, identified as "left" populations, given populations identified as reference or "right" populations. Reference or "right" populations are populations from which there is no recent gene flow to the "left" populations.

qpWave can be used to make inferences about whether a set of "left" populations are cladal with respect to a set of reference populations or "right" populations. It can also indicate how many waves of populations can account for admixture among the "left" populations with respect to the set of reference or "right" populations. *qpAdm* adds an estimate of admixture proportions in modeling one of the "left" populations identified as a target resulting from an admixture of the other "left" populations, given the "right" populations.

qpWave and *qpAdm* also provide an assessment of plausibility or non-rejectability of the proposed models[98]. For inferences using *qpWave* and *qpAdm* the cut-off point used here for not rejecting results is $p \geq 0.05$.

The labels for the reference, or "right" populations, are as follows: Mbuti.DG; Russia_Ust_Ishim_HG_published.DG; Ethiopia_4500BP_published.SG; Russia_MA1_HG.SG; Italy_North_Villabruna_HG; Papuan.DG; Indian_GreatAndaman_100BP.SG; Han.DG; Karitiana.DG; Hungary_EN_HG_Koros_published.SG; Hungary_EN_Koros; Iberia_EN.

They are in Allen 2021 and are similar to the "right" populations in Mittnik *et al*. 2019. The main difference is that a hunter-gatherer and early Neolithic farmers from Central Europe replace Germany LBK samples to ensure that all populations from central Europe in the "right" set antedate the mid-sixth millennium BCE[99].

The following is information on the pre-mid-sixth millennium individuals from Central Europe in the set of"right" populations:
Hungary_EN_HG_Koros_published.SG: 5780–5640 cal BCE,Tiszaszolos-Domaháza.

Hungary_EN_Koros (4 samples)
I2794, Hungary_EN_Koros, 5706–5541 cal BCE, Törökszentmiklós, road 4, site 3;
I2373, Hungary_EN_Koros, 6000–5500 BCE, Törökszentmiklos Tiszapüspöki Karanycs haromag 3. lh.; I1508, Hungary_EN_Koros, 5710–5570 cal BCE, Berettyóújfalu-Morotva-Liget;
I2374, Hungary_EN_Koros, 6000–5500 BCE, Törökszentmiklos Tiszapüspöki Karanycs haromag 3. lh.

The following provides information on the populations used in the models as "left" populations:
Urziceni Bodrogkersztúr (4 samples)
I4088, Romania_C, 4331–4076 cal BCE (Urziceni 16); I4089, Romania_C, 3761–3645 cal BCE (Urziceni 48); I11902, 6300–6050 BP (Urziceni 27); I11906, 6300–6050 BP (Urziceni 56).

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97 Haak *et al.* 2015; Patterson *et al.* 2012.

98 Harney *et al.* 2021a.

99 This is the main difference with results reported in Vicas 2021. Principal results, including for modern populations, are not changed.

The main Urziceni sample is Urziceni 48, which has the highest coverage. The other samples from Urziceni are included in some analyses for comparison with Urziceni 48.

Hungary_EarlyC_Tiszapolgar (4 samples)
I2353, I2354, I2356, I2395; 4500–4000 BCE, Pusztataskony Ledence 1.

Hungary_EarlyC_Tiszapolgar_Bodrogkeresztur_published (1 sample)
I2793_published, 4444–4257 cal BCE, Törökszentmiklos, Road 4, site 3.

Italy_North_MN_Iceman_contam.SG (1 sample), 3484–3104 cal BCE.

Italy_North_Remedello_C.SG (2 samples)
RISE487.SG, 3483–3107 cal BCE, RISE489.SG, 2908–2578 cal BCE, Lombardy, Remedello di Sotto.

Bulgaria_C (10 samples)
I2427, 4445–4335 cal BCE, Sushina; I2431, 4725–4605 cal BCE, Ivanovo;
I0785, 4455–4359 cal BCE, Yunatsite; I0781, 4528–4371 cal BCE, Yunatsite;
I2509, 4452–4354 cal BCE, Dzhulyunitsa; I2519, 4337–4246 cal BCE, Dzhulyunitsa; I2423, 4520–4356 cal BCE, Smyadovo; I2424, 4448–4260 cal BCE, Smyadovo; I2425, 4679–4450 cal BCE, Sushina; I2430, 4545–4450 cal BCE, Smyadovo.

Hungary_LateC_Baden (11 samples)
I2368, 3300–2850 BCE, Budakalász, Luppa csárda; I2369, 3367–3103 cal BCE, Budakalász, Luppa csárda; I2370, 3346–2945 cal BCE, Alsonemedi; I2371, 3359–3098 cal BCE, Alsonemedi; I2752, 3600–2850 BCE, Balatonlelle, Fels-Gamász; I2753, 3332–2929 cal BCE, Balatonlelle, Fels-Gamász; I2754, 3337–3024 cal BCE, Balatonlelle, Fels-Gamász; I2755, 3600–2850 BCE, Balatonlelle, Fels-Gamász; I2763, 3360–3103 cal BCE, Vörs; I2785, 3600–2850 BCE, VámosgyUork, MHAT telep; I1497, 2900–2700 cal BCE, Apc-Berekalya I.

Russia_EBA_Yamnaya_Samara (9 samples)
I0370, 3300–2500 BCE, Samara Oblast, Volga River Valley, Ishkinovka I; I0441, 3010–2622 cal BCE, Samara Oblast, Volga River Valley, Kurmanaevka III; I0444, 3335–2882 cal BCE, Samara Oblast, Volga River Valley, Kutuluk; I0439, 3321–2921 cal BCE, Samara Oblast, Volga River Valley, Lopatino I; I0357, 3090–2913 cal BCE, Lopatino I; I0429, 3339–2918 cal BCE, Lopatino I; I0438, 3021–2635 cal BCE, Samara Oblast, Volga River Valley, Luzkhi I; I0443, 3300–2500 BCE, Samara Oblast, Volga River Valley, Lopatino II; I7489, 3323–2928 cal BCE, Samara Oblast, Volga River Valley, Utyevka V.

Estonia_CordedWare.SG (5 samples)
MA969.SG, 2871–2505 cal BCE, Ardu, Harju; MA971.SG, 2850–2050 BCE, Kursi, Jõgeva; MA973.SG, 2580–2340 cal BCE, Kursi, Jõgeva; MA826.RISE00.SG, 2575–2350 cal BCE, Jäbara, Ida-Viru, Sope; MA968.MA976.SG, 2871–2505 cal BCE, Ardu, Harju.

Hungary_Maros_EBA.SG (4 samples)
RISE349.SG, 2034–1784 cal BCE, Battonya Vörös Oktober; RISE371.SG, 2136–1941 cal BCE, Szöreg, Sziv Utca; RISE373.SG, 1886–1696 cal BCE, Szöreg, Sziv Utca; RISE374, 1866–1619 cal BCE, Szöreg, Sziv Utca.

Moldova_Scythian (5 samples)
scy192.SG, 450–150 BCE; scy197.SG, 450–150 BCE; scy300.SG, 397–209 cal BCE; scy305.SG, 399–209 cal BCE; scy311.SG, 389–204 cal BCE, Slobodzeya District, Glinoe.

Italy_IA_Republic.SG (8 samples)
R1015.SG, 900–800 BCE, Veio Grotta Gramiccia; R1016.SG, 900–700 BCE, Castel di Decima; R1021.SG, 700–600 BCE, Boville Ernica; R1.SG, 930–839 cal BCE, Martinsicuro; R435.SG, 600–200 BCE,

Palestrina Colombella; R473.SG, 700–600 BCE, Civitavecchia; R473.SG, 700–600 BCE, Civitavecchia; R474.SG, 700–600 BCE, Civitavecchia; R851.SG, 800–500 BCE, Ardea.[100]

In the following summaries, the relevant information is the difference between results concerning model rejectability as the Urziceni Bodrogkeresztúr sample with the best coverage, Urziceni 48, is compared with Tiszapolgár and Bodrogkeresztúr individuals from Hungary and, sometimes, other Urziceni individuals and a later population of the Copper Age, Late Baden in Hungary.

Section 1: Possible relation between some of the Urziceni Bodrogkeresztúr individuals with an as yet unsampled population proxied by Bulgaria Chalcolithic

Some of the Urziceni Bodrogkeresztúr individuals show evidence of ancestry associated with a Bulgaria Chalcolithic population, which is what is currently available as a proxy for the most probable population of contact from which metallurgical know-how could have been acquired, bearers of Sălcuța Culture, who are also thought to derive in part from Gumelnița Culture bearers. Nevertheless, not all the Urziceni individuals show this southeastern affinity, while none of the Great Hungarian Plain Copper Age populations do.

Results that satisfy the condition that $p \geq 0.05$ for *qpWave* and *qpAdm* are shaded in the remainder of this Appendix.

Table 1. Testing for cladality of various individuals/populations of interest with Bulgaria Chalcolithic with *qpWave*

Cladal with Bulgaria Chalcolithic?	**Urziceni 48**	**Tiszapolg Hung**	**Bodrog Hung**	**Urziceni 16**	**Urziceni 27**	**Urziceni 56**
p-value	1.26E-01	2.68E-02	7.31E-05	2.30E-01	2.67E-03	3.69E-04

Conclusion: That there was gene flow between a population modeled as Bulgaria Chalcolithic and the ancestors of some of the Urziceni Bodrogkeresztúr individuals (48 and 16) is not rejected. Evidence of gene flow can support the hypothesis that cultural transmission of metallurgical know-how occurred in part by developing kinship relations with a more southeastern population, here modeled with Bulgaria Chalcolithic. Some Urziceni individuals do not show evidence of this kind of admixture, suggesting that the Urziceni Bodrogkeresztúr were a relatively diverse group with respect to descent from individuals who may have had direct contact with a population proxied by Bulgaria Chalcolithic.

Section 2: Possible relevance of an Urziceni-like population to Bronze and Iron Age populations/individuals

The admixture weights in this section are not meant to provide a complete genetic profile of individuals and populations of interest, only to highlight Urziceni-like admixture in comparison with some other Copper Age populations/individuals from Hungary.

Table 2a. Assessing gene flow from either Urziceni 48 or individuals of the Great Hungarian Plain Copper Age to Maros Early Bronze Age and admixture weights with *qpAdm*

Maros EBA Hung as X+Estonia Corded Ware?	**p-value**	**Admixture weights X/Estonia Corded Ware/Standard Errors**
Urziceni 48	9.96E-02	0.512/0.488/0.045
Tiszapolgár Hung	3.00E-03	0.524/0.476/0.048
Bodrogkeresztúr Hung	1.32E-03	0.466/0.534/0.051

100 The samples for the individuals and populations of interest first appeared in the following sources: Allentoft *et al.* 2015; Antonio *et al.* 2019; Harney *et al.* 2021b; Krzewińska *et al.* 2018; Lipson *et al.* 2017; Mathieson *et al.* 2018.

Maros EBA Hung as X+Estonia Corded Ware?	**p-value**	**Admixture weights X/Estonia Corded Ware/Standard Errors**
Baden Hung	8.98E-04	0.427/0.573/0.042

Conclusion: The hypothesis that an Early Bronze Age population to the immediate west of the intra-Carpathian area, Maros Early Bronze Age, has admixture from an Urziceni 48-like source is not rejected. By contrast, the hypotheses that there is Tiszapolgár or Bodrogkeresztúr Hungary admixture in Maros Early Bronze Age individuals are rejected. The hypothesis that Maros Early Bronze Age has admixture from Late Copper Age Baden Culture in Hungary can also be rejected.

The results suggest that there is an ongoing presence of Urziceni 48-like admixture in the intra-Carpathian area in the Early Bronze Age. The contrasting results for Urziceni 48 and Baden Late Copper Age admixture in Maros Early Bronze age individuals suggest that there could be a duality in admixture results into the Bronze Age, with Urziceni-like admixture enduring to the east, in the intra-Carpathian area, but not further west, in territories occupied by Baden Late Copper Age communities.

Table 2b. Assessing gene flow from Urziceni 48 to some Iron Age Moldovan Scythians and admixture weights with *qpAdm*

X as Urziceni 48+Yamnaya Samara?	**p-value**	**Admixture weights Urzi48/Yamnaya Sam/ Standard Errors**
Moldova_Scythian300	4.58E-01	0.714/0.286/0.047
Moldova_Scythian192	7.59E-01	0.629/0.371/0.039
Moldova_Scythian197	3.42E-01	0.698/0.302/0.050
Moldova_Scythian305	2.74E-01	0.596/0.404/0.054
Moldova_Scythian311	8.88E-02	0.440/0.560/0.049

Table 2c. Assessing gene flow from Bodrogkeresztúr Hungary to some Iron Age Moldovan Scythians and admixture weights with *qpAdm*

X as Bodrogkerestúr Hung+ Yamnaya Samara?	**p-value**	**Admixture weights Bodrogk Hung/Yamnaya Sam/Standard Errors**
Moldova_Scythian300	2.95E-02	0.676/0.324/0.046
Moldova_Scythian192	3.98E-02	0.600/0.400/0.041
Moldova_Scythian197	4.50E-02	0.642/0.358/0.047
Moldova_Scythian305	9.38E-02	0.575/0.425/0.056
Moldova_Scythian311	9.10E-03	0.405/0.595/0.050

Table 2d. Assessing gene flow from Tiszapolgár Hungary to some Iron Age Moldovan Scythians and admixture weights with *qpAdm*

X as Tiszapolgár Hung+ Yamnaya Samara?	**p-value**	**Admixture weights Tiszapolg Hung/Yamnaya Sam/Standard Errors**
Moldova_Scythian300	8.05E-03	0.724/0.276/0.042
Moldova_Scythian192	1.12E-02	0.646/0.354/0.037
Moldova_Scythian197	1.70E-02	0.682/0.318/0.045
Moldova_Scythian305	1.63E-02	0.618/0.382/0.053
Moldova_Scythian311	9.71E-04	0.456/0.544/0.055

Table 2e. Assessing gene flow from Baden Hungary to some Iron Age Moldovan Scythians and admixture weights with *qpAdm*

X as Baden Hung+ Yamnaya Samara?	**p-value**	**Admixture weights Baden Hung/Yamnaya Sam/Standard Errors**
Moldova_Scythian300	1.34E-02	0.619/0.381/0.039
Moldova_Scythian192	1.82E-03	0.582/0.418/0.035
Moldova_Scythian197	3.25E-03	0.585/0.415/0.041
Moldova_Scythian305	2.40E-02	0.480/0.520/0.046

X as Baden Hung+ Yamnaya Samara?	p-value	Admixture weights Baden Hung/Yamnaya Sam/Standard Errors
Moldova_Scythian311	2.76E-03	0.355/0.645/0.044

Conclusion: Urziceni 48-like admixture in Iron Age individuals to the east of the intra-Carpathian area is not rejected. This is the case for Moldova-Scythian 192, 197, 300, 305, and 311. Bodrogkeresztúr Hungary-like admixture in some Iron Age individuals to the east of the intra-Carpathian area is also not rejected in the case of Moldova-Scythian 305 and, marginally, Moldova-Scythian 197. Thus, the source of the admixture is ambiguous in those two cases.

Conclusion for the Early Bronze and Iron ages:

It is plausible that there is Urziceni 48-like admixture that is detectable in Early Bronze Age and Iron Age individuals west and east of the intra-Carpathian area.

Section 3: Possible relation between Remedello Culture individuals of the Chalcolithic and some of the Urziceni Bodrogkeresztúr individuals; continued impact into Iron Age North Italy

It is plausible that individuals of the Remedello Chalcolithic have ancestry from an Urziceni-like population, but not other populations or individuals whose burial location was in the Great Hungarian Plain. Information for Urziceni 48 and individuals from Tiszapolgár and Bodrogkeresztúr cultures in Hungary in relation to the Iceman is also provided, since the location of the Iceman is relatively close to Brixlegg, a site in Austria in which evidence of metallurgy was noted.

Table 3a. Testing for cladality of Urziceni 48 and two populations/individuals from the Great Hungarian Plain Copper Age with the Iceman and Remedello Chalcolithic with *qpWave*

p-value	Urziceni 48	Tiszapolg Hung	Bodrog Hung
Italy_North_MN_Iceman	8.33E-01	2.01E-02	2.89E-04
Italy_North_Remedello Chalcolithic	1.40E-01	3.97E-04	1.02E-02

Table 3b. Testing for cladality of other Urziceni individuals with Remedello Chalcolithic with *qpWave*

p-value	Urziceni 16	Urziceni 27	Urziceni 56
Italy_North_Remedello Chalcolithic	9.93E-02	5.16E-03	1.81E-01

Conclusion: Admixture from Urziceni 48 in Remedello Chalcolithic individuals and Iceman is not rejected, contrary to the case for Tiszapolgár and Bodrogkeresztúr samples from Hungary. Moreover, combining the results of this section with Table 1, some of the Urziceni individuals for whom gene flow to Remedello Culture is not rejected, such as Urziceni 56, do not appear to have southeastern European ancestry as proxied by Bulgaria Chalcolithic, since the hypothesis that Urziceni 56 has Bulgaria Chalcolithic-like ancestry is rejected. Some Urziceni individuals, such as Urziceni 27, appear to show no genetic relation to either Bulgaria Chalcolithic or Remedello Chalcolithic individuals, since the hypotheses that Urziceni 27 has Bulgaria Chalcolithic ancestry and that Remedello Chalcolithic has Urziceni 27 ancestry are both rejected. Neither hypothesis is rejected for Urziceni 48 and Urziceni 16.

These results suggest that the Urziceni group were diverse and that the Urziceni-like communities for which gene flow to Remedello Chalcolithic individuals is not rejected were not necessarily made up of close kin.

The admixture weights below are not meant to provide a complete genetic profile of the named individuals and populations, only to highlight Urziceni-like admixture in comparison with some Copper Age populations/individuals from Hungary.

In what follows, Urziceni 48, the Urziceni sample with the best coverage, is compared with individuals or groups from Copper Age Hungary.

Table 3c. Assessing gene flow from either Urziceni 48 or individuals from Copper Age Hungary to Iron Age northern Italy individuals and admixture weights with *qpAdm*

Italy_IA_Republic as X+Yamnaya Samara?	**p-value**	**Admixture weights: X/Yamnaya Samara/Standard Errors**
Urziceni 48	2.11E-01	0.696/0.304/0.024
Tiszapolgár Hung	1.44E-03	0.709/0.291/0.020
Bodrogkeresztúr Hung	4.62E-03	0.659/0.341/0.024
Baden Hung	1.39E-04	0.637/0.363/0.015

Conclusion: Gene flow from an Urziceni 48-type source to Iron Age northern Italy individuals is not rejected. This is consistent with the impact of an Urziceni-like population having been significant enough to be detectable into the Iron Age. The same cannot be said for sources from the Great Hungarian Plain Copper Age. A later Copper Age population, Baden, was added to the earlier Copper Age populations of individuals for comparison. The hypotheses of gene flow to individuals of Iron Age northern Italy from Tiszapolgár and Bodrogkeresztúr of the Great Hungarian Plain and Baden Late Copper Age individuals are rejected.

BIBLIOGRAPHY

Allen 2021 — Allen Ancient DNA Resource. https://reich.hms.harvard.edu/allen-ancient-dna-resource-aadr-downloadable-genotypes-present-day-and-ancient-dna-data.

Allentoft *et al.* 2015 — M. E. Allentoft, M. Sikora, K. G. Sjögren, S. Rasmussen, M. Rasmussen, J. Stenderup, P. B. Damgaard, H. Schroeder, T. Ahlström, L. Vinner, A. S. Malaspinas, A. Margaryan, T. Higham, D. Chivall, N. Lynnerup, L. Harvig, J. Baron, P. Della Casa, P. Dąbrowski, P. R. Duffy, A. V. Ebel, A. Epimakhov, K. Frei, M. Furmanek, T. Gralak, A. Gromov, S. Gronkiewicz, G. Grupe, T. Hajdu, R. Jarysz, V. Khartanovich, A. Khokhlov, V. Kiss, J. Kolář, A. Kriiska, I. Lasak, C. Longhi, G. McGlynn, A. Merkevicius, I. Merkyte, M. Metspalu, R. Mkrtchyan, V. Moiseyev, L. Paja, G. Pálfi, D. Pokutta, Ł. Pospieszny, T. D. Price, L. Saag, M. Sablin, N. Shishlina, V. Smrčka, V. I. Soenov, V. Szeverényi, G. Tóth, S. V. Trifanova, L. Varul, M. Vicze, L. Yepiskoposyan, V. Zhitenev, L. Orlando, T. Sicheritz-Pontén, S. Brunak, R. Nielsen, K. Kristiansen, E. Willerslev, *Population genomics of Bronze Age Eurasia*. Nature 522(7555) 2015, 167–72.

Anthony 2020 — D. W. Anthony, *Migration, Ancient DNA, and Bronze Age Pastoralists from the Eurasian Steppes*. In: M. Daniels (ed.), Homo Migrans: Modeling Mobility and Migration in Human History. Albany, NY in press 2020.

Antonio *et al.* 2019 — M. L. Antonio, Z. Gao, H. M. Moots, M. Lucci, F. Candilio, S. Sawyer, S, V. Oberreiter, D. Calderon, K. Devitofranceschi, R. C. Aikens, S. Aneli, F. Bartoli, A. Bedini, O. Cheronet, D. J. Cotter, D. M. Fernandes, G. Gasperetti, R. Grifoni, A. Guidi, F. La Pastina, E. Loreti, D. Manacorda, G. Matullo, S. Morretta, A. Nava, V. Fiocchi Nicolai, F. Nomi, C. Pavolini, M. Pentiricci, P. Pergola, M. Piranomonte, R. Schmidt, G. Spinola, A. Sperduti, M. Rubini, L. Bondioli, A. Coppa, R. Pinhasi, J. K. Pritchard, *Ancient Rome: A Genetic Crossroads of Europe and the Mediterranean*. Science 366(6466), 2019, 708–714.

Bălășescu *et al.* 2005 — A. Bălășescu, D. Moise, V. Radu, *The Palaeoeconomy of Gumelnița*. Cultura și Civilizatia de la Dunarea de Jos 22, 2005, 167–200.

Balasse *et al.* 2015 — M. Balasse, A. Bălășescu, C. Tornero, D. Fremondeau, R. Hovsepyan, R. Gillis, D. Popovici, *Investigating the Scale of Herding in Chalcolithic Pastoral Communities Settled along the Danube River in the 5th Millennium BC: A Case Study at Bordușani-Popină and Hârșova-Tell (Romania)*. Quarternary International 30, 2015, 1–12.

Benecke *et al.* 2013 — N. Benecke, S. Hansen, D. Nowacki, A. Reingruber, K. Ritchie, J. Wunderlich, *Pietrele in the Lower Danube Region: Integrating Archaeological, Faunal, and Environmental Investigations*. Documenta Praehistorica 40(1), 2013, 175–193.

Bertemes, Heyd 2015 F. Bertemes, M. Heyd, *2200 BC— Innovation or Evolution: Genesis of the Danubian Early Bronze Age*. In: H. Meller, R. Risch, R. Jung, H.-W. Arz (eds), 2200 BC— A Climatic Breakdown as a Cause for the Collapse of the Old World? Halle/Saale 2015, 561–578.

Biagi, Voytek 2006 P. Biagi, B. A. Voytek, *Excavations at Peștera Ungurească (Caprelor) (Cheile Turzii, Petrești de Jos, Transylvania) 2003–2004: A Preliminary Report on the Chipped Stone Assemblages from the Chalcolithic Toarte Pastilate (Bodrogkeresztúr) Layers*. Analele Banatului S. N. 14(1), 2006, 177–202.

Bognár-Kutzian 1972 I. Bognár-Kutzian, *The Early Copper Age Tiszapolgár Culture in the Carpathian Basin*. G. Dienes (trans.). Budapest 1972.

Borgerhoff Mulder *et al.* 2010 M. Borgerhoff Mulder, I. Fazzio, W. Irons, R. L. McElreath, S. Bowles, A. Bell, T. Hertz, L. Hazza, *Pastoralism and Wealth Inequality: Revisiting an Old Question*. Current Anthropology 51(1), 2010, 35–48.

Borić 2015 D. Borić, *The End of the Vinča World: Modelling the Neolithic to Copper Age Transition and the Notion of Archaeological Culture*. In: S. Hansen, P. Raczky, A. Anders, A. Reingruber (eds), Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to the 4th millennium BCE. Berlin 2015, 167–227.

Boroneanț *et al.* 2018 A. Boroneanț, C. Virag, C. Astaloș, C. Bonsall, *Sourcing Obsidian from Prehistoric Sites in Northwest Romania*. Materiale si Cercetări Arheologice (serie noua) 14, 2018, 13–23.

Bréhard, Bălășescu 2012 S. Bréhard, A Bălășescu, *What's Behind the Tell Phenomenon? An Archaeozoological Approach of Eneolithic Sites in Romania*. Journal of Archaeological Science 39, 2012, 3167–3183.

Brummack 2015 S. Brummack, *New Radiocarbon Dates from Eastern Slovakia: The Cases of Malé Raškovce and Barca Baloty*. In: S. Hansen, P. Raczky, A. Anders, A. Reingruber (eds.), Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to the 4th Millennium BCE. Berlin 2015, 1–19.

Chmielewski *et al.* 2021 T. J. Chmielewski, A. Hałuszko, T. Goslar, O. Cheronet, T. Hajdu, T. Szeniczey, C. Virag, *Increase in ^{14}C Dating Accuracy of Prehistoric Skeletal Remains by Optimized Bone Sampling: Chronometric Studies on Eneolithic Burials from Mikulin 9 (Poland) and Urziceni-Vada Ret (Romania)*. Geochronometria 47, 2021, 196–208.

Chohadzhiev 2016 S. Chohadzhiev, *The Prehistoric Cemetery at Smyadovo, Shumen District*. T. Stefanova (trans.). In: Z. Tsirtoni (ed.), The Human Face of Radiocarbon: Reassessing Chronology in Prehistoric Greece and Bulgaria, 5000–3000 cal BC. Lyon 2016, 69–83.

Ciută 2009 E.-B. Ciută, *Cultivators or Shepherds? New Archaeobotanical Data Regarding Plant Cultivation within Aeneolithic-Bronze Age Communities, Located in the Romanian Intracarpathian Area*. Acta Terrae Septemcastrensis 8, 2009, 169–179.

Diaconescu 2009 D. Diaconescu, *Cultura Tisapolgár în România*. Sibiu 2009.

Diaconescu 2014 D. Diaconescu, *Considerations Concerning the Chronology of the Early Copper Age Tiszapolgár Culture*. Praehistorische Zeitschrift 89(2), 2014, 219–241.

Dolfini 2013 A. Dolfini, *The Emergence of Metallurgy in the Central Mediterranean Region: A new Model*. European Journal of Archaeology 16(10), 2013, 21–62.

Dumitrescu 1925 V. Dumitrescu, *Les fouilles de Gumelnița*. Dacia 2, 1925, 29–103.

El Susi 2018 G. El Susi, *Ofrande Animale in Necropola Culturii Bodrogkeresztúr de la Urziceni-Vama, Jud. Satu Mare*. In: S. Fortiu (ed.), Arheovest VI. Szeged 2018, 631–647.

Flannery 2002 K. V. Flannery, *The Origin of the Village Revisited: From Nuclear to Extended Households*. American Antiquity 67(3), 2002, 417–433.

Georgieva 2018 P. Georgieva, *Possible Approaches to Tracing the Fate of the Population of the Varna, Kodjadermen-Gumelnița-Karanovo VI and Krivodol-Sălcuța cultures*. In: S. Dietz, F. Mavridis, Ž. Tankosić, T. Takaoğlu (eds.), Communities in Transition: The Circum-Aegean Area During the 5th and 4th Millennia BC. Oxford 2018, 95–106.

Giblin 2011 J. I. Giblin, *Isotope Analysis on the Great Hungarian Plain: An Exploration of Mobility and Subsistence Strategies from the Neolithic to the Copper Age*. PhD Dissertation. Ohio State University 2011.

Giblin *et al*. 2013 J. I. Giblin, K. J. Knudson, Z. Bereczki, G. Pálfi, I. Pap, *Strontium Isotope Analysis and Human Mobility During the Neolithic and Copper Age: A Case Study from the Great Hungarian Plain*. Journal of Archaeological Science 40, 2013, 227–239.

Gindele *et al*. 2014 R. Gindele, L. Marta, C. Virag, *Archaeological Treasure from Satu Mare County*. Satu Mare 2020.

Govedarica 2004 B. Govedarica, *Szepterträger-Herrscher der Steppen: Die frühen Ockergräber des älteren Äneolithikums im karpatischen Gebiet und im Steppenraum Südost und Osteuropas*. Mainz 2004.

Gresky *et al.* 2016 J. Gresky, E. Batieva, A. Kitova, A. Kalmykov, A. Belinskiy, S. Reinhold, N. Berezina, *New Cases of Trepanations in Southern Russia in the Context of Previous Research: Possible Evidence for a Ritually Motivated Tradition of Cranial Surgery?* American Journal of Physical Anthropology 160(4), 2016, 665–682.

Gurven *et al.* 2010 M. Gurven, M. Borgerhoff Mulder, P. L. Hooper, H. Kaplan, R. Quinlan, R. Sear, S. Bowles, E. Schniter, C. von Rueden, T. Hertz, A. Bell, *Domestication Alone Does Not Lead to Inequality: Intergenerational Wealth Transmission among Horticulturalists*. Current Anthropology 51(1), 2010, 49–64.

Haak *et al*. 2015 W. Haak, I. Lazaridis, N. Patterson, N. Rohland, S. Mallick, B. Llamas, G. Brandt, S. Nordenfelt, E. Harney, K. Stewardson, Q. Fu, A. Mittnik, E. Bánffy, C. Economou, M. Francken, S. Friederich, R. G. Pena, F. Hallgren, V. Khartanovich, A. Khokhlov, M. Kunst, P. Kuznetsov, H. Meller, O. Mochalov, V. Moiseyev, N. Nicklisch, S. L. Pichler, R. Risch, M. A. Rojo Guerra, C. Roth, A. Szécsényi-Nagy, J. Wahl, M. Meyer, J. Krause, D. Brown, D. Anthony, A. Cooper, K. W. Alt, D. Reich, *Massive Migration from the Steppe Was a Source for Indo-European Languages in Europe.* Nature 522 (7555), 2015, 207–11.

Hansen 2015 S. Hansen, *Pietrele— A Lakeside Settlement, 5200–4250 BC*. In: S. Hansen, P. Raczky, A. Reingruber (eds.), Neolithic and Copper Age between the Carpathians and the Aegean Sea. Chronologies and Technologies from the 6th to the 4th Millennium BC. Bonn 2015, 273–293.

Hansen *et al.* 2019 S. Hansen, I. Montero-Ruiz, S Rovira, D. Steiniger, M. Toderaș, *The Earliest Lead Ore Processing in Europe. 5th Millennium Finds from Pietrele on the Lower Danube.* PLoS ONE 14(4), 2019, e0214218.

Harney *et al*. 2021a É. Harney, N. Patterson, D. Reich, J. Wakeley, *Assessing the Performance of qpAdm: A Statistical Tool for Studying Population Admixture*. Genetics 217(4), 2021, doi: 10.1093/genetics/iyaa045.

Harney *et al*. 2021b É. Harney, O. Cheronet, D. M. Fernandes, K. Sirak M. Mah, R. Bernardos, N. Adamski, N. Broomandkhoshbacht, K. Callan, A. M. Lawson, J. Oppenheimer, K. Stewardson, F. Zalzala, A. Anders, F. Candilio, M. Constantinescu, A. Coppa, I. Ciobanu, J. Dani, Z. Gallina, F. Genchi, E. Gyöngyvér Nagy, T. Hajdu, M. Hellebrandt, A. Horváth, Á. Király, K. Kiss, B. Kolozsi, P. Kovács, K. Köhler, M. Lucci, I. Pap, S. Popovici, P. Raczky, A. Simalcsik, T. Szeniczey, S. Vasilyev, C. Virag, N. Rohland, D. Reich, R. Pinhasi, *A Minimally Destructive Protocol for DNA Extraction from Ancient Teeth*. Genome Research 31, 2021, 1–12.

Heeb 2014 J. M. Heeb, *Copper Shaft-Hole Axes and Metallurgy in South-Eastern Europe: An Integrated Approach*. Oxford 2014.

Hoekman-Sites, Giblin 2012 H. A. Hoekman-Sites, J. L. Giblin, *Prehistoric Animal Use of the Great Hungarian Plain: A Synthesis of Isotope and Residue Analyses from the Neolithic and Copper Age*. Journal of Anthropological Archaeology 31(4), 2012, 515–527.

Hofmanová 2016 Z. Hofmanová, *Palaeogenomic and Biostatistical Analysis of Ancient DNA from Mesolithic and Neolithic Skeletal Remains.* PhD Dissertation. Johannes Gutenberg University Mainz 2016.

Honch *et al.* 2013 N. Honch, T. Hingham, J. Chapman, B. Gaydarska, H. Todorova, V. Slavchev, Y. Yordanov, B. Dimitrova, *West Pontic Diets: A Scientific Framework for Understanding the Durankulak and Varna I Cemeteries, Bulgaria*. Interdisciplinaria Archaeologica 4(2), 2013, 147–162.

Höppner *et al.* 2005 B. Höppner, M. Bartelheim, M. Huijsmans, R. Krauss, K.-P. Martinek, E. Pernicka, R. Schwab, *Prehistoric Copper Production in the Inn Valley (Austria), and the Earliest Copper in Central Europe.* Archaeometry 47(2), 2005, 293–315.

Kienlin 2016 — T. L. Kienlin, *Some Thoughts on Evolutionist Notions in the Study of Early Metallurgy*. In: M. Bartelheim, B. Horejs, R. Krauß (eds.), Von Baden bis Troia. Ressourcennutzung, Metallurgie und Wissenstransfer. Rahden 2016, 123–137.

Kovács 2013 — K. Kovács, *Late Neolithic Exchange Networks in the Carpathian Basin*. In: A. Anders, G. Kulcsár (eds.), Moments in Time. Budapest 2013, 385–400.

Kranton 1996a — R. E. Kranton, *The Formation of Cooperative Relationships*. Journal of Law, Economics, and Organization 12(1), 1996, 214–233.

Kranton 1996b — R. E. Kranton, *Reciprocal Exchange: A Self-Sustaining System*. The American Economic Review 86(4), 1996, 830–851.

Krzewińska *et al*. 2018 — M. Krzewińska, Kılınç, G.M., Juras, A., Koptekin, D., Chyleński, M., Nikitin, A.G., Shcherbakov, N., Shuteleva, I., Leonova, T., Kraeva, L., Sungatov, F.A., Sultanova, A.N., Potekhina, I., Łukasik, S., Krenz-Niedbała, M., Dalén, L., Sinika, V., Jakobsson, M., Storå, J., A. Götherström, *Ancient Genomes Suggest the Eastern Pontic-Caspian Steppe as the Source of Western Iron Age Nomads*. Science Advances 4(10), 2018, eaat4457. doi: 10.1126/sciadv.aat4457.

Lazăr *et al.* 2017 — C. Lazăr, A. Bălășescu, I. Crăciunescu, C. Covătaru, M. Danu, A. Darie, M. Dimache, O. Frujină, M. Golea, C. Haită, T. Ignat, B. Manea, M. Mărgărit, V. Opriș, V. Radu, T. Sava, G. Sava, D. Ștefan, G. Vasile, *Gumelnița: Then and Now. The research results of the 2017 fieldwork*. Studii de Preistorie 14, 2017, 19-174.

Lazarovici *et al*. 2015 — G. Lazarovici, C. M. Lazarovici, B. Constantinescu, *New Data and Analyses on Gold Metallurgy During the Romanian Copper Age*. In: S. Hanson, P. Raszky, A. Ander, A. Reingruber (eds.), Neolithic and Copper Age Between the Carpathian and the Aegean Sea. Bonn 2015, 325–352.

Leusch *et al.* 2015 — V. Leusch, B. Armbruster, E. Pernicka, V. Slavčev, *On the Invention of Metallurgy: The Gold Objects from the Varna I Cemetery (Bulgaria) —Technological Consequence and Inventive Creativity.* Cambridge Archaeological Journal 25(1), 2015, 353–376.

Lipson *et al*. 2017 — M. Lipson, A. Szécsényi-Nagy, S. Mallick, A. Pósa, B. Stégmár, V. Keerl, N. Rohland, K. Stewardson, M. Ferry, M. Michel, J. Oppenheimer, N. Broomandkhoshbacht, E. Harney, S. Nordenfelt, B. Llamas, Gusztáv, B. G. Mende, K. Köhler, K. Oross, M. Bondár, T. Marton, A. Osztás, J. Jakucs, T. Paluch, F. Horváth, P. Csengeri, J. Koós, K. Sebők, A. Anders, P. Raczky, J. Regenye, J. P. Barna, S. Fábián, G. Serlegi, Z. Toldi, E. Gyöngyvér Nagy, J. Dani, E. Molnár, G. Pálfi, L. Márk, B. Melegh, Z. Bánfai, L. Domboróczki, J. Fernández-Eraso, J. A. Mujika-Alustiza, C. Alonso Fernández, J. Jiménez Echevarría, R. Bollongino, J. Orschiedt, K. Schierhold, H. Meller, A. Cooper, J. Burger, E. Bánffy, K. W. Alt, C. Lalueza-Fox, W. Haak, D. Reich, *Parallel Palaeogenomic Transects Reveal Complex Genetic History of Early European Farmers*. Nature 551(7680), 2017, 368–372.

Luca 1999 — S. A. Luca, *Sfârșitul Eneoliticului pe Teritoriul Intracarpatic al României – Cultura Bodrogkeresztur.* Alba Iulia, 1999.

Luca 2000 — S. A. Luca, *Répertoire des découvertes de la culture Bodrogkeresztur sur le territoire de Roumanie*. Cercetari Arheologice 11(1), 2000, 305–316.

Łukasik *et al*. 2017 — S Łukasik, J. Bijak, M. Krenz-Nieblała, G. Lubińska, V. Sinika, J. Piontek, *Warriors Die Young: Increased Mortality in Early Adulthood of Scythians from Glinoe, Moldova, Fourth through Second Centuries BC*. Journal of Anthropological Research 2017, 73(4), 584–616.

Marciniak *et al*. 2021 — S. Marciniak, C. M. Bergey, A. M. Silva, A. Hałuszko, M. Furmanek, B. Veselka, P. Velemínský, G. Vercellotti, J. Wahl, G. Zariņa, Cristina Longhi, Jan Kolář, Rafael Garrido-Pena, Raúl Flores-Fernández, A. M. Herrero-Corral, A. Simalcsik, W. Müller, A. Sheridan, Ž. Miliauskienė, R. Jankauskas, V. Moiseyev, K. Köhler, Á. Király, B. Gamarra, O. Cheronet, V. Szeverényi, V. Kiss, T. Szeniczey, K. Kiss, Z. K. Zoffmann, J. Koós, M. Hellebrandt, L. Domboróczki, C. Virag, M. Novak, D. Reich, T. Hajdu, N. von Cramon-Taubadel, R. Pinhasi, G. H. Perry, *An integrative skeletal and paleogenomic analysis of prehistoric stature variation suggests relatively reduced health for early European farmers.* Biorxiv preprint, 2021, https://doi.org/10.1101/2021.03.31.437881.

Mareș 2002 — I. Mareș, *Metalurgia Aramei in Eno-Eneoliticul Romaniei*. Suceava 2002.

Mărgărit *et al*. 2020 — M. Mărgărit, A. Diaconu, C. Virag, *Were Personal Adornments Just for Women? The Case of the Eneolithic Necropolis from Urziceni-Vamă (Satu Mare County, Romania)*. In: M. Mărgărit, A. Boroneanț (eds.), Beauty and the Eye of the Beholder: Personal Adornments Across the Millennia. Tărgoviște 2020, 399–412.

Mathieson *et al*. 2018 — I. Mathieson, S. Alpaslan-Roodenberg, C. Posth, A. Szécsényi-Nagy, N. Rohland, S. Mallick, I. Olalde, N. Broomandkhoshbacht, F. Candilio, O. Cheronet, D. Fernandes, M. Ferry, B. Gamarra, G. G. Fortes, W. Haak, E. Harney, E. Jones, D. Keating, B. Krause-Kyora, I. Kucukkalipci, M. Michel, A. Mittnik, K. Nägele, M. Novak, J. Oppenheimer, N. Patterson, S. Pfrengle, K. Sirak, K. Stewardson, S. Vai, S. Alexandrov, K. W. Alt, R. Andreescu, D. Antonović, A. Ash, N. Atanassova, K. Bacvarov, M. B. Gusztáv, H. Bocherens, M. Bolus, A. Boroneanţ, Y. Boyadzhiev, A. Budnik, J. Burmaz, S. Chohadzhiev, N. J. Conard, R. Cottiaux, M. Čuka, C. Cupillard, D. G. Drucker, N. Elenski, M. Francken, B. Galabova, G. Ganetsovski, B. Gély, T. Hajdu, V. Handzhyiska, K. Harvati, T. Higham, S. Iliev, I. Janković, I. Karavanić, D. J. Kennett, D. Komšo, A. Kozak, D. Labuda, M. Lari, C. Lazar, M. Leppek, K. Leshtakov, D. L. Vetro, D. Los, I. Lozanov, M. Malina, F. Martini, K. McSweeney, H. Meller, M. Menđušić, P. Mirea, V. Moiseyev, V. Petrova, T. D. Price, A. Simalcsik, L. Sineo, M. Šlaus, V. Slavchev, P. Stanev, A. Starović, T. Szeniczey, S. Talamo, M. Teschler-Nicola, C. Thevenet, I. Valchev, F. Valentin, S. Vasilyev, F. Veljanovska, S. Venelinova, E. Veselovskaya, B. Viola, C. Virag, J. Zaninovićm, S. Zäuner, P. W. Stockhammer, G. Catalano, R. Krauß, D. Caramelli, G. Zariņa, B. Gaydarska, M. Lillie, A. G. Nikitin, I. Potekhina, A. Papathanasiou, D. Borić, C. Bonsall, J. Krause, R. Pinhasi, D. Reich. 2018. *The Genomic History of Southeastern Europe*. Nature 555 (7695): 197–203.

Mittnik *et al.* 2019 — A. Mittnik, K. Massy, C. Knipper, F. Wittenborn, R. Friedrich, S. Pfrengle, M. Burri, N. Carlichi-Witjes, H. Deeg, A. Furtwängler, M. K. Harbeck. C. von Heyking. Kociumaka, I. Kucukkalipci, S. Lindauer, S. Metz, A. Staskiewicz, A. Thiel, J. Wahl, W. Haak, E. Pernicka, S. Schiffels, P. W. Stockhammer, J. Krause, *Kinship-Based Social Inequality in Bronze Age Europe.* Science. 366(6466), 2019, 731–734.

Nisbet 2009 — R. Nisbet, *New Evidence of Neolithic and Copper Age Agriculture and Wood Use in Transylvania and the Banat (Romania).* In: F. Drașovean, D. L. Ciobotaru, M. Maddison (eds.), Ten Years after: The Neolithic of the Balkans, as Uncovered by the Last Decade of Research. Timișoara 2009, 167–177.

Papac *et al.* 2021 — L. Papac, M. Ernée, M. Dobeš, M. Langová, A. B. Rohrlach, F. Aron, G. U. Neumann, M. A. Spyrou, N. Rohland, P. Velemínský, M. Kuna, H. Brzobohatá, B. Culleton, D. Daněček, A. Danielisová, M. Dobisíková, J. Hložek, D. J. Kennett, J. Klementová, M. Kostka, P. Krištuf, M. Kuchařík, J. K. Hlavová, P. Limburský, D. Malyková, L. Mattiello, M. Pecinovská, K. Petriščáková, E. Průchová, P. Stránská, L. Smejtek, J. Špaček, R. Šumberová, O. Švejcar, M. Trefný, M. Vávra, J. Kolář, V. Heyd, J. Krause, R. Pinhasi, D. Reich, S. Schiffels, W. Haak, *Dynamic changes in genomic and social structures in third millennium BCE central Europe*. Science Advances 7(35), 2021, doi: 10.1126/sciadv.abi6941. PMID: 34433570.

Pătroi 2006a — C. N. Pătroi, *Metalurgia Cuprului in Cadrul Complexului Cultural Eneolitic Sălcuța-Bubanj-Krivodol*. Drobeta 16, 2006a, 89–112.

Pătroi 2006b — C. N. Pătroi, *Realități Culturale în Neolithicul Târziu din Oltenia în Contextul Primelor Influențe Stepice din Zona Nord Pontică*. Revista Romana de Studii Eurasiatice 2(1), 2006b, 9–21.

Pătroi 2010 — C. N. Pătroi, *The Gumelnițian Character of the Eneolithic Culture Sălcuța*. Oltenia. Studii și Communicari. Arheologie-Istorie 22, 2010, 7–12.

Pătroi 2013 — C. N. Pătroi, *About the Sălcuța Eneolithic Culture*. Annales de l'Université Valahia Tărgoviște, Section d'archéologie et d'histoire 15(1), 2013, 117–140.

Pătroi 2018 — C. N. Pătroi, *O Completare la catalogul de așezari și descoperiri aparținând culturii eneolitice Sălcuța*. Oltenia. Studii și Communicării. Arheologie-Istorie 25, 2018, 9–68.

Patterson *et al.* 2012 — N. Patterson, P. Moorjani, Y. Luo, S. Mallick, N. Rohland, Y. Zhan, T. Genschoreck, T. Webster, D. Reich, *Ancient Admixture in Human History*. Genetics. 192(3), 2012, 1065–93.

Peterson *et al*. 2016 D. L. Peterson, P. Northover, C. Salter, B. Maldonado, D. W. Anthony, *Bronze Age Metallurgy in the Middle Volga*. In: D. W. Anthony, D. R. Brown, A. A. Khokhlov, P. F. Kuznetsov, O. D. Mochalov (eds.), A Bronze Age Landscape in the Russian Steppes: The Samara Valley Project. Los Angeles 2016, 291–332.

Radivoievič, Rehren 2016 M. Radivoievič, T. Rehren, *Paint It Black: The Rise of Metallurgy in the Balkans*. Journal of Archeological Method and Theory 23, 2016, 200–237.

Radu 2002 A. Radu, *Cultura Sălcuța în Banat*. Reșița 2002.

Raghavan *et al.* 2013 M. Raghavan, P. Skoglund, K. E. Graf KE, M. Metspalu, A. Albrechtsen, I. Moltke, S. Rasmussen, T. W. Stafford Jr, L. Orlando, E. Metspalu, M. Karmin, K. Tambets, S. Rootsi, R. Mägi, P. F. Campos, E. Balanovska, O. Balanovsky, E. Khusnutdinova, S. Litvinov, L. P. Osipova, S. A. Fedorova, M. I. Voevoda, M. DeGiorgio, T. Sicheritz-Ponten, S. Brunak, S. Demeshchenko, T. Kivisild, R. Villems, R. Nielsen, M. Jakobsson, E. Willerslev, *Upper Palaeolithic Siberian genome reveals dual ancestry of Native Americans.* Nature 505(7481), 2013, 87–91.

Regenye 2020 J. Regenye, *Early Copper Age in Western Hungary: The Case of Lengyel Culture's Latest Phase in Central Transdanubia*. In: C. Gutjahr, G. Tiefengraber (eds.), Beiträge zur Kupferzeit am Rande der Südostalpen. Rahden 2020, 11–22.

Reingruber 2015 A. Reingruber, *Absolute and Relative Chronologies in the Lower Danube Area during the 5th Millenium BC*. In: S. Hansen, P. Raczky, A. Anders, A. Reingruber (eds.), Neolithic and Copper Age between the Carpathians and the Aegean Sea: Chronologies and Technologies from the 6th to 4th Millennium BCE. Bonn 2015, 301–24.

Ringbauer *et al.* 2020 H. Ringbauer, J. Novembre, M. Steinrücken, *Human Parental Relatedness through Time-Detecting Runs of Homozygosity in Ancient DNA*. BioRxiv preprint 2020. https://doi.org/10.1101/2020.05.31.126912.

Roman 1971 P. I. Roman, *Strukturäderungen des Endäneolithikums im Donau-Karpaten-Raum*. Dacia 15, 1971, 31–161.

Roman 1973 P. I. Roman, *Modificări Structurale ale Culturilor Eneoliticul Final din Regiunea Carpato-Danubiană.* Banatica 2, 1973, 57–77.

Rowlands 1971 M. J. Rowlands, *The Archaeological Interpretation of Prehistoric Metalworking*. World Archaeology 3(2), 1971, 210–224.

Sakalauskaite *et al*. 2019 J. Sakalauskaite, S. H. Andersen, P. Biagi, M. A. Borrello, T. Cocquerez, A. C. Colonese, F. Dal Bello, A. Girod, M. Heumüller, H. Koon, G. Mandili, C. Medana, K. E. Penkman, L. Plasseraud, H. Schlichtherle, S. Taylor, C. Tokarski, J. Thomas, J. Wilson, F. Marin, B. Demarchi, *'Palaeoshellomics' reveals the use of freshwater mother-of-pearl in prehistory.* Elife 2019, May 7; 8:e45644. doi: 10.7554/eLife.45644.

Sava 2015 V. Sava. *Neolithic and Eneolithic in the Lower Mureș Basin*. Cluj-Napoca 2015.

Scharl 2016 S. Scharl, *Patterns of Innovation Transfer and the Spread of Copper Metallurgy to Central Europe.* European Journal of Archaeology 19(2), 2016, 215–244.

Scheiner *et al.* 2012 M. Scheiner. V. Heyd, E. Pernicka, *Kupferzeitliches Metall in der Westslowakei*. In: R. Kujovský, V. Mitáš (eds.), Václav Furmánkek a doba bronzová. Zborník k sedemde-siatym narodeninám. Nitra 2004, 355–366.

Siklósi 2004 Z. Siklósi, *Prestige Goods in the Neolithic of the Carpathian Basin – Material Manifestations of Social Differentiation*. Acta Archaeologica Academiae Scientiarum Hungaricae 2004, 55, 1–62.

Siklósi, Szilágyi 2021 S. Siklósi, M. Szilágyi, *Culture, Period or Style? Reconsideration of Early and Middle Copper Age Chronology of the Great Hungarian Plain*. Radiocarbon 63(2), 2021, 585–646.

Šiška 1964 S. Šiška, *Pohrebiska tisapolgaresky kultúry Tibava*. [The Burial Ground of the Tiszapolgár Culture of Tibava] Slovenska Archeologia 12(2), 1964, 293–356.

Strahm 2005 C. Strahm, *L'Introduction et la diffusion de la métallurgie en France*. In: P. Ambert, J. Vaquer (eds.), La Première métallurgie en France et dans les pays limitrophes. Paris 2005, 27–36.

Strahm 2007 C. Strahm, *L'Introduction de la métallurgie en Europe*. In: J. Guilaine (ed.), Le Chalcolithique et la construction des inégalités, tome 1: Le Continent européen. Arles, 2007, 49–71.

Szücs-Csillik, Virag 2016 I. Szücs-Csillik, C. Virag, *The Orientation of the Dead at Urziceni Necropolis*. In: D. Micle, A. Stavila, C. Oprean, S. Fortiu, (eds.), ArheoVest IV, Vol. 2. Szeged 2006, 591–599.

Vicas 2021 A. Vicas, *Mining Data on the Spread of Early Metallurgy: Revisiting the Carpathian Hypothesis with Ancient Genomes*. Studia Antiqua et Archaeologica 26(2), 2021, 149–168.

Voinea 2005 V. Voinea, *Ceramica Complexului Cultural Gumelnița-Karanovo VI: Fazele A1 și A2*. Constanța 2005.

Wailes 1996 B. Wailes, *V. Gordon Childe and the Relations of Production*. In: B. Wailes (ed.), Craft Specialization and Social Evolution: In Memory of V. Gordon Childe. Philadelphia, 1996, 3–14.

Zalai-Gaál 1996 I. Zalai-Gaál, *Die Kupferfunde der Lengyel-Kultur im südlichen Transdanubien*. Acta Archaeologica Academiae Scientiarum Hungaricae 48, 1996, 1–39.

Abbreviations

AEM	Archäologisch-epigraphische Mitteilungen aus Österreich-Ungarn, Vienna.
AM	Arheologia Moldovei, Iași.
AMN	Acta Musei Napocensis, Cluj-Napoca.
AMP	Acta Musei Porolissensis, Zalău.
AMV	Acta Musei Varnaensis, Varna.
Angustia	Angustia. Revista Muzeului Național al Carpaților Răsăriteni, Sf. Gheorghe.
Anuarul MJIAP (S.N.)	Anuarul Muzeului de Istorie și Arheologie Prahova, Serie Nouă, Ploiești.
Antiquity	Antiquity. A review of world archaeology, Durham.
Archaeological Journal	Archaeological Journal. New Series. Chișinău.
ArchÉrt	Archaeologiai Értesitő, Budapest.
ArchPol	Archaeologia Polona, Warsaw.
ArchRozhledy	Archeologické Rozhledy, Praha.
ASM	Archaeologica Slovaca Monographiae, Bratislava.
BAR (Int. S.)	British Archaeological Reports (International Series), Oxford.
Biharea	Biharea. Culegere de studii și materiale de etnografie și artă, Oradea.
BMG	Bibliotheca Musei Giurgiuvensis, Giurgiu.
BMJT	Buletinul Muzeului Județean Teleorman. Seria Arheologie, Alexandria.
BMM	Bibliotheca Musei Marisiensis, Târgu Mureș.
Budapest Régiségei	Budapest Régiségei Régészeti és Történeti Évkönyv. Budapest.
CA București	Cercetări arheologice în București, București.
CCA	Cronica Cercetărilor Arheologice, București.
CIL	Corpus Inscriptionum Latinarum, Berlin.
CsSzMÉ	A Csíki Székely Múzeum Évkönyve. Csíkszereda.
Dacia (N.S.)	Dacia. Revue d'archéologie et d'histoire ancienne. Nouvelle serie. Bucureşti.
Dolgozatok	Dolgozatok a Magyar Királyi Ferencz József Tudományegyetem Archaeológiai Intézetéből. Szeged.
EphNap	Ephemeris Napocensis, Cluj-Napoca.
Erdély	Erdély. Turistai, fürdőügyi és néprajzi folyóirat, Cluj-Napoca.
FontArchPrag	Fontes Archaeologici Pragenses, Prague.
Földtközl.	Földtani közlöny, Budapest.
HOMÉ	A Herman Ottó Muzeum Ėvkönyve, Miskolc.
ILD	C. C. Petolescu, *Inscripții latine din Dacia*, Bucharest 2005.
JAHA	Journal of Ancient History and Archaeology, Cluj-Napoca.
Jahrb. RGZM	Jahrbuch des Römisch Germanischen Zentralmuseums zu Mainz, Mainz.
JAMÉ	Jósa András Múzeum Évkönyve, Nyiregyháza.
Karpatika	Karpatika, Uzhorod.
LMI	List of Historic Monuments, updated 2015.
Marisia	Marisia. Studies and Materials. Archeology. Târgu-Mureș.
MCA (S.N.)	Materiale și Cercetări Arheologice Serie Nouă. București
MemAntiq	Memoria Antiquitatis, Piatra Neamț.
NNA	Nordisk Numismatisk Årsskrift, Stockholm.
PAS	Prähistorische Archäologie in Südosteuropa, Rahden/Westf.
PAT	Patrimonium Archaeologicum Transylvanicum, Cluj-Napoca.
Paléo	PALEO – Revue d'archéologie préhistorique, Les Eyzies-de-Tayac-Sireuil.
Pallas	Pallas. Revue d'études antiques, Toulouse.

PNAS	Proceedings of the National Academy of Sciences of the United States of America, Washington.
PZ	Prähistorische Zeitschrift. Berlin.
RAN	National Archaeological Repertory.
RM	Revista Muzeelor, București.
Sargetia	Sargetia. Acta Musei Devensis, Deva.
SatuMareSC	Satu Mare Studii și Comunicări, Satu Mare.
SCIV(A)	Studii şi Cercetări de Istorie Veche şi Arheologie, Bucureşti.
SCȘMI	Studii și Comunicări Științifice ale Muzeelor de Istorie, București.
SIB	Studii de Istorie a Banatului, Timişoara.
SlovArch	Slovenská archeológia, Nitra.
SP	Studii de Preiostorie, București.
St.Cerc.Antropol.	Studii și Cercetări de Antropologie, București.
StudUBB-G	Studia Universitatis Babeș-Bolyai. Seria Geologia, Cluj-Napoca.
ZborníkSlovNMA	Zborník Slovenského Národného Múzea. Archeológia, Bratislava.
ZSA	Ziridava. Studia Archaeologica, Arad.
ИАИ	Известия на Археолигическия Институт при БАН, София.