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Participants of THE FLOW Conference at Viminacium.



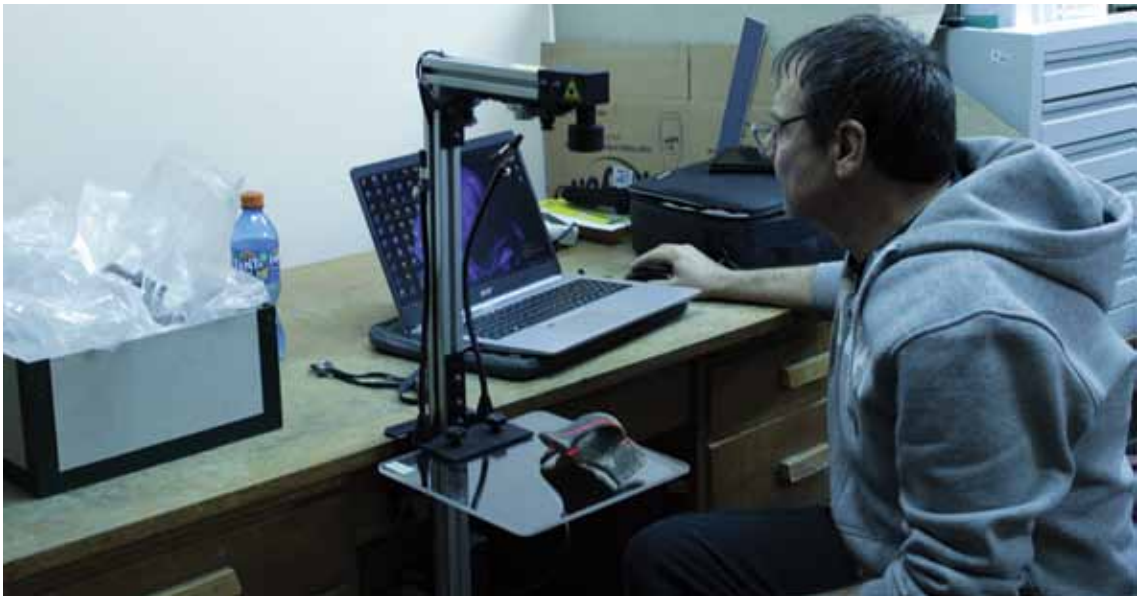
The Kick-Off meeting, presenting the background of the project.



Meeting at the Science Fund of the Republic of Serbia.

The background of **THE FLOW** project developed through individual and coauthored works and publications by its team members. In a sense, each of the team members focused their studies on the subjects of mutual connections between communities of the Metal Ages in the Central Balkans, with particular attention on the origin and circulation of different raw materials, and various forms of material culture. The project officially started in 2022, since it was approved and funded by the Science Fund of the Republic of Serbia, Grant No. 7750074.

The project was imagined as a multidisciplinary collaboration between three institutions, the Institute of Archaeology in Belgrade, Vinča Institute of Nuclear Sciences, and the University of Belgrade - Faculty of Philosophy. The members of the team were gathered together with the idea to optimise the realisation of the project, based on the researchers' fields of study and previous successful mutual collaboration. The principal investigator of the project was Dr. Aleksandar Bulatović (Institute of Archaeology), and the team members were Dr. Aleksandar Kapuran (Institute of Archaeology), Dr. Vojislav Filipović (Institute of Archaeology), Dr. Maja Gajić Kvaščev (Vinča Institute of Nuclear Sciences), Dr. Marija Ljuština (Faculty of Philosophy, University of Belgrade), Dr. Ognjen Mladenović (Institute of Archaeology), Dr. Petar Milojević (Institute of Archaeology),[1] and Dr. Bogdana Milić (Spanish National Research Council, Barcelona)[2]



Pottery sampling, Museum of Mining and Metallurgy in Bor.

The long-distance connections between Copper and Bronze Age communities in the Central Balkans were recognized by the team members as one of the key issues regarding the studies of mobility and migrations in the later prehistory of Europe. One of

[1] At the time, both Ognjen Mladenović and Petar Milojević were enrolled in PhD Studies at the University of Belgrade - Faculty of Philosophy, and mentored by Dr. Marija Ljuština, also a team member.

[2] At the time Dr. Bogdana Milić was affiliated to the Institute for Oriental and European Archaeology, Vienna.

the issues was the traditional interpretation of the so-called "imports" or foreign objects and raw materials based solely on their stylistic and typological characteristics. Hence, **THE FLOW** project aimed to apply a multidisciplinary research framework on such objects through cutting-edge methods of archaeological science, with a particular focus on provenance studies, spatiotemporal distribution, and the analyses of networks between prehistoric communities. The project was based on a diachronic perspective, covering



Regular meetings of the project team.



Team members at the International Workshop in Vienna.

the period between the mid-5th to the end of the 2nd millennium BCE, or the Copper and Bronze Age in the Central Balkans. The design of the project was based on four complementary case studies, based on artifacts made of copper, obsidian, ceramics, and bronze, in order to evaluate the complex links between production based on locally available raw materials and imported objects/raw materials from other regions.

Through previous research and studies of its team members, **THE FLOW** project had access to various data from a number of well-documented and key archaeological sites for the Copper and Bronze Age in the Central Balkans. Such direct access to a variety of artifacts gave the project the opportunity to revise traditional archaeological and



Sampling of copper axes for isotope analyses, National Museum in Šabac.



Sampling of ceramic vessels from the site of Velika Humska Čuka.

anthropological theoretical frameworks regarding the long-distance connections and offer new models of interactions between prehistoric communities of Southeastern and Central Europe, from the Central Balkans perspective. Some of the main results of the project are distribution maps of targeted artifacts for each of the studied periods, a database of absolute dates, a database of various archaeometric results, and diachronic spatiotemporal models.

During the project duration, the team collected samples and analyzed more than



Taking first steps in magnetometry.

400 pieces of pottery, 90 copper artifacts, 225 bronze artifacts, 35 obsidian artifacts, and 25 deposits of clay and copper in the territory of Serbia. The analyzed artifacts originate from 158 sites, and the team members visited and collaborated with 12 museums. Additionally, the project resulted in 30 new AMS dates and 11 OSL dates.

The dissemination of the project background, methodology, and results was conducted throughout the project duration. In the last 33 months, the team members published 3 articles in international peer-reviewed journals and 3 articles in national peer-



Sampling clay pits in Northeastern Serbia.

reviewed journals. Further, the results of the project were to a certain extent incorporated into 3 monographs and 2 PhD theses. The project was also presented at international conferences, workshops, and fairs in Belgrade, Brugges, Lisbon, Athens, Belfast, Vienna, Barcelona, and Varna, and two national conferences in Prokuplje and Niš.

Besides the scientific results of the project, which are partially published in this volume, **THE FLOW** project acquired several pieces of state-of-the-art equipment that will serve as a solid base for our future research. *The Olympus BTX II Compact Benchtop*



Team members at the 29th EAA Annual Meeting in Belfast, Northern Ireland.

XRD is a portable and compact device designed for precise mineralogical analyses. It has a wide array of applications, of which the most important is its potential to identify and quantify crystalline phases within geological samples. The device has a solid application in pottery provenance analyses, as demonstrated through the analyses conducted as a part of **THE FLOW** project. For testing the nature and magnetic characteristics of potential clay pits in the vicinity of archaeological sites, the project acquired the *Bartington Flux-gate gradiometer Grad601*. It is an instrument that is commonly used in archaeology for detecting variations in the magnetic field. Its high sensitivity and portability make it an elementary tool for non-invasive research, ideal for detecting archaeological features. So

far, the application of the instrument provided outstanding results on a number of projects conducted by the Institute of Archaeology in Belgrade.

The unexpected, yet major result of the project is the establishment of the **VinArh** Center for Archaeometry in 2024, by the Institute of Archaeology and the Vinča Institute of Nuclear Sciences. It was formed with the idea of becoming an accredited interdisci-



Sampling of copper axes, National Museum in Užice.



Team meeting at the Institute of Archaeology.

plinary Center of Excellence, which would conduct wide-scale research and support the works of colleagues from institutions for the protection and study of cultural heritage. Currently, the center offers various analytical services to the archaeological community and encourages the integration of scientific methods into the study of different aspects of cultural heritage. The **VinArh** Center currently possesses an EDXRF spectrometer, XRD instrument, FTIR instrument, instruments for Gamma-ray spectrometry, high-quality stereo and digital microscopes, and professional UV laps with various wavelengths. Further, the **VinArh** Center possesses a reference collection of clay samples, that is being used for the pottery provenance analyses. The analytical techniques conducted at the Center are



In search for pigments.

focused on the analyses of archaeological materials, such as pottery, metals, stone, and various pigments, with a goal of identifying the origin of raw materials, provenance, and production technologies. The acquisition of new state-of-the-art equipment, as a novelty in the region, is planned in the near future.

Our final step was the organization of the international conference that would gather scholars from different disciplines, institutions, and countries, in order to exchange the most recent results and ideas in the fields of archaeometry, archaeological materials and settlement patterns, metal transmission and communication networks, and general interactions, transmission and transformations in the societies during the Metal Ages. The international conference *Interactions-Transmission-Transformation: Long-distance Connections in Metal Ages of South-eastern Europe* was held at the Domvs Scientarivm of the archaeological site of Viminacium, from the 31st of October to the 3rd of November 2024. Parallel to the conference, colleagues had a chance to attend LANTERNA II, an



THE FLOW project at the International Fair of Technics and Technical Achievements.



Presenting at the Kick-Off meeting.

archaeometry conference co-organized by the Academy of Arts, University of Novi Sad. The conference gathered scholars from Austria, Bulgaria, Croatia, Germany, Greece, Hungary, Italy, North Macedonia, Poland, Romania, Serbia, Slovenia, the United Kingdom and the United States of America.

The presentations at the conference, published in this volume and complemented by a number of completely new, thematically related studies, provided

a fresh insight into the results of implementing new research techniques, state-of-the-art theoretical approaches, and interpretations, establishing new and consolidating already recognized networks of trade and exchange. A significant number of case studies - on specific categories of artifacts and their archaeological contexts, different raw materials, and deposits - provided a solid base for research into past economic systems and their agents.

Last but not least, we would like to thank our colleagues, friends, and associates for fruitful collaboration during the realization of the project.

THE FLOW team



Preparing the samples for pottery provenance analyses.

Late Bronze and Early Iron Age metal depositions in northeastern Serbia – archaeometallurgical perspective

Mario Gavranović[1]
Mathias Mehofer[2]
Aleksandar Kapuran[3]
Dragan Jacanović[4]

Abstract: In this paper, we present and discuss the results of archaeometallurgical analyses (ED-XRF and Lead Isotope Analysis) on metal objects from several hoards from northeastern Serbia dating to different periods, including Topolnica and Urovica (BA D–Ha A1), Bradarac, Bradarac-Rukumija and Stari Kostolac- Mali Grad (Ha A1), Alun, Brza Palanka, Leskovo and Vojilovo (Ha A2–Ha B1) and Stari Kostolac-Leštar and Živica (Ha C1). The area along the Danube River Gorge stands out as one of the very few European microregions with a continuity of metal deposition activities throughout the Late Bronze and Early Iron Ages (13th–8th centuries BC). The deposition of metal hoards additionally highlights the unique character of this landscape and the importance of the Danube Gorge in the prehistoric communication networks. From a diachronic perspective, our analyses revealed different alloy mixtures and provided hints regarding the provenance of copper raw material used for the casting. Currently, there are no data that support the use of nearby abundant local copper deposits in northeastern Serbia during this period.

Key words: metal hoards, northeastern Serbia, Danube Gorge, copper, chemical composition, lead isotope analysis

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Introduction

The frequent deposition of metal hoards in the proximity of bodies of water and, in particular, along the river courses has been the subject of many essential studies dealing with metal deposition phenomena during the later stages of the Bronze Age in central and southeast Europe.[1] In relation to flowing waters, T. Soroceanu noted that hoard finds occur both in the source and mouth areas, as well as along the course of rivers, and he lists numerous examples for the Romanian region.[2] Similar concentrations of Late Bronze Age hoards related to specific sections of a river can also be observed in some areas of the western and central Balkans, such as the region along the Sava near Slavonski Brod,[3] the middle course of the Bosna River,[4] or the valley of the Mlava River in northeastern Serbia, which flows into the Danube a few kilometers north of Viminacium.[5] In most cases, such regional hoard clusters are limited to one or two chronological phases, with a clear focus during the period's BA D–Ha A1, when the practice of metal deposition reached its peak in southeastern Europe.[6]

The hoards discussed here were all found in the broader region of the right bank of the Danube, between the beginning (the mouth of the Mlava, Golubac Gorge) and the end of the Danube Gorge (Iron Gate II) (Fig. 1). Therefore, they can be considered a regional group, spanning over several chronological phases, and thus indicating a continuity of the metal deposition practice over centuries. Besides the nearby Danube River Gorge (Iron Gate), another noteworthy topographical feature is the rich copper deposits located immediately to the south, with the famous site at Rudna Glava as the most prominent spot, whose extraction can be traced back to the early Copper Age.[7] The Late Bronze and Iron Age hoards in northeastern Serbia were often linked to ores, mining, and metal production. However, specific evidence of local metalworking or mining activity for this period (13th to 8th centuries BC) is lacking.[8] As recent studies demonstrated, the copper production in eastern Serbia during the Bronze Age can, based on available radiocarbon data, only be postulated for the period between the 20th and 16th centuries BC, with a cluster of sites around the town of Bor (Trnjane, Ružana, Čoka Njica).[9] Due to the chronological gap, it is hardly possible that the copper produced in the smelting sites around Bor had a significant role in the production of Late Bronze Age objects from discussed hoards. Our previous analyses confirmed that the local copper from eastern Serbia was not substantially fed into the Late Bronze Age raw material networks[10] but was instead used in the Middle Bronze Age.[11]

Also largely missing in northeastern Serbia are traces of local founding or casting workshops, with only a few moulds indicating domestic production.[12] The more numerous finds of Late Bronze Age casting moulds from Pleniţa in adjacent southwestern Romania suggest the existence

[1] Hansen 1994; Soroceanu 1995; Hänsel 1997; König 2004; Váczi 2013; Dietrich 2014; Szabó 2019.

[2] Soroceanu 1995, 15.

[3] Vinski-Gasparini 1973; Miklik-Lozuk 2009; Miklik-Lozuk, Ložnjak Dizdar 2011.

[4] König 2004; Blečić-Kavur, Jašarević 2014; Blečić-Kavur et al. 2019.

[5] Јацановић 1992; Stojić, Jacanović 2008; Gavranović et al. 2024a.

[6] Holste 1951; von Brunn 1968; Garašanin 1975; Vinski-Gasparini 1973; Petrescu-Dîmboviţa 1978; Vasić 1982; Mozsolics 1985; Hansen 1994; Teržan 1995; König 2004.

[7] Jovanović 1982; Borić 2009.

[8] Јацановић 1992; 1997.

[9] Mehofer et al. 2021; Kapuran 2022; Gavranović et al. 2024b.

[10] Gavranović et al. 2022.

[11] Mitrović et al. 2024.

[12] Bulatović 2003; Stojić, Jacanović 2008, 120. 436.

of workshops in the area around the Iron Gates that operated on a regional level.[13] At the present state of research, the option that the majority of metals deposited in northeast Serbia were produced somewhere else should not be excluded. This is also partly supported by the typological assessment showing that many of of the objects are indicative of the Urnfield culture in the Carpathian Basin and in Southeast Europe.

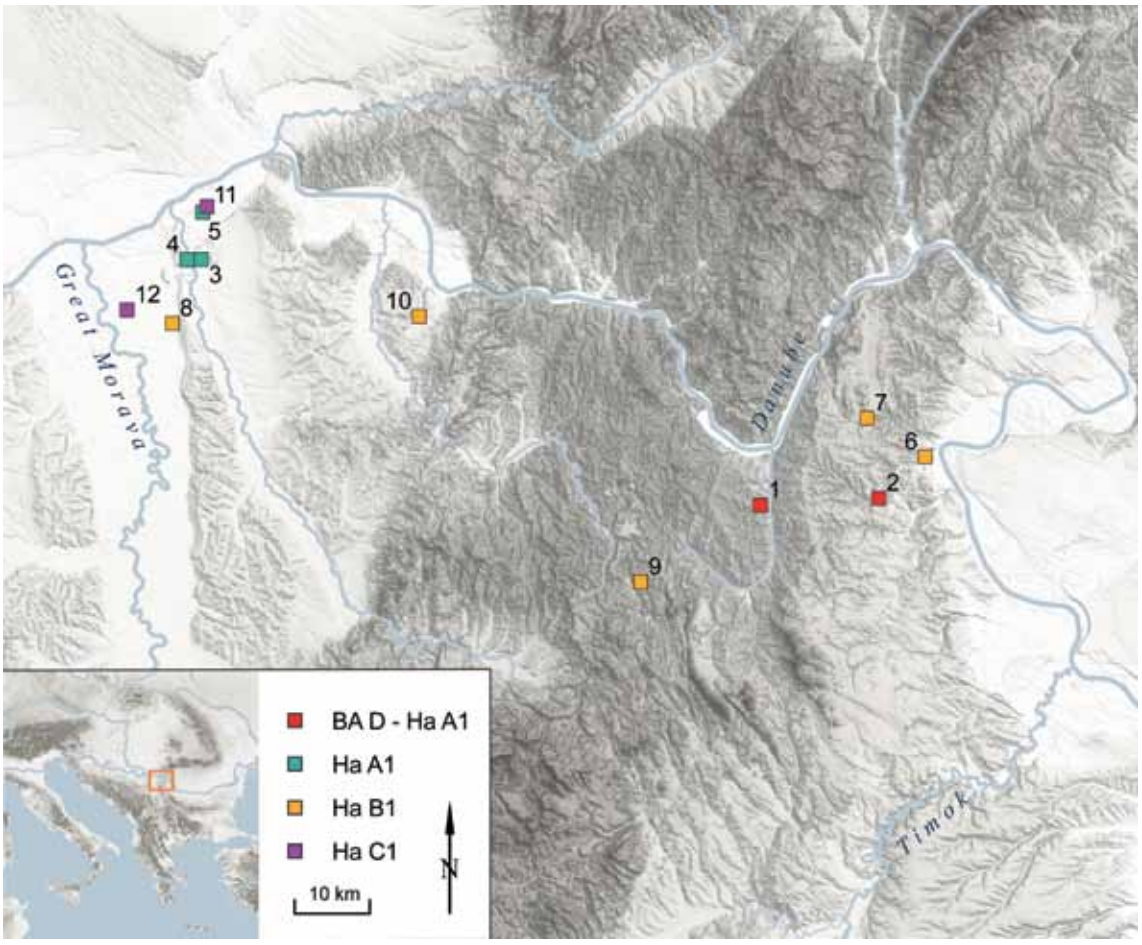


Fig. 1 – Position of the discussed hoards. 1. Topolnica; 2. Urovica; 3. Bradarac; 4. Bradarac-Rukumija; 5. Stari Kostolac-Mali Grad; 6. Alun; 7. Brza Palanka; 8. "Požarevac"; 9. Leskovo; 10. Vojilovo; 11. Stari Kostolac-Leštar; 12. Živica (Map created by I. M. Petschko, Austrian Archaeological Institute).

Materials

In terms of structure, the deposits discussed here reflect well the general regional and supra-regional trends. The find from Topolnica was initially dated to the Ha A2–Ha B1, based on purportedly younger elements (e.g., ornamentation) and the fact that the objects are mostly not fragmented. However, it was also noted that older forms are present.[14] R. Vasić proposed a much earlier dating, referencing some comparable Romanian finds and the decorated spiral bracelets typical of the BA D, and highlighted Topolnica as one of the few finds of his Phase I (BA D–Ha A1).[15] A BA D dating for Topolnica is further supported by similarly structured hoards with

[13] Boroffka, Ridiche 2005; Dietrich 2012.

[14] Јовановић 1970; Јовановић 1975, 86.

[15] Vasić 1982, 278–279.

comparable types (such as flange hilted swords, full-hilt swords of the Riegsee type,[16] long pins, arm spirals of Salgótarján type,[17] and socketed axes[18]) from Bükkaranyos-I, Szécseny-I, Zalkod, Sárospatak, and Viss-III hoards in northeastern Hungary, showing a notable concentration along



Fig. 2 – Analysed metal objects from BA D–Ha A1 hoards. 1–11. Topolnica; 12–23. Urovica. (Museum of Krajina Negotin, Photos: M. Gavranović).

the Tisza River.[19] These finds characterize the so-called Aranyos Horizon, which is contemporary to the BA D stage. Hence, the dating of the Topolnica hoard in Ba D seems very likely. The Urovica hoard, consisting of 20 almost complete socketed axes and one flanged axe, was also

[16] Holste 1951, 36; Harding 1995, 71, No. 232,

[17] Tarbay 2014, fig. 16, list 2.1, No. 45; Trnka 2015.

[18] Gavranović, Kapuran 2014.

[19] Moszolics 1985, T. 2. 8-12.

dated initially to Ha A2–Ha B1 and described as a mixture of older and newer forms.[20] However, R. Vasić assigned Urovica to his Phase II (Ha A1) and pointed out analogies from Ha A1 contexts.[21] As shown by comprehensive publications of socketed axes from the Romanian[22] and Bulgarian[23] regions, most finds from Urovica (Fig. 2: 12–23) belong to specific metal types primarily distributed along the lower Danube and in Transylvania during the Br D stage.[24] Thus, a similar dating is likely to be assumed for the Urovica hoard, mainly since there are no forms that would necessarily suggest a later deposition.

The hoards from Bradarac,[25] Bradarac-Rukumija,[26] and Stari Kostolac-Mali Grad, are all typical examples of so-called "scrap hoards," that appear throughout the Carpathian Basin and in all adjacent areas, particularly during the Ha A1 phase.[27] In northeastern Serbia, which S. Hansen described as a as a distinct deposition region in his comprehensive study,[28] there is a concentration of "scrap hoards" (with intentionally fragmented objects), particulary in the Mlava River Basin. The only exception thus far is the hoard from Klenje, which consists mainly of complete objects and features a characteristic composition of axes, sickles, and arm rings.[29] The sampled objects from Bradarac, Bradarac-Rukumija, and Stari Kostolac include representative metal items from this period, such as sickles of the Uioara type 1, 2, and 4 (Fig. 3: 8. 18–21. 29),[30] flange hilted swords of the Novigrad type (Fig. 3: 28),[31] spearheads with curved blades (Fig. 3: 5. 27),[32] a pin with "Bohemian" profiling (Fig. 3: 26),[33] a *Petschaftkopfnadel* with an undecorated neck (Fig. 3: 9),[34] a pin with a double-conical, horizontally ribbed head (Fig. 3: 23)[35] as well as parts of belts (Fig. 3: 17), ribbed arm rings (Fig. 3:7), and neck rings (Fig. 3:24).

The hoard finds from Vojilovo,[36] Alun,[37] Brza Palanka,[38] Leskovo,[39] and „Požarevac"[40] date to Phase III or IV or to the period of Ha A2–Ha B1, according to R. Vasić's chronological classification of Serbian hoards.[41] In this paper, we will regard them as finds of Ha B1 period. As the studies from the neighboring regions convincingly demonstrated, the definition of Phase III (Ha A2) in the areas of the Carpathian Basin and the western and central Balkans is somewhat problematic since it has arisen more from the demand to synchronize local developments with

[20] Срејовић 1960; Срејовић 1975b, 100.
[21] Vasić 1982, 280.
[22] Dietrich 2021.
[23] Dergačev 2010.
[24] Typ Negreşti nach Dergačev 2010, 55; Typ C2 nach Dietrich 2021, 471.
[25] Јацановић 1992.
[26] Јацановић 1997.
[27] Hansen 1994; König 2004; Rezi 2011; Dietrich 2014.
[28] Hansen 1994, 348, „Region 15"; Gavranović et al 2024a.
[29] Јацановић 1986; Gavranović et al. 2024a.
[30] Vasić 1994, No. 69- 74; 165; 174–175; 213.
[31] Harding 1995, 46, No. 144. 164.
[32] Vasić 2015, 56, No. 91, 219.
[33] Vasić 2003, 78, No. 507.
[34] Vasić 2003, 41, No. 214.
[35] Vasić 2003, 70, No. 406.
[36] Тодоровић 1975a.
[37] Срејовић 1960; 1975a.
[38] Срејовић 1975c.
[39] Тодоровић 1975b.
[40] Vasić 1990.
[41] Vasić 1982, 282.

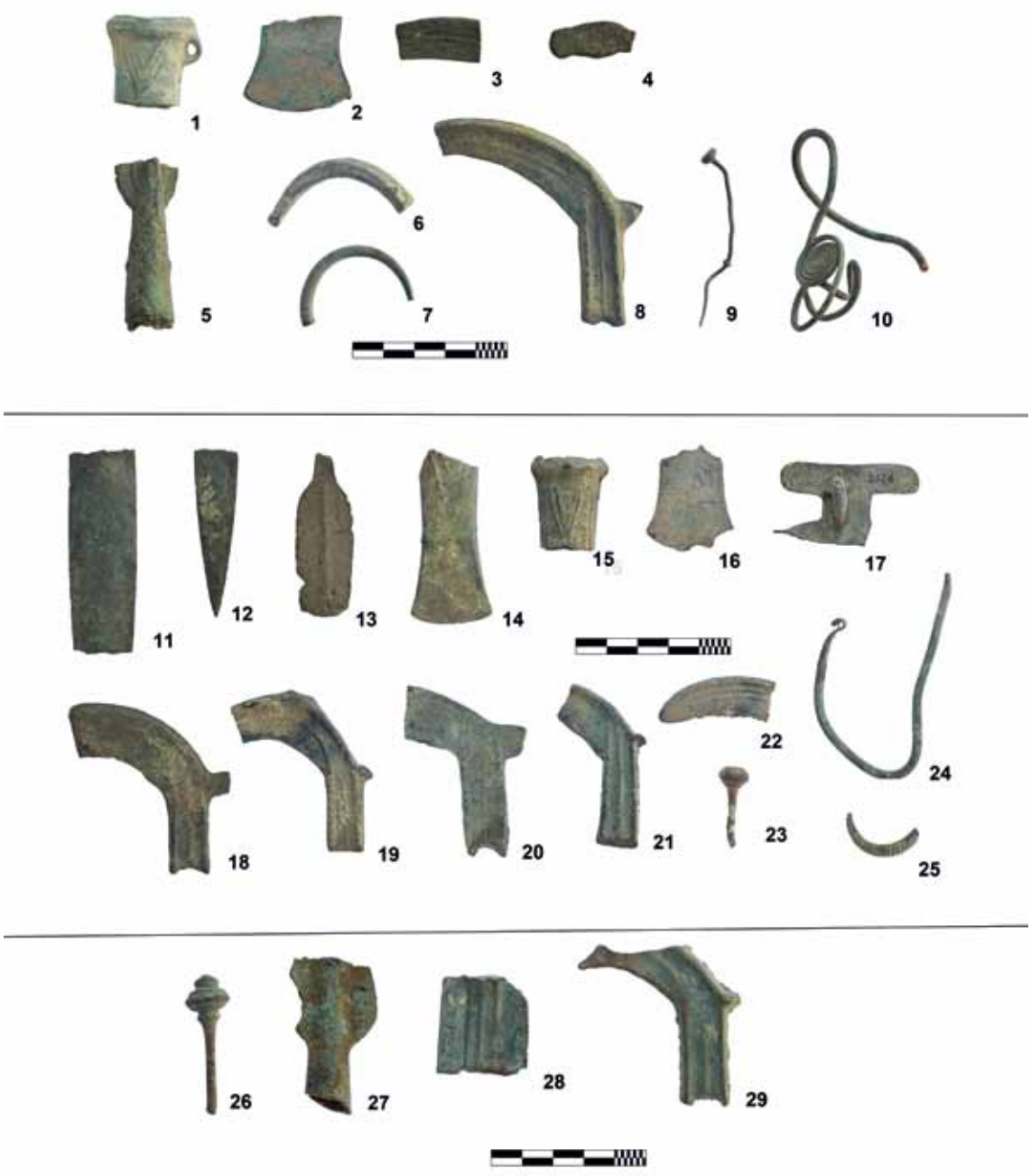


Fig. 3 – Analysed metal objects from Ha A1 hoards: 1–10. Bradarac-Rukumija; 11–25. Bradarac; 26– 29. Stari Kostolac-Mali Grad. (National Museum in Požarevac, Photos: M. Gavranović).

the established chronology of the Urnfield Period after Müller-Karpe.[42] Although younger hoards occasionally contain some typologically older objects, such as a fragment of a Reutlingen-type sword from Leskovo (Fig. 4: 25),[43] this should not imply the possibly older time of deposition as hoards are mostly assemblages collected over a longer period.[44] In the case of hoards discussed here, there is a clear prevalence of novel metal types, especially among socketed axes. Most common are axes with an arch on the broadsides, a wide blade, and a loop positioned below the rim

[42] Hansen 1996; König 2004; Tarbay 2015.
[43] Harding 1995, 36, No. 80.
[44] Dietrich 2021.



Fig. 4 – Analysed metal finds from Ha B1 hoards: 1–10. Brza Palanka; 11–14. Alun; 15–18. "Požarevac"; 19–24 Vojilovo; 25–27. Leskovo. (1–14, 19–27 National Museum in Požarevac; 15–18 Natural History Museum in Vienna, Photos: M. Gavranović).

(Fig. 4: 13. 16. 20–22. 26), which both in Serbia[45] and in the neighboring regions of Romania[46] appear from Ha A1 and continue into Ha B1. There are also some regional forms, such as the two socketed axes with fluted rim from Brza Palanka (Fig. 4: 3–4) or an axe with a Y-rib decoration from "Požarevac" (Fig: 4: 17), which both show typological traits (triangular shape, straight blade) indicative of younger Urnfield period.[47] Apart from socketed axes, almost a regular part of younger hoards are also spearheads, with no traces of fragmentation or intentional damage. Some of them, such as the long and decorated spearhead from Alun (Fig. 4: 11) or the decorated spear from Brza Palanka (Fig. 4:1),[48] appear to have a more representative than utilitarian function.[49] Besides spearheads and socketed axes, other analyzed objects from Ha B1 hoards include bracelets, neck rings, one knife, and pendants (Fig. 4). Not fitting in the general picture of this period are two massive bracelets from Brza Palanka with ends bent one above the other (Fig. 4: 8–9) as they are the jewelry type more characteristic of the Early Iron Age (Ha C1).[50] However, it should be mentioned that already M. Garašanin raised doubts about the content of the hoards from Alun and Brza Palanka, questioning the reliability of the sources.[51]

The youngest group of sampled objects includes finds from the Stari Kostolac-Leštar and Živica hoards, which, based on certain distinctive forms—such as a two-looped fibula with a ribbed bow (Fig. 5: 9)[52]—can be dated to the Early Iron Age (8th century BC), though a somewhat later deposition cannot be ruled out.[53] Both hoards also contain fragmented, presumably older objects, such as a knife handle and a socketed axe blade (Fig. 5: 1–2), as well as several items, like a roll-headed pin (Fig. 5: 13),[54] or animal figurines (Fig. 5: 6–7), which likely date to the time of the hoard's deposition. Both hoards are notable for containing peculiar items in the shape of a reclining „E" (Fig. 5: 3–5. 10–11), which M. Stojić and D. Jacanović have interpreted as pre-monetary currency in the regional frame of northeastern Serbia, indicating that such objects were made from both bronze and silver.[55]

Methods

The metal objects were sampled with a polished 1 mm stainless steel drill bit. Before use, each drill bit was cleaned with highly concentrated ethyl alcohol (97%) to remove possible remains from the production process (e.g., polishing emulsion). As a first step, the patina was removed with a drill, and afterward, a new bit was used to drill a hole 1-2 mm deep. Finally, the resulting drill shavings were collected for analysis. All samples were analysed at the Curt-Engelhorn Centre of Archaeometry (CEZA) in Mannheim. For the measurements of the trace element concentrations, an energy dispersive X-ray fluorescence (ED-XRF) spectrometer (ARL Quant X, Thermo Scientific) was used to analyse the elements silver (Ag), arsenic (As), bismuth (Bi), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), tin (Sn), antimony

[45] Gavranović, Kapuran 2014.
[46] Dergačev 2011, 92, Typ Pleniţa und Typ Ţelna; Dietrich 2021, 458, Typ C3 and Typ C6.
[47] v. Brunn 1968, 50; König 2004, 99.
[48] Leshatkov 2015, 55, Type E III.2; Vasić 2015, 39, No. 65.
[49] Vasić 2015, 20.
[50] Vasić 1977, 9; Vasić 1987, 660; Gavranović 2011, 210.
[51] Garasanin 1973, 447.
[52] Vasić 1999, 58, No. 381.
[53] Јацановић 1992, 76; Vasić 1999, 59.
[54] Vasić 2003, 22, No. 109.
[55] Stojić, Jacanović 2008, 400.

(Sb), tellurium (Te) and zinc (Zn). The detection limits lie at approximately 0.005 % for Ag, Sb, Sn, Pb, Bi and 0.05 % for Fe as well as around 0.01 % for Co, Ni, and As. Selenium and tellurium were measured but were below 0.005 % in all samples. All measurements are given in mass%.

The lead isotope ratios ($^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{204}Pb$) were measured using a high-resolution multi-collector mass spectrometer (Thermo Scientific Neptune Plus) with inductively coupled plasma as ion source (HR-MC-ICP-MS). The $^{208}Pb/^{204}Pb$, and $^{207}Pb/^{204}Pb$ ratios were calculated from the aforementioned measured ratios. The drill shavings were rinsed with dilute HNO3 to remove any surface contamination, then dissolved in half-concentrated HNO3 in an ultrasonic bath (70˚C) for several hours. Insoluble residues were removed by decantation; afterwards, the solution was diluted with deionised water. Ion exchange columns were prepared with PRE-filter and Sr-resin and were preconditioned with 500 µl 3N HNO3 before the solution was added. In four steps, the matrix was first eluted using HNO3, and then the Pb was eluted using HCl. The mass fractionation of lead is corrected by the addition of thallium (Tl), for which a ratio of $^{205}Tl/^{203}Tl = 2.3871$ and an exponential fractionation behaviour are assumed. The interference of ^{204}Pb and ^{204}Hg was corrected by measuring ^{202}Hg with a ratio of $^{204}Hg/^{202}Hg = 0.2293$. The in-run precision of the measurement was typically 0.02 to 0.05% (2σ), depending on the isotopic ratio. The reference sample NIST SRM 981 was measured after every eight samples to check for instrumental drift and to guarantee high-level precision and accuracy. The methods are described in detail by Lutz and Pernicka.[56]



Fig. 5 – Analysed metal finds from Ha C1 hoards:
1–7. Stari Kostolac-Leštar; 8–13. Živica
(National Museum in Požarevac, Photos: M. Gavranović).

Results and Discussion

In terms of the chemical composition and presence of Ni, Ag, As, Bi, and Sb, which all mostly come from the copper used for the production of objects, the four analyzed chronological groups (BA D–Ha A1, Ha A1, Ha B1, and Ha C) all show certain distinct tendencies, even though a number of objects also overlaps regardless of chronological determination (Fig. 6). For the Pb, we observed intentional addition (over 1%) in several instances in each of the groups, with clear peak among the objects from the youngest chronological group (Ha C1). Tin (Sn) values expose

[56] Lutz, Pernicka 1996; Niederschlag et al. 2003.

considerable variation within and between the four chronological groups, with the most consistent values among the objects from the oldest group (BA D–Ha A1).

With regard to the chemical composition (Ni, Ag, Bi, As, and Sb) of the objects from the Topolnica and Urovica hoards (B D–Ha A1), three finds have values strikingly different than the rest of the group. The first two are one socketed axe from Urovica (Fig. 6: 24, MA-186747) and one decorated spiral ring of Salgótarján type from Topolnica (Fig. 6: 17, MA-186745), both with lower Ni values than the remaining objects from the group. However, these two objects significantly differ mutually as the spiral armring has a very low As-value (detection limit) and lower Sb value than most the contemporary objects (Fig. 6: Nr. 17), while the socketed axe has one of the highest antimony amounts (1.98%) of all discussed here objects (Fig. 6: 24) Moreover, the socketed axe has only 2.65% tin, which is the lowest value among the finds from Urovica and Topolnica (Tab. 1). The third object from the BA D–Ha A1 group with somewhat deviating values is the Riegsee type sword from Topolnica (Fig. 6: Nr. 6) with lower Ag and especially Sb values, which indicate the use of other raw materials than for most of the other finds. In the case of the Riegsee type sword and the decorated spiral arm ring of Salgótarján type, different chemical composition aligns with the archeological assessment as both objects have their main distribution in central Europe and the northern part of the Carpathian Basin[57] and are most probably products of workshops situated far away from northeastern Serbia, i.e., from the place of their final deposition. The remaining finds from Topolnica and Urovica largely overlap with metals from Bradarac, Bradarac-Rukumija, and Stari Kostolac (Ha A1), which form a very coherent group in terms of chemical composition (Fig. 6). The results of chemical composition for Ha A1 objects are in good alignment with previously analyzed contemporary finds from nearby hoards from Klenje and Kličevac-Rastovača,[58] and other metals from this period in the western and central Balkans.[59] The only significant outlier is a casting remain from Bradarac-Rukumija (MA-196098) with a lower As-value than the remaining objects, which might be an outcome of remelting or recycling (Fig.6)

The chemical composition of the analyzed objects from Alun, Brza Palanka, Leskovo, Vojilovo und "Požarevac" (Ha B1) is largely in correspondence with the general trend after which the finds from the Ha B1 period have generally higher values of Ag and Sb than the objects from the previous period (Ha A1).[60] Such higher values of Ag and Sb are usually ascribed to the switch from chalcopyrite copper ore to fahlore copper.[61] It is further to observe that objects from Ha B1 hoards with lower Ag and Sb values are often typologically older, such as, for example, the fragment of Reutlingen type sword from Leskovo (Fig. 4: 25, MA-186756) or the long spearhead from Alun (Fig. 4: 11, MA-196030). Hence, these objects were presumably produced long before the time of deposition and were in circulation or a part of metal collections that eventually came to the ground during Ha B1. Three further objects from the Ha B1 group stand out due to the significantly lower Ni, As, and Sb values. All three (MA-196032, MA-196033, and MA-196034) are bracelets assigned to the Brza Palanka hoard (Fig. 6: Nr. 50–51), with somewhat doubtful history of finding.[62] According to the typological evaluation, the bracelets from Brza Palanka do not fit in the same chronological span as they represent a younger jewelry type (Fig. 4: 8–9). The differing chemical composition of the three bracelets, supports the previously stated assumption about the wrong assignment of objects to Brza Palanka hoard.[63]

[57] Bader 1991; Kemenczei 1991, 26; Tarbay 2014, fig.16.

[58] Gavranović et al. 2024a.

[59] Gavranović et al. 2022; Bruyère et al 2024; Orfanou et al. 2024.

[60] Trampuž-Orel 1996; Gavranović, Mehofer 2016.

[61] Trampuž-Orel 1996; Grutsch et al. 2019.

[62] Vasić 1982, 280.

[63] Garašanin 1973, 447; Vasić 1982, 280.

The analyzed objects from Ha C1 hoards Stari Kostolac-Leštar and Živica can clearly be divided into two groups with regard to chemical composition. The first group consists of finds that fit well with the cluster of Ha A1 metals and which are typologically also more to connect with previous periods. These include a socketed axe (Fig. 5:2, MA-196101) and knife (Fig. 5: 1, MA-196102) from Stari Kostolac-Leštar, and pin (Fig. 5: 13, MA-196132) and knife (Fig. 5: 8, MA-196133) from Živica. It is thus possible that they represent older finds, which were collected in a long period before the final deposition. The second group contains objects with notably lower Ni-values, including all E-shaped items and two animal figurines. Apart from low Ni value, striking is a very high amount of added lead, with most objects having between 15% and 17% of lead (Tab. 1). While in the case of animal figurines, the intentional addition of lead could be explained by the particular properties of the alloy and lower viscosity of the material that helps to cast sophisticated objects, the high amount of lead in E-shaped objects can only be connected with a desire to increase weight. Hence, their original interpretation as "objects connected with monetary trade"[64] might partly be associated with their specific weight, which is manipulated with the deliberate addition of lead in the alloy.

The amount of tin in the alloy of the analyzed objects varies significantly, and no clear chronological or typological preferences are attested. Most consistent values (highest mean) are measured in the objects from the BA D–Ha A1 group, with only one socketed axe from Topolnica (MA-186747) having a markedly small (2.65%) tin amount (Tab. 1). At the same time, this is an axe with the second highest Sb amount (1.98%) among all analysed objects (Fig. 6: Nr. 24). These values hint at a somewhat different production process than for most of the contemporary finds, not excluding the possibility that the axe is made of partly recycled material. Indicative is also that objects with the highest tin values in the BA D–Ha A1 group are also socketed axes from Topolnica (MA-186743) with 9.2% and Urovica (MA-196024 and MA-196021) with 9.4% and 9.0% (Tab. 1). Striking is also that two socketed axes from Topolnica (MA-186743 and MA-196018) are also the only two objects from the BA D–Ha A1 group with lead values above 1% (1.53% and 2.40%), suggesting the intentional addition, despite relatively sufficient tin amount (9.2% and 5.4%). Two swords of Reutlingen type from Topolnica (MA-186739 and MA-196017) with 8.4% and 8.5% fall in the category of "well-alloyed bronzes" (>8%), while the two other swords (MA-186740 and MA-186742), including the one of Riegsee type, have an alloy with somewhat lower tin values (6.9% and 6.7%) than most of the contemporary swords in the Carpathian Basin and the areas of western and central Balkans (8%–10%).[65]

Highly varying tin values are observed among metals from the Ha A1 group with two objects, a sickle from Bradarac (MA-196118) and a spearhead from Bradarac-Rukumija (MA-196095), being made only of copper (98% and 97%) with some impurities (Tab. 1). Thus, technically speaking, these two objects are not bronzes since there is no indication of alloying, and even remelting of objects is hardly possible considering the low tin amount. The objects with the highest tin values are two sword fragments from Bradarac (MA-196120 and MA-196119) with 9.3% and 7.3% and two adornment items (a belt piece and a neckless) (MA-196123 and MA-196124) from Bradarac-Rukumija with 10.2% and 8.3% (Tab. 1). In correspondence with the data from other contemporary hoards in the surrounding, such as Klenje and Kličevac-Rastovača,[66] the sickles from Bradarac, Bradarac-Rukumija, and Stari Kostolac-Mali Grad hoards represent an group with lowest tin averages, seldomly exceeding 5%, which is a trend observable in a

[64] Stojić, Jacanović 2008, 403.

[65] Liversage 1994, 65; Trampuž-Orel 1996, 186; Gavranović et al. 2022; Bruyère et al. 2024.

[66] Gavranović et al. 2024a.

much wider geographical region during the Ha A1 period.[67] Two objects from Ha A1 group have increased lead values pointing at intentional addition. Both are bracelets (MA-196125 and MA-196097) with relatively low tin values (2.3% and 3.5%). Hence, the addition of lead (5.8% and 1.4%) might be explained with the intention to reduce the viscosity of the material, which is much needed in the course of casting in order to cast closed bracelets that also have additional ribbed ornaments successfully.[68]

The object with the highest tin value from the Ha B1 group is the animal (bovid) figurine from Brza Palanka (MA-196036) with 10.3%, which is most probably attributable to the specific casting properties (lower viscosity) and challenging production of such an item (Tab. 1). Other finds that are made of well-alloyed bronze with tin amount of 8% and more are one socketed axe and long spearhead from Alun (MA-196029 and MA-196030) with 8.2% and 9.8% and a small socketed axe and flange hilted sword from Leskovo (MA-196051 and MA-186756) with 8.4 and 9.5% (Tab. 1). Made of well-alloyed bronze are also two bracelets with bent ends from Brza Palanka (MA-196032 and MA-196033) with 8% and 8.3% tin, however in both objects, we also attested intentionally added lead with 2.03% and 1.96%, presumably with the purpose to increase the liquidity of the material. It is further interesting that the two strikingly resembling axes of a specific regional type from Brza Palanka (MA-196037 and MA-196038) have an unalike chemical composition (As values) and varying tin values (3.0% and 4.4%), suggesting that they are made in different batches. To note are also spearheads from Brza Palanka (MA-196039), Požarevac (MA-1962469), and Vojilovo (MA-196246) with relatively low tin values (3.2%, 3.1%, and 3.9%), which is opposing the general regional trend from previous periods as the spearheads represented the group with higher tin average values (8%<).[69] Noteworthy are also very similar tin values in all objects from the Vojilovo hoard (6.1%–7.1%), with the exception of the mentioned spearhead (3.9%).

Among the analyzed objects from the youngest group (Ha C1), only a few of them fall in the category of well-alloyed bronzes, with one E-shaped object from Stari Kostolac-Leštar (MA-196103) as the only find exceeding 8% of tin, however having also 17.6% of added lead (Tab. 1). Made of copper with a high As-value (2.93%) and with no added tin or lead, it is an awl from Živica (MA-196135). Another find with the strikingly low tin amount (0.8%) is another E-shaped object from Stari Kostolac-Leštar (MA-196104) made solely of copper and lead (6.1%) alloy.

Considering the lead isotope ratios, the results are currently available for most of the finds from Topolnica and Urovica, four finds from the Stari Kostolac-Mali Grad hoard (Fig. 3: 26–29), three objects from the Leskovo hoard (Fig. 4: 25–27), and the spearhead from the Vojilovo hoard (Fig. 4: 19). The majority of the objects correlate with the isotopic signature of copper deposits in the Southern Alps or the AATV (Alto Adige, Trentino, Veneto) zone, one of the main copper production districts in Late Bronze Age Europe.[70] Thus, the objects from northeastern Serbia are in line with the general trend observed in the western and central Balkans, showing that Alpine copper was the prevailing raw material for the local and regional casing workshops during the Late Bronze Age.[71]

From the objects discussed here, only a few from the oldest chronological group (Topolnica and Urovica hoards) do not fit into the general cluster. Most probably made of copper coming from some other deposit is the sword of Riegsee type from Topolnica (Fig. 2: 1). With the

[67] Liversage 1994, 65; Frana et al. 1997, 69; Fejer 2020, 73.

[68] Nowak et al. 2024.

[69] Liversage 1994, 76; Trampuž-Orel 1996, 186; Molloy, Mödlinger 2020; Gavranović et al. 2022.

[70] Addis et al. 2015; Ling et al. 2019.

[71] Gavranović 2022; Bruyère et al 2024.

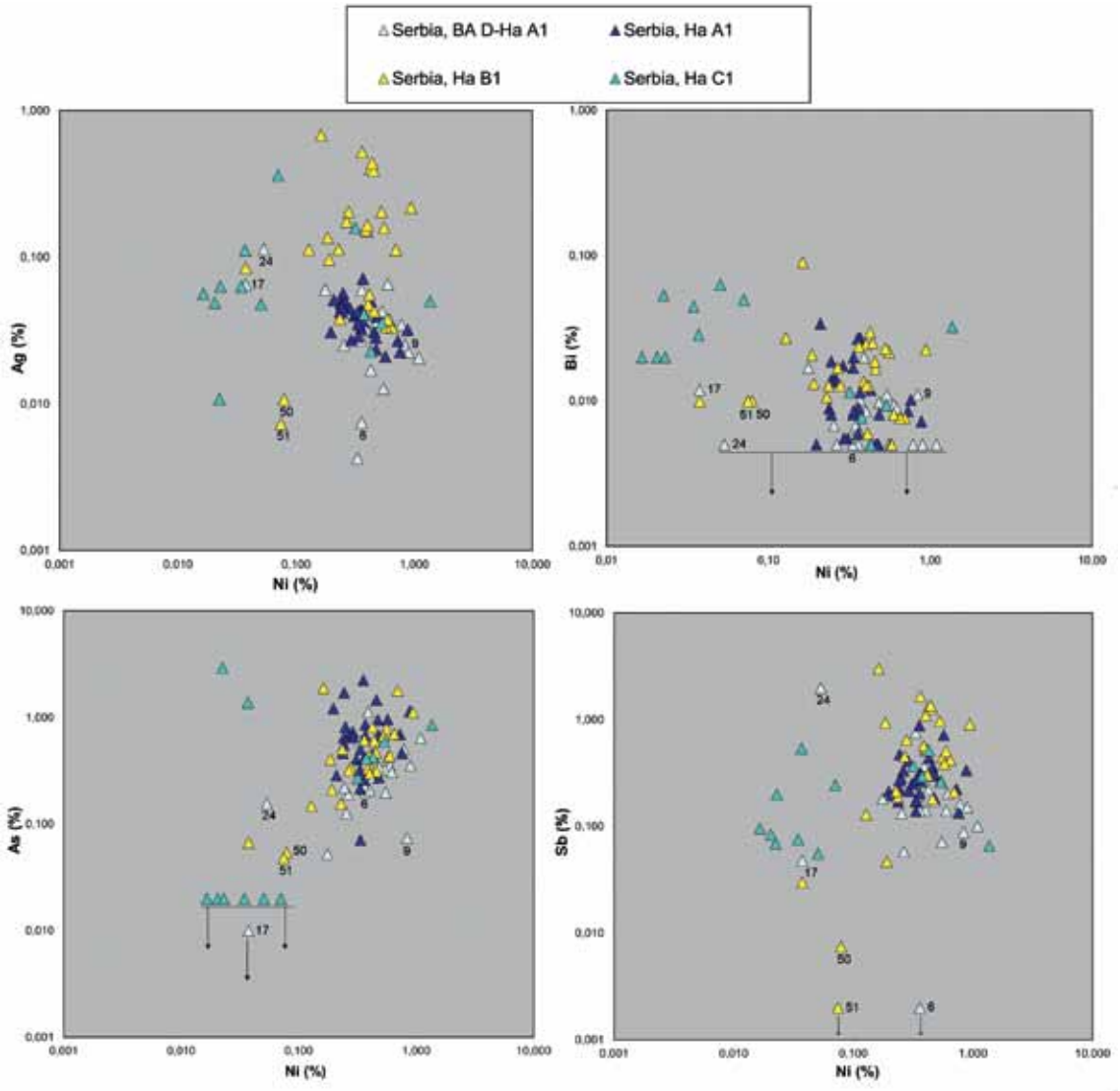


Fig. 6 – Double logarithmic diagrams of the trace element composition of the analysed objects from northeastern Serbia (chart: N. Mittermair and M. Mehofer, VIAS, University Vienna).

lead value of 0.006% in the alloy, it is almost certain that the lead originates from the copper ore and not from the deliberate addition. The lead isotope values from the sword fall marginally in the range of copper deposits in Slovakia, although some other copper sources that are still not isotopically characterized should not be excluded (Fig. 7: Nr. 6). The second outlier is one of the socketed axes from Urovica (Fig. 2: 15). With the lead value of 0.005% in the alloy, there is also no reasonable argument to assume the intentional addition of the lead, which could affect isotope values. The lead isotopes also overlap with some copper deposits in Slovakia but are also in the range of deposits and slags from Southern Tyrol (Fig. 7: Nr. 24). It should be pointed out that this axe represents an outlier also in terms of chemical composition with an unusually high amount of antimony (1.98%) (Fig. 6: Nr. 24). Together with increased silver values (0,114%), this is a strong indication that fahlore copper was used as a primary raw material. This is unusual in that most objects from both the BA D and the Ha A1 contexts generally have lower values of silver and antimony, which indicate chalcopyrite copper ore. Hence, this particular axe is most probably made out of fahlore copper, which was not frequently used during this time.

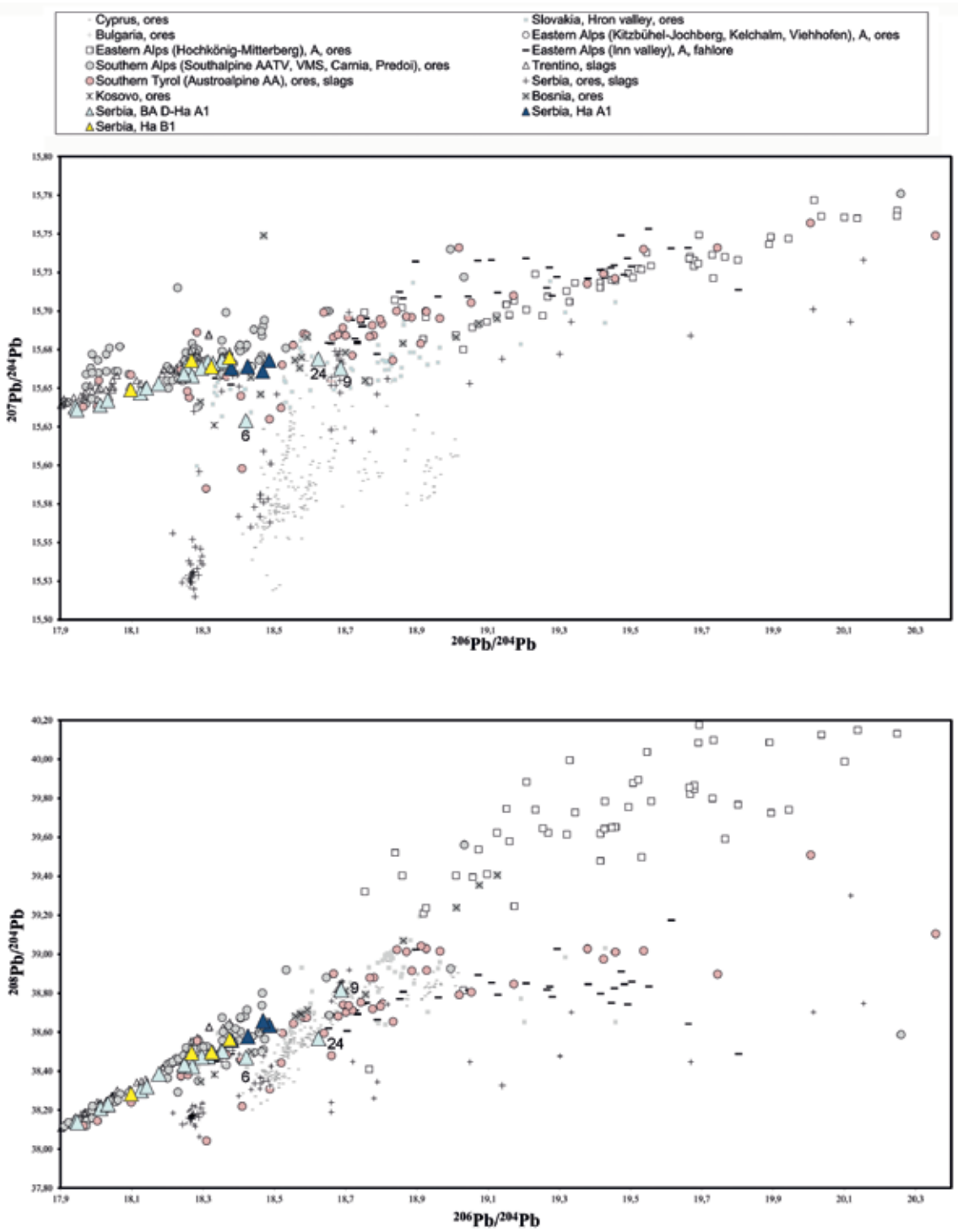


Fig. 7 – Lead isotope diagram with lead isotope values of analysed object and major copper ore deposits between central Europe and Mediterranean
(data: Pernicka et al. 1993; Pernicka et al. 1997; Artioli et al. 2016; Stos-Gale 2021, Koch Waldner et al. 2020) (chart: N. Mittermair and M. Mehofer, VIAS, University Vienna).

For the purpose of testing the influence of added lead on isotopic values, we also analyzed the sample from one of the axes from Topolnica (Fig. 2:6) with 2.8% lead (Tab. 1). Hence, the measured lead isotopes point at the possible source of added lead and not at the source of copper

ore. Interestingly, the lead isotopes indicate nearby deposits in Serbia as the most probable lead source (Fig. 7: Nr. 9). Similar results were also observed in the case of one object (bracelet) from the Klenje hoard with 13.4% lead[72] and isotopic signature that correlated with the deposits of lead-zinc minerals from Serbia.[73] The chemical composition of the axe from Topolnica, with very low Arsenic values has already indicated somewhat different primary material and deviating alloy practices (Fig. 6, Nr. 9). As the results of analyses suggest, the axe from Topolnica is probably a product of the mixing of raw materials (copper, tin, lead) from different sources. At his point, it is not possible to assume the origin of copper (Southern Alps, Slovakia), yet the deliberately added lead is most probably of local origin, pointing at the production in some of the regional workshops.

Conclusion

The region of northeastern Serbia provides a unique opportunity for archaeometallurgical studies throughout the Late Bronze and Early Iron Ages. The occurrence of hoards and a specific repertoire of metal finds with different distribution tendencies in the broader region of southeastern and central Europe, makes northeastern Serbia a perfect case study to understand some general trends from a diachronic perspective and to pinpoint regional and local peculiarities when it comes to the choice of alloys and procurement of the raw materials. In a few instances, the results of the archaeometallurgical analyses confirmed, by means of the archaeological assessment already assumed, the different backgrounds of particular objects, such as the sword of Riegsee type or spiral arming of Salgótarján type from the Topolnica hoard. Both objects originate presumably from other areas in central Europe and are products of different metallurgical networks than most of the other metals discussed here. At the same time, they also bear witness to the long-ranging communications and interaction mechanisms between the Late Bronze Age communities that eventually led to their deposition south of the Danube. From a diachronic perspective, we can observe two general shifts in metal production. The first shift is marked by the introduction of copper with higher values of silver and antimony from Ha B1 onwards. Unlike metals from earlier groups (BA D–Ha A1 and Ha A1), most of the objects from Ha B1 are presumably made with an input of fahlore copper. Within the group are also a few outliers with somewhat different compositions, but these are all objects that, in terms of archaeological evaluation, do not chronologically fit the Ha B1 period. The outliers represent either typologically older objects that came into the ground together with younger finds (e.g., the sword from Leskovo hoard, Fig. 4:25) or metal objects with questionable documentation records (bracelets from Brza Palanka hoard, Fig. 4: 7–9). The second major change in archaeometallurgical practices is attested to the Early Iron Age and the metal objects, with a significant addition of lead (Tab. 1). The relatively high amount of tin in most of the Early Iron Age objects opposes the assumption that the lead was added as a substitute for tin, it was rather due to the casting properties (low viscosity) or to increase the weight of the objects. In general, we do not observe a substantial shortage of tin throughout the period in question (13th–8th centuries BC), with the finds from the oldest group (BA D–Ha A1) showing the most constant values (Tab. 1). A few objects from the Ha A1 group with very low tin values (1-2 %) might suggest the addition or remelting of smaller objects into the alloy. In the case of metals with 0.04% or 0.2% of tin and 97% or 98% copper one should assume the processing of copper with some natural impurities

[72] Gavranović et al. 20224.

[73] Pernicka et al. 1993, 26.

rather than alloying. Technically, these objects do not qualify as bronzes; they are most probably made of fresh copper without any intentional additions of other materials.

The results of lead isotope analyses confirmed that most of the copper raw material used to produce finished objects comes from the Southern Alpine mining districts. Three objects from the oldest group do not fall in the cluster of Southern Alpine copper deposits, with two of them probably connected with Slovakian copper deposits (Fig. 7: Nr. 6 and 9). In the case of the third object (Fig. 7: Nr. 24), the copper provenance is diluted by the deliberate addition of lead or lead-rich ores, which are most probably of local origin. Currently, there is no analytic or archaeological evidence that any of the nearby abundant copper ore deposits in eastern Serbia was exploited in the Late Bronze Age. Hence, the increased deposition activities in northeastern Serbia throughout all stages of the Late Bronze and Early Iron Ages are an outcome of an intensive collecting of metal finds and complex social and communal practices, are not directly linked to regional-scale mining or copper processing. At present, we can only speculate about the reasons and backgrounds of such an intense and enduring metal deposition. What, however, should be highlighted is the fact that northeastern Serbia represents the geographical border of the phenomena that could be described as "Urnfield culture" in the broadest sense of the word. One of the most characteristic features of the "Urnfield culture" are hoards with a particular repertoire of shared metal types, particularly in the early stages (BA D and Ha A1).[74] Thus, the regional accumulation of hoards might also be connected with the peripheral position of northeastern Serbia and the Danube River as both a communication axe and a distinct geographical border of the "Urnfield culture".

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[74] Hansen 1994; Váczi 2013.

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0	Inv./ mus. no.	MA-lab. no.	Cu	Mn	Fe	Co	Ni	Zn	As	Se	Ag	Sn	Sb	Pb	Bi	object	site	date	Figure
			%	%	%	%	%	%	%	%	%	%	%	%	%				
NegM 1	1759	MA-186739	90	<0.005	0.26	0.03	0.37	<0.1	0.200	<0.005	0.043	8.4	0.144	0.280	0.010	sword, type Reutlingen	Topolnica	BA D - Ha A1	Fig. 1:2
NegM 2	1760	MA-186740	92	<0.005	<0.05	0.02	0.18	<0.1	0.05	<0.005	0.060	6.9	0.183	0.51	0.02	sword, type Reutlingen	Topolnica	BA D - Ha A1	Fig. 1:3
NegM 4	1758	MA-186741	90	<0.005	0.19	0.03	0.60	<0.1	0.35	<0.005	0.066	8.5	0.141	0.103	0.009	sword, type Reutlingen	Topolnica	BA D - Ha A1	Fig. 1:4
NegM 5	1761	MA-196017	92	<0.01	0.12	0.03	0.54	<0.1	0.32	<0.005	0.043	6.7	0.267	0.41	0.011	sword, type Reutlingen	Topolnica	BA D - Ha A1	Fig. 1:5
NegM 6	1757	MA-186742	92	<0.005	<0.05	0.02	0.36	0.1	0.214	<0.005	0.007	7.6	<0.002	0.006	<0.005	sword, type Riegsee	Topolnica	BA D - Ha A1	Fig. 1:1
NegM 8	1764	MA-186743	88	<0.005	<0.05	0.02	0.40	<0.1	0.21	<0.005	0.032	9.2	0.142	1.53	0.01	socketed axe	Topolnica	BA D - Ha A1	Fig. 1:7
NegM 9	1765	MA-196018	90	<0.01	0.48	0.10	0.84	0.1	0.07	<0.01	0.025	5.7	0.089	2.40	0.01	socketed axe	Topolnica	BA D - Ha A1	Fig. 1:6
NegM 11	1752	MA-186744	92	<0.005	0.08	0.02	0.48	1.0	0.34	<0.005	0.036	5.6	0.171	0.49	0.010	spiralring	Topolnica	BA D - Ha A1	Fig.1:9
NegM 15	1747	MA-196019	90	<0.01	0.54	0.03	0.27	<0.1	0.192	<0.005	0.046	8.8	0.058	0.45	<0.005	bracelet	Topolnica	BA D - Ha A1	Fig. 1:10
NegM 17	1755	MA-186745	93	<0.005	0.26	0.04	0.04	<0.2	<0.01	<0.005	0.065	5.5	0.048	0.68	0.01	spiralring, decorated	Topolnica	BA D - Ha A1	Fig. 1:8
NegM 20	1763	MA-186746	91	<0.005	0.13	0.02	0.43	<0.1	0.272	<0.005	0.017	7.4	0.221	0.086	<0.005	pin	Topolnica	BA D - Ha A1	Fig. 1:11
NegM 22	168	MA-196020	90	<0.01	0.91	0.07	0.39	<0.1	1.13	<0.005	0.032	7.1	0.37	0.076	0.020	socketed axe	Urovica	BA D - Ha A1	Fig. 1:12
NegM 23	169	MA-196021	89	<0.01	0.48	0.10	1.09	<0.1	0.64	<0.005	0.021	9.0	0.100	0.020	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:13
NegM 24	167	MA-186747	95	<0.005	0.10	<0.01	0.05	<0.1	0.157	<0.005	0.114	2.65	1.98	0.005	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:14
NegM 26	182	MA-196022	93	<0.01	0.34	0.05	0.25	<0.1	0.220	<0.005	0.042	5.5	0.242	0.20	0.013	socketed axe	Urovica	BA D - Ha A1	Fig. 1:15
NegM 28	177	MA-186748	92	<0.005	<0.05	0.02	0.25	<0.1	0.127	<0.005	0.025	7.4	0.133	0.41	0.007	socketed axe	Urovica	BA D - Ha A1	Fig. 1:16
NegM 29	181	MA-196023	92	<0.01	0.71	0.08	0.33	<0.1	0.60	<0.005	0.004	5.2	0.75	0.044	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:17
NegM 30	170	MA-196024	89	<0.01	0.19	0.04	0.78	<0.1	0.50	<0.005	0.035	9.4	0.161	0.33	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:18
NegM 31	175	MA-196025	92	<0.01	<0.05	0.01	0.55	<0.1	0.198	<0.005	0.013	7.2	0.072	0.079	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:19
NegM 32	176	MA-186749	91	<0.005	<0.05	0.02	0.36	<0.1	0.262	<0.005	0.028	7.8	0.141	0.242	0.006	socketed axe	Urovica	BA D - Ha A1	Fig. 1:20
NegM 35	171	MA-186750	91	<0.005	0.12	0.03	0.35	<0.1	0.232	<0.005	0.037	8.3	0.190	0.219	0.007	socketed axe	Urovica	BA D - Ha A1	Fig. 1:21
NegM 36	184	MA-196026	90	<0.01	0.14	0.03	0.36	<0.1	0.230	<0.005	0.060	8.4	0.260	0.26	0.009	socketed axe	Urovica	BA D - Ha A1	Fig. 1:22
NegM 37	174	MA-186751	91	<0.005	0.08	0.03	0.90	<0.1	0.35	<0.005	0.022	7.5	0.151	0.114	<0.005	socketed axe	Urovica	BA D - Ha A1	Fig. 1:23
NegM 39	185	MA-196027	91	<0.01	0.12	0.04	0.62	<0.1	0.31	<0.005	0.038	7.1	0.203	0.32	0.009	winged axe	Urovica	BA D - Ha A1	no picture
PozM 114	2081	MA-196111	93	<0.01	0.16	0.04	0.43	<0.1	0.45	<0.005	0.050	4.8	0.44	0.30	0.012	socketed axe	Bradarac	Ha A1	Fig. 2:14
PozM 115	2079	MA-196112	92	<0.01	<0.05	0.04	0.26	<0.1	0.65	<0.005	0.049	6.4	0.33	0.42	0.014	socketed axe	Bradarac	Ha A1	Fig. 2:15
PozM 116	2080	MA-196113	92	<0.01	<0.05	0.03	0.29	<0.1	0.74	<0.005	0.044	6.3	0.41	0.46	0.017	socketed axe, blade	Bradarac	Ha A1	Fig. 2:16
PozM 117	2081	MA-196114	94	<0.01	1.87	0.07	0.57	<0.1	0.96	<0.005	0.021	1.23	0.72	0.16	<0.005	grip tongue sickle	Bradarac	Ha A1	Fig. 2:18
PozM 118	2085	MA-196115	93	<0.01	0.08	0.13	0.37	<0.1	0.86	<0.005	0.071	4.5	0.266	0.38	0.027	grip tongue sickle	Bradarac	Ha A1	Fig. 2:19
PozM 119	2086	MA-196116	96	<0.01	0.16	0.06	0.20	0.1	1.21	<0.005	0.031	2.07	0.212	0.29	<0.005	grip tongue sickle	Bradarac	Ha A1	Fig. 2:20
PozM 120	2087	MA-196117	93	<0.01	<0.05	0.03	0.31	<0.1	0.40	<0.005	0.040	5.8	0.251	0.14	0.006	grip tongue sickle	Bradarac	Ha A1	Fig. 2:21
PozM 121	2093	MA-196118	98	<0.01	0.87	0.05	0.76	<0.1	0.46	<0.005	0.023	0.041	0.134	0.079	0.010	knob sickle?	Bradarac	Ha A1	Fig. 2:22
PozM 122	2103	MA-196119	91	<0.01	0.07	0.03	0.29	<0.1	0.65	<0.005	0.027	7.3	0.215	0.19	0.006	sword, blade fragment	Bradarac	Ha A1	Fig.2: 11
PozM 123	2104	MA-196120	89	<0.01	0.07	0.09	0.24	<0.1	0.46	<0.005	0.042	9.3	0.170	0.40	0.009	sword, blade fragment	Bradarac	Ha A1	Fig. 2:12
PozM 124	2108	MA-196121	94	<0.01	0.08	0.03	0.33	<0.1	0.217	<0.005	0.041	5.1	0.139	0.50	0.01	dagger	Bradarac	Ha A1	Fig. 2:13
PozM 125	2117	MA-196122	92	<0.01	0.21	0.03	0.73	<0.1	0.70	<0.005	0.027	5.5	0.225	0.15	0.009	pin	Bradarac	Ha A1	Fig. 2:23
PozM 126	2126	MA-196123	87	<0.01	0.11	0.06	0.88	<0.1	1.15	<0.005	0.032	10.2	0.34	0.23	0.007	belt piece	Bradarac	Ha A1	Fig. 2:17
PozM 127	2155	MA-196124	90	<0.01	<0.05	0.02	0.48	<0.1	0.274	<0.005	0.039	8.3	0.297	0.13	0.008	neck ring	Bradarac	Ha A1	Fig. 2:24

PozM 128	2112	MA-196125	88	<0.01	0.17	0.05	0.36	<0.1	2.24	<0.01	0.044	2.30	0.88	5.8	0.03	ribbed bracelet	Bradarac	Ha A1	Fig. 2:25
PozM 91	2017	MA-196091	92	<0.01	0.32	0.06	0.25	<0.1	0.82	<0.005	0.057	5.7	0.284	0.36	0.014	socketed axe	Bradarac-Rukumija	Ha A1	Fig. 2:1
PozM 92	2020	MA-196092	93	<0.01	<0.05	0.03	0.36	<0.1	0.42	<0.005	0.042	5.8	0.31	0.18	0.009	socketed axe, blade	Bradarac-Rukumija	Ha A1	Fig. 2:2
PozM 93	2021	MA-196093	94	<0.01	<0.05	0.05	0.21	<0.1	0.29	<0.01	0.051	4.4	0.195	0.53	0.03	grip tongue sickle	Bradarac-Rukumija	Ha A1	Fig. 2:8
PozM 94	2029	MA-196094	95	<0.01	<0.05	0.03	0.24	<0.1	0.65	<0.01	0.049	2.88	0.272	0.56	0.01	sickle, frag.	Bradarac-Rukumija	Ha A1	Fig. 2:3
PozM 95	2037	MA-196095	97	<0.01	0.39	0.10	0.24	<0.1	1.71	<0.005	0.048	0.233	0.47	0.040	0.008	spearhead	Bradarac-Rukumija	Ha A1	Fig. 2:5
PozM 96	2044	MA-196096	92	<0.01	0.15	0.01	0.36	<0.1	0.263	<0.005	0.033	6.6	0.205	0.13	0.006	pin	Bradarac-Rukumija	Ha A1	Fig. 2:9
PozM 97	2045	MA-196097	94	<0.01	0.24	0.04	0.24	<0.1	0.55	<0.01	0.046	3.5	0.223	1.44	0.02	bracelet	Bradarac-Rukumija	Ha A1	Fig. 2:6
PozM 98	2053	MA-196098	76	<0.01	0.07	0.05	0.34	<0.1	0.07	<0.02	0.029	5.3	0.278	17.8	<0.02	casting remain	Bradarac-Rukumija	Ha A1	Fig. 2:4
PozM 99	2057	MA-196099	90	<0.01	0.55	0.11	0.46	<0.1	1.46	<0.005	0.031	7.0	0.36	0.054	<0.005	ribbed bracelet	Bradarac-Rukumija	Ha A1	Fig. 2:7
PozM 100	2054	MA-196100	94	<0.01	0.10	0.04	0.37	<0.1	0.68	<0.01	0.037	3.9	0.31	0.69	0.01	spiral wire	Bradarac-Rukumija	Ha A1	Fig. 2:10
PozM 109	1524	MA-196108	94	<0.01	0.26	0.02	0.48	<0.1	0.68	<0.005	0.023	4.1	0.183	0.17	<0.005	pin	Stari Kostolac-Mali Grad	Ha A1	Fig. 2:26
PozM 110	1528	MA-196109	93	<0.01	<0.05	0.03	0.33	<0.1	0.32	<0.01	0.042	4.7	0.170	1.43	<0.02	grip tongue sickle	Stari Kostolac-Mali Grad	Ha A1	Fig. 2:29
PozM 112	1532	MA-186773	94	<0.005	0.18	0.02	0.34	<0.1	0.50	<0.005	0.035	3.9	0.176	0.47	0.009	sword, type Novigrad	Stari Kostolac-Mali Grad	Ha A1	Fig. 2:28
PozM 113	1533	MA-196110	91	<0.01	0.10	0.05	0.47	<0.1	0.95	<0.005	0.028	6.7	0.31	0.23	<0.005	spearhead	Stari Kostolac-Mali Grad	Ha A1	Fig. 2:27
NegM 46	189	MA-196028	94	<0.01	<0.05	0.03	0.56	<0.1	0.79	<0.005	0.159	3.7	0.45	0.26	0.022	socketed axe	Alun	Ha B1	Fig: 3:13
NegM 47	190	MA-196029	90	<0.01	<0.05	0.06	0.40	<0.1	0.44	<0.005	0.150	8.2	0.51	0.24	0.025	socketed axe	Alun	Ha B1	Fig. 3:14
NegM 48	192	MA-196030	89	<0.01	<0.05	0.05	0.24	<0.1	0.50	0.01	0.038	9.8	0.189	0.58	0.01	spearhead	Alun	Ha B1	Fig. 3:11
NegM 49	191	MA-196031	92	<0.01	0.19	0.04	0.70	<0.1	1.78	<0.005	0.112	5.2	0.211	0.17	0.008	spearhead	Alun	Ha B1	Fig. 3:12
NegM 50	206	MA-196032	88	<0.01	1.36	0.07	0.08	<0.1	0.05	<0.01	0.011	8.0	0.007	2.03	<0.01	bracelet	Brza palanka	Ha B1	Fig. 3:8
NegM 51	205	MA-196033	88	<0.01	1.47	0.06	0.07	<0.1	0.05	0.01	0.007	8.3	<0.002	1.96	<0.01	bracelet	Brza palanka	Ha B1	Fig. 3:9
NegM 52	207	MA-196034	93	<0.01	<0.05	<0.01	0.04	<0.1	0.07	<0.01	0.085	6.1	0.030	0.76	<0.01	bracelet	Brza palanka	Ha B1	Fig. 3:7
NegM 53	209	MA-196035	91	<0.01	0.13	0.03	0.65	<0.1	0.70	<0.005	0.033	6.3	0.42	0.22	0.008	neck ring	Brza palanka	Ha B1	Fig. 3:6
NegM 54	208	MA-196036	88	<0.01	<0.05	0.03	0.41	<0.1	0.33	<0.005	0.048	10.3	0.53	0.32	0.006	bull figure	Brza palanka	Ha B1	Fig: 3:10
NegM 55	201	MA-186752	94	0.005	<0.05	0.03	0.53	<0.1	0.67	<0.005	0.204	3.8	0.97	0.222	0.023	socketed axe	Brza palanka	Ha B1	Fig. 3:5
NegM 56	199	MA-196037	91	<0.01	<0.05	0.01	0.16	<0.1	1.89	<0.005	0.68	3.0	3.0	0.11	0.090	socketed axe	Brza palanka	Ha B1	Fig. 3:3
NegM 57	200	MA-196038	92	<0.01	<0.05	0.05	0.94	<0.1	1.12	<0.01	0.218	4.4	0.90	0.75	0.02	socketed axe	Brza palanka	Ha B1	Fig. 3:4
NegM 58	204	MA-196039	95	<0.01	<0.05	0.01	0.28	<0.1	0.34	<0.005	0.204	3.2	0.65	0.25	0.013	spearhead	Brza palanka	Ha B1	Fig. 3:1
NegM 59	203	MA-186753	93	<0.005	<0.05	0.02	0.19	<0.1	0.210	<0.005	0.096	6.6	0.047	0.222	0.013	spearhead	Brza palanka	Ha B1	Fig: 3:2
PozM 20	154	MA-196051	90	<0.01	0.22	0.04	0.42	<0.1	0.42	<0.005	0.055	8.4	0.30	0.14	0.013	socketed axe	Leskovo	Ha B1	Fig. 3:26
PozM 21	155	MA-186756	89	<0.005	0.16	0.05	0.46	<0.1	0.31	<0.005	0.043	9.5	0.182	0.156	0.017	sword, type Reutlingen	Leskovo	Ha B1	Fig. 3:25
PozM 23	144	MA-186757	94	<0.005	<0.05	0.03	0.58	<0.1	0.43	<0.005	0.034	4.1	0.39	0.078	<0.005	neck ring	Leskovo	Ha B1	Fig. 3:27
PozM 305	45788	MA-196244	91	<0.01	0.27	0.02	0.42	<0.1	0.82	<0.005	0.40	5.1	1.30	0.31	0.030	socketed axe	Požarevac	Ha B1	Fig. 3:16
PozM 306	45787	MA-196245	93	<0.01	0.05	0.01	0.45	<0.1	0.47	<0.005	0.39	3.9	1.28	0.21	0.019	socketed axe	Požarevac	Ha B1	Fig. 3:17
PozM 307	45787	MA-196246	94	<0.01	<0.05	0.01	0.44	<0.1	0.60	<0.005	0.44	3.1	1.36	0.35	0.025	spearhead	Požarevac	Ha B1	Fig. 3:15
PozM 308	45786	MA-196247	92	<0.01	<0.05	0.01	0.36	<0.1	0.61	<0.005	0.52	4.7	1.66	0.17	0.024	knife	Požarevac	Ha B1	Fig. 3:18
PozM 24	59	MA-196052	92	<0.01	0.07	0.02	0.60	<0.1	0.44	<0.005	0.038	6.2	0.51	0.47	0.008	socketed axe	Vojilovo	Ha B1	Fig. 3:20
PozM 25	60	MA-186758	92	<0.005	<0.05	0.02	0.27	<0.1	0.32	<0.005	0.175	6.1	0.45	0.204	0.017	socketed axe	Vojilovo	Ha B1	Fig. 3:21
PozM 26	61	MA-196053	91	<0.01	0.49	0.02	0.39	<0.1	0.33	<0.005	0.154	7.1	0.57	0.15	0.014	socketed axe	Vojilovo	Ha B1	Fig. 3:22
PozM 27	62	MA-186759	95	<0.005	0.06	0.04	0.13	<0.1	0.148	<0.005	0.113	3.9	0.129	0.165	0.027	spearhead	Vojilovo	Ha B1	Fig. 3:19
PozM 28	65	MA-196054	92	<0.01	<0.05	0.05	0.19	<0.1	0.40	<0.01	0.136	6.1	0.94	0.50	0.02	bracelet	Vojilovo	Ha B1	Fig. 3:23
PozM 29	67	MA-196055	92	<0.01	<0.05	0.02	0.23	<0.1	0.156	<0.005	0.113	6.8	0.213	0.28	0.011	pendant	Vojilovo	Ha B1	Fig. 3:24
PozM 50	413	MA-196067	91	<0.01	<0.05	0.03	0.40	<0.1	0.299	<0.005	0.166	6.9	1.10	0.33	0.013	knife	Vojilovo	Ha B1	no picture
PozM 101	2059	MA-196101	93	<0.01	0.14	0.03	0.54	<0.1	0.59	<0.005	0.036	4.9	0.258	0.15	0.009	socketed axe	Stari Kostolac-Leštar	Ha C1	Fig. 4:2
PozM 102	2061	MA-196102	93	<0.01	<0.05	<0.01	0.43	<0.1	0.42	<0.005	0.023	5.3	0.52	0.23	<0.005	knife	Stari Kostolac-Leštar	Ha C1	Fig. 4:1
PozM 103	2063	MA-196103	74	<0.01	<0.05	<0.01	0.02	<0.1	<0.02	<0.02	0.056	8.4	0.096	17.6	<0.02	E-shaped object	Stari Kostolac-Leštar	Ha C1	Fig. 4:3
PozM 104	2064	MA-196104	90	<0.01	0.60	<0.01	1.37	0.2	0.86	<0.01	0.050	0.80	0.066	6.1	0.03	E-shaped object	Stari Kostolac-Leštar	Ha C1	Fig. 4:4
PozM 105	2065	MA-196105	81	<0.01	<0.05	<0.01	0.03	0.3	0.02	<0.02	0.063	3.4	0.076	15.2	0.04	E-shaped object	Stari Kostolac-Leštar	Ha C1	Fig. 4:5

PozM 106	2058	MA-196106	77	<0.01	<0.05	0.01	0.07	<0.1	<0.02	<0.02	0.36	5.3	0.245	17.1	0.05	horse figure	Stari Kostolac-Leštar	Ha C1	Fig. 4:6
PozM 107	2070	MA-196107	78	<0.01	0.22	0.06	0.05	<0.1	<0.02	<0.02	0.048	5.3	0.056	16.3	0.06	animal figure	Stari Kostolac-Leštar	Ha C1	Fig. 4:7
PozM 133	1511	MA-196130	76	<0.01	0.08	<0.01	0.02	0.8	<0.02	<0.02	0.049	7.2	0.084	15.5	<0.02	E-shaped object	Živica	Ha C1	Fig. 4:10
PozM 134	1512	MA-196131	77	<0.01	0.23	<0.01	0.02	0.9	<0.02	<0.02	0.063	6.3	0.199	15.3	<0.02	E-shaped object	Živica	Ha C1	Fig. 4:11
PozM 135	1507	MA-196132	96	<0.01	<0.05	0.02	0.32	<0.1	0.269	<0.005	0.158	2.09	0.37	0.39	0.011	pin	Živica	Ha C1	Fig. 4:13
PozM 136	1506	MA-196133	96	<0.01	<0.05	0.01	0.38	<0.1	0.41	<0.01	0.041	2.28	0.293	0.77	0.01	knife	Živica	Ha C1	Fig. 4:8
PozM 137	1514	MA-196134	91	<0.01	0.68	0.01	0.04	<0.1	1.37	<0.01	0.112	4.8	0.54	1.50	0.03	fibula	Živica	Ha C1	Fig. 4:9
PozM 138	1507	MA-196135	96	<0.01	<0.05	<0.01	0.02	<0.1	2.93	<0.01	0.011	0.007	0.069	0.60	0.05	awl	Živica	Ha C1	Fig. 4:12

Table 1. Chemical composition of the analyzed objects as determined with energy-dispersive XRF. All values are given in mass percent. Se and Mn was below the detection limit of 0.01 %, Te and Cd below 0.005 % in all samples.

VIAS lab. No.	Inv./ mus. no.	MA-lab. no.	208Pb/206Pb	2σ	207Pb/206Pb	2σ	206Pb/204Pb	2σ	208Pb/204Pb	2σ	207Pb/204Pb	2σ
NegM 1	1759	MA-186739	2.1131	0.0001	0.86328	0.00002	18.125	0.001	38.301	0.006	15.647	0.001
NegM 2	1760	MA-186740	2.1213	0.0001	0.86828	0.00003	18.012	0.001	38.209	0.001	15.639	0.001
NegM 4	1758	MA-186741	2.1200	0.0001	0.86740	0.00003	18.033	0.002	38.230	0.005	15.642	0.002
NegM 5	1761	MA-196017	2.1032	0.0001	0.85705	0.00001	18.270	0.001	38.424	0.001	15.658	0.001
NegM 6	1757	MA-186742	2.0884	0.0001	0.84844	0.00002	18.421	0.001	38.471	0.007	15.629	0.001
NegM 9	1765	MA-196018	2.0772	0.0001	0.83818	0.00001	18.687	0.001	38.816	0.001	15.663	0.001
NegM 11	1752	MA-186744	2.0982	0.0001	0.85378	0.00001	18.350	0.003	38.502	0.005	15.667	0.002
NegM 17	1755	MA-186745	2.1259	0.0001	0.87156	0.00003	17.943	0.003	38.144	0.006	15.638	0.002
NegM 20	1763	MA-186746	2.1053	0.0001	0.85816	0.00002	18.253	0.002	38.427	0.004	15.664	0.002
NegM 15	1747	MA-196019	2.1120	0.0001	0.86123	0.00002	18.176	0.001	38.387	0.002	15.653	0.001
NegM 24	167	MA-186747	2.0709	0.0001	0.84132	0.00001	18.624	0.001	38.568	0.001	15.669	0.001
NegM 22	168	MA-196020	2.1249	0.0001	0.87124	0.00001	17.947	0.001	38.137	0.002	15.636	0.001
NegM 23	169	MA-196021	2.1028	0.0001	0.85605	0.00001	18.296	0.001	38.474	0.003	15.663	0.001
NegM 26	182	MA-196022	2.1122	0.0001	0.86266	0.00002	18.142	0.001	38.320	0.002	15.650	0.001
NegM 28	177	MA-186748	2.0978	0.0001	0.85368	0.00001	18.354	0.002	38.502	0.004	15.668	0.002
NegM 32	176	MA-186749	2.1008	0.0001	0.85545	0.00002	18.314	0.001	38.475	0.001	15.667	0.001
NegM 35	171	MA-186750	2.1062	0.0001	0.85816	0.00003	18.247	0.001	38.433	0.003	15.659	0.001
NegM 37	174	MA-186751	2.1003	0.0001	0.85479	0.00002	18.328	0.001	38.493	0.004	15.666	0.001
PozM 20	154	MA-196051	2.1009	0.0001	0.85483	0.00001	18.324	0.001	38.497	0.002	15.664	0.001
PozM 21	155	MA-186756	2.1154	0.0001	0.86468	0.00003	18.098	0.002	38.283	0.006	15.649	0.002
PozM 23	144	MA-186757	2.0988	0.0001	0.85282	0.00004	18.375	0.002	38.564	0.006	15.670	0.002
PozM 109	1524	MA-196108	2.0979	0.0001	0.85215	0.00001	18.380	0.005	38.559	0.010	15.663	0.004
PozM 110	1528	MA-196109	2.0932	0.0001	0.84799	0.00001	18.468	0.001	38.657	0.003	15.661	0.001
PozM 112	1532	MA-186773	2.09	0.0001	0.84757	0.00003	18.486	0.002	38.636	0.01	15.668	0.002
PozM 113	1533	MA-196110	2.0937	0.0001	0.85014	0.00001	18.426	0.002	38.578	0.004	15.664	0.001

Table 2. Lead isotope ratios in the samples discussed within this article.

Traces of Use, Damage, and Context of Deposition of Bronze Age Swords: A Case Study of Reutlingen-Type Swords from Vojvodina

Anđelka Putica[1]

Abstract: This study investigates the Reutlingen-type swords from the LBA, emphasizing their context, damage patterns, and use. In Vojvodina, 86% of these swords appear in fragmented forms within hoards, with single finds accounting for 13%. Grave finds are exceedingly rare, with the Ritiševo specimen potentially being the only example. Among 14 identified swords, 79% were found in hoards. The remaining fully preserved specimens are now lost, although newer discoveries, such as fragments from the Krčedin II and Poljanice hoards, expand the dataset. Notably, the Poljanice hoard contained fragments of multiple sword types, reflecting diverse regional weapon usage. Damage analysis reveals evidence of intense use, with 50% of fragments displaying wear. V-shaped notches, indicative of direct sword contact, were the most common, alongside U-shaped notches, micro-notches, and rippling. Plastic deformations, such as bending and twisting, were significant and are attributed to deliberate human actions rather than natural causes. Intentional damage to the swords, including chisel marks and strategic fragmentation, often rendered them non-functional, though the motives remain unclear and not necessarily ritualistic. The fragmentation process was systematic, with most fragments comprising hilts and upper blade sections. These patterns align with Late Bronze Age hoards in the region, particularly from the HaA1 period. Evidence suggests these swords were highly versatile, serving both offensive and defensive roles, often used alongside spears and secondary blades. In conclusion, the Reutlingen-type swords represent an advanced innovation in Bronze Age weaponry. Their widespread distribution, strategic damage patterns, and utility in combat highlight their dual role as functional tools and culturally significant artifacts. This analysis enriches our understanding of Late Bronze Age martial practices and material culture in the Carpathian Basin.

Key words: Reutlingen-type swords, LBA, Vojvodina, hoard finds, weapon damage, fragmentation, combat use

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The Reutlingen sword type, also known as Naue II/Cetona, emerged as a distinct form of weaponry during the BzD period, introducing an innovative technique suited for cutting, tearing, and stabbing.[1] The origin of Naue II-type swords,[2] also referred to as the Reutlingen type[3] and the Cetona type,[4] is traced to the Central European-Carpathian region or northeastern Italy.[5] Significant concentrations of these swords are found on the Jutland Peninsula and in the Carpathian

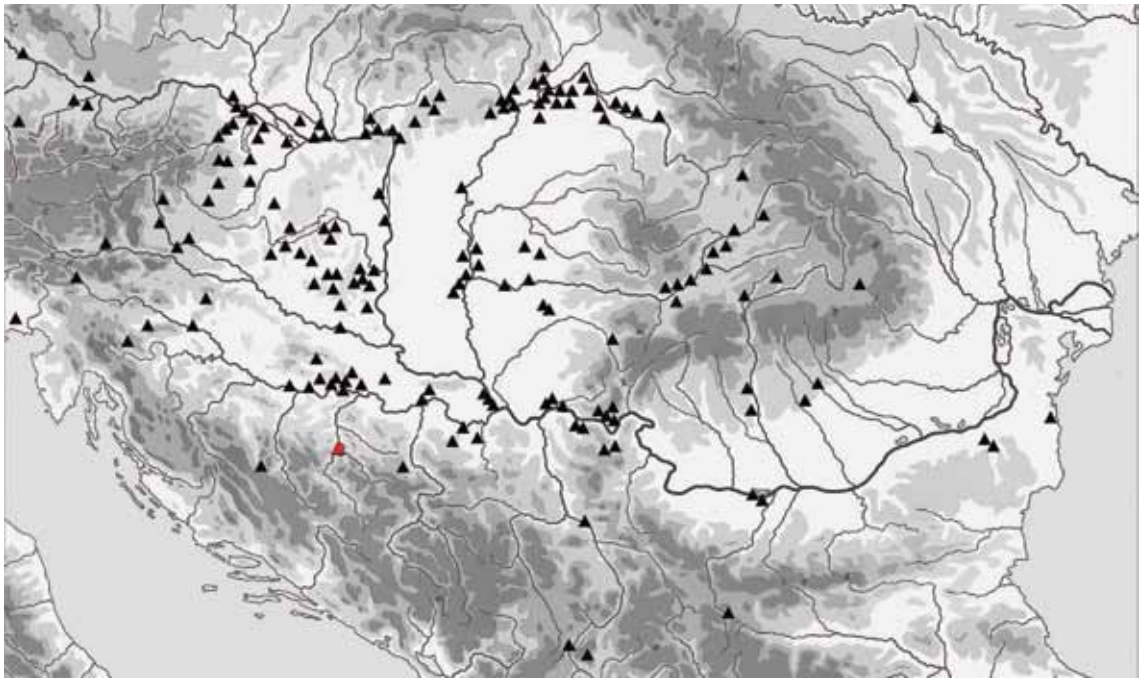


Fig. 1 – An overview map showing the distribution of Reutlingen-type swords located south of the Danube bend within the Carpathian Basin, the Eastern Alps, and part of the Balkans (Blečić Kavur and Jašarević 2014, fig. 5).

Basin.[6] Notably, the largest numbers of these swords are found in fragmented form, especially from the HaA1 period, within hoards extending from Transdanubia to Slavonia.[7] Additionally, examples of this weapon type have been uncovered in the Middle East, likely introduced there by manufacturers or warriors from the central Mediterranean[8] (fig. 1).

Context of Finds

The context of Reutlingen-type sword discoveries varies significantly across regions. On the Jutland Peninsula, they are primarily found in graves, whereas in the Carpathian Basin, they

[1] Naue 1903, 13-27, Taf. VI-XI; Cowen 1955; Schauer 1971, 132-142; Bianco Peroni 1970, 62-64; Kemenczei 1988, 53-56; Bader 1991, 86-100; Harding 1995, 11; Pabst 2015.

[2] Group A, Kilian-Dirlmeier 1993, 94-105.

[3] Schauer 1971, 132-144; Bader 1991, 86-100; Harding 1995, 35-44.

[4] Bianco Peroni 1970, 62-64.

[5] Pabst 2013, Fig. 1.

[6] Suchowska-Ducke 2015, 260, fig. 2.

[7] Blečić Kavur and Jašarević 2014, fig. 5.

[8] Jung and Mehofer 2008, 134; Suchowska-Ducke 2015, 258.

are often uncovered in hoards.[9] In Western Europe, these swords are frequently associated with wet soil and river deposits.[10] Only one example has been located in the sanctuary of Škocjan-Mušja Jama in Slovenia,[11] and another in the settlement of Bălcești near Vâlcea in Romania.[12] In Serbia, Croatia, and Slovenia, findings exhibit the following patterns: the majority of artifacts—46 in total—have been discovered in hoards, with only 2 found in graves. Additionally, the number of isolated finds from dry environments has risen to 15, and one specimen was retrieved from water. In two instances, the context of the find remains unknown. The sword discovered in the necropolis of Donja Brnjica represents the sole example of a classic Reutlingen sword found in a grave within Serbia.[13]

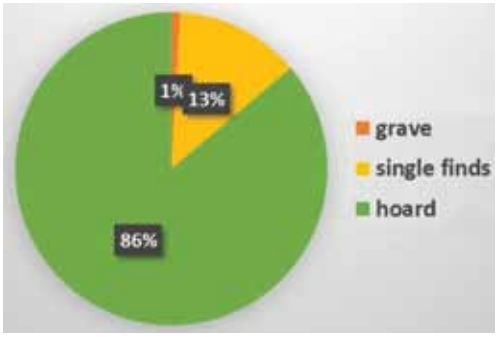


Fig. 2 – Contextual analysis of LBA sword discoveries in the territory of Vojvodina.

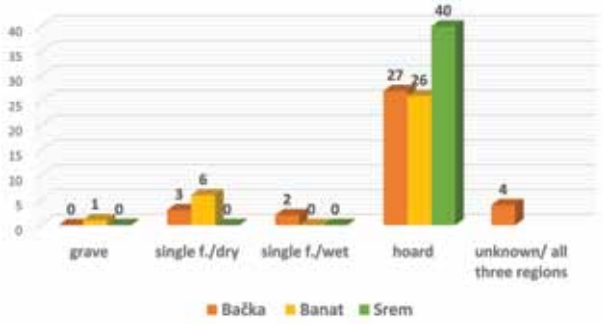


Fig. 2a – Types of contexts found in the region.

In the Vojvodina area, artifacts generally appear in fragmented form within hoards.[14] An exception may be the specimen from Ritiševo, previously classified as having an unknown context.[15] This sword, likely a grave find, was discovered in the early 20th century at Ritiševo (Banat) during construction work, alongside human bones.

A striking feature of the Late Bronze Age findings in Vojvodina is the exceptionally high percentage of weapons—86% of swords and sword fragments—that originate from hoard contexts (figs. 2, 2a). Single finds account for only 13%, with just one sword potentially representing a grave find. In contrast, during the Middle Bronze Age, swords are mostly found in graves or as single finds, with only one sword recovered from a hoard.[16] Among the 14 known specimens of the Reutlingen type, 11 (79%) originate from hoards.[17] Two completely preserved specimens have either an unknown context[18] or are from a

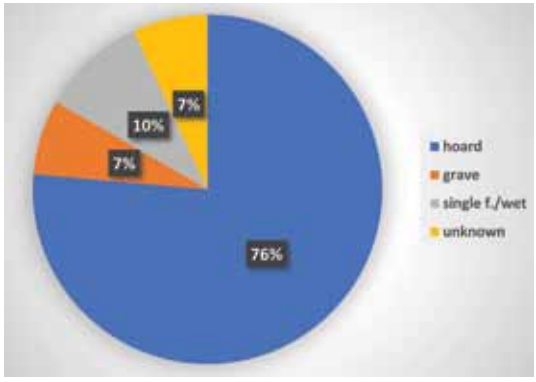


Fig. 3 – Context of Reutlingen-type sword finds in the territory of Vojvodina.

[9] Kristiansen, Suchowska-Ducke 2015, 373-378; Suchowska-Ducke 2015, 259.
[10] Burgess and Colquhoun 1988; Cowen 1955.
[11] Harding 1995, p. 51; Turk 2016, p. 105.
[12] Bader 1991, p. 87.
[13] Srejović 1959/60, 95, sl.8.
[14] Harding 1995, nos. 81, 105, 110, 113-114, 130; Jovanović 2010.
[15] Harding 1995, 39, T.13/92; Jovanović 2010, 39.
[16] Harding 1995; Putica 2022.
[17] Harding 1995; Jovanović 2010.
[18] Коледин и Николић 2021, Сл. 1.

grave (Ritiševo), while one nearly intact specimen was retrieved from the Danube River.[19] Unfortunately, both fully preserved specimens are now lost. Recent discoveries have added to this analysis, including three fragments from the Krčedin II hoard[20] and two from the Poljanice hoard near Bečej.[21] Notably, the Poljanice hoard comprises 17 sword fragments of various types, with the Tenja, Reutlingen, and Novigrad types being the most prevalent (fig. 3).

Damage caused by use

The markings found on the blades were compared with results from experimental tests conducted on various types of European swords.[22] Traces of use were observed on seven fragments, which accounts for 50% of the total number. The V-notch, recognized as the clearest indicator of direct contact with another sword, was identified on three specimens located at the upper, middle, and lower parts of the blade (fig.4,4a;fig.5,5a;fig.6,6a). The most common markers include micro-notches resulting from various movements (21%), followed by rectangular indentations (17%) and other types of indentations (13%). Other markers were recorded with a presence of less than 10% on the blades. Rippling, U-notches, and additional indentations were all noted on the same specimen (fig.7a-c). The only marker noted along the entire length of the blade is the V-shaped notch. Traces of sharpening were observed only on one specimen (fig.6b). After summarizing the data, it is evident that the largest number of markers was recorded on the central and lower parts of the blade.

Deliberately damage and fragmentation

Highlighting the end of the useful life of objects, particularly swords, it is clear that intentional damage sometimes significantly impacts their final appearance. This includes all forms of damage and wear that are not related to regular use. The act of fragmentation can also be seen as intentional harm, though this does not necessarily mean it has a ritualistic purpose.



Figs. 4, 4a – A V-notch example from the Poljanice hoard (Inv. No. 1616, City Museum Bečej), showing the hilt and upper part of the blade, which is slightly bent.

[19] Harding 1995, Taf. 27/218.

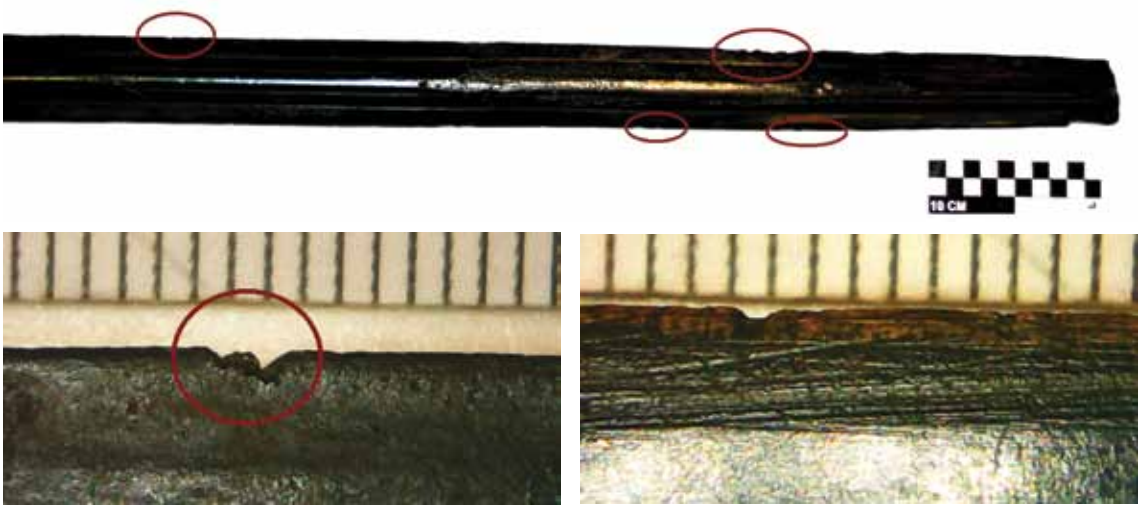
[20] Коледин и Гачић 2022, кат. 18-20.

[21] Карапанџић и Рамадански 2021, кат. 6, 8.

[22] Bridgeford 2000; Kristiansen 2002; Molloy 2007, Molloy 2008; Molloy 2011; Knight 2018; Gentile and van Gijn 2019; Herman et al. 2020.



Figs. 5, 5a – A V-notch example from the Krčedin II hoard
(Inv. No. 3514, City Museum of Novi Sad), featuring a deliberately bent blade



Figs. 6, 6a, 6b – Markers along the blade, including a V-notch (6a) and evidence of grinding (6b), from a single find in the Danube River (AP 3744, The Museum of Vojvodina).

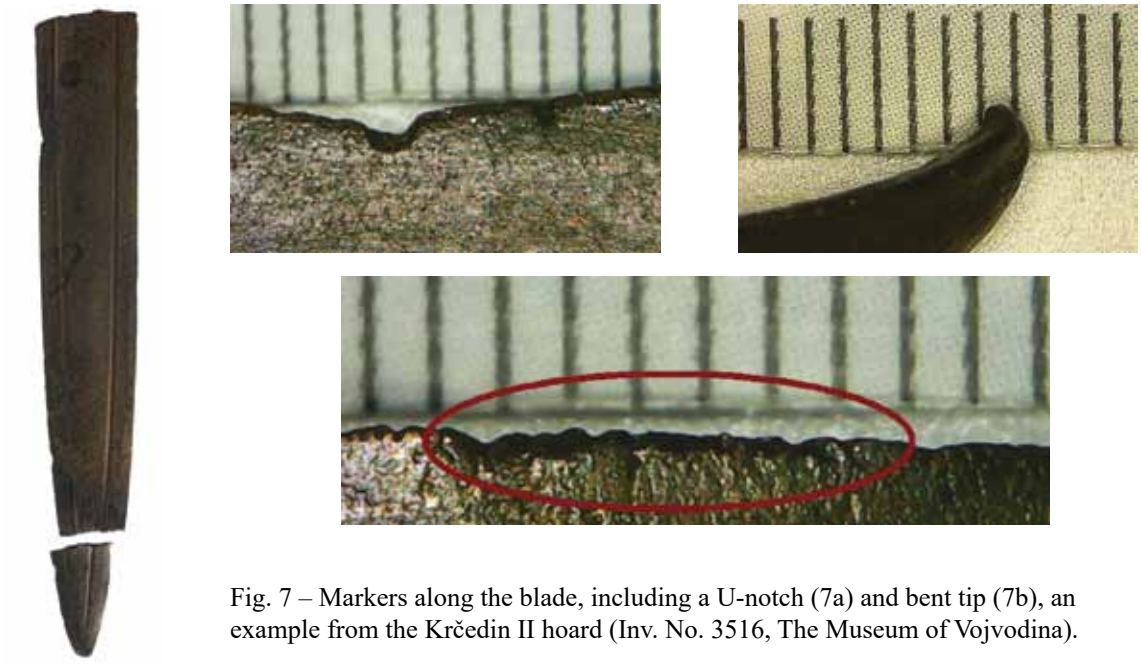


Fig. 7 – Markers along the blade, including a U-notch (7a) and bent tip (7b), an example from the Krčedin II hoard (Inv. No. 3516, The Museum of Vojvodina).

One of the fundamental steps of the methodological approach proposed for this research was the division of swords according to their completeness. Damaged items may be fragmented or slightly damaged. The goal was to identify and quantify different types of fragmentation.

The specimens range from completely and almost completely preserved to fragments. The largest portion of fragments consists of the hilt and the upper part of the blade (36%). (fig. 8). Traces of use were observed on only two of these fragments. The preserved tongue, along with the upper part of the blade, is a common type of fragmentation found in hoards from the Late Bronze Age, particularly during the HaA1 period in the territory of Vojvodina.

The damage to the blades of the swords varies considerably, ranging from a slight twist to a fully folded blade that shows visible signs of violent handling (fig.5a). Bending is also characteristic of the HaA1 period, with varying degrees of blade bending ranging from minimal to extreme. Typically, only the lower third of the blade is bent, or the top may bend upwards by a few centimetres (fig.7). Curvature is also present in the hilt and upper blade fragments, likely occurring after the lower part of the blade is fractured. In all instances, the distortion is the result of significant force and cannot be attributed to post-depositional processes.

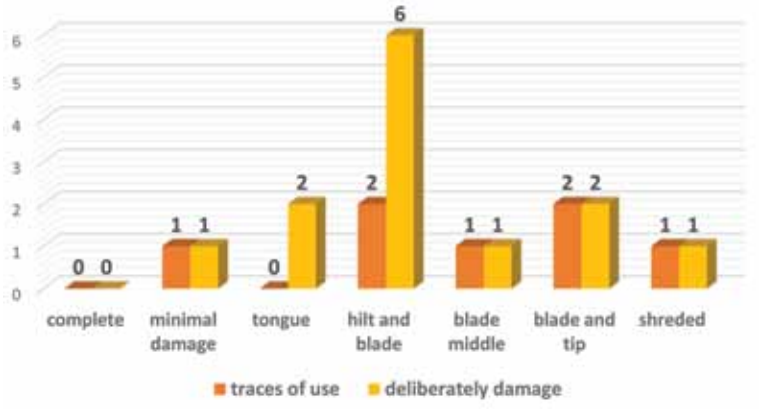
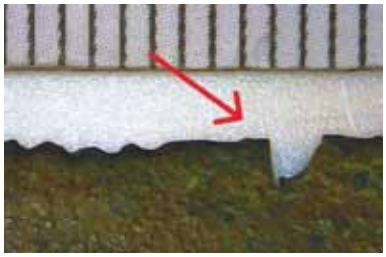


Fig. 8 – The main type of fragmentation of Reutlingen-type swords found in the territory of Vojvodina.





Figs. 9, 9a – Tool marks (chisel) on the blade, with an example from the Krčedin I hoard (AP 3198, The Museum of Vojvodina).

Tool Marks

Tool marks on the swords indicate a deliberate effort to render the objects non-functional. The most common marks are straight, V-shaped indentations with sharp edges, varying in size.[23] This type of damage is typically associated with the use of a chisel (figs. 9, 9a).

Conclusion

Among the 14 Reutlingen-type swords found in Vojvodina, 11 (79%) come from hoards, with most being fragmentary. Unfortunately, both fully preserved specimens are now lost. The majority of these fragments consist of hilts with the upper parts of the blades (36%). Traces of use are present on 7 fragments, representing 50% of the total.

The damage to blades indicates direct contact with other objects or weapons, evident in the V-shaped nicks resulting from brief blade-to-blade impact. U-shaped notches likely formed through rotational movements during prolonged contact between blades. Additionally, dents may indicate blows against a wooden handle, bone, or the flat side of another blade. The combination of different markings suggests that some blades underwent intensive use.

Plastic deformations are visible on several specimens; these curved forms appear to be the result of human action rather than natural processes.

In summary, Reutlingen-type swords were employed in combat alongside a secondary blade and spear hilt, fulfilling both offensive and defensive functions. Although many survive in a fragmentary state, this analysis supports the conclusion that Reutlingen-type swords were innovative weapons designed for cutting, slashing, and stabbing.

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Jászladány axes from Northeastern Serbia: An insight into copper isotope analysis

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Abstract: Copper axe-adzes of the Jászladány type are a prominent feature of Eneolithic material culture, particularly in Southeastern Europe, with significant finds in Serbia. Characterized by dual bits positioned horizontally and vertically relative to the shaft-hole, these tools are distributed across a wide territory, from the Carpathian Basin to the Balkans. In Serbia, six subtypes have been identified, suggesting production in localized workshops. Their association with copper-rich regions, particularly in Northeastern Serbia, supports a functional link to mining activities. Isotopic analyses of 14 axes from Eastern Serbia aimed to trace the origins of the copper used in their production. The δ65Cu values revealed a preference for supergene ores, such as malachite and azurite, indicating shallow mining during the mid-5th millennium BCE. A geographic variation in isotopic signatures, with lower δ65Cu values in the Bor region compared to other areas, suggests earlier or more intensive mining activity in this region. These findings refine the understanding of copper exploitation patterns, highlighting a transition from oxide to sulfide mineral processing post-2000 BCE. The study corroborates the hypothesis of local production of Jászladány-type tools in the Central Balkans, aligning with new insights into the genesis of the Early Eneolithic in this region. This research emphasizes the large-scale copper production in the Central Balkans during the Early/Middle Eneolithic and its impact on regional metallurgy.

Key words: Jászladány-type axes, Copper isotopic analysis, Eneolithic metallurgy, Central Balkans copper production, Supergene copper ores.

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Introduction[1]

Copper axe-adzes of the Jászladány type represent a common, yet a quite specific feature of the Copper Age material culture, studied for more than 70 years. Such axe-adzes have two bits on opposite ends of the body, of which one is positioned horizontally and the other vertically to the axis of the shaft-hole. The shaft-hole is usually positioned in the central part of the tool and separates it into two arms of almost identical length. The upper and lower parts of the cylindrical shaft-hole have ring-shaped protrusions. The lower protrusion is usually more emphasized and larger than the upper one. The cross-sections of both arms are semi-ellipsoidal and often have a recessed base. When observed laterally, the arms of the tool are not aligned, and their axis angularly cut at the shaft-hole. Both bits are arched and fan-shaped (Figure 1). Their distribution is

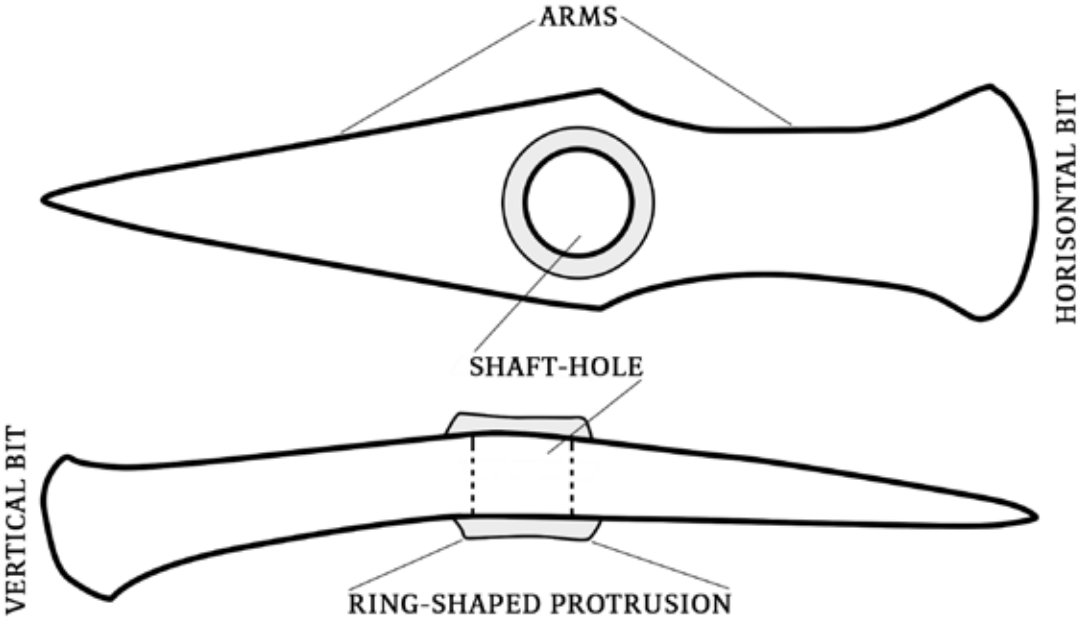


Fig. 1 – Axe-adze of the Jászladány type.

primarily connected with the Southeastern Europe, and such objects represent frequent finds in a wide territory between the eastern parts of Central Europe and the Balkans. Their distribution is particularly well defined in the territories of Bulgaria, Serbia, and the Romanian and Hungarian parts of the Carpathian Basin.[2] In the territory of Serbia, the highest distribution of different variants of copper axes of the Jászladány type is connected with the Sava and Danube Regions, meaning the territories of Northwestern and Northeastern Serbia.[3]

More than 160 examples are known from the territory of Serbia, which are divided into several basic and several local variants. Unfortunately, the majority of finds are either chance finds, or originate from hoards,[4] except the example from Padina,[5] which disabled the determi-

[1] This paper is the result of the project THE FLOW – Interactions – Transmission – Transformation: Long-distance connections in Copper and Bronze Age of the Central Balkans, funded by the Science Fund of the Republic of Serbia (Programme IDEAS, Grant No. 7750074).

[2] Vulpe 1975; Todorova 1981; Antonović 2014.

[3] Cf. Antonović 2009; Antonović 2014. Tafel 49, Tafel 50.

[4] Antonović 2009, 171.

[5] Jovanović 1971.

nation of their precise chronological position in the territory of Serbia. Within the territory of Serbia, six subtypes or local variants of the Jászladány type have been separated – Ruma, Barice, Donji Milanovac, Šarkamen, and Šabac. Each of the variants possesses basic characteristics of the Jászladány type, and the differences are based on small deviations from those characteristics. Presumably, those differences are the result of various local workshops.[6]

In the territory of the Carpathian Basin, such axes-adzes are correlated with the Bodrogkeresztur group burials.[7] Recent typological analyses and a series of absolute dates from the site of Rakoczifalva-Bagifold, where an axe-adze of the Jászladány type was recorded within a symbolic grave (cenotaph) (Grave 218), indicated the period of the final third of the 5th millennium calBC.[8] The origin of the axe-adzes of the Jászladány type has in light of their territorial distribution been sought in the territory of the Carpathian Basin. However, a recent comprehensive study on the genesis of the Early Eneolithic in the Central Balkans, supported by new absolute dates, indicated that such objects could have originated from the so-called Transitional Region (Peripannonian Region) between the Pannonian Plain and the Central Balkans, possibly during the mid-5th millennium BCE.[9]

Although the question of their origin remains open, and such objects are still considered as "imports" in the Central Balkans, several indicators point to the possibility of their Central Balkan origin. Namely, the function of those axe-adzes is not precisely defined, yet certain authors considered them as mining tools, connected with the expansion and evolution of copper metallurgy during the later stages of the Eneolithic.[10] This is further supported by the fact that such tools are usually undecorated, and hence possibly represent tools rather than weapons for prominent members of the community. In Serbia, the only decorated example, with rows comprised of four punctuated marks, comes from Batajnica.[11] One of the indicators of their origin could be their distribution in the territory of Serbia, which as aforementioned can be connected with Northwestern and Northeastern Serbia. Both of these regions, and particularly the territory of Eastern Serbia, are rich in ore deposits, such as gold, tin, and especially copper.[12] Hence, their territorial distribution and possible function might indeed indicate their connections with the copper deposits in the Central Balkans. Further, the metallurgical analyses that have been previously conducted on some of the examples of copper tools (including the axe-adzes of the Jászladány type) from the territories of the Carpathian Basin and the Central Balkans, point to the possible origin of copper for their production in Eastern Serbia.[13]

This study will present the results of the isotopic analyses of 14 axe-adzes of the Jászladány type from the territory of Eastern Serbia (Figure 2). The goal of the study was to potentially determine the origin of the axe-adzed through their composition and isotopic values.

[6] Antonović 2014: 66 and further.

[7] Kienlin, Pernicka 2009, 259-260.

[8] Csányi et al. 2010; Brummack, Diaconescu 2014, 246-254.

[9] Bulatović et al. 2020; Mladenović et al. 2024.

[10] Jovanović 1979, 38-41.

[11] Antonović 2014: Taf. 12/149.

[12] Вујадиновић 1953, 56; Мишић, Ђокић 2011, 95-97; Филиповић 2015, 16-18, with cited literature; Powell et al. 2018; Powell et al. 2020

[13] Pernicka et al. 1993; Siklósi, Szilágyi 2019.

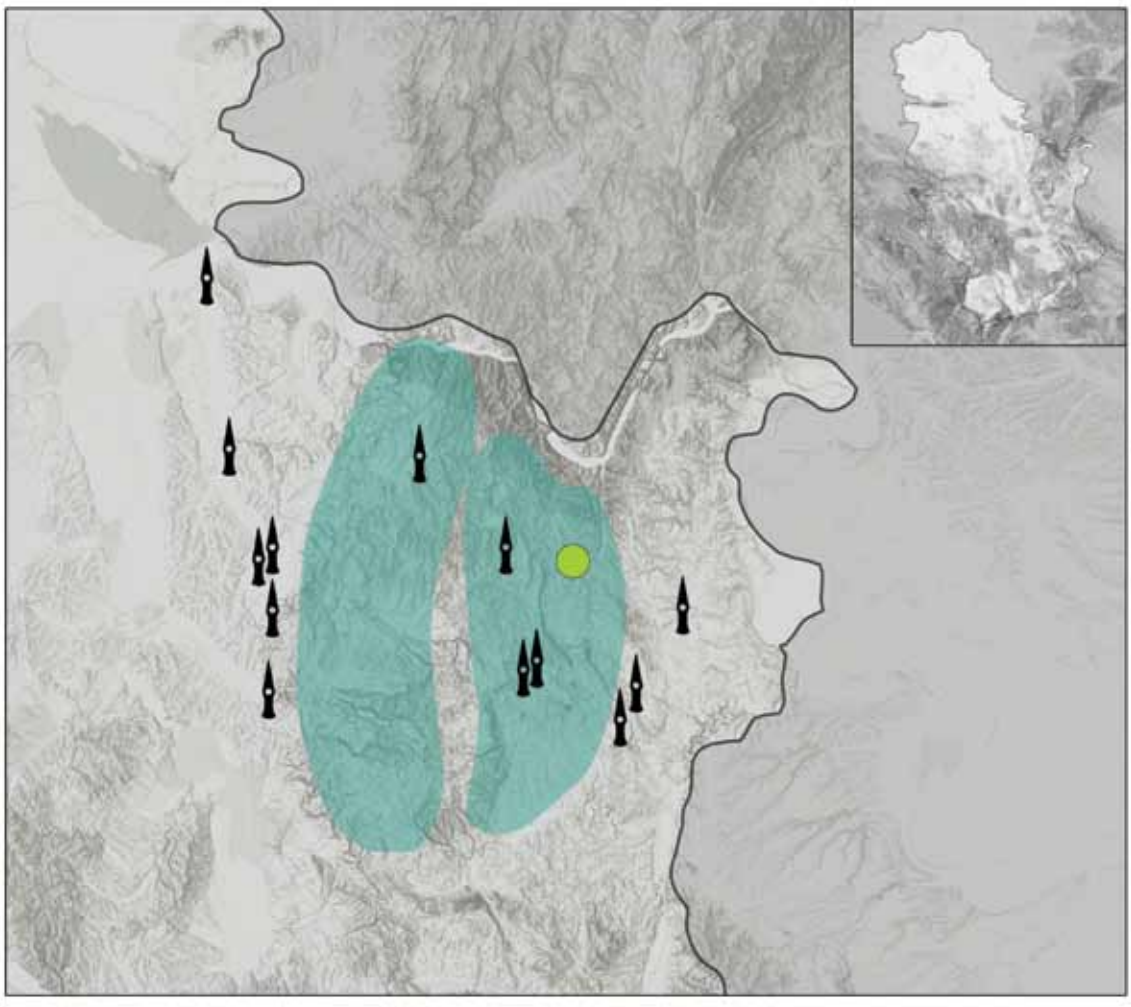


Fig. 2 – Distribution of samples presented in this study
(dark green – areas with copper deposits) (green dot – Rudna Glava prehistoric mine).

Catalogue

1. Museum of Mining and Metallurgy in Bor, Inv. No. 1518. Village of Krivelj, site Bunar.[14]
A single find of an axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. The cross-sections of both arms are semi-ellipsoidal. From the lateral side, the arms of the axe are not aligned, as their axis cut angularly at the shaft-hole. Both bits are arched and fan-shaped. Length: 28 cm. (T. I/1)

[14] Pernicka et al. 1993, 4 (HDM 1326), Taf. 9, 5; Antonović 2014, Taf. 15/170.

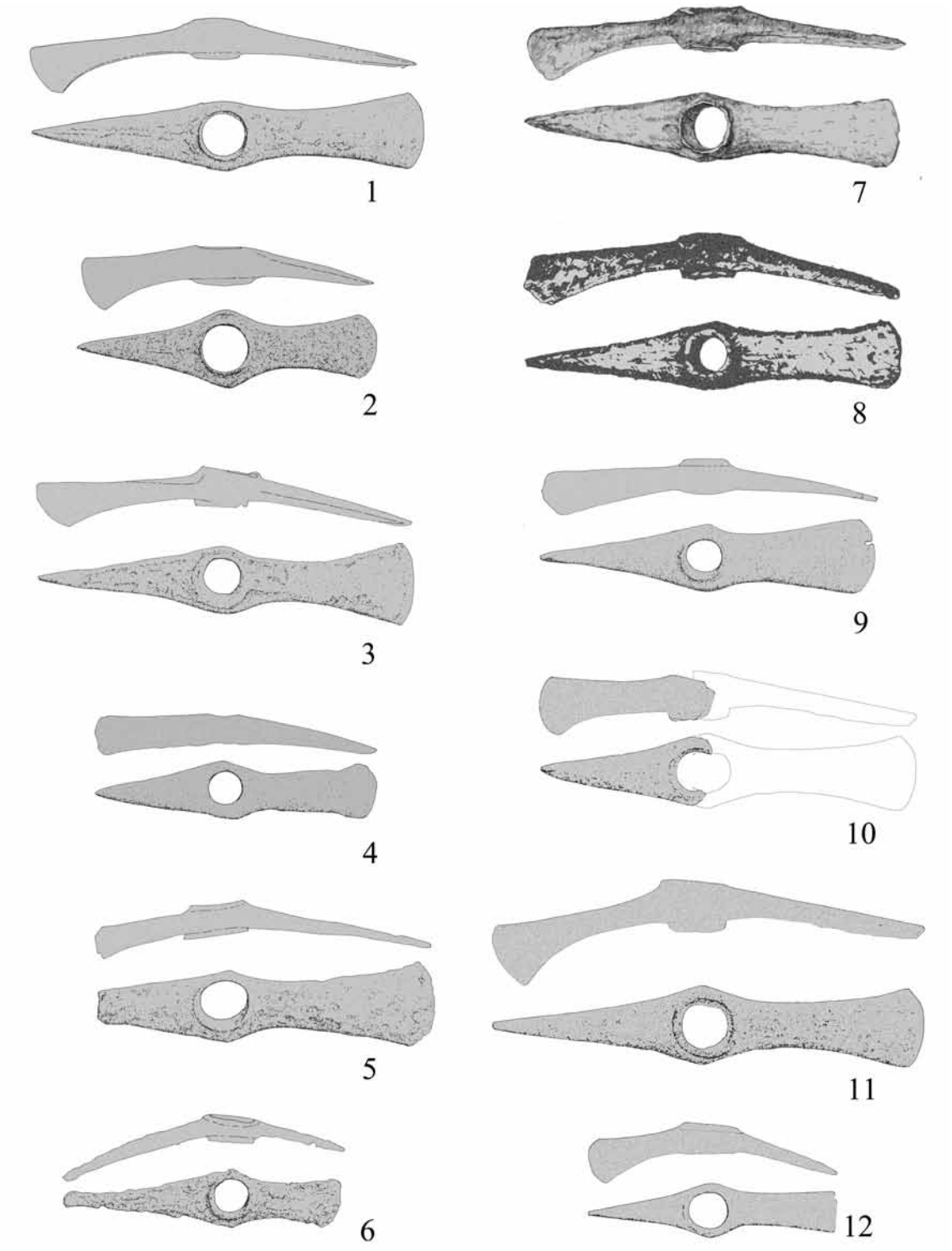
2. Museum of Mining and Metallurgy in Bor, Inv. No. 2191. Village Donja Bela Reka.[15]
A single find of an axe of the Barice variant of the Jászladány type. The axe has two opposite bits, of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned in the center of the tool, hence separating it into two parts of almost identical length. The horizontal arm is slightly reduced towards the shaft-hole compared to the other examples. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. The cross-sections of both arms are semi-ellipsoidal. From the lateral side, the arms of the axe are not aligned, but equally curved. Both bits are arched and fan-shaped. Length: 21.5 cm. (T. I/2)

3. Museum of Mining and Metallurgy in Bor, Inv. No. 3026. Village Krivelj, site Kriveljski Kop.[16]
A single find of an axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. The diameter of the shaft-hole is slightly smaller compared to the common shaft-holes for this type. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. From the lateral side, the arms of the axe are not aligned. Both bits are arched and fan-shaped. The horizontal bit is disproportionately extended compared to similar examples of this type. Length: 27 cm. (T. I/3)

4. Museum of Mining and Metallurgy in Bor, Inv. No. 4597. Vicinity of Bor, unknown site.[17]
A single find of an axe of Jászladány type, variant Šabac according to D. Antonović. The axe has two opposite bits, of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned closer to the vertical arm, and has a slightly smaller diameter compared to the common shaft-holes for this type. There are no ring-shaped protrusions at the cylindrical shaft-hole. The cross-section of the horizontal arm is semi-ellipsoidal and flattened, and the cross-section of the other arm is circular. From the lateral side, the arms are almost completely aligned. Both bits are arched and slightly fan-shaped. Length: 20.5 cm. (T. I/4)

5. Museum of Mining and Metallurgy in Bor, Inv. No. 797. Village Voluja, unknown site.[18]
A single find of a fragmented axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. From the lateral side, the arms of the axe are not aligned, as their axis cut angularly at the shaft-hole. The horizontal bit is arched and fan-shaped. Length: 24.7 cm. (T. I/5)

[15] Pernicka et al. 1993, 4 (HDM 1319), Taf. 8, 8; Antonović 2014, Taf. 24/226.
[16] Antonović 2014, Taf. 16/171.
[17] Antonović 2014, Taf. 30/264.
[18] Pernicka et al. 1993, 4 (HDM 1317); Antonović 2014, Taf. 31/275.



T. I

6. Museum of Mining and Metallurgy in Bor, Inv. No. 2289. Village Glogovica, site Selište.[19] A find of a doubled axe-adze based on the Jászladány type. The example is poorly preserved and has two horisontal fan-shaped bits on the opposite ends. The cylindrical shaft-

[19] Pernicka et al. 1993, 4 (HDM 1318), Taf. 8, 9; Antonović 2014, Taf. 36/326.

hole is positioned closer to the wider arm. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. From the lateral side, the arms of the axe cut at a sharp angle in the upper part of the shaft-hole. Length: 20 cm. (T. I/6)

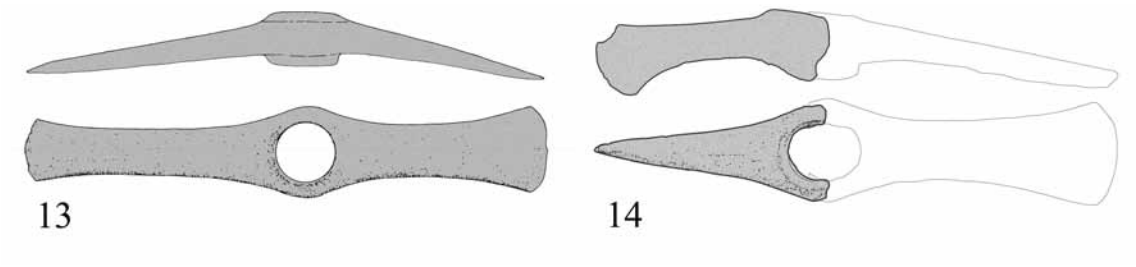
7. Museum in Majdanpek, Inv. No. 7. Vicinity of Bor, site Pustinac.[20]
A single find of a massive axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. The cross-sections of both arms are semi-ellipsoidal. From the lateral side, the arms of the axe are not aligned, but equally and slightly curved. Both bits are arched and fan-shaped. Length: 31.1 cm. (T. I/7)

8. Museum in Majdanpek, Inv. No. 8. Village Leskovo, site Čoka Lušanji.[21]
A single find of a massive axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. The cross-sections of both arms are semi-ellipsoidal. From the lateral side, the arms of the axe are not aligned, but equally and slightly curved. Both bits are arched and fan-shaped. Length: 31.1 cm. (T. I/8)

9. Krajina Museum, Inv. No. 1785. Village Šarkamen, site Duga Poljana.[22]
A hoard consisting of five axes of the Jászladány type, variant Šarkamen according to D. Antonović. Similar to the other examples, this example has two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned closer to the vertical bit, with an emphasized difference in the length of the arms. The arm with horizontal bit is larger and more massive compared to the common examples of the Jászladány type. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The upper protrusion is larger and more emphasized than the lower one. The cross-sections of both arms are semi-ellipsoidal. From the lateral side, the arms are slightly out of the axis, which is a characteristic of this variant. Both bits are arched and fan-shaped, and the horizontal bit is larger compared to the common Jászladány type. Length: 24.3 cm. (T. I/9)

10. National Museum in Požarevac, Inv. No. 181. Village Starčevo, site Mali Bubanj.[23]
A single find of a fragmented axe of the Jászladány type. A portion of the shaft-hole is preserved, and the bit is vertically positioned to the axis of the shaft-hole. The lower part of the shaft-hole has a ring-shaped protrusion. The cross-section of the arm is a combination

[20] We would like to thank Borivoje Krčmarević, curator of Museum of Majdanpek for data and illustrations.
[21] We would like to thank Borivoje Krčmarević, curator of Museum of Majdanpek for data and illustrations.
[22] Pernicka et al. 1993, 4 (HDM 1314); Antonović 2014, Taf. 28/250.
[23] Pernicka et al 1993, 4 (HDM 1428); Antonović 2014, Taf. 31/271.



T. II

of a polygon with two angles on the longer side and a semi-ellipsoidal shape on the other side. From the lateral side, the arm of the axe is out of the presumed axis. The bit is arched and fan-shaped. Length: 12.5 cm. (T. I/10)

11. National Museum in Požarevac, Inv. No. 432. Village Veliko Laole, site Plandište.[24]
A single find of a massive axe of the Jászladány type with two opposite bits of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. From the lateral side, the arms of the axe are not aligned, as their axis cut angularly at the shaft-hole. Both bits are arched and fan-shaped. Length: 31 cm. (T. I/11)

12. National Museum in Požarevac, Inv. No. 1002. Village Dvorište, site Krušar.[25]
A single find of a small axe of the Jászladány type, variant Donji Milanovac according to D. Antonović. Similar to the other axes of this type, this example has two opposite bits, of which one is positioned parallel and the other vertical to the axis of the shaft-hole. The characteristic of this type is that the arm with the horizontal bit retains its width throughout its length. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The upper protrusion is significantly larger and more emphasized than the lower one. From the lateral side, the arms of the axe are not aligned, as their axis cut angularly at the shaft-hole. The vertical bit is arched and fan-shaped. Length: 18 cm. (T. I/12)

13. National Museum in Požarevac, Inv. No. 1001. Village Rečica, site Ladne Vode.[26]
A find of a doubled axe-adze, based on the Jászladány type. The example has two horisontal fan-shaped bits on opposite ends. The cylindrical shaft-hole is positioned approximately in the center of the tool, hence separating it into two parts of almost identical length. Ring-shaped protrusions are positioned on the upper and lower parts of the shaft-hole. The lower protrusion is larger and more emphasized than the upper one. From the lateral side, the arms of the axe are not aligned, as their axis cut angularly at the shaft-hole. Length: 24.4 cm. (T. I/13)

[24] Pernicka et al. 1993, 5 (HDM 1427), Taf. 11, 1; Antonović 2014, Taf. 20/200.
[25] Pernicka et al. 1993, 4 (HDM 1430); Antonović 2014, Taf. 27/241.
[26] Pernicka et al. 1993, 4 (HDM 1429), Taf. 11, 2; Antonović 2014, Taf. 36/328.

14. National Museum in Požarevac, Inv. No. 2876. Village Veliko Laole, unknown site.[27]
A single find of a fragmented axe of the Jászladány type. Half of the shaft-hole and arm with bit vertical to the axis of the shaft-hole are preserved. The upper part of the shaft-hole has a ring-shaped protrusion. From the lateral side, the arm of the axe is out of the presumed axis. The bit is arched and fan-shaped. Length: 16.5 cm. (T. I/14)

SAMPLE	$d^{65}Cu$
1	0,41
2	0,53
3	0,15
4	0,61
5	0,29
6	1,21
7	1,15
8	0,82
9	0,53
10	1,37
11	1,86
12	1,96
13	1,48
14	1,71

Table 1 – Values of $d^{65}Cu$ isotopes.

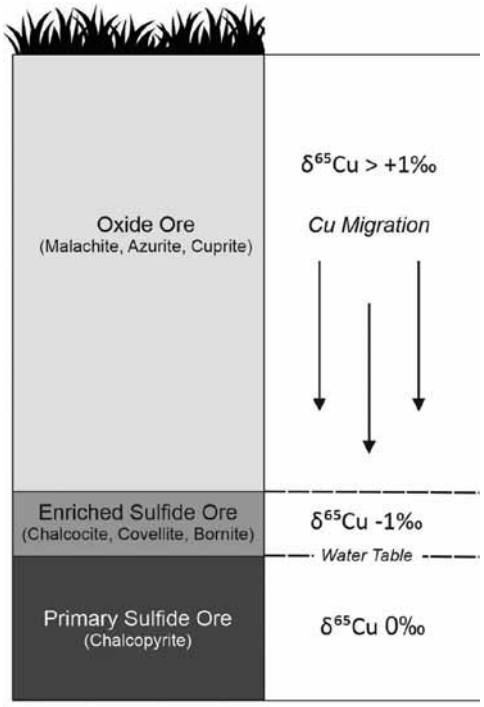


Fig. 3 – Isotopic and mineralogical stratification of copper ores due to weathering in humid climates.

Methods

Samples of artifacts for which the oxidized patina had been removed were dissolved in 5 ml of heated (100 C) aqua regia (3:1 ultrapure 11MHCl and 16 N HNO3) in a 15 ml telfon jar for 4 hours. A small aliquot was taken from the jar and diluted to 100 ppb for isotopic analysis. No ion exchange chromatography was needed as copper was >80% of all ions present in solution. The solutions were measured on a Thermo Scientific Neptune Plus multicollector ICPMS at Juniata College. The instrument was in low-resolution mode with on-peak blank subtraction, and 30 ratios were measured for each sample. Copper isotope values are reported relative to the NIST 976 standard, and mass bias is controlled with standard sample bracketing. Errors for each measurement were calculated to be ±0.09‰, (n ¼ 29, 2s) by monitoring the variation of the NIST 976 through four different sessions. An in-house standard, a USA penny from 1838 reported in Mathur et al. (2009), overlapped previous reported values at $\delta^{65}Cu$=0.02‰ ± 0.08‰.

[27] Unpublished, we would like to thank D. Jacanović and S. Živanović on the data and illustration.

Discussion

Copper has two isotopes (^{65}Cu and ^{63}Cu); ^{65}Cu tends to favor stronger bonding environments associated with oxidation.[28] Thus, the oxidation of copper generates fluids and associated minerals that are enriched in the ^{65}Cu isotope, as seen in watersheds impacted by weathering of sulphide minerals.[29] Non-weathered, primary sulphide ores lack appreciable fractionation (<1‰).[30] Thus, oxidative weathering of sulphide ores leads to the development of stratified isotopic reservoirs for copper (Figures 3 and 4): 1) a leach cap depleted of ^{65}Cu because of oxidative weathering; 2) a positively fractionated ($\delta^{65}Cu$ >1‰) supergene enriched zone of copper oxides and sulfides beneath the leach cap; and 3) non-fractionated, non-weathered primary sulphide ore ($\delta^{65}Cu$ around 0‰) lies below the water table.[31] Accordingly, Cu isotopic composition of artifacts can be used to identify the mineralogical assemblage from which the copper was smelted.

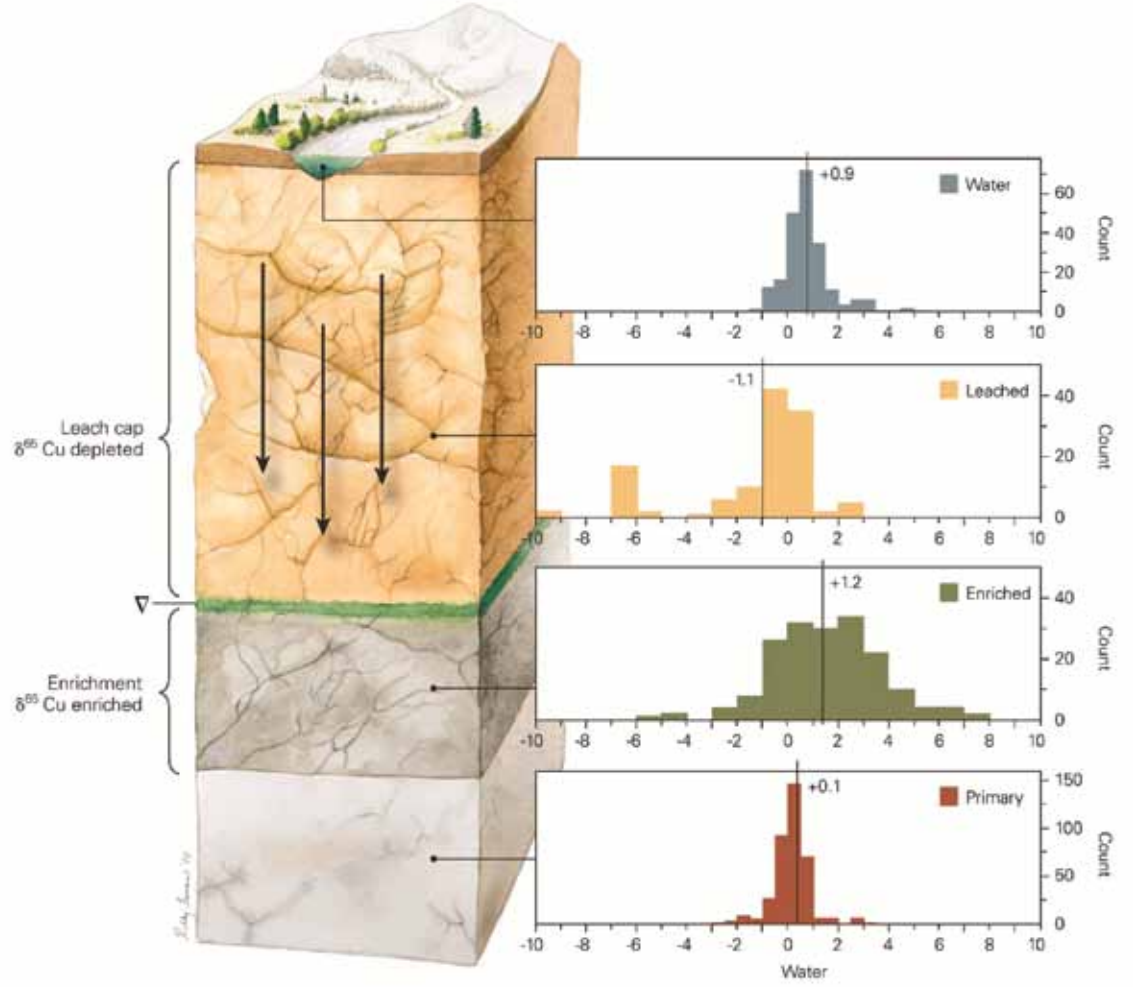


Fig. 4 – Isotopic and mineralogical stratification of copper ores due to weathering in humid climates (after Mathur, Fantle 2015).

[28] Zhu et al. 2002.

[29] Borok et al. 2008; Pokrovsky et al. 2008; Mathur et al. 2013; Mathur et al. 2014

[30] Larson et al. 2003.

[31] Asadi et al. 2015; Mathur et al. 2009; Mathur et al. 2010; Mirnejad et al. 2010.

Mathur *et al*. (2017) applied this method to an assemblage of copper and bronze artifacts ranging in age from Eneolithic to Late Bronze Age, and concluded that supergene ores were exhausted in the region of Serbia late in the Eneolithic. Herein, we refine their model by augmenting the data set with a collection of 20 Jászladány-type axes (4300-3900 BCE),[32] which predate the Eneolithic material published in Mathur *et al*. (2017). δ^{65}Cu values for these axes range from 0.15 to 4.67‰ with a median value of 1.18‰ (Table 1; Figure 5). The range and median of the Jászladány-type axes is higher than those of the younger Eneolithic artifacts of Mathur *et al*. (2017). Furthermore, the Jászladány-type axes are distinct from the younger objects in their lack any negative values of δ^{65}Cu (Figure 5). This pattern in δ^{65}Cu indicates that the copper for the Jászladány-type axes was derived from highly fractionated ores composed of supergene minerals such as malachite and azurite. In contrast, the of δ^{65}Cu values of the younger Eneolithic artifacts suggest that the associated copper was derived from the base of the oxide zone and was likely a mix of oxide and enriched sulfide minerals. Thus, the full copper isotope dataset identifies greater depths of exploitation of Serbian copper oxide ores throughout the Eneolithic.

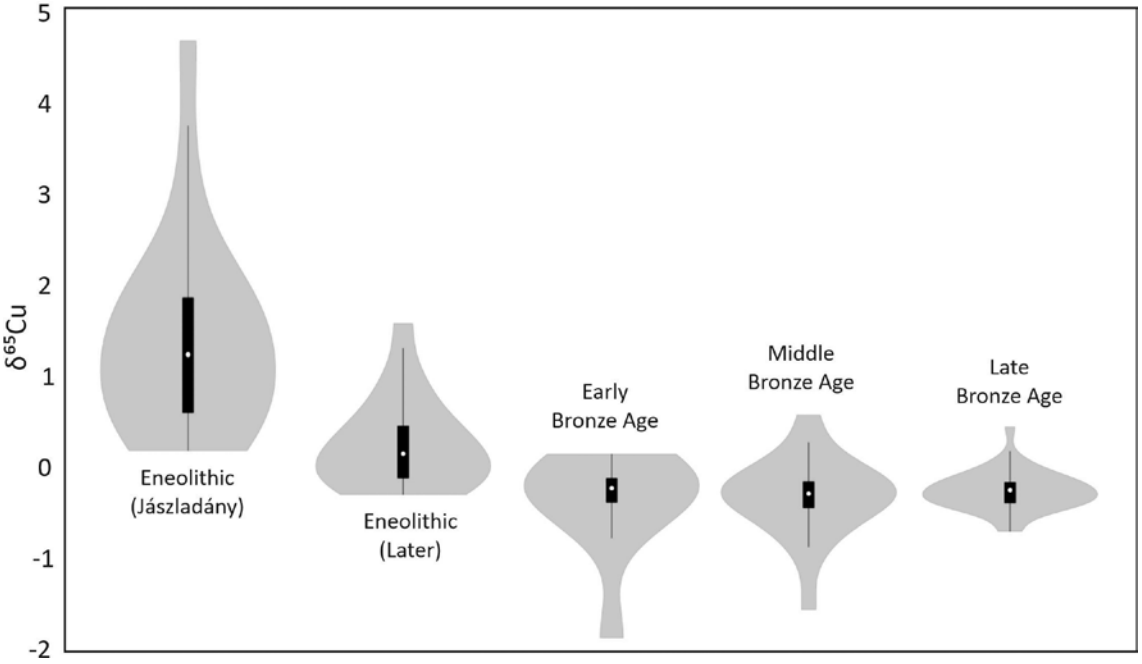


Fig. 5 – Distribution patterns of δ65Cu in Serbian Eneolithic Jászladány-type axes compared with younger artifacts presented in Mathur et al. (2017).

It is interesting to note that there is a geographic variation in the δ^{65}Cu of the Serbian Jászladány-type axes. The 121 samples from the Bor region yield a lower range of δ^{65}Cu values (0.15-1.21‰) with a median of 0.53%, compared to those from other locations (0.65-4.47%,) with a median of 1.86%. This may indicate that mining in the Bor region had been initiated earlier, or worked more intensively, than other copper deposits in the region.

[32] Gross et al. 2021.

Conclusion

The isotopic analyses of axe-adzes of the Jászladány-type have shown that there are differences in the range of isotopic values between the examples from the surroundings of Bor and the examples from the Mlava Valley. Such differences might indicate a different geographic origin of copper. The results acquired from the presented examples further support the idea of the so-called *Copper Hiatus* between the mid-4th and the mid-3rd millennia BCE. Based on the distribution of copper/bronze finds during the Eneolithic and the Bronze Age in the Central Balkans, including the axe-adzes of the Jászladány-type (Figure 6),[33] it is indicative that the production of copper objects almost completely ceased for a millennium. Within the Central Balkans, the noticeable lack

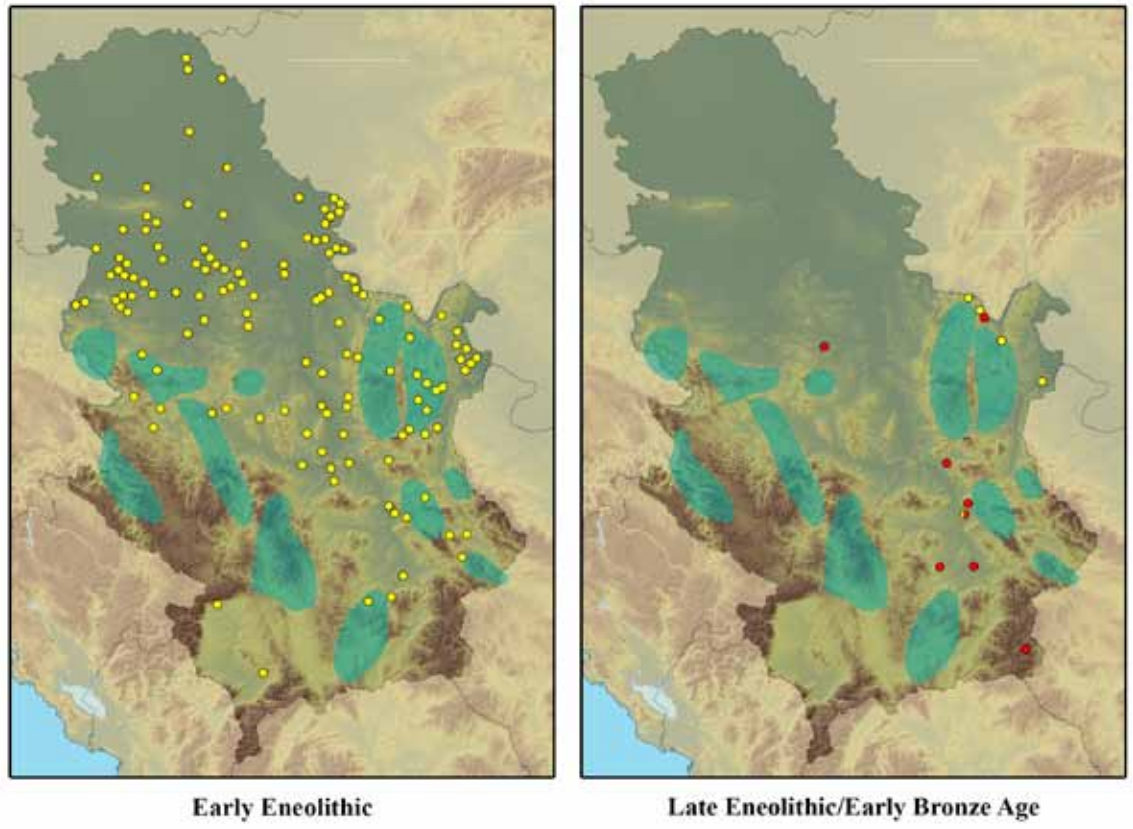


Fig. 6 – Disposition of copper finds in Serbia during the Early Eneolithic and Late Eneolithic/Early Bronze Age.

of copper objects is connected with the Late Eneolithic (c. 3500-2800 BCE) and the Early Bronze Age (c. 2800-2000 BCE), and the extraction of copper ores from the Bor region continues or intensifies at the beginning of the 2nd millennium BCE, or from the Middle Bronze Age (c. 2000-1600/1500 BCE).[34] Additionally, the study of topography and disposition of Late Eneolithic, Early Bronze Age, and Middle Bronze Age sites in this part of the Central Balkans, indicate that the settling of the bearers of those groups was not conditioned by the occurrence of copper or tin deposits.[35] Such a hiatus could have been caused by the depletion of oxide minerals (malachite,

[33] Mladenović, Bulatović 2024a.
[34] Gavranović et al. 2020; Mehofer et al. 2021.
[35] Mladenović 2023; Mladenović, Bulatović 2024b.

azurite) due to extensive exploitation during the Late Neolithic and the Early Eneolithic, and the production continues with the processing of sulfide (chalcopyrite-bornite) minerals post-2000 BCE.[36] Certainly, with more than 160 axe-adzes of the Jászladány type, and with the addition of other copper artifacts, the Early/Middle Eneolithic copper production was on a large-scale, and could affect the depletion of the available copper ores.

The exact function of axe-adzes of the Jászladány type remains unknown. Even within a small sample presented in this paper, we can observe that such objects tend to concentrate in the copper-rich regions, both regarding Serbia and their wider area of distribution. Such distribution indicates their strong connection with mining regions or even mining activities. However, their appearance within funeral contexts might indicate a more profound meaning of such objects for their owners, or possibly to the communities that procured the copper. On the other hand, such a high number of examples indicates that such objects were common, and most likely did not represent an exclusive object.

The isotopic analyses have once again confirmed the possibility of their local origin, from the copper-rich regions of the Central Balkans. Such results, combined with the new data on the genesis of the Early Eneolithic in the Central Balkans, indicate that their production started already during the mid-5th millennium BCE, or at the onset of the Early Eneolithic.

[36] Powell et al. 2017, with cited literature.

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Prehistoric slags from the Metal Ages in the vicinity of Bor (NE Serbia)

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Abstract: „Timok eruptive basin" was very densely settled during the Early and Middle Bronze Ages, exclusively by copper ore miners and collectors during the 3rd and 2nd millennium BC. During the last century, discoveries connected to copper metallurgy were identified at 3 settlements, and after a series of excavations undertaken in the last ten years, at least 3 sites with similar situation were discovered too. Due to the surveys carried out in 2020, the number of sites where prehistoric metallic slag where discovered increased by another 4. Main topic of this paper has been to explain the character of the prehistoric sites where the objects of copper ore smelting were identify. Physicometrical analysis and grained results of the aforementioned metallic slags, some information regarding the method of ore smelting technology, characteristic for this part of Southeastern Europe can be revailed.

Key words: Northeastern Serbia, Early Bronze Age, Middle Bronze Age, prehistoric copper metallurgy, slag, physicochemical analysis, EDXRF spectrometry

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The interest in researching the space of NE Serbia, in immediate hinterland of the Iron Gates, began in the 60s and 70s of the last century with the rescue excavations of Lazareva or Zlotska Cave,[1] as well as excavations of the several settlements of the Early Bronze Age Cotofeni-Kostolac culture, led by the academician Nikola Tasić. In the same time academician Borislav Jovanović discovered Rudna glava,[2] the oldest copper mine in the Balkans from the beginning of the 6th millennium BC, as well as, the first Bronze Age necropolis with cremated individuals from this part of Serbia. Apart from the Lazareva or Zlotska Cave, Nikola Tasić excavated Early Bronze Age settlements Kulmja Škjopului, Pjatra Kosti and Čoka lu Balaš,[3] while Borislav Jovanović discovered the Middle Bronze Age necropolis and settlement of Trnjane near Bor.[4]

In geological terminology portion of the Serbian territory situated southern from Iron Gates is known as a "Timok eruptive basin" (fig. 1).[5] The first results of systematic excavations conducted during the 70s of the last century, led to certain indications which point to activities related to copper metallurgy by the communities of Cotofeni-Kostolac cultural, or Early Bronze Age cultural complex, which occupied almost the entire territory of today's 5 municipalities of NE Serbia (Bor, Majdanpek, Zaječar, Negotin and Knjaževac).[6] The density of these settlements is on the highest level in the area of Bor and Majdanpek. The key evidence for the assumption that copper exploitation was one of the most important motives for the occupation of the space of NE Serbia by the Cotofeni-Kostolac communities could be one of the absolute dates from mine shaft No 10 at Rudna glava-Dnevni kop copper mine which is astimated to from 30th - 29th century BC, according to Dr. Dušan Borić.[7] These assumptions are also confirmed by the finds of metallic slag discovered on the Kmpije site in Bor, which was investigated by Igor Jovanović, curator of the Museum of Mining and Metallurgy in Bor.[8] These slags, together with samples from the Paulešti site near the Luka north of Bor, were analyzed by experts from the Technical Faculty in Bor and the Vinča Institute of Nuclear Sciences, Prof. Dragana Živković and Dr. Velibor Andrić.[9] Besides slags, some of the discovered archaeological objects also pointed out to prehistoric mettalurgy, such as copper bursters, ceramic tylers and malachite drops glue to

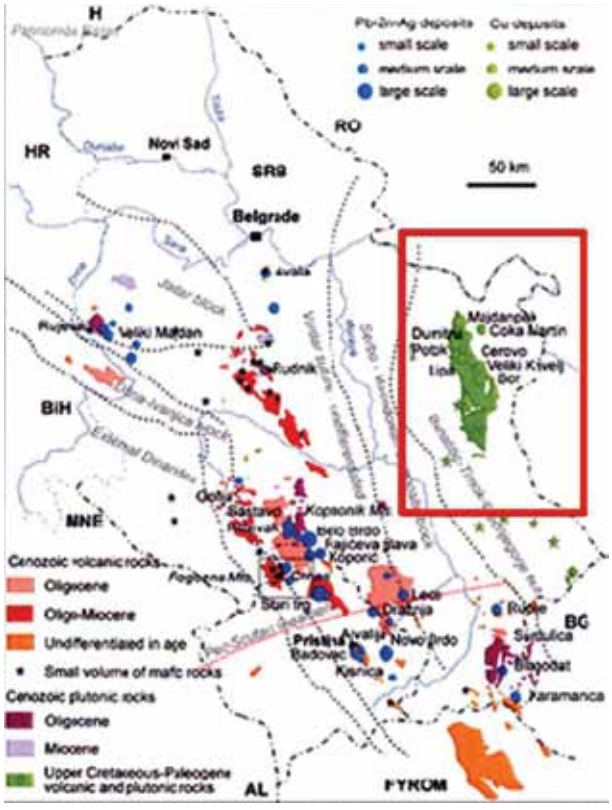


Fig. 1

[1] Tasić 1969.
[2] Jovanović 1982.
[3] Tasić 1995.
[4] Jovanović, Janković 1987-1990.
[5] Николић 1993.
[6] Капуран, Булатовић 2013.
[7] Borić 2009.
[8] Јовановић 2013.
[9] Živković at al. 2012; Živković at al. 2014.

pottery fragments, as you can see on figure 2 (fig. 2).

During the 80s of the last century, with the excavations of Middle Bronze Age settlements and necropolises with cremated individuals on Trnjane near Brestovačka Banja, a new phase of research related to the Middle Bronze Ages began.[10] In the early 90s of the last century a new discoveries such as hill fort on Banjska stena near Gamzigradska Banja and the Middle/Late Bronze Age necropolis Magura near Felix Romuliana also appears, thanks to the efforts of academician Dragoslav Srejović (fig. 3).[11]

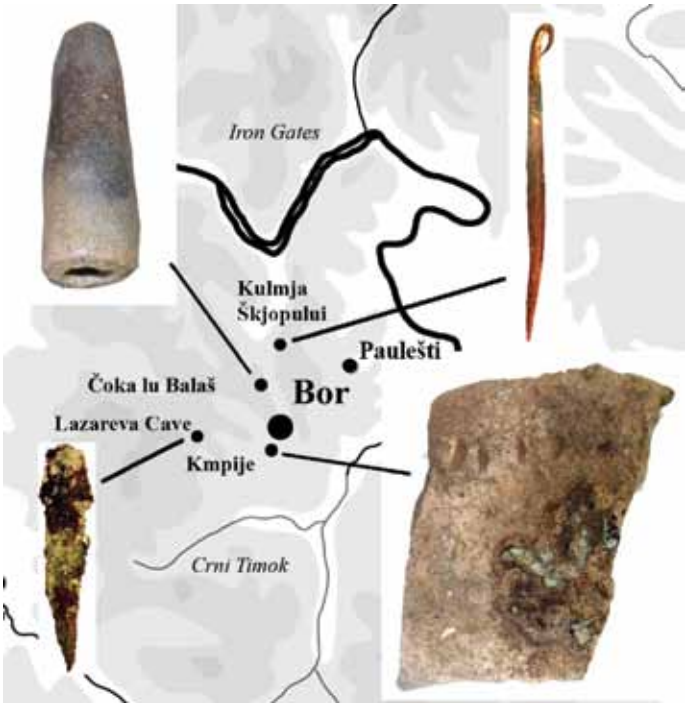


Fig. 2

During the half of the 2nd millenium or Middle Bronze Age phase in NE Serbia, two groups of settlements with following necropolises were clearly identify.[12] The first group appears in the mineral-rich area around Bor, on the soil that is not so fertile, and the second group, which was established in the area of the Gamzigrad village in the close vicinity of Zaječar, with incomparably better soil resources and conditions for agriculture (fig. 3). While the so called „mettalurgicall sites" are very frequent in the vicinity of Bor, in the vicinity of Gamzigrad they were spotted only in two cases. While metallurgical activities in the group of settlements in the vicinity of Bor were confirm during the investigations of Trnjane,[13] Ružana 1 and 2[14] and Čoka Njica sites,[15] among the group of settlements concentrated around village of Gamzigrad, certain metallurgical activities were found only at Seliste

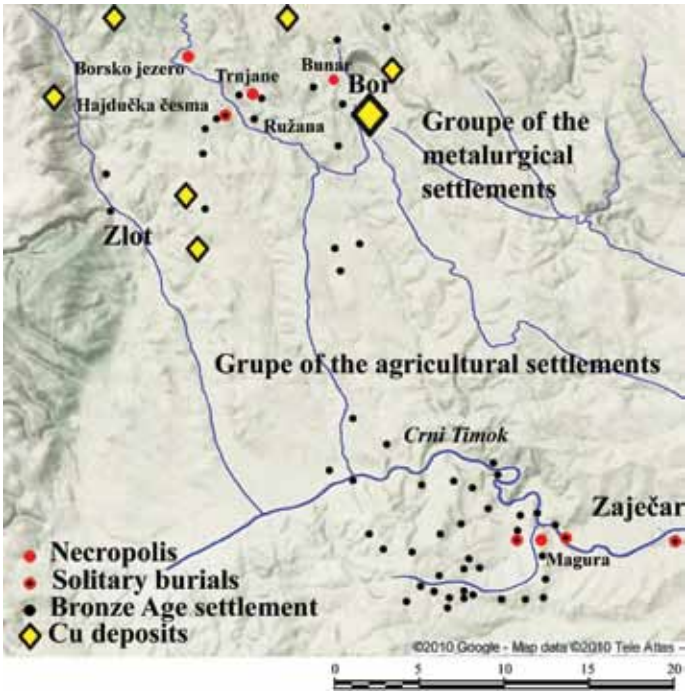


Fig. 3

[10] Jovanović, Janković 1996.
[11] Срејовић, Лазић 1997; Лазић 2010.
[12] Kapuran 2014, karta 13.
[13] Jovanović, Janković 1997-1990; Jovanović, Janković 1996; Kapuran, Gavranović, Mehofer 2020.
[14] Kapuran, Živković, Štrbac 2016.
[15] Gavranović at al. 2020.

and Varzari sites. During survey conduced in 2020 on the Bor Lake, Kormaroš, Bučje-Ogašu driki, Bučje-Kornjet Lu Petku and the Medanova glavica site near Bela Reka, a new group of sites connected with the Middle Bronze Age metallurgical activities was spoted (fig. 4).[16]

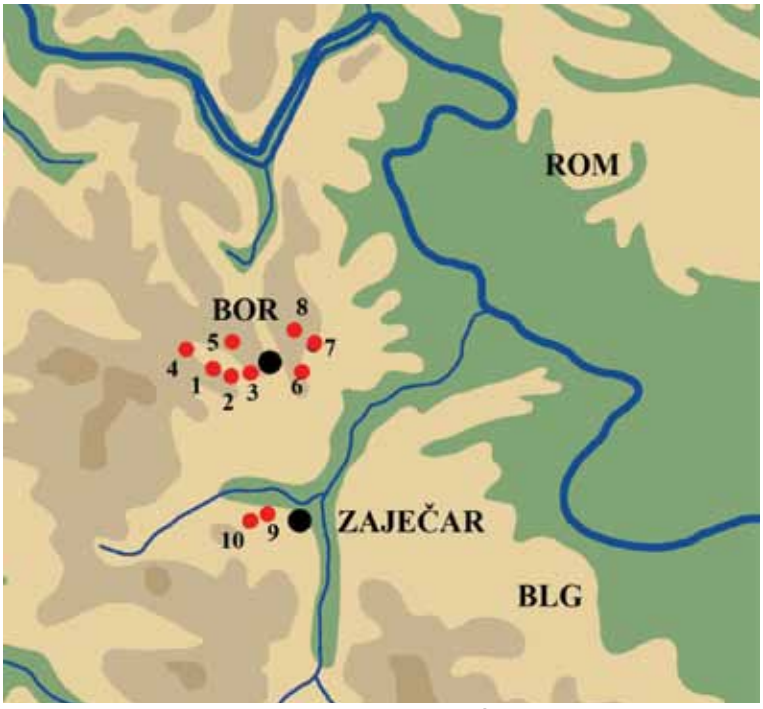


Fig. 4 – 1. Trnjane; 2. Ružana 1 and 2; 3. Ćoka Njica; 4. Bor lake; 5. Kormaroš; 6. Medanova Glavica; 7. Bučje-Ogašu driki; 8. Bučje-Kornjt lu Petku; 9. Selište; 10. Varzari.

In this paper we also presented a new results of the physicochemical analysis of the slags collected during the survays on Middle Bronze Age sites Varzari, Bučje-Ogašu driki, Bučje-Kornjet Lu Petku and Medanova glavica, and their comparation with previous published data from Early Bronze Age sites Kmpije and Paulešti (fig. 4).

Selection of the 4 archaeometalurgical slags were analyzed by EDXRF spectrometry, non-destructive analytical technique usually used for investigation of the cultural heritage objects. For the initial measurements, qualitative analysis on as-received objects was done using portable in-house built instrument

[16] Kapuran at al 2020.

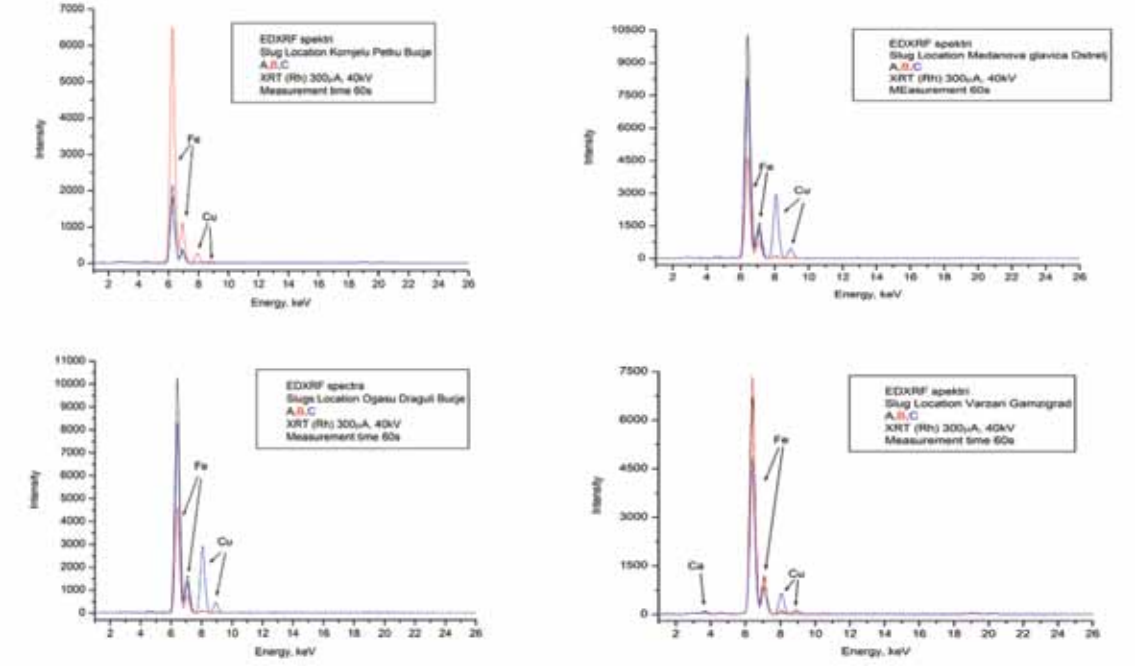


Fig. 5 – EDXRF spectra of analyzed archaeometalurgical slags.

with X-ray tube (Oxford Instruments, Rh anode, max. voltage 50 kV, max. current 1 mA) with pinhole collimator and XRF spectrometer X-123 (AMPTEK Inc., Si-PIN detector 6 mm2/500 μm, 12.5 μm Be window and 1.5" extension). Results showed prominent non-homogeneity of the samples since aquired spectra on 3 distinct positions on every sample were characterized with different peak intensities of detected elements. (fig. 5). The most intensive peaks of copper and iron significantly vary depending on the measuring spot All analyzed samples have irregular size and uneven rough surface which are conditions not favorable for the quantitative analysis. The decision is made to cut in half all samples with mechanical tool in order to gain flat surface for the quantitative analysis with hand held EDXRF instrument Hitachi X-MET8000 Optimum which is calibrated for analysis of metal alloys. So, each sample is divided in two parts, cross-section flat surfaces were cleaned and separately analyzed with hand held device with measurement time 15s.

Quantitative results are presented in Table 1 for just selected informative elements detected in all measurements, namely silicon, iron, copper, titanium, aluminum and sulfur. Since these measurements also produced results with significant discrepancies, average value of 2 measurements (for both cross-sections) of each object are also presented in Table 1.

	Varzari Gamzigrad			**Medanova glavica**		
Element	Meas1	Meas2	Average	Meas1	Meas2	Average
Si, %	28.18	35.13	**31.66**	20.66	23.69	**22.18**
Fe, %	58.02	44.08	**51.05**	66.18	64.92	**65.55**
Cu, %	8.09	14.63	**11.36**	6.55	3.89	**5.22**
Ti, %	0.35	0.53	**0.44**	0.33	0.44	**0.39**
Al, %	2.82	0.42	**1.62**	5.17	5.96	**5.57**
S, %	2.09	4.98	**3.54**	0.06	0.08	**0.07**
	Bučje-Ogašu driki			**Bučje-Kornjet Lu Petku**		
Element	Meas1	Meas2	Average	Meas1	Meas2	Average
Si, %	22.94	31.35	**27.15**	37.29	30.71	**34.00**
Fe, %	65.3	57.33	**61.32**	55.67	61.57	**58.62**
Cu, %	4.95	3.99	**4.47**	4.29	4.1	**4.20**
Ti, %	0.27	0.25	**0.26**	0.24	0.36	**0.30**
Al, %	4.3	5.2	**4.75**	0.39	1.69	**1.04**
S, %	0.71	0.88	**0.80**	1.97	1.33	**1.65**

Table 1 – Results of the EDXRF analysis of the archaeometallurgical slags from Middle Bronze Age sites (hand held instrument Hitachi X-MET8000 Optimum).

All quantitative results showed same trends like qualitative ones and most abundant elements detected were silicon, iron and copper. The range of values of iron content is from minimum 51.05% (Varzari site) to maximum value of 65.55% (Medanova glavica site). The content of the second most abundand element silicon also varies from minimum value of 22.18 (Medanova glavica site) to maximum value of 34.00 (Bučje-Kornjet Lu Petku site) while results of the copper content in analyzed slags varied from 4.20% (Bučje-Kornjet Lu Petku site) to maximum value of 11.36 (Varzari site). It can be noticed that results of the content of iron and sulfur are inversely correlated while it cannot be stated for other results although it is clear that slag from the Varzari site can be distingushed with minimum iron content and maximum copper content. The large discrepancy in sulfur content could indicate usage of a different raw materials, ones with dominantly oxide composition proably are used on the locations Medanova glavica and Bučje-Ogašu driki since analysis showed sulfur content bellow 1.0%. The analyzed slags from other 2 locations are

characterized with few times higher contents of the sulfur and probably sulphate ores are presented in higher amount.

Previously published results of the XRD and EDXRF analzysis of the slags from the Early Bronze Age sites Kmpije,[17] and Paulešti,[18] presented together (Table 2), confirmed assumption that these sites can be characterized as archaeological localities with ferrous metallurgy (copper contents found in analyzed slags are bellow 0,1% except for the Kmpije S1 object with copper content of 1.57%). Opposite to that, results of the elemental analysis of the slags from the Middle Bronze Age sites presented in this paper inidicate that these localities can be associated with copper metallurgy activities since copper content in all analyzed slags are few times higher then copper content in the slags from Early Bronze Age sites. Nevertheless, since number of analyzed archaeometallurgical slags is a quite small, aditional analytical data will be neccessary to confirm initial presumption and classification.

Element	Paulešti P1*	Šetaće Z1*	Kmpije S1**	Kmpije S2**
Fe, %	4.58	4.00	14.43	54.73
Cu,%	0.031	0.009	1.65	0.037
Si, %	24.46	30.56	22.74	8.23
S, %	-	-	0.21	1.00
Al,%	8.10	7.65	1.63	2.29
Ti, %	0.35	0.31	0.27	0.10

Table 2 – Elemental composition of the archaeometallurgical slags from the Early Bronze Age sites (* Živković at al 2012, ** Živković at al 2014).

[17] Živković at al. 2014.

[18] Živković at al. 2012.

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Bronze Age metal production in north-western Croatia - alloys and copper sources

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Mathias Mehofer[3]

Abstract: In this paper we discuss metallurgical aspects of Late Bronze Age finds from north-western Croatia based on the ED XRF analyses of finds from two workshops areas at the Kalnik-Igrišče site and from the depot Kamena Gorica, located ca. 15 km to the west. Apart from finished metal products, we also analysed melted casting remains as a direct evidence of metal production in the two excavated workshops at Kalnik-Igrišče site. The first results point at various alloy practices, occasional recycling and remelting and existence of ingots with diverse chemical compositions.

Key words: metallurgy, Late Bronze Age, settlement, copper alloy

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Introduction

Kalnik-Igrišče is a multi-layered settlement near the town of Križevci in northwestern Croatia (Fig. 1). The site is situated on the southern slopes of the Kalnik hill (500 m a. s. l) in a strategically favourable position overlooking the wide area of the local landscape to the south or towards Sava valley. The first metal finds from Kalnik (a sickle, two pins and a spear head) came to the Archaeological Museum in Zagreb at the beginning of 20th century and were later published

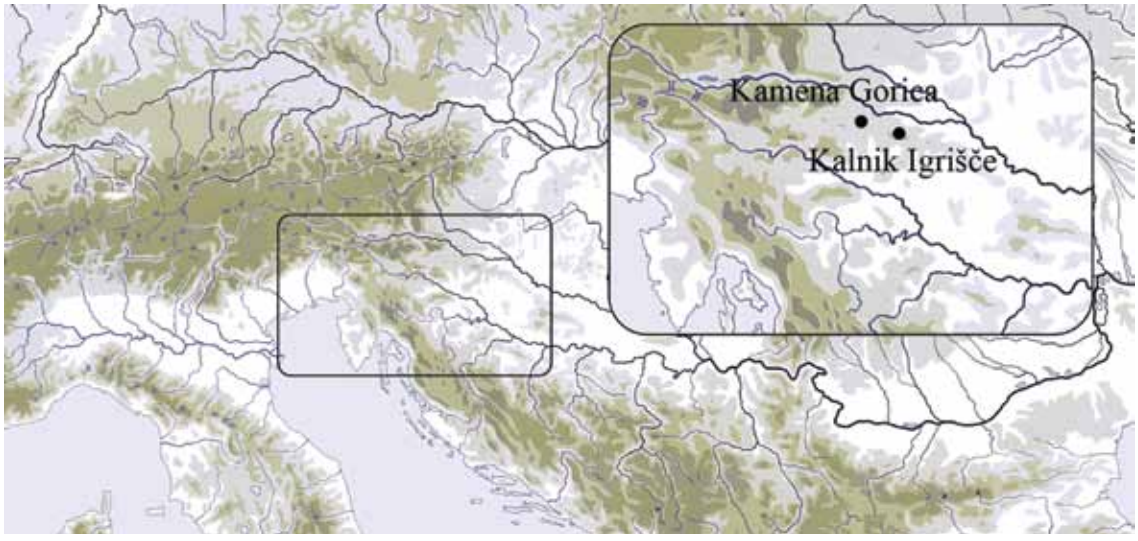


Fig. 1 – Position of the sites Kalnik and Kamena Gorica (S. Vrdoljak).

by K. Vinski-Gasparini and dated to the Ha A2 or the middle stage of the Urnfield period.[1] In the early 1980s, Zoran Homen, archaeologist curator of the City Museum in Križevci, encouraged by numerous archaeological objects found in the area of Kalnik, conducted systematic field surveys resulting in first excavation in 1987 at the location of Igrišče.[2] The finds included pottery indicative of Baierdorf-Velatice[3] or Zagreb group according to Vinski-Gasparini[4] dating between BA D and Ha A2. In addition, metal items and a stone mould for casting pins were also found, providing the first indications about the metallurgical activity at the site.[5] In following years, between 1988 and 1990, an area of 90m² at the same location (Kalnik-Igrišče I) was systematically excavated, which at first glance seems small, but the results were very important for the archaeology of the Late Bronze Age in northwestern Croatia, and especially for the research of the settlements of Urnfield Culture, which until then were not investigated in this region.

In 2006 Institute of Archaeology Zagreb started new excavations at Kalnik at the area about 200m east from the Kalnik-Igrišče I position. This second area (Kalnik-Igrišce II) encompasses a naturally elevated plateau and was, with some breaks, investigated until 2023. The archaeological record has shown that the plateau was inhabited in different periods, including Medieval, late Antiquity and Roman time, and Late and Early Iron Ages.[6] The Bronze Age layers provide archaeological material dated between 1050 and 800 B.C. or in the younger stage of Urnfield Culture.

[1] Vinski-Gasparini 1973, 136, T.93:13–17.
[2] Homen 1987.
[3] Lochner 2013.
[4] Vinski-Gasparini 1983, 566.
[5] Karavanić 2005, fig. 3; Karavanić, Kudelić 2019, fig. 7:2,1.
[6] Karavanić, Kudelić 2019, 46.

Metallurgical workshop – Kalnik-Igrišče I

The unearthed features in the excavations between 1987 and 1990 included seven hearts made of stamped clay. While some of them a had a substructure made of pottery fragments,[7] one of the hearths stands out as its substructure was made of medium-sized limestone stones. It was in surrounding of this hearth where a large number of metal items, different fragments of stone moulds made of polished sandstone and smelted metal remains have been found (Fig. 2).[8]

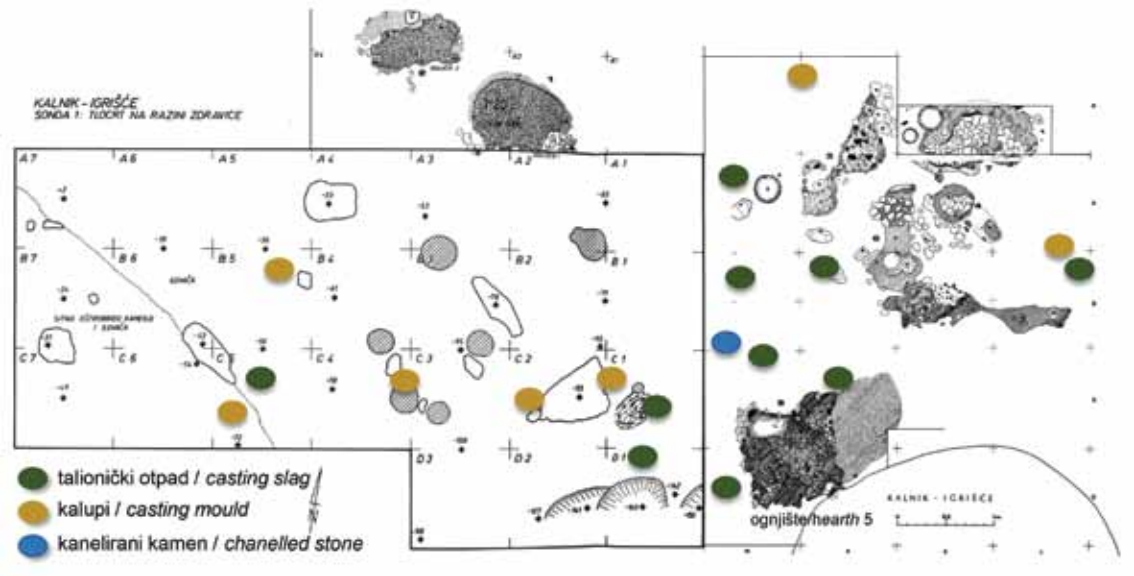


Fig. 2 – Spatial distribution of bronze casting evidence at Kalnik-Igrišće I workshop (after Karavanić, Kudelić 2019, fig. 7.1).

Most of the moulds are bipartite and thus common for the Urnfield period.[9] The bipartite stone moulds enable the multiple casting of metal items leading to the assumption that the workshops in Kalnik-Igrišče I was involved in a serial production of different object.

One of moulds was used to cast bronze pins with nail-shaped head (*Nagelkopfnadel*) and possibly pins with knots on the neck of Velemszentvid type (Fig. 3). Both types are widely distributed over the Carpathian Basin between BA D and Ha A2,[10] with nearest positive analogies in the urn cemetery in Virovitica and in Ha A1 hoard finds from Veliko Nabrđe and Brodski Varoš near Slavonski Brod.[11] Another object that was casted in Kalnik-Igrišče I workshop is a socketed axe with a loop and three horizontal ribs.[12] Axes with such a decoration are not common for the earlier stages of Urnfield period (BA D–Ha A1) as there are currently no exact positive analogies among numerous metals from hoards in northern Croatia and in neighbouring territories of Slovenia, Hungary, Serbia and Bosnia. Three horizontal ribs are a typological trait, which occurs more often on the socketed axes from Ha A2 period onwards, as suggested by the finds from hoards

[7] Majnarić-Pandžić 1992.

[8] Majnarić-Pandžić 1992; Vrdoljak 1992; Vrdoljak, Forenbaher 1995; Karavanić 2009; Karavanić,Kudelić 2019, fig.7:1.

[9] Wanzek 1989; Karavanić 2009; Gavranović 2013.

[10] Hänsel 1968, 204; Říhovský 1979, 42; Vasić 2003, 45.

[11] Vinski-Gasparini 1973, T. 10:10, 44:16, 52:40).

[12] Karavanić 2009, fig 44:1; Karavanić, Kudelić 2019,108.

Siče northern Croatia[13] or Brezovo Polje in Bosnia.[14] Other mould fragments from Kalnik Igrišče I are too small for the reconstruction of forms that have been cast in them. There is also one mould made of slate or phyllite for the production of flat axes. Such a mould raw material is not common during the Urnfield Culture, but at the Kalnik site it was attested in both workshops.

Besides mould fragments a significant number of small utilitarian bronze items have been discovered near the hearths, including mostly pins of various types, but also several buttons, small chisels, an arrow head, a grip plate dagger with one rivet, a bronze biconical bead and several sheet and wire fragments.[15] Based on typo-chronological assessment, the pins found at the Kalnik-Igrišče I location cover the large time span between earlier and middle/younger Urnfield periods (Ha A1–HaA2/HaB1). Indicative of middle/younger Urnfield period is the pin of the Velemszentvid type with main distribution in the Middle Danube area[16] and with closer regional analogies in the cemetery of Dobova in Slovenia[17] and in Donja Dolina on the Bosnian bank of the Sava River.[18] In the frame of here discussed metallurgical investigations, we sampled three pins from the Kalnik-Igrišče I site: a club-shaped, non-decorated pin ("*Keulenkopfnadel*") (VIAS lab. no. 618), a pin with flattened spherical head (VIAS lab. no. 616) and a pin with biconical head (VIAS lab. no. 7402). Additionally, a sample has also been taken from the dagger (VIAS lab. no. 619). The club-shaped pins are widely spread across the southern and western part of Carpathian Basin and appear both in graves and depots of the early Urnfield period.[19] The pins with flattened spherical head date to same period (BA D–Ha A1) and are a metal type with main distribution area in the southern part of Carpathian Basin.[20] The nearest analogies for the pin from Kalnik are finds from depots in northern Croatia such as Bošnjaci, Gornja Vrba and Brodski Varoš.[21] However, most of these analogies display smaller flutings at the base of the head, which is not the case for the pin from Kalnik that might represent an unfished product.[22]



Fig. 3 – Casting mould from for the production of pins from Kalnik-Igrišće I workshop (photo A. Kudelić and H. Jambrek IARH) (photo Memolab Križevci).

The pin with biconical head is a widespread metal type between the Middle Bronze Age and beginning of Hallstatt period.[23] At the Donja Dolina site, similar pins were found within the area of "older settlement", which according to Z. Marić existed between Ha A1 and Ha B1.[24]

[13] Vinski-Gasparini 1973, T. 95: 2–3.

[14] König 2004, T. 30:14.

[15] Majnarić-Pandžić 1998; Karavanić 2009, fig. 24–25.

[16] Říhovský 1979, 104; ebd. 1983, 20; Majnarić-Pandžić 1993, 61; Karavanić 2009, 31.

[17] Dular 1978, T. 1.

[18] Marić 1964, T. 3:3; Gavranović 2011, 163.

[19] Říhovský 1979, 151; Novotnà 1980, 141; Majnarić-Pandžić 1992, 59; Vasić 2003, 85, T. 63A.

[20] Majnarić-Pandžić 1992, 60; Vasić 2003, 59; König 2004, 70; Karavanić 2009, 31; Gavranović 2011, 162.

[21] Vinski-Gasparini 1973, T. 30A:13, 51:19, 52:33–34.

[22] Karavanić 2009, 31.

[23] Říhovský 1983, 24; Novotnà 1980, 119; Vasić 2003, 62.

[24] Marić 1964, 27; Gavranović 2011, fig. 162:13.

Metallurgical workshop – Kalnik-Igrišče II

Based on the stratigraphical sequence, the area investigated at the location Kalnik-Igrišče II has been divided into four horizons A–D.[25] The remains of metallurgical activity were discovered in the youngest horizon (A) and were located next to the burned house from previous horizon (B). It is assumed that the workshop activities took place in the time when the house was already burnt and abandoned. The features in the workshop area included a complex, multilayered structure with daub fragments that was described as an oven and one hearth with smoothed surface and a substructure made of pottery fragments (Fig. 4).

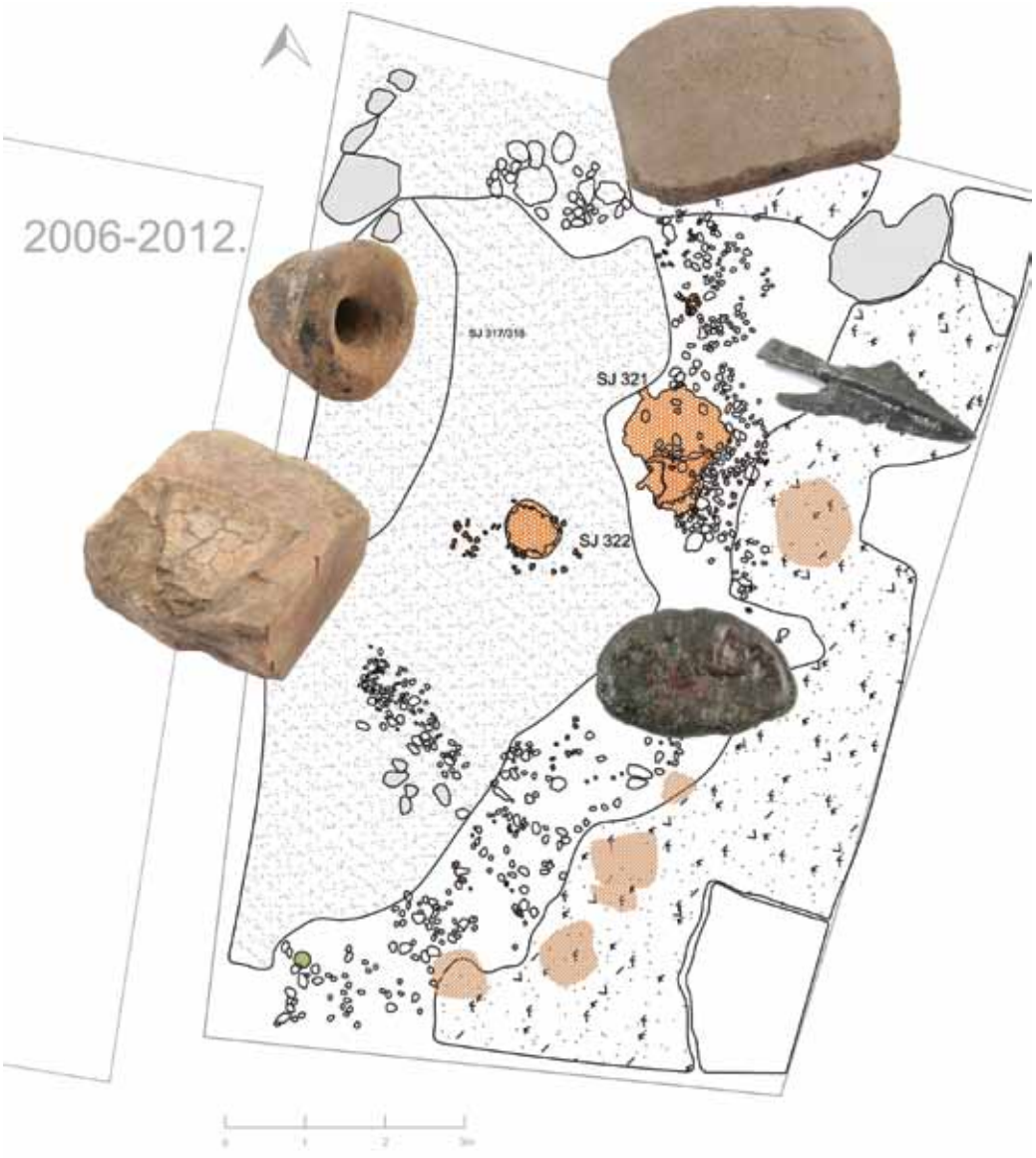


Fig. 4 – Workshop area at Kalnik-Igrišče II (after Karavanić, Kudelić 2019, fig. 7.4).

In the vicinity of oven, fragments of eight casting moulds but also tuyere for blow pipes and traces of melted metal were found. As in the case of Kalnik-Igrišče I, all moulds are bipartite and made of sandstone except the one that was made of phyllite. On some of them we also ob-

[25] Karavanić, Kudelić 2019.

served functional parts or marks like runner, grooves for fastening two halves of the mould and also marks for alignment of the halves. Most of the moulds are too fragmentary to reconstruct the shape of the casted item, however one of moulds from Kalnik-Igrišče II was used for the production of socketed axes with double hourglass-shaped ribs (fig. 5, 2).

Positive analogies are known from the depots Beravci in Northern Croatia[26] and Szarvas in Hungary,[27] both dated to Ha B1. Similar decoration appears also on the socketed axe from the Grave 1/1911 at Velika Gorica cemetery in Croatia[28] and on the one axe from the depot Vinički II in Slovakia,[29] which both confirm the dating of this specific ornament to the younger stage of Urnfield period.

The find of tuyere for blow pipe indicates that the metals have been melted or recycled, probably in crucibles at the hearth. The tuyere has dimensions of 3,2 cm.[30] Similar tuyere has been found at the Mačkovac-Crišnjevi settlement in Sava valley in the layers dating to Ha A1, also near the hearth made of burnt and stamped clay.[31] At the Mačkovac-Crišnjevi site, a hoard with deposited metal items from the same period (Ha A1) has also been found.[32]



Fig. 5 – Casting moulds and metal items from Kalnik-Igrišče II workshop (photo A. Kudelić and H. Jambrek IARH).

Direct evidence for smelting activities within the workshops area at Kalnik-Igrišče II are melted metals or casting remains, of which three pieces (VIAS lab. no. 611, 612, 613) have been sampled and analysed in terms of chemical composition. Additionally, one of the smelted metal pieces (VIAS lab. no. 611) contained also charcoal remains that have been extracted and absolutely dated.

Particularly interesting is an oval shaped piece weighing 107 g (VIAS lab. no. 612) that originally was interpreted as a bronze ingot.[33] Similar, somewhat lighter (85,8 g), piece was found at the site Gór in western Hungary.[34] Most probably connected with metalworking finishing processes are also stone artefacts (hammers) and a large stone slab found near the oven, which could

[26] Vinski-Gasparini 1973, T. 108:10.
[27] Mozsolics 2000, T.91:7.
[28] Vinski-Gasparini 1973, T.103:4; Karavanić 2009, 61, T. 61:7.
[29] Novotná 1970, T. 38: 691.
[30] Karavanić, Kudelić 2019, fig. 7:7.
[31] Karavanić 2007.
[32] Karavanić, Mihaljević 2001; Karavanić 2009.
[33] Karavanić, Kudelić 2019, fig. 7:8.
[34] Gábor 1996, T. 5:26.

be interpreted as stone anvil.[35] The finds from the workshop area included also metal items such as bronze wire, a pin, an arrow and one small socketed axe (fig. 5, 4-5). Samples for the metallurgical analyses were taken from the arrow (VIAS lab. no. 509), socketed axe (VIAS lab. no. 615) and from one object that could be interpreted either as a pin or drift (VIAS lab. no. 620).

The arrow belongs to a widespread type with a thorn and two wings of basic form E according to typology proposed by J. Říhovský, which appears from the Middle Bronze Age to Hallstatt period.[36] In the area of central Balkans, similar arrows were found in Zemun near Belgrade, however without a proper context.[37]

The sampled socketed axe has several characteristic typological traits (size, lower loop, and wide blade), which are indicative of late Urnfield period (Ha B2/3).[38] Similar axes occur in the depot of this period such as Gajina Pećina in the Lika region[39] or Tešanj 3 in the neighboring northern Bosnia.[40] Socketed axes with similar blade shape are also known as singular finds from several sites in central Croatia and northern Bosnia.[41]

Kamena Gorica depot

The metal finds were accidentally discovered in 1873 and are in the collection of Natural History Museum Vienna (fig. 6).[42] The depot consists of 10 objects (a sickle, a socketed axe, a spear head, three bracelets, two torcs and two curved metal bars) and dates to final stage of Urnfield period (Ha B3) or Phase V according to the chronology proposed by K. Vinski-Gasparini.[43] The combination of smaller spearhead and socketed axe appears also in some other depots from this period such as Matijevići in central Croatia[44] and in a number of depots from northern Bosnia, including Lučica, Tešanj 1, Os-



Fig. 6 – Sampled metal finds from the Kamena Gorica depot (M. Gavranović/Natural History Museum Vienna).

[35] Karavanić, Kudelić 2019, fig. 7:10.
[36] Říhovský 1996, 130.
[37] Vasić 2015, 73, T. 18:353.
[38] Wanzek 1996, 166; König 2004, 133.
[39] Vinski-Gasparini 1973, T. 198:4.
[40] König 2004, T.59C.
[41] Žeravica 1993, 102–103.
[42] Holste 1951, 26; Vinski-Gasparini 1973, 215.
[43] Vinski-Gasparini 1973, 169, T. 126B.
[44] Vinski-Gasparini 1973, T. 12.

redak and Pašalići.[45] Socketed axes of similar type and typological comparable sickles are also part of the depot Gajina Pećina near Drežnik, which is also dated to Ha B3 period.[46] It is thus to conclude, that both in terms of the typology of deposited objects and with regard to combination, the find from Kamena Gorica resembles the depots of the Late Urnfield period from the Croatian and Bosnian territory south of the Sava River.

Methods

The metal objects were sampled with a polished 1 mm stainless steel drill bit. Before use, each drill bit was cleaned with highly concentrated ethyl alcohol (97%) to remove possible remains from the production process (e.g., polishing emulsion). As a first step, the patina was removed with a drill, and afterwards, a new bit was used to drill a hole 1-2 mm deep. Finally, the resulting drill shavings were collected for analyses. All samples were analysed at the Curt-Engelhorn-centre of Archaeometry (CEZA) in Mannheim. For the measurements of the trace element concentrations, an energy dispersive X-ray fluorescence (ED-XRF) spectrometer (ARL Quant X, Thermo Scientific) was used to analyse the elements silver (Ag), arsenic (As), bismuth (Bi), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), lead (Pb), selenium (Se), tin (Sn), antimony (Sb), tellurium (Te) and zinc (Zn). The detection limits lie at approximately 0.005 % for Ag, Sb, Sn, Pb, Bi and 0.05 % for Fe as well as around 0.01 % for Co, Ni, and As. Selenium and tellurium were measured but were below 0.005 % in all samples. All measurements are given in mass%.

The lead isotope ratios ($^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{204}Pb$) were measured using a high-resolution multi-collector mass spectrometer (Thermo Scientific Neptune Plus) with inductively coupled plasma as ion source (HR-MC-ICP-MS). The $^{208}Pb/^{204}Pb$, and $^{207}Pb/^{204}Pb$ ratios were calculated from the aforementioned measured ratios. The drill shavings were rinsed with dilute HNO3 to remove any surface contamination, then dissolved in half-concentrated HNO3 in an ultrasonic bath (70˚C) for several hours. Insoluble residues were removed by decantation; afterwards, the solution was diluted with deionised water. Ion exchange columns were prepared with PRE-filter and Sr-resin and were preconditioned with 500 µl 3N HNO3 before the solution was added. In four steps, the matrix was first eluted using HNO3, and then the Pb was eluted using HCl. The mass fractionation of lead is corrected by the addition of thallium (Tl), for which a ratio of $^{205}Tl/^{203}Tl = 2.3871$ and an exponential fractionation behaviour are assumed. The interference of ^{204}Pb and ^{204}Hg was corrected by measuring ^{202}Hg with a ratio of $^{204}Hg/^{202}Hg = 0.2293$. The in-run precision of the measurement was typically 0.02 to 0.05% (2σ), depending on the isotopic ratio. The reference sample NIST SRM 981 was measured after every eight samples to check for instrumental drift and to guarantee high-level precision and accuracy. The methods are described in detail by Lutz and Pernicka.[47]

Radiocarbon dating of charcoal piece extracted from the melted metal remains were measured using a MICADAS AMS system. The $^{14}C/^{12}C$ and $^{13}C/^{12}C$ isotope ratios of samples, calibration standards (oxalic acid II), blanks and control standards were measured simultaneously in the AMS. The ^{14}C ages determined are normalized to and calibrated to calendar ages using the INTCAL13 data set.

[45] König 2004, T. 59–61.

[46] Vinski-Gasparini 1973, T.128; Žeravica 1993, T. 24: 319–321.

[47] Lutz – Pernicka 1996; Niederschlag et al. 2003.

Results and Discussion

The following chapter discusses the metallurgical results of finds from the two metallurgical workshops and the Kamena Gorica hoard. The dating of the workshops, from BA D–Ha A2 (Kalnik-Igrišče I) to Ha A2-Ha B1, with some elements indicating also existence during the Ha B3 (Kalnik-Igrišče II), and the hoard dated to Ha B2/B3, allows for a insight into the metal supply of a settlement community over an extended period. Based on trace element and especially lead isotope analyses, it is already known that during this time, copper from the Southern Alps (mainly Trentino) and the Eastern Alps (Mitterberg-Hochkönig) reached the western and central Balkans, dominating the local metal supply.[48] This copper, derived from chalcopyrite, was supplemented from phase Ha A2 onwards by copper from fahlore deposits or so-called "diluted" fahlore copper.[49] The organization of copper utilization in the western and Central Balkans – including primary supply, mixing, and recycling – has recently been subjected to a detailed analysis by Bruyere et al.[50] and Orfanou et al.[51]

An examination of the tin and lead values of the objects from Kalnik-Igrišče I and II reveals that they are mostly low-alloyed bronzes. The tin concentrations range between 3.1–10.5%, while lead values lie between 0.11–0.68%. In the hoard from Kamena Gorica, the average tin values are around 5.7% (with a range between 1.3–10.3 %), and the lead values are situated at approx. 0.5% (see Tab. 1). Two handle fragments (VIAS lab. no. 324 and 325) represent exceptions in both respects, being composed of unalloyed copper without tin. Their lead values, at 0.005%, are either at or below the detection limit of the analytical equipment.

The evaluation of the trace element concentrations shows that older finds from Kalnik-Igrišče I consist of chalcopyrite-based copper, while many of the more recent artifacts can already be identified as fahlore-based or "diluted" fahlore copper as they have elevated trace element concentrations. The two aforementioned handle fragments can be classified as fahlore copper due to their high concentrations of arsenic (As), antimony (Sb), and silver (Ag) (Fig. 7).

The element patterns of the analysed objects indicate that three of them (VIAS lab. no. INZG 616, 618, and 619) exhibit such similar elemental concentrations that it can be hypothesized they derive the same source or copper mine. The fourth object, a pin with a biconical head (VIAS lab. no. INZG 617), shows comparable nickel concentrations, but the rest of the element values do not align as closely. This object also exhibits the lowest arsenic and highest silver concentrations within this group.

Among the artifacts attributed to Kalnik-Igrišče II are three casting remains, an arrowhead, a socketed axe, and a chisel. Interestingly, all of these, with the exception of VIAS lab. no. INZG 620, have lower nickel concentrations (similar to the finds from Kamena Gorica) than the older finds from Kalnik-Igrišče I (Table 1). Tin concentrations average around 5%, with the socketed axe being the sole exception, containing 10.5% Sn. Lead also remains within a low concentration range, below 1%, indicating that there was no intentional addition to the alloy. The casting residues vary in their tin and lead concentrations (Table 1), suggesting they do not originate from a single casting batch. Similarly, no significant analytical relationships can be identified among the remaining finished products.

The hoard from Kamena Gorica contains the most recent objects discussed here. The finished products are made of tin bronze, with a few of them notably exhibiting tin concentrations

[48] Mehofer et al. 2021; Gavranović et al. 2022.

[49] Gavranović et al. 2022.

[50] Bruyere et al. 2024.

[51] Orfanou et al. 2024.

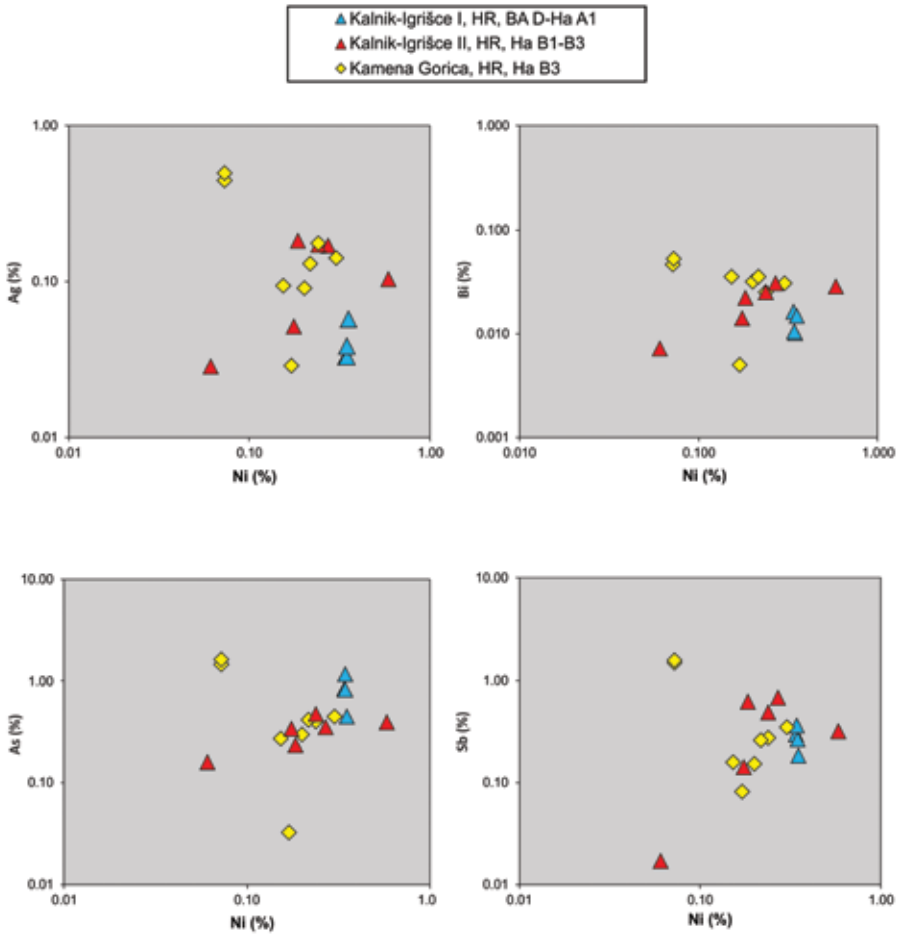


Fig. 7 – Concentrations of silver, bismuth, nickel, arsenic and antimony in the analysed objects. The black arrows mark the detection limit of the analytical device. (M. Mehofer, University Vienna).

between 8–10%. Generally, tin concentrations for finds from this period fall within the 5–7% range, as evidenced by objects from Bosnia-Herzegovina[52] and Slovenia.[53] Lead concentrations are similarly low, remaining below 1%. The spearhead (VIAS lab. no. INZG 318) has the lowest tin concentration (1.32% Sn), and its lead content (0.098%) is the second-lowest within the hoard. Two handle fragments (VIAS lab. no. INZG 324 and 325) form an exception; as previously mentioned, they are unalloyed and made from fahlores copper, likely fragments of the same object.

No definitive conclusions can be drawn regarding the origin of the copper, as only one casting remain (VIAS lab. no. INZG 612) from Kalnik-Igrišče II was analyzed using lead isotope analysis. This piece, dated to Ha A2–Ha B1, has a strong correlation with the ore deposits of the Southern Alps[54] suggesting that the copper likely originated from this region.

Conclusion

At Kalnik-Igrišče we have bronze casting evidence at two chronologically different locations at the Late Bronze Age site. Early Urnfield culture evidence, although as a result of different excavation methodology, is very similar to younger Urnfield culture bronze casting which on the

[52] Gavranović et al. 2022.

[53] Trampuž-Orel 1996, 184.

[54] Artioli et al. 2016.

other hand stays rather conservative in the means of functional structures/features and the metal-working artifacts.

A synthesis of the analyses reveals that the results align with the established knowledge of the metallurgical development in the western and central Balkans. Noteworthy, however, is that the finds from Kalnik-Igrišče I exhibit unusually low tin concentrations. Comparable objects from the adjacent southern regions show significantly higher tin values, while finds from Slovenia[55] also exhibit similarly low tin concentrations, around 6% Sn. Whether this reflects a broader phenomenon, possibly due to varying access to tin resulting from different supply networks, remains a question for future research. Particularly interesting in this context are also nearby metallurgical workshops and their supply copper networks such as Sv. Peter Ludbreški in northwestern Croatia with larger number of casting moulds[56] or Dragomelj in neighboring Slovenia, where a number of copper ingots have been discovered.[57] The first evaluation of trace element patterns of analysed object confirms the previously described trends for the region. In the older finds, copper primarily derived from chalcopyrite is predominant, while in the more recent objects, there is a growing influence of copper sourced from fahlores. The results of the lead isotope analysis once again suggest that the Southern Alps played a significant role in metal supply. However, it must be noted that the total number of analyses available from the study material is too low to draw definitive conclusions.

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Writing of sections: Mario Gavranović, Snježana Vrdoljak: Introduction, conclusion; Mathias Mehofer: methods, results and discussions, conclusion. Authors Contributions: Snježana Vrdoljak, Mario Gavranović: project administration, resources, conceptualisation, supervision, writing – original draft, writing – review and editing – final text, Mathias Mehofer: data curation, formal analyses, investigation, methodology, supervision, writing – original draft, writing – review and editing – final text.

[55] Trampuž-Orel 1996, 185.
[56] Šimek 1979; Wanzek 1989.
[57] Turk et al. 2003, 93.

VIAS lab. no.	Inv. no.	CEZA lab. no.	site	object	analyses	Cu	Fe	Co	Ni	Zn	As	Ag	Cd	Sn	Sb	Pb	Bi
INZG 616	4110	MA-201545	Kalnik-Igrišće I	Pin with flattened spherical head	RFA	92	0.05	0.04	0.34	0.1	0.84	0.033	0.005	5.5	0.294	0.57	0.02
INZG 617	7402	MA-201546	Kalnik-Igrišće I	Pin with biconical head	RFA	92	0.21	0.06	0.35	0.1	0.44	0.058	0.005	6.0	0.184	0.24	0.015
INZG 618	4112	MA-201547	Kalnik-Igrišće I	Club-shaped pin	RFA	94	0.06	0.03	0.35	0.1	1.17	0.033	0.005	3.1	0.266	0.47	0.010
INZG 619	7397	MA-201548	Kalnik-Igrišće I	Dagger	RFA	95	0.05	0.04	0.34	0.1	0.82	0.039	0.005	3.1	0.36	0.21	0.011
INZG 611	452	MA-201540; MAMS 45757	Kalnik-Igrišće II	Melted metal/ casting remain	RFA, ^{14}C	93	0.32	0.10	0.27	0.1	0.35	0.171	0.005	4.0	0.68	0.61	0.03
INZG 612	512	MA-201541	Kalnik-Igrišće II	Melted metal/ casting remain	RFA	95	0.05	0.04	0.18	0.1	0.234	0.183	0.005	3.6	0.61	0.49	0.022
INZG 613	2435	MA-201542	Kalnik-Igrišće II	Melted metal/ casting remain	RFA	92	0.13	0.04	0.18	0.1	0.34	0.051	0.005	6.5	0.140	0.33	0.014
INZG 614	509	MA-201543	Kalnik-Igrišće II	Arrowhead	RFA	93	0.05	0.01	0.06	0.1	0.160	0.029	0.005	6.6	0.017	0.11	0.007
INZG 620	520	MA-201549	Kalnik-Igrišće II	Pin or drift	RFA	95	0.05	0.08	0.58	0.1	0.39	0.104	0.005	3.1	0.32	0.68	0.03
INZG 615	574	MA-201544	Kalnik-Igrišće II	Socketed axe	RFA	87	0.05	0.09	0.24	0.1	0.47	0.172	0.01	10.5	0.49	0.58	0.03
INZG 318	1976	MA-196252	Kamena Gorica	Spearhead	RFA	98	0.05	0.02	0.17	0.1	0.033	0.029	0.005	1.32	0.081	0.098	0.005
INZG 319	1975	MA-196253	Kamena Gorica	Socketed axe	RFA	90	0.06	0.16	0.30	0.1	0.45	0.141	0.005	8.0	0.35	0.89	0.03
INZG 320	1969	MA-196254	Kamena Gorica	Sickle	RFA	90	0.20	0.18	0.20	0.1	0.30	0.091	0.005	8.3	0.151	0.55	0.03
INZG 321	1972	MA-196255	Kamena Gorica	Bracelet	RFA	88	0.15	0.12	0.15	0.1	0.27	0.094	0.01	10.3	0.157	0.64	0.04
INZG 322	1973	MA-196256	Kamena Gorica	Bracelet	RFA	89	0.08	0.04	0.24	0.1	0.40	0.177	0.005	8.6	0.275	0.99	0.03
INZG 323	1974	MA-196257	Kamena Gorica	Bracelet	RFA	89	0.05	0.16	0.22	0.1	0.42	0.131	0.005	9.0	0.260	0.87	0.04
INZG 324	1970	MA-196258	Kamena Gorica	Handle/bar	RFA	96	0.05	0.01	0.07	0.1	1.47	0.45	0.005	0.005	1.48	0.005	0.046
INZG 325	1971	MA-196259	Kamena Gorica	Handle/bar	RFA	96	0.05	0.01	0.07	0.1	1.63	0.50	0.005	0.005	1.56	0.005	0.053

VIAS lab. no.	Inv. no.	CEZA lab. no.	site	object	analyses	$^{208}Pb/^{206}Pb$	2σ	$^{207}Pb/^{206}Pb$	2σ	$^{206}Pb/^{204}Pb$	2σ	$^{208}Pb/^{204}Pb$	2σ	$^{207}Pb/^{204}Pb$	2σ
INZG 612	512	MA-201541	Kalnik-Igrišće II	Melted metal/ casting remain	LIA	2.1034	0.0001	0.85533	0.00003	18.316	0.001	38.526	0.003	15.666	0.002

Table 1. Chemical composition of the analyzed objects as determined with energy-dispersive XRF. All values are given in mass percent. Se and Mn was below the detection limit of 0.01 %, Te below 0.005 % in all samples. Lead isotope ratio in the sample VIAS lab. no. INZG 612 discussed within this article.

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The travel of metal axes along the Danube during the 3rd millennium BC

Radu Băjenaru[1]

Abstract: Since Gordon Childe in 1929, the Danube (and its main tributaries) has been perceived as one of the main communication routes across Europe in prehistoric times[2]. This is demonstrated by the numerous commodities transmitted along the Danube in the various pre- and protohistoric periods. Among these, metal artefacts play a special role. From the 3rd millennium BC, the northeastern part of the Balkan Peninsula (including the Lower Danube and Thrace) became an important centre of production of shaft-hole axes, developing its own distinct types, such as Veselinovo, Izvoarele, and Pătulele, according to the Alexandru Vulpe's typology[3]. Some specimens of this type can also be found in the Middle Danube basin, testifying to the close contacts between the two areas. The author presents an analysis of the main types of shaft-hole axes manufactured in the Danube basin in the 3rd millennium BC, from the oldest (Baniabic, Corbasca) to the newest (Pătulele, Pădureni), and how they are distributed along the Danube. This analysis illustrates and certifies the complexity of the long-distance exchange connections facilitated by the hydrographic network of the Danube basin.

Key words: Early Bronze Age, Danube Basin, Metal Shaft-hole Axes, Technology, Long-distance Connections

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[2] Childe 1929.

[3] Vulpe 1970.

Introduction

The travel of people and commodities is a key concept in the study of cultural processes and change over time in specific regions, and it is well documented that rivers have been a significant means of transportation since early prehistory. With a length of approximately 3,000 km, the Danube represents the primary route connecting central Europe with the southeastern regions of the continent. The Danube basin, which encompasses the river itself and its tributaries, covers approximately 800,000 km^2 (fig. 1/1). It incorporates a multitude of regions that are markedly diverse in terms of landscape and cultural traditions. The Danube river basin thus represents one of the most complex networks of long-distance connections in European prehistory. Through its tributaries, the Danube basin is connected to the other neighbouring cultural areas, such as the one north of the Carpathian Mountains (the Tisza, Siret, and Prut rivers), but also with the Aegean area, through the corridors Velika Morava - Vardar/Axios and Iskăr - Struma. For prehistoric metallurgy, extremely important are the links with the Alpine area, through the Isar, Inn, and Enns rivers, but also through the Drava and Sava, which ensure the connection with the middle Danube. Equally important is the connection with the Slovakian Ores Mountains, through the Váh and Hron rivers, an area known for intensive copper and tin mining in prehistoric times.

The Danube basin is divided into three distinct areas, as is widely accepted: the Upper Danube basin, from the origins to the confluence with the Morava river; the Middle Danube basin, from the confluence with the Morava river to the Iron Gates; the Lower Danube basin, from the Iron Gates to the Danube Delta (fig. 1/2). Each of these geographical segments has developed particular, specific cultural features in prehistory, but there are no genuine cultural borders between them. There has always been a continuous flow of people and commodities along the Danube. Conversely, the entire Danube basin has never emerged as a single cultural space. The main value of these extensive communication networks developed within the Danube basin is that they enabled and facilitated small-scale processes to become large-scale phenomena.

One of these processes is undoubtedly the appearance and development of extractive metallurgy, which is a key process in shaping prehistoric societies. In the Bor district of eastern Serbia, situated in close proximity to the border between the Middle and Lower Danube, a significant corpus of evidence pertaining to the earliest copper ore mining activities in Europe has been unearthed. The discoveries at Maidanpek and, in particular, Rudna Glava indicate that these mining operations commenced in the latter half of the 6th millennium BC[1]. Additionally, several late Vinča-type sites have been identified in central Serbia, exhibiting clear evidence of smelting and casting of finished artefacts. The finds from Belovode, Vinča and Pločnik are worth mentioning here[2], where, according to lead isotope analysis, copper from the Maidanpek mines was mainly processed[3]. All these activities can be dated to the advent of the 5th millennium BC, when the first heavy copper items, such as flat axes and hammer-axes, were cast, as indicated by the finds from Pločnik[4].

It is therefore reasonable to assume that this new technology of extractive metallurgy, together with the finished artefacts, disseminated relatively rapidly and uniformly over several hundred years throughout the Danube basin, as indicated by the distribution areas of flat axes, hammer-axes, and, somewhat later, axe-adzes. It is evident from Julia Heeb's analysis that

[1] A complete overview at Radivojević et al. 2021; Jovanović 1982; Borić 2009; Antonović 2014, 4-12; O'Brien 2014, 39-47.

[2] See general works of Antonović 2014, 18-28, and Radivojević et al. 2021, with bibliography.

[3] Pernicka et al. 1993.

[4] Antonović 2014, 37-42, 55-57, pl. 55-58.

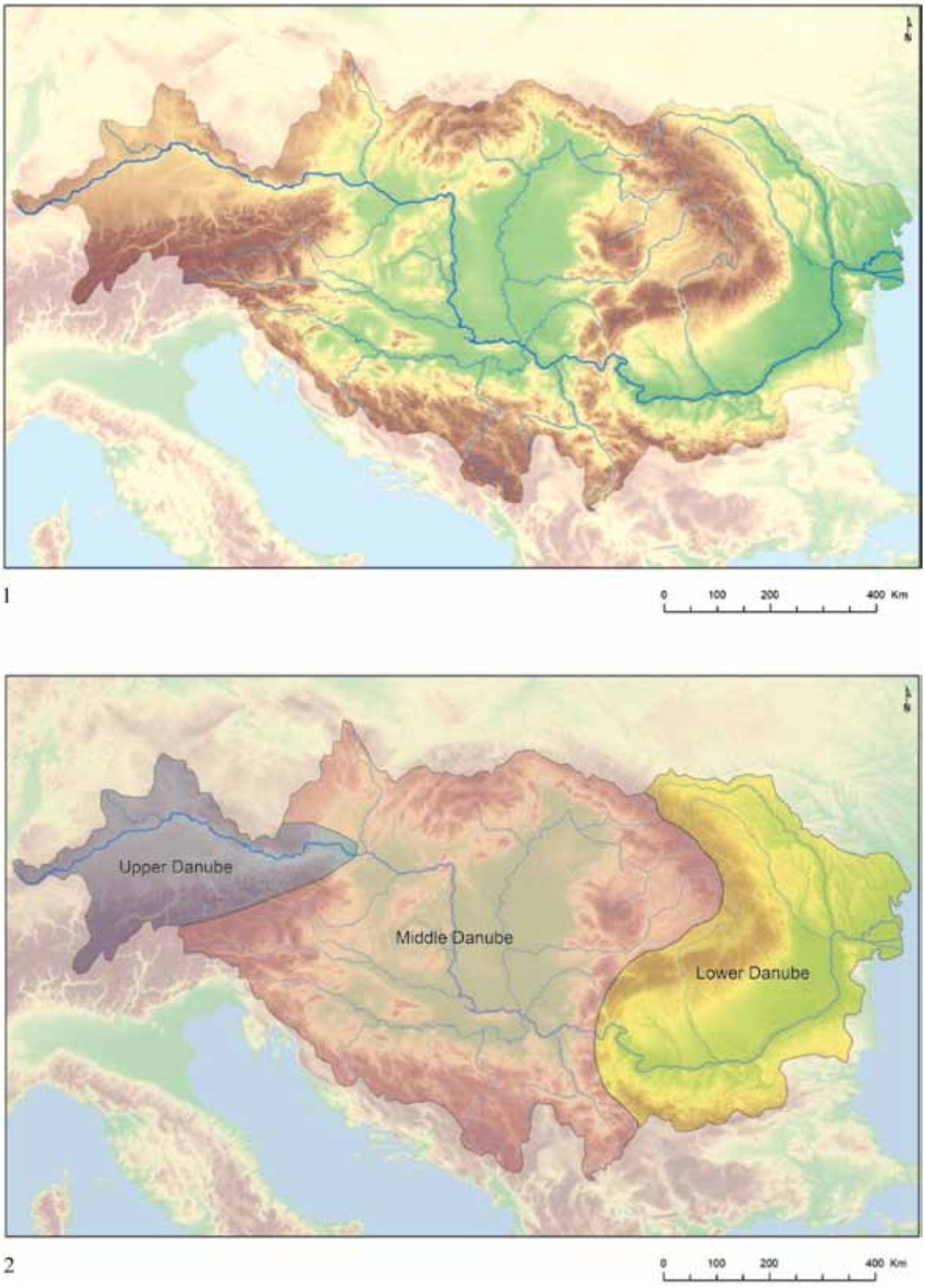


Fig. 1 – 1: The Danube river basin; 2: Upper, Middle, and Lower Danube basins (map copyright: www.sor.ro, data source: USGS GTOPO30/EEA).

these axes are present only in small numbers outside the Danube basin[5]. This suggests that the Eneolithic metallurgy of the 5th millennium and the first half of the 4th millennium BC in southeastern Europe is, in fact, an entirely Danubian phenomenon. In any case, this is the first example of such a large-scale phenomenon in the Danube basin, underscoring the significance of the intricate network connections that have been established within the area.

The second half of the 4th millennium BC

Towards the middle of the 4th millennium BC, a series of significant changes in the material culture of the Eneolithic communities of the Danube basin led to the appearance of new types of metal objects in this area. Most probably, these changes are the result of contacts with the North Pontic area, which have been observed in the Danube basin since the second half of the 5th millennium BC[6] but which, intensified in the following periods, finally led to the entirely change of the Eneolithic way of life. It should also be noted that these transformations are more pronounced in the Lower Danube than in the other two segments of the Danube basin and mainly concern settlement patterns, funerary practices, and metallurgy[7]. Within the new 'package' of metal objects, the shaft-hole axe, the flanged axe, and the tanged dagger stand out.

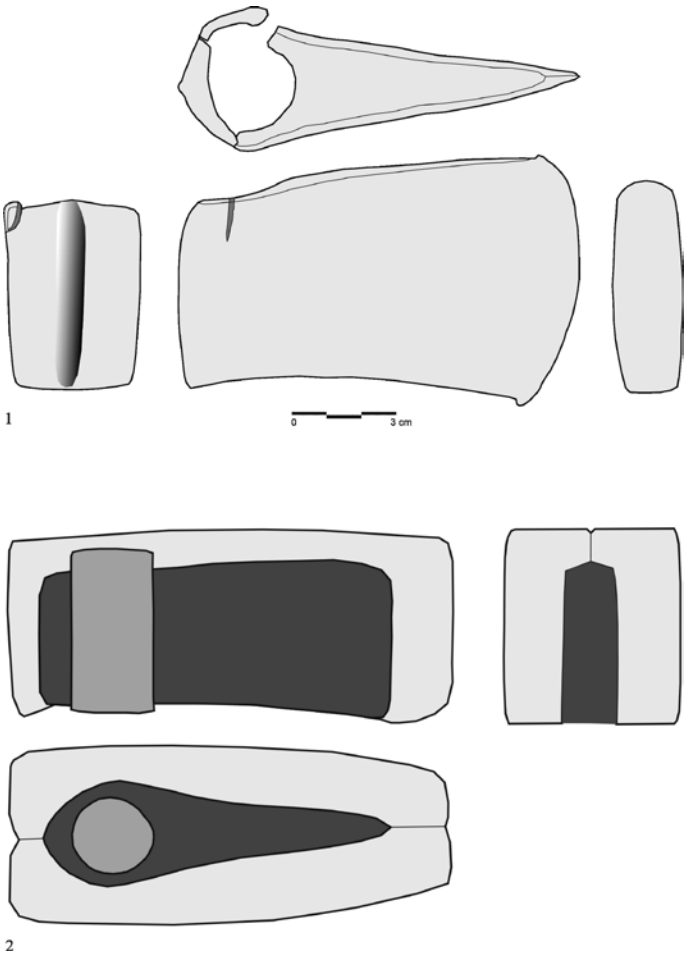


Fig. 2 – 1: The shaft-hole axe of Baniabic type from Moghila (Bulgaria, Lower Danube); 2: The reconstruction of the bivalve mould open at the lower edge (2: after Băjenaru, Tuţulescu 2021).

The shaft-hole axe represents the most significant innovation in Early Bronze Age metallurgy within the Danube basin[8]. The evidence suggests that this type of axe first emerged in this area during the second half of the 4th millennium BC, replacing the hammer-axes and axe-adzes that were prevalent during the Eneolithic period in terms of social representation. The initial production of this type of axe is thought to have occurred in the Caucasus region, probably as early as the second quarter of the 4th millennium BC. Over a relatively short period of time (sev-

[5] Heeb 2014, 31-41, fig. 8-9.
[6] Govedarica 2004.
[7] Băjenaru 2010a.
[8] Hansen 2011; Hansen 2014.

eral hundred years), this axe spread over a vast area, from the Middle Volga to the Upper Danube basin[9].

The eastern origin of this axe type is evidenced by the technological and typological resemblances of the earliest examples from the Danube basin (Baniabic type[10]) to those from the North Pontic and Caucasian regions (fig. 2/1). These axes lack an elongated sleeve and are cast in bivalve moulds open along the entire length of the lower edge, including the sleeve area[11] (fig. 2/2). Valentin Dergachev has identified almost 250 specimens of the Baniabic type, distributed from the Ural basin to the Upper Danube basin. Of these, nearly 60 items have been found in the Danube basin[12]. Although Dergachev includes among these axes some belonging to other types (Corbasca, Veselinovo), the number remains high, suggesting that these axes were produced locally. This is the only argument in this regard, as there is no other evidence of the casting of these items in our area. The complete absence of moulds for Baniabic-type axes in the Danube basin, along with the typological and technological similarities with the steppe area, indicate that many of these axes are rather 'imports' from the Caucasian and North Pontic regions[13].

Given the extensive geographical range of Baniabic axes, it is difficult to identify a Danubian spatial distribution pattern. However, the discovery of at least eight specimens along the river, spanning the Lower to Upper Danube basin, offers valuable insight into the distribution of these artefacts. It is notable that this distribution encompasses all three segments of the Danube basin, indicating that the networks of communication and exchange established during the Eneolithic period remain active.

Another category of axes, similar to a large extent to the Baniabic ones, are those included in the Corbasca type[14]. Cast by the same archaic technology, in bivalve moulds completely open at the lower edge, it seems rather that this kind of item originated exclusively in the North Pontic area (middle and lower basin of the Dnieper), from where they spread to the Danube area, most probably in the second half of the 4th millennium BC[15]. The main typological features of these axes are the sharp curvature of the blade and a usually widened cutting edge, sometimes with the lower corner pulled down. In contrast to the Baniabic axes, the Corbasca ones show a greater typological diversity, and several variants can be identified.

Thus, on the one hand, we note the presence in the Danube basin of axes similar to those found in the northern Pontic area, such as the one from the Corbasca hoard (Bacău County, Romania)[16] (fig. 3/1). It seems reasonable to conclude that such items also represent 'imports' from the aforementioned region. On the other hand, two distinct typological variants, which are almost exclusively characteristic of the Danube basin, have been identified[17]. Firstly, approximately nine axes are present in the Lower Danube region, predominantly in north-central Bulgaria, with only two items outside this area (fig. 3/B). Despite their substantial size, these axes display all the features of Corbasca specimens, including a markedly curved blade, a broad cutting edge that is sometimes indented at the lower corner, and obviously all cast in bivalve moulds open at the lower edge (fig. 4/1-2). The second variant is exemplified by the four axes discovered in hoard I

[9] Bátora 2003; Hansen 2009; Băjenaru 2010b; Hansen 2011; Szeverényi 2013; Дергачёв 2019; Bátora 2023.
[10] Vulpe 1970, 26-28, pl. 1-3.
[11] Chernykh 1992, 61, fig. 18/1; Дергачев 2021, 380-386, fig. 6; Băjenaru, Tuţulescu 2021, 142-143, fig. 6/1.
[12] Дергачёв 2019, fig. 1.
[13] Băjenaru 2024, 259.
[14] Vulpe 1970, 29-30, pl. 3-4.
[15] Băjenaru, forthcoming.
[16] Florescu, Căpitanu 1968, 50-51, fig. 1/2; Vulpe 1970, 30, no. 40, pl. 3/40, 65/C; Soroceanu 2012, 130-131, pl. 51.
[17] Băjenaru, forthcoming.

from Ostrovul Corbului (Mehedinți County, Romania)[18]. They are also massive objects, with very wide but also very thin blades (fig. 4/3-4). Three specimens are identical and originate from Šarengrad (Croatia), two of which are part of a hoard[19] (fig. 4/5-6). The two axes from the Žitavany hoard (Nitra region, Slovakia) exhibit similar typological characteristics but have a thicker blade than those from Ostrovul Corbului and Šarengrad[20] (fig. 4/7-8). A similar observation can be made of two other axes from the Middle Danube basin, namely those from Vevčice and possibly Vlčnov, both in Moravia (Czech Republic)[21] (fig. 4/9-10).

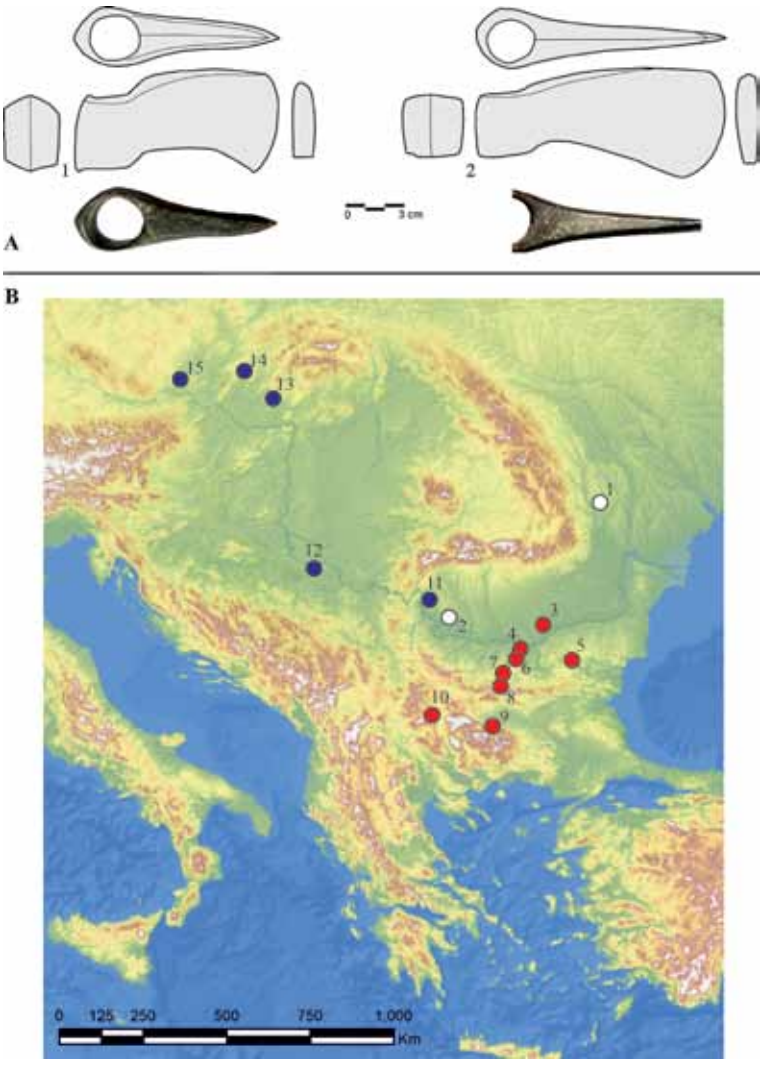


Fig. 3 – A: Shaft-hole axes of the Corbasca type; 1: Corbasca (RO); 2: Izvoare (RO). B: The distribution of the Corbasca-type axes (red: Seydol variant; blue: Šarengrad variant). 1: Corbasca (RO); 2: Izvoare (RO); 3: Schitu (RO); 4: Belene (BG); 5: Seydol (BG); 6: Dekov (BG); 7: Sennik (BG); 8: Krăvenik (BG); 9: Bratsigovo (BG); 10: Smochevo (?) (BG); 11: Ostrovul Corbului (RO); 12: Šarengrad (HR); 13: Žitavany (SK); 14: Vlčnov (CZ); 15: Vevčice (CZ).

While the first typological variant (Seydol) of the Corbasca-type axes can be seen as limited to the Lower Danube basin, the 11 items of the Šarengrad variant indicate a distribution along the river, extending from the western boundary of the Lower basin to the north-western limit of the Middle basin (fig. 3/B). This is the first clear example of the long-distance transmission of shaft-hole axes within the Danube basin, with the river corridor serving as the primary distribution route. It is important to note that during the period in which these axes were in circulation, including the Baniabic ones, the cultural background across a significant part of the Danube basin was characterised by the presence of the Baden, Kostolac, and Coțofeni cultures. These three cultures are usually regarded as being closely related, displaying numerous similarities in material culture, which facilitated this transmission of early axes over large areas of the Danube basin.

[18] Berciu 1937; Vulpe 1970, 30, no. 44-47, pl. 4/44-47, 65/E; Soroceanu 2012, 147-150, pl. 59.
[19] Garašanin 1954, 70, no. 45-46, fig. 1/7; Balen-Letunić 2004, 20, no. 11, pl. 2/2.
[20] Novotná 1970, 27, no. 137-138, pl. 8/137-138.
[21] Říhovský 1992, 36-37, no. 34-35, pl. 5/34-35.

The Šarengrad variant of the Corbasca axes exhibits certain typological similarities with several artefacts from the Caucasus region, classified by Sergey Korenevskiy in group 4-1 of his typology (Psebayskaya type)[22]. The similarities refer particularly to the curvature of the upper edge, the width of the cutting edge, and the thinness of the blade. Considering the example of the Baniabic axes, it is not excluded that the inspiration for the Šarengrad variant also came from the Caucasus. A good example of this is the axe from Izvoare (Dolj County, Romania)[23], typologically resembling the Corbasca type but very well worked and finished, with the lower edge decorated with parallel oblique incisions, similar to some Caucasian shaft-hole axes (fig. 3/2).

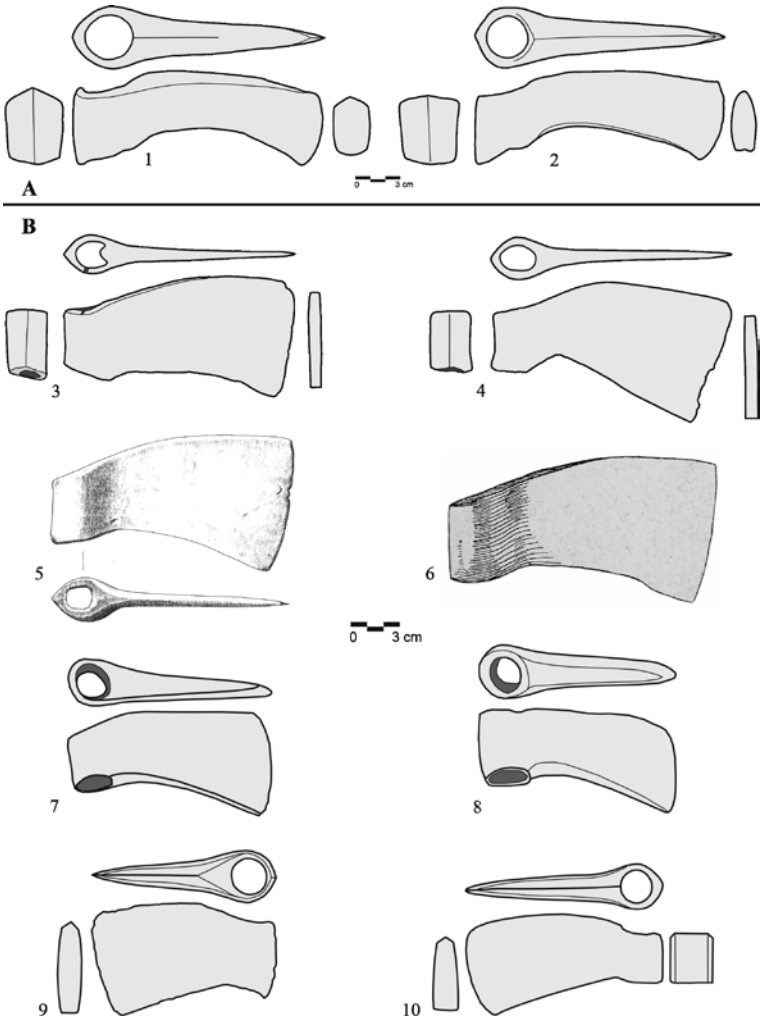


Fig. 4 – A: Shaft-hole axes of the Corbasca type, Seydol variant; B: Shaft-hole axes of the Corbasca type, Šarengrad variant. 1: Seydol (BG); 2: Smochevo (?) (BG); 3-4: Ostrovul Corbului (RO); 5-6: Šarengrad (HR); 7-8: Žitavany (SK); 9: Vlčnov (CZ); 10: Vevčice (CZ) (5: after Balen-Letunić 2004; 6: after Garašanin 1954; 7-8: after Novotná 1970; 9-10: after Říhovský 1992).

A close typological relationship between the Corbasca and Fajsz types of axes has already been noted in the literature[24]. The axe no. 2 from Ostrovul Corbului (fig. 4/4) or those from Vlčnov (fig. 4/9) display characteristics of both types, and it is difficult to classify them as one or the other. The Fajsz-type axes represent the third archaic type of shaft-hole axes present in the Danube basin. Cast in the same way as the bivalve moulds open at the lower edge, they also exhibit certain typological correspondences in the North Pontic and Caucasian area, particularly among the items classified by Korenevskiy in group 2-2[25]. However, the axes of the Fajsz type have a well-defined distribution in the northern half of the Middle Danube basin[26] (fig. 5), with very few specimens outside the core area[27]. Therefore, the production and spatial spread of Fajsz-type axes appear to be a phenomenon specific to the Tisza basin and its tributaries.

[22] Кореневский 2011, 65-66, fig. 46-1.
[23] Vulpe 1970, 30, no. 43, pl. 3/43.
[24] Vulpe 1970, 28-30; Dani 2013, 207.
[25] Кореневский 2011, 64-64, fig. 41-2/1, 43-1/3.
[26] Dani 2013, 205, fig. 2.
[27] Bátora 2023, fig. 28.



Fig. 5 – The core distribution area of the Fajsz-type axes.

Although there is no conclusive evidence for a local production of the aforementioned types of axes (I refer primarily to moulds and casting workshops), the analysis of their spatial distribution and a more detailed examination of their specific typological features suggest that the Seydol and Šarengrad variants of the Corbasca type, along with those that can be classified as Fajsz[28], represent the earliest evidence of shaft-hole axe production in the Danube basin[29]. The stratigraphic position of the Brno-Líšeň hoard (Moravia, Czech Republic)[30], which contains a Fajsz-type axe, indicates that this phenomenon occurred at the border of the 4th and 3rd millennia BC, most probably between 3200 and 2900 BC[31]. It is also noteworthy that this early local production of axes in the Danubian region reflects the same technological and typological principles observed in the regions from which these types originated (North Pontic and Caucasian).

The first half of the 3rd millennium BC

This period is characterised by the emergence of autonomous production of shaft-hole axes in the Danube basin, distinct from the North Pontic area, both in terms of the types of axes produced and the technology used in their casting, particularly the one in closed bivalve moulds[32]. The process is closely related to the emergence and development of the Vučedol culture in the Middle Danube basin, an extremely creative cultural environment in terms of material culture, including metallurgy. A cultural phenomenon of a similar scale and importance is documented in Thrace, where the well-known tell settlements (Ezero, Yunacite, Veselinovo, or Nova Zagora) developed. Both areas stand out for the richness and originality of their material culture, primarily through the pottery ornamented with white inlay, but it is also here that the first foundry

[28] Dani 2013, 205; Batora 2023, 253.
[29] Băjenaru, Tuţulescu 2021, 144; Băjenaru 2024, 260.
[30] Benešová 1956; Říhovský 1992, 37, no. 36, pl. 5/36, 85/A.
[31] Baldia et al. 2008, 43.
[32] Băjenaru, Tuţulescu 2021, 149; Băjenaru 2024, 260.

workshops in the Danube basin and the Balkan Peninsula are documented[33]. At the same time, the Lower Danube basin remained significantly connected to the northern Pontic area, with an expansion of Yamnaya-type burials throughout the region. It was not until the second quarter of the 3rd millennium BC, with the emergence of Glina-type settlements in Muntenia and Oltenia, that the western Lower Danube area became active in the local production of shaft-hole axes.

The main type of axe produced in the Vučedol cultural area during the first half of the 3rd millennium BC is the Kozarac, spread throughout most of the Middle Danube basin as well as along the Adriatic coast[34]. Unlike the earlier types of axes mentioned above, the Kozarac ones are designed with an extended sleeve, which implies new casting techniques to ensure an even distribution of metal in the moulds, including in the sleeve area. The evidence from the moulds and finished artefacts indicates that multiple casting methods were used in the production of Kozarac axes. This suggests the existence of multiple metallurgical workshops with different traditions. Furthermore, it indicates that this particular type of axe was produced in a variety of forms over an extended period of time, spanning almost the entire first half of the 3rd millennium BC.

The casting process primarily employs the use of bivalve moulds that are open at the upper edge, with the opening sometimes restricted to a smaller portion of the upper edge (fig. 6/1). The technology in question was utilised across a broader geographical area during the third millennium BC, including the North Pontic region, where it was used for casting early Kolontaiv axes[35]. Consequently, the precise origin of this technology remains uncertain. On the other hand, a significant number of Kozarac-type axes are produced using closed bivalve moulds, with the sprue situated on either the upper or lower edge, in proximity to the cutting edge, or even on the cutting edge itself, as evidenced by some moulds[36] (fig. 6/2-3). The casting in closed bivalve moulds with the sprue situated on the upper edge is also attested in the North Pontic area, for the production of Kolontaiv-type axes, but for some later variants of it, generally dated to the second half of the 3rd millennium BC. It may therefore be concluded that the technology of casting shaft-hole axes in closed bivalve moulds was invented by the metallurgists

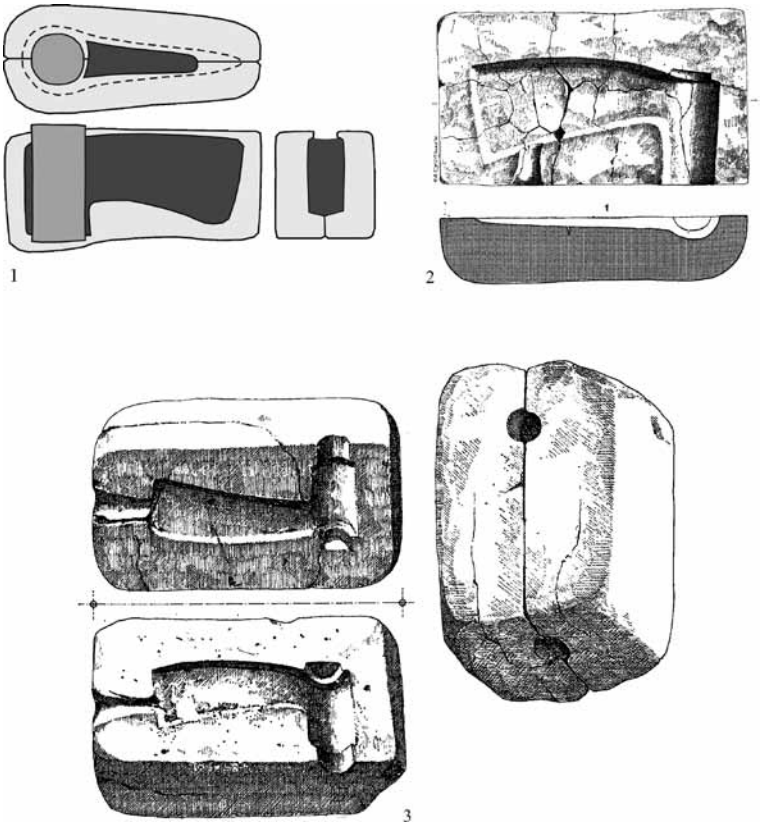


Fig. 6 – Different types of technologies used for casting Kozarac-type axes (1: after Băjenaru, Tuţulescu 2021; 2-3: after Durman 1983).

[33] Durman 1983; Ilon 2022; Черных 1978.

[34] Žeravica 1993, 22-32, pl. 6-8; Antonović 2014, 90-92, pl. 37-39; Dani 2013, 207-208.

[35] Chernykh 1992, 61, fig. 18/4; Băjenaru, Tuţulescu 2021, fig. 11/2.

[36] Durman 1983, pl. 2-3.

of the Vučedol cultural area, from where it subsequently disseminated into the Lower Danube region.

During the same period, the northeastern part of the Balkan Peninsula produced and used axes of the Veselinovo type (Veselinovo I, according to Alexandru Vulpe's typology[37]). The origin of these axes can be traced back to the Seydol and Šarengrad variants of the Corbasca type, from which they inherit a number of typological characteristics. Nevertheless, a certain Caucasian influence in the emergence of this type of axe in the Balkans, mediated by the Anatolian area, cannot be ruled out, as suggested by the recent finds in south-eastern Thrace at Uzunköprü (Edirne region, Turkey)[38], but the evidence of such connections is quite problematic.

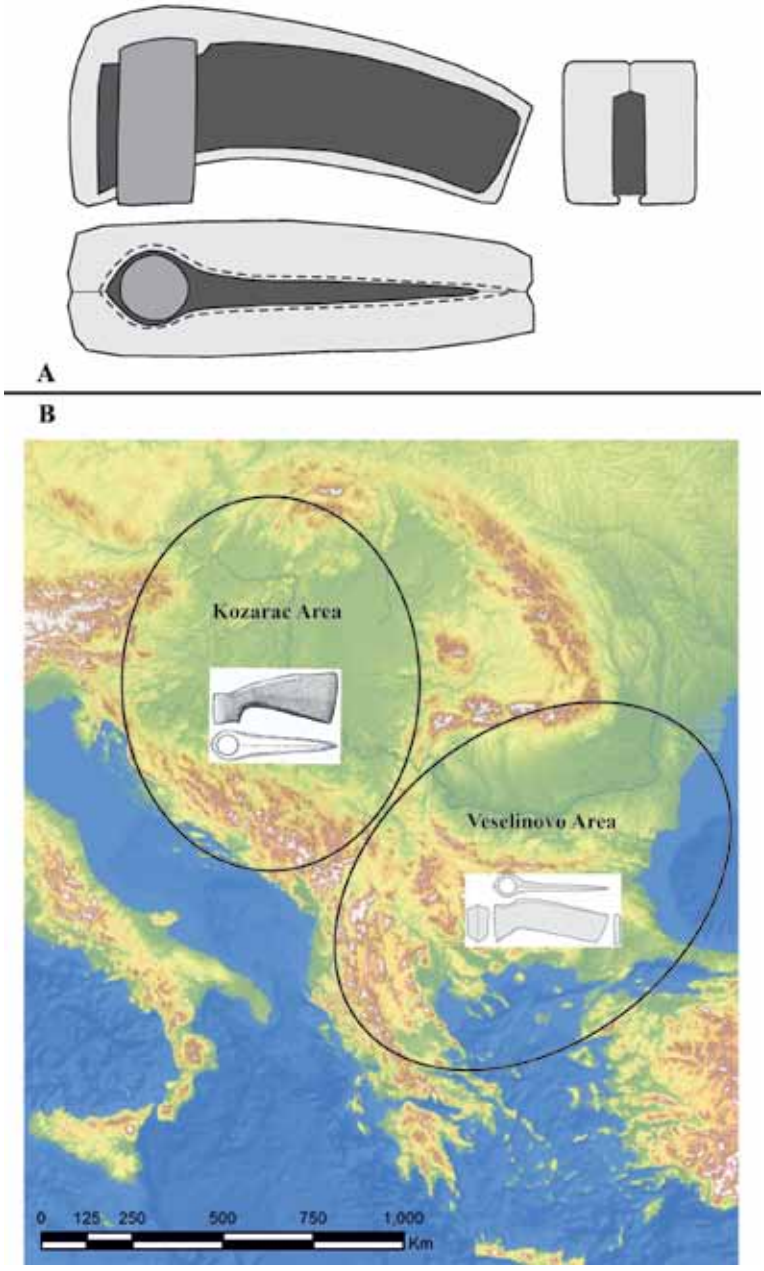


Fig. 7 – A: The main technology used for casting Veselinovo-type axes; B: The distribution areas of Kozarac- and Veselinovo-type axes (1: after Băjenaru, Tuţulescu 2021).

Moulds for the production of Veselinovo-type axes have been discovered in Thrace[39] and the northern Aegean[40]. The mould from Cernavoda (Constanţa County, Romania), referenced by Dumitru Berciu[41], still remains an enigma due to the absence of supplementary data regarding this discovery. In contrast to the Kozarac-type axes, in the casting technology of early Veselinovo axes, bivalve moulds open at the lower edge continue to be used (fig. 7/A). The number of axes cast in closed bivalve moulds with the sprue on the upper edge is extremely limited[42]. The distribution area of Veselinovo-type

[37] Vulpe 1970, 35-37, pl. 5-6.
[38] Doğan 2024.
[39] Черных 1978, pl. 20/6-8, 21/10, 26/6.
[40] Maran 2001; Kleitsas 2019.
[41] Berciu 1966, 155; Vulpe 1970, 36, no. 74.
[42] Băjenaru 2024, 265, fig. 8.

axes extends from Epirus and the northern Aegean region to northern Dobrogea, with very few items found north of the Danube.

It is quite evident that the production and distribution of the Kozarac-type axes is concentrated along the Middle Danube and its main tributaries. In contrast, the distribution of Veselinovo-type axes is more extensive across the Balkan region, with the Danube playing a secondary role. More interesting is the fact that the distribution areas of the two types of axes exclude each other, with no Kozarac item being found in areas where Veselinovo axes occur and vice versa (fig. 7/B). Furthermore, the presence of Kozarac-like axes in the northeastern part of the Lower Danube area, especially in the Siret basin, is a particularly intriguing observation[43].

Only in the second quarter of the 3rd millennium BC, along the emergence of Glina-type settlements in southern Romania, the western area of the Lower Danube was integrated into the production system of shaft-hole axes. Representative are the Izvoarele-type axes[44], probably inspired by the Kozarac-type ones but without the distinctive curvature of the blade that is characteristic of the latter. A still unpublished fragmentary stone mould, discovered in a settlement at Seaca (Gorj County, Romania), probably used for casting Izvoarele axes, ensures the relationship between Izvoarele-type artefacts and the Glina cultural environment. This type of axe is produced and used for a longer period in the Lower Danube, with the earlier items being cast in closed bivalve moulds with the sprue located on the upper edge, most often near the socket[45] (fig. 8/A). There is an evident concentration of these axes towards the western limit of the Lower Danube, and, more importantly, a few have also been discovered in the

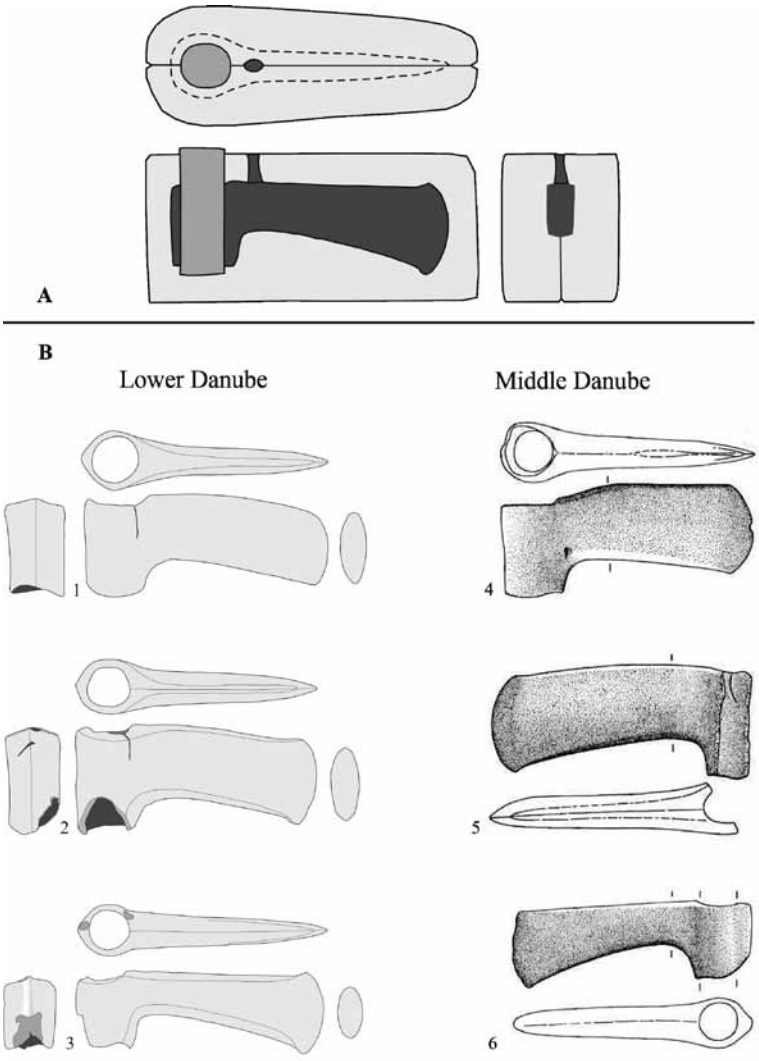


Fig. 8 – A: The main technology used for casting early Izvoarele-type axes (after Băjenaru, Tuţulescu 2021); B: Shaft-hole axes of the early Izvoarele-type from the Lower and Middle Danube. 1: Borovan (BG); 2: Altimir (BG); 3: Berbeşti (RO); 4: Jasika (RS); 5: Kostol (RS); 6: Laznica (RS) (4-6: after Antonović 2014).

[43] Popescu 2006.

[44] Vulpe 1970, 32-35, pl. 4-5.

[45] Băjenaru, Tuţulescu 2021, 151, fig. 15/2

neighbouring area of the Middle Danube basin (fig. 9). In this context, the axe from Skobanja (Zaječar district)[46] must also be mentioned, which can be classified as an early variant of the Pătulele type, likely having reached the Middle basin of the Danube as a result of contacts with the Lower Danube area.

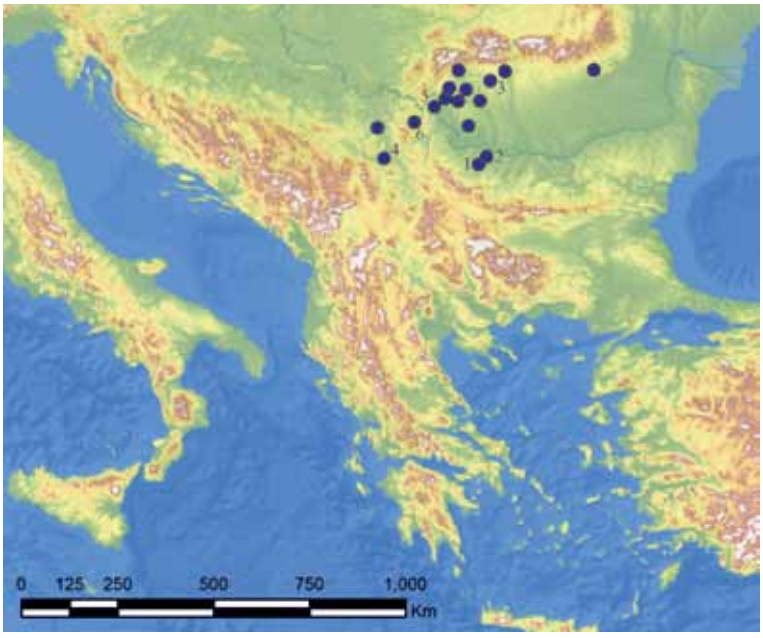


Fig. 9 – The distribution of the early Izvoarele-type axes.
1: Borovan (BG); 2: Altimir (BG); 3: Berbeşti (RO); 4: Jasika (RS); 5: Kostol (RS); 6: Laznica (RS).

The second half of the 3rd millennium BC

Is undoubtedly a very dynamic period in terms of cultural relations across the Danube basin. Following a period of approximately half a century, there has been a discernible intensification of long-distance connections, including those facilitated by ceramics, between the Lower Danube, Thrace, and the Aegean region[47]. Additionally, there has been a significant increase in interactions between the eastern and western parts of the Balkan Peninsula[48], as evidenced by the exchange of cultural elements between Odaia Turcului and Cetina groups, for instance (fig. 10).

From the perspective of the production and circulation of shaft-hole axes, by the middle of the 3rd millennium BC, new casting technologies continued to be experimented with, now particularly in the

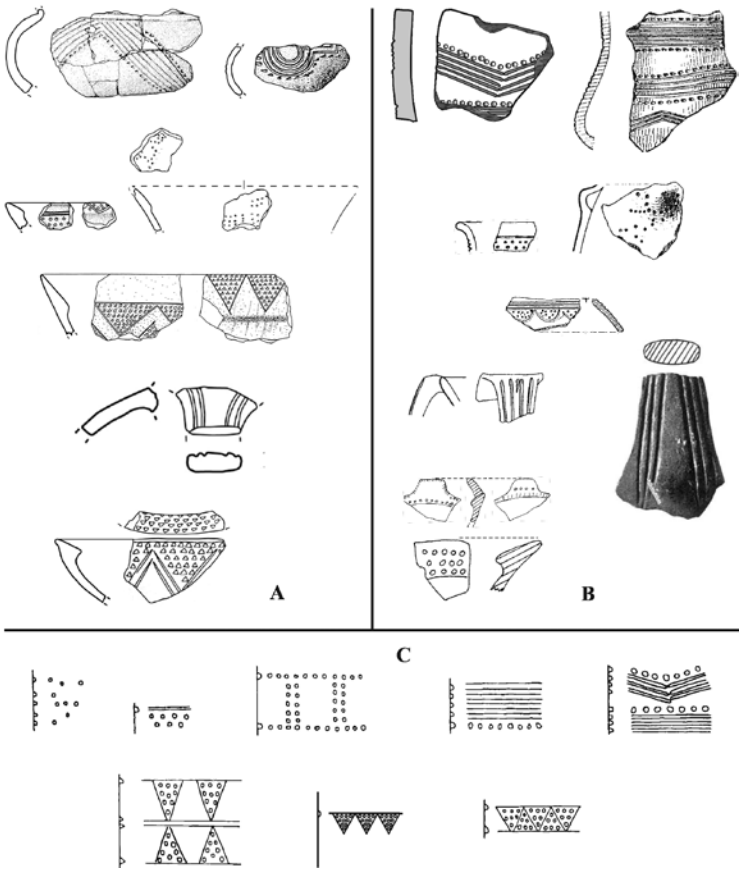


Fig. 10 – A: Cetina-type pottery in the Middle Danube area; B: Odaia Turcului-type pottery in the Lower Danube area; C: Decoration patterns similar to both the Cetina and Odaia Turcului cultural groups (A: after Gori et al. 2018).

[46] Antonović 2014, 94, no. 357, pl. 39/357.

[47] Băjenaru 2003.

[48] Băjenaru 2014, 261, fig. 86.

Lower Danube basin. Casting in closed bivalve moulds becomes more widespread throughout the area, with metal now being poured through the lower edge of the sleeve, or, more commonly, through a small portion at the end of the butt[49] (fig. 11/1-2). As I have already mentioned, at the same time, new types of axes, such as the Veselinovo II, Izvoarele (the developed series), and the early Pătulele, are produced[50]. Sometimes, a kind of funnel is used for introducing the metal into the moulds, which allows the elongation of the butt in that area.

This process continues into the second half of the 3rd millennium BC, with the evolved Pătulele and Pădureni type axes becoming characteristic. Both types of axes were defined by Vulpe almost sixty years ago; thus, new approaches to their typology are required in light of subsequent discoveries[51]. In this study, I am referring to those items with an elongated butt, ending either in a protruding or blunted button, representing the area where the metal was poured into the mould[52] (fig. 11/3). The axes in question are typically of considerable size, a defining feature of the period, yet demonstrate a high level of craftsmanship and finishing[53]. They are predominantly found in the Lower Danube and Thrace regions, with approximately 50 examples known to the author (fig. 12). Axes with an arched blade and an angle between the sleeve and blade are typically classified as Pătulele type, while those with a straight blade are regarded as a Balkan variant of the Pădureni type.

Their chronology is ensured by the axe found in level 6 of the tell at Yunatsite (Pazardzhik district, Bulgaria)[54] (fig. 13/4), dated most probably around 2500-2450 BC[55]. Another specimen comes from the area of an EBA III necropolis (the second half of the 3rd millennium BC) at Petarch (Sofia district, Bulgaria)[56] (fig. 13/3). Several items of this kind have also been discovered in the Middle basin of the Danube, with the axe from Mokrin (Vojvodina, Serbia) being of particular importance as part of the inventory of a grave dated in the last quarter of the 3rd millennium BC[57].

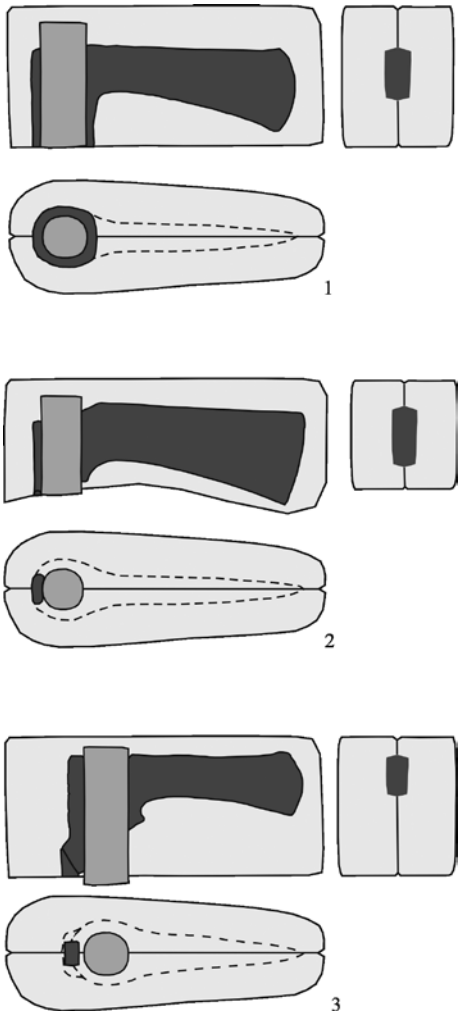


Fig. 11 – Different types of technologies used for casting developed Izvoarele-, Pătulele-, and Pădureni-type axes (after Băjenaru, Tuţulescu 2021).

It is of significant relevance to the present discussion to note the discovery of a hoard of four axes at Bölcske-Bolondvár (Tolna County, Hungary) on the right bank of the Danube (fig.

[49] Băjenaru, Tuţulescu 2021, 151-152, fig. 17; Băjenaru 2024, 266.

[50] Vulpe 1970, 36-39, 42-46.

[51] Popescu 2006; Băjenaru 2017.

[52] Băjenaru, Tuţulescu 2021, 152-153, fig. 21/1; Băjenaru 2024, 266.

[53] Băjenaru 2017.

[54] Катинчаров, Мацанова 1993, 157, fig. 18/7; Băjenaru 2017, 119, fig. 6.

[55] Boyadzhiev, Aslanis 2016, 163.

[56] The axe was unearthed during excavations conducted by Alexey M. Gotzev, for which I am grateful for his permission to publish this artefact.

[57] Antonović 2014, 91, no. 339, pl. 37/339.

14). The hoard was published in 2015 by Gábor Váczi, who attributes the axes to the Balșa type, their presence in the Middle Danube being a marker of cultural relations with the Transylvanian area during the Middle Bronze Age (Hajdúsámson horizon)[58]. Balşa-type axes are generally small items, usually not exceeding 13 cm in length and 300 grams in weight, cast in closed bivalve moulds with the sprue at the bottom of the butt, which is elongated but usually without buttons[59]. The artefacts from the hoard at Bölcske-Bolondvár are actually similar to those presented above, with the most appropriate comparisons being those from the hoard found in Pazardzhik district (Bulgaria)[60] (fig. 13/1-2). Consequently, they reflect the long-distance connections established between the Lower Danube basin and the Middle Danube during the latter half of the 3rd millennium BC.

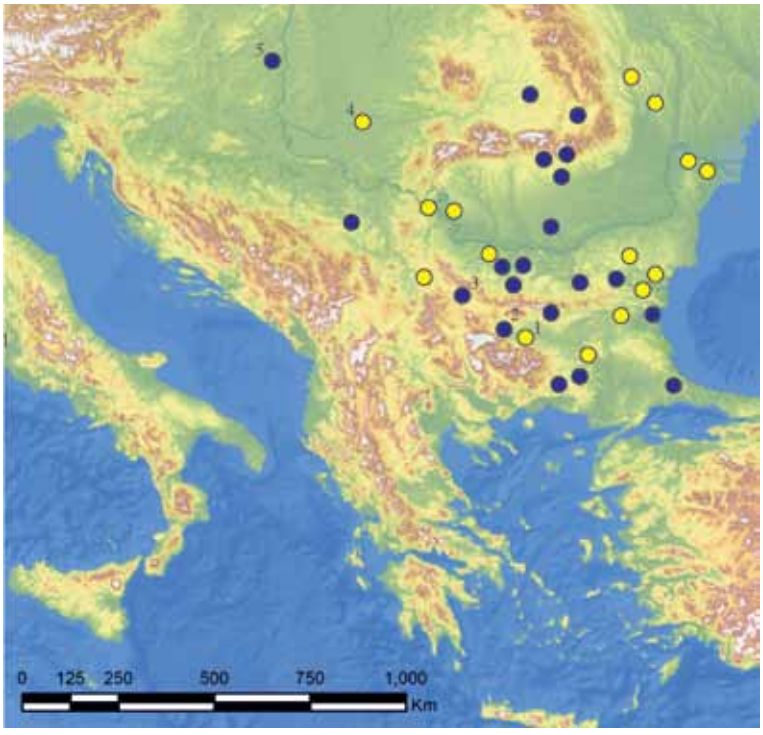


Fig. 12 – The distribution of the developed Pătulele (yellow) and Pădureni (blue) types of axes. 1: Pazardzhik district (BG); 2: Yunatsite (BG); 3: Petarch (BG); 4: Mokrin (RS); 5: Bölcske (HU).

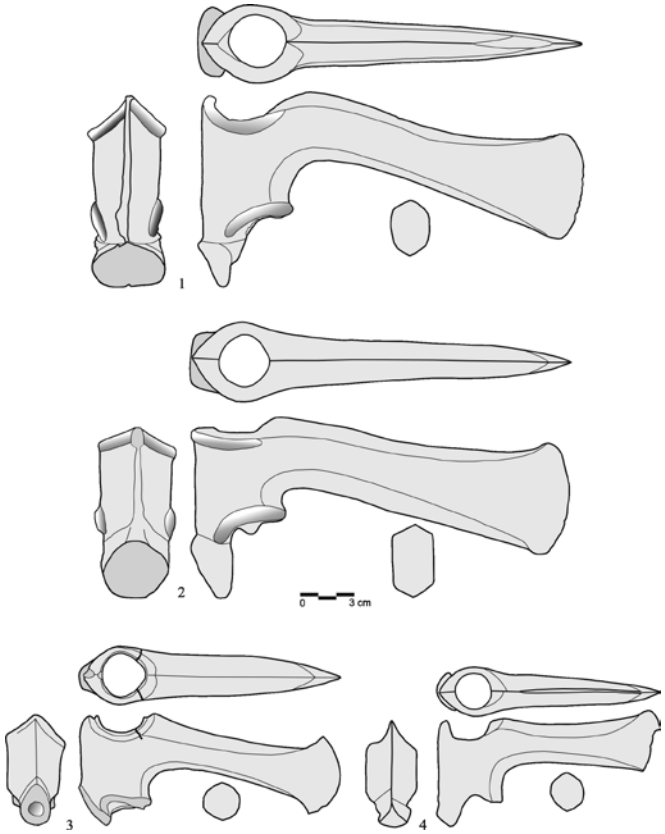


Fig. 13 – 1-2: Pazardzhik district (BG); 3: Petarch (BG); 4: Yunatsite (BG).

Conclusions

The above presentation is merely an outline of a process that began in the latter half of the 4th millennium BC and subsequently evolved in various forms throughout the third millennium in the Danube basin. The issues per-

[58] Váczi 2015.

[59] Vulpe 1970, 51-53, pl. 14.

[60] Черных 1978, 143, pl. 25/2-3; Băjenaru 2017, 120, no. 5-6, fig. 4/1-2.

taining to the production, circulation, and social impact of shaft-hole axes are considerably more intricate and necessitate a more detailed examination at the micro-regional level.

As I have mentioned on other occasions[61], the proposed evolution should not be viewed in a linear manner. In light of the available evidence, it can be asserted that during the 3rd millennium BC, a multitude of metallurgical workshops for the production of diverse metal artefacts were developing in the Danube basin, each characterised by its own traditions and methods. Some of these workshops have proven to be extremely dynamic and innovative, yet the advent of new technologies or types of artefacts did not necessarily signify the abandonment of those already in use. They certainly coexist and are utilised in parallel for long periods of time. In the above presentation, I have only tried to identify the specific instances when these changes occur, given that estimating their duration is a considerably more challenging endeavour.

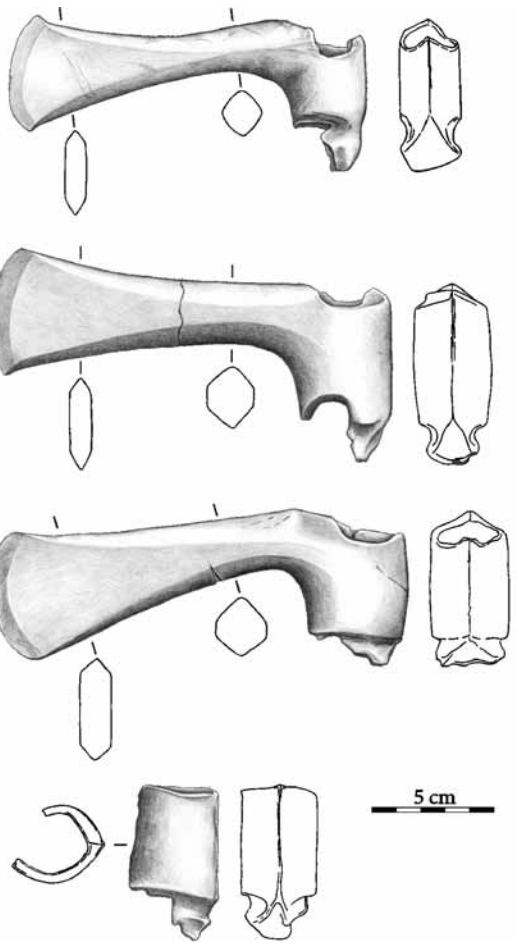


Fig. 14 – The hoard from Bölcske-Bolondvár (HU) (after Váczi 2015).

The openness of the entire Danube basin towards the adoption of new social symbols in the second half of the 4th millennium BC, and moreover, their production towards the end of this millennium, represents a significant development. Therefore, shaft-hole axes are incorporated into social practices in a distinctive manner, largely different from the patterns observed in their areas of origin. This autonomy of the Danube basin is further evidenced by the development of specific casting technologies and the production of its own types of axes during the 3rd millennium BC.

The role of the Danube as a corridor for the dissemination of knowledge and finished products is well highlighted for the entire chronological period under discussion. In addition, the transportation of raw materials for the manufacturing of metal items should also be taken into account. Nevertheless, the intensity of long-distance exchanges fluctuates over time. The adoption of the shaft-hole axes in the second half of the 4th millennium BC appears to be a phenomenon encompassing the entire Danube basin. With the development of local production in the first half of the 3rd millennium BC, a certain regionalisation and a lower intensity of long-distance circulation of these artefacts within the Danube basin are observed. A certain revival of contacts and exchanges is documented for the second half of the 3rd millennium BC, as in the western half of the Middle Danube basin, the shaft-hole axes lose their relevance. However, it should be noted that metal items often reflect broader patterns of relationships, exchanges, and contacts established through a range of commodities.

[61] Băjenaru 2024, 268.

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Late Hallstatt horse equipment in the south-eastern Carpathian Basin: In-between cultural connectivity and social identity

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Abstract: The Late Hallstatt period in the south-eastern Carpathian Basin is defined by a recognizable group of grave finds, primarily women's costume and jewellery items, attributed to the Syrmian group. A distinguishing feature of the Syrmian group is the appearance of separate horse burials, with or without horse equipment, dated to the 5th and 4th centuries BC, attesting to the importance of horses for these communities. These horse burials are believed to be connected to a wide territory stretching from north-eastern Italy, across the south-eastern Alpine region and the Carpathian Basin, all the way to the Lower Danube. Additionally, finds of horse equipment from Syrmian group sites, likely originating from destroyed graves, have been discovered. Various forms of horse equipment have been identified, most often iron bits, as well as different decorative objects indicating contacts with both neighbouring and distant regions. Recent research in western Syrmia and eastern Slavonia has uncovered new forms, such as bronze phalerae of the Magdalenska Gora type. These finds indicate cultural connectivity with sites in the south-eastern Alpine area and the northern parts of the Carpathian Basin, where the Vekerzug culture spread. Analyses of horse equipment of the Syrmian group, like other types of finds, point to cultural connectivity between different Late Hallstatt communities. These communities used the same or similar objects, selectively incorporating new forms through various transfer mechanisms. These transfers likely served to express social identities within local communities. For this reason, the Syrmian group can be considered one of the most dynamic Late Hallstatt cultural groups in the Carpathian Basin.

Key words: Late Hallstatt period, horse equipment, horse burials, Syrmian group, cultural connectivity, supra-regional networks

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Introduction

The Late Hallstatt period in the south-eastern Carpathian Basin was marked by the material legacy of the Syrmian group, identified through finds from graves or those assumed to originate from destroyed grave assemblages. Contemporary settlements were also considered within the latest phase of the Bosut group or the phase of fluted pottery. Numerous researchers have written about the Syrmian group, which is dated from the mid-6th to the second half of the 4th century BC, highlighting its characteristic flat cemeteries with inhumation burials.[1] During its development, the group was subject to various influences, eventually forming its own recognizable legacy, which is most apparent today in female grave assemblages. One characteristic feature of this group is the appearance of horse burials, with or without horse equipment, in cemeteries such as Vinkovci – Nama[2] and Lovas.[3]

The phenomenon of horse burials in the southern Carpathian Basin, also known from the cemeteries of Doroslovo,[4] Donja Dolina,[5] and Szentlőrinc,[6] has been frequently discussed (Fig. 1).[7] Similarly, finds of Late Hallstatt horse equipment from this area, most of them probably originating from destroyed graves, have been published. In addition to the recently published

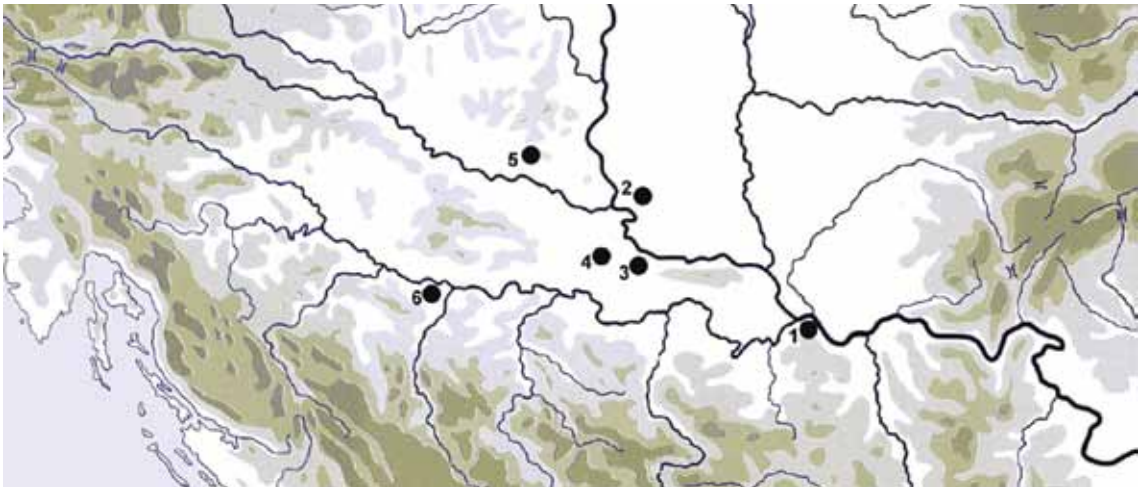


Fig. 1 – Late Hallstatt sites in the south-eastern Carpathian Basin with horse burials and horse equipment: 1 Ritopek; 2 Doroslovo; 3 Lovas; 4 Vinkovci; 5 Szentlőrinc; 6 Donja Dolina (made by: M. Dizdar).

finds of Magdalenska Gora-type phalerae,[8] earlier finds of horse equipment from the cemetery of Ritopek[9] as well as from prominent sites in the Sava River valley such as Donja Dolina[10] and Sisak[11] are known. The diverse finds of Late Hallstatt horse equipment from the aforementioned sites indicate cultural connectivity between different communities and the existence of supra-regional networks.

[1] I.e. Garašanin 1973; Vasić 1977; 1987; 1988; 1989; Guštin, Teržan 1976; Teržan 1977; Medović 1991; 2003; 2007; Metzner-Nebelsick 2002; Medović, Hänsel 2006; Ljuština 2010; 2020; Dizdar 2015; 2019; 2020a etc.

[2] Majnarić-Pandžić 2000; 2003.

[3] Dizdar 2020b.

[4] Trajković 2008.

[5] Arsenijević 2019.

[6] Jerem 1968.

[7] Metzner-Nebelsick 2002, 206; Kmeť ová 2013, 254; 2014, 267; 2017, 99–101; 2018, 276–280, fig. 4 etc.

[8] Dizdar 2023.

[9] Todorović 1967; 1971; Jovanović 1977.

[10] Marić 1964.

[11] Drnić 2020.

Late Hallstatt horse burials in the south-eastern Carpathian Basin

Late Hallstatt horse burials, with or without horse equipment, have so far been found in cemeteries of the Syrmian group in Vinkovci and Lovas. A horse burial from the Doroslovo cemetery in south-western Bačka could probably be dated to the same time. The horses were placed in separate graves, meaning they were not buried together with humans. Zooarchaeological analyses were conducted on the horses from the Vinkovci and Doroslovo cemeteries. These horse burials indicate a complex connection between humans and horses. The horse was part of their culture, accompanying them in life and in death.

On the western edge of the Vinkovci – Nama cemetery, in eight inhumation burials dating to the late 5th and first half of the 4th century BC, three horse burials were found, two of which contained horse equipment. The horses, whose remains were damaged, were positioned on their right sides with their legs bent. The horse equipment in two graves was found near the head, while iron bits, otherwise a common find, were missing. N. Majnarić-Pandžić attributes the horse equipment from burial 1 to the Early La Tène sphere, with parallels in the area of Central Europe, while burial 2 contained equipment of Thracian-Scythian origin, indicating a connection with the Lower Danube region. This seems to be confirmed by the results of the zooarchaeological analysis, which showed that burial 1 contained a mare aged 3.5 to 6 years with a withers height of 130 cm, close to the Central European horse type, although slightly taller and stronger. This horse is similar to the mare about 3.5 years old from burial 3 with a withers height of 128 cm. On the other hand, the horse from burial 2, with a withers height of as much as 156 cm, seems to belong to the eastern, taller, and more robust type, and is even taller than that. It was a stallion aged 3 to 4 years. The typologically and stylistically different horse equipment seems to correspond to the breed characteristics of the horses with which it was interred.[12]



Fig. 2 – Horse burial – grave 6 from the Lovas cemetery (photo by: M. Dizdar).

Excavations in Lovas, western Syrmia, have uncovered a biritual cemetery dating from the Late Hallstatt to the beginning of the Middle La Tène period. Near Late Hallstatt inhumation grave 2, a horse burial (grave 6) was discovered. It was placed at the bottom of a rectangular pit with rounded corners lying in a southwest – northeast direction. The burial pit measured 2.69 x 1.46 meters. The burial was partially damaged, and the horse was lying

[12] Majnarić-Pandžić 2000, 27–30, pls. 1–4; 2003, 482, 490–502, figs. 8–12.

on its left side with its legs drawn up; an iron bit was found in its mouth (Fig. 2).[13] Another notable find is the horse burial in the cremation cemetery of the Dalj group in Doroslovo – Đepfeld in south-western Bačka, dating to the Late Bronze Age and Early Iron Age, where several inhumation graves of the Syrmian group were also found.[14] Grave 11, discovered on the northern edge of the cemetery, contained the burial of an entire horse, which was lying on its right side with its legs drawn up. Beside the horse, cremated remains of a human were found with ceramic vessels and a fragment of a bronze twisted fibula with a curved bow,[15] which probably belonged to an older grave from the Early Iron Age. This is the burial of a stallion about 3 years old with a withers height of 130.74 cm, classifying it as a smaller horse.[16]

The identification of two different horse breeds in the Vinkovci cemetery has a parallel in the cemetery at Szentlőrinc, dated from the late 5th to the end of the second third of the 4th century BC. On the south-western edge of the cemetery, six horse burials were found (graves 48, 51, 52, 58, 60, 61) that cannot be linked to human burials. The heads and legs of the horses were preserved; it is assumed that the body was consumed. Diverse horse equipment was found in four graves (graves 48 and 51 were without finds), including Szentes-Vekerzug type iron bits. S. Bökönyi recognized the western and eastern types of horses, with three horses buried together in grave 52.[17]

In the southern Carpathian Basin, horse burials were discovered as early as 1975 at the important site of Donja Dolina on the Sava river. On the Timenačka Greda, south of the well-known cemetery at the Starije Naselje site, trench C1 contained not only human burials, but also three horse burials with iron bits and bronze horse equipment.[18] S. Arsenijević states that three horses, each with its own equipment – one with an iron bit and bronze equipment, and the other two only with iron bits – were found in the same grave. Along with horse B, finds of an iron knife and a fragment of a Certosa fibula of type XIIIh are mentioned.[19] Based on the finds from the human graves (a Certosa fibula of type XIIIh, a fibula of the Sanski Most type, a silver twisted temple ring, glass amphora beads, etc.), the horse burials are dated to the second half of the 4th century BC.[20]

The results of zooarchaeological analyses of horse remains from the aforementioned cemeteries show that the south-eastern Carpathian Basin during the Late Hallstatt period was a breeding ground of both breeds of horses, especially strong horses closely related to the eastern group.[21] The finds of two different horse equipment types in the Vinkovci cemetery, and the identification of Central European and eastern horse breeds, suggest the breeding and trade of horses over long distances, even to north-eastern Italy. It included the south-eastern Carpathian Basin as a crossroads of worlds: connected by the Danube with the north and east, and by the Sava and Drava with

[13] Dizdar 2020b, 26, figs. 9–10.

[14] Ljuština 2010, 60–62, figs. 4–5, pl. 5.

[15] Trajković 1975, 64, pl. LXVI/4; 2008, 18, 35–36, fig. on p. 18 and p. 190; Metnzner-Nebelsick 2002, 205–206. In the bowl, bones of cattle, sheep/goat, pig, dog, and horse were found (Blažić 2008, 363). E. Teleaga (2017a, 61, n. 17; 2017b, 21, n. 79) attributes this burial to the older horizon of the cemetery, specifically to the Dalj group.

[16] Blažić 2008, 361, 363–366, fig. 1.

[17] Jerem 1968, 169–176, 189–193, figs. 10–13; 15–17; Kmeťová 2014, 125. Of the eight horses found, five were analyzed: three were smaller, western-type horses, and two were eastern-type. Grave 48: older western-type horse; grave 51: older western-type horse; grave 52: three horses; the horse in the western part was complete, the other two horses were damaged, two were older eastern-type horses, the third was an older western-type; grave 58; grave 60; grave 61. Also, horse teeth were found in grave 46 (Jerem 1968, 169–171, 192, figs. 10–13, pl. XXVIII/2, 5).

[18] Žeravica 1976, 50.

[19] Arsenijević 2019, 12–13, 119–120.

[20] Arsenijević 2019, 121.

[21] Majnarić-Pandžić 2000, 29–30; 2003, 499.

the west, or more precisely with the south-eastern Alpine region and northern Italy.[22] In general, eastern horses were larger than western ones. Eastern horses have an average withers height of 136 cm and were robust and slender,[23] as confirmed by recent research.[24] An analysis of horse remains from the Kalakača settlement in Syrmia from the end of the Late Bronze Age, where the bones of eastern-type horses predominate, indicates that a mixed, local type in the Danube region originated from the crossbreeding of eastern and western horse groups and was most likely bred domestically. Mixed-type horses inherited their size from the eastern group and their slenderness from the western group.[25]

The aforementioned horse burials from the Syrmian group cemeteries in Vinkovci, Lovas, and Doroslovo are dated the late 5th and 4th centuries BC. Along with those from the cemeteries in Donja Dolina and Szentlőrinc (Fig. 1), they belong to a phenomenon that appears in a wide area from north-eastern Italy, across the south-eastern Alpine region and the Carpathian Basin, all the way to the Lower Danube, from the late 6th to the 4th centuries BC.[26] As shown by the excavations at the Syrmian group cemeteries, horses with or without horse equipment were always buried separately and without any connection to a specific human. Also, horse equipment items are absent from human graves. The same funerary record and mortuary practice can be seen in the Vekerzug culture cemeteries (i.e. Szentes – Vekerzug, Tiszavasvári – Csárdapart, Chotín IA, etc.) where such burials date from the late 6th to the 4th centuries BC; horse equipment items do not appear in human graves, except for rare cases (e.g., grave 142 in the Szentes – Vekerzug cemetery). Also, horse equipment was only found in horse burials in the Szentes – Vekerzug cemetery. Some cemeteries include parts of horses.[27] In her analysis of the Szentes – Vekerzug cemetery, B. Teržan emphasizes that horses were buried separately, with horse equipment and sometimes with wagons, and that horse breeding had a special significance for the community and horses were more likely to be the property of the entire community rather than an individual.[28]

Aside from the Vekerzug culture cemeteries, parallels for horse burials have been found in the areas neighbouring the Syrmian group: in the Lower Danube region and Lower Carniola. For example, horse burials were found in the Zimnicea – Câmpul Morților cemetery, dating to the 4th and 3rd centuries BC. Again, horse burials are separated from human graves; they are located between them and not occupying any specific part of the cemetery. A total of 18 horse burials were found, and two types were identified: burials of whole horses (12) and burials of horse parts like heads and legs (6); the latter are characterized by the absence of any finds. The horses most often had their legs drawn up, were positioned on different sides, and were also buried at different depths and with different orientations. One horse (no. 13) had its lower legs burned. Horse burials are most often without finds, with bits appearing most frequently (in four graves).[29] The horses

[22] Jerem 1968, 192–193; 1998, 330–332; Bökönyi 1983, 335–336; Majnarić-Pandžić 2000, 29–30; 2003, 499.

[23] Bökönyi 1993, 45–56, figs. 7–17.

[24] Benecke 1994, 138–142, fig. 93; 1998, 91–98.

[25] Bökönyi 1981, 110; 1988, 358–359; Blažić 1994, 165; 2008, 363–366.

[26] Guštin, Teržan 1976, 191; Metzner-Nebelsick 2002, 206; Kmeť ová 2013, 254; 2014, 125–126, 190–192, 267; 2017, 92, 94, 99–101, 108–111, fig. 1; 2018, 190–202, 267–282, fig. 4; Kmeť ová, Barta 2018, 215; Kozubová 2019a, 143; 2021, 82, n. 4; Teleaga 2017a, 61, 63; 2017b, 21. At the beginning of the Early Iron Age in the Carpathian Basin, especially in graves associated with the Dalj group, horse equipment items begin to appear intensively; they are linked to the portrayal of the high status of a mounted warrior. It is assumed that, in addition to horse equipment, horses themselves also arrived from Eastern Europe (Metzner-Nebelsick 2002, 357–362; Kmeťová 2018, 281).

[27] Werner 1988, 4, 6–7; Kmeťová 2014, 125–126, 179–183, 186–190, 252–253 with earlier literature; 2017, 94, 97, 99, 108–111; 2018, 276–282; Kmeťová, Barta 2018, 206, 214; Kozubová 2019b, fig. 2; 2021, 95, 99, 103, 105; Teleaga 2017a, 52, 61–63.

[28] Teržan et al. 2011, 265; Kozubová 2021, 105.

[29] Alexandrescu 1980, 55; 1983, 67, 78, figs. 1–3; Werner 1988, 7; Ganciu, Dumitraşcu 2015, 61–62, 65–67.

belonged to two eastern-type groups. For 17 horses, the age of the animals could be estimated to be between five and ten years, except for one horse about 3.5 years old. The sex could be determined for 11 horses, and they all appear to have been male.[30] On the remains of the horse from burial 15, osteoarthritis was observed on the hind legs. In burial 17, only the horse's head was preserved, and the traces on the bones indicate that the head was severed with a heavy blade. The only remains of horse no. 18 are the distal limbs, divided into two parts with cut marks, indicating that they had been separated from the rest of the body. Complete horse skeletons do not show traces of meat removal or any kind of butchering, while the finds of heads and distal limbs with butchering traces indicate that their dietary use was not important.[31]

Horse burials within tumuli in Lower Carniola have been the subject of detailed discussions. Horses or their parts were more often buried with a human equipped with weaponry; they were less frequently found in a separate burial near a warrior's grave.[32] The appearance of horse burials without a connection to human graves dates back to the 6th to 4th centuries BC, from the serpentine fibula horizon to the end of the Negova-type helmet horizon.[33] In tumuli 48, 5, and 125 in Stična, horses or their parts were buried separately from humans, either in their immediate vicinity or above them. A long tradition of horse burials is documented in tumulus 48, indicating that this ritual was passed down from generation to generation.[34] Incidentally, horse parts have been found in graves with weapons since the beginning of the Early Iron Age, while burials of whole horses appear from the Certosa fibula horizon. Horse equipment has been found in the graves of richly equipped humans, while it appears less frequently in horse burials.[35] Szentes-Vekerzug-type horse equipment first appears in the serpentine fibula horizon, when the entire material legacy of the Lower Carniola group changed,[36] meaning that its appearance dates back to the second half of the 7th century BC.[37] A. Kozubová dates the first Szentes-Vekerzug type bits in Lower Carniola to the end of the 6th century BC, but most of them belong to the first half of the 5th century BC.[38] From the Certosa fibula horizon onwards, Szentes-Vekerzug-type horse equipment becomes increasingly numerous.[39] It has been observed that the graves of the Lower Carniola group that included horse remains are characterized by significant variability in their inventory, with the most common find being weapons. As much as one half of the horse burials did not contain horse equipment, meaning that the horse and its equipment were not necessarily connected in the burial ritual; instead, horse equipment is found in human graves.[40] The connection of fast horses with the burials of prominent individuals indicates that horses represented prestige and a status symbol.[41] It is emphasized that the area of the Lower Carniola group connects two regions

[30] Alexandrescu 1983, 67, 71; Ganciu, Dumitraşcu 2015, 65–67.

[31] Ganciu, Dumitraşcu 2015, 65–67. Generally speaking, the oldest horse burials near the Black Sea come from the necropolis of Histria, dated around the middle of the 6th century BC. They were found in tumulus XVII (4), where the horses were buried on the edge of the mound and within a circular ditch (Alexandrescu 1983, 67, 71).

[32] Dular 2007.

[33] Dular 2007, 745–746, fig. 9; Teržan 2010, 286; Kmeťová 2014, 102, 107–111, 249–250; 2018, 274–275. In northwestern Croatia, a horse burial was found in a richly equipped warrior's grave at the cemetery of Sv. Križ Brdovečki, dated to the 6th century BC. The horse equipment, specifically mentioned as the bit and phalerae, was not placed with the horse (Cvitković, Škoberne 2003, 221, fig. 5; Škoberne 2004, 164–170, figs. 24–28).

[34] Teržan 2010, 238–243, 245, 262–263; Kruh 2010, 75.

[35] Dular 2007, 739–745, fig. 1; Tecco Hvala 2012, 157–159, fig. 61.

[36] Teržan 1998; Dular 2003, 131; Teržan 2010, 308; Kruh 2010, 81.

[37] Teržan 1998, 287–290; Preložnik 2007, 163; Kmeťová 2014, 103–104, 108–109; 2018, 275.

[38] Kozubová 2011, 85; 2013, 115; 2019b, 49.

[39] Guštin, Teržan 1976, 190; Gabrovec 1987, 62; Teržan 1998, 514, 526–530; Dular 2003, 131; 2007, 744–746; Preložnik 2007, 156, 163.

[40] Dular 2007, 745–746, fig. 8; Kozubová 2011, 83; Kmeťová 2014, 101, fig. 25; 2017, 99, 102.

[41] Teržan 2010, 238, figs. 34–35; 62; Tecco Hvala 2012, 31.

where the phenomenon of horse burials has been recorded: north-eastern Italy, where horse burials appear from the 6th century BC, and the Carpathian Basin, making it difficult to determine the origin of this phenomenon. This connection is also shown by certain items of horse equipment, which would indicate an exchange of harnessed horses of the eastern type, probably including the exchange of the idea of a separate burial of horses. These horses could have represented prestigious gifts between social elites, where the horse and equipment were status symbols.[42] The assumption of the Lower Carniola group as an intermediary seems to be confirmed by the results of zooarchaeological analyses of horse remains from graves in Lower Carniola, which show that they were older male horses of the so-called eastern group, with an average withers height of 136 cm and with some of them used as riding horses. The example from Magdalenska Gora shows that even sick animals could have been buried.[43] On the other hand, horse remains from the Cvinger settlement above Vir near Stična are attributed to the western group or local origin, and were probably used for everyday tasks, and even for food.[44]

An interesting find of a horse in a pit at the Sopron – Krautacker settlement was laid on its right side, with its legs drawn up and an iron ring bit in its mouth. The burial is dated to LT C2. Osteometric data show that it was the burial of an 8-9-year-old stallion with a withers height of 143 cm; it shows similarities to several horses from north-eastern Italy.[45] Also, zooarchaeological analyses show a similarity between Veneto horses and Central European horses,[46] with the most burials containing young or adult stallions, while older horses are predominantly mares. The explanation is that mares were generally more valued for breeding, while most stallions and young horses were generally of low value.[47]

Late Hallstatt horse bits in the south-eastern Carpathian Basin

Most horse burials found in the south-eastern Carpathian Basin include items of horse equipment. Also, there are finds of horse equipment with unknown discovery contexts, but it is likely that they came from destroyed graves. Based on its function, horse equipment can be divided into functional parts of horse equipment (bits), decorative parts (phalerae and strap separators), and other parts of harness. However, this division should not be taken literally, as bits could also have a decorative function, just as phalerae are not just decorative but also have a certain functional position on the horse harness.[48]

Finds of iron bits of various types are known from the south-eastern Carpathian Basin. Horse bits have been found in horse burials (Lovas, Szentlőrinc, Donja Dolina) or in cemeteries (Ritopek, Donja Dolina). Interestingly, bits were not found in the cemetery in Vinkovci, nor e.g. in the horse burials in the Chotín IA cemetery.[49] Szentes-Vekerzug type bits are the most frequent – in the Szentlőrinc cemetery and in Donja Dolina, to which we can add the find from Sisak. „Thracian-type" bits were found in the cemeteries in Lovas, Ritopek, and Donja Dolina.

[42] Metzner-Nebelsick 2002, 362; Dular 2007, 746–747; Teržan et al. 2011, 265; Kmeťová 2014, 254–257; 2017, 92, 103, 108–111, fig. 1; 2018, 278–282, fig. 4; Kmeťová, Barta 2018, 215.

[43] Bökönyi 1964; 1968; 1993; Dular 2007, 742–744; Tecco Hvala 2012, 28–31, 157, fig. 3; Kmet'ová 2018, 275–276, 279–280, fig. 5.

[44] Bökönyi 1994, 199; Dular 2007, 744.

[45] Jerem 1998, 320, 325–326, figs. 2–5; Kmet'ová 2017, 110–111.

[46] Kmet'ová 2018, 278–279 with literature.

[47] Kmet'ová 2018, 279–280, fig. 5.

[48] Kozubová 2011, 72; 2013, 112, n. 224.

[49] Kozubová 2011, 81.

Horse bits of the Szentes-Vekerzug type

Szentes-Vekerzug type bits were first analyzed by M. Párducz, who distinguished five types,[50] and then M. Guštin and B. Teržan added a type 6 (Werner type II A2), which is characteristic of the Lower Carniola group.[51] Divisions and chronologies of these bits were subsequently proposed by T. Kemenczei[52] and J. Chochorowski.[53] Detailed divisions were made by W. M. Werner,[54] followed by A. Hellmuth,[55] A. Kozubová,[56] and E. Tealaga.[57] T. Kemenczei dates their appearance to the 6th century BC,[58] and W. M. Werner to the 5th century BC, emphasizing that they exist both before and after this time.[59] C. Metzner-Nebelsick dates their origin to the second half of the 7th century BC,[60] A. Hellmuth as early as the first half of the 7th century BC,[61] while E. Teleaga dates their appearance to the second half and end of the 7th century BC.[62] A. Kozubová, who does not consider Szentes-Vekerzug type bits to be a chronologically particularly sensitive group of finds, has written in detail about their appearance, dating them to the second half of the 7th and the first half of the 6th century BC. This smaller group of finds has been found at Vekerzug culture sites, but also in other areas. Most of the bits from the Vekerzug and Ferigile culture sites belong to the second half of the 6th and the first half of the 5th century BC, but they persist into later periods. Szentes-Vekerzug type bits are considered to be of local origin in the Vekerzug culture area without external influences.[63]

Szentes-Vekerzug type bits are characteristically made of iron. They have a hole in the middle of each side, through which they are connected to the mouthpiece with a rivet, and there are two more eyelets or holes on each side for threading the reins. These bits are characterized by a great variability in the shape of the lateral sides and their terminals, while the mouthpiece is always the same: two-part and smooth, ending with a larger eyelet for the rein at each end. A. Kozubová divided Szentes-Vekerzug type bits into two basic types and then into variants and sub-variants. The types are defined based on the shape of the side openings (type I with eyelets and type II with holes); the variants are defined based on the shape and cross-section of the lateral sides and their terminals. Both basic types are divided into four variants.[64] A slightly different, but essentially similar division was proposed by E. Teleaga, who distinguishes three basic types based on the shape of the lateral sides. The oldest bits have almost flat sides that gradually

[50] Párducz 1965, 149–171, fig. 5; 1973, 36.
[51] Guštin, Teržan 1976, 190–191, map 1.
[52] Kemenczei1985, 50, fig. 1; 2009, 51–52.
[53] Chochorowski1985, 114–119, fig. 40.
[54] Werner1988, 12–30, fig. 4, pl. 68A.
[55] Hellmuth 2007, 79, fig. 15.
[56] Kozubová 2011; 2013.
[57] Teleaga 2017a, 54–60, figs. 33–34; 2017b.
[58] Kemenczei 1985, 64.
[59] Werner 1988, 30, 117.
[60] Metzner-Nebelsick 2002, 292.
[61] Hellmuth 2007, 81, 83.
[62] Teleaga 2017a, 56, 60; 2017b, 11, 21.
[63] Kozubová 2011, 73–75, 84–85; 2013, 113, 115, n. 225; 2019a, 92–94, fig. 16; 2019b, 49; 2021, 94, 106.
[64] Kozubová 2011, 73–75; 2013, 113–115, fig. 36; 2019a, 92–94, fig. 16; 2019b, 49; 2021, 94. Type I bits have rounded (arched) and relatively narrow lateral sides. Most of the sides are widened and flattened at the eyelet area, and they taper towards the terminals, gradually taking on the shape of a rod. Based on the termination of the sides, four variants have been distinguished. Type II bits have a characteristic central panel-like and flat part with three holes. Based on the shape of the sides and their terminals, four variants have also been distinguished (Kozubová 2011, 75, 79, 83; 2013, 113–115, fig. 36; 2019a, 92–93; 2019b, 49; 2021, 94).

become slightly curved, while the strongly curved bits of the third type are the youngest and are dated to the second half of the 5th century BC. The shape of the terminals did not depend on the development of the turning angles and proportions; spherical terminals are the most common.[65] E. Teleaga conducted an interesting analysis of the preserved bits regarding their inner width – the distance between the lateral sides – which ranges from 8.0 to 12.8 cm (9.7 cm on the average), showing that they were made for smaller horses and that they correspond to the Hallstatt bits of Central Europe.[66]

Iron bits of the Szentes-Vekerzug type are not common outside the area of the Vekerzug culture, although differences can be observed in individual variants.[67] They are known from sites of the Ferigile culture, are somewhat more numerous in the Lower Carniola and in cemeteries in the southern Carpathian Basin, and are considered evidence of established contacts between these communities.[68]

A chance find of a bit without one side comes from Donja Dolina, specifically from the Greda site, which is part of the cemetery.[69] This bit is attributed to type 4 after M. Párducz, which has been extended from the Vekerzug culture area westward and southward;[70] it is also mentioned as variant B I,[71] while A. Kozubová classifies it as type I 4.[72] Horse burial A from the Timenačka Greda cemetery, dated to the second half of the 4th century BC, included a horse bit with sides that are more strongly arched, with two eyelets on the outer side, while the terminals are missing. The mouthpiece is composed of two rectangle-sectioned bars that end in larger eyelets. The preserved length is 11.5 and 10.5 cm for the sides and 8.5 cm for the mouthpiece.[73] Given that the sides are curved, this bit could belong to type 6 after M. Guštin and B. Teržan, just like those found in Sisak. The bit also has more strongly curved (arched) sides and curved S-shaped terminals, which have spherical expansions at the upper end. Each outer side has two round eyelets, while the mouthpiece is composed of two rectangle-sectioned bars that end in larger eyelets.[74] W. M. Werner defines bits of this shape as type II A2,[75] while A. Kozubová classifies them as type II 4.[76] Horse bits of this shape are considered characteristic of the Lower Carniola area, where they develop from type 2 and 3 bits found throughout the Carpathian Basin, but also in Lower Carniola during the Certosa fibula phase. Horse bits of type 6 (II 4) are younger, and are found in graves of the early Negova-type helmet phase (late 5th and 4th centuries BC) with an important innovation

[65] Teleaga 2017a, 54, 60, figs. 33–34; 48; 2017b, 6, 14–21, figs. 1; 8–9.

[66] Teleaga 2017a, 57, 60; 2017b, 16–18, 21.

[67] Werner 1988, 25, 30, pl. 68A.

[68] Kmet'ová 2017, 103; Teleaga 2017a, 54–56, fig. 31; 2017b, 6–13, 25, fig. 2; Kozubová 2021, 106, n. 76. Worth mentioning are the type II1 bits from tumulus II in Atenica, dated to the second quarter of the 6th century BC. These bits are considered imports from the Tisza river region. Bits of this variant are widespread in the Vekerzug and Ferigile culture, in Serbia and Ukraine, and are dated from the second half of the 7th to the first half of the 5th century BC (Kozubová 2011, 79–80, 84–85; 2013, 115; 2019a, 93). E. Teleaga attributes two of the four bits from tumulus II to the first group, while the fragments of the other two bits cannot be definitively categorized. Two bits from tumulus I are preserved in fragments, and one of them belongs to the second type, perhaps even the third (Teleaga 2017a, 56, 110–125; 2017b, 11, 14, figs. 4–5).

[69] Marić 1964, 33, pl. VI/27; Arsenijević 2019, 118.

[70] Guštin, Teržan 1976, 190, map 1.

[71] Werner 1988, 19, pl. 8/42.

[72] Kozubová 2011, 83–84.

[73] Arsenijević 2019, 120, 222, cat. no. 48. The bit of horse C has not been preserved (Arsenijević 2019, 120).

[74] Drnić 2020, 95, fig. 57.

[75] Werner 1988, 16–17, pl. 68A.

[76] Kozubová 2011, 83; 2013, 115; 2019a, 93.

in the design of forward-curved, S-curved terminals of the sides.[77] This dating has been confirmed by new finds in Kapiteljska Njiva cemetery in Novo Mesto.[78]

Horse burial 61 at the Szentlőrinc cemetery contained a bit together with bronze horse equipment; it was attributed to type 2 after M. Párducz,[79] or type II A1.[80] A. Kozubová associates it with type I 2; they are numerous at Vekerzug culture sites in eastern Hungary, where they are dated perhaps as early as the end of the 7th century BC and up to the 5th century BC.[81] Horse bits of this shape also appear at sites in Lower Carniola (e.g., Brezje, Vače, Zagorje, Magdalenska Gora, Novo Mesto – Malenškova Gomila). Grave 61 is dated to the first half of the 5th century BC.[82] Three other graves at the same cemetery (52, 58, and 60) contained bits that are attributed to type 4,[83] or type II B1.[84] A. Kozubová associates these bits to the aforementioned type I 4, with lateral sides that are flat and square-expanded in the middle, while the terminals taper, are arched, and end in a spherical expansion. Horse bits of this shape appear as early as the second half of the 7th century BC and are considered characteristic of the Ferigile culture in the second half of the 6th century BC, while they are rarer at Vekerzug culture sites. At the Szentlőrinc cemetery, they are considered to most likely belong to the first half of the 5th century BC, although a dating to the second half of the 5th century BC cannot be ruled out.[85]

Horse bits of the Thracian-type

„Thracian-type" iron bits were discovered together with horse burials at the cemeteries of Lovas, Donja Dolina, and Ritopek. Their shapes and parallels clearly distinguish them from the previously described Szentes-Vekerzug type bits.

A damaged horse burial (grave 6) was discovered in Lovas. The horse had an iron bit in its mouth with S-curved and square-sectioned lateral sides, which apparently ended in conical expansions at both terminals (Fig. 3). Its length is 26.0 cm. The sides are split in the middle into two rhombic plates, each with a hole. The mouthpiece of the bit, 11.7 cm long, consists of two square-sectioned rods with curved terminals. One end is wrapped around the sides between the rhombic plates, while



Fig. 3 – An iron bit from horse burial (grave 6) from the Lovas cemetery (photo by: H. Jambrek).

[77] Guštin, Teržan 1976, 191, map 1; Knez 1986, 88, pl. 34/10; Gabrovec 1987, 62, 73; Teržan 1998, 529; Dular 2003, 144, fig. 87/15; Tecco Hvala 2012, 160, fig. 61/18; Kozubová 2011, 75, 83, 85; 2013, 115; 2019a, 93; 2019b, 49; Teleaga 2017b, 21.

[78] Križ 1997, 58, 60, pl. 37/2; Egg 2003, 335, fig. 10/1.

[79] Jerem 1968, 171, fig. 28/61-1.

[80] Werner 1988, 16.

[81] Kozubová 2011, 75–79; 2013, 115.

[82] Kozubová 2011, 77, 79; 2013, 115; 2019a, 92.

[83] Jerem 1968, 169–171, 189, figs. 26/52-1; 28/58-1; 28/60-1.

[84] Werner 1988, 19–20.

[85] Kozubová 2011, 83–84; 2019a, 93.

the other end connects them.[86] The bit is associated with the VA1 variant, which is known from sites in Romania and south-western Ukraine, where they are dated to the 4th century BC.[87]

A horse bit of this type was also found in the Ritopek – Dalekovod cemetery, likely originating from a destroyed grave (Fig. 4: 1).[88] The bit is 30 cm long and has conical terminals on S-curved, circular-sectioned lateral sides. At each outer end of the mouthpiece, there is one octagonal-shaped pendant, which served to connect to the bridle. The bit is dated to the Ha D period and attributed to the Scythian culture.[89] W. M. Werner associates this bit with the VA1 variant.[90] The same site included one more iron bit, 28 cm long, that is attributed to the VB1 variant and also likely originates from a destroyed grave (Fig. 4: 2). The lateral sides are more C-shaped and have spherical and conical terminals. In the central part of the sides, there are two perforated expansions. One end of the mouthpiece is wrapped between them, while the other wrapped end connects the parts of the mouthpiece. The bit was also dated to Ha D.[91] R. Vasić suggests that the bit and the bronze zoomorphic fittings may have belonged to the same burial assemblage.[92]

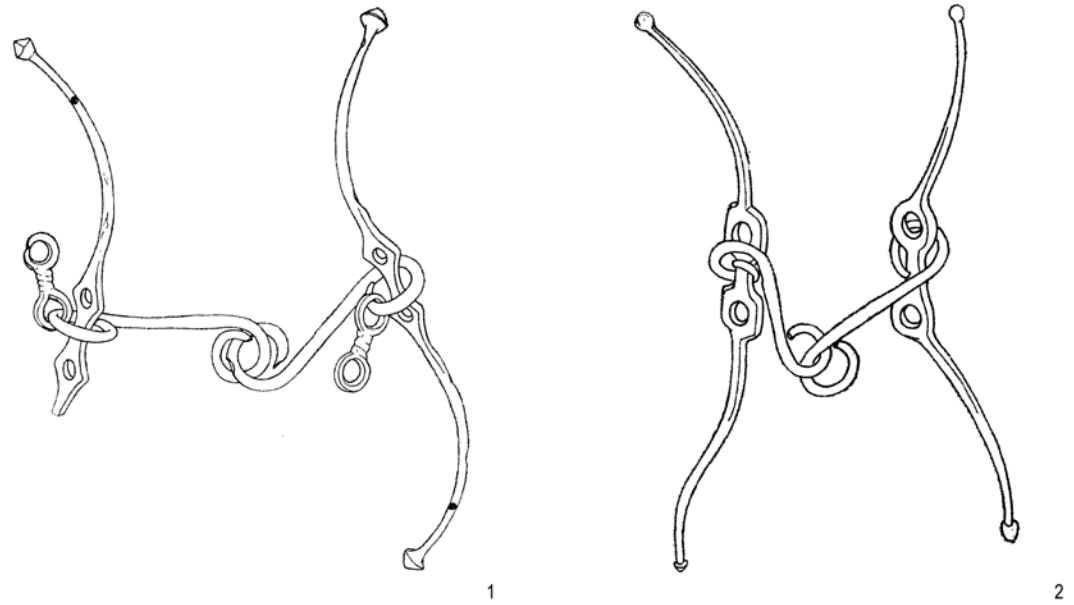


Fig. 4 – Iron bits from the Ritopek cemetery (after: Todorović 1971).

Type V bits are characterized by two rhombic extensions (plates) with holes in the central part of the lateral sides, while the mouthpiece is two-part, sometimes twisted, and has extensions. The terminals of the mouthpiece are bent into eyelets between the extensions on the sides. The lateral sides can vary in shape, which is the basis of their variants, while sub-variants are based

[86] Dizdar 2020b, 26, figs. 9–10.

[87] Werner 1988, 36–38, 41, pl. 69A.

[88] The Ritopek – Dalekovod site includes graves dating from the Middle and Late Bronze Age, as well as the Early Iron Age. One destroyed grave with two iron spears, Kossack Ib-type bits, a bronze sheet, and fragments of pottery belongs to the Early Iron Age (Todorović 1967). On the bits of type Kossack Ib (typ IIIa) from Ha C1: Metzner-Nebelsick 1994, 386, 389, 399, 441–442, Abb. 3; Liste 2; 2002, 217, 291–292, 509; Egg et al. 1999, 443–444, Abb. 8; Schäfer 2019, 197–198, Abb3; Dörrer 2022, 108–109, Abb. 3 etc.

[89] Todorović 1967, 156, 159–160, pl. III/8; 1971, 95, cat. no. 372, pl. XLIV/6; Vasić 1977, 64, pl. 48/7–8; Ljuština, Ninčić 2017, 250, Fig. 8/2; Ninčić 2023, 56, pl. 5/9.

[90] Werner 1988, 38, pl. 18/121.

[91] Todorović 1971, 96, cat. no. 373, pl. XLIII/12; Vasić 1977, 64, pl. 48/6; Werner 1988, 40, pl. 20/134; Ninčić 2023, 56, pl. 5/7.

[92] Vasić 1977, 64; 1987, 566–567.

on the shape of the terminals of the sides. Variant A and B horse bits are widespread north of the Lower Danube, while type VI bits, characterized by a chain-like mouthpiece, are found south of it. They are rare in the south-eastern Carpathian Basin and are dated to the 5th and 4th centuries BC.[93]

A smaller horse bit of variant VA1 was found in horse burial 1 at the Zimnicea cemetery. One side of the both lateral sides has a ring, and the other has a pendant with one ring at each end. The bit is dated to the end of the 5th and beginning of the 4th century BC.[94] Another bit of this type was found in horse burial 15, with the mouthpiece made of two twisted rods. The terminals of the sides have not been preserved; they are dated to the second quarter of the 4th century BC.[95] The same cemetery included a bit of variant VB in horse burial 13, with the mouthpiece consisting of two double decorated rods.[96] The westernmost bit of variant VB was found in the Manching oppidum in Bavaria;[97] also, one was found in the Hradiště oppidum near Stradonice.[98] An interesting iron bit of variant VA1 was found in hoard II from the site of Pakoszówka in south-eastern Poland, dated to LT C1. This hoard also contained two bits of different shapes, as well as tools and possibly a wheel hub. The bits are two-part, with S-curved, square-sectioned lateral sides, two rhombic plates in the central part, and expanded terminals. The mouthpiece is composed of two joined parts of oval to square cross-section. At the terminals of both parts, there is a larger ring that connects to the sides between the two rhombic plates. This find may indicate that horse bits of variants VA and VB were used in the 3rd century BC too. It is assumed that the hoard was buried for ritual reasons by the local elite.[99]

Horse B at the Donja Dolina cemetery was accompanied not only by a horse bit, but also by horse equipment dated to the second half of the 4th century BC. The bit, not entirely preserved, is described as having a mouthpiece composed of small and wide rings and rod-shaped, S-shaped elongated lateral sides with damaged terminals. The preserved length of the sides is 18 and 14 cm. The central eyelet on the sides is turned inward; both above and below it, there is one smaller eyelet on the outer side. The terminals of the mouthpiece, which appears to have been formed from rings, passed through the central eyelet. For the rear rings, before the eyelet, there were attachments with a ring at the top, while the lower part was bent. It is also mentioned that there is a pendant consisting of four connected rings on the central eyelet,[100] which may actually have been part of the mouthpiece.

This bit can be attributed to Type IV after W. M. Werner, characterized by being made of iron and having three eyelets on the sides and a chain-like mouthpiece. The lateral sides of Type IV bits can be S-shaped or rounded. The mouthpiece consists of five to seven rings forming a chain (chain bit), with the last ring on both ends connecting to the central eyelet on the sides. A figure-of-eight attachment for connecting the reins is suspended on each end. It is believed that bits of this type have a narrow distribution in the area of eastern Bulgaria, with rare finds outside this region. They are dated from the mid-5th to the mid-4th century BC.[101] The bit from Donja Dolina is most similar to the one described by W. M. Werner as coming from an unknown site, pos-

[93] Werner 1988, 36–42, pl. 69A.
[94] Alexandrescu 1983, 74, figs. 4/4; 5/5; Werner 1988, 38, pl. 18/123.
[95] Ganciu, Dumitraşcu 2015, 68–69, fig. 4.
[96] Alexandrescu 1983, 74, pls. 7/2; 8/2; Werner 1988, 40–41, pl. 20/137.
[97] Jacobi 1974, 188–192, fig. 52, pl. 51/793; Werner 1988, 41.
[98] Píč 1903, pl. XXX/12.
[99] Bochnak et al. 2016, 212–213, 232–233, figs. 8; 11; Bochnak 2021, 23, fig. 5/3.
[100] Arsenijević 2019, 119, 121, cat. no. 47.
[101] Werner 1988, 34–36, 118, pl. 68B.

sibly from Oltenia.[102] Based on finds from Ciumeşti and Viiaşu, A. Rustoiu pointed out that type IV bits also appear later.[103] Parallels for the type IV bit from Donja Dolina are also known from the exceptional wagon burial discovered at the Ždanec necropolis on the southern edge of Skopje. In the grave, probably in a dromos, there were two horses harnessed to a four-wheeled wagon, as well as the remains of five people who, based on the finds, are dated to the end of the 5th or the first half of the 4th century BC. In front of the horses' muzzles were two iron bits similar to type IV and 14 silver rivets from two sets with an eyelet or prong on the underside. The bits, 22.5 and 23 cm long, have slightly curved square-sectioned sides and are slightly more bent inwards in the lower part, which is also longer than the upper part (Fig. 5). The central part is a little wider, while the terminals taper off slightly. The terminals end in small spherical expansions with a narrow annular expansion in front of them. The inner eyelets are larger than the side ones, which served to attach the reins. The mouthpiece, 12 cm long, is composed of two joined figure-of-eight parts. The end eyelets are connected to round-sectioned extensions, 11.5 and 12 cm long, with a ring at the top, while the lower part is bent and ends in a knob.[104] An iron bit of type IV was also found in tumulus 1 at the Bostanlũk necropolis. The bit was in the mouth of a male horse-stallion, and is attributed to the East Thracian type. The lateral sides are slightly S-shaped, with expansions at the ends, and the mouthpiece is composed of five rings, some of which are double. Each end ring of the mouthpiece has a hanging extension with a ring at the top and bottom. Parallels from other Thracian sites are mentioned and dated to the 4th century BC.[105]

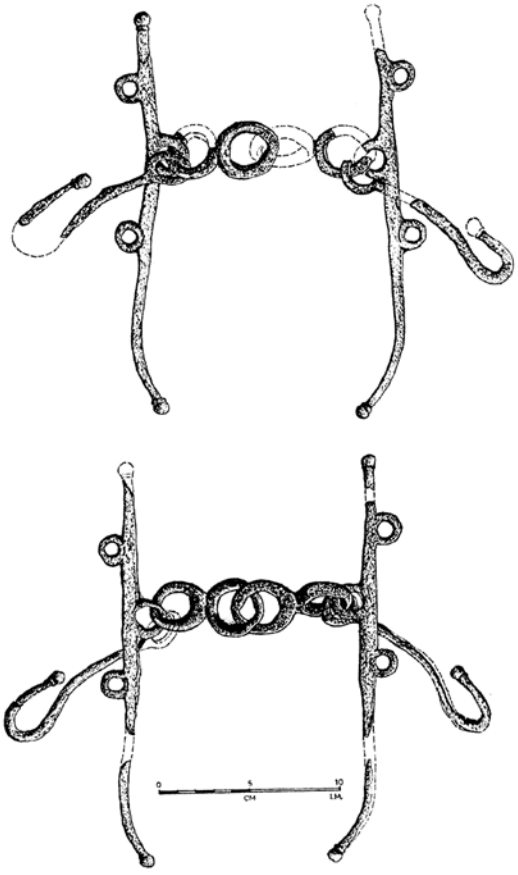


Fig. 5 – Iron bits from the grave in Ždanec (after: Mikulčić 1991).

Late Hallstatt horse harness in the south-eastern Carpathian Basin

Along with iron bits, the Late Hallstatt sites in the south-eastern Carpathian Basin contained bronze items of horse harness. They have been found in graves, while chance finds are assumed to originate from destroyed graves. This is a small group of finds for now that, however, shows a great diversity of shapes. There are phalerae of various shapes, strap separators, and decorative buttons for straps. There are exceptional finds of Early La Tène phalerae from Vinkovci and cast zoomorphic decorative fittings from Vinkovci, Donja Dolina, and Ritopek. Diverse and numerous

[102] Werner 1988, 35, pl. 17/117.
[103] Rustoiu 2017, 41, fn. 54, Fig. 6/1.
[104] Mikulčić 1991, 184, 189–191, figs. 6; 13.
[105] Tonkova, Ivanov 2007, 221, fig. 3.

Late Hallstatt horse harness items have also been recorded in the Lower Carniola group.[106] On the other hand, decorative horse harness items in the area of the Vekerzug culture are considered rare finds, represented by various items dated from the second half of the 7th to the first half of the 5th century BC, indicating the symbolic significance of this type of grave goods in the burial practices of the Vekerzug culture.[107]

Phalerae from Vinkovci

A special form of Late Hallstatt horse equipment at the sites of the Syrmian group is represented by bronze phalerae from horse burial 1 at the Vinkovci – Nama cemetery (Fig. 6). This is an exceptional find at sites in the southern Carpathian Basin. The phalerae were found near the horse's head and could have been arranged on the bridle; smaller ribbon-twisted bronze fittings were also found with them. They were found in small fragments and seem to belong to two differently decorated sets. They are made of bronze sheet in three sizes, with an iron rivet in the middle. The reconstructed phalerae are three large phalerae with a diameter of 13 cm, two medium ones with a diameter of 11.5 cm, and three smaller ones with a diameter of 5.4 to 6.2 cm. The decorations were made by punching and are concentrically arranged in zones between one low rib on each side. Two types of decoration are distinguished: rows of triangular groups composed of three punched circles, which are found on large and some smaller phalerae; the second type of decoration is recorded on medium and some smaller phalerae, and consists of a row of punched circles. The large amount of small fragments of bronze sheet, and the central profiled parts with or without a rivet, indicates that there were probably more phalerae, so it is concluded that it could have been a rich equipment of one or two horses (?), but without the possibility of defining their primary arrangement.[108] In terms of appearance and style of decoration, as well as dimensions, these phalerae show similarities with Bohemian-Moravian finds from Early La Tène princely graves with two-wheeled chariots, in which, however, no horses were found. On the other hand, these phalerae are also associated with northern Italy and seen as evidence of contacts established through horse trade.[109] For the phalerae from Vinkovci and Most na Soči, Ch. Pare finds parallels in Champagne, again considering them evidence of the horse trade that also brought Thracian-Scythian horse equipment to the West.[110]

The closest finds of similar phalerae made of bronze sheet are known from the cemetery of Most on the Soča river. Grave 592 with a horse burial contained an iron bit, but also six smaller phalerae with a diameter of 6.3 to 7.7 cm. In the middle is a rivet with a hemispherical head. The phalerae have a higher punched rib around the rivet and one lower rib on the edge that is bent downwards. Two larger phalerae, 14 cm in diameter, have a profiled rivet with a conical lower part and a higher rib around the rivet. There are two more concentric ribs on the body. The grave is dated to phase IIc, or the end of the 5th and the 4th centuries BC.[111]

In her analysis of the Vinkovci phalerae, N. Majnarić-Pandžić highlights their similarity to finds from Bohemian and Moravian sites, which were first analysed in detail by W. Dehn, where they appear in graves with chariots and equipment for two horses. W. Dehn divided the Bohemian

[106] Teržan 1976; Gabrovec 1987; Dular 2003; Tecco Hvala 2012 etc.
[107] Kozubová 2011, 86; 2019a, 93–94; 2021, 84, 95.
[108] Majnarić-Pandžić 2000, 27–28, pls. 1–3; 2003, 482, 491–494, figs. 8–10.
[109] Majnarić-Pandžić 2000, 28, 30; 2003, 492–494.
[110] Pare 2012, 167.
[111] Teržan et al. 1985, 120–121, pls. 51/17–22; 52A/23–24.

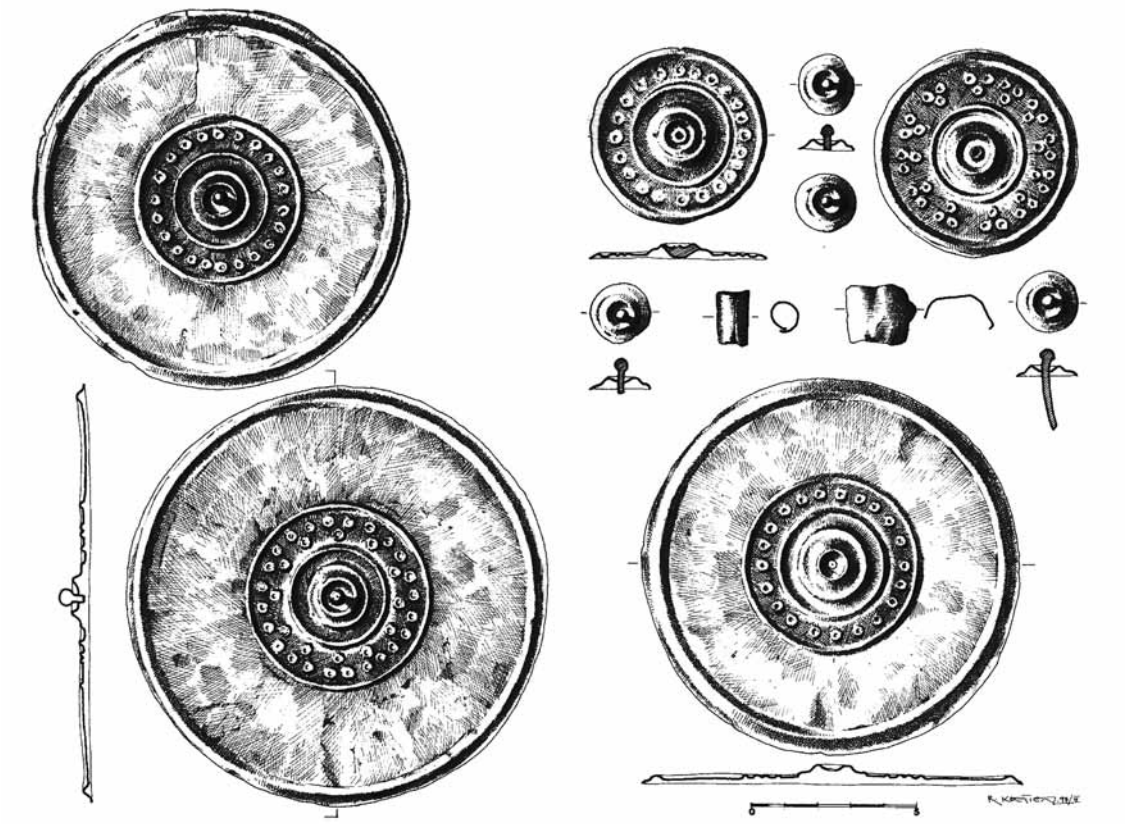


Fig. 6 – Phalerae from horse burial 1 in the Vinkovci cemetery (after: Majnarić-Pandžić 2000).

group of phalerae into three basic types: a) flat phalerae with a central protrusion and a profiled rivet; b) flat, bowl-shaped phalerae with a profiled rivet; c) flat or slightly arched phalerae with a conical, massive or hollow cast central part and a simple rivet. The phalerae were finished on a lathe, while the engraved motifs of circles and arcs were made with a compass. The decoration with a row of punched circles between the ribs is reminiscent of the Hallstatt *perlenbuckel* style of decoration. They are dated to the Late Hallstatt and Early La Tène periods, and it is believed that they were located on the straps of the horse harness.[112] Phalerae were probably located at the place where the straps joined, that is, they decorated the head, chest, and sides of the horse. For the group of Late Hallstatt phalerae from Bohemia and Moravia, it is emphasized that they were mostly decorated with concentrically arranged zones around one more or less profiled rivet. In addition to the decoration of small punched circles, some phalerae could also be decorated with geometric motifs and in the "arc style".[113]

M. Chytráček has written extensively on Late Hallstatt and Early La Tène phalerae from Bohemian sites.[114] Phalerae, as well as other horse harness items and parts of chariots, have been found in richly equipped graves in southern and western Bohemia. Differently shaped and decorated phalerae are attributed to a special Bohemian group that differs from the western cast phalerae with openwork decoration. They are dated to the Late Hallstatt and Early La Tène periods.[115] The oldest phalerae are those from grave 28 at the Hradenín cemetery, dated to Ha D1, with parts

[112] Dehn 1966, 142–144, fig. 8.

[113] Echt 2014, 68, fig. 53.

[114] Chytráček 1988; 1990; 2000; 2012a; 2012b.

[115] Chytráček 1988, 44, fig. 16; 1990, 365; 2000, 368–370, fig. 5; 2012a: 193–198, 202–208, fig. 3; 2012b, 303, 307, 309, fig. 1; Sankot 2002, 199.

of a four-wheeled wagon. Two types of phalerae are distinguished: smaller ones with a prong and larger ones with three punched ribs and a rivet with a conical head, with sometimes one additional rivet on each edge.[116] What is probably the youngest grave with a two-wheeled chariot in Bohemia comes from Hořovičky, with two bronze bits of type A and originally 12 phalerae of different sizes; it is dated to the middle or second half of the 5th century BC. These phalerae show a tradition of bowl-shaped phalerae with complex decoration organized in concentric zones around a central rivet. The composition is much more complex than before and consists of 21 masks with a leaf-like crown in the Early La Tène style.[117]

The phalerae from Vinkovci are most similar, both in shape and decoration, to those found in tumulus XII at the Mírkovice cemetery in southern Bohemia. These are two flat phalerae, 10.6 and 12.3 cm in diameter, with the downward-bent edge; they are decorated with two double rows of small ring-and-dot motifs – one around the rivet and the other in the middle of the phalera – which are separated by a groove. In the middle is a rivet with a flat head. It is stated that the phalerae show a late Hallstatt character, while the grave is dated to the end of the Hallstatt period and the beginning of the La Tène period.[118] Their closest highlighted parallels are the phalerae from a grave with a two-wheeled chariot under a tumulus from the Kladruby site.[119] This is the earliest grave with the remains of a two-wheeled chariot from the late Ha D, containing four phalerae decorated with a complex ornament consisting of small punched semicircles and ring-and-dot motifs arranged in zones separated by low ribs. Two phalerae have a rivet with a hemispherical head, and the third one is flat. The diameters are 9.4 and 9.6 cm for the smaller phalerae and about 14 cm for the larger ones. Due to their construction, these phalerae are believed to precede the younger phalerae of curved cross-section because of the method of attaching a central conical rivet.[120] The finds from Vinkovci are also similar in shape to flat phalerae with a profiled rivet from the princely grave of Hradiště, dated to LT A, or the first half of the 5th century BC. The grave contained two sets of finds of different ages, with the phalerae belonging to the older group. The phalerae appear in two sizes and are decorated between the ribs with a row of hatched triangles, or a motif of triangles in negative.[121] These phalerae can be added to the decorated phalerae from the tumulus with the remains of a chariot from the Skalice site.[122] Bronze phalerae decorated with motifs of punched circles, which is considered a late Hallstatt decorating method, are known not only from tumulus XII from the Mírkovice cemetery and the tumulus from Kladruby, but also

[116] Chytráček 2000, 360, figs. 2; 3/11–17.

[117] Chytráček 2000, 369–370, 375; 2012a, 200, figs. 10–11; 2012b, 310, 312, figs. 4–5; 11/3 reconstruction on the phalera on the horse.

[118] Chytráček 1990, 97, 117, 125, fig. 21/12–13; 2000, 368, fig. 7/4; Sankot 2012, 698. Tumulus IX at the Mírkovice cemetery contained a richly equipped cremated burial of an adult male with weapons and parts of a two-wheeled chariot. The horse equipment for two horses included six bronze phalerae with a slightly bowl-shaped form, measuring 11.8 to 12.8 cm in diameter. In the centre is a profiled rivet with a spherical head, while the lower part is conical. In the centre, around the rivet, there is an engraved decorative semicircle surrounded by two circles; along the edge, compass-drawn arc motifs are found, belonging to the so-called "arc style" common on objects from the Late Hallstatt and especially the Early La Tène periods. There was also a fragment of a small phalera, 7.2 cm in diameter, decorated with transverse incisions between two circles. The grave is also dated to the end of the Hallstatt and the beginning of the La Tène periods (Chytráček 1988, 15, 21, figs. 3/2–5; 4/1–3; 1990, 87, 90, 114, 125, figs. 12/2–5; 13/1–3; 2000, 366, 368, figs. 7/3; 12; 2012a, 198, fig. 6; 2012b, 309, fig. 8; Sankot 2002, 199). The phalerae used to be associated with the Želkovice site (Chytráček 1990, 114), while the bit from the tumulus is associated with type B (Chytráček 2012a, 198, fig. 6).

[119] Chytráček 1990, 117, 128; Pare 1992: 164, 329, pl. 116A/1–2; Chytráček 2000, 365–366, fig. 7/4; 2012a, 194–195; 2012b, 303.

[120] Sankot 2012, 696–698, 700, 718, fig. 1/1–5.

[121] Sankot 2002, 197–201, figs. 1/11–18; 2/1–4; Chytráček 2012a, 205, 207, fig. 13/7–13.

[122] Pare 1992, 336, pl. 124B/2–3.

from tumulus 2 from Opařany.[123] The same motif of punched circles can also be found on phalerae of a different shape, such as those from tumulus 44 from the Sedlec-Hůrka cemetery, dated to the late Hallstatt (Ha D2/D3). On these phalerae, a row of punched circles is also located between one rib on each side.[124] Also, the ring-and-dot motif appears on older phalerae of the Libna type, and the link between the Czech sites and the southeastern Alpine region is also indicated by the finds of some types of horse bits.[125]

The phalerae from tumulus XII in Mírkovice are associated with the Hundersingen type, which is characterized by a flat surface and the absence of a central protrusion, instead having a rivet. Most are undecorated, except for those from the Bohemian sites of Mírkovice, Kladruby, and Skalice, which are considered to belong to a younger group of finds. Phalerae of this type appear in the area north of the Alps and are dated to Ha D1-2. More generally, concentric ribs on phalerae also appear on those of the Ludwigsburg and Hradenín 28 types, which also show a western distribution.[126] J. K. Koch questions whether phalerae with a diameter greater than 10 cm, like most of those from Vinkovci, were head ornaments for horses. Phalerae with a diameter greater than 15 cm certainly were not. Hundersingen-type phalerae have a central rivet, that is, they lack a protrusion, and their dating to Ha D2 cannot be confirmed with certainty. Richly decorated phalerae with concentric ribs and rows of bosses were included by H. Parzinger in the Hohmichele type, but because of their decoration type and different method of fastening with rivets, these phalerae were classified as a separate Ludwigsburg type. Phalerae of this type appear from Burgundy to central Bohemia, with finds in grave 28 at the Hradenín cemetery showing that they appeared as early as Ha D1, while other finds belong to Ha D2. Phalerae from grave 592 at Most on the Soča river cemetery, and from Kladruby, Skalice, and others, have been associated with the Hundersingen type, while phalerae from grave 28 of the Hradenín cemetery, tumulus 2 in Opařany, and some others, have been classified as the Ludwigsburg type.[127] M. Trachsel has provided a detailed classification of phalerae, again noting that phalerae up to a certain size could be found on bridles, while larger ones could be on horse harnesses or chariots. Numerous forms have been identified, divided into various types and variants, with some differences compared to the previously mentioned classifications.[128] Phalerae are particularly numerous during the Early La Tène period, appearing in such a variety that their development is difficult to describe more clearly. Phalerae from grave 592 at the Most on the Soča river cemetery are attributed to type FAL 16c with concentric ribs and a low rivet, and dated to the Early La Tène period. Phalerae from Hradiště are also attributed to this type, while phalerae with a punched decoration between the ribs from tumulus XII in Mírkovice and Kladruby are classified as a separate variant. The Vinkovci phalerae could be attributed to this type. Phalerae of type FAL 17c Ludwigsburg have a protruding centre and ribs, and are dated to Ha D2. Phalerae of type FAL 18 Želkovice are those with a concave shape, a small horizontal rim, and a profiled central rivet, which are also dated to the Early La Tène period. This type includes the phalerae from tumulus IX in Mírkovice, Hořovičky, Lučice, tumulus 44 in Sedlec, grave 196 in Želkovice Manétin – Hrádek, and others, as well as some special forms from Nevězice, grave 175 in Nynice, etc.[129]

[123] Chytráček 1990, 117; 2012a, 195; 2012b, 303.

[124] Dehn 1966, 141, figs. 10; 12; Soudská 1976, 634, fig. 5/1, 4–7; Chytráček 2000, 367–368, figs. 6; 7/1–2; 2012a, 196, fig. 4; 2012b, 307, fig. 6.

[125] Chytráček 2012a, 195; 2012b, 303.

[126] Parzinger 1995, 71–73, 269, fig. 25/1; Sankot 2012, 700–701.

[127] Koch 2006, 191–196, 336–337, figs. 181–182.

[128] I.e. he associates ribbed phalerae from grave 28 in the Hradenín cemetery with a variant of type FAL 16a Strettweg, and phalerae from tumulus Opařany 2 with a special type FAL 16b etc. (Trachsel 2004, 452–453).

[129] Trachsel 2004, 443–444, 452–453, figs. 25–26; Mírová 2019, 128.

It can also be noted that similar bronze phalerae are found in human graves, as shown by the example of cremation grave 74 from the Manětín – Hrádek cemetery. The grave included four phalerae with a central hemispherical-head rivet, two vessels, and an anthropomorphic fibula. The phalerae were probably worn on clothing. The phalerae are decorated between each rib on either side with punched circle motifs, followed by a punched zigzag pattern, and then another punched row of circles. It is noted that these phalerae could have been part of a belt, helmet, sword sheath, or even part of a fibula as in grave 49. Such phalerae are dated to the Late Hallstatt and Early La Tène periods, and the grave is dated to the first half of the 4th century BC, or LT A.[130] Such plate-like fibulae resembling phalerae appear in the Early La Tène period in western and central Europe, and are often decorated with gold and coral.[131]

Zoomorphic fittings of the horse harness

One of the distinctive and recognizable forms of Late Hallstatt horse equipment in the south-eastern Carpathian Basin is represented by bronze zoomorphic fittings found in the cemeteries of Vinkovci and Ritopek; those from the cemetery in Donja Dolina can also be added. In horse burial 2 in Vinkovci, above the remains of the horse, harness was found consisting of four bronze cast zoomorphic fittings with an eyelet on the underside for threading the reins (Fig. 7). Three of the fittings are considered to represent a stylized depiction of a griffin – a spirally curved figure of a fantastic animal with a pronounced mane, ribbed body, prominent eye, and muzzle. The fourth fitting may represent a depiction of a deer with stylized antlers, or perhaps a series of heads of birds of prey with pronounced bird beaks below. This is a unique set made in the "Scythian-Thracian" zoomorphic style of the late 5th and early 4th century BC, with parallels in Thracian princely graves (e.g., Agighiol) and in the "Craiova treasure".[132] The grave included a stylistically different fitting, which also has an eyelet on the underside and may have been a frontal ornament on the horse's head.[133] The ensemble of finds

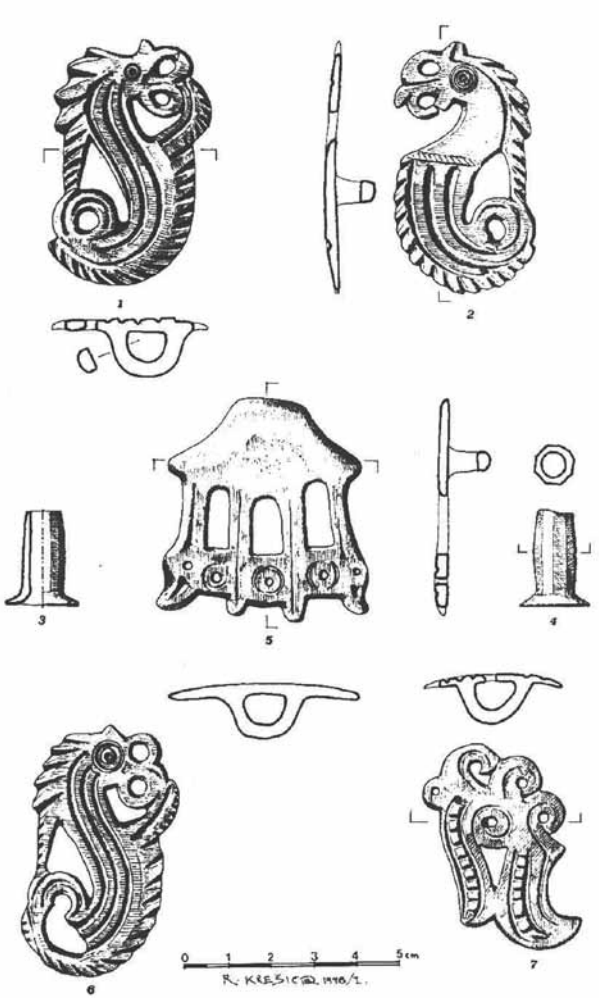


Fig. 7 – Horse equipment from horse burial 2 in the Vinkovci cemetery (after: Majnarić-Pandžić 2000).

[130] Soudská 1968, 453–456, 468, figs. 3/1, 3–4, 6; 4; 1994, 154–155, figs. A10; B13/1-4; E17/7.
[131] Echt 1999, 73–77, fig. 22.
[132] Majnarić-Pandžić 2000, 27–28, pl. 4; 2003, 482, 490, 494, fig. 11/1–2, 6–7.
[133] Majnarić-Pandžić 2000, 28, pl. 4/5; 2003, 498, fig. 11/5.

also includes two polygonal tubes with a widened rim, which could have been fittings at the ends of the reins.[134]

The closest parallels to the finds from Vinkovci are two bronze zoomorphic fittings found in the Ritopek – Dalekovod cemetery (Fig. 8), where two aforementioned iron bits of type V were also found. The larger fitting, measuring 5.0 x 4.7 cm, seems to have the shape of a stylized griffin's head (or deer, according to B. Jovanović) with the lower part fan-shaped in the form of seven connected volutes. There is an eyelet on the underside.[135] The other fitting, measuring 3.7 x 4.2 cm, is thought to have the shape of a rooster's head (or griffin, according to B. Jovanović) with a crest and a prominent beak, while there is a horizontal rib in the lower part. There is a perforation at the junction of the rib and the body.[136] J. Todorović describes the fittings as pendants, dates them to Ha D and attributes them to the Scythian legacy, noting that the smaller fitting may belong to the bit.[137] B. Jovanović associates the fittings with the Scythian animal style and dates them to the second half of the 5th or the first half of the 4th century BC. He believes that the fittings could have arrived in Ritopek from the north along the Tisza river or via Banat.[138] He considers them younger than the horse equipment items made in the animal style from Lower Carniola, which were probably imports from northeastern Pannonia.[139] R. Vasić believes that the fittings are no older than the third quarter of the 4th century BC.[140]

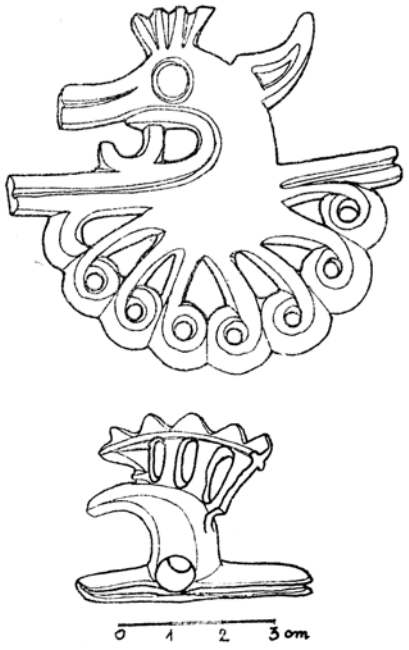


Fig. 8 – Zoomorphic appliqués from the Ritopek cemetery (after: Todorović 1971).

In analyses of the fittings from Ritopek, a mention is also made of a find of a bronze buckle in the shape of a lion from the site of Baraće near Hajdučka Vodenica in Đerdap/Iron Gates. It was considered to be part of a belt or horse equipment, with the buckle dated to the 5th or the beginning of the 4th century BC, and it was assumed to be a local product of a Thracian or Getic workshop with direct parallels at sites in north-western Bulgaria.[141] Belt buckles like those from Baraće at sites in north-western Thrace are dated to the 5th century BC.[142] This is a Scythian motif of a crouching cat with outstretched front legs and a mouth open forward. Such buckles are dated to the 5th century BC and may represent a warrior symbol.[143]

Of particular importance is the discovery of five bronze zoomorphic fittings in horse burial B at Timenačka Greda in Donja Dolina. It is assumed that one piece is missing, i.e. that the fittings

[134] Majnarić-Pandžić 2000, 28, pl. 4/3–4; 2003, 498, fig. 11/3–4.

[135] Todorović 1967, 156, 160, pl. IV/11; 1971, 94–95, cat. no. 369, pl. XLV/1; Jovanović 1977, 21–22, fig. 2/1; Vasić 1977, 64, pl. 48/9; Ljuština, Ninčić 2017, 251, Fig. 9/1; Ninčić 2023, 57, pl. 6/1.

[136] Todorović 1967, 156, pl. IV/10; 1971, 95, cat. no. 370, pls. XLV/7; LXXXVII/30; Jovanović 1977, 21–22, fig. 2/2; Vasić 1977, 64, pl. 48/10; Parović-Pešikan 1994, 106, fig. 1/6, 9; Ljuština, Ninčić 2017, 251, Fig. 9/2; Ninčić 2023, 58, pl. 6/2.

[137] Todorović 1967, 159–160; 1971, 94–95.

[138] Jovanović 1977, 22–25, 27–28, fig. 1.

[139] Jovanović 1977, 20–21, 25–27, figs. 3–5.

[140] Vasić 1987, 566–567.

[141] Jovanović 1977, 21–22, 28, pls. I–II; Vasić 1987, 566–567; Parović-Pešikan 1994, 106, fig. 1/12; Ljuština, Ninčić 2017, 252, Fig. 10; Ninčić 2023, 58, pl. 6/3.

[142] Paunova 1999, 20, figs. 1–4, map on fig. 13.

[143] Teleaga 2012, 134, 137, figs. 4/14; 6/6–8; 2015, 33, 67–69, figs. 7/14; 19/2; 2016, 236–237, fig. 7/5.

were originally a pair. This grave contained the aforementioned iron bit and other bronze parts of horse equipment. The fittings are believed to represent a stylized form of two joined birds with widely open beaks and spread wings, while the eyes are marked by circular openings. They are rectangular at one end and have an eyelet on the underside. The fittings are considered to be made in the Scythian-Thracian zoomorphic style, perhaps in a local southern Pannonian workshop.[144]

In their analysis of the zoomorphic fittings from Ritopek and Vinkovci, B. Jovanović and N. Majnarić-Pandžić emphasized their conceptual Lower Danube origin, noting that zoomorphic fittings of a different form appear even earlier at sites in Lower Carniola.[145] It is a group of finds from graves under tumuli; their analyses emphasized that there were no parallels for them in the Carpathian Basin (Fig. 9). Fittings in the form of a swirl (swastika) ending in horse heads and with a hole in the middle or eyelet(s) on the underside, along with S-shaped fittings, are associated with horse equipment of Eastern origin and dated to the Certosa fibula phase and the early Negova-type helmet phase.[146] In fact, the Vinkovci fittings are cited as parallels for the S-shaped fittings ending in bird-like heads with an eyelet on the underside, from grave 13 of tumulus II at Preloge in Magdalenska Gora.[147] Interestingly, the fittings are made of a tin-lead or zinc-lead alloy, indicating their local origin.[148] This seems to be supported by the find of a swastika-shaped fitting in grave 38 of tumulus II at Magdalenska Gora, where one fitting depicts one of the horse heads devouring a human leg, a motif of Situla art.[149] Ch. Pare also recognizes this motif in Greco-Thracian mythology.[150] Two zoomorphic fittings in the shape of a swirl with a hole in the middle were also found in grave 33 of tumulus V in Dolenjske Toplice; one of them has a preserved eyelet on the underside.[151] Fittings of this type were found in two more tumuli in Magdalenska Gora.[152] For their dating, the finds in grave 99 of tumulus 48 in Stična are important. It is the grave of a richly equipped warrior-horseman, located in the youngest circle of graves in the tumulus. In addition to a Szentes-Vekerzug type bit, the horse equipment includes four bronze fittings with four horse heads at the ends, a central rosette motif, and two eyelets on the underside. One fitting (find 93) was probably found together with the remains of the horse, about 1.40 m above the bottom

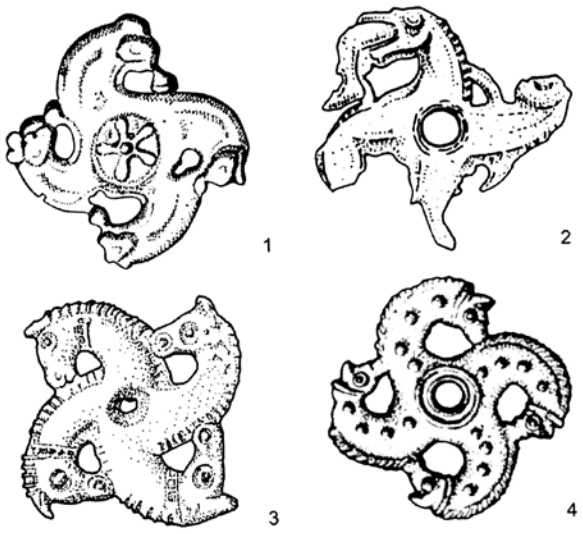


Fig. 9 – Zoomorphic appliqués from sites in Lower Carniola (after: Pare 2012).

[144] Arsenijević 2019: 120–122, 213, cat. no. 21.

[145] Jovanović 1977; Majnarić-Pandžić 2000; 2003.

[146] Frey 1980, 229, 233; Gabrovec 1987, 63, fig. 5/2, pl. VIII/1–2; Dular 2003, 136, fig. 79/23–26; Teržan 1998, 529; 2010, 290; Preložnik 2007, 157, 159–162, figs. 10–12; Tecco Hvala 2012, 163; Pare 2012, 158.

[147] Kromer 1960, 112, fig. 1/1, 3; Frey 1980, 229, fig. 2/3; Tecco Hvala 2012, 162, fig. 61/10; Pare 2012, 162, fig. 10/4–5.

[148] Kromer 1960, 114–115; Hencken 1974, 126; Frey 1980, 227, 236; Gabrovec 1987, 63; Preložnik 2007, 159; Teržan 2010, 290; Tecco Hvala 2012, 163; Pare 2012, 156.

[149] Kromer 1960, 113, fig 1/4; Frey 1980, 227, 234, figs. 1; 2/1; 4/17; Gabrovec 1987, 63; Preložnik 2007, 159, fig. 11; Tecco Hvala 2012, 162–163, fig. 61/22.

[150] Pare 2012, 156.

[151] Kromer 1960, 113, fig. 1/5; Teržan 1976, 402, pl. 38/2–3; Frey 1980, 229, fig. 2/2.

[152] Hencken 1978, 20, 38, figs. 51; 151.

of the grave, while three fittings were placed next to the human. The grave is dated by Certosa fibulae of type V to the end of the 6th and the first half of the 5th century BC.[153] Furthermore, the rich warrior grave III/12 at the Kapiteljska Njiva cemetery in Novo Mesto, which contained a Szentes-Vekerzug type horse bit and bronze vessels, dated to around the middle of the 5th century BC, included a swastika-shaped fitting made of a lead alloy with two eyelets on the underside.[154]

For the fittings from Stična, parallels have been found in phalerae from the early Scythian kurgan 8 in Volkovcy in the Podnieper region, dated to the second half or late 7th century BC; it could be a prototype for swastikas that reached Lower Carniola via the Carpathian Basin.[155] Ch. Pare also emphasizes the connection between the finds from Lower Carniola and those along the Black Sea,[156] even as far as the Dnieper and perhaps even further east.[157] A comparison is made with a swastika-shaped bronze horse equipment fitting from Olbia, with four heads of a hybrid animal resembling a horse, with open curled beaks, and an eyelet on the underside.[158] This motif of a hybrid beast combining a horse's neck and head with a curled beak is not particularly frequent in the west. This is the way of depicting the motif of the griffin, which is otherwise the most common fantastic creature in Early Celtic art.[159] Such selective inclusion of foreign (Scythian) forms, and the continuity of the domestic legacy, indicates the acceptance and adoption of certain parts of horse harness through e.g. war trophies, trade, or perhaps gifts to the princes of Lower Carniola.[160] Objects made in the zoomorphic style thus become part of local material legecy, produced by local craftsmen in a recognizable technological manner. Although finds of Vekerzug type horse harness have been considered evidence of decisive Scythian influences on Lower Carniola,[161] there is currently no evidence of their presence in that area.[162]

E. Teleaga has devoted numerous studies to objects made in the zoomorphic style, including finds of horse harness from the southern Carpathian Basin.[163] He highlights bronze objects made in the Scythian, Greek, and mixed zoomorphic styles that appear as early as the 5th century BC in graves and hoards, but rarely in settlements in northern Thrace and the area north of the Danube. At the beginning of the 4th century BC, the Thracian artistic style emerged; horse harness is made of silver and associated with the local elite, with the finds of moulds and matrices testifying to local production.[164] It is difficult to recognize which animal or hybrid creature is represented by the motifs on the fittings from Ritopek, Vinkovci, and Donja Dolina. N. Majnarić-Pandžić and B. Jovanović believe that these are motifs of griffins and deer, while E. Teleaga believes that the griffin motif as a hybrid creature (a common motif on Thracian horse equipment from the 4th century BC) should be classified into the "mixed motifs group".[165] The three fittings from Vinkovci are believed to resemble the depiction of a seahorse and are thought to be local products inspired by motifs from the Thracian-Scythian world, documenting the connectivity between the west and

[153] Teržan 2010, 241–242, 290, pl. 57/10–13; 2014, 457, 459, fig. 25.8/9–12; Dular 2003, 136, fig. 79/23–26.
[154] Križ 1997, 58, pl. 36/6.
[155] Preložnik 2007, 160–162, figs. 12–13; Teržan 2010, 290, fig. 41.
[156] Pare 2012, 156, fig. 3.
[157] Kull 1998, 213, fig. 13.
[158] Pare 2012, 154–155, fig. 1/1.
[159] Pare 2012, 158.
[160] Preložnik 2007, 163.
[161] Teržan 1998, 530, 536.
[162] Tecco Hvala 2012, 163.
[163] Teleaga 2012; 2015; 2016.
[164] Teleaga 2012, 127, 130–131, 143–144, fig. 4; 2015, 17–37, fig. 7; 2016, 207–210, 212–219; 251–253, 267.
[165] Teleaga 2012, 139, fig. 8/7–9; 2015, 76–77; 2016, 240–241.

the Lower Danube.[166] The smaller fitting from Ritopek, with a parallel in Lazar Stanevo, may represent a deer head[167] or the head of a water bird,[168] while the fittings from Donja Dolina could represent the horns of an ibex.[169] It is also believed that zoomorphic horse equipment of eastern conceptual origin played a significant role in the development of Early La Tène art, although it is noticeable that finds of eastern origin are rare in Central Europe during the 5th century BC. The question remains as to which route(s) were taken by these eastern influences to reach the workshops north of the Alps,[170] with the finds from Ritopek, Vinkovci, and Donja Dolina clearly indicating communication that followed the Sava river, connecting the Danube region with the southeastern Alpine region and further west. Also, zoomorphic fittings, as well as finds of type IV and V horse bits, indicate an intensive connection between the southern Carpathian Basin and the Lower Danube region during the late 5th and 4th centuries BC. Although they may have been products of local workshops, their conceptual origin should probably be sought in the area along the Danube east of the Iron Gates.[171]

Other items of the late hallstatt horse harness

Apart from horse bits and zoomorphic fittings, other items of Late Hallstatt horse harness are known from the sites of the Syrmian group. Horse burial 2 in Vinkovci included not only the zoomorphic fittings, but also two polygonal bushings with a widened rim, which are presumed to have been fittings for the ends of the reins (Fig. 7).[172] Fittings of this type were analysed in detail by Y. Ivanov when examining the three silver fittings in the shape of a truncated cone that were found in a richly equipped tumulus near the village of Ruets in northeastern Bulgaria. The fittings have a diameter of 2.1–2.5 cm and a height of 1.1–1.2 cm; iron horse bits of type IV were also found in the grave.[173] These fittings are lower than those from Vinkovci; parallels have been noted in numerous finds dated from the mid-5th to the mid-3rd century BC in Thrace; it is emphasized that younger examples have steeper sides and appear to be taller.[174] Their position on the horse harness is not entirely clear, but the prevailing opinion is that they connected the reins. On the other hand, it is believed that they had a decorative purpose, as indicated by the variety of shapes and sizes, and by the small openings through which only a thin strap could be threaded. In graves, they were found on the horse's forehead and on both sides of the head. Interestingly, they are usually found in pairs, as in Vinkovci, or in sets of three fittings.[175]

One of the recognizable forms of Late Hallstatt horse equipment, only recently recorded in the south-eastern Carpathian Basin, consists of phalerae of the Magdalenska Gora type with two eyelets on the underside. They are considered characteristic of the southeastern Alpine region and the area of distribution of the Vekerzug culture, and are dated from the end of the 6th to the 4th century BC. New finds from eastern Slavonia and western Syrmia, which may originate from

[166] Pare 2012, 157, fig. 4/1–3, 5; Teleaga 2015, 82–83, fig. 23/5.

[167] Teleaga 2012, 134–135, fig. 4/7; 2015, 55–62, fig. 7/7; 2016, 232, 235.

[168] Teleaga 2015, 119.

[169] Teleaga 2012, 134, fig. 4/8; 2015, 63–66; 2016, 233, 235, figs. 9/1–2; 12.

[170] Pare 2012, 153.

[171] Interestingly, these horse equipment items – zoomorphic fittings or bits of types IV and V – are thus far absent from the Vekerzug culture cemeteries in the northern Carpathian Basin.

[172] Majnarić-Pandžić 2000, 28, pl. 4/3–4; 2003, 498, fig. 11/3–4.

[173] Ivanov 2018, 182, fig. 2.

[174] Ivanov 2018, 182, 184–185, 189, fig. 3.

[175] Ivanov 2018, 186, 189–190, figs. 4–5.

destroyed graves, confirm the cultural connectivity between different regions, so we can expect more such finds in this area.[176]

Other items of horse harness were found in horse burial B at Timenačka Greda in Donja Dolina and in several graves with horse burials at the Szentlőrinc cemetery (Fig. 10–11). Together with horse B, in addition to zoomorphic fittings and a horse bit, four phalerae were found, decorated with concentric ribs on the upper side and two rectangular lugs on the underside. The phalerae have a diameter of 5.1–5.2 cm. This burial included five large bronze buttons with a prism-shaped upper part 1.5 cm high, as well as 50 smaller buttons, 1 cm high, with a low conical upper part and a lug on the underside.[177] In graves 52 and 61 at the Szentlőrinc cemetery, bronze and iron horse harness items were found with an iron bit. In grave 52 (Fig. 10), with the burial of three horses, horse harness was found with the westernmost horse; it includes a pendant with a spherical and hollow central part and an eyelet at the top, four strap separators, 44 buttons with an eyelet, a bronze plate with a rivet, seven iron rings, and four iron rivets.[178] Grave 61 (Fig. 11) contained 30 bronze buttons and 10 cross-shaped buttons.[179] Iron rings were found not only in grave 52,[180] but also in graves 58 (five pieces) and 60 (one piece) with an iron horse bit.[181] Two rings, a smaller bronze one and a larger

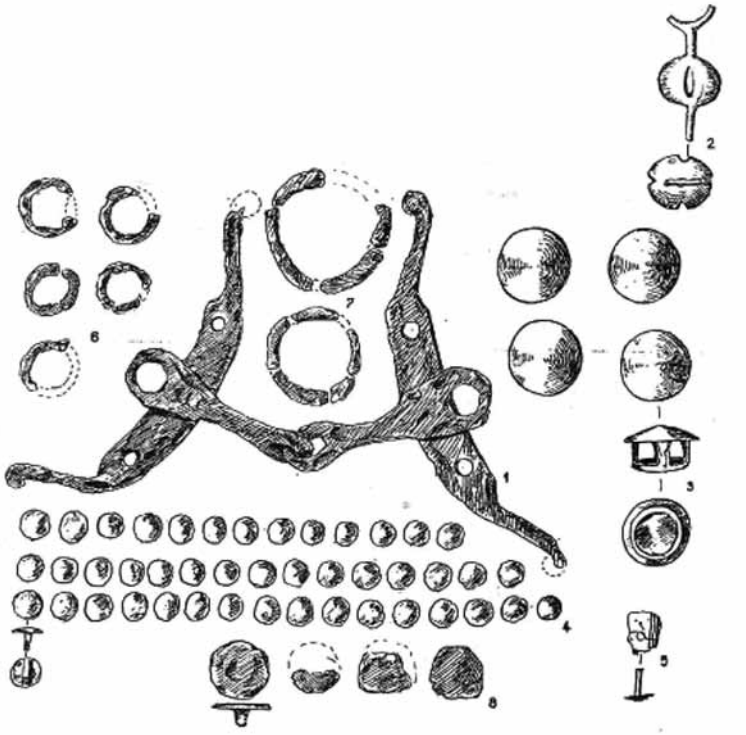


Fig. 10 – Horse equipment from grave 52 in the Szentlőrinc cemetery (after: Jerem 1968).

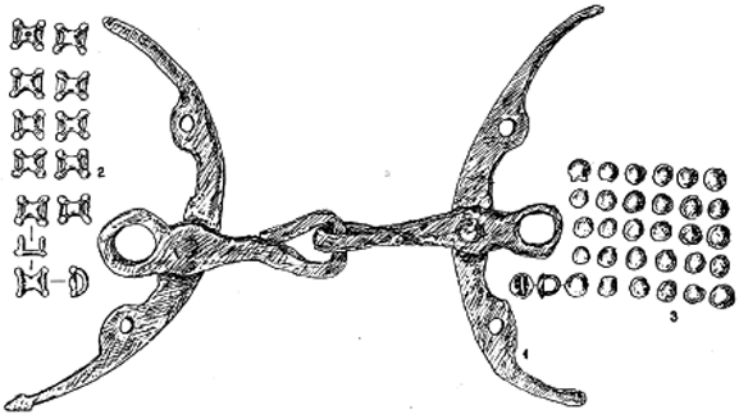


Fig. 11 – Horse equipment from grave 61 in the Szentlőrinc cemetery (after: Jerem 1968).

[176] Dizdar 2023.
[177] Arsenijević 2019, 119–120, 212–213, cat. no. 20, 22–23.
[178] Jerem 1968, 169–170, fig. 26/52-2–8.
[179] Jerem 1968, 171, fig. 28/60-2–3.
[180] Jerem 1968, 170, fig. 26/52-6–7.
[181] Jerem 1968, 171, figs. 28/58-2–6; 28/60-1.

iron one, which are believed to also belong to horse harness, were found in grave 19 of tumulus VII in Kapiteljska Njiva.[182]

Parallels for the phalerae found with horse B in Donja Dolina are known from grave 19 of tumulus VII at Kapiteljska Njiva in Novo Mesto, dated to the early phase of the Negova-type helmet; the grave also contained an iron horse bit and Magdalenska Gora type phalerae. The grave included three phalerae with two eyelets on the underside, while the upper side was decorated with concentric ribs and a central depression, and it seems that the ribs were worked on a lathe.[183] Bronze buttons with an eyelet on the underside were found not only in Donja Dolina, but also in graves 52 and 61 at the Szentlőrinc cemetery (Fig. 10–11).[184] Strap separators with a square bottom part were found in grave 52 with a horse bit of type I 4.[185] Separators of this type are included in the geometric group of horse equipment[186] and can be attributed to type A/Ia and dated to the Late Hallstatt period.[187] Grave 52 included a silvered hollow spherical pendant with a rod-shaped lower part (Bommelanhänger).[188] It resembles pendants of the Prozor type, which are widespread in the western Balkans as a women's costume item.[189] Grave 61 (Fig. 11) contained a horse bit of type I 2, but also 10 cross-shaped buttons with two eyelets on the underside,[190] also included in the geometric group of horse equipment[191] and connecting southern Pannonia with Lower Carniola and the Sveta Lucija group.[192] Parallels can be found in the aforementioned grave 19 in tumulus VII at Kapiteljska Njiva. This grave contained three cross-shaped buttons with two semicircular eyelets on the underside.[193] Two more buttons of this type were found in grave 41 in tumulus III.[194] In Magdalenska Gora, cross-shaped buttons were found in graves of the Negova-type helmet phase.[195] Particularly noteworthy finds are some 90 cross-shaped buttons in grave 29 of tumulus V with the burial of two mounted warriors and four horses, likely belonging to the earlier phase of the Negova-type helmet.[196] Cross-shaped buttons also appear at other sites in Lower Carniola, often with horse bits of the Lower Carniola variant 6.[197] A detailed analysis of cross-shaped buttons was conducted based on the finds in grave 11 of tumulus 5 in Stična (13 pieces), dated to the late phase of the Certosa fibula or the beginning of the Negova-type helmet phase.[198] Such buttons, as part of horse harness, can have one or two eyelets on the underside and are often decorated with double or triple incisions on the protrusions. In addition to sites in Lower Carniola and Bela Krajina, cross-shaped buttons are also known from Hallstatt cemetery, while finds at sites in the Una valley are considered somewhat different and younger.[199] The find of a mould at the settlement of Gradišče above Vintarjevec near Litija suggests local production.[200]

[182] Egg 2003, 335, fig. 10/12–13, pl. 17/12–13.
[183] Egg 2003, 335, fig. 10/6–8, pl. 17/6–8.
[184] Jerem 1968, 170–171, 190, figs. 16; 26/52-4; 28/61-3.
[185] Jerem 1968, 170, fig. 26/52-3.
[186] Preložnik 2007, 157, figs. 4–5.
[187] Metzner-Nebelsick 2002, 318, fig. 140A/Ia; Koch 2006, 192–193, fig. 179/1; Kozubová 2011, 93.
[188] Jerem 1968, 170, fig. 26/52-2.
[189] Teßmann 2001, 75–79, figs. 45–46; Kozubová 2011, 83.
[190] Jerem 1968, 171, 190, figs. 17, 28/61-2.
[191] Preložnik 2007, 157, fig. 3.
[192] Kmet'ová 2017, 103, fig. 7/5.
[193] Egg 2003, 335, fig. 10/9–11, pl. 17/9–11.
[194] Križ 1997, 77, pl. 64/2–3.
[195] Hencken 1978, figs. 109d; 144a–b; 158f.
[196] Egg 2003, 335, 345, fig. 21/11–13; Tecco Hvala 2012, 158, 162, fig. 61/15.
[197] Gabrovec 1987, 70; Tecco Hvala 2012, 162.
[198] Kruh 2010, 97, pl. 116/5.
[199] Kruh 2010, 97–98, fig. 6.
[200] Stare 1999, 30, fig. 9/1; Kruh 2010, 97–98.

Conclusion

The analyses of horse equipment found at sites of the Syrmian group (Fig. 1), like other types of finds (especially women's costume and jewellery), point to cultural connectivity between different Late Hallstatt communities in the Carpathian Basin and neighbouring regions. They used the same or similar objects, selectively incorporating forms through various kinds of transfers, probably intended to signify social identities within local communities. For this reason, the Syrmian group can be considered one of the most dynamic cultural groups of the Early Iron Age in the Carpathian Basin. Horse equipment found at sites of the Syrmian group is currently dated to the 5th and 4th centuries BC, but is most common in contexts belonging to the late 5th and the first half of the 4th century BC. So far, it appears only in horse burials, while it is currently absent from human graves. On the other hand, men's graves contain weapons, most often one or two spears and, exceptionally, a curved-bladed battle knife (*falcata*). This is shown by finds from graves at Vučedol[201] and Alsónyék cemeteries[202] and from slightly younger ones at the cemeteries of Szentlőrinc, Vinkovci – Nama, and Novi Sad.[203]

Different items of horse equipment from sites of the Syrmian group have been singled out: different forms of iron bits, as well as decorative bronze objects. Analyses of individual types indicate interregional contacts with neighbouring regions, but also with distant areas. Connectivity with the Lower Danube region to the east can be recognized in some forms of horse bits and bronze zoomorphic appliqués. Contacts with the south-eastern Alps were marked by horse bits of the Lower Carniola variant of the Szentes-Vekerzug type, as well as phalerae of the Magdalenska Gora type and some other horse harness objects. The Magdalenska Gora type of phalerae also points to connectivity with the communities of the Vekerzug culture, as do some types of iron horse bits. Bronze phalerae from the Vinkovci cemetery, made in the Early La Tène style, indicate some kind of connection with Central Europe, but possibly also with north-eastern Italy. All of this demonstrates that Late Hallstatt communities in the south-eastern Carpathian Basin were exposed to external influences which they selectively adopted, modified, and then transmitted further. Connectivity and contacts with the mentioned regions are also indicated by the ritual burial of horses with or without horse equipment, which is currently lacking in human graves. This reveals a difference compared to the Lower Carniola group and shows similarities with the Vekerzug culture. In fact, the trade of horses equipped with horse harness explains contacts linking the distant regions of the Lower Danube and north-eastern Italy; the communities in the southern Carpathian Basin and the southeastern Alpine region could have been intermediaries, but they probably also actively participated by breeding high-quality horses which they then equipped with rich horse equipment. This seems to be confirmed by the presence of horse equipment items in the Thracian-Scythian animal style, which probably reached the west along with stories and myths.[204] The finds from Ritopek, Vinkovci, and Donja Dolina testify to this communication. Of course, there are also other objects, especially women's costume and jewellery items,[205] which confirm the intensive connectivity of the communities of the Syrmian group in all the mentioned directions and their inclusion in supra-regional networks.[206]

[201] Brunšmid 1902; Teržan 1977, 14, fig. 4.

[202] Soós 2020.

[203] Jerem 1968; Majnarić-Pandžić 2003; Anđelić 2017.

[204] Pare 2012, 154, 165–167, 169–170.

[205] E.g. Dizdar 2019; Soós 2021.

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A small chieftain in a big wide world
On the reproduction of social roles in the Late Bronze Age

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Abstract: The hoard from Moravička Sela in Gorski Kotar (Croatia) is an accidental find. It consist of a smaller number of fragmented bronze tools, weapons, jewelleries and half products. Its composition proves the connections ranging from the southeast Alpine, Pannonian and Carpathian territory. In a cultural and historical perspective, it represents the application of a classic pattern of hoards from the southern Pannonian territory characterized by regional cultural expressions of the older phase of Urnfield culture (Ha A1) in the 13th and early 12th century BCE. The most interesting find within the hoard was a miniature double pick. The latter were characteristic for the territory of the Carpathian Basin, especially for the northern Hungarian and Slovakian territory. Numerous discussions have been presented in recent decades on the functions of double pics, but all the authors agreed that the miniature examples precisely because of their size were of symbolic, most probably votive character or a form of a status symbol. As a sign/symbol, they undoubtedly had a leading role in the recognition of different cultural values of the Carpathian Basin, while their status outside of this milieu, as for example in the discussed hoard, needs additional efforts to be interpreted in context. It remains, for now, the most southern find and is understood as a *specific subject* of inter/transregional contacts and transmissions between individuals and societies.

Key words: Croatia, Moravička Sela, Late Bronze Age, hoard, miniature double picks

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What precisely miniaturisation is all about

This article examines small things and things made small. However, it is not primarily about size – it focuses on scale. It is specifically concerned with the relation of information between the world at large and the world of miniatures. Since miniatures help us imagine grander schemes, it is essential to remember that a miniature must be a reduced version of something originally larger, consciously created as such.

Miniature artefacts owe some of their appeal to their small size, but their design goes beyond mere considerations of size, skill, or the artist's ingenuity in working within constraints. A miniature bronze axe, for instance, differs fundamentally from a life-sized one simply reduced in scale. The small size forces the artisan to be highly selective, ruthlessly eliminating inessential elements. This selective process results in the characteristic clarity and intensity of miniature items.[1]

When functionality and pragmatic qualities are removed – in this case, due to the diminutive size of the artefact – their symbolic qualities, or epistemic features, come to the forefront.[2] Miniatures are scaled-down versions of real objects, which, because of their reduced dimensions, cannot typically serve the same practical purposes as their larger counterparts. Freed from functional constraints, the process of miniaturization highlights the connotative meaning of the objects.

In addition, the process of miniaturisation can be described as a strategy to further enhance and emphasize the specific symbolic meaning of already symbolically meaningful artefacts. Being a representation of ideal, certain characteristics, can purposefully be omitted or left ambiguous.[3] Reducing something significant through the miniaturisation process imbues the ideological qualities of the original idea into the miniature in a format designed to appeal directly to its intended audience.[4] Therefore on a more abstract level of social communication the person using (and hoarding) it is supposed to promote and reinforce specific social models.

Identities are shaped not only through practices, discourses, and symbolic representations but also through material and physical experiences. In all societies, children require specific forms of training to prepare for adulthood. This training, integrated into teaching and socialisation processes, may be facilitated by different community members. Children do not acquire through these processes only the information and knowledge about the manipulation of ritual items – they provide insight into technologies used in their production and the economies sustained by them.[5]

Coming of age is not merely an introduction into society but also a step toward inclusion in the productive sphere, forming the basis for local identities and economies. The process of learning how to manipulate with an object included the memorisation of cognitive geographies, as well as spatial and temporal patterns composed from compressed individual experiences of generations sustaining long-distance cultural contacts. Transferred into the next generation the knowledge was intended for the creation of experiences, specific forms of cultural understanding that created the local identities and connected them to broader networks.

[1] Gentleman 1972, 6.
[2] Richard 2019, 815.
[3] Kohring 2011, 36.
[4] Davy, Dixon 2019, 3.
[5] Lucy 2005, 43; Sánchez Romero 2008, 19; Fahlander 2011, 14.



Fig. 1 – The hoard from Moravička Sela (photo by Martina Blečić Kavur).

The hoard

The hoard from Moravička Sela was discovered in Gorski Kotar in Croatia (fig. 1). Not more than several fragmented bronze tools, weapons and semi-finished products. Their typological features demonstrate cultural influences converging from the southeast Alpine, Pannonian, and Carpathian regions. From a cultural and historical perspective, the hoard represents the classic pattern of hoards from the southern Pannonian territory, characterized by regional cultural expressions of the early phase of Urnfield culture (Ha A1), dating to the 13th and early 12th centuries BCE.[6] The most intriguing find within the hoard is a miniature double pick. Double picks are generally considered characteristic of the territory of the Carpathian Basin. However, miniature examples, being infrequent even on the core territory, making them especially uncommon. Furthermore, the find from Moravička sela remains, for now, the southernmost finds of such an artefact (fig. 3).

In the last decades, there were numerous discussions about the functions of double picks and regardless their interpretation, all the authors agreed that the miniature examples were of symbolic, most probably votive character. As a sign/symbol, they undoubtedly had a leading role in the recognition of different cultural values of the Carpathian Basin, while their status outside of this milieu, as for example in the discussed hoard, needs additional efforts to be interpreted in

[6] Blečić Kavur et al. 2020; Blečić Kavur 2025.

context. Its primary milieu was a relatively small group of bronze items – a middle-sized hoard of mixed composition containing 34 fragments of different items weighting together 2.259 grams. Discovered were: a fragment of a flange-hilted sword with a rivet; a fragmented miniature double pointed pick; 6 fragments of two damaged flange-handled sickles; 7 fragments of sickles; a fragment of a bronze tube, most probably part of a bracelet or torques; a fragment of bent bronze sheet; two bent bracelets and 14 larger and smaller fragments of ingots and pieces of amorphous bronze.[7]

Consequently, the hoard from Moravička Sela is dated to the II. horizon of hoards on the broader territory of *Caput Adriae* and its hinterland[8] – linked to the II. horizon of hoards i.e. Veliko Nabrđe type in northern Croatia[9] and chronologically synchronized with Ha A1 phase of the central European periodization. The composition of items was deliberately collected, thoughtfully selected, and systematically deposited. When observing individual items, we can recognize that they were mostly determined for future elaboration or transformation, but the sword and the miniature double pick had a completely different meaning and social biography.[10]

Of major importance to the present discussion is the fragmented flange-hilted sword discovered at the site (fig. 1). Its current state of preservation clearly demonstrates that it was intentionally bent in the past, with two-thirds of the blade now missing. According to its typological characteristics, the sword is included into the group of Budišćina type according to S. Hansen[11] or Krško type according to A. Harding's typology.[12] Further it could be ascribed to the group A4 of flange-hilted swords as generally determined by T. Kemenczei.[13] Such swords were most prevalent in the broader territory of southern Pannonia, with individual examples found in river valleys of the Mura and Danube. The presence of this type of sword in Moravička Sela extends their known distribution southward from the Sava corridor into the Pokuplje region. These swords are predominantly associated with hoards[14] and using the dating of Otok – Privlaka, Brodski Varoš, and Budinšćina in Croatia,[15] as well as Straßengle in Austria,[16] it can be dated to the Ha A1 phase of central European periodization.

And the pick

In contrast to the regional distribution of Budinšćina/Krško type swords, the double-pointed picks exhibit a wide, international distribution (figs. 1; 2: 8). The example from Moravička Sela is miniature in size – it features a small central knob on the shaft where both "arms" are attached.[17] A

[7] Blečić Kavur et al. 2020, 411, 418–420.

[8] Turk 1996, 108–112, fig. 5.

[9] Vinski-Gasparini 1973; 1983; Ložnjak Dizdar 2011.

[10] Blečić Kavur et al. 2020, 420–421.

[11] Hansen 1994, 34, fig. 14.

[12] Harding 1995, 53, Pl. 22: 183–186.

[13] Kemenczei 1988, Pl. 23: 227.

[14] Hansen 1994, fig. 14.

[15] Vinski-Gasparini 1973, Pl. 27: 10, Pl. 55: 2, Pl. 77: 5.

[16] Müller-Karpe 1959, Pl. 126A: 23; Schauer 1971, 191–192, Pl. 91: 598.

[17] Fragmented double pick, unfinished and damaged. Cylindrical tube has a small knob on the central part and a horizontal decorative rib at the bottom. Partly is preserved single arm with a rhomboid cross-section. Oval and asymmetrical plate at the top of the tube has thinner ribs forming a cross-shaped enforcement. Traces of casting in a double-sided mould are visible below the disc along the edge of the tube. Size: length 4.6 cm; radius of the socket 1.1 cm; length of the termination plate 3 cm; width of the termination plate 1.8 cm; weight 24.37 g. (Blečić Kavur et al. 2020, 419, fig. 3: 2).

single horizontal rib is preserved on the lover part of the shaft, while the oval disc-shaped terminal is irregular in form, with preserved casting seams on both the top and bottom, indicating that the item was cast in a double mould. The casting seams on top of the disc form a cross around the central hole. The preserved short and thin broken "arms" suggest that the item was not produced with great precision – further evidenced by the fact that the casting seams were never removed.[18]

Double picks are a specific form of tools characteristic for the wider territory of the Carpathian Basin,[19] but miniature examples form a smaller group amongst them. According to its morphological characteristics, we could ascribe the pick to the E type according to the elaborated typology of S. Stuchlík.[20]

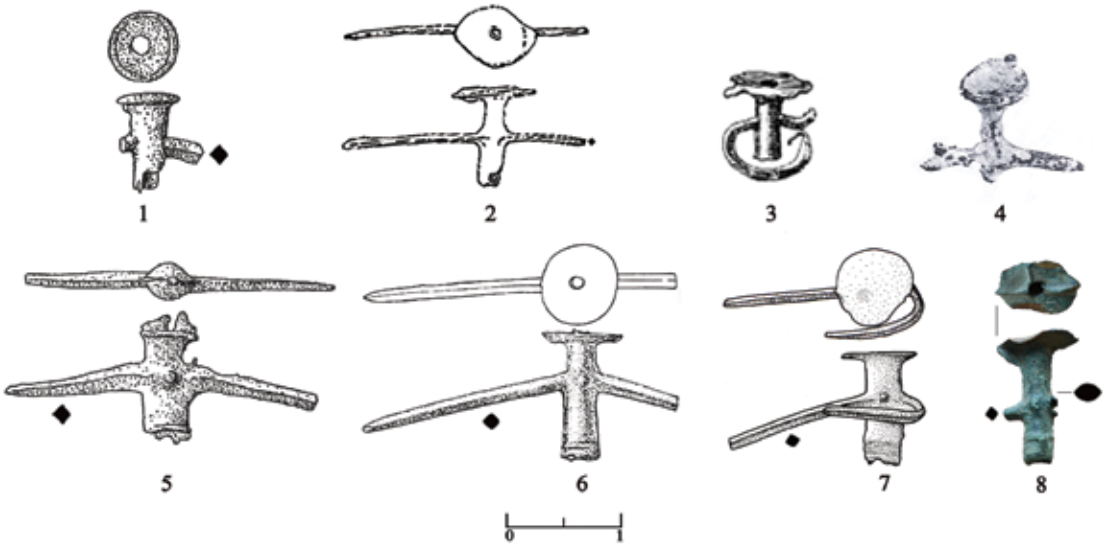


Fig. 2 – Miniature double picks from 1 Vršatské Podhradie (Novotná 2002), 2 Žitný ostrov (Novotná 1980), 3 Bodrogkeresztúr (Hampel 1886), 4 Trenčianske Bohuslavice (Novotná 1970b), 5 Vršatské Podhradie (Novotná 2002), 6 Dobrochov (Salaš 2005), 7 Peggau (Weihs 2004), 8 Moravička Sela (M. 1: 2 graphics M. Blečić Kavur).

They form a group with only 13 examples known from 11 sites[21] on the territory of Slovakia, Moravia and Hungary belonging to the Piliny and Lužice cultures at the end of Br D and during the Ha A horizon.[22] Such age is additionally confirmed by the dating of double picks in closest hoards from Peggau[23] and Jurka vas.[24]

Until recently, they were characteristic only for the territory of Slovakia with individual finds discovered in Moravia and Hungary – their spatial distribution expanded dramatically towards the south with the discovery in Moravička Sela (fig. 3). Most of the miniature picks are carelessly cast and not quite elaborously decorated – they give us the impression as if they were unfinished. Definitely, less energy and skill was invested into their finalization and decoration than in normal sized picks. Further, all the examples are marked by substantial damages – from

[18] Blečić Kavur et al. 2020, 416.

[19] Hansen 1994, 204, fig. 124; Teržan 1996, 246, fig. 1; Salaš 1997, 35; Vachta 2008, 31, figs. 17, 18; Novotná, Furman 2018; Blečić Kavur et al. 2020, 416–418, fig. 7.

[20] Stuchlík 1988, 306–317, fig. 19; Novotná 1970a, 64–65; 1980; cf. Novotná, Furman 2018.

[21] Novotná, Furman 2018, 91–93.

[22] Novotná 1980; Salaš 1997; Vachta 2008, 31; Novotná, Furman 2018.

[23] Weihs 2004.

[24] Čerče, Šinkovec 1995, 199, Pl. 89: 13, Pl. 161: 9.

breaking and bending of "arms" to bending of the disc and body of the pick. We could consider this observation as just another confirmation of the ritual manipulation and intentional destruction of items before their deposition.[25]

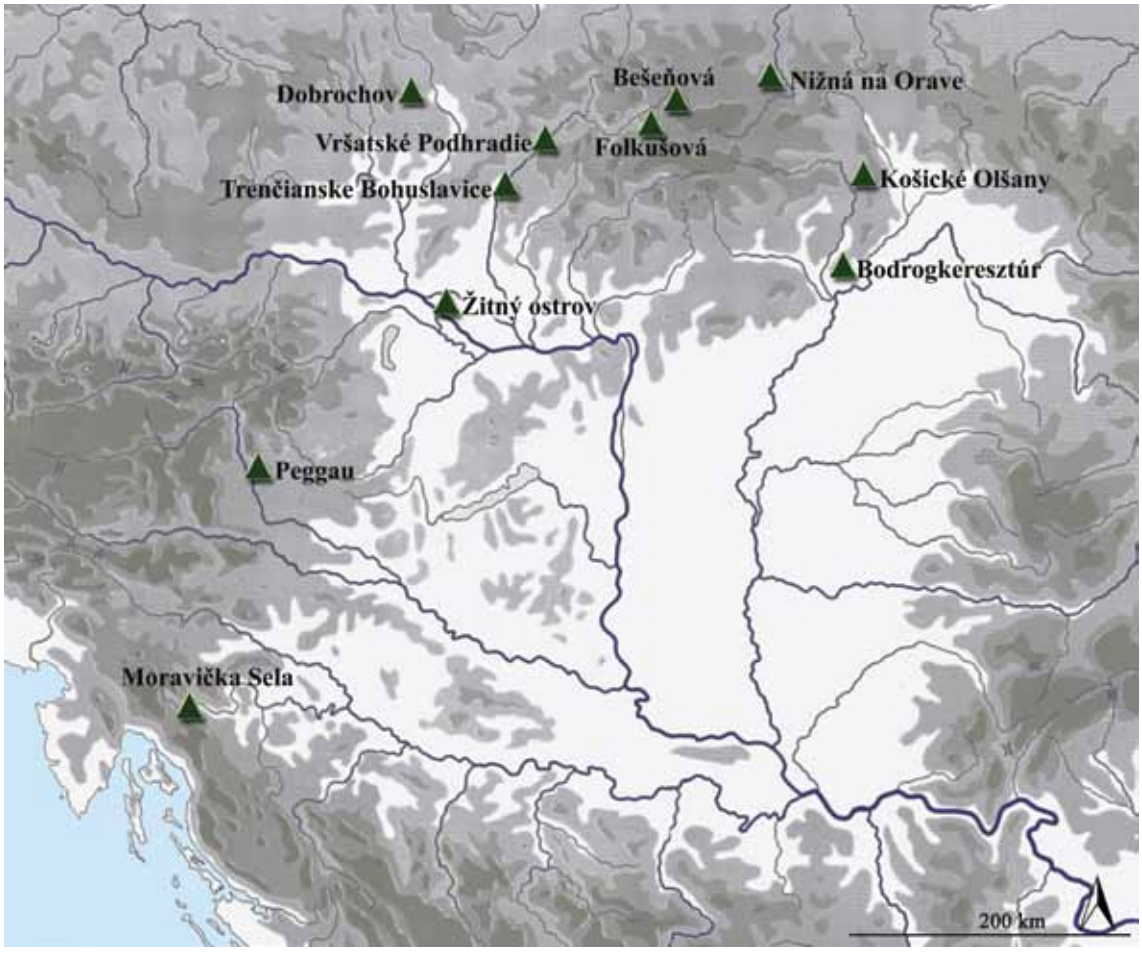


Fig. 3 – Spatial distribution of miniature double picks (after Blečić Kavur et al. 2020).

The miniature picks must have functioned as artefacts with reinforced connotative meaning, chosen because of their association with specific spheres of action. There were numerous discussions about their use or symbolic functions, but all the authors agreed that they were of symbolic, most probably votive character[26] or a form of a status symbol such as a *sceptre*.[27] Their presence indicates a hierarchical dimension – they were reflections of social status, real or ascribed. As a sign/symbol they undoubtedly had a leading role in the recognition of different cultural values of the Carpathian basin, while their status outside of this milieu, as for example in the hoards such as Peggau or the discussed hoard, needs additional efforts to be interpreted in context. The double pick from Moravička Sela remains for now the most southern find and could be understood as a subject of inter/transregional contacts and communications between individuals and societies, as the most distant material reflection of ideas connecting the Urnfield culture world (fig. 3).[28] An additional interpretative momentum was added by its physical characteristics

[25] e.g. Chapman 2000; Târlea 2008; Dietrich 2014.

[26] Hansen 1994, 204; Weihs 2004, 46; Novotná 1970a, 64–65; 1980; Vachta 2008, 31.

[27] Teržan 1996, 246.

[28] Blečić Kavur et al. 2020, 418, fig. 7.

– it is a miniature reproduction of the real pick. It is following all its formal characteristics, but the poorly manufacture could not be only the consequence of the small size (and difficult casting). Several elements such as the irregular disc on the top and unremoved casting seams indicate that the artefact was produced with much less accuracy, attention and care for the details. It is formed as a symbolic artefact, but it was not produced as such. Or was it?

… and the reproduction of social roles

A reduction in dimension does not result in a corresponding reduction in significance; indeed the "ideological" properties of the miniature pick make this form particularly effective as a "containers" of didactic concepts. Its reduced physical dimensions has only peripheral bearing upon the meaning of its importance – it continues to emphasize the pick as a complete and meaningful object. In a certain way, we would expect symbolic artefacts to be precisely manufactured, but this expectation does not necessarily apply to miniatures. It has been suggested that a distinction should be made between miniatures and models. The later are authentic copies reduced in size but with meticulous attention to,[29] while miniatures rely on abstraction and the compression of details and features, serving as iconic representations of their full-sized counterparts.

What constitutes a normal or standard size for an item? The term "normal size" typically refers to dimensions that enable an item to fulfill its functional role in everyday use.[30] But how can we determine the relationship between size and functionality in symbolic items? We cannot, or actually we should not. For symbolic objects, their symbolic use *is* their practical use, whether the object is miniature or full-sized. The connotative meaning of such items is tied to the associations and emotions they evoke as iconic signs. These meanings are culturally coded, shaped by prevailing values, attitudes, and beliefs. This leads us to the opposing forces of interests, to tensions embedded in the production of miniatures: tensions between the aspirations to achieve a graphic clarity in the produced artefact, which is in sharp opposition to the complicated technical demands of their production. This tension represents a dynamic interplay between the complexity of meaning and the simplicity of expression – a dynamic relation between the introspective, formal, abstract, and ordered attitude of cultural implications and the more observant, inquiring, and objective considerations of production.

Another conceptual challenge in studying miniatures lies in the notion – predominantly rooted in classical archaeological studies—that miniatures found as offerings in sanctuaries and graves are merely cheaper substitutes for the "real" things. This perspective places too much emphasis on the material value of objects, attributing numerous aspects such as poverty or even a lack of religious devotion to the donors. Such interpretations are deeply entrenched in economic models shaped by the dominant capitalist market ideology, which prioritizes the material worth of goods above all else.[31]

Further hypothesis, explaining the function of the miniature pick, could be suggested by the state of preservation of the sword. Nowadays, it is fragmented and bent, but it seems that these were consequences of two individual processes. Reconstructing its biography, we can conclude that the sword was initially produced as an formidable weapon and used as such but at the same time as an instrument of public display of power, an *insignia* of the male/social elite. At the end of its first life circle the sword was fragmented and blunted. It entered into its second cycle in which

[29] Bailey 2005, 23–33.
[30] Pilz 2011, 18.
[31] Pilz 2012, 156.

it retained the physical characteristics that could assure that it was still recognized as an *insignia*, but it was not an active weapon any more. At the end of the third cycle, it was violently destroyed, removed from public display and positioned into an intentionally structured hoard. Question arising here is the role of the sword in its second life cycle. Due to its shape, it could not have been practically used as a weapon – it remained just a recognizable symbol of the sword. Perhaps we are going too far but the blunt tip associates the modern observer with children's toys, actually with items that are intended to be used by "as" real artefacts, but deliberately made non-functional. Consequently, we assume that it was in the second cycle transformed from an, with symbolism laden, weapon into an, with the same symbolism laden, toy. But not a toy in a modern sense – an element of mimicry, an artefact used as an aid to learn the future symbolic use of the real artefact.

The toy is a physical embodiment of the fiction; it is a device for fantasy, a point of beginning for narrative leading to fantasy. It is something to manipulate with, to try it out within sets of contexts, but under strict control, this develops to social play. The toy world presents a projection of the world of everyday life – the real world is miniaturized testing the relation between materiality and meaning. This brings us also to the question of childhood on the Bronze Age – we imagine it being distanced and diminutive, but we have to admit, that it was most of all clearly framed. The child, used here as an metaphor, is not in a physical sense a miniature of the adult, but limited in physical scope yet fantastic in content it is a miniature and fictive chapter in one's life history.[32]

Material culture plays a fundamental role in the deliberate construction of childhood, which is a social concept rather than a biological one. Children's experiences are shaped by a specific set of material culture enabling their interaction with their social environment. Focusing on object in which we would like to encapsulate the distinction between childhood and adulthood, we often overlook that there are specific artefacts functioning as catalysts – tools that aid in the transgression/transition from one stage of socialization to the next.[33] And, toys are not only artefacts to play with, but also aids to educate.

Were the miniature double pick and transformed sword artefacts used in the processes of ideological reproduction, where junior members of the social elite were trained the proper use, manipulation and public display of (symbolic) artefacts? Did these processes incorporate transformed artefacts – real items that had lost their primary function, but still preserved all formal characteristics necessary for their symbolic recognition? Was for them produced a specific material culture such as miniatures, manufactured with less care but displaying all the characteristics of the actual artefacts expressing the cultural connotations in a more direct and immediate way. Perhaps the broken and blunted sword offers the clearest evidence of this trajectory of and artefact's life course that could, due to its material transformation indicate an act of child's appropriation.

Unfortunately lacking these items in graves, we will never be able to pinpoint the age in which the children left behind their marginal status and acquired a public identity. Since the hoard was most probably buried in a single event, we can interpret it as a permanently designated "act" of a specific cultural knowledge following patterns from the tradition of a broader, but contemporary, transcultural network of meanings. Recognizing its importance and meaning (representation) in a broader region, the hoard enforces its connections with northern south-eastern Alpine region of Slovenia,[34] eastern Karlovac region of Pokuplje[35] and further along Posavina all the way to eastern Danube region in Serbia.[36]

[32] Stewart 2007, 44.

[33] Crawford 2009.

[34] Čerče, Šinkovec 1995; Križ, Stipančić 2007; Pavlin, Stipančić 2023.

[35] Perkić, Ložnjak Dizdar 2005, 42.

[36] Blečić Kavur et al. 2020, 423–424, fig. 7.

While the miniature pick, contextualised in it's social setting is not an isolated objective entity, but is connected to an array of artefacts, locations, social institutions, values and even humans – we assume that it was used by the people to reproduce their social and ideological frameworks, to make sense of the world around them and to define the proper way to do things. It was a materialisation of a strategy for constructing social groups and identity, to form social personae.[37] It is an item, that could demonstrate not only the local processes of social role learning and knowledge transfer, but most important the materialization of active Urnfield ideological system reproduction located on southern fringes of the Pannonian world.

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[37] López-Bertran, Vives-Ferrándiz 2015, 82.

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Communication network and crossroads in Western Serbia
A case study of the West Morava valley and neighboring area during the Iron Age

Katarina Dmitrović[1]

Abstract: Analyzing roads and communication networks from prehistory has the basic importance for understanding contacts, directions of influences, economy or area controlled by certain communities. It has been noted that princely tumuli and findings from the Iron Age in southwestern Serbia were often discovered in the immediate vicinity of the other exceptional archaeological and cultural sites established in later centuries, especially next to Serbian medieval royal endowments. The continuity of such cult places is explained by its favorable geographical position, in the vicinity of roads and crossroads, where economic, social and religious activities took place. The assumption is that in the surroundings of these nodes, new and important localities can be expected. Among these of great importance would be the Iron Age settlements connected to princely tumuli of the 6th and 5th centuries BC, which still represent a completely unknown category in our country.

Key words: roads, princely tumuli, communication networks, nodes, continuity, settlements

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Introduction

Researching the roads and communication networks that functioned in prehistoric periods is a great challenge. With specifying them, it is possible to reveal the contacts, the influence directions, the economic strategies, and even marking the area controlled by certain communities. By defining routes it becomes easier to discover archaeological sites, which, in dependance on their type, are often situated in the vicinity.[1] The existence of roads and complex communication networks,[2] among the other facts, is confirmed by many archaeological finds originating from very distant regions.

The methods of specifying the ancient roads represent a combination of a few factors - the geomorphological features of the area and mapping already known sites and communications, which often retained the routes used during previous periods.[3] However, in addition to the solid conversance of the main routes, it seems that the secondary roads are less explored, especially when needed to precise them within certain microregions.

One of them is the West Morava valley, a natural link between the eastern periphery of the mountain massif of the Inner Dinaric Alps typical for western Balkans and the central Balkans with wide river valleys and smaller mountains and hills. The West Morava valley has been used for communication since the immemorial times, which is confirmed by both old and modern roadways, routed along the edges of the left and right high river terraces.

West Morava valley and neighboring regions during the Bronze and Iron Ages

Since the Bronze Age, the western Serbia, with the West Morava valley on its eastern periphery, had firmly established ties with its northern neighbors across the Sava River, in the territory of today's Syrmia.[4] These connections were obviously very long-lasting and very intense, primarily concerning the flow of goods and ideas, while migrations in terms of the relocation of larger groups are excluded.[5] The influences that came from synchronous cultures are manifested on the material culture appearance, not as a direct import, but through the transfers of technologies and ideas. Imitations of northern models are evident especially in terms of style, but manufactured locally.[6]

The autochthonous population base in western Serbia is confirmed by the continuity of the traditional way of burial under tumuli. A specific funeral concept, different from the one in the north, has been maintained in this area for over two millennia. The various forms of treatment of the deceased represent the characteristic of time, the culture and other norms of the sepulchral cult. Up to now, the use of burial mounds in western Serbia, according to the more recent absolute dates from the graves, is determined between the 28th – 5th centuries BC.[7]

Influences from the north are followed to the end of the Bronze Age. With the beginning of the Iron Age, the situation changes and new contacts are realized, especially with the western

[1] Babić 1980, 61, 65.
[2] Dawson 2020, 74-79.
[3] Palavestra 1994, 51-54; Бабић 2008, 80, Gaffney, Gaffney 2010.
[4] Dmitrović 2016, 228-236.
[5] Тасић 2002, 172; Metzner - Nebelsick 2010, 122.
[6] Knappett, Kiriatzi 2016, 5-9.
[7] Bulatović et al. 2020, Dmitrović, Molloy 2022.

and southwestern neighbors.[8] In this way, through the Adriatic, the Balkan communities got in contact with the highly developed Mediterranean world. In order to better illustrate this fact, we will emphasize very early iron items that consisted of bracelets and an arched fibula from tumuli necropolis in Mojsinje (Fig. 1), situated on the left bank of the West Morava river.[9] The fibula has parallels in Epirus and present-day Albania and it is highly probable that these iron items



Fig. 1 – Lugovi Bent in Mojsinje: Iron items from Mound V (Nikitović et al. 2002; photo: M. Bojović).

have been acquired through new communication networks with the southwestern areas. New radiocarbon dates define the appearance of iron in Mojsinje in the 9th and first decades of the 8th century,[10] which additionally determines the time of the establishment of new communications between western Morava region and the southern Adriatic. At the end of the 6th and the beginning of the 5th century BC, on the other side of the West Morava river, across from Mojsinje, the already well-known princely necropolis in Atenica was founded.[11] The abundance of exceptional prestigious objects from both tumuli eloquently illustrates the already well-established networks in the Balkans (Fig. 2).

Bearing in mind the changes by establishing new connections on completely different regions compared to the previous traditional contacts with the north, the question arises why such special sites, such as Mojsinje and Atenica, are located exactly on these positions and why in the immediate neighborhood? One possibility can be the thesis on the founding princely graves from the central Balkans at crossroads or at significant points of the transregional network of interaction.[12] By adding a wider picture of sites of great importance at the assumed nodes - crossroads,[13] will make an attempt in communication reconstruction more accurately,[14] as already proposed on the Via Egnatia route.[15] The nodes must encompass several criteria – the primary is the geographical predisposition, characterized by a river valley with the larger mountain massifs in the hinterland. This is followed by the meeting point of natural communications, the concentration of exceptional finds and sites and the continuity of use since prehistoric times and during the later periods.

[8] Filipović 2018, 112-113. These ties are based on weapons and defensive equipment distribution during the 7th - 5th century BC.

[9] Nikitović et al.2022.

[10] Dmitrović 2024.

[11] Djuknić, Jovanović 1966.

[12] Palavestra 1998, 41-42; Potrebica, Pravidur 2022, 177.

[13] Knappett 2013, 3-6.

[14] Palavestra 1994, 52.

[15] Stibbe 2003, 95; David 2017, 66-67.



Fig. 2 – Umke (Royal chairs) in Atenica: A selection of inventory from princely graves (Djuknić, Jovanović 1966; photo M. Bojović).

Toward the reconstruction of roads in West Morava region and neighboring areas in the Iron Age

For the reconstruction of the road network between the West Morava valley and the Adriatic Sea during the Iron Age, the routes used both in Roman era and in the Middle Ages can be assumed.[16] Geographically, this wide area belongs to the Dinaric Alps system. Due to the characteristics of the terrain, medieval roads followed mountain ranges, saddles, narrow valleys and canyons, which required continuous climbing and descending, and contributed to a very difficult

[16] Palavestra 1994, Fig. 5.1.

travelling.[17] In contrast, the routes running through the large river valleys from Niš, Sofia, Constantinople, Thessaloniki or to Kosovo Polje (ancient Ulpiana) were much easier. These roads are considered as the main communications in the Balkans, while the rest of the road network was of secondary importance and served to connect the main routes and the hinterland.[18]

During the Middle Ages, the journey from the Adriatic coast to the hinterland was made in two stages and different means of travel. A good example is the transport from Dubrovnik, which in the first stage reached the Lim river valley the vicinity of Višegrad on the Drina river, the vicinity of Sarajevo, Glasinac, Rogatica and other locations at a similar distance from the seaside. From there, the carrier was changed, and probably switched from horses or cargo cattle to carts.[19] Horses and cattle were rented from the local population, where monastery estates had a special role.[20]

West Morava region, in addition to its natural characteristics of a wide river valley that connected the mountainous western Balkans with the Great Morava valley, the main transfersal of the central Balkans, also had good communication with other regions. In order to present them more precisely, several important directions that were potentially used in prehistory will be listed.

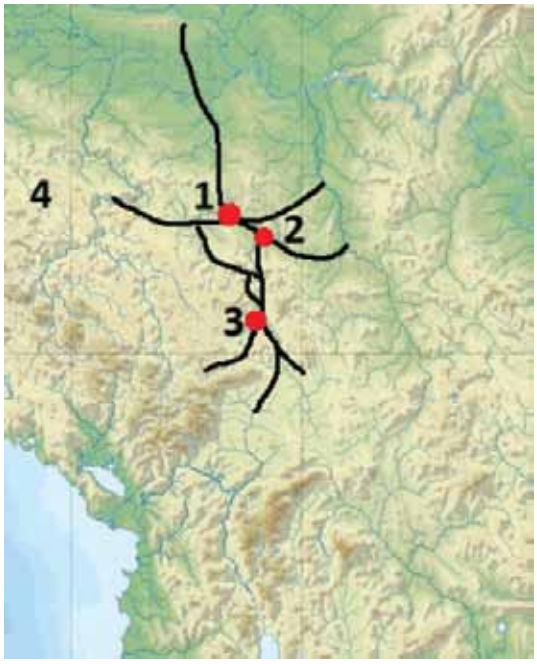


Fig. 3 – Routes connecting the West Morava region with the neighboring area: 1 – Čačak: 2 – Kraljevo; 3 – Novi Pazar; 4 - Glasinac.

Towards the north, communication run through Ljubić, Brusnica, Despotovica and Majdan to the Rudnik mountain, and then along the Ljig and Kolubara rivers to the Sava river (Fig.3).[21] To the southeast the road run along the West Morava river. At Bresnica, it branched out and across Šumadija and the Lepenica river reaching the Great Morava river valleys. Near Kraljevo, the other branch went along the Ibar river to the south, towards Novi Pazar. From the Ibar road, the path connecting the Studenica and Gradac monasteries separated and continued over the Čemerno mountain to the Moravica river valley.[22] Toward the west, the northern part of West Morava valley was connected over the Jelica mountain to the Đetinja river valley and further with Podrinje.[23] In addition to the mentioned routes, one should not ignore the possibility of using river courses, a much more profitable and faster way of transport[24], however, without particular evidence for now.

On the aforementioned communications, especially those connecting the West Morava valley with the west and southwest, we find very important prehistoric, Roman and medieval sites that confirm the continuity of their use. We will start with the analysis of the site from the northern part

[17] Шкриванић 1974, 13-14.
[18] Filipović 2018, 106-108.
[19] Шкриванић 1974, 14-15.
[20] Шкриванић 1974, 25.
[21] Шкриванић 1974, 103-104.
[22] Шкриванић 1974, 109.
[23] Васић 1986, 27.
[24] Potrebica 2013, 78, 79.

of West Morava region, from the point where the mountain massif passes into the wide river valley, today the surroundings of the city of Čačak (Fig. 4). Very important archaeological sites are known from this area. Among the prehistoric ones, the already described mound necropolis in Mojsinje with very early early iron objects and the later rich princely tumuli from Atenica stand out. In the very center of the modern city, a Roman fortification with a settlement was recently discovered,[25] on which the medieval Morava Gradac with a monastery, an endowment of Duke Stracimir from the end of the 12th century, was founded.[26] Of particular importance is the Early Byzantine fortification on Jelica mountain, in the immediate vicinity of the modern city.[27]

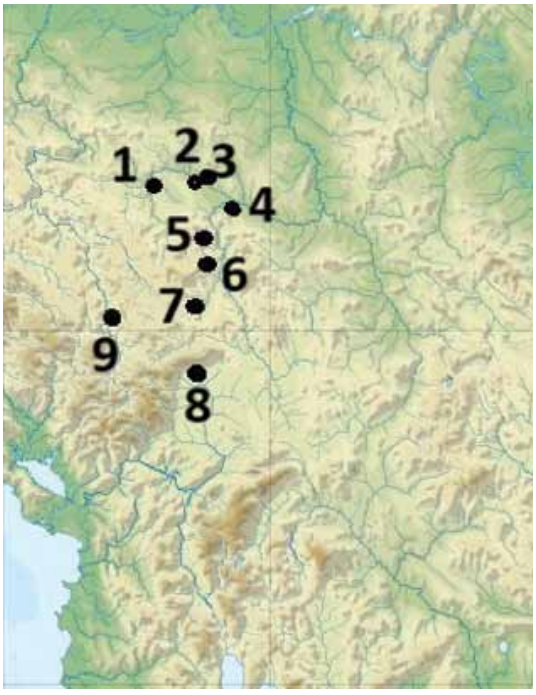


Fig. 4 – Nodes in the West Morava region and its southwestern neighboring area: 1 – Pilatovići; 2 – Atenica, 3 – Mojsinje; 4 – Kraljevo (Žiča monastery); 5 – Studenica monastery; 6 – Kruševica; 7 – Novi Pazar; 8 – Pećka banja; 9 – Lisijevo polje.

The next important point is the surroundings of today's Kraljevo, where the road running trough the valley of West Morava river turns to the south and continues along the Ibar river. In the vicinity of this point, on a dominant hill at the footstep of the mighty mountain massif, the Žiča monastery is located. Žiča is the endowment of the first Serbian king from the Nemanjić dynasty, Stefan the First-Crowned from the first half of the 13th century.[28] Apart from Felix Kanic's statement regarding the remains of a Roman fortification in the vicinity of Kraljevo,[29] the toponyms of Kovači and Kovanluk[30] in the surroundings of the monastery point very likely to a significant archaeological potential of this area.

Continuing along the Ibar road to the south, the next important point is the Studenica monastery, the endowment of Stefan Nemanja, the founder of the Nemanjić dynasty from the end of the 12th century.[31] The road from Studenica runs to the Gradac monastery, the endowment of Queen Jelena from the 13th century,[32] situated on the dominant plain above the Gradac river, on the slopes of the Golija mountain. In the immediate vicinity of the monastery, in the village of Kruševica, an exceptional find of jewelry and dishes from the 5th century BC was found, very likely originating from a destroyed princely tumulus.[33] This area was connected via Čemerno mountain to the Moravica river valley in the northwest, with a large princely tumulus with monumental architecture and extremely rich finds in Pilatovići.[34] It is located at the crossroads right next to the communications that led eastward - over the Krstac and Jelica mountains to the West

[25] Дмитровић, Ћирковић 2024.
[26] Чанак-Медић, Бошковић 1986, 149-157; Рајић, Тимотијевић 2021, 31-37.
[27] Милинковић 2014.
[28] Чанак-Медић et al. 2014.
[29] Каниц 1985, 10, 14.
[30] In Serbian language the literary meaning of these toponymes is tied with the forging activities.
[31] Кашанин et al. 1986.
[32] Кандић 1989.
[33] Срејовић 2002, 272-274, 284.
[34] Zotović 1985, 88-99.

Morava valley (Atenica) and westward - through the Djetinja river valley to Podrinje and further to Glasinac. In the context of continuity with the exceptional prehistoric sites, it is important to point out that about 5 km from Pilatovići, in the town of Arilje, a monastery endowment of King Dragutin Nemanjić from the 13th century have been founded.[35]

Another important point is Novi Pazar, situated on the road that runs from the West Morava valley to the south along the Ibar river. Today's surroundings of Novi Pazar houses several very important sites dating to the period of Serbian early medieval state - Ras, which later became the throne city of the Nemanjić dynasty in the 12th and 13th centuries.[36] In this environment, a special place has the early medieval St. Peter's church,[37] built over the princely Iron Age tumulus with extremely rich findings.[38] In a wider circle, important spot in communication networks where exceptional prehistoric and medieval sites intertwine are located in Pećka banja[39] (Patriarchal monastery of Peć)[40] and Lisijevo polje near Berane (Ivangrad)[41] (Đurđevi Stupovi monastery).[42]

Discussion

The described routes and important nodes on them were formed according to the natural features of the terrain, and after the archaeological findings, these are defined as communications used in prehistoric times and in later periods. Of particular interest are the crossroads, which have maintained an important role for many centuries and are characterized by the existence of exceptional archaeological sites.[43] The sites where princely graves from the Iron Age were discovered in combination with exceptional Roman or medieval sites are Atenica (Mojsinje, Roman fortification and settlement, Morava Gradac, Gradina on Jelica), Kruševica (Gradac monastery), Novi Pazar (St. Peter church), Pilatovići (Arilje), Pećka banja (Patriarchal monastery of Peć) and Lisijevo Polje (Djurdjevi Stupovi monastery). For the establishment of medieval Serbian monasteries, an open, dominating location with drinking and running water, solid building ground and an older cult site near important roads and crossroads that connected the internal network of settlements were usually chosen.[44] In the vicinity of Žiča or Studenica, no particularly prominent finds from the Bronze or Iron Ages there are familiar, but the extraordinary importance of this landscape is confirmed by the medieval monasteries of the highest status.

The mutual distance between the described nodes is between 30 km and 60 km. In the context of caravan daily transportation, which is approximately 30 km,[45] they can be assumed as points where transport animals spent the night and changed. In addition, it is very likely that trade and craft activities could have take place as various social gatherings important in the process of information, ideas and technologies transfers, which altogether influenced the settlements foundation. The use of cult places in trading is a familiar phenomenon, and in addition to

[35] Војводић 2005.
[36] Popović 1999.
[37] Marković, Vojvodić 2021.
[38] Mano-Zisi, Popović 1969; Babić 2015.
[39] Palavestra 1997.
[40] Ђурић et al. 1990.
[41] Срејовић 2002, 255-259.
[42] Тодић 2011.
[43] Diaz-Guardanime et al. 2015.
[44] Поповић 1994, 67-71.
[45] Ферјанчић et al. 2008, 11.

the already mentioned functions of the space, the centers of political power in that area can also be expected.[46]

In the Roman system, supply bases along with the military resources and settlements spread in about 50 km of distance.[47] The organization of contacts, travel and trade during the Iron Age must have had a completely different concept from the caravan trade during antiquity or the Middle Ages, which was of vital state interest and implied good organization and institutions.[48]

If we take into account that the mentioned localities are distributed in the territory of Glasinac - Mati complex during the Early Iron Age,[49] it can be assumed that within that large community, characterized by a great similarity of material culture, existed smaller, regional groups. They had power on certain territories and controlled roads, possibly resources,[50] and their seats can be assumed within these nodes. Parallels from Western and Central Europe clarify their concept,[51] and could clearly instruct researchers in detecting such a settlement in our region as well.[52]

The contents of princely tumuli from Atenica, Novi Pazar, Pilatovići, and probably also Kruševica are in close relation with the existence of strong local political centers of power. Numerous luxury items of mostly Greek, sometimes Etruscan, and even of Egyptian provenance played an important role in the process of exchanging prestigious goods.[53] Their symbolic role in the funeral cult, from which they are only known so far, was aimed at distinguishing and emphasizing the status of the ruling elite from the other contemporaries. The cessation of the princely mounds erection during the first decades of the 5th century BC was not the end of their existence. Undisturbed princely tumuli became a non-divisible part of the landscape for many centuries,[54] as confirmed by continual use.

By defining the roads and nodes several important assumptions can be determined: the nodes were organized at a distance of about 30 km and represented important points on the ancient road network. In addition to the place for a break, trade, craft and other social activities, in the immediate vicinity settlements with certain administrative and political functions where the local elite resided can be expected. The emergence of important religious, military and administrative centers in the same area during the Roman or medieval period underlines the supremacy of geomorphological predisposition and tradition in networks.

Nodes as focal destinations in life of the Iron Age population in the West Morava region and its southwestern neighboring areas can be the basis for the future discovery of new localities, especially settlements or perhaps new princely tumuli, assumed in the vicinity of the Žiča or Studenica monasteries. A similar method could be suitable in defining nodes to the north or east of the West Morava region, where a completely different cultural character have been identified.[55]

[46] Potrebica 2013, 80.
[47] Rizos 2013, 681.
[48] Palavestra 1994, 53-54.
[49] Čović 1987.
[50] Popov 2018, 204-207.
[51] Palavestra 1994, 50; Бабић 2008, 79; Potrebica, Pravidur 2022, 174, Figure 9.19.
[52] Срејовић 2002, 286. Srejović lists two potential settlement locatios near Kruševica.
[53] Babić 2002; Potrebica 2013, 83.
[54] Бабић 2008, 80-81.
[55] Vasić 1987.

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Pins from the Late Bronze Age Ulanci Group

Zlatko Videski[1]

Abstract: A new picture of the Late Bronze Age of the Ulanci group has been obtained through the excavations of the cemeteries Dimov Grob v. Ulanci-Gradsko, Vodovratski Pat v. Vodovrati-Gradsko, Mali Dol v. Tremnik-Negotino and Manastir – Chashka-Veles. These excavations provided a wealth of archaeological material, which in turn allowed for initial more detailed studies of the development, distribution and function of individual groups of archaeological objects. Here we will focus on the large number of newly discovered pins, which represent an important corpus of finds, and which were mostly discovered at the Dimov Grob cemetery in closed archaeological complexes-graves. So far, over forty pins have been discovered, the main feature of most of them is that they are part of a large group of pins with a perforated neck. All discovered pins are dated to the Late Bronze Age, and as forms are widely distributed in Central Europe. But there are variants of pins which, despite being typically Central European, no longer have their classical characteristics and form their own local features. It is also important to emphasize that the pins of the Ulanci group represent a border zone, since they correspond to the southernmost borderline of the distribution of the corresponding pin types of northern origin, and temporally correspond to the last phase of their use further north.

Key words: Ulanci group, cemetery Dimov Grob, Pins, pins with a perforated neck, long-distance connections

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With the exception of some incidental findings and small archaeological excavations from the second half of the twentieth century, archaeological excavations of the Late Bronze Age in the Republic of North Macedonia have been carried out in the last twenty years. A new picture of the Late Bronze Age of the Ulanci group has been obtained through the excavations of the cemeteries Dimov Grob v. Ulanci-Gradsko,[1] Vodovratski Pat v. Vodovrati-Gradsko,[2] Mali Dol v. Tremnik-Negotino [3] and Manastir – Chashka-Veles.[4] These excavations provided a wealth of archaeological material, which in turn allowed for initial more detailed studies of the development, distribution and function of individual groups of archaeological objects. Here we will focus on the large number of newly discovered pins, which represent an important corpus of finds, and which were mostly discovered at the Dimov Grob cemetery in closed archaeological complexes-graves. The pins made it possible to trace the main characteristics of the funeral costume, and how it was reflected in the funeral custom, in the expression of social identities and long-distance relationships.



Fig. 1 – Pins from cemetery Dimov Grob: 1. grave 95; 2. grave 23; 3. grave 47; 4. grave 26; 5. grave 56; 6. grave 30; 7. grave 71; 8. grave 17.

The initial observations on the pins of the Ulanci group were made by Rastko Vasić in the monograph "Die Nadeln im Zentralbalkan" from the series Prahistorishce Bronzefunde, which presents some older discoveries and only a few pins from the cemetery of Dimov Grob.[5] In the meantime, new pins have been discovered, both at the cemetry Dimov Grob and at other cemeteries, which allow us to make a new typological analysis and chronological determination. This analysis of the pins is necessary for a stricter chronological sequence of the specific cemetery, and is also essential for the general chronology and cultural development of the Ulanci group.

[1] Видески 2022;

[2] Митревски 1997, 285-286;

[3] Папазовска 2019, 121-152;

[4] Јовчевска 2008;

[5] Vasić 2003, 30-31, 35, 93-94;

So far, over forty pins have been discovered, the main feature of most of them is that they are part of a large group of pins with a perforated neck. With the exception of two pins with a body with a square cross-section, all other pins from the Ulanci group are versions of pins with a body with a circular cross-section. The shape of the head and body, the position of the perforation of the elongated swelling and the type and placement of the decoration allow for many types and variants to be distinguished. (Fig.1) All discovered pins are dated to the Late Bronze Age, and as forms are widely distributed in Central Europe. But there are variants of pins which, despite being typically Central European, no longer have their classical characteristics and form their own local features.

First, we will consider the pins with a biconical head, with a perforated elongated swelling on the neck and a circular cross-section of the body (Lochhalsnadeln mit doppelkonischem Kopf und rundem Schaft). Three of the four pins were discovered at the Dimov Grob cemetery from graves 23 (Pl. 1,1), 26 (Pl.1,2) and 95 (Pl. 1,3), and one at the Mali Dol cemetery, from grave 43 (Pl. 1,4). It is noticeable that in the space between the head and the swelling, a small flat and sharp biconical bead is placed, which resembles a disk. The decoration is made with groups of horizontally engraved lines, decorating the head, the perforated swelling and the biconical bead. The pin from grave 23 of Dimov Grob and the pin from Mali Dol are undecorated variants, the pin from grave 26 of Dimov Grob does not have a biconical bead. All pins were found in male burials. The pins of this group are locally produced products, imitating the Paarstadl type, which is widespread in central Europe, where the type is dated to the Lohharn phase (Bz B) of the Tumuli culture, and originates from the northwestern Carpathian Basin.[6] Vasić dates the pin from grave 26 at Dimov Grob to the LH III B period.[7] These pins can be associated with southern influences of the Tumuli culture, so our samples would represent the southernmost borderline of the distribution of the Paarstadl type.

A variant of the group of pins with a double conical head are the pins with a rounded conical head (Kugeligem kopf nadeln), which are identical in appearance to the pins with a double conical group. Four pins were discovered, two from Dimov Grob, a bronze one from grave 47 (Pl. 1,5) and the bone pin from grave 100 (Pl. 1,6), and one specimen each from Mali Dol from grave 20 (Pl. 1,7) and Manastir Chashka (Pl. 1,8). The pin from grave 47 from Dimov Grob and the pin from grave 20 from Mali Dol have an elongated swelling on the neck that is perforated, and a decoration on the neck made with a group of horizontal lines is observed on the pin from Dimov Grob from grave 47, and on the pin from Mali Dol the decoration with a group of horizontal lines is made on the perforated elongated swelling. On the pin from Manastir Chashka the perforation is made on the biconical bead, which is located immediately below the rounded head of the pin. The pin from grave 100 from Dimov Grave is made of bone, has no decoration and is not decorated, but instead of the elongated swelling there is a recess made for hanging the pin, it should also be noted that there is no biconical bead, but a circular bead on the neck above the elongated swelling. These pins were discovered in male burials.[8]

A group of pins with a pressed double-conical head (Nadeln mit doppelkonischen kopf und profililiertem kopfende) is represented by a single specimen that comes as a chance find from the Mali Dol necropolis (Pl.2,1).[9] This group of pins has numerous variants, and the pin from Mali Dol is a variant with a small double-conical head with horizontal ribs performed as a decoration

[6] Vasić 2003, 30;

[7] Vasić 2003, 31;

[8] Видески 2022, 219;

[9] Папазовска 2019, 126-127, T.XXIII 1B; The finds from this accidentally discovered grave were identified by researcher Aleksandra Papazovska as grave 1 at the Mali Dol cemetery.

on the head. This type of pins is widespread in Germany, Austria, Moravia, Slovakia and less frequently in Hungary and Romania. In the Balkans, they have been discovered in Slavonia, Srem, southern Banat and northern Serbia along the Danube. Our pin can be connected to the Morava Valley, especially the areas of Jagodina and Paračin, which represents the center of these pins, but they are smaller heads, so it can be assumed that our pin is also part of this regional group. Chronologically, this group of pins belongs to the older and middle Urnenfield, which corresponds to the end of the Br D stage.[10] As a variant of this group, the pin from the chance find from Fortuna Štip (Pl. 2,2) [11] should be added, which has a double conical head with a slightly depressed tip, it has no decoration.

The second group is represented by pins with a small nail-headed pin (Nagelkopf nadeln). These pins are part of a large family, the main characteristic of which is the expanded flattened head. In the Ulanci group, seven pins were discovered, three pins from Dimov Grob from graves 45 (Pl. 2,4) and 105 (Pl. 2,5), which are bronze, and from grave 31 (Pl. 2,3), which is made of bone, three pins were discovered at Mali Dol, one from grave 30 (Pl. 2,6), a pair of pins from grave 85 and one pin from Manastir Čaška (Pl. 2,7). The pins from graves 45 and 31 from Dimov Grob have an almost identical appearance, with perforation on the elongated swelling of the neck and a small flat and sharp biconical bead placed under the head, which resembles a disk. The decoration is made with groups of horizontal lines, made on the neck and the elongated swelling. These pins were discovered in male burials.[12] From Manastir Čaška comes one pin with a small head – a nail, unperforated and undecorated body. The pin from grave 105 from Dimov Grob, in addition to the head – nail, has a decoration made in the technique of torq on the neck. The pins from Mali Dol grave 85 represent a kind of rudimentary variant of this type of pin, with a not so precisely made nail head and a large rounded biconical bead on the neck and no perforation. The discovered pair of pins from grave 85 was discovered in an urn with a cremated deceased, and are identical to the pin from grave 30, which was discovered with an inhumed deceased buried in a stone cist, this shows the popularity of this variant in the necropolis.[13] The pins from Mali Dol and the pin from grave 105 from Dimov Grob were discovered in female burials.[14]

A popular variant of the nail-headed pins are the pins with a strongly emphasized biconical bead placed on the neck, and a perforated elongated swelling. Two pins were discovered at Dimov Grob in graves 104 (Pl. 2,8) and 129 (PL. 2,9), and one each from Manastir Chashka (Pl. 2,11) and from grave 28 (Pl. 2,10) from Mali Dol. The decoration is made with groups of horizontal lines placed on the large biconical bead and the elongated swelling, or on the neck as on the pins from grave 104 from Dimov Grob and Manastir Chashka. Decoration made with plastic ribs is presented on the pin from grave 129 from Dimov Grob, with one rib on the neck and two ribs placed under the large biconical bead. On the pin from grave 28 from Mali Dol the rib decoration is made on the perforated elongated swelling. This variant with a pronounced biconical bead shows the local development of the nail-headed pins, in which the small biconical bead enlarged to such a proportion that it became the main decorative motif of the pin. The pinss were discovered on male deceased.[15] The nail-headed pin type is widespread in western and central Europe and the Carpathian Basin and is influenced by the Tumuli culture. Chronologically, they appear as early as the Middle Bronze Age, and are found throughout the Late Bronze Age.[16]

[10] Vasić 2003, 74;

[11] Гарашанин и др. 1971, 19, кат.бр. 217c; Kilian 1975, 82, Taf. 43,3;

[12] Видески 2022, 219;

[13] Grave 85 has not been published, the information was received from cemetery researcher Aleksandra Papzovska.

[14] Папазовска 2019, 133; Видески 2022, 219;

[15] Папазовска 2019, 132; Видески 2022, 219;

[16] Vasić 2003, 32

Another large group of pins present in the Ulanci group are the club-headed pins (Nadeln mit keulenformingen kopf), which are characteristic forms of the Late Bronze Age. The pins that we will consider here are three examples, one pin from grave 76 from Dimov Grob (Pl. 3,1), and a pair of pins from grave 29 from Mali Dol (Pl. 3,2). In these pins, the decoration is placed on the head, on the pin from Dimov Grave the decoration is made with horizontal lines, and on the pair of pins from Mali Dol, one pin has a decoration of groups of horizontal lines, and the second groups of oblique lines that form a chevron pattern.[17] In these pins, there is no biconical bead and perforated elongated swelling, and it should be noted that these pins were discovered in damaged burials, in which there were osteological remains of female deceased.

A fairly popular variant of the club-headed pins in the Ulanci group are the funnel-headed pins (Trichterkopf nadeln). This group is represented by six specimens, of which the pins from Dimov Grob from graves 30 (Pl. 3,3), 71 (Pl. 3,5) and 102 (Pl. 3,6) and the accidental find of the pin from Ratkin Dol – Negotino (Pl. 3,7)[18] have a hollow cast head, and the pin from Dimov Grob from grave 56 (Pl. 3,4) and the pin from Manastir Chashka (Pl. 3,8) have solid cast heads. All pins have a perforated elongated swelling. The pin from grave 71 from Dimov Grob also has a biconical bead under the head. The decoration made with groups of horizontal lines placed on the head, the biconical bead and the perforated elongated swelling is present in the pins from graves 71 and 56 from Dimov Grob, and the pin from Ratkin Dol - Negotino. The pin from grave 71 of Dimov Grob has a decoration of hatched hanging triangles on the head. The pin from grave 30 of Dimov Grob has ribs on the head as a decoration. The pin from grave 102 of Dimov Grob and the specimen from Manastir Čaška have no decoration. Another pin is known from the southeastern cemetery of Skupi near Skopje, which is identical to the pin from grave 31 of Dimov Grob.[19] This type of pin was discovered on male deceased.[20] The popularity and longevity of this form of funnel-headed pins is also evidenced by a younger variant of a funnel-headed pin from grave 56 from cemetery Suva Reka near Gevgelija, which is dated to the 8th century BC.[21] The dating of the group of club-headed pins is the beginning of the Late Bronze Age (Bz D to Ha A I), and the distribution is wide from Bohemia, Moravia, Slovakia, Austria, Bavaria, western Hungary, Slavonia, northern and eastern Bosnia and Romania. In Serbia, it occurs in Srem, Banat and northern Serbia and sporadically occurs in the Drina and Morava valleys,[22] and with new discoveries, the Vardar valley as well.

Another group of pins present in the Ulanci group are members of the large group of pins with a spiral head (Rollenkopf nadeln). Represented by three specimens, the pin from grave 16 from Mali Dol (Pl.4,1), then the pin from the pile-dwelling settlement of Mrdaja near Dojran (Pl. 4,2) and the fragmented pin from grave 93 from Dimov Grob (Pl. 4,3). The pins from Mali Dol and Dimov Grob have a square cross-section of the body, on the pin from Dimov Grob the spiral head is broken off, but part of the hammering of the head, which has a thin plate-like shape, is preserved, which allows us to determine the type of this pin. The square cross-section of the body represents the older variant of the pins with a spiral head, which can be dated to the Middle Bronze Age.[23] The pin from Mrdaja has a circular cross-section of the body. The head of the two

[17] Папазовска 2019, 134, T.XXIII 1ѓ;

[18] The pin from Ratkin Dol - Negotino has not been published and is a accidentall find, the information was received from Stojanche Atanasov, curator at the Negotino Museum.

[19] Јованова 2015, 18; The pin from the Southeastern cemetery of Skupi has not been published, the information was received from cemetery researcher Lence Jovanova, curator at the Museum of the City of Skopje.

[20] Видески 2022, 219

[21] Vasić 2003, 94-95;

[22] Vasić 2003, 85-86;

[23] Vasić 2003, 21;

pins that are preserved is thinly hammered and wound in a single thread, and both pins have a curved body. There is no decoration on this type of pins. They are widespread in Western, Central and Northern Europe and the Balkan Peninsula, and due to their simple form they were produced everywhere. They appear around the beginning of the Bronze Age and remained in use until the end of the Iron Age.[24]

The spherical-headed pins (Kugelkopf nadeln) are a group of pinss that are represented in the Ulanci group. Two specimens were discovered, from Dimov Grob from grave 17 (Pl. 4,4) and the pin from grave 58 (Pl. 58), which is made of bone. The pins are almost identical although they are made of different material, the spherical head has small perforations, the pin from grave 17 has a small biconical bead on the neck, which is not perforated. The bone pin from grave 58 has a perforated elongated swelling on the body. The pins have good parallels with the pins discovered at the Livadia cemetery near Ajane in the region of northwestern Greece. Several such spherical-headed pins were discovered there, several of which were discovered in pairs. Chronologically, the Livadia pins are placed in the LH III A period.[25] While in central Europe (Bohemia, Moravia, Austria, Slovakia, Hungary) spherical-headed needles belong to the early Urnfield period, and in isolated cases they are also known from later periods.[26]

As a group that is characteristic of the Ulanci group, pins with a discoid head stand out, with an elongated swelling on the neck (Nadeln mit flächem scheiben kopf und oval halsverdickung) and a small flat and sharp biconical bead, resembling a disk, is made under it. In the literature, this group of pins is known as the Fortuna type, as Rastko Vasić called them, according to the accidental find from Štip.[27] However, during the research of the Dimov Grob cemetery, as many as seven pins of this type were discovered, of which three pairs in graves 54 (Pl. 4,6), 73 (Pl. 5,1) and 80 (Pl. 5,2) and one single pin from grave 97 (Pl. 5,3), one pin was accidentally discovered in the village of Beli near Kočani (Pl. 6,2), a pair of accidentally found pins come from the Mali Dol cemetery (Pl. 6,3) and together with the pair of accidentally found pins from Fortuna near Štip (Pl. 6,1), a total of 12 pins have been discovered so far, of which as many as five pairs of this type. The largest number of newly discovered pins and the only preserved archaeological context of their discovery was recorded only at the Dimov Grob. The three pairs of pins were discovered in the richest female burials, two pairs from graves 54 and 80 together with the famous belts with labrys, due to which these graves stood out as a special group of burials of priestesses.[28] Another characteristic of this group of pins is the place of their discovery in the graves. All



Fig. 2a – Cemetery Dimov Grob, the discovered pins in a costume position - crossed on the chests, grave 54.

[24] Vasić 2003, 20;
[25] Karamitrou-Medesidi 2002, 601-603, fig.14;
[26] Vasić 2003, 53;
[27] Vasić 2003, 92-93;
[28] Видески 2022,201-203;

pairs of pins were discovered crossed on the chests of the deceased, (Fig. 2 a,b) and the single pin discovered in grave 97 was also discovered crossed on the chests. The pins are of a distinct length, the pins from grave 54 are 29 cm long, from grave 73 – 31 cm (Fig. 3,2), from grave 80 – 32 cm (Fig. 3,1), the single pin from grave 73 is 20 cm. The other pins are of shorter length, the pins from Fortuna are 18.8 cm long, the pin from Beli -20 cm, one pin from Mali Dol is 14 cm long, and the second one, which is fragmented, is 11 cm long. The decoration is identical in all pins, and is performed on the elongated swelling, which is framed on both sides with a group of horizontal lines, and on the swelling itself there are several vertical lines. (Fig. 4) The biconical bead is decorated with groups of horizontal lines. The great uniformity of the pins is surprising, according to which the pins from Dimov Grob from graves 73 and 80 seem to be made from the same mold.



Fig. 2b – Cemetery Dimov Grob, the discovered pins in a costume position - crossed on the chests, grave 80.



Fig. 3 – Cemetery Dimov Grob, pins with a discoid head, with an elongated swelling on the neck: 1) grave 80, 2) grave 73.

According to the place of their discovery and the function they had in the funerary custom, this type represents the only pins discovered in the rich female burials which, together with the labrys belts, certainly had a certain role in the conduct of the cult and rituals. According to the specific length, the place of placement of the costume and the discovery in pairs, they were hardly part of the everyday costume, but rather objects that were worn on special occasions and represented status symbols that showed the higher social status of their wearers. The wearers of these pins would represent a small specialized social group of religious - civil leaders who maintained the cultivation of traditional social values.[29] The large number of newly discovered pins, their role in the funerary custom, together with the identical typological characteristics, distinguish these pins as a special local feature of the Ulanci group. Thus, the previous dating of the Fortuna pins by K. Kilian and M. Garašanin in the first phase of I B of the Macedonian Iron Age or at the

[29] Videski 2024, 155-157;

end of the 9th and beginning of the 8th century BC,[30] this group of pins should also be corrected to be placed in the Late Bronze Age. At the same time, the name of these local pins should also be changed to the Ulanci type. The origin of this type of pins should perhaps be sought in the group of pins with a conical head and an updated elongated swelling from Glogović – a pair of pins and Iglarevo – which is also a pair but with a different pins. These pins originate from the Middle Bronze Age and precede the pins from the Ulanci group, and are widespread in the area of southern Serbia and Kosovo.[31] It should be noted that they were also found in pairs, in inhumed female burials, as is the case in the Ulanci group, whose pins would represent a local variant of this older group of pins.

At the Dimov Grob and Mali Dol cemeteries, which have been fully explored, a complete anthropological analysis of the skeletal material was carried out,[32] and the burial custom was established, which allows us to determine the gender identity and appearance of the costume of the wearers of the Ulanci group pins. Thus, pairs of pins and a small number of individual pins are characteristic of the women's costume, and it should be noted that the pins are not perforated. Another feature is that the pins in the graves were discovered in a costume position, in the place where they were worn in life, as fasteners for the costume, which is visible from the group of pairs of pins with a flat disk on the head and an elongated swelling on the neck from Dimov Grob.[33] (Fig. 2 a,b) It should be noted that the biconical bead in these needles is placed under the swelling that is a feature of the women's costume. The men's costume is characterized by the placement of one perforated pin, in which the perforation is placed on the elongated swelling. Unlike the female costume, the pins from the male costume were not discovered in a costume position, but as part of a toilet set, consisting of a pin, a knife and a whet stone, which was placed next to the palms of the crouched deceased.[34] (Fig. 5) In the male costume, it is noted that many different types of pins are used. The biconical bead of the pins from the male costume is placed above the elongated swelling, which is another indicator of the male costume.



Fig. 4 – Cemetery Dimov Grob, decoration with incising of the pins, from grave 80.



Fig. 5 – Cemetery Dimov Grob, toilet set from the grave 129.

[30] Гарашанин и др., 1971, 17-19, кат. бр. 217 a-b; Kilian 1975, 79-83, Taf. 43, 1-2; Vasić 2003, 94;

[31] Vasić 2003, 66-67;

[32] Вељановска 2000, 159,312-314; Видески 2022, 167-169; Папазовска 2019, 131-133;

[33] Видески 2022, 202-203;

[34] Видески 2022, 218-219;

These are the characteristics of the pins in the costume through which they could define the gender identity of the wearers of the Ulanci group. Gender identity is present in the Ulanci group, and has previously been noted in the funerary custom with the opposite placement of the deceased in the graves and the separation of gender-symbolic standardization of ceramic vessels, which are placed in the graves as grave finds.[35]

The appearance of pins in the Late Bronze Age in the burials of the Ulanci group is part of a common trend originating from Central Europe, which is also found in this period in Italy, the central Balkans, the Aegean and as far as the Near East.[36] The large number of pins, the typological characteristics and the decoration indicate influences and relations with the strong metallurgical centers in Central Europe.[37] On the other hand, the pins of the Ulanci group show a clear local development and characteristics of these northern pin types, which also indicates the existence of local workshops for the production of these pins on the territory of the Ulanci group. It is also important to emphasize that the pins of the Ulanci group represent a border zone, since they correspond to the southernmost borderline of the distribution of the corresponding pin types of northern origin, and temporally correspond to the last phase of their use further north. These influences from central Europe arrived on the territory of the Ulanci group, through the communication networks along the river valleys of the Danube, Morava and Vardar, making the pins stand out as types of finds that have a supra-regional distribution and represent objects through which long-distances connections can be recognize.

[35] Videski 2024, 154;
[36] Kurti 2017, 234;
[37] Ljuština, Dmitrović 2015, 47;

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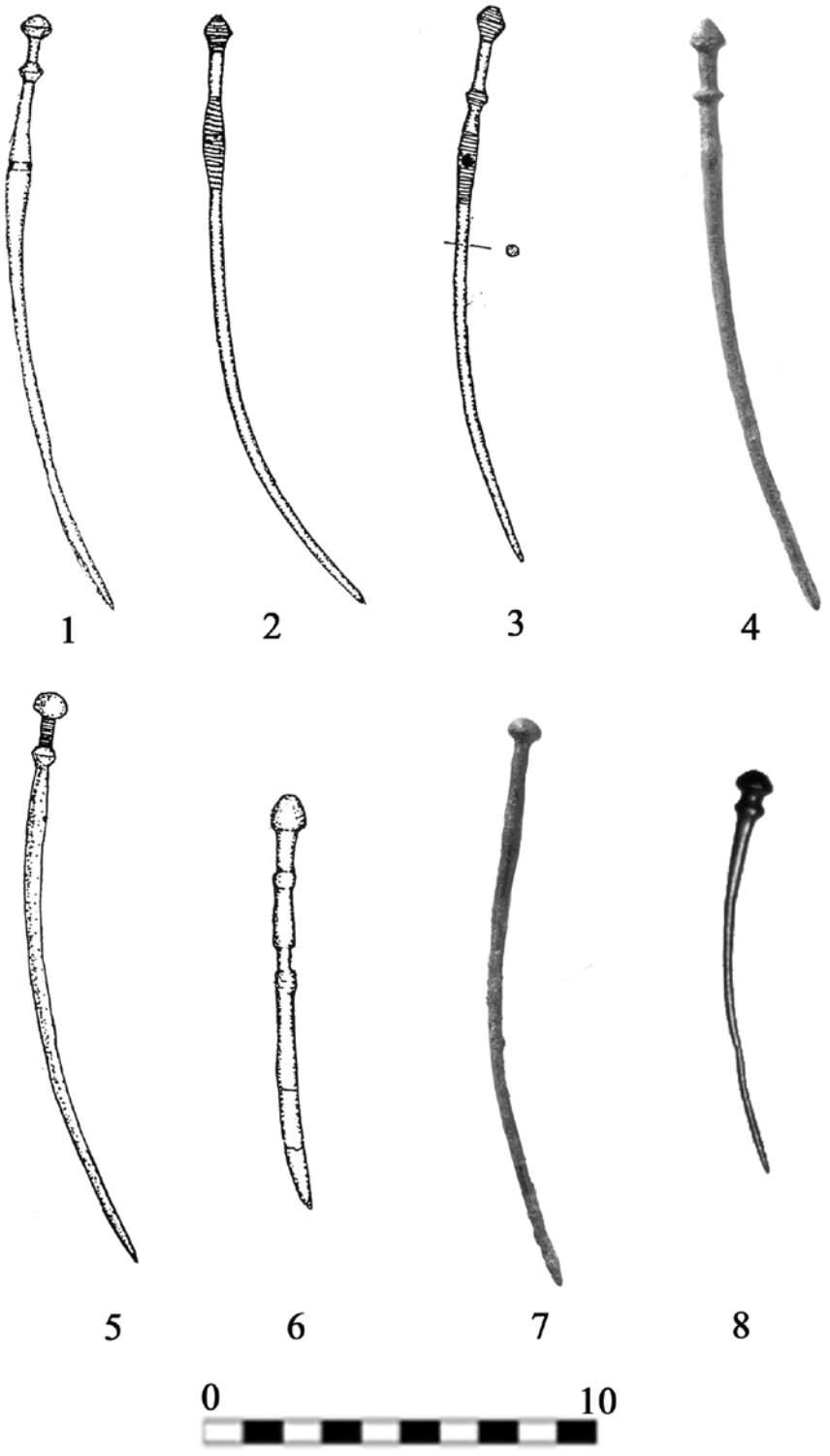
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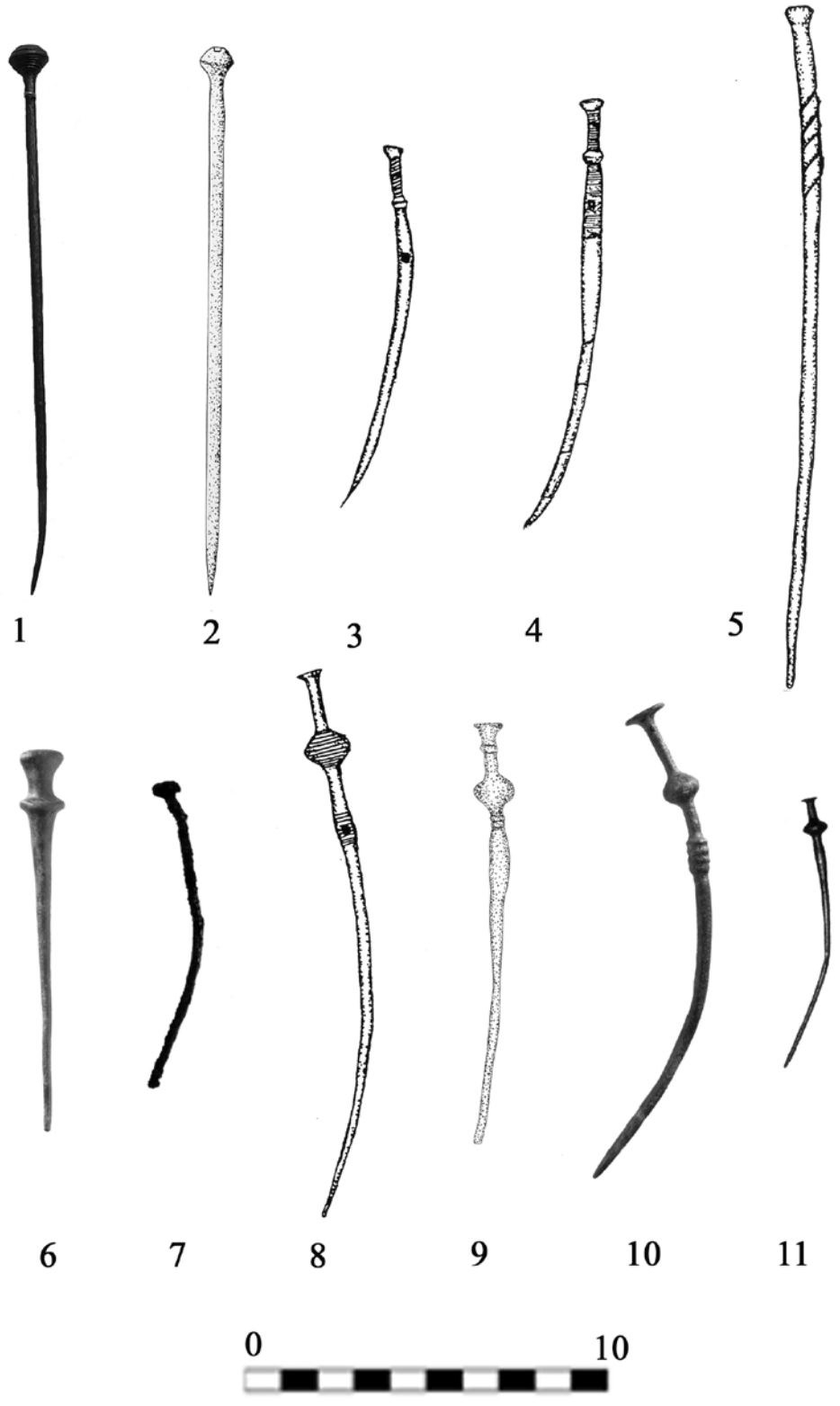
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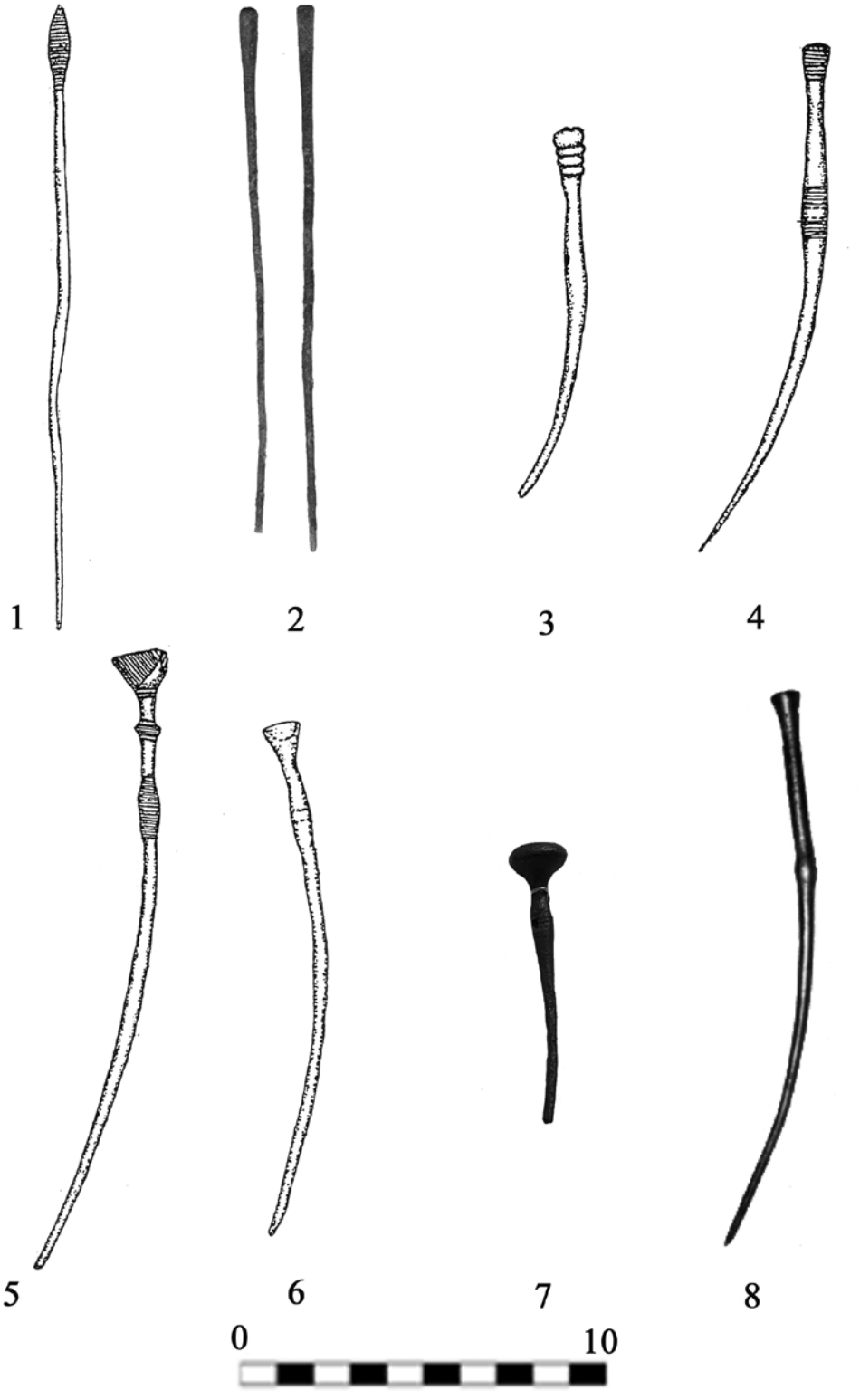
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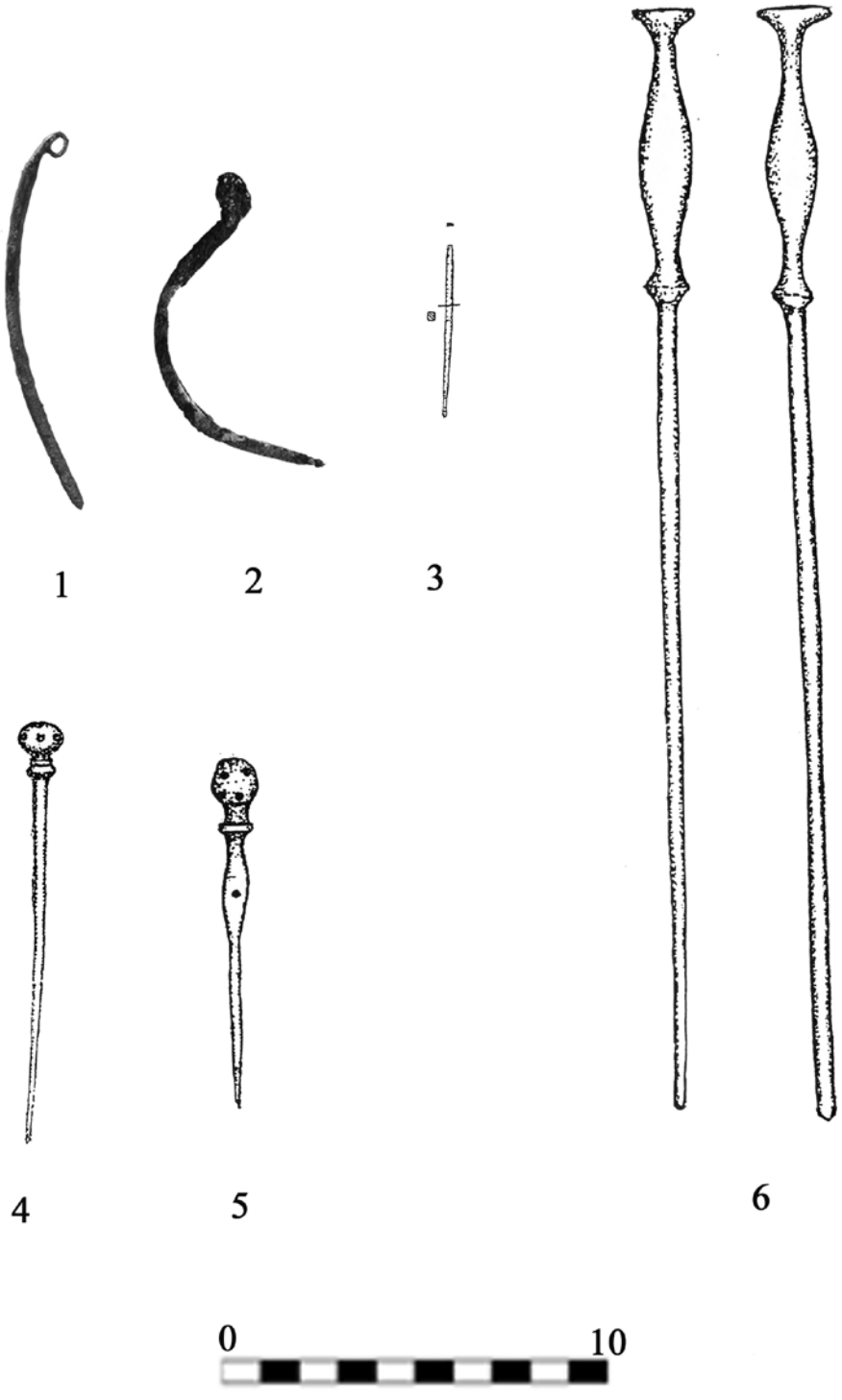
Pl. I



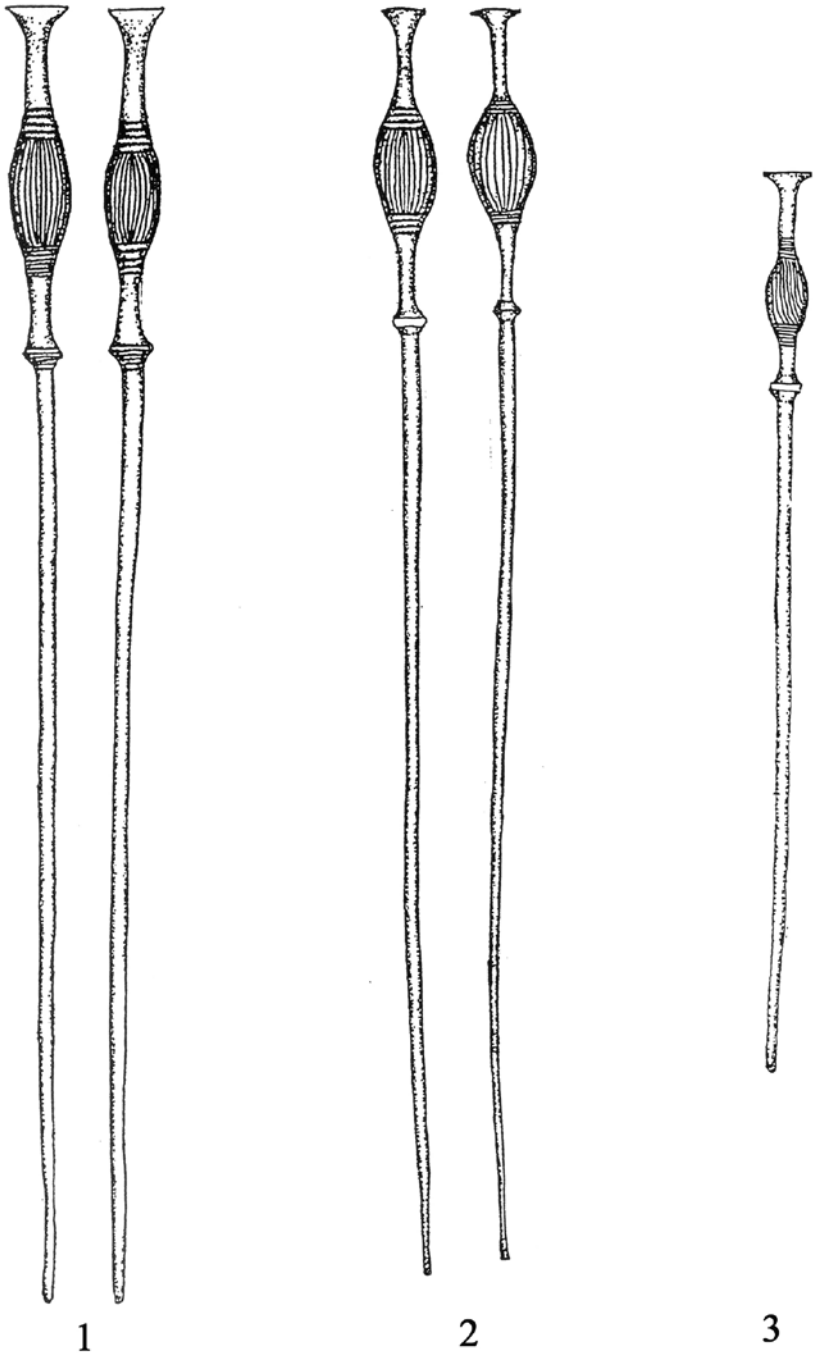
Pl. II



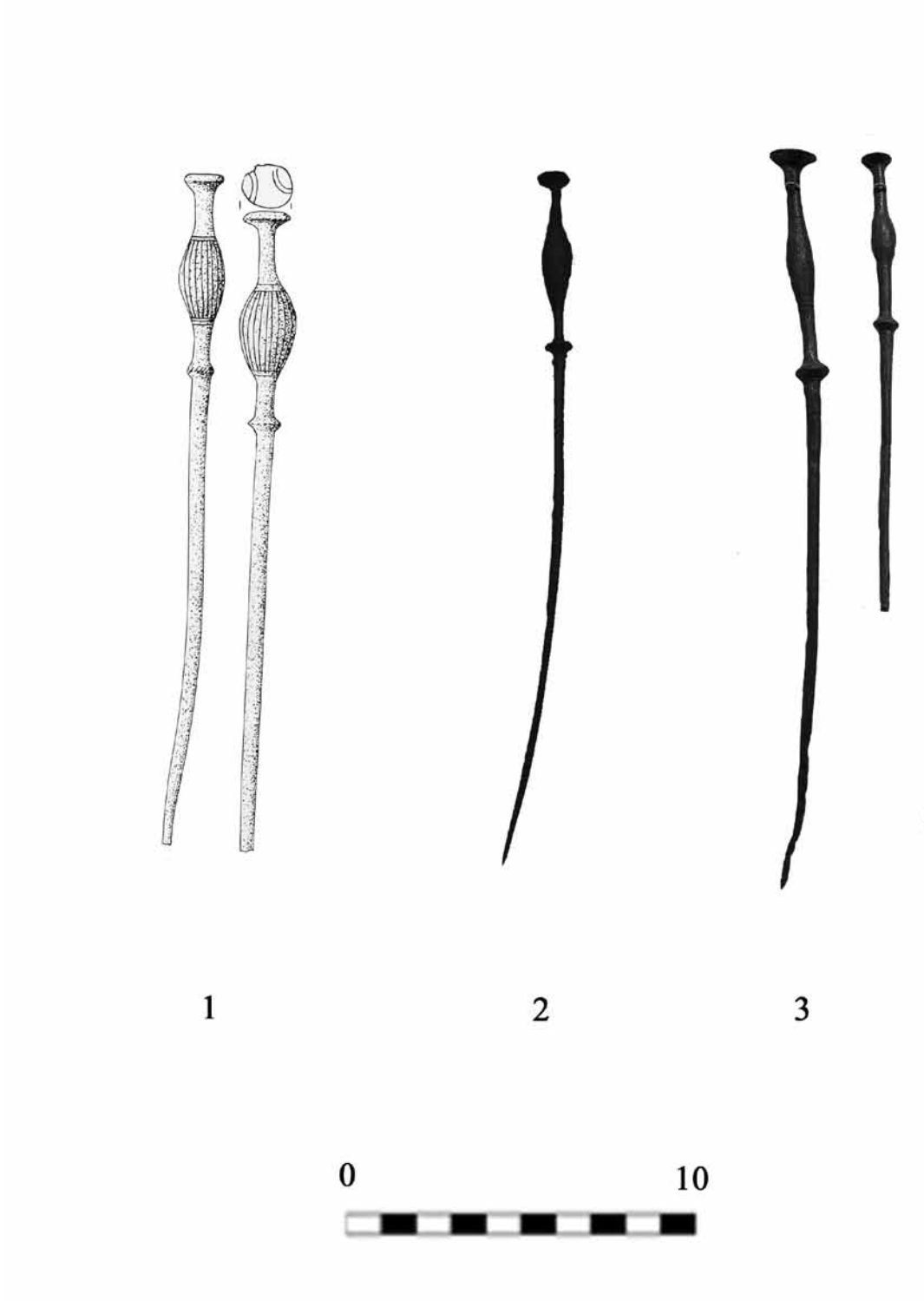
Pl. III



Pl. IV



Pl. V



Pl. VI

How to build a rampart – On the development of complex fortifications in Bronze Age (south-eastern) Europe

Bernhard Heeb[1]
Jochen Schmid[2]

Abstract: Based on the large fortified Late Bronze Age complexes in Banat (e.g. Corneşti-Iarcuri/-Cornet, Sântana), questions arise not only about the communities or culture behind this phenomenon. There are also fundamental questions about the practical organization and technical knowledge required for such construction projects. Who, with what resources, is able to plan, implement and maintain large-scale facilities such as Corneşti-Iarcuri? Based on this approach, the authors would like to take a more general look at whether such complex large-scale projects such as kilometre-long and complex (wood-earth) ramparts were dependent on external specialization (cf. the mud-brick wall of the Heuneburg in Baden-Württemberg or the "Cyclopean Wall" on the Stätteberg in Bavaria) or whether they could have been built solely on the basis of the skills of a local population. In the course of this, chronological and technological considerations are necessary, which can give us information about (Europe-wide?) connections without primarily dealing with the actual find material (especially pottery and bronzes).

Key words: Mega Sites, box ramparts, vernacular archtiecture, chronological aspects, professional craftsmen and planners.

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Topic and hypothesis

Woodworking is possibly the most fundamental and oldest craft that we know of. Potential tools (e.g. wedges, axes and drills) can be found in all epochs: made of stone, bronze and iron. In the following, we will outline which techniques can be recognised as everyday woodworking crafts from the Bronze Age. In contrast to this, individual examples of complex defensive structures in the form of so-called timber box earth ramparts will be analysed, which in their sometimes monumental implementation require a high level of carpentry knowledge and experienced planning as well as logistical skills.[1] In addition, attention is paid to the type of structure of a complex and its staggering, which can also reveal something about the level of planning and its realisation. These specifications lead to the assumption that especially large and complex fortifications of the late Middle Bronze Age, but above all the Late Bronze Age with box ramparts (Holzkasten-Erde-Mauern), could not have been built by a single (settlement) community with everyday craftsmanship alone, but rather that 'specialists' must have been at work. Who they were and where these 'specialists' came from and whether they possibly also worked in different places in Europe is a question that resonates in the background of this article but will hardly ever be answered with certainty.

Basic (technical) considerations

Wooden objects such as plates, spoons, boxes or disc wheels are always something very special in an archaeological context, but can be viewed as more or less everyday objects that do not require any overly complex technical knowledge. In this respect, they cannot be compared with carpentry tasks, which are the main focus of this discussion. Logistically, the production of the above-mentioned items or their procurement are also not particularly challenging. This may

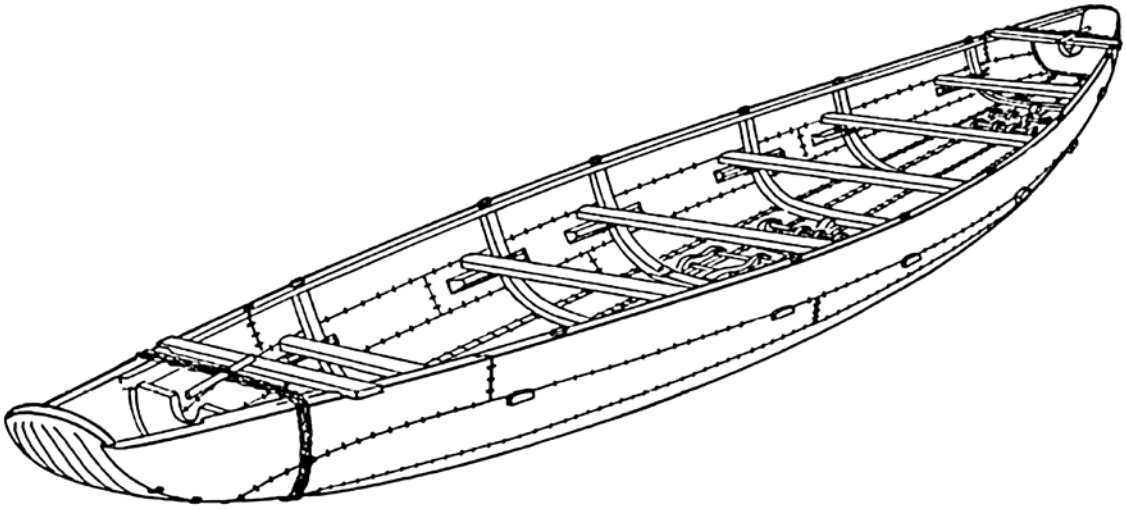


Fig. 1 – Reconstruction of the boat from North Ferriby, GB, ca. 2000 BC (Wright 1990, 86 Fig. 5.2).

look different when it comes to building wells or boats and, above all, house building. In individual cases the archaeological findings indicate what knowledge, skills and techniques were in principle available and, on a different scale, can also be assumed for fortification construction. Shelled well

[1] A distinction must be made between carpentry and joinery. If this craft already existed in a specialised form, the latter would hardly have played a leading role in the construction of complex and monumental wooden architecture.

systems made of planks and mortis/scarph formation have been documented since the Neolithic. Examples of boat building (not dugout canoes) are extremely rare, but in some instances provide detailed information, especially on lacing (Fig. 1). When building a house, you must adopt different techniques, depending on the part of the house under construction. All techniques are also suitable for the construction of ramparts in one form or another. Examples of this have only been preserved in very few cases: in the Middle Bronze Age settlement of Békés (HU), for example, there are burnt sleeper beams of a house that were connected to each other by scarphs (Fig. 2).[2] The effort involved in this technology is low, but the strong intervention in the beam structure

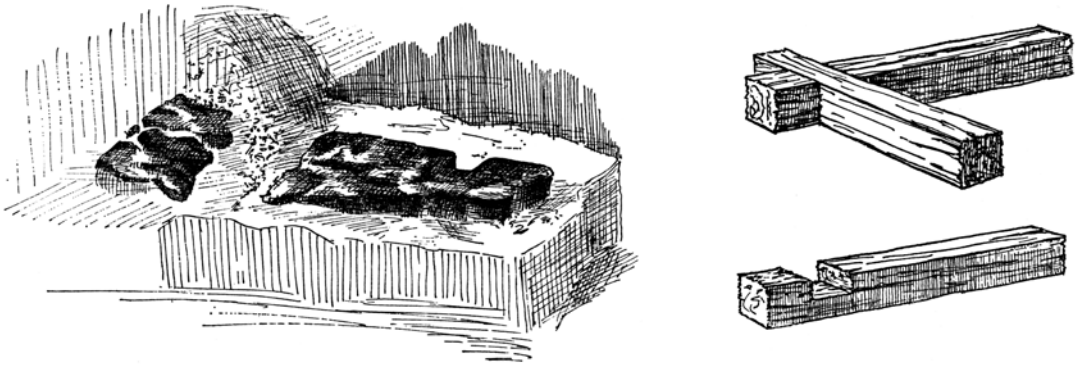


Fig. 2 – Békés, House V, foundation beams, drawing and reconstruction (Banner/Bóna 1974, 37 Abb. 14 a and c).

makes this connection mainly interesting for sleeper beams. However, it can also have been used in box constructions of a rampart system. Most of the time, house reconstruction proposals do not show connection details. On the one hand, certainly because there is no archaeological evidence. On the other hand, it could also be due to the fact that authors have no knowledge of carpentry techniques. Because often the function probably already provides a certain connection (form follows function[3]). More or less wild lacings are often shown or used in reconstructions, even on load-bearing components (Fig. 3), but these are seen as secondary to long-term stability. Especially because there is and has actually been a more solid type of connection for every case. Fastening in large structures is mainly used for small internal structures, such as slats or branches, on which there was hardly any tension or pressure and which had to be connected quickly (perhaps temporarily). For a basic construction of a timber box earth rampart, with assumed bars, struts and posts/stands, on which tons of weight lay due to tension or pressure from the earth filling (see below), ties are certainly out of the question. This assumes scarphs, cambering, offset or mortise, which in turn could be used in numerous sub-variants (Fig. 4).

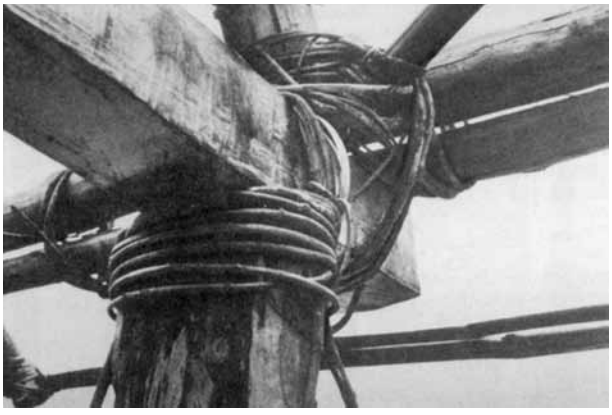


Fig. 3 – Example of tied timberwork (Črešnar 2007, 333 Fig.22).

[2] Banner/Bóna 1974, 37 Abb. 14c.

[3] The American architect Louis Sullivan coined this phrase in his article *The Tall Office Building Artistically Considered* in 1896.

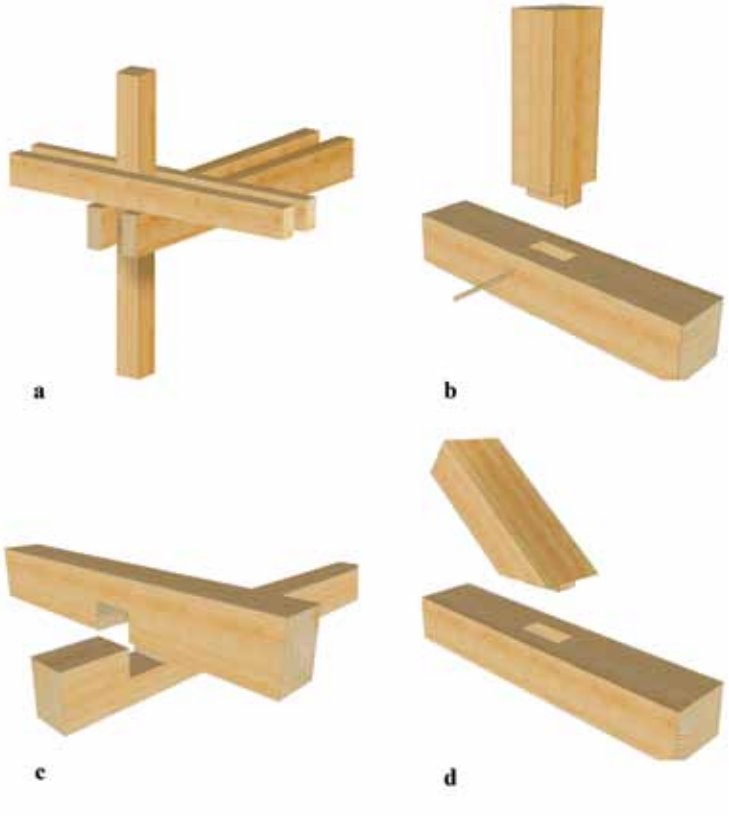


Fig. 4 – Basic and important connection types (Graphic: Daniela Greinert, based on baubeaver, S. J. Schneider and Verband High-Tech-Abbund).

Putting the level of technical consideration in connection with a logistical-construction-planning level leads to the above-mentioned hypothesis of (non-local) "specialists"[4], which cannot be formulated here, but should at least be checked for the possibility: complex fortifications like Iarcuri or Sântana (both RO) require planning and implementation that go beyond the capabilities of individual communities and local knowledge. Similar to how master builders and stonemasons travelled through Europe for large building projects in the Middle Ages, there may also have been wooden construction specialists who offered their services in the construction of large fortifications in the Bronze Age. The large number of fortifications in Central Europe alone shows that there may well have been demand for such specialists.[5] In this context, the question arises as to whether the transfer of knowledge and technology through complex buildings across large parts of Europe can be proven or at least made plausible? A parallel to traveling craftsmen from the Middle Ages is not a new idea, but it has so far been, in our opinion, not applied to prehistoric "architecture." We generally assume, often unspoken that prehistoric building was mostly "planned" and carried out more or less individually. This means "vernacular architecture".[6] But if you look at complex fortifications from the late Middle and Late Bronze Age, then you have to doubt this simple picture. "Cyclopian" stone walls are excluded from this consideration.[7] It is limited to wood crafts and only includes box ramparts.

[4] The fundamental question remains as to whether they were migrating specialists or whether it was only the knowledge that travelled or was passed on over many stations. However, it is not possible to discuss this in detail in this article.

[5] An overview work by Becker 2021 lists 212 Bronze Age "Burgwälle" for the Transylvanian Basin and parts of the Banat to the west alone. If you were to add others e.g. from Hungary, Austria, southern Germany and the area of Lusatian culture (s. Fig. 5), which probably also had a variant of the timber box earth ramparts, then you would certainly have to count on several hundred more or less complex and large systems for the period between the 15th and 9th centuries BC.

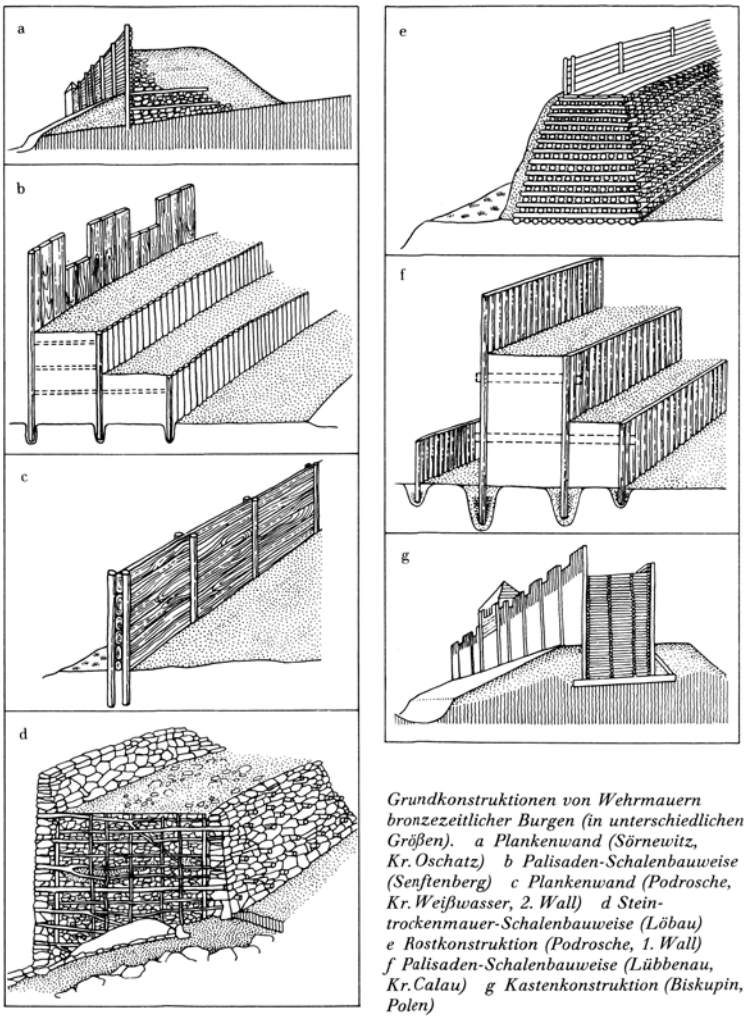
[6] Includes indigenous building, which develops on the basis of independent traditions instead of going back to concrete planning by an architect (see Rudolfsky 1964). The authors would like to take this opportunity to thank Ruben Wehrheim M.A. for sharing his thoughts on the subject of vernacular architecture, as he has dealt with this topic in his recent dissertation specifically on Bronze Age house construction.

[7] If you look at the Stätteberg (Bavaria), Spišský Štvrtok (CZE) or Góra Zyndrama (P), then the walls of Mycenae and Tiryns quickly come to mind as a comparison. But purely structurally and chronologically, the Greek castles are not suitable as a model (Alusik 2012) for the Central European variants. Nebelsick et al. 2022, 25 attribute these "cyclopean walls" (using the Stätteberg as an example) more to "expertise" from the northwestern Adriatic region (cf. the "Castelliere" in Monkodonja, Croatia).

Corneşti-Iarcuri - A major project with numbers and facts

For this overview, the box ramparts can be divided into various rough basic types. Excessively detailed considerations make no sense at this point because preservation, excavations and documentation, if available, are never actually high-resolution enough for detailed considerations. A fairly old illustration by Joachim Herrmann from 1989 helps with a simple typification (Fig. 5). Although it only refers to Late Bronze Age fortifications in the area of the former GDR with neighbouring Poland, it is ideally suited for clarification. The variants b, f and g are considered as possible construction types. Basically, these are different box constructions, not simple palisades or post walls with earth embankments in front and behind them or similar.

If one considers the complexity of an entire fortification (gates, line of ramparts, gradation, etc.), then the Bronze Age highlights include Iarcuri, Sântana and, to a certain extent, Csanádpalota (HU) (Fig. 6a-c) with their structured fortification systems. Whether the Bullenheimer Berg (Bavaria)[8], Bernstorf (Bavaria)[9], Stillfried (A)[10], the Heuneburg (Baden-Württemberg)[11] or the "Römerschanze" near Postdam (Brandenburg)[12], just to name a few examples with probable timber box earth ramparts, were thought to be similarly complex, cannot be determined precisely today. Some settlements, such as Montlinger Berg (CH)[13], probably had a similar construction method, but cannot be described as a complex system in its form of a simple sectional rampart. It didn't require much strategic planning, especially since the material requirements were significantly smaller. Nevertheless, knowledge of the basic



Grundkonstruktionen von Wehrmauern bronzezeitlicher Burgen (in unterschiedlichen Größen). a Plankenwand (Sörnewitz, Kr. Oschatz) b Palisaden-Schalenbauweise (Senftenberg) c Plankenwand (Podrosche, Kr. Weißwasser, 2. Wall) d Steintrockenmauer-Schalenbauweise (Löbau) e Rostkonstruktion (Podrosche, 1. Wall) f Palisaden-Schalenbauweise (Lübbenau, Kr. Calau) g Kastenkonstruktion (Biskupin, Polen)

Fig. 5 – Basic construction patterns of Bronze Age defensive ramparts (Herrmann 1989, 115).

[8] Falkenstein et al. 2011.

[9] Gebhard/Krause 2016, 45ff.

[10] Hellerschmid 2006, 17ff. und 292ff.

[11] Gersbach 1989.

[12] Schuchhardt 1909.

[13] Steinhauser-Zimmermann 1989.

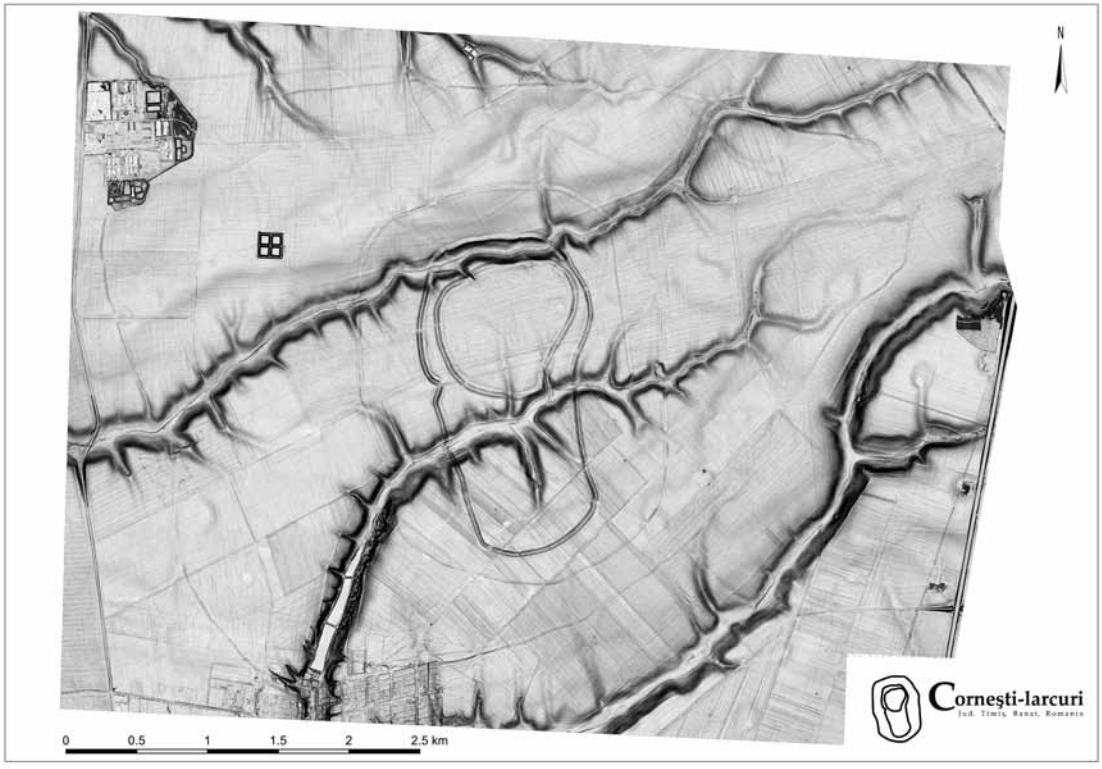

N
0 0.5 1 1.5 2 2.5 km
Cornești-Iarcuri

Fig. 6a

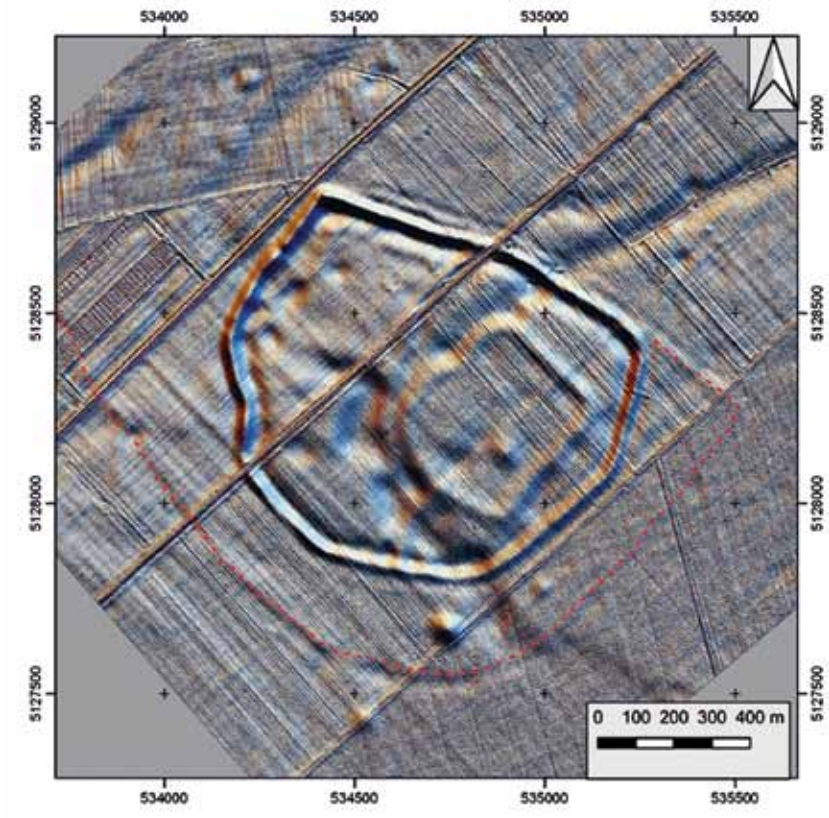

534000
534500
535000
535500
5129000
5128500
5128000
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0 100 200 300 400 m

Fig. 6b

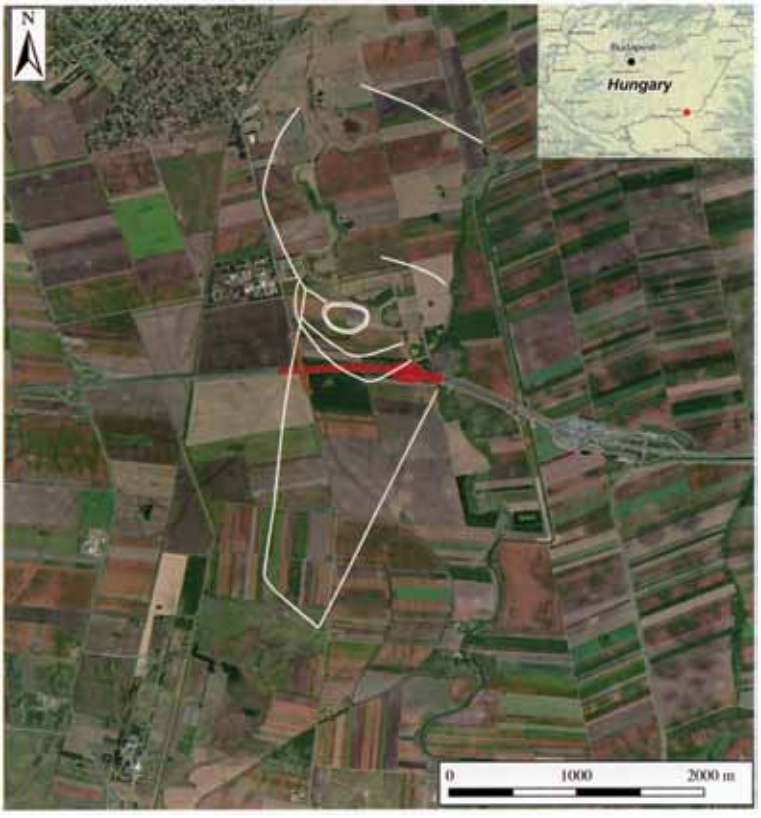


Fig. 6c

Figs. 6a-c – The Mega Sites Iarcuri (Cornești-Project), Sântana (Krause et al. 2022, Abb. 8) and Csanádpalota (Szeverényi et al. 2022, 214 Fig. 1) in the south-eastern part of the Pannonian Plain.

construction must have been available here and the construction must have been practical. Even on a smaller scale, such a work cannot be seen as a constantly recurring event and the question remains where the know-how came from. The already mentioned house construction, well construction or even simple palisades can certainly be viewed as locally accomplished and partly individual construction. But at what point was this "vernacular" knowledge and logistical skills no longer sufficient for the construction?

To approach this question, we can look at a few facts and figures from Iarcuri. The calculation example and the (theoretical) technical explanations of this system should serve as a starting point. Jochen Schmid assumes around 40,000 m³ of lumber for all of Iarcuri's rings.[14] The wooden structures were filled with earth. One cubic meter of compacted soil weighs approximately 1.5 tons. Accordingly, the earth filling of all Iarcuri's rings had a weight of approx. 740,000 t with the assumed minimum total volume of 493,000 m³. In order to move this mass in a structured way, in large parts, only hard labour is needed. However, in order to organise the logistics like transport and the method of filling, great planning skills are necessary. As an example, if we assume a rampart segment that is one meter wide and (for Ring I) six meters high[15], then assuming a depth of just one meter results in 10.8 t of earth alone. In reality, according to the excavation findings, we are talking about a depth of the structure of around 8 to 10 meters. Now, this earth filling does not press completely onto the outer or inner posts of a wooden box rampart, but you can still assume several tons per segment inside and out. From a static point of view, there are at least two critical points for the walls in Iarcuri: on the one hand, the large posts (entire trunks?) that are deepened

[14] Schmid in: Krause et al. 2016 (2019), 169ff. Regarding his overall calculations, however, it must be added that Ring 3 had not yet been dug at that time and that the information is based on estimates that can be viewed as conservative.
[15] Ebd. 171.

up to 60 cm into the ground and, on the other hand, the cross-connections with the bars or even struts to be assumed. Based on the numbers mentioned, only massive and stable methods are possible for the connections (see above) and therefore extensive carpentry knowledge must have been available and coordinated.

In addition to the purely technical implementation of the construction, the procurement of materials, organization of material processing, construction logistics and processes, and supply of workers, to name just a few, are no less challenging. The suitable and necessary wood cannot have come in such quantities from the immediate area alone. So at least one network can be assumed that worked from the selection of wood, through logging to delivery to the construction site. The selection of suitable timbers in the forest alone requires special knowledge, as does their processing and construction on site. The design of the internal structure of the rampart in Iarcuri does not indicate "learning by doing" during construction, but rather reveals a plan that was deliberately implemented. By firing Rings 1 and 2, the magnetically prospected areas provide a detailed insight into the internal construction. Although Rings 1 and 2 differ in details, both initially have an outer and an inner row of large vertical posts that were connected and stiffened via cross connections along and through the body of the rampart (Fig. 7). The archaeological record also shows posts and thus several rows of boxes inside. They led to further stiffening of the structure (Fig. 8).

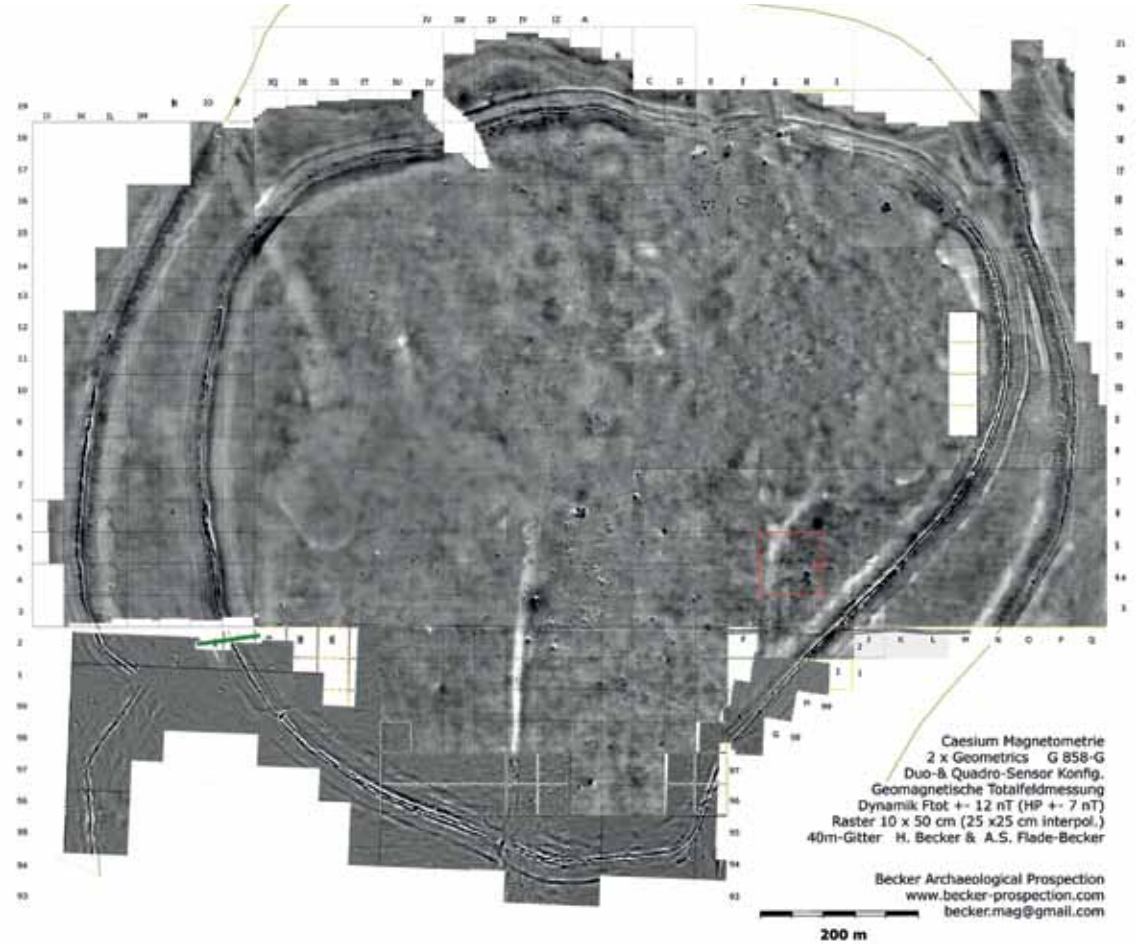


Fig. 7 – Magnetogram of Ring 1 and of parts of Ring 2 with burned structures (Cornești-Project).

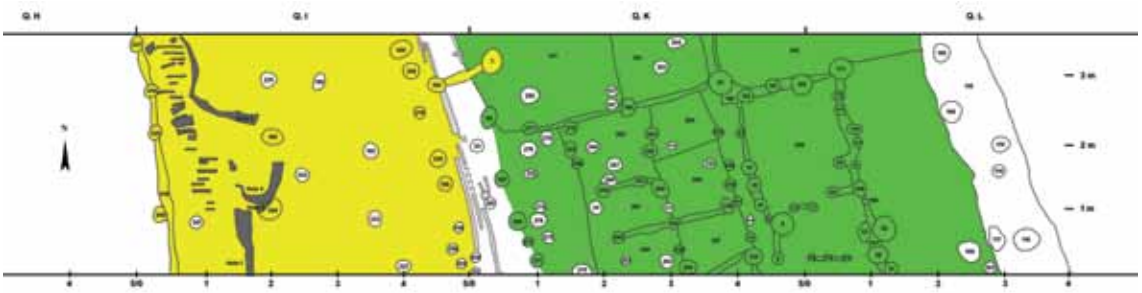


Fig. 8 – Ring 1: Trench II, Planum II (2008). Green: Phase A, Yellow: Phase B (Cornești-Project).

The structure of the entire facility in Iarcuri has been presented in several articles. The previous presentations also include a sophisticated gate system in Ring 4.[16] Stratigraphic circumstances and numerous 14C dates show that the four rampart systems were not all built at the same time and there must have been construction phases. Based on current information, it can be assumed that Ring 1 was first created around 1450 BC at the latest and was probably followed by 2 and 3 shortly afterwards. Ring 4 appears to have been built from around 1300 BC, a few generations later.[17] It also shows significant differences in construction. This means we are not talking about a single construction process, but rather an ongoing adjustment, i.e. a long-term,

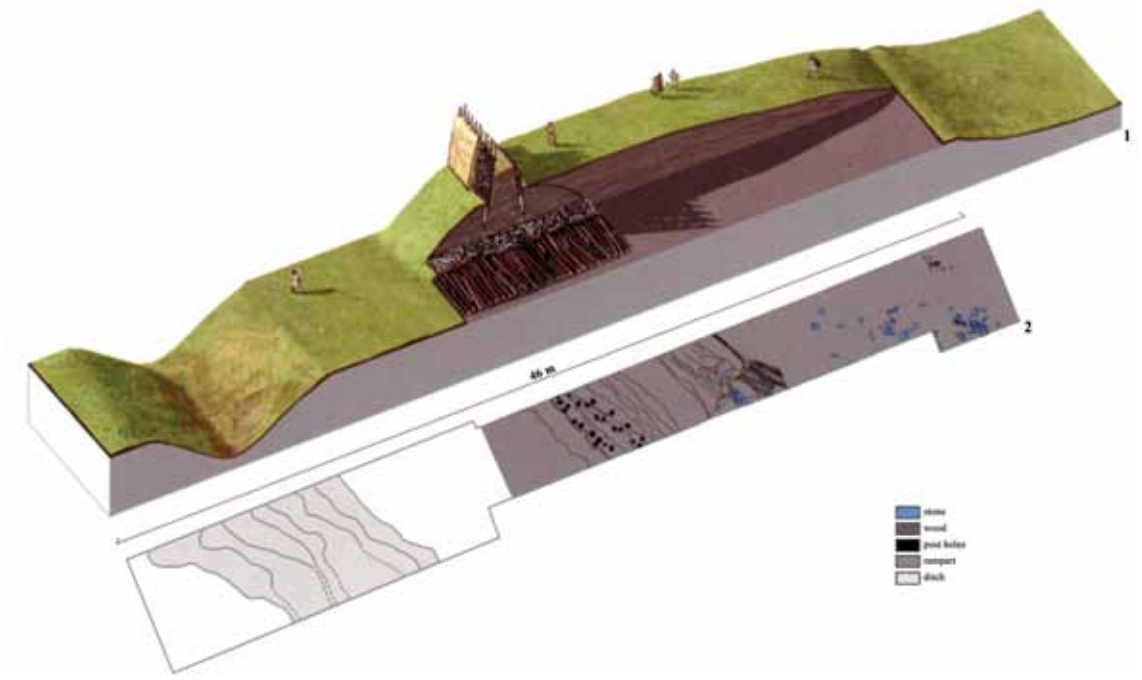


Fig. 9 – Proposal for reconstruction of the rampart in Sântana (Gogôltan/Sava 2018, fig 2).

large-scale project. We do not need to look for the original reasons for construction and expansion in the context of this article. The only important question is how a targeted and planned approach could be demonstrated when designing the system. What is striking is the location of Ring 1 on a level between two stream valleys, which is a clear indication that the topography played a significant role in the planning. When building Ring 4, the sources of the streams were taken into account and incorporated. These two examples alone show that there was initially a plan and

[16] Heeb et al. 2014, Abb. 19.

[17] Lehmphul et al. 2019, 273ff.

that, based on this, specific efforts were made to implement it. Sântana's inner ring lies on a spur above an oxbow (Fig. 6b and 9). At Csanádpalota this is not directly visible. But it is also hardly conceivable that people simply built "on top of it", and topographical considerations are obvious or at least assumed in almost all other known fortifications. It was certainly important to use the available resources efficiently even back then. However, it remains unclear to what extent it was possible to estimate the need for building materials before or right at the start of construction in order to adapt procurement to this. Or did they simply procure wood and everything else "just in time" until everything was finished? The question of the maintenance of such systems, or whether and in what form this was systematically operated at all, also remains unanswered.

Something else is noticeable in the construction process of the ramparts of Iarcuri. Ring 1 has two construction phases, of which the older one (A) is probably dilapidated, after which phase B is built. As far as the archaeological picture allows an interpretation, it appears as if this younger phase was achieved in principle in the same way, but in detail with far less care and also less suitable timber. It is conceivable that there was little or no good timber available in the surrounding area, but it seems rather unlikely. It is possible that at this point there were simply no longer any specialists or people trained in construction planning available who could have ensured the reconstruction in the appropriate manner.

Chronological aspects

It is difficult to determine exactly when we encounter such complex fortifications - especially in terms of the type of rampart, but also in the structure of the complex. A rough overview, however, suggests that we can expect this to occur no later than 1450 BC in the eastern Pannonian Plain, specifically with Iarcuri and similar facilities. About a century later, the construction method seems to have become generally established in Central Europe (see Bernstorf – Fig. 10a and b) and from the turn of the 13th century until the 9th century they belong to the usual spectrum of fortification construction (e.g. Heuneburg or Teleac[18]). The extent to which Celtic construction methods ("Pfostenschlitzmauer" or "Murus Gallicus") later relate to these and can therefore be found in modifications up to the La Tène period is a different topic. However, although fortifications in themselves are nothing new, the concrete form of the box rampart in a more or less comparable design did not develop in several places in Europe at the same time, and not before 1500 BC. Possibly, we recognize a (geographical) development starting with the oldest of their kind in der Banat (see above), perhaps even a style, that proves itself and establishes itself within a certain formal framework.

Of course, one can try to derive the box ramparts typologically from previous fortifications. The result may be that a precursor consisting of a palisade and earthen embankment is likely (see Fig. 5, variant a) and was certainly built in parallel throughout Europe for a long time; depending on the possibilities and needs of a building community. The known data is not sufficient to make such statements. However, a development of large and complex buildings and complexes towards the late Bronze Age can definitely be seen.

[18] Uhnér et al. 2022.

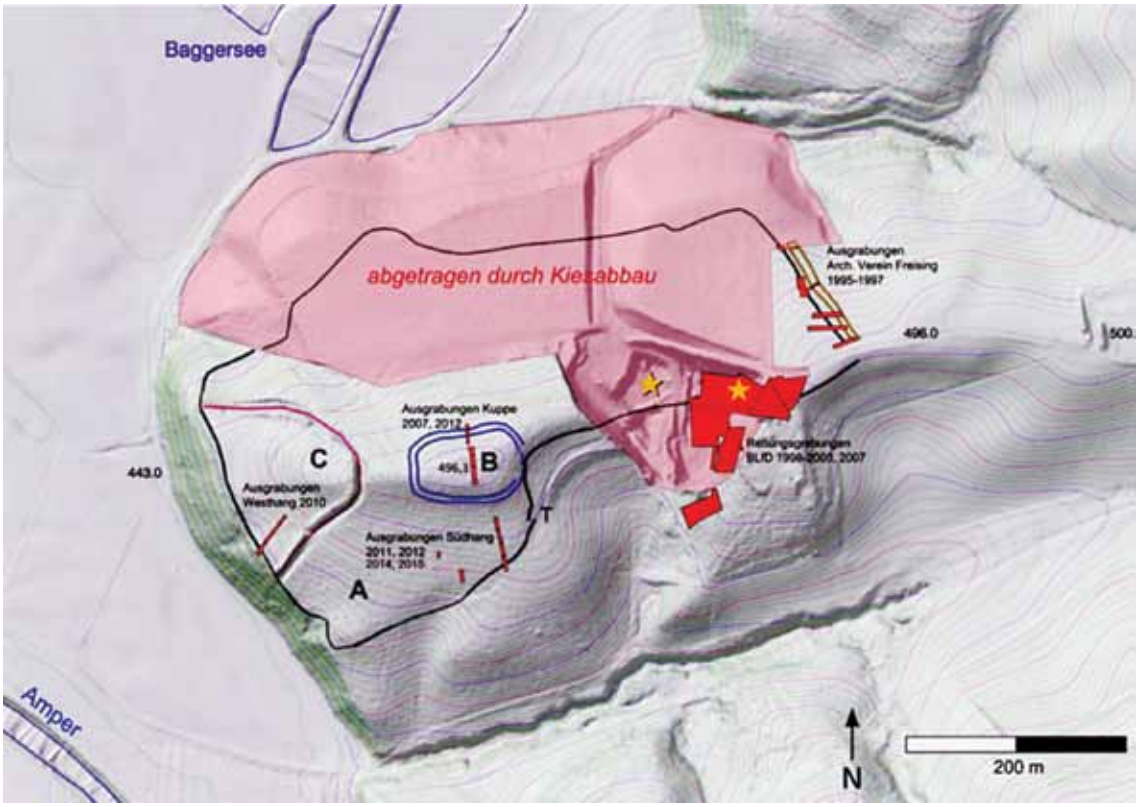


Fig. 10a

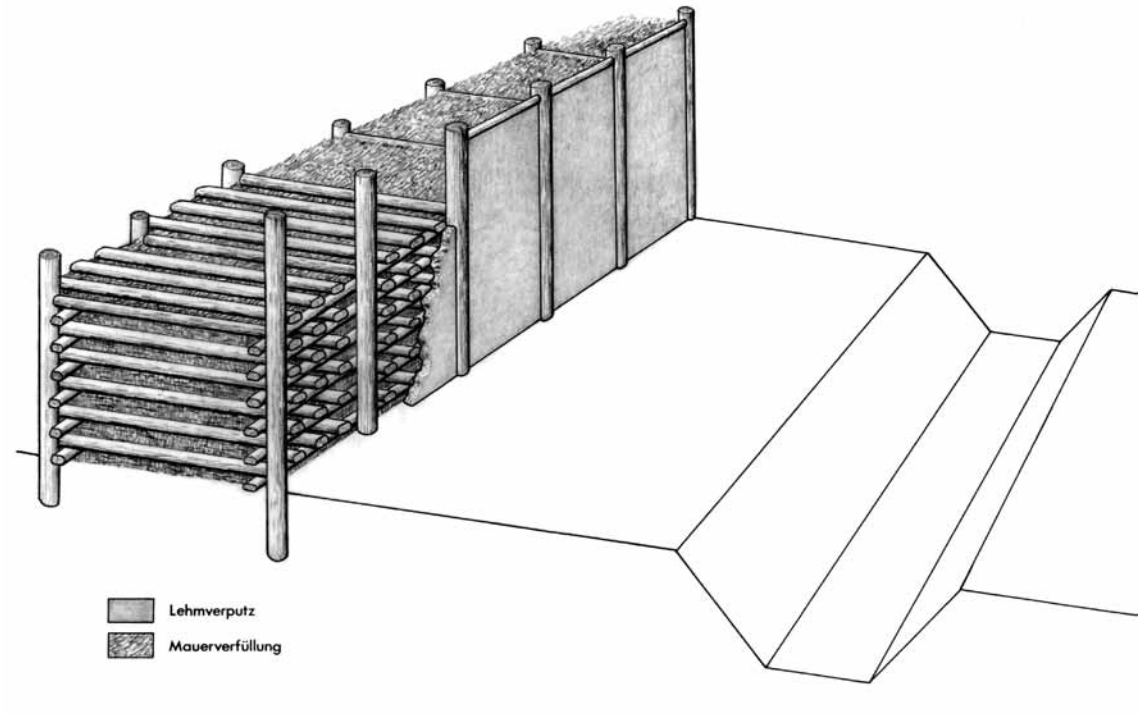


Fig. 10b

Figs 10a and b – Bernstorf with reconstruction drawing of the rampart (Gebhart/Krause 2016 44 and 50, Abb. 8 and 13).

Synthesis

Especially in the context of the Hessian research funding program LOEWE with a focus on "Prehistoric conflict research" (Römisch-Germanische Kommission and Johann Wolfgang Goethe-University Frankfurt/Main), numerous works and publications on the subject of "Bronze Age castles" have been created in recent years, but few deal with architecture as such. To fully investigate the above-mentioned hypothesis would require a monographic work; and it would still be questionable whether existing data would provide a consistent picture. Until then, the following aspects remain relevant when viewed together: We see from around the middle of the 2nd millennium BC fortifications that we do not notice before, both in terms of their specific construction and their scope. The so-called Mega Sites in the southeastern Hungarian Plain represent an absolute highlight for the Bronze Age. As far as can be proven, these often have in common the construction of their walls: box ramparts. They may have differed in detail, but in terms of basic construction they were often very similar. In order to build such ramparts in a stable manner, in the case of Iarcuri over a length of over 33 km, it seems inconceivable that they were conceived and created solely by a community with limited access to resources and a manageable amount of knowledge and limited (craft) specialist skills. Preliminary planning at all levels, procurement of raw materials and labour and the actual construction as a large-scale logistical undertaking and under carpentry aspects is a Herculean task that, in the author's opinion, is inconceivable without experienced and highly specialized people. In the following centuries, comparable ramparts were found in large numbers across large parts of Europe. The construction principle seems to have spread geographically, but the fortifications as a system never reach the complexity and size of the Mega Sites. As things currently stand, these appear to be both the starting point and the climax for the Bronze Age.

The basic question, however, remains whether a type of specialist is conceivable, i.e. a "professional group" of craftsmen and planners who, for centuries, offered their services in building fortifications in wood and earth across Europe and recruited and, if necessary, trained local support workers. And did this "professional group" appear for the first time in the eastern Pannonian Plain? This probably cannot be proven, but the observations described suggest the possibility. The manifest need to build such immensely large fortifications had the effect of inevitably raising the well-known craft to a new level. This cannot have gone unnoticed by observers from outside. Getting advice and support from those who know how to do it seems only logical and plausible. Whether the much younger but foreign clay brick wall of the Iron Age Heuneburg is a good example to fundamentally support the assumption of qualified "foreign forces" is debatable. At least it doesn't get in its way.

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Pottery from the Bubanj Archaeological Site: A Study on Provenance and Production Technology

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Abstract: The paper presents the results of the first provenience study conducted on ceramic materials that belong to different stratigraphy layers on the same archaeological site. The suitable site was Bubanj, positioned on a high terrace near the Nišava River in the middle of the Niš Plain. The period from the Early to Late Eneolithic was archaeologically divided into cultural groups associated with these phases: Early Eneolithic, the Bubanj-Hum I group, Middle Eneolithic, the Chernavoda III-Boleraz-Baden group, and Late Eneolithic, the Cotofeni-Kostolac group. This study aims to determine similarities/differences in the origin of raw materials (based on compositional and mineralogical analysis) as well as the production technology (based on firing temperature assessment). The elemental composition of the ceramics and clay was determined using EDXRF spectrometry, and the mineral composition and its phases were determined using XRPD analysis, while FTIR spectrometry results were used for the firing temperature estimation. The analytical techniques used and mathematical models developed in this study showed that they were efficient in analyzing materials made of the same/similar raw materials. The usage of local raw and non-local raw materials was confirmed, and the archaeological grouping was confirmed based on the results. The results substantiate the notion of dynamic social interactions in the period following the mid-4th millennium calBC. This is evident not only by the distinct stylistic and typological features of Early Eneolithic ceramics compared to those of the Middle and Late Eneolithic but also by the technological differences in firing ceramics.

Key words: ceramics, vertical stratigraphy, physicochemical analysis, provenience study

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Introduction

The Bubanj site is located on the eastern periphery of Novo Selo, approximately 5 km west of Niš, on an elevated terrace on the left bank of the Nišava River, about 7 km upstream from its confluence with the South Morava. The site has been excavated on several occasions: in the 1930s and 1950s, and later between 2008 and 2014[1]. This is a multi-layered prehistoric site, with the earliest settlement dating to the Middle Neolithic period and the most recent to the Iron Age, as well as a necropolis from the Modern Era[2].

Three clay deposits have been identified in the vicinity of the site. These are located in the area of Crepana in the center of Novo Selo, approximately 800 meters west of the site; in Crepana in Lalinac, about 2.6 km west of the site; and in the area of Tri Bresta, roughly 2 km west-southwest of the site. Access to all these clay deposits from the site is easy and open, with flat terrain and no significant topographical obstacles.

The vertical stratigraphy of the site is highly complex, with some excavated trench profiles extending over 3 meters deep to the sterile soil layer. However, the best-preserved cultural layers containing dated archaeological contexts originate from the Early to Late Eneolithic period (circa 4350/4250–2900 cal BC)[3]. This is one of the reasons why pottery from these layers was selected for this type of analysis.

The period from the Early to Late Eneolithic can be archaeologically divided into cultural groups associated with these phases: Early Eneolithic, the Bubanj-Hum I group (henceforth BH I), Middle Eneolithic, the Chernavoda III-Boleraz-Baden group (henceforth CV), and Late Eneolithic, the Cotofeni-Kostolac group (henceforth KK). Another reason this pottery was chosen for compositional and firing technique analyses is related to the origins of these groups. Based largely on the stylistic and typological features of the pottery, it has been suggested that the population associated with the BH I group was of local origin, descending from the population of the Late Vinča culture[4], while the later two groups (CV and KK) were of foreign origin, coming from the north, the Pomoravlje region, and the Timok area[5].

For these reasons, it was necessary to analyze and compare the properties of pottery from these groups with one another, as well as with the clay from the aforementioned nearby deposits. The primary aim of this study is to compare the raw material procurement strategies and the firing techniques employed during this period, especially between the population considered indigenous and those thought to have migrated from the north, to evaluate the validity of the aforementioned hypothesis.

Studies of provenance, as well as investigations into production technology (specifically in terms of assessing the firing temperature of clay used in artifact production), have become inseparable from modern archaeological techniques, largely due to advancements in physico-chemical analyses. Various instrumental techniques and effective analytical procedures have been developed and established for these purposes. Provenance studies (aimed at identifying the raw materials used in the creation of analyzed ceramic fragments or artifacts) are based on various techniques, including X-ray fluorescence analysis (XRF) in its various instrumental implementa-

[1] Oršić-Slavetić 1940; Garašanin 1958; Bulatović & Milanović 2020.

[2] Bulatović & Milanović 2020; Miladinović-Radmilović & Bikić 2022.

[3] Bulatović & Vander Linden 2017; Bulatović et al. 2020.

[4] Bulatović et al. 2020a.

[5] Bulatović & Kapuran 2017.

tions[6], particle-induced X-ray emission (PIXE)[7], X-ray powder diffraction (XRPD)[8], petrographic analysis supported by optical microscopy (OM) and/or scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX)[9], and instrumental neutron activation analysis (INAA)[10]. For assessing firing temperatures, the most informative techniques include XRPD[11], Fourier transform infrared spectroscopy (FTIR)[12], and Raman spectroscopy[13].

Preliminary investigations into the provenance of ceramic vessel fragments from the Bubanj site[14] revealed that the analyzed fragments were most likely made from locally sourced raw materials. The ceramic fragment assemblages were organized based on archaeological interpretations. Provenance analyses showed that the ceramic fragments shared the same elemental composition as clay samples collected near the Bubanj archaeological site, except for those belonging to the KK cultural layer. This study highlighted weaker coherence within some of the assemblages into which the fragments were grouped, forming the basis for further research.

This paper presents the results of investigations into the production technology of ceramic fragments from the Bubanj site, specifically focusing on determining the firing temperatures of these fragments. Two analytical techniques, pXRPD and rFTIR, were used to determine firing temperatures. This approach also allowed the comparison of results with those from the previous raw material provenance study. The hypothesis of local production was confirmed, along with differences in raw material usage for the Cotofeni-Kostolac (KK) group. The results also indicated a broader spectrum of firing temperatures, reflecting variability in technological practices.

Materials and Methods

Materials

The ceramic fragments used in this study were organized into three groups based on archaeological findings: Bubanj-Hum I (Early Eneolithic) – BHI, Chernavoda III-Boleraz-Baden (Middle Eneolithic) – CV, and Cotofeni-Kostolac (Late Eneolithic) – KK. The same number of fragments from each group were used as in the previous study[15], as shown in Figure 1a. Additionally, clay samples were collected from local pits in Crepara–Novo Selo, Tri Bresta, and Crepara–Lalinac.

Sample Preparation

The ceramic fragments were prepared for analysis following the procedure outlined in [16]. The main difference in this study is that the powdered material was not pressed into tablets; instead, it was sieved to the desired granularity for XRPD analysis after drying (Figure 1b).

For the clay samples, preparation began with drying and removing impurities. The dried clay was hydrated by gradually adding water until a paste of suitable consistency for molding was

[6] Ruschioni et al. 2022, Holakooei et al. 2024.
[7] Gao et al. 2023.
[8] Ion et al. 2024.
[9] Botticelli et al. 2022.
[10] Kilikoglou et al. 2007.
[11] Andrini et al. 2016.
[12] Bruni et al. 2023.
[13] Dellefant et al. 2023.
[14] Gajić-Kvaščev et al. 2024.
[15] Gajić-Kvaščev et al. 2024.
[16] Gajić-Kvaščev et al. 2024.

achieved. The shaping mold consisted of two identical plexiglass plates with a 3 cm gap between them, into which the prepared clay paste was placed. A rolling pin made of plexiglass was used for shaping, chosen specifically to prevent contamination, as wooden rolling pins could retain impurities from previous samples. This method ensured uniform thickness, matching the gap between the plexiglass plates. The samples were shaped into squares.

The clay samples were left to air dry, covered with paper and a wooden board. The paper was replaced daily to absorb moisture, while the wooden board applied consistent weight, helping the samples retain their shape.



Fig. 1 – a) Representative samples of ceramic fragments; b) prepared clay material; c) prepared clay tiles.

A crucial step for this study's results was the firing of the prepared clay samples. The firing process was conducted in two stages. The first stage involved heating the samples in a kiln from 25°C to 400°C over three hours. This was followed by incremental heating at a rate of 100°C per hour. Target firing temperatures ranged from 500°C to 900°C, transforming the samples into ceramics. After firing, the samples were left in the kiln to cool completely (Figure 1c).

X-Ray Powder Diffraction (XRPD)

XRPD is a technique that allows real-time identification of minerals and mineralogical phases. For this study, a portable X-ray diffractometer (Olympus BTX III Benchtop XRD Analyzer), known for its compact design and suitability for fieldwork, was utilized. The analysis covered a 2θ range of 5° to 55°, with 200 scans performed for each sample.

Integrating the results of determined dominant peaks in the diffraction patterns with quantitative analysis (conducted using the analyzer's software) facilitated both the provenance study and the determination of firing temperatures.

Fourier Transform Infrared Spectroscopy (FTIR) in Reflection Mode

Reflective infrared spectra of ceramic materials were recorded using a portable infrared spectrophotometer, ALPHA-R Bruker Optics. The instrument is equipped with a Globar Mid-IR source, a modified Michelson interferometer capable of operating in all environmental conditions (RockSolid™), and a DLaTGS detector operating at room temperature.

Specialized reflection modules enable contactless and non-destructive FTIR analysis by placing the samples in front of the instrument at a 4 mm-wide aperture, with the pre-flattened surface facing the device. For this study, the instrument was configured to perform 64 scans per sample.

Results and Discussion

Based on the elemental composition of ceramic fragments determined using the EDXRF spectrometry technique and processed with PCA multivariate analysis (Figure 2a), it is evident that the fragments grouped under BHI and CV were most likely produced using the same raw material. However, as shown in Figure 2b, the BHI group exhibits a certain degree of incoherence, suggesting potential deviations from the earlier conclusion that local raw materials were used in the production of the analyzed vessel fragments.

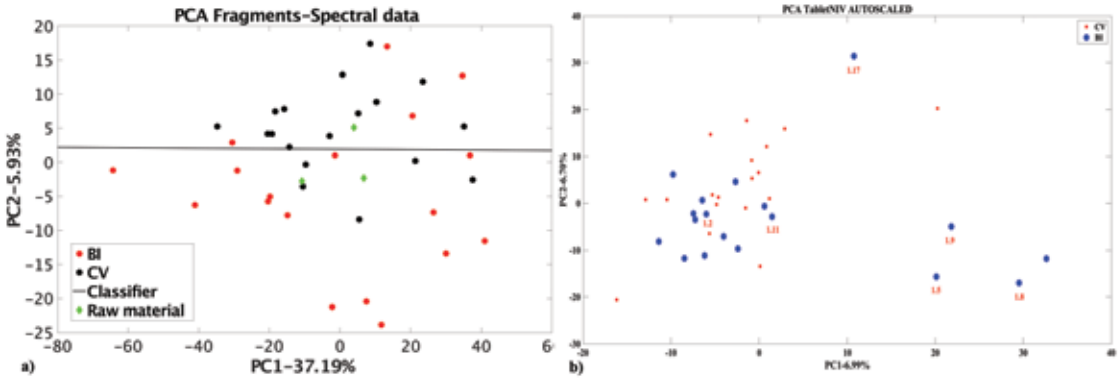


Fig. 2 – a) Classification of BHI and CV archaeological ceramic fragments based on PCA analysis of elemental composition; b) PCA analysis of the elemental composition of BHI and CV groups of ceramic fragments.

To investigate the source of this incoherence and to expand upon the previous study,[17] fragments labeled BHI 1-2, BHI 1-5, BHI 1-8, BHI 1-11, and BHI 1-17 were analyzed using the pXRPD spectrometry technique. The results of this analysis are presented in Figure 3. This

[17] Gajić-Kvaščev et al. 2024

technique enabled the determination and quantification of the mineralogical composition of the analyzed ceramics, and the results are presented in Table 1.

Based on the spectra (Figure 3a), the use of local raw materials for the production of the analyzed fragment can be confirmed. The mineralogical composition of sample BHI 1-5 was determined as follows: Quartz-SiO_2 (51%), Calcite-$CaCO_3$ (16%), Muscovite-$KAl_2(AlSi_3O_{10})(F,OH)_2$ (13%), Microcline-$KAlSi_3O_8$ (11%), Illite-$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$ (5%), and Albite-$NaAlSi_3O_8$ (5%). Based on the XRD spectra and the determined mineralogical composition, it can be concluded that while the quartz content decreases, the presence of a certain percentage of residual calcite indicates that the firing temperature did not exceed 800°C. This finding is corroborated by the FTIR results shown in Figure 3b.

Identified minaral [%]	**CV 2-4**	**CV 2-11**	**CV 2-17**	**BHI 1-2**	**BHI 1-11**	**Crepara**
Quartz	29	36	48	54	49	50
Clacite	1	2	n. d.	n. d.	2	4
Microcline (K-feldspar)	11	11	15	10	12	7
Albite (plagioclase feldspar)	35	31	18	16	17	14
Muscovite (illite group phyllosilicates)	24	19	18	18	17	21
Illite (illite group phyllosilicates)	n. d.	n. d.	1	2	3	3

n. d.-not detected

Table 1. The mineralogical composition of CV and BHI group fragments determined using the pXRPD technique.

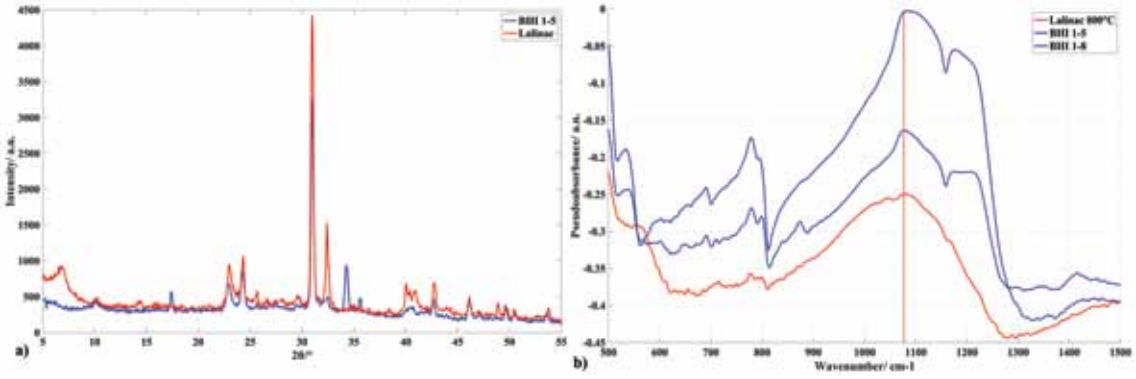


Fig. 3 – a) Comparative XRD spectra of fragment BHI 1-5 and clay from the Lalinac deposit; b) Comparative FTIR spectra of clay test tiles from Lalinac and representative ceramic fragments from the BHI group (1-5 and 1-8).

Based on the spectra (Figure 4a), the use of local raw materials for the production of the analyzed fragment can again be confirmed. The mineralogical composition of sample BHI 1-11 was determined as follows: Quartz-SiO_2 (49%), Calcite-$CaCO_3$ (2%), Muscovite-$KAl_2(AlSi_3O_{10})(F,OH)_2$ (17%), Microcline-$KAlSi_3O_8$ (12%), Illite-$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$ (3%), and Albite-$NaAlSi_3O_8$ (17%). Based on the XRD spectra and the determined mineralogical composition, it can be concluded that the low percentage of residual calcite and the quartz content suggest a firing temperature exceeding 800°C, most likely within the range of 800–900°C[18]. This finding is further corroborated by the FTIR results shown in Figure 4b.

[18] Viani et al. 2018

The FTIR results for fragment BHI-17 have been presented in Figure 5, indicating the firing temperature of 600°C, which is way lower compared to the majority of the fragments belonging to group BHI. This fact might indicate the reasons for the non-similar position of this analysis in the PC1-PC2 space (Figure 1a) since a kind of temper might caused the change in the composition.

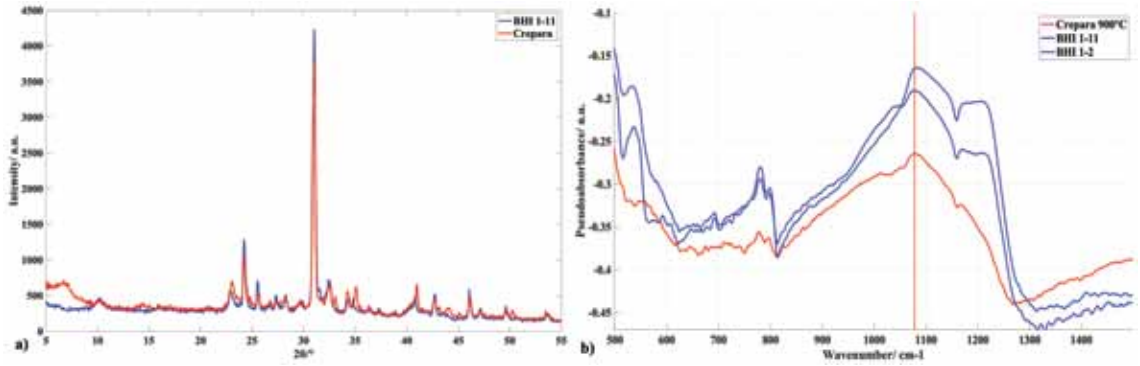


Fig. 4 – a) Comparative XRD spectra of fragment BHI 1-11 and clay from the Lalinac deposit; b) Comparative FTIR spectra of clay test tiles from Lalinac and representative ceramic fragments from the BHI group (1-2 and 1-11).

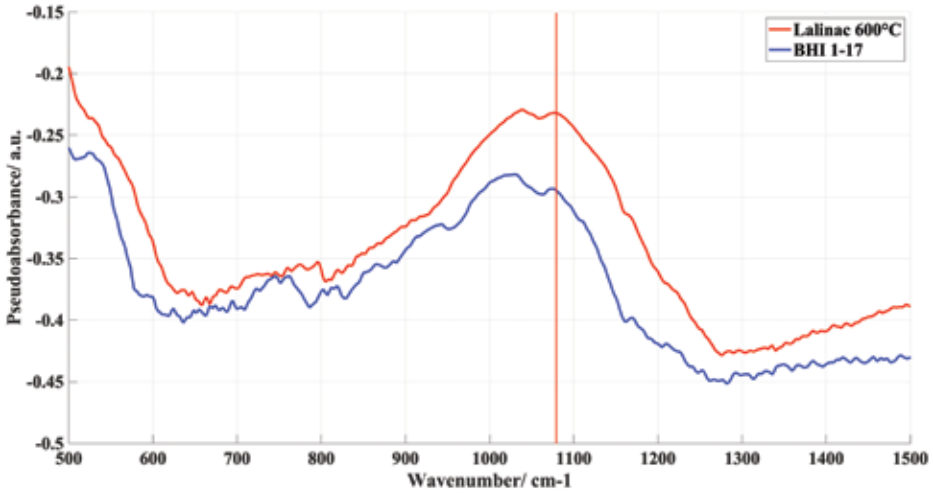


Fig. 5 – Comparative XRD spectra of fragment BHI 1-17 and clays from the Lalinac deposits.

As shown in Figure 6, the group composed of fragments from the Chernavoda (CV) cultural layer demonstrates significantly greater coherence in terms of elemental composition. For further analysis, the selected fragments include CV 2-4, CV 2-11, CV 2-15, CV 2-17, and CV 2-20.

By comparing the mineralogical composition (obtained using pXRPD spectrometry, Table 1) of the representative CV fragments and the clay from the Crepara deposit near the archaeological site, the hypothesis of using local raw materials for the production of the analyzed fragments was confirmed. Based on the mineralogical composition presented in Table 1, the coherence of the CV fragment group in terms of material characteristics can also be reconfirmed. Given that the majority of CV group members share their composition with the BHI group (Figures 1 and 6), the mineralogical composition of representative BHI group members (BHI 1-2 and BHI 1-11) is also included in Table 1.

The estimated firing temperatures for fragments CV-15 and CV-20, which are more distinct from the majority of the CV group members (Figure 6), are illustrated in Figures 7 and 8. As expected, the estimated firing temperature of fragment CV 2-15 is slightly lower, approximately 500°C, while fragment CV 2-20 is estimated to have been fired at around 700°C.

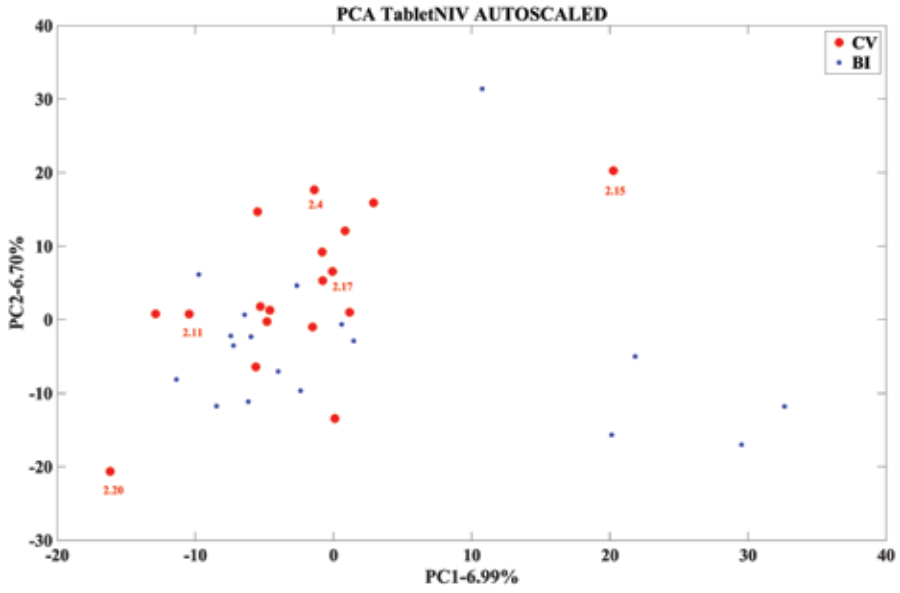


Fig. 6 – PCA analysis of the elemental composition of BHI and CV groups of ceramic fragments.

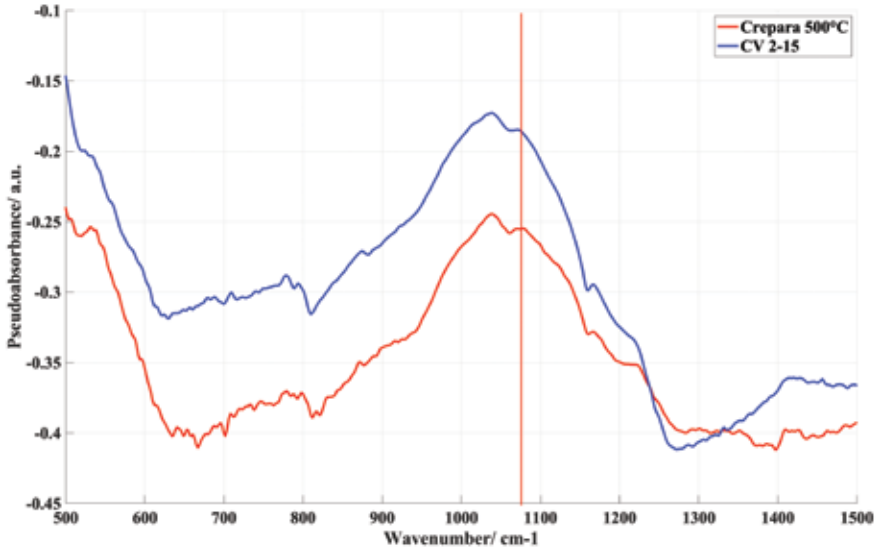


Fig. 7 – Comparative FTIR spectra of fragment CV 2-15 and clay from the Crepara deposit.

The group previously identified in the earlier study as the KK group[19], used to validate the mathematical model, has been analyzed in detail in this study. The mineralogical composition of the selected fragments is shown in Table 2. Based on the XRD results presented, the hypothesis of a different raw material source for the production of the analyzed fragments becomes even more convincing. The firing temperature estimates for these fragments were derived from the FTIR spectra shown in Figures 9 and 10.

[19] Gajić-Kvaščev et al. 2024

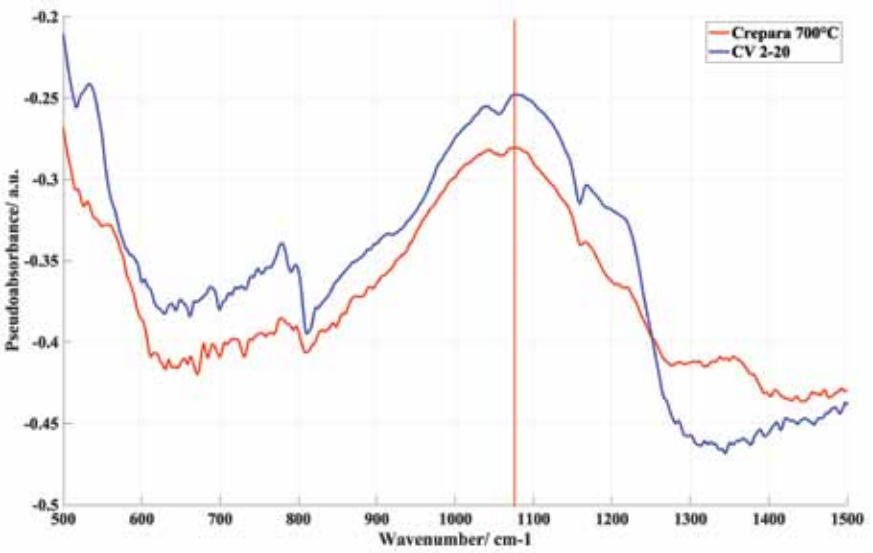


Fig. 8 – Comparative FTIR spectra of fragment CV 2-20 and clay from the Crepara deposit.

Identified mineral [%]	KK3-5	KK3-17	Crepara
Quartz	45	33	50
Clacite	n. d.	n. d.	4
Microcline (K-feldspar)	21	17	7
Albite (plagioclase feldspar)	1	36	14
Muscovite (illite group phyllosilicates)	29	13	21
Illite (illite group phyllosilicates)	4	n. d.	3

n. d.-not detected

Table 2. Mineralogical composition of KK group fragments determined using the pXRPD technique.

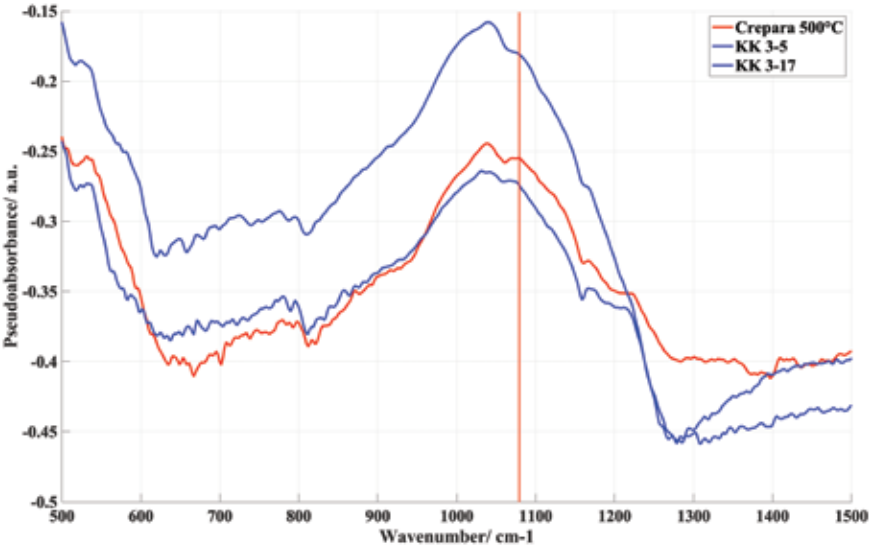


Fig. 9 – Comparative XRD spectra of fragments KK 3-5 and KK 3-17 and clay from the Crepara deposit.

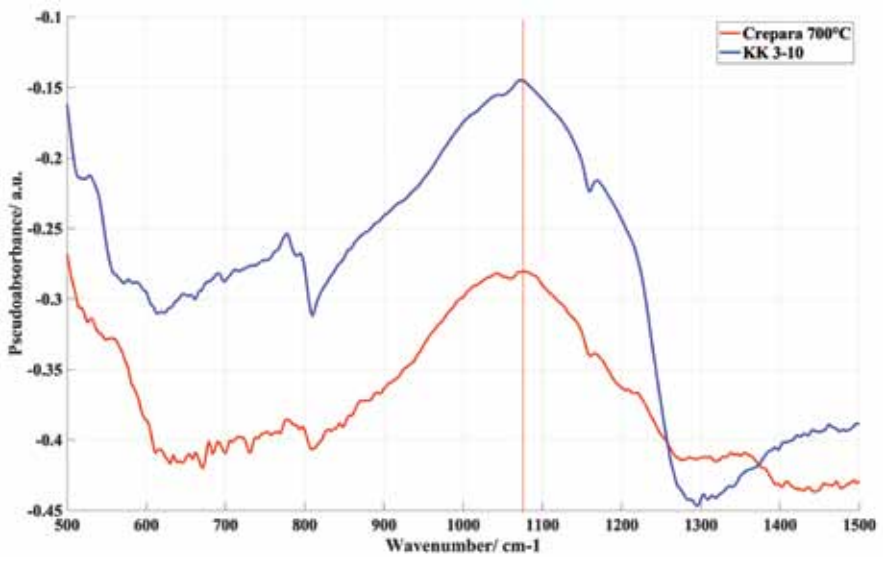


Fig. 10 – Comparative XRD spectra of fragment KK 3-10 and clay from the Crepara deposit.

Conclusions

This study presents a methodological approach to determining the firing temperatures of archaeological ceramics. The fragments selected for analysis were intentionally chosen to include various vessel types, aiming to assess the efficiency of the applied methods. Consequently, this study does not discuss technological changes in the production of the analyzed fragments. Instead, it provides insights into the capability of different techniques to offer precise answers to archaeological hypotheses.

For all three groups, which were formed based on vertical stratigraphy and dated archaeological contexts, the results of the previous study regarding the provenance of raw materials were confirmed. The findings indicate that the ceramic vessels of the BHI group exhibit a wider range of firing temperatures (800–900°C), suggesting variability in production techniques. Such conclusions were not reached for the CV group, which was expected, as this group demonstrated greater coherence in elemental composition in the previous study. The firing temperatures for the CV group were lower, ranging from 500–700°C, a range also observed for the vessels of the KK group.

The results indicate that the ceramics of the BHI group differ in firing methods (temperatures) from those of the CV and KK groups, even though fragments of various vessel types were analyzed across all groups. This finding highlights another distinction between the BHI ceramics and those of the CV and KK groups, in addition to the differences in clay provenance. It supports the hypothesis that the BHI group represents a local tradition, while the CV and KK groups exhibit foreign influences and origins, reflecting external interactions during the Middle and Late Eneolithic.

These results further substantiate the notion of dynamic social interactions in the period following the mid-4th millennium calBC. This is corroborated not only by the technological differences in firing methods but also by the distinct stylistic and typological features of Early Eneolithic ceramics compared to those of the Middle and Late Eneolithic.

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Approaching societal complexity in 2nd millennium BC Europe through the lens of megaforts and related settlements of the Carpathian Basin

Barry Molloy[1]

Abstract: The terms urban and urbanism are commonly synonymous with concepts of social complexity, sophistication and the paradigm of civilisation in prehistoric archaeology. Those terms provide a link that enables societies sharing such features to be considered in comparative perspective. However, this equation risks marginalising societies lacking urban features but possessing complexity from discussion on social change in large spatial and temporal perspectives. Bronze Age Europe is a case in point, where complexity that has been recognised was commonly evaluated through the lens of influence from urban areas around the Mediterranean despite the weak evidential match. Evidence for other, less centralised and less hierarchical modes of complexity, is abundant in regional literature though over-arching frameworks that enable that rich and varied record to be mobilised in comparative perspective are less commonly encountered. To address this, the paper takes a lead from recent work on Iron Age settlement archaeology. It dispenses with the term "proto-urban" and explores the utility of the term agro-agglomerate to characterise organisationally complex settlement systems in Bronze Age temperate Europe. This is pursued through the settlement archaeology of the northern Balkans / south Carpathian Basin during the late third to end of the second millennium BC. Promoting a comparative approach that includes urban frameworks, these settlements are considered in the context of contemporary Aegean societies. It is argued the Bronze Age societies of the Pannonian Plain present an important case for a form of complexity that was long-lived, resilient and widely influential within temperate Europe.

Key words: Settlement archaeology, argo-agglomerate, contra-urban, proto-urban, social complexity.

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Introduction

Urbanism and the rise of civilisations in a broad zone extending from the East Mediterranean to the Persian Gulf have been a focus of archaeology almost since its inception as a discipline. Seen as high points of achievement on the path from primitive to modern, the interconnected world of the fourth to second millennia BC was home to complex and richly textured societies across that wide region. In striking contrast, at least by way of narrative approaches, European prehistory presents a picture of structurally smaller, less sophisticated societies. It is perhaps no surprise that looking from northwest to southeast, there is a long history of exploring the extent to which European societies were influenced by these complex neighbours[1]. The contrast between modern ideas of urban and non-urban lies at the core of this schism, and so in this paper, I consider alternative paths of complexity in Europe that do not couple complexity with notions of urbanism, following recent work on this theme.[2]

The discovery of a dense, hierarchically ordered network of settlements in the South Carpathian Basin (the lower Pannonian network) in recent years presents an opportunity to reconsider how we characterise complexity in later Bronze Age Europe through the lens of settlement systems.[3] In this paper I make the argument that a distinct, contra-urbanist ideology permeated the long-term settlement history of the Carpathian Basin and that this ideology increasingly took hold across Europe from the 13th century BC, mirroring other transregional phenomena such as distinctive mortuary practices and metalworks styles attributed to Urnfield traditions.[4] This contra-urbamism was embodied in a form of settlement design I term *agro-agglomerative* below. I will argue this built environment is a product of a form of social complexity that was fundamentally distinct to urbanism - specifically that of the contemporary Aegean societies – but with a broadly equivalent level of organisational, military and political sophistication. Differences in building forms, functions and density are obvious but we can also identify shared features indicative of complexity including hierarchical ordering of settlements, monumentality of central places, polyfocal / multipurpose ordered spaces, a military aspect, territories incorporating many settlements and large-scale settlement planning. This affords an opportunity to better explore alternative ways in which societies may exhibit complexity, shifting focus from normative model of 'civilisations' with specific forms of urbanism, art, writing and hierarchies as being the zenith of human achievement based on equivalencies with contemporary, global north paradigms.[5]

This settlement network also presents an opportunity to think further on the place of societies from the later Bronze Age Balkans and south Carpathian Basin in wider European networks of their time (Figure 1). The varied political and intellectual histories of the 20th century and early 21st centuries have led to very different regional approaches to archaeology in Europe, which often left research in and from this region marginalised ().[6] Recently, the FLOW project at the Institute of Archaeology in Belgrade began to reassess the generative and innovative aspects of Balkan societies during the later Bronze Age. With that viewpoint in mind, my paper explores the context and regional significance of a horizon of settlements dating to ca. 1500-1200 BC that we have called the lower Pannonian network.[7]

[1] Harding, 2022; Kienlin et al. 2017; Kristiansen, 2018; Zamboni et al. 2020.

[2] e.g. Harding, 2018; Jennings, 2021; Moore, 2017a, 2017b; Moore and Fernández-Götz, 2022; Pearce, 2020.

[3] Bruyère et al. 2024b; Estanqueiro et al. 2023; Molloy et al. 2023c, 2020a.

[4] Cavazzuti et al. 2022; Gimbutas, 1965; Sørensen and Rebay-Salisbury, 2023.

[5] Graeber and Wengrow, 2021; Jennings, 2021; Moore and Fernández-Götz, 2022; Scott, 2017; Wengrow, 2010.

[6] Babić et al. 2017; Babić and Kuzmanović, 2015; Gori et al. 2023 with references; Harding, 2009: 631; Kristiansen, 2008: 23.

[7] Molloy et al. 2023c.

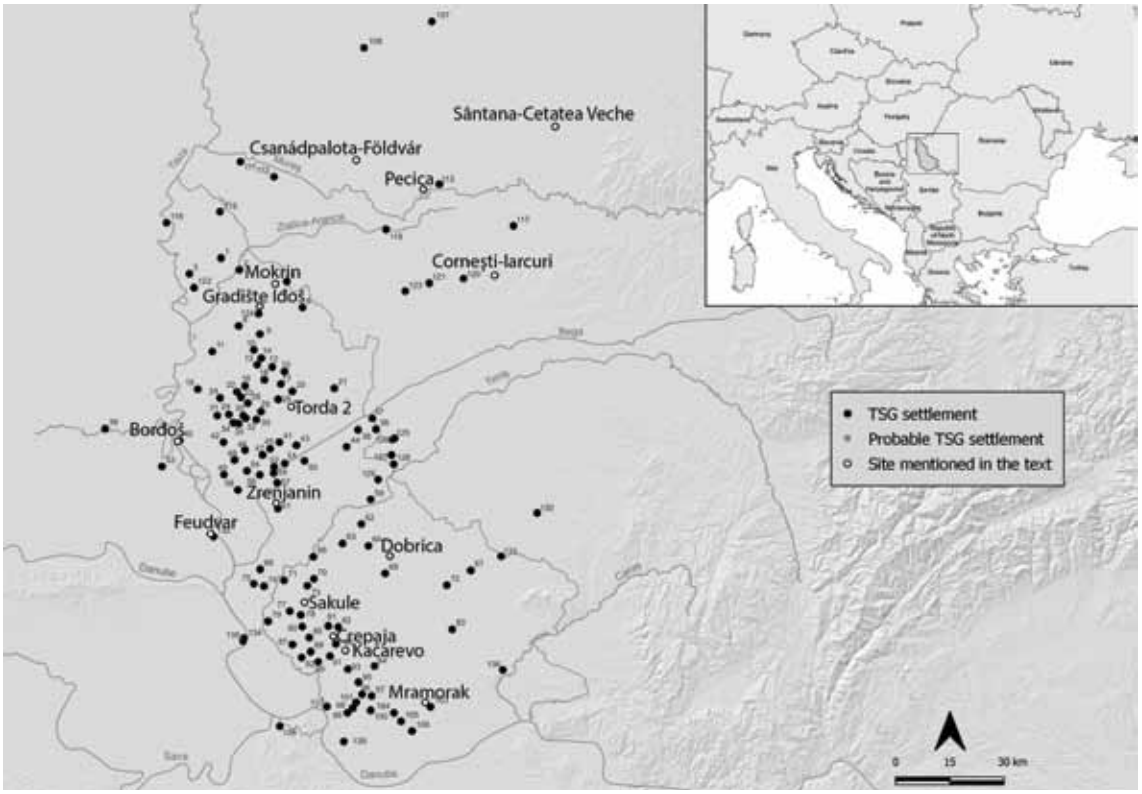


Fig. 1 – Map of sites mentioned in the text. The numbered sites are not listed herein for brevity, a full list can be found in Molloy et al. 2023. (Map by Caroline Bruyere and Barry Molloy; basemap hillshade derived from ALOS DSM AW3D30, reprinted from https://www.eorcJaxaJp/ALOS/en/dataset/aw3d30/aw3d30_e.htm under a CC BY license, with permission from JAXA -Japan Aerospace Exploration Agency, original copyright 2023).

As an alternative to urbanism will be our focus, it is instructive for calibrating discussion to first look to the Aegean Bronze Age, where a particularly European form of urbanism is said to have developed. My concern will not be with elite-level directional influence from the Aegean to other groups in Europe, as has commonly been argued, but rather to use it as a sounding board against which to consider complexity in contemporary society in the Pannonian Plain region of the Carpathian Basin.

Some lessons from the study of Aegean urbanism

The study of urbanism in Aegean prehistory has a long history and has been central to important discourses on the development of societal complexity for over a century.[8] While we can identify multiple steps and phases, there were broadly three interlocking trajectories or traditions divided along both geographic and chronological lines. The first is the Cycladic Bronze Age of the third millennium BC. The region was home to villages with evidence of planning and systematic inter-site networks.[9] This was followed in the second millennium BC by the palatial societies of Crete. On that island, the first villages likely coalesced around extended family units before shifting to community based networks, potentially including house societies, in what is called

[8] Barrett and Boyd, 2019; Barrett and Halstead, 2004; Branigan, 2001; Davis and Stocker, 2022; Dickinson, 2006; McEnroe, 2010; Renfrew, 1972; Schoep et al. 2012.

[9] Renfrew et al. 2022.

the Protopalatial period and this urban phenomenon continued into the following Neopalatial period, which ended ca. 1450 BC.[10] The palatial periods were marked by the emergence of shared canonical architectural elements in large, monumental buildings often called palaces and villas, that were configured in different ways at sites including Knossos, Petras, Malia, Sissi, Gournia, Zominthos, Galatas, Phaistos, Zakros Chania and Hagia Triada. Towns surrounded many, but not all, of these architectural complexes which appear to have had a communal / corporate function (i.e. they were not the seats of specific rulers). The function of palaces is much debated, though they are generally understood to have been administrative complexes also serving ritual, storage, economic, political and group performative space roles, with little evidence of routine domestic habitation within the structures.[11] Other small towns and villages were home to both domestic and specialist buildings, often two or more storeys high, and densely packed with connecting streets.[12] We know little of how power was managed, as there was no ruler iconography, but it is apparent that religion and ritual were important for negotiating influence and hierarchical relations within society.[13] While military power is evident, particularly later in the Neopalatial period, it is never prevalent in how political influence was articulated through art or architecture.[14] Following rapid decline in the 15th century on Crete, exponential growth occurred on the Greek mainland with the emergence of Mycenaean palatial centres.[15]

The third tradition relates to mainland Greece. Early complexity is evident in some locales in the third millennium BC – for example at Lerna – though this represents influence from Cycladic groups. The more striking changes occur only in the 17th century BC with the emergence of material culture and social practices collectively termed Mycenaean. Power is initially articulated through mortuary practices, such as the well-known Shaft Graves at Mycenae, with little complexity evident in contemporary settlement design.[16]

Beginning in the 15th century, but gathering pace in the 14th century BC, small urban centres emerged in southern Greece and at central sites, administrative complexes emerged, commonly surrounding a palatial building.[17] A complex of rooms was centred on a two-storey megaron building, commonly measuring ca. 250 square metres per storey. Activity within palatial and ancillary buildings appears to have largely included administrative, small-scale storage and craft activity and they were unlikely to have housed more than a few people within. The Linear B archives from these complexes indicate power was wielded from within the palace in principle, but distributed throughout the landscape in practice as elites of various seniority / levels appear to have lived in locations within territories covered by the archives.[18] Linear B tablets reveal a remarkably hierarchical society that is also well-attested in material culture, particularly in the mortuary sphere.[19]

Social hierarchies also have architectural allegories, extending out from the throne room (highly restricted access), through the special function rooms of the palace complex to a network of immediately proximate buildings associated with the palace. There was a gap then between these elite spaces and the small surrounding settlements, some large enough to be called towns

[10] Driessen and Letesson, 2024.

[11] see recently: Driessen and Letesson, 2024.

[12] McEnroe, 2010.

[13] Haysom, 2018.

[14] Alušík, 2023; Molloy, 2023, 2012).

[15] Zeman, 2020.

[16] Dickinson, 2014.

[17] Dakouri-Hild, 2010; Davis and Stocker, 2022; Maran, 2022; Mühlenbruch, 2020; Zeman, 2020.

[18] Nakassis, 2021.

[19] Boyd, 2016a, 2016b; Cosmopoulos, 2019; Davis and Stocker, 2022; Killen, 2024.

(e.g. at Mycenae and Tiryns). Notably, only the core palatial area and ancillary buildings were enclosed by fortifications at excavated sites, with the surrounding towns remaining unenclosed on current knowledge.

The population of Mycenaean centres was apparently small in comparison to the myriad hamlets, villages and small towns that made up palatial polities and have been discovered by survey and documented in Linear B, particularly from Pylos. The majority of the population appears to have lived in non-urban settlements and such compact urban centres as existed were likely home to a small proportion of the overall population during the palatial period.[20]

The Mycenaean economy was once perceived to have been redistributive – such that the palace played a centralising function with resources being brought there as a tax (of sorts), and then re-allocated as a means to procure, reward or otherwise sustain service and fealty. More recent work views palace economies as mobilising proportions of resources (material and human) and managing how and where they were employed, in part through the allocation of land and resources as reward.[21] That is, participants within the system had substantial control over their resources and benefitted from the protection and networks of the palace in return for dispensing with portions of the human, animal and material resources as instructed. Some labour was directly mobilised by the palatial administration / leaders whereas other labour was indirectly mobilised through these intermediaries who were compensated / rewarded by the palace.[22]

A key issue with centres of power is that they were incrementally exclusionist, creating a hierarchy of access and visibility with the seat of the ruler being at a substantial conceptual and physical remove from the inhabitants of the attached urban space. The special function buildings reflect the complexity (or complicated nature) of Mycenaean society, with their multiple functions reflecting multiple facets of society from distribution of resources to craft workers to documenting agricultural produce to feasting. Through hierarchies of spaces within centres and hierarchies of status differentiating other sites from each other within palatial territories, urbanism defined differences in Mycenaean society and supported elite agendas of hierarchisation and social differentiation. Through wealth and prestige economic practices, an important aspect of elite competition in the Aegean was the acquisition and display of small, wearable / portable personal wealth. This resulted in a rich array of material culture and often exquisite art that was consumed by a tiny portion of the population but takes pride of place in museums and how we envisage Mycenaean society. Similarly, just as the majority of the population would not experience these prestige objects in person, they would not routinely encounter urban spaces. Essentially, there were very different contemporary experiences of being "Mycenaean" or at least living in palatial territories.

It is quite probable that Mycenaean polities were highly competitive and frequently in armed conflict with each other as they rose to their height in the thirteenth century, marking a highly fragmented political world.[23] The crystallisation of kingdoms such as Pylos may have only occurred in the mid-13th century, for example.[24] If there ever was a primes-inter-pares ruler in the mould of Agamemnon of Homer's Trojan War cycle, it would have most probably have been then.[25] With regard to interaction with Europe, then, we must be cognisant that the Mycenaean world for most of its history was a place fragmented into small polities that occupied a highly fractious region. The timeline and shifting character and experiences of Aegean urbanism has implications for our discussion below of relationships with Europe.

[20] various in Wijngaarden and Driessen, 2022.

[21] various in Galaty and Parkinson, 2007; Halstead, 1992; Timonen, 2024; various in Voutsaki and Killen, 2001.

[22] Nakassis, 2021.

[23] Dickinson, 2006; Maran, 2022; Middleton, 2020a.

[24] Cosmopoulos, 2019.

[25] Kelder, 2012.

The South Carpathian Basin at the time of Aegean urbanism

We must begin by looking at the trajectory of our area of interest in the Carpathian Basin on the same timeline to evaluate spaces for long-distance interaction and influence. In the early days of European prehistory, Gordon Childe argued that the tell settlements of the Carpathian Basin may represent early forms of complex society in Europe, largely based on their superficial similarity to Near Eastern tells – a comparison we now know to be fundamentally inaccurate.[26] Nonetheless, the societies that emerged at and around these tells have subsequently been shown to exhibit a different form of complexity than Childe envisaged, and they were well-connected into long-distance networks.[27] They were exceptionally resilient, with key elements of their macroculture continuing throughout the later third and entire second millennium BC.

Tells began to form at the same time as the final, waning years of the Cycladic Early Bronze Age and at a time when Cretan societies had entered a transitional, late-Prepalatial period when communal tholos tombs with comingled burials were abandoned and our very limited settlement data infers a slow, gradual move toward nucleation.[28] Many tells were already in their heyday when, in the 19th century BC, the first palatial buildings were established in Crete. This precludes directional influence from south to north, as Kienlin[29] discusses in further detail. What we find, therefore, is the emergence of sustained and long-lived lifeways around tells in the Carpathian Basin fully independent of the embryonic forms of Aegean urbanism. The two societies then coevally develop throughout the 19th to 16th centuries BC following trajectories clearly established in each area, with no deviations that suggest influence from one upon the other.

There is a striking contrast between the underlying social orders also. In the Aegean, monumental spaces were built asynchronously and with relatively short timelines at sites such as Knossos, Phaistos, Mallia, Petras and Monastiraki. Within this emerging system, hierarchical relations became increasingly evident even if specific elite identities are difficult to identify.[30] In the tell-centred networks of the Pannonian Plain, polities developed strategic 'levelling' mechanisms to reduce the visible manifestations of hierarchisation and inequality in the sense of wealth-based political economies.[31] Architecture and mortuary practices alike reveal little taste for exceptional differentiation.[32] Monumentality was constructed through the intergenerational re-use of spaces to create tells. This focus on the importance of the continued use of specific places across centuries is shared between both areas, but at a superficial level.

After the collapse of the Cretan Neopalatial system ca. 1450 BC, the slowly developing and small-scale societies of the mainland begin to expand in complexity and reach. However, given the chronology, the case for Mycenaean influence from mainland Greece on Carpathian tells is weaker recognising that Mycenaean identity only emerged during the abandonment / collapse phase of the Carpathian tell-centred societies from the 17th to 16th centuries BC. There were interactions and some concepts did move between realms, this much is clear, but at a point in time when the fortunes of both societies were moving in different directions.[33] Most importantly, Mycenaean urban spaces emerged later still around 1400 BC.[34] However, as it is now apparent

[26] Chapman, 2009.

[27] Dani et al. 2019; Duffy, 2014; Duffy et al. 2024; Gogâltan et al. 2020; Kienlin, 2020; O'Shea, 2013.

[28] Legarra Herrero, 2014; Molloy et al. 2020b; Renfrew et al. 2022; Whitelaw, 2012.

[29] Kienlin 2020.

[30] Legarra Herrero, 2016.

[31] Duffy et al. 2024.

[32] Sorensen and Vicze, 2024.

[33] Harding, 2007; Maran, 2013, 2020; Molloy et al. 2024; Vandkilde, 2014.

[34] Zeman 2020.

that the tell-centred networks were succeeded by a horizon of massive, enclosed sites in the south Pannonian Plain (along with other settlements), the potential for Mycenaean urbanism to have influenced societies there requires reconsideration.

Interaction between Mycenaean Greece and the Carpathian Basin was much more substantial after the tell-centred societies had collapsed. This is visible though an exponential increase in the two-way transmission of technologies, ideologies and trade of metals, for example.[35] It is also quite probable that small-scale migration from the Carpathian-Balkan ambit into Greece as the Mycenaean koiné developed was occurring around this time, though this possibly began in the 18th century BC.[36] To evaluate potential Mycenaean influences in the Carpathian Basin, an overview of the local background is first provided to give context to resilient systems that crossed the Middle to Late Bronze Age divide there.

Bronze Age settlement in the southern in the Carpathian Basin in the late Early to Middle Bronze age

Beginning in the third to fourth quarter of the third millennium BC, tell settlements were established, with at least 188 known.[37] They stand up to 4 metres or more in elevation and were home to tens of houses at most and many were surrounded by a lower flat settlement, often enclosed partly or wholly by a ditch. They were home to modest communities, perhaps numbering up to the low hundreds at each site.[38] Though densely occupied, the inhabited space was typically dominated by simple domestic structures and little differentiation between buildings or spaces has been detected.[39] The open ceremonial area at Pecica and bronze casting in and around a building at Feudvar remind us that some sites may have had special function areas.[40] However, in general, tells lack the range of special function buildings or spaces characteristic of contemporary urban sites in the Aegean and they were by definition predominantly residential.

Alongside true tells, sites with shorter or more sporadic settlement history created lower, stratified sites that Gogaltan and colleagues[41] call tell-like settlements. Greater in number again are flat settlements that had little or no vertical stratigraphy. These broad divides are in themselves simplifications, because of the outer "lower" flat-settlement that surrounded many tells. We lack detailed information about the nature of activity in flat settlements, though it is probable they were better suited to an array of routine activities, including animal management (such as milking) than the dense cores of tells. This may mark a divide between the activity within tells and that carried out in the lower settlement and flat settlements.

Hierarchical relations between sites have been argued for, ranging from flat settlements at the bottom through to large tells at the top. O'Shea identifies Primary and Secondary tells with affiliated flat-settlements in a three-tier hierarchical relation in his Pecica Polity.[42] Dani and colleagues[43] argue for a simpler hierarchy, perhaps only operating at two levels with tells and flat settlements.

[35] Bouzek, 1994; Bruyère et al. 2024a; Bulatović et al. 2021; Gavranović et al. 2022; Harding, 1984; Molloy, 2016; Molloy et al. 2024).

[36] Lazaridis et al. 2022; Yediay et al. 2024.

[37] Gogâltan et al. 2020.

[38] Duffy, 2014; O'Shea and Nicodemus, 2019.

[39] Sorensen and Vicze, 2024.

[40] Falkenstein et al. 2016; Gogâltan, 2008; O'Shea and Nicodemus, 2019; O'Shea, 2013.

[41] Gogâltan et al. 2014.

[42] O'Shea, 2013.

[43] Dani et al. 2019.

The uppermost layers of tells have often been disturbed (being the highest), confounding clear definition of the chronology of abandonment at many sites, though existing 14C dates suggest most had at best low-level activity after 1500 BC. Nonetheless, it is apparent that virtually all tells were abandoned within a century or so, on current evidence.[44] This decadal to ca. one century timeline is consistent with recent models for the collapse of socio-political infrastructures.[45] The nature and extent of change – the irreversible loss of the role of tells as key nodes within societal networks – is also consistent with the collapse of a system and does not require substantial population loss.

Bronze Age settlement in the southern in the Pannonian Plain in the Late Bronze Age

I will begin by describing the spatial characteristics of the settlements of the Late Bronze Age before linking back to the discussion above on Aegean urbanism and the preceding tell-centred network. This provides the details necessary to build into a discussion about the character of complexity in the Late Bronze Age and to consider what was distinctly local and what may be indicative of ideological exchanges between the regions.

After 1500 BC, settlement continued in the area around many tells, though this was typically in the form of flat settlements, many newly built. In landscapes that had been marginal during the zenith of the tell-centred settlement network, a fully new system emerged between 1600 and 1500 BC. This was comprised of newly built sites, many enclosed, that we have called the lower Pannonian network. Within that network, over the course of LBA I-II (1600/1550-1200 BC), a sub-network of sites we have called the Tisza Site Group is comprised of a cluster of over 120 highly similar settlements, counting those in today's Serbia and Romania together (Figure 2). Chronological schema vary in different regional systems, but here I consider the end of the tell-centred system to represent the end of the Middle Bronze Age and the emergence of the Tisza Site Group (TSG) to characterise the beginning of the Late Bronze Age.

The known TSG settlements occurred alongside other new small settlements, probably farmsteads, in this same region.[46] The wider lower Pannonian network, of which the TSG is a component, is comprised of a series of massive, enclosed sites that had different layouts but shared a range of features, notably enclosure ditches. Taken as a general phenomenon, the lower Pannonian network emerged in the 16th century with building gathering pace in the 15th to peak in the 14th century BC, though with clear continuity in the 13th and earlier 12th centuries BC.[47]

The smallest TSG were in the region of 10 hectares, with many being several 10's of hectares, the largest being up to 100 hectares and the exceptional case of Gradište Iđoš was nearly 200 hectares in extent.[48] Within, TSG sites typically had 10 to 30 distinct, sub-circular activity areas. Ceramic sherds from cooking, storage and tableware vessels along with animal bone, quern stone fragments, burnt daub and occasional small finds that were recovered in surface survey at each of these sites indicate that these were the focal points of domestic spaces (as yet unexcavated). These loci are ca. 25 metres in diameter and were separated by 10's of metres, and pending excavation, have been termed 'activity areas' (Figure 3).

[44] Staniuk, 2021.

[45] Haldon et al. 2020; Johnson, 2017; Middleton, 2020b, 2017; Tainter, 1988.

[46] Bruyère et al. 2024b; Ćuković, 2013; Dorogostaisky and Hegyi, 2017; Estanqueiro et al. 2023; Girić, 1994; Harding, 2017; Hristov, 2017; Molloy et al. 2023c, 2020a; Sava and Gogâltan, 2022; Sava and Ignat, 2016; Szeverenyi et al. 2015; Szeverényi et al. 2017.

[47] Lehmpuhl et al. 2019; Molloy et al. 2023c; Sava et al. 2019.

[48] Marić et al. 2016; Molloy et al. 2023b.

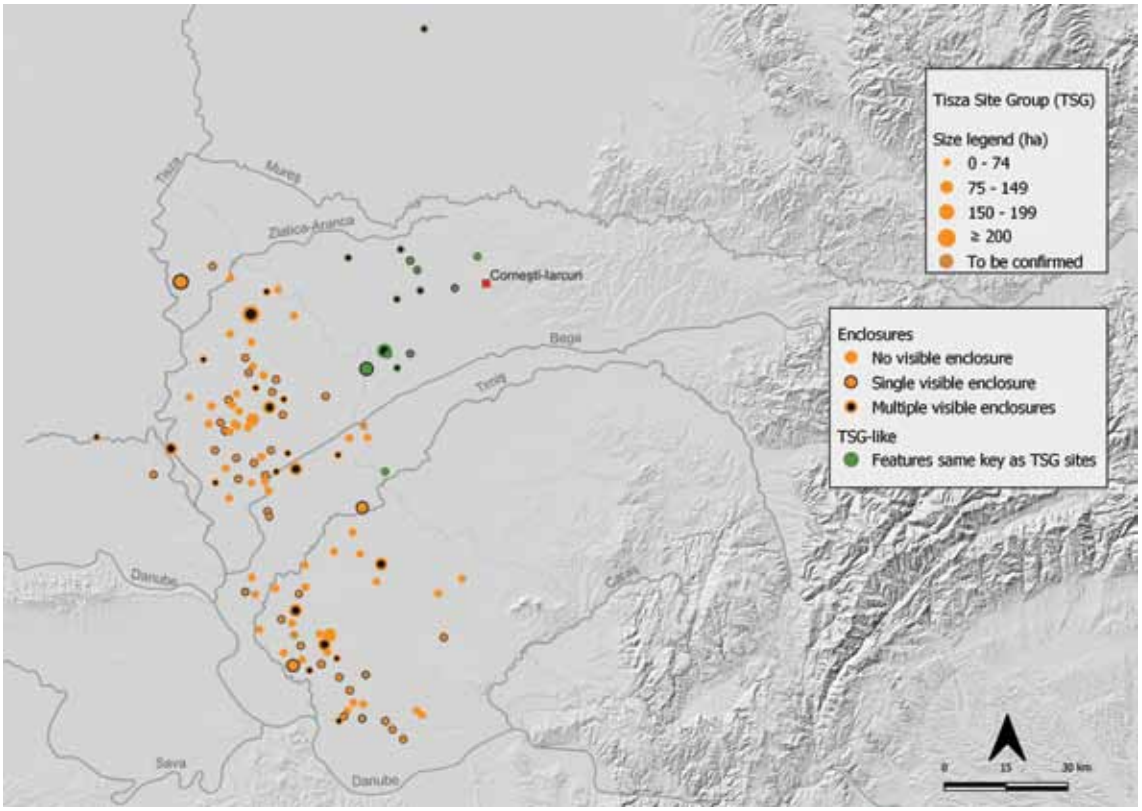


Fig. 2 – Size and visible features of TSG and TSG-like sites in Banat and east Backa. All definitions refer to features visible in aerial imagery. Single-enclosure sites have one complete or partially visible ditch outside of activity areas. Multiple-enclosure sites have two or more complete or partially visible ditches. Sites with no visible enclosures refers to detection using remote prospection visibility only and has not been ground truthed.
(Map by Marta Estanqueiro and Caroline Bruyere; basemap hillshade derived from ALOS DSM AW3D30, reprinted from https://www.eorcJaxaJp/ALOS/en/dataset/aw3d30/aw3d30_e.htm under a CC BY license, with permission from JAXA -Japan Aerospace Exploration Agency, original copyright 2023). https://doi.org/10.1371/journal.pone.0288750.g008. Originally published as Molloy et al. 2023: Figure 8).

Multiple activity areas formed an agglomerated habitation area we termed an 'activity zone' that was many hectares, occasionally tens of hectares, in extent. Unbuilt space in between these loci was the focus of other activities, for example pits detected through geophysics.[49]

The boundary between the activity zone and what lay beyond was often defined purely by a sharp drop off in visible surface and sub-surface activity, though sometimes it was defined by a palisade or ditch. The surrounding area was commonly devoid of archaeologically visible activity and we have termed this a 'buffer zone'. It lay between the activity zone and an outermost boundary defined by ditches, topography and / or natural water courses. When defined by an outer boundary, the buffer zone is most commonly ca. four times larger in spatial extent than the activity zone.

It is notable that at sites where geophysical surveys have been conducted, ditches not visible in aerial imagery have commonly been identified as well as confirming those that are in the visible spectrum.[50] Bruyère and colleagues[51] have further confirmed that the organisation of set-

[49] Bruyère et al. 2024b.
[50] Bruyère et al. 2024b.
[51] Bruyère et al. 2024b.

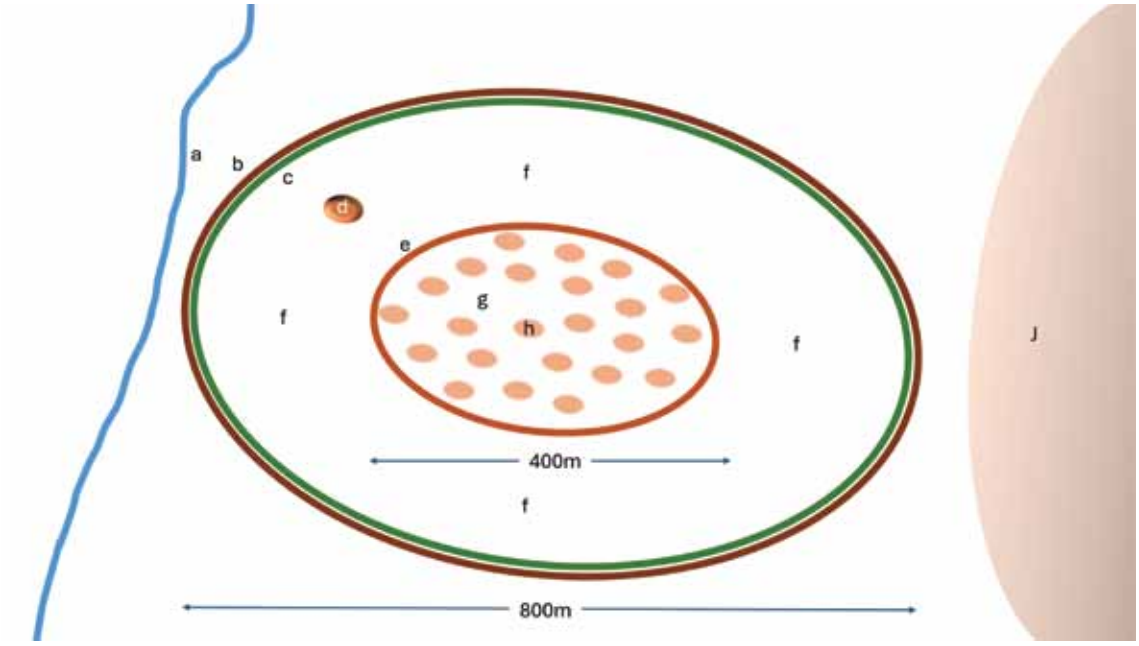


Fig. 3 – Schematic view of a middle-sized TSG site illustrating main spatial divisions and features and indicative dimensions. a) river, b) ditch, c) rampart, d) tumulus, e) palisade, ditch or rampart, f) buffer zone, g) activity zone, h) activity area, j) high ground / sandy terrace.

tlements as visible in aerial imagery with respect to loci of activity, empty spaces, the existence of enclosures etc. is closely similar to the data from surface survey and geophysical survey (Figure 4). As a result we can be confident that macro-scale features of these settlements have been accurately defined, while we await excavation to evaluate specifics.

All sites in this network follow the same canon of activity areas, activity zones and buffer zones with most also having visible outer boundaries (Figure 5A). This indicates that the design of sites shared an established and culturally defined template for shaping their domestic realm. That defines them as belonging to a unified phenomenon and similar socio-political configurations.

There is also a direct correlation between the number and density of activity areas, the overall size of sites, and the complexity of internal divisions. In some cases it is likely that smaller sites grew to become larger, but in many cases (e.g. Sakule, Mokrin, Crepaja, Dobrica) it is apparent that larger sites were constructed to be functionally different as they were built larger when they were founded. Based on size, density of activity, and complexity of design it is apparent that there was a hierarchy of sites within this network (Figure 5C). Such a hierarchy may relate to the status of those dwelling within (e.g. elites), though as the density of sites in the network suggests they were multi-local polities in which people moved between settlements (e.g. for marriage), it is also likely that site size related to function. Some may have been home to specialised craft activities or exploited environment niches, while others may have been regional gathering places.

The open spaces within sites appear closely correlative to overall site size, from the smaller sites suited to hosting outlying farmsteads through to medium sized sites (e.g. Kačarevo, Torda 2, Mramorak, Zrenjanin) that could host gatherings of several smaller communities through to the largest sites that could host a great many from within the network, notably Gradište Iđoš. At the top of this spectrum lies Cornești Iarcuri, which if related to the TSG network, could host many thousands of people and animals seasonally.[52]

[52] Gaydarska and Chapman, 2022; Krause et al. 2019; Lehmpuhl et al. 2019; Szentmiklosi et al. 2011.

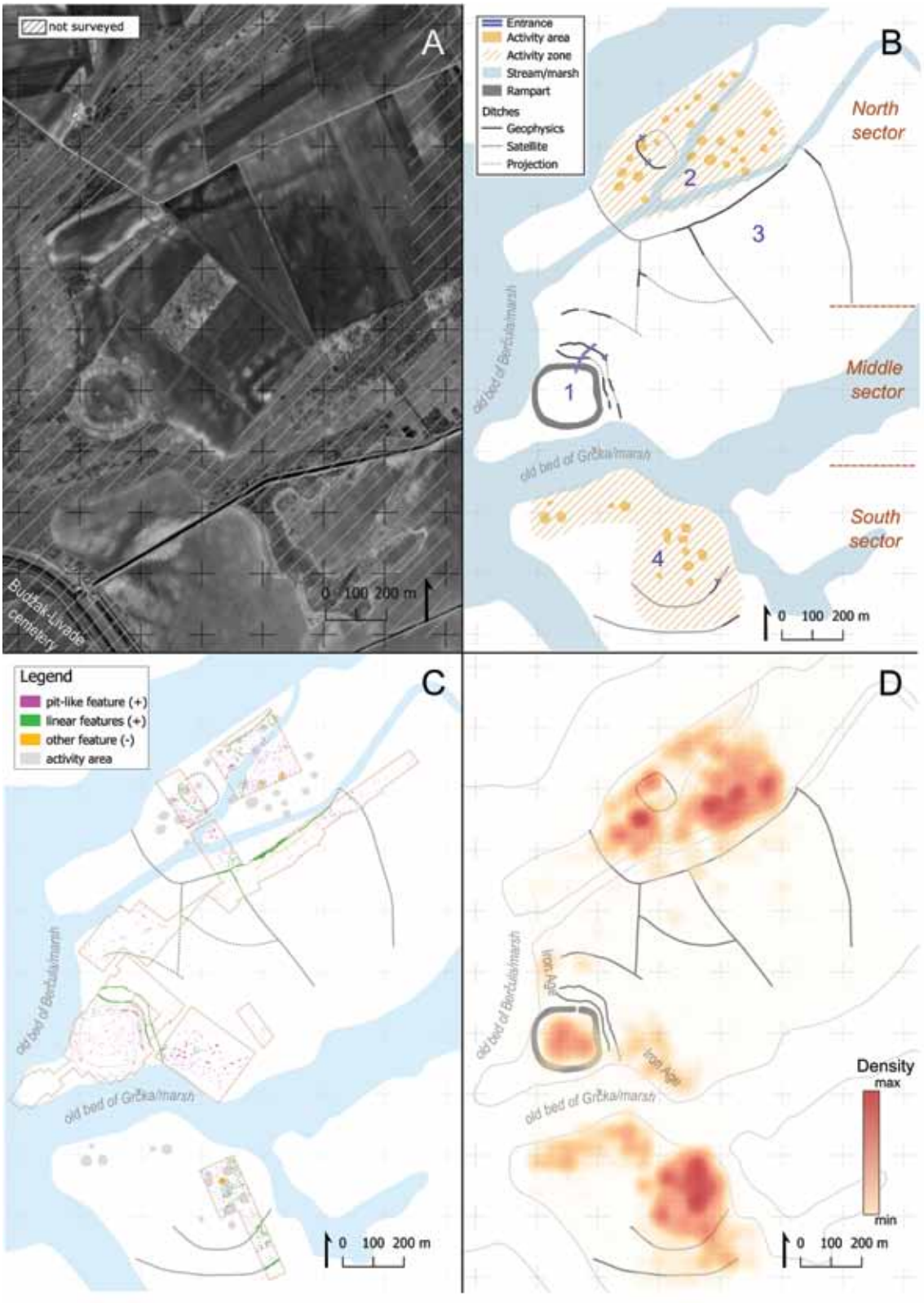


Fig. 4 – Gradište Iđoš results of remote prospection, geophysical survey and systematic surface survey: A) satellite image (source: Google and Maxar Technologies (grey-scale)), B) vector illustration combining data from satellite and geophysics and key for numbered enclosures for text, C) geophysics interpretation (grey activity areas from satellite imagery, beige lines show extent of geophysics data), and D) heatmap of pottery count from surface survey. Originally published as Bruyère et al. 2024: Figure 14.

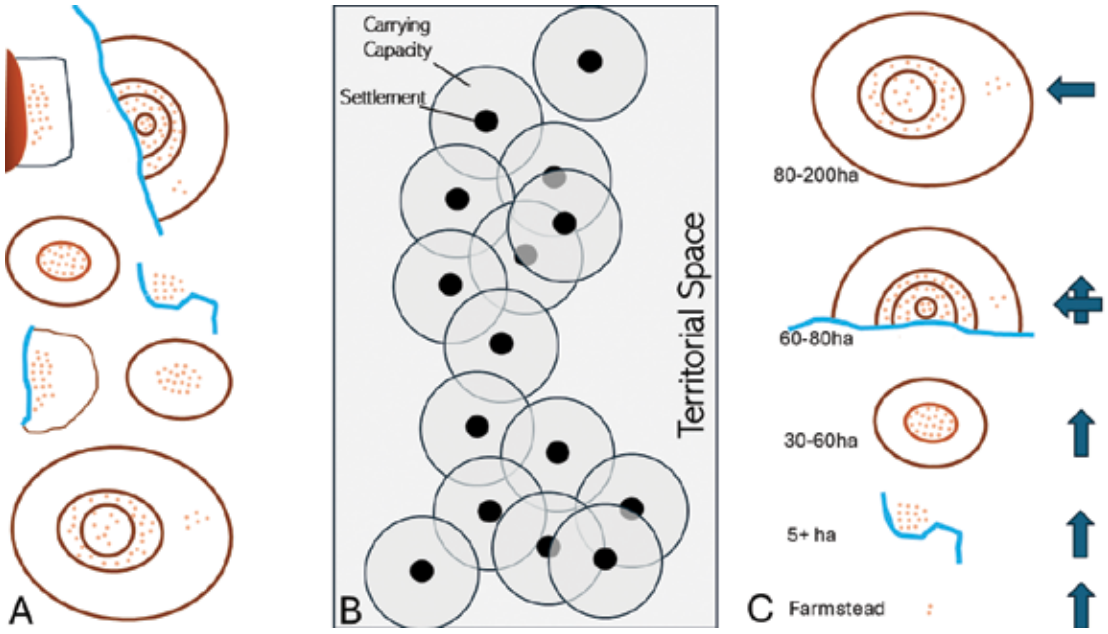


Fig. 5 – A) Schematic layout of a TSG settlements illustrating shared features within different configurations; B) Schematic of the overlapping carrying capacity of settlements in the TSG network; C) Schematic hierarchy of settlements ranging from farmsteads to the largest sites, including a possible categorical division between the largest sites in the network.

The "ingredients" that make up the organisation of settlements within the TSG network were modular but consistent and therefore attest to a common cultural package that links the communities that lived within them (Figure 3). The archaeologically detectable elements are:

1) Activity areas measuring 20-30m in diameter where domestic refuse is found amid anthropogenically modified soil, characterised by its paler colour relative to surrounding soil.
2) The broadly equidistant, but unordered, distribution of these activity areas in a concentrated space termed an activity zone
3) The definition of different spaces within the settlement that become more elaborate as site size increases
4) The retention of an unbuilt area within the defined space of the settlement
5) The enclosure of most (not all) sites using ditches and / or the local topography
6) Topographical preference for low lying areas including frequent avoidance of nearby higher ground / sand-clay terraces
7) Proximity to, and frequently incorporation of, minor water courses
8) Regularly, but not always, associated with earlier tumuli
9) Located in most cases within 5km of another settlement of the same form

Divisions within the larger sites indicate a complexity of spatial arrangements. Access to some was incremental, such that a visitor would pass through several zones defined by boundaries and gates to reach more central areas. Richer[53] defines social topographies as a concept that shapes "the structure of the built environment, as well as the symbolic actions through which elites demarcate and defend exclusionary spaces, have bearing on where and how status practices take place". Colleagues and I have discussed elsewhere how physical divisions embedded social topographies relating to the performance of status difference and exclusionary activities at TSG

[53] Richer 2015: 348

sites.[54] Structurally embedded social topographies indicate that moving between the bounded spaces of these sites related to identity, status or changing activities and it is notable that the capacity to segregate people spatially increased at larger sites.

The presence of these large, nodal settlements of the Tisza Site Group infers the presence of a network that linked them to smaller, farmsteads or hamlets in their hinterlands - settlements of a size that are notoriously difficult to identify without large-scale intensive surveys. However, a combination of extensive survey based on local knowledge, old finds and development led excavations reveal the presence of a few such settlements, providing a small but important supporting dataset.[55]

An indication of economic complexity in the TSG network comes in the form of a balance beam (Figure 6) found by P. Medović at the settlement of Borđoš.[56] This is dated to the LBA and demonstrates the presence of a form of weights and measures that would have supported complex economic activities.[57] A further indicator of such complexity comes in the far-reaching sources of copper that were being obtained by people of this network, including Alpine, Carpathian and Cypriot sources.[58]

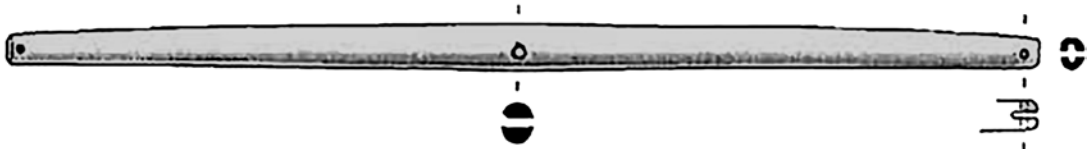


Fig. 6 – Bone balance beam used for measuring weights found at the TSG settlement at Borđoš (after Pare, 1999: Figure 22B).

Considering the outer boundaries of TSG settlements, these may be viewed as boundedness of communities, but given that sites were rarely located more than 5km distance from their nearest neighbour, the carrying capacity of each site overlapped with others (Figure 5B; Molloy et al. 2023: Figure 10). This suggests that the landscape was shared between these enclosed settlements and smaller sites that lay between. Viewed as a system within which mobility was likely to be a norm between nodes through phenomena such as marriage, fostering or houses (in the Levi-Strauss sense), it is probable that communities were not bounded in or anchored to loci.[59] Just as the boundary to activity zones did not define an end to the social space of the community, so too the outer boundary ditches can be seen to have defined a limit only to certain activities and conceptualisation of spaces.

The sites themselves appear to make a territorial claim on the space they directly inhabit, but their proximity to each other suggests that this territorial claim extended to the space between, thereby staking a territorial claim to the land throughout this vast network (Figure 5). The overall area of the wider TSG network extends over hundreds of square kilometres, which is expanded further taking into account the entire lower Pannonian network. This sense of territoriality accords with what Moore[60] has called the building of "powerscapes" comprised of chains of defensible settlements. With territories extending beyond specific sites we infer that there was one or

[54] Molloy et al. 2023a; see also Müller, 2013.
[55] Ćuković, 2013; Girić, 1994; Hristov, 2017; Трифуновић, 2020, 2016, 2012.
[56] Pare, 1999: 452.
[57] Ialongo et al. 2021.
[58] Bruyère et al. 2024a; Gavranović et al. 2022.
[59] Furholt, 2017.
[60] Moore 2017a

more polities in existence within the TSG and lower Pannonian network. The construction of sites with highly similar designs and the creation of some that were intended to hold different status from their foundation, provides clear evidence of planning at a regional level. This is indicative of a complex, centralised and well-organised socio-political system. Such a system emerged over the course of more than a century as settlements were established successively within this TSG network.

Categorical architectural hierarchies of sites within the Tisza Site Group may be inferred through a combined view of size, complexity and density of activity.[61] However, taking the system as a whole, I suggest that the largest and most complex sites served as administratively dominant centres and that the role of other sites within the network was defined relationally with these centres and each other. This should not equate with a sliding scale of hierarchies of autonomy or power for communities resident within each settlement. Power was negotiated through relationships between people not places and therefore, in my view, it was not manifested through the size of each individual settlement but rather performed through actions associated with each. In lieu of hierarchies emanating power from a truly central site with satellite secondary centres controlled by subordinate leaders, the internal layouts of settlements and inter-site relationships both appear to better fit with heterarchical or factional social structures.

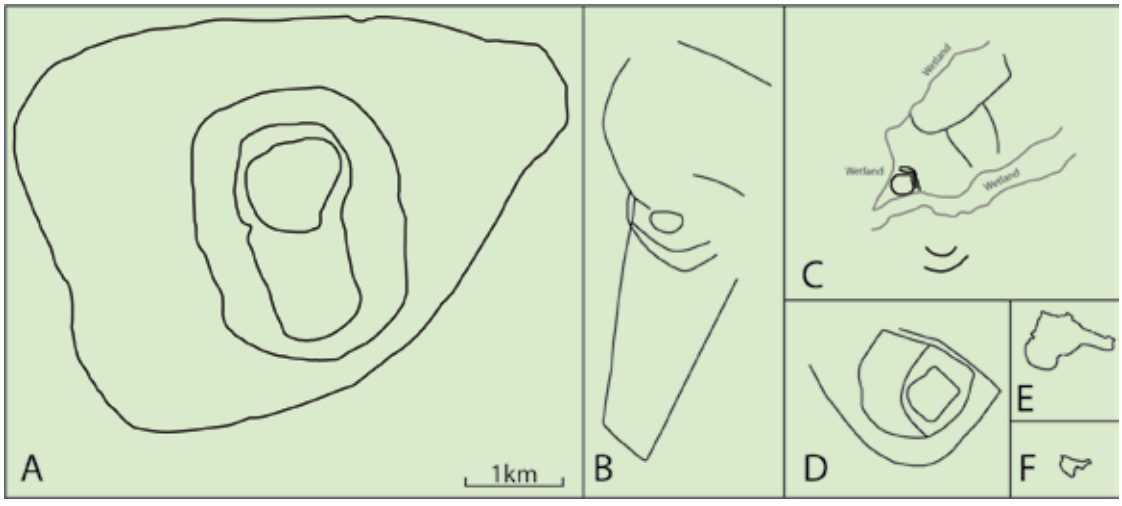


Fig. 7 – Outline drawing of key large sites in the lower Pannonian network. A) Cornești Iarcuri, B) Csanádpalota Földvár, C) Gradište Iđoš, D) Sântana - Cetatea Veche, E) Glas, F) Mycenae.

Looking to other sites of the lower Pannonian network, we can identify important similarities and differences. Santana Cetatea Veche measured over 120 hectares (Figure 7D) and it was designed differently by virtue of its broad ramparts. Within the enclosers of this site, a large building and / or enclosed structure has been identified within enclosure I, as well many unexcavated rectangular house sites within enclosure III.[62] These buildings indicate clear differences in internal organisation between Santana and the TSG network as does its distinctive ramparts. Csanádpalota (Figure 7B) was quite different again, enclosing a space of over 460 hectares but with very low density occupation evident within.[63] It is plausible that the mega-site of Cornești Iarcuri (Figure 7A), where 33km of ditches and ramparts enclose an area of more than 1,750 hectares, was intimately linked to the TSG network. Despite its massive size, the footprint of activity within is very

[61] Bruyère et al. 2024b; Molloy et al. 2020a.

[62] Krause et al. 2022; Sava et al. 2019.

[63] Szeverényi et al. 2017.

sparse and much of the space enclosed appears to have been left open.[64] We have argued that the TSG network may have served as at least one element of its congregation catchment, constituting the society that built and maintained this mega-site as a communal resource.[65]

Alternative complexities: Contra-urbanism, rurbanism, proto-urbanism and agro-agglomerate perspectives on Bronze Age societies of the Carpathian Basin

Building on the above descriptive sections, I will return in this section to a consideration of complexity in the lower Pannonian network. This will include consideration of terminology that can assist in levelling the playing field for a comparative approach between the distinct social systems discussed above.

Contra-urban is a term borrowed from urban planning literature in which it stands as an area distinct from urban by virtue of rejecting dense building, retaining open spaces within the boundaries of settlements and having a soft transition to surrounding rural landscapes. In its basic essence, contra-urban is related to concepts like Ebenezer Howard's[66] *Garden City* model that consisted of a clustered settlement that integrated organically with surrounding reserved rural spaces. Barua[67] argues that a "contra urban political ecology/economy… recuperates the other than human as a productive economic force", such that unbuilt land was a conceptual necessity for the system to work. In this archaeological text, I use contra-urban to describe a settlement system in which social institutions and praxes required open spaces and soft boundaries between dense living space and surrounding lands. In practice, this is antithetical to urban models associated with densely built living spaces that combined myriad domestic, administrative and ritual functions in special purpose buildings that were connected by formal street networks to form a continuous and exclusively anthropogenic space, as we find in the central palatial centres of the Aegean world. Contra-urban is used here as a modern retrospective perspective on settlement layouts and is not intended to reflect in any way a deliberate model conceptualised in past societies to stand in contradistinction to urbanism.

The absence of urbanism as a structuring concept for the built environment is of course not by default contra-urbanism; the latter is relevant to settlements with spatial footprints and labour investments similar to those required to build an urban space but were employed in a fundamentally different manner. The special function buildings in urban spaces can be seen as materialisations of social institutions. Such institutions required space and in urban models, this came to be linked to a belief that buildings were the appropriate means to provide such space. Over time, these became co-constituted with one reenforcing the need for the other. Contra-urban is envisaged here as a state of affairs where spaces were defined that enabled the segregation of activities when required but these were not perpetually reserved for a narrow range of activities.

The term proto-urban has commonly been used in European prehistory as a marker of complexity for non-urban societies that exhibited organisational complexity and monumental, often hierarchically ordered, settlements. The phrasing infers an early developmental state of being that existed as pre-, sub- or otherwise lesser-than-urban in its state. As to defining proto-urban,[68] emphasises its ambiguity, characterising it as being "something with inchoate elements of 'urbanity',

[64] Krause et al. 2019; Lehmpuhl et al. 2019; Szentmiklosi et al. 2011.

[65] Gaydarska and Chapman, 2022; Molloy et al. 2023c.

[66] Howard 1902.

[67] Barua 2023.

[68] Harding, 2018: 317.

not yet fully formed." He highlights that the term appears sporadically in literature on prehistoric Europe, but its meaning has never been explicitly defined in that setting against clear exemplars. The core issue is that the term infers but does not describe the nature of complexity. Proto-urban is increasingly rejected as ultimately unhelpful and founded upon colonialist perspectives of how we recognise complexity through the lens of urbanism.[69] In comparative perspective, the term proto-urban risks relocating the more spatially complex societies in prehistoric Europe into a discourse in which urbanism is the barometer of complexity. In effect, that further marginalises societies falling short of any definition of proto-urban.

Moore and Fernández-Götz[70] recently explored the term "rurban" to define large, complex settlements in Iron Age Europe that retained open, multi-functional spaces while also having comparatively dense built-environments concentrated in spaces within. They are termed polyfocal, referring to their role in fulfilling a range of social, political, economic and possibly religious roles. These may include anything from festivals to markets to market-gardening to animal management to defence to ritual to stages of mortuary activity and more. A key tenet of Moore and Fernández-Götz's rurban model was a capacity for humans, plants and animals to routinely encounter each other within the defined space of a settlement.

Though well-suited to Iron Age Europe where knowledge of contemporary urban systems was increasingly impactful, the retention of urban as the key to defining the status of the settlement is problematic. Moore and Fernández-Götz[71] rightly point out, as Harding[72] has before, that debating terminology is less productive than agreeing upon observable features that reveal degrees of centralisation, resource management and political complexity. Nonetheless, as with proto-urban, retaining urban as the root through which we infer complexity is unhelpful in a Bronze Age context when urbanism had not taken root beyond one small corner of the continent. Looking to the Late Bronze Age societies of the south Carpathian Basin, and seeking to remove the word urban from the equation, I propose that the term *agro-agglomerate* may be appropriate for describing the network of large enclosed sites there. This takes its lead from the more detailed discussion of low-density urbanism and related systems by Moore,[73] and Moore and Fernández-Götz.[74]

The *agro* component stresses the structural need for space for pastoral and / or arable agricultural activity to be integrated into the physical and conceptual design of settlements. It also defines the low or at least graduated differentiation between settled space and agricultural space in the continuous belt of land connecting settlements. Certain primary agricultural activities may be transplanted directly into the heart of settlements which were spatially dominated by "unbuilt or scarcely occupied space, often more similar to farmed landscapes than to our traditional notions of high-density urbanism".[75] *Agglomerate* can mean a thing that is comprised of heterogeneous components that though clustered together do not form a coherent, monolithic whole. The term agglomeration has been used in Iron Age research to define larger, central sites where multiple activities often associated with urban infrastructures took place.[76] In our context, agglomerate refers to a location in which multiple activities take place, for example craft, administration, butchery, rituals, legal trials, and gatherings. These reserved, open spaces must be related directly to sub-

[69] Gaydarska, 2019, 2017.
[70] Moore and Fernández-Götz, 2022.
[71] Moore and Fernández-Götz, 2022.
[72] Harding 2018.
[73] Moore, 2017b.
[74] Moore and Fernández-Götz, 2022.
[75] Moore and Fernández-Götz, 2022: 109.
[76] Moore, 2017a.

stantial settled spaces withing the same agglomeration. To be meaningful, the agro-agglomerate model should form a pattern across many (tens to hundreds) settlements within a given spatial setting. Agro-agglomerate allows us to focus on the means through which complexity can be defined unchained from concepts of urbanicity.

Discussion

The idea of urban as a categorical phenomenon is one where dense building takes place, potentially including domestic and/or special function buildings with connecting streets or paths. The presence of such an urban space presupposes its opposite, a rural countryside that is categorically beyond the urban. For a society to be urban, therefore, it cannot be at the single site level but must be repeated with multiple loci that sustain this difference.[77] However, beyond categories, it is also reasonable to consider urban places as specialised locations that fulfil a range of centrally ordered activities serving a wider community. With reference to Mycenaean urbanism, Zeman[78] takes this relational perspective further, arguing that urban centres should possess greater organisational complexity within than other sites in the same network, a point to which we return below with respect to similarities and differences within sites of the Tisza Site Group.

The concept of hierarchically ordered settlements within a densely spaced settlement network that we encounter in the LBA had been characteristic of MBA tell-centred systems. The concepts of focussing settlement primarily in one area (tells) and enclosing wholly or partly unbuilt spaces (so-called lower towns) was prominent around tells. Though generalised and glossing over exceptions, these same features can be recognised in a modified form at TSG sites during the LBA. Domestic spaces were evenly distributed within a defined area rather than densely nucleated, and test excavations indicate repeated constructions took place on the same spot, generating discrete, multi-layered settlement deposits. This shows a similar concern for continuity of domestic space in both the MBA and LBA, but on a more localised scale in the latter case.

The concentration of domestic spaces and retention of open spaces has general roots in the MBA, but this was taken to a different level in the LBA, including retention of fully unbuilt spaces around domestic activity zones. A further feature retained was the hierarchical ordering of settlements that shared cultural attributes. Individual settlements constituted components in a multi-local polity that was planned and managed in a manner suggesting centralised organisation. Contrary to the inter-generational creation of monumentality in the MBA, labour was harnessed in the LBA to create monuments by and for the power brokers of the time.[79] That constitutes one of the sharpest changes between these phases.

TSG sites lack evidence currently for spatial or size differentiation of activity areas or other structures within the settlement that may indicate hierarchies or special function buildings / civic buildings requiring an alternative architectural design. We also have no evidence of centralised storage at any sites, and difficult as that may be to define archaeologically, the absence remains an absence thus far. Taking a lead from work on the Mycenaean economy, discussed above, elite mobilisation of resources may be a salient model. A substantial labour investment was required to build and maintain enclosed sites, which may represent shared or favourably distributed resourcing. Given the repetition of the formula across the landscape at over 100 sites, I would argue that one or more self-aggrandising groups of elite status were managing this. Drawing on

[77] Zeman, 2020.
[78] Zeman, 2020.
[79] Sharples, 2007.

the Mycenaean model, this need not be direct control and micro-managing, but rather the means through which local leaders can sustain participation within a system. It is perhaps salient that this participation is also potentially evident in the emergence of a common style of pottery - Belegis II / Proto-Gava – across the wider area.[80]

Management at a regional scale is also seen in the metal industry. The metal coming into this region was recycled within a zone incorporating the lower Pannonian network and communities west along the River Sava, creating a regionally identifiable "metal pool" through lead isotope and trace element analysis.[81] This further indicates a managed mobilisation of resources within a network that had controlling / influential nodes. Likewise, in this same zone, the regularity of style, production, repair and decommissioning practices indicates the presence of a community of practice of metalworkers that trained within a definable system.[82] There was doubtless competition and conflict within this region and between groups embedded in this community of practice, but there was also clearly organisational complexity linking the region up that is made visible through these shared practices.

Considering how these settlements functioned routinely, seeing them as agro-agglomerate infers loci in which humans, animals and plants would be encountered by each other in myriad contexts within lived spaces. Human space was not divided or constrained but integrated alongside these other living organisms. Activities of many sorts would thus have taken place in this mixed environment. While open areas were a component of the MBA lower settlements of tell and open settlements, they became a defining characteristic of LBA settlement design. This organisation of space suggests that there was a lack of inclination towards materialising political and administrative institutions through architecture in the urban mould or towards creating narrowly defined and differentiated spaces to selectively encounter human and non-human others. I view this as the crucial difference between the institutions and beliefs shaping the urban societies of the Aegean and the contra-urban, agro-agglomerative societies of the Pannonian Plain. The spaces created to shape and control interactions in the Aegean were dominated by managing how people alone would interact, with capacity to exclude being paramount. The spaces to manage interaction in the Pannonian Plain were in essence co-constructed social spaces that facilitated the needs of humans and animals. This important facet of how Bronze Age societies functioned is the focus of an ERC Advanced Grant project at University College Dublin led by Joanna Brück and her team that focusses on applications of post-humanist theory.[83]

Up to this point, I have emphasised differences between Aegean urbanism and agro-agglomerates at an ideological level and continuity with earlier MBA systems has been discussed. The idea of high-culture to low-culture transfer of concepts of organisational complexity was shown to lack evidential basis and, to the contrary, the social structures and broader worldviews underlying Aegean urbanism were argued to have been incompatible with the long-term macroculture characteristics and the agro-agglomerate system flourishing in the Pannonian Plain.

Nonetheless, as contemporary societies, there are firm grounds to believe they were aware of, and interacting with, each other.[84] This creates space for broader ideological concepts to have been shared. I recently argued, for example, that the Dupljaja chariot models are indicative of manifold cultural exchanges between the Aegean and the lower Pannonian network.[85] A shared

[80] Molloy et al. 2023b.
[81] Bruyere et al. 2024a.
[82] Orfanou et al. 2024.
[83] Kanne et al. 2024.
[84] Bouzek, 1994; Bulatović et al. 2021; Molloy, 2018a, 2016.
[85] Molloy et al. 2024. see also Bilić, 2016.

feature in the built environment of both areas can readily be identified in the creation of monumental, enclosed settlements with, at least superficially, martial visual aspects. This refers both to the finished product and to the mobilisation of resources to create them.

Reflecting on the construction of citadels in the Aegean world, Brysbaert[86] has emphasised the labour investment in the creation and maintenance of monuments as a prestige statement in their own right. The act of making, as well as the product, was ideologically loaded and a power statement. Sharples[87] has discussed similar for earthen enclosures and further emphasised that the labour for making and long-term commitment and vision for maintenance were both statements of power and tools to build community cohesion. Labour was even seen as an exchangeable resource in Davis'[88] model for the sociality of fort building. This is particularly relevant when we consider the multi-local community or communities that formed the lower Pannonian network. That statement was writ large in the creation of the 33km of ditches and ramparts around Cornești Iarcuri, seen as a central site for a catchment area that may have included one or more political entities.[89] A similar and contemporary colossal investment in domestic monumentality is documented in Friuli in Italy – an area in contact with communities of the Pannonian Plain and Aegean. This was the construction of the mound at Udine, standing 40 metres in height high and 400,000 m^2 in volume.[90]

Fortifications or defensible architecture fulfils myriad roles, including symbolic and ritual functions, but they were also implicitly functional as defensive features. The power exhibited in enclosures in both regions was thus clearly flavoured with military symbolism. With this in mind, it is noteworthy that developments in weaponry followed closely related paths during the LBA in both areas. We can trace this with swords progressing from long and thin Type A-D and Sauerbrunn-Boiu swords, through to shorter swords of Type Dii and F and similarly short ones from Rabina-Vranjkuša and Joševa-Popov Potok and on to the nexus of both traditions when Naue II/Reutlingen sword were used in both areas alongside bell helmets, shields and greaves that shared close correspondences.[91] Material culture and settlements are commonly viewed in isolation, but in this case, the parallel pathways in material culture reflect the parallel architectural pathways. Both objects and structures were highly functional things that furthermore embodied symbolic power by being status symbols. Interactions between distinct societies can commonly be in the form of conflict, and narrowing of the gap between hardware and tactical traditions can reveal intensifying interactions. The closely contemporary trajectories in defensive architecture and weaponry reflects similar expressions of power symbolism that were new in both areas.

Bringing this all together, the urban infrastructures of the Aegean world were embedded in the heritage and organisational logic of society there, and it is evident that these were fully incompatible with Pannonian Plain lifeways. If anything, the idea of a dense, central defensible area with a surrounding settlement may reflect influence of Carpathian Tells on Mycenaean citadels, which were so fundamentally distinct from and smaller than Neopalatial precursors in Crete. The TSG and lower Pannonian network were other-than-urban and not less-than-urban and the societies there represent a long lived and resilient, but nonetheless malleable and adaptable, socio-political system. They displayed a high degree of complexity that was suited to sustaining comparatively extensive political entities and large populations. The fundamental structural dif-

[86] Brysbaert, 2018; Brysbaert, 2017.
[87] Sharples, 2010; Sharples, 2007.
[88] Davis, 2019.
[89] Gaydarska and Chapman, 2022.
[90] Fontana et al. 2023.
[91] Harding, 1995; Kilian-Dirlmeier, 1993; Mödlinger, 2018, 2013; Molloy, 2018b.

ferences in how settlements, humans, landscapes and animals were viewed left little space for Aegean urban lifeways to impact on the Carpathian ambit, but a two-way ideological flow may be visible in the use of built enclosures to monumentalise settlements with a martial aspect.

Conclusion

If we accept contra-urbanism as having deep roots in the materiality of European societies, then the lack of urbanism in later prehistoric Europe was not a lack of something but a thoroughly resilient other thing. When that other thing lacks a term, it remains nebulous and fragmented into specific, contextually situated discussions. The word urban enables a comparative approach spatially (e.g. the Mycenaean realm and Egypt) and temporally (e.g. the Mycenaean realm and Classical Greece). Even so, recent work emphasises that the word urban itself has many contextually specific meanings.[92] We could therefore continue to shoehorn proto-urban into that growing discussion, but this leaves us with a structurally unequal starting point. I proposed that the term agro-agglomerate has value. This is because it is descriptive and relational, not categorical, and in so being it removes urban as the barometer of complexity. That in turn enables a more inclusive comparative approach to settlement systems in Bronze Age Europe across multiple scales of complexity. It also acknowledges that complexity can and did exist outside of the global north's civilisation paradigm even within the past of the global north itself.[93]

Using the case of the lower Pannonian network, I argued some European societies were engaged with and aware of the small-scale urbanism of the Mycenaean world. While concepts such as monumentalising settlements may have been shared, the design of settlements fulfilled fundamentally different purposes that supported very different institutions, but ones that shared certain characteristics. In the Aegean, the fragmentation of spaces for engagement into multiple microcosms was part of a strategy of hierarchisation that extended from political and administrative institutions through to settlements and the urban / rural divide was abrupt and sharp (at urban centres). In the Pannonian Plain, the division of spaces enabled different types of engagement between humans and non-humans that may have been modular. Differentiation was created through large, bounded spaces typically (not buildings) and intervisibility remained important so that the settled / farmed divide was incremental and soft moving from farmlands through buffer zones and into the activity zone(s) of settlements. Nonetheless, the desire to monumentalise places of the living through a martial aspect was seen to be new, at this scale, to both areas and to have occurred around the same time. The potential for communication of ideologies between the areas was supported by the sharing of military hardware, including an extensive coalescence by 1200 BC uniting both areas (and much of Italy).

The agro-agglomerative model existed outside of regions in which urban spaces occurred in prehistory, and by extension constitutes and area that has been situated outside of literature in which discussions linking urbanism, complexity and civilisations are deeply embedded. My argument has been rather basic at its core - if archaeology of urban societies is increasingly focussed on identifying diversity in modes of urbanism, this also provides a useful moment to more fully consider complex systems that ran parallel to urbanism. Urban and civilisation are terms ensnared in a teleological perspective linking the present and the past – a colonialist link many have called to be broken.[94] To understand alternative paths to complexity and ways of being human in popu-

[92] Rönnlund, 2024.

[93] Moore and Fernández-Götz, 2022: 114-116.

[94] Jennings 2021: 38.

lous political entities, the Carpathian Basin provides long-lived and illustrative examples from the Bronze Age.

As a way of ordering societies, agro-agglomerative (or later rurban) systems first emerged in the second millennium BC but the concept continued into the following millennium in Europe. The contra-urbanist underpinnings of the lower Pannonian network were not simply an absence of urbanicity, but embodied social institutions that at a fundamental level were organisationally, ideologically and spatially incompatible with contemporary forms of urbanism. Despite collapse and transformation reshaping tell-centred societies in the mid-second millennium, the centuries-old macro-culture retained prominence in the re-ordering of societies in the southern Pannonian Plain. This demonstrated the resilient underpinnings to societies there. The concept of proto-urban was dismissed in this paper because it leverages the academic respectability of the word "urban" with little to no justification founded in the archaeological record. If we regard the agro-agglomerative concept as antithetical to, rather than subordinate to, urbanism then the Pannonian Plain provides a useful venue for exploring alternative forms of complexity in prehistoric Europe.

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Materials, Techniques and Technology of the Encrusted Pottery Culture Anthropomorphic Figurines in Bulgaria (based on Baley necropolis excavations)

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Abstract: This study analyzes an anthropomorphic figurine from the Encrusted Pottery Culture, excavated at the Baley necropolis in Bulgaria. Utilizing scanning electron microscopy, X-ray diffraction, and optical microscopy, the research focuses on the figurine's surface characteristics and white inlay materials. The findings reveal intentional use of blue pigment in the slip, achieved by adding cobalt and copper—the earliest such use in Balkan ceramics dating to the 15th–13th centuries BC. The white inlay consists of calcite and bone ash, mainly Calcium Hydroxyapatite. These technological insights link the figurine's materials and techniques to its symbolic role in ancient cult practices and beliefs.

Key words: Encrusted Pottery Culture (EPC), Anthropomorphic Figurines, Baley Necropolis, Bulgaria, Cobalt-Copper Blue Pigment

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Introduction

Anthropomorphic female figurines are among the most emblematic artifacts left by the Encrusted Pottery Culture (EPC) population.[1] These figurines were made of clay, with surfaces additionally coated with a well-refined slip. They were richly decorated with incised motifs inlaid with white material. The ornamental compositions were arranged in three registers—upper (head), middle (body), and lower (lower part of the body)—each representing a complete ornamental scheme. Despite different approaches to their interpretation, the connection of these artifacts to ancient cult practices and beliefs is evident.

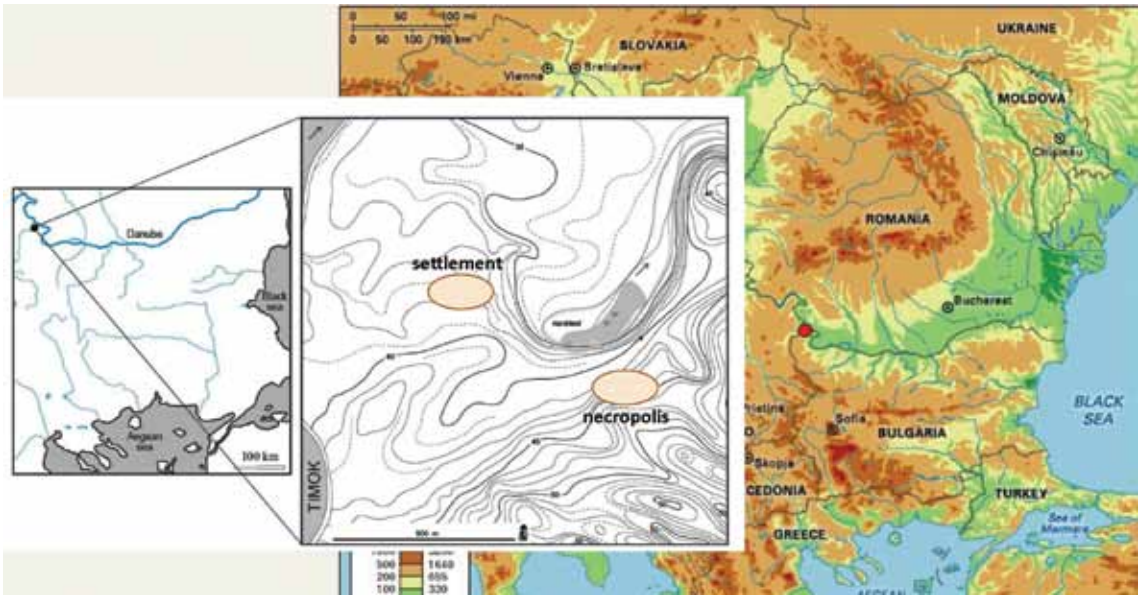


Fig. 1 – Location of Baley settlement and necropolis.

Comprehensive expert analyses of these figurines are scarce, which was one of the reasons to initiate a pilot study for a more elaborate investigation. A well-documented figurine from the Baley necropolis in Bulgaria, designated as feature no. 166, was chosen to commence such analyses.

Archaeological Context

The Baley Site

The Baley site is located in northwest Bulgaria, on the right bank of the Timok River, approximately 2 km from its confluence with the Danube River (Fig. 1). The settlement was excavated from 1970 to 1989 under the direction of Rumen Katinčarov (NAIM-BAS) and Ana Iocova (Vidin Museum). Four Late Bronze Age (LBA) occupation levels have been established, referred to as building horizons I to IV. Additionally, Early Iron Age pits have been discovered cutting through the LBA levels.[2] The second millennium BC cremation necropolis is located approximately 500 m southwest of the settlement (Fig. 1). Its investigation started in 2010.[3] Up to 2024,

[1] Şandor-Chicideanu 2003, 101–115.
[2] Alexandrov et al. 2012.
[3] Alexandrov et al. 2012.

186 features related to Middle and Late Bronze Age mortuary practices have been explored there.

Feature 166 and the Figurine

Feature 166 at Baley is a Late Bronze Age multiple cremation grave containing five urns:

- Urn A: Contained burnt remains of a *Iuvenis* (14–18 years old), probably female, and a child (*Infans I*).
- Urn B: Contained cremated remains of an *Infans I* (1–2 years old).
- Urns D–E: Contained small quantities of burnt bones belonging to individual(s) aged 0–6 months.



Fig. 2 – Baley necropolis, feature 166 photos.

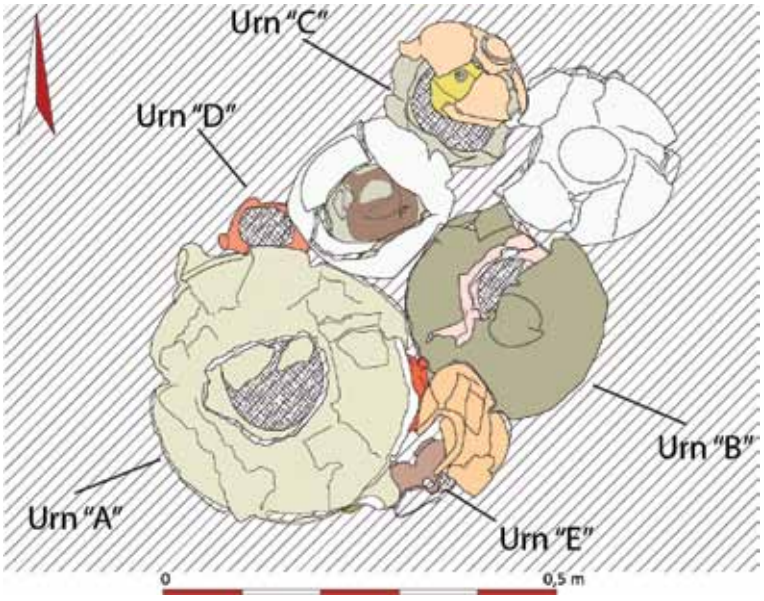


Fig. 3 – Baley necropolis, feature 166 graphic representation.

The anthropomorphic figurine was discovered under Urn A (Figs. 2 and 3). It can be assigned to type Φ1-B1 according to M. Şandor-Chicideanu's classification.[4] The figurine was coated on all sides except for the upper rear part. After coating, white inlay was applied in the incised lines that form the ornamental composition.

Materials and Methods

The investigation of the figurine focused on two main aspects:

- Surface Characteristics and True Color: Determining the characteristics and true color of the figurine's surface.
- Nature of the White Inlay: Analyzing the material used for the white inlay in the ornamental motifs.

[4] Şandor-Chicideanu, 2003, 104, pl. 198.



Fig. 4 – Baley necropolis, feature 166 figurine.

To achieve optimal results, the following approaches and equipment were used:

- Scanning Electron Microscopy (SEM): A JEOL 6390 microscope and an INCA Oxford analyzer were used to obtain data on surface morphology, density distribution, and elemental composition in atomic ratio and weight percentage.
- Powder X-Ray Diffraction (XRD) Analysis: Performed with a Bruker D8 Advance diffractometer. The radiation source was a Cu X-ray tube ($\lambda = 1.5418$ Å) operating at 40 kV/40 mA. Data were recorded within a 2θ range from 5° to 80°, using a LynxEye solid-state detector. Phase composition was determined using EVA software and the ICDD-PDF2 (2021) database.

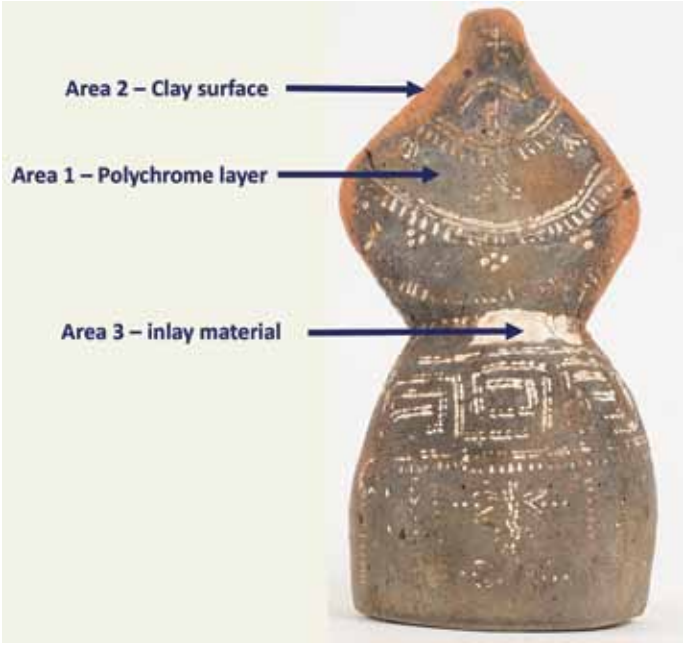


Fig. 5 – Baley necropolis, feature 166 figurine. Areas explored.

• Optical Microscopy: A Zeiss Axioscope 5 microscope was used for a non-destructive examination of the object.

Results and Discussion

Figurine Surface Investigations

The JEOL 6390 microscope and Bruker D8 Advance diffractometer provided data for elemental and phase identification of the coating. The results are presented in Table 1 and Figure 6.

Weight %

Statistics	C	O	Na	Mg	Al	Si	K	Ca	Ti	Fe	Co	Cu
Average	11.98	24.91	0.32	0.55	4.35	17.22	1.55	0.59	5.04	32.87	0.13	0.49

Atomic %

Statistics	C	O	Na	Mg	Al	Si	K	Ca	Ti	Fe	Co	Cu
Average	22.85	33.89	0.30	0.54	3.82	12.87	0.91	0.35	2.87	21.30	0.06	0.23

Table 1. Baley, feature 166 anthropomorphic figurine – surface analyses. Elemental composition.

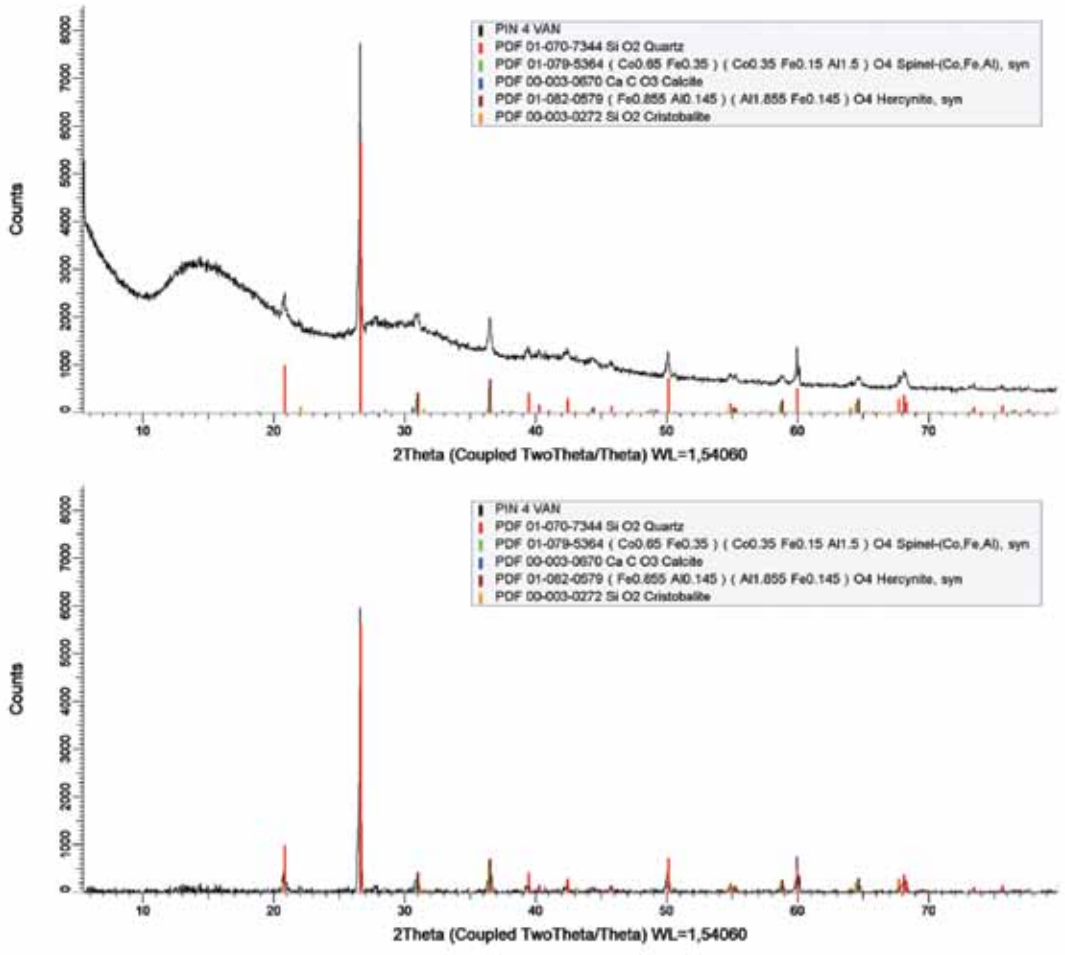


Fig. 6 – Powder XRD analysis of the polychrome layer performed on a Bruker D8 Advance diffractometer.

The data of the figure 6 indicate that the slip covering the figurine's surface was intentionally colored with a blue pigment. The color was achieved by adding cobalt (Co) and copper (Cu) into the slip, forming compounds with silicates and aluminates. The increased percentage levels of titanium and iron may be related to the extraction of cobalt or copper. The blue polychromy is well-preserved but has been modified due to oxidation and aging of the pigment (Figs. 7a and 7b).

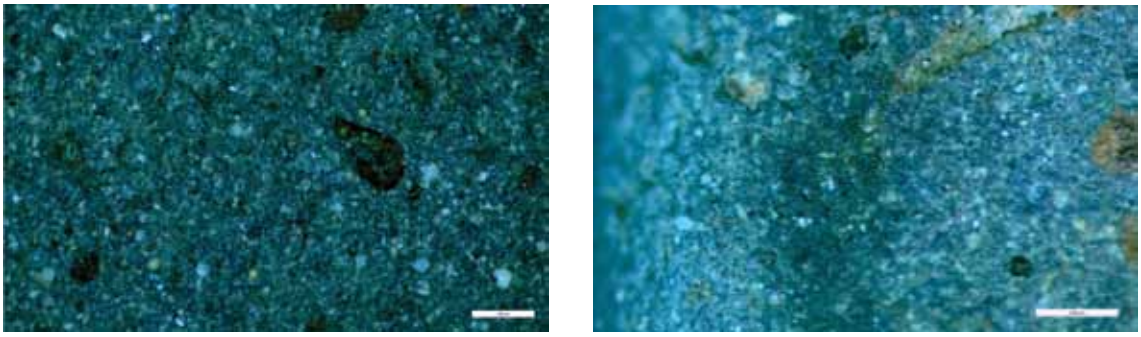


Fig. 7a-b – Baley necropolis, feature 166 figurine. Cobalt–copper polychrome layer—optical microscopy under 2000 nm magnification.

Figurine Clay Investigations

To ensure accuracy, the uncolored part of the figurine was also examined. The results are shown in Table 2 and Figure 8.

Weight %

Statistics	C	O	Na	Mg	Al	Si	K	Ca	Ti	Mn	Fe
Average	13.05	44.10	0.34	1.69	9.12	21.92	0.78	0.34	0.65	0.08	7.95

Atomic %

Statistics	C	O	Na	Mg	Al	Si	K	Ca	Ti	Mn	Fe
Average	20.66	52.68	0.29	1.32	6.50	14.96	0.39	0.17	0.26	0.03	2.75

Table 2. Baley necropolis, feature 166 anthropomorphic figurine – clay analyses. Elemental composition.

The results on the figure 8 clearly show that the composition of the clay lacks cobalt and copper, and the quantity of titanium is significantly reduced. Higher values of magnesium (Mg), aluminum (Al), and silicon (Si) are characteristic of clay composition, as clays are chemically defined as aluminosilicates with the formula $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$. Additionally, clays can contain talc, mica, iron compounds, and various organic substances.[5] The transition between the clay layer and the coating was examined with an optical stereo microscope, highlighting the visual difference between the two layers (Figure 9).

[5] Kulev, 2012, 287–300.

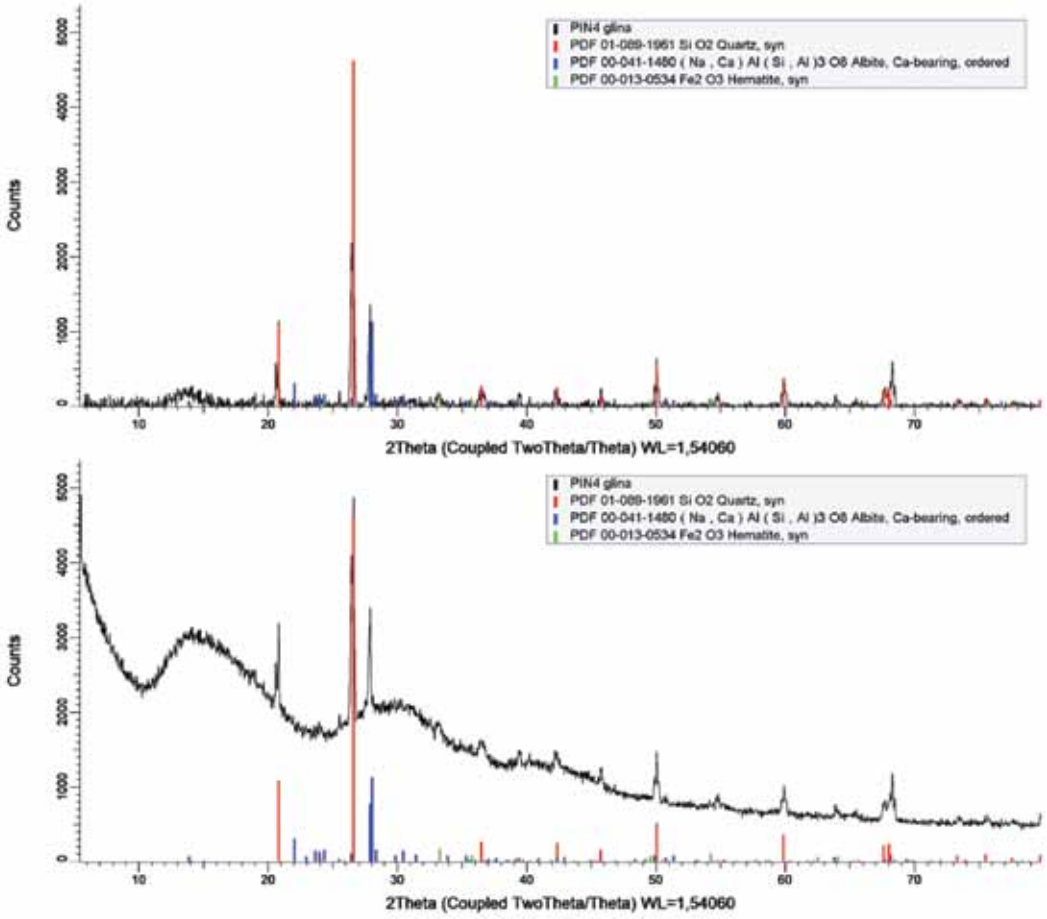


Fig. 8 – Powder XRD analysis of the clay layer performed on a Bruker D8 Advance diffractometer.



Fig. 9 – Baley necropolis, feature 166 figurine. Cobalt–copper polychrome and clay layers under 2000 nm magnification.

Based on several radiocarbon dates from similar features in the necropolis, feature 166 is generally dated to the 15th–13th centuries BC. This figurine appears to be the earliest ceramic artifact in the Balkans colored with blue slip. Without delving into a profound discussion, it is worth mentioning that similar ceramics, known as *blue-painted pottery*, appear in Egypt during

the period from the mid-18th Dynasty to the 19th Dynasty,[6] which generally corresponds to the date of the Baley figurine.

White Inlay Analyses

The elemental analyses are shown at table 3.

Weight %

Statistics	C	O	Na	Mg	Al	Si	P	K	Ca	Fe	Co	Cu
Average	9.37	47.31	0.34	0.72	5.42	7.54	6.58	1.23	18.24	3.16	0.04	0.04

Atomic %

Statistics	C	O	Na	Mg	Al	Si	P	K	Ca	Fe	Co	Cu
Average	15.55	59.04	0.30	0.59	3.99	5.33	4.27	0.62	9.15	1.13	0.01	0.01

Table 3. Baley necropolis, feature 166 anthropomorphic figurine – white inlay analyses.

The results indicate that the white material used for the inlay was obtained by mixing calcite and bone ash in varying proportions. The white decoration consists of calcium hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$), also known as bone mineral (both human and animal). The small amounts of calcite could be related to additional heating—if the figurine was close to the pyre—during which the calcium hydroxyapatite partially disintegrated. Analyses of the Baley figurine‘s inlay correspond with findings from EPC inlays at Cârna, Gârla Mare, Balta Verde, and Ostrovu Mare, confirming the idea that „hydroxyapatite was dominant“ as an incrustation material in the „Late Bronze Age in South Romania.“[7]

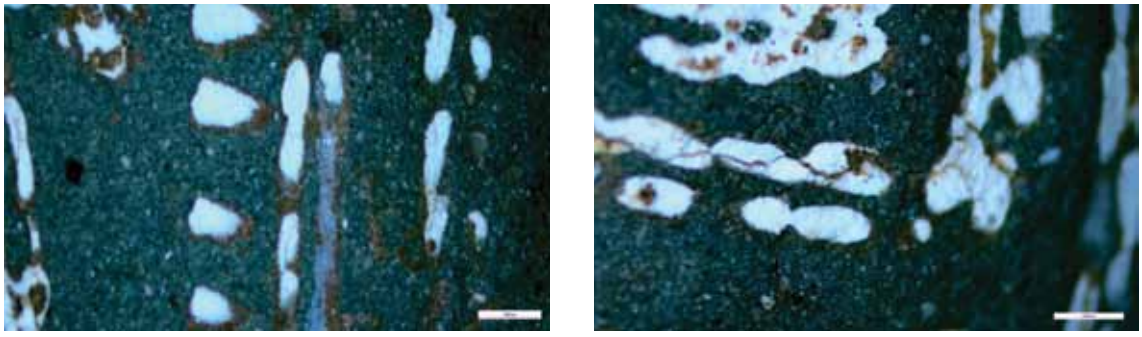


Fig. 7a-b – Baley necropolis, feature 166 figurine. Cobalt–copper polychrome layer—optical microscopy under 2000 nm magnification.

Conclusions

The EPC anthropomorphic figurines, characterized by their distinct iconography, served as symbols with clearly defined functions. The analyses presented here represent a preliminary step toward linking the material technologies and application techniques to the symbols, which convey a complex concept of universality, potentially associated with themes of life and death. The pigments and dyes of each civilization can be analyzed and accurately interpreted, as the symbols they form served as means of visual communication, transmitting information across millennia.[8]

[6] Abe et al. 2009.

[7] Secu et al. 2023.

[8] Manova, 2023, pp. 22–42.

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Obsidian Artefacts in Post-Neolithic Central Balkans: Exploring Assemblage Features and Regional Dynamics

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Marija Ljuština[3]
Vojislav Filipović[4]
Aleksandar Bulatović[5]

Abstract: The study of obsidian artefacts in the Central Balkans has predominantly focused on the Neolithic period, leaving the role of this material in the subsequent Copper (Eneolithic) and Bronze Ages largely underexplored. This paper presents the initial results of a detailed techno-typological analysis of 39 obsidian artefacts recovered from four archaeological contexts dated between 5th and 2nd millennium BC in Serbia. The study examines the features related to the production and use of these artefacts and it is complemented by macroscopic observations of their colour, texture, transparency, and banding. The analysis provides insights into the characteristics of obsidian products, suggesting that they were most likely imported as ready-made products (mainly blades) and thicker flakes or chunks, while highlighting evidence of further on-site full exploitation towards exhaustion. The primary objective of this study is to contribute to our understanding of the post-Neolithic use of obsidian at sites in the central Balkans located far from known sources, while also laying the groundwork for future provenance studies and broader interpretations of exchange systems.

Key words: Obsidian, Eneolithic, Bronze Age, Central Balkans, Exchange Networks.

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Introduction

Obsidian, a volcanic glass renowned for its exceptional sharpness and knapping properties, has held a prominent position in the prehistoric archaeological record. Its appeal as a raw material comes not only from its excellent physical properties but also from its perceived exotic nature, which made it a desirable commodity in prehistoric exchange systems. In regions far from well-known sources, the presence of obsidian often signifies participation in long-distance trade networks and cultural interactions, reflecting complex socio-economic dynamics.[1] During the Neolithic period, obsidian was extensively utilized across Southeast Europe and beyond, demonstrating its undeniable practical value. However, its procurement and distribution were not merely economic activities; they were integral to the social organization and technological choices of early farming communities, playing a crucial role in shaping interactions across different regions.[2]

Obsidian artefacts found in the Central Balkans are exclusively of exogenous origin, as no local sources containing knappable obsidian raw materials have been identified in the study area. The nearest obsidian outcrops are located in the Carpathians to the north and on the Aegean islands to the south. In the Central Balkans, obsidian artefacts were used throughout the Neolithic period, already from the Early Neolithic Starčevo phase in the final centuries of the 7th and first half of the 6th millennium BC,[3] but most extensively during the Late Neolithic period of the Vinča culture (second half of the 6th to the first half of the 5th mill. BC).[4] Previous provenance studies have shown that obsidian use in the Late Neolithic was predominantly associated with Carpathian sources, primarily Carpathian 1, while at some sites, such as Vinča-Belo Brdo, the presence of Carpathian obsidian became surprisingly numerous in the assemblages in 6th millennium,[5] despite the sources being approximately 400 km away. This extensive use suggests the existence of well-established long-distance exchange routes and a sustained demand for high-quality raw materials. However, potential links to specialized production or symbolic practices known from the other contexts in Anatolia or Aegean,[6] remain uncertain and require further investigation in the Balkan case.

Despite this documented presence of obsidian in Neolithic contexts, its use in the subsequent Eneolithic and Bronze Age periods in the Central Balkans remains extremely poorly understood. As societies transitioned into these periods, profound socio-economic changes – such as the advent of metallurgy and shifting subsistence strategies – likely influenced the perception and utilization of obsidian. In general, chipped stone artefacts have received little attention during these periods, as their use coincides with the gradual introduction of metal technologies, raising important questions about continuity and change in lithic traditions. Furthermore, the extent to which obsidian continued to be valued and utilized in post-Neolithic contexts, whether for functional or symbolic purposes, has not been systematically explored.

This paper is the first attempt by the authors to address this research gap by focusing on obsidian artefacts from post-Neolithic contexts in the Central Balkans, specifically modern-day Serbia. Within the framework of the FLOW project (*Interactions-Transmission-Transformation: Long-distance connections in the Copper and Bronze Age of the Central Balkans*), obsidian finds

[1] E.g. Renfrew 1969; Tykot 1996; Ibáñez et al. 2015.

[2] Perlès 2001.

[3] Several obsidian artefacts from the site of Svinjarička Čuka have been analyzed by B. Milić and M. Brandl and are awaiting provenance study results.

[4] Tripković 2004; Bogosavljević-Petrović 2015.

[5] Tripković, Milić 2009; Milić 2016, 211.

[6] Milić 2019a; 2019b.

from both old and recent excavations in the country have been examined to gain insights into the production and circulation of exotic goods.

The primary objective of this study is to conduct a detailed techno-typological analysis of obsidian artefacts recovered from four archaeological sites in Serbia (fig. 1), and provide first macroscopic observation of finds. By examining their technological attributes, potential function, and raw material characteristics, including colour, texture, transparency and banding, the study aims to provide a foundational understanding of the role of obsidian in post-Neolithic contexts. Additionally, it seeks to lay the groundwork for future provenance studies and broader interpretations of exchange systems in the region, ultimately contributing to a deeper understanding of long-distance interactions and resource management strategies in the Central Balkans.

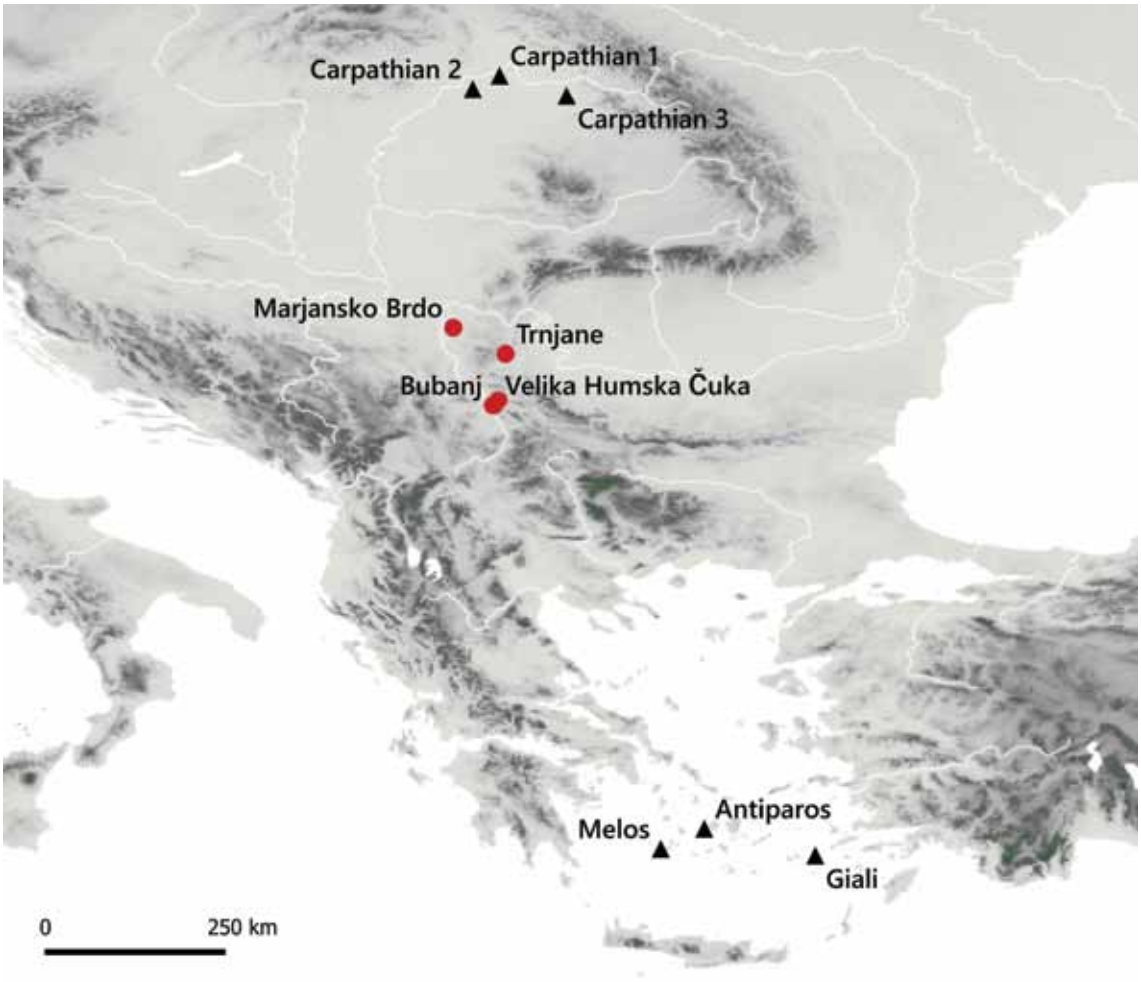


Fig. 1 – Distribution of known obsidian sources and the sites analysed in this study (© B. Milić).

Materials and method

This study examines a total of 39 obsidian artefacts recovered from four archaeological contexts across eastern and southeastern Serbia. The analysed collections originate from distinct sites representing also different chronological and cultural phases (spanning between the second half of the 5th and the 2nd mill. BC), although the majority comes from the Early Eneolithic context. The sites included in the study are as follows:

● **Marjansko Brdo** (near Veliko Gradište): Three obsidian artefacts were recovered from Marjansko Brdo most recent excavations in 2023 by the Institute of Archaeology team (Belgrade), where the chronological framework lined to finds is rather complex. One artefact is securely attributed to the Late Eneolithic, another to the Late Bronze Age, and the third was found above a Vinča culture house but in a stratigraphic context mixed with Late Bronze Age (Žuto Brdo group) materials (fig, 2:a).

● **Bubanj** (Niš)**:** The collection from Bubanj consists of four obsidian artefacts, with one recovered during the 2009 excavations and three from the 2014 excavations led by A. Bulatović from the Institute of Archaeology in Belgrade (fig. 2:b). The artefact from 2009 originates from an Early Eneolithic context, while the three artefacts from 2014, although primarily associated with the Early Eneolithic phase, show evidence of potential stratigraphic mixing with Middle Eneolithic layers. Notably, these three artefacts are the only ones published to date from the entire assemblages concerned in this paper.[7]

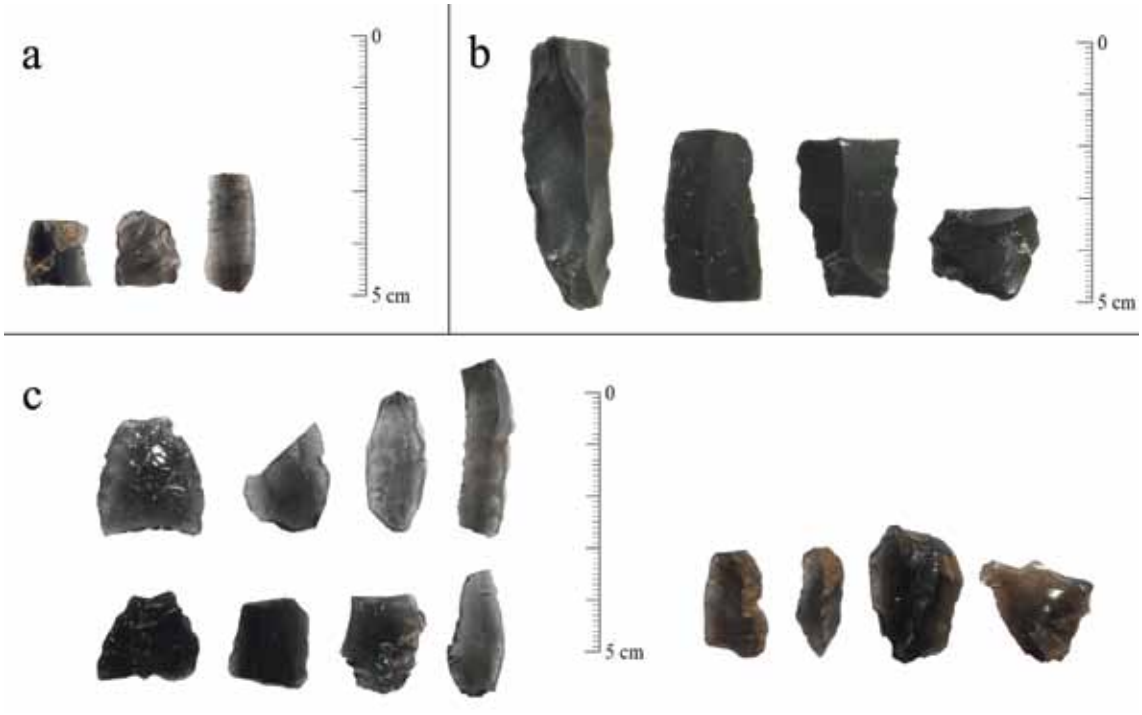


Fig. 2 - Obsidian from the studied sites/excavations
(a-Marjansko brdo, b-Bubanj, c-part of Velika Humska Čuka collection) (© B. Milić).

● **Velika Humska Čuka** (Niš): This site yielded the largest collection of obsidian in this study and, until now remains the most extensively documented post-Neolithic obsidian assemblage in the Central Balkans for this period, comprising 31 obsidian artefacts. Fourteen artefacts, which were recovered during the excavations of A. Bulatović, Institute of Archaeology, Belgrade conducted between 2014 and 2021, are securely dated to the Early Neolithic based on recent stratigraphic investigations. Additionally, 17 artefacts were found during earlier excavations in 1934 and 1954, which, according to archival records and documentation, are most likely all associated with the Early Eneolithic (fig. 2:c). The entire assemblage from this site is attributed to the second half of the 5th millennium BC.[8]

[7] Šarić 2020, fig. 8:3,4, 399, fig. 9:1, 400).

[8] Bulatović et al. 2018.

● **Trnjane** (near Bor): This is a single obsidian artefact (fig. 3), discovered during a survey around the settlement and necropolis at Trnjane. The entire archaeological material from this site is attributed to the Middle Bronze Age, dated to 1900–1700 cal BC, which could suggest the same dating of obsidian find in the direct vicinity of the site as well.[9]



Fig. 3 - Obsidian from the survey of Trnjane (© B. Milić).

The techno-typological analysis in this study is based on a structured database comprising 35 recorded attributes per artefact, following the methodology established for documenting obsidian artefacts in Anatolia and the Aegean.[10] The database categorizes artefacts into core types, core maintenance elements, central blades, flakes, and debris. Key aspects such as core reduction strategies, knapping direction on cores and blanks, platform preparation and butt types, platform and surface treatments, blade shape-profile-section features, among others are systematically recorded to reconstruct production techniques and overall aim of production. Additionally, the presence of cortex is documented, alongside precise measurements of artefact size and weight. Further analysis records secondary modifications of blanks by assessing the continuity and position of retouch, distinguishing intentional retouch from natural edge damage and artefacts with edge use without modification. Macroscopic characterization of raw materials focuses on the visual characteristics of the artefacts, including colour (black, grey), surface texture (shiny/matt), transparency ((semi-)transparent, glass-like) and banding (if present), allowing for a refined assessment of material properties, while serving as an initial step in provenance studies. Final aims of these studies are to determine whether obsidian artefacts were introduced as ready-made tools, or blanks and small unworked nodules for local production.

[9] Kapurran et al. 2020.
[10] Milić 2018.

Results

The obsidian assemblage from **Marjansko Brdo** consists of three fragmented blades of relatively small size (fig. 2:a), with the largest measuring 22.2 mm in length. Two of the blades exhibit different core reduction strategies – one showing unidirectional and the other bidirectional reduction – both achieved through percussion techniques. Additionally, one blade has retouch, while the other displays macroscopic use-traces along the edges. The third artefact, a medial blade fragment, was turned into mini core, as evidenced by the extraction of tiny micro-blades through bipolar percussion supported by an anvil. This process is indicated by the preparation of a "platform" through truncation and an end-crushing. The blades range in weight from 0.57 to 0.88 g and share consistent macroscopic characteristics, being grey, shiny, and transparent.

The obsidian assemblage from **Bubanj** consists of four artefacts – three blades and one flake – exhibiting distinct technological characteristics. Among the blades, two are central fragments (without traces of cortex or preparation traces, coming from the central phase of core reduction), while the third originates from core preparation or rejuvenation, as indicated by the presence of a crest, however without implying on-site production. The blades, all unidirectional and preserved as proximal or medial fragments, are ranging in lengths between 30 and 50 mm. In contrast, the flake, which is the only complete unfragmented piece in the assemblage, is shorter, measuring 15 mm in length and displaying a hinged termination and a hard percussion butt. Notably, one blade fragment is likely a fragment of a much longer pressure blade, potentially produced using standing pressure with a long crutch. The artefacts vary in weight, ranging from 1.7 to 5.5 grams per piece. The assemblage differs significantly from others in terms of raw material properties, with all pieces exhibiting a dark grey color, either matt or slightly shiny, but lacking any transparency. Two pieces show parallel lighter gray bands.

The obsidian assemblage from **Velika Humska Čuka** represents the largest collection in this study, comprising 31 artefacts distributed across different excavation sectors. The analysis of primary blank production reveals an almost equal distribution of flake and blade blanks, followed by lateral (cortical or crested) blades and flakes, with a small number of cores also present (fig. 4). The core assemblage includes two bipolar cores set on anvils, both associated with blade and flake recycling. One of these cores is a thick flake with regular bladelet removals and crushed ends, measuring over 30 mm in length. The other core made on a thicker flake, exhibits only a few removals, suggesting it was tested but not fully utilized. Additionally, four specimens derive from the core preparation or rejuvenation stage prior to the central reduction phase. These include cortical and crested blades, a plunging blade, and a crested flake. The central blades are predominantly unidirectional, with only three fragments displaying regularity indicative of pressure blade production. The remaining blades were likely produced through direct percussion, as suggested by their large, often natural, non-prepared or facetted butts, or perhaps in some cases, indirect percussion. The flake assemblage consists mainly of small flakes under 25 mm, along with flake fragments measuring between 20 and 30 mm. Additionally, a few bipolar flakes, produced as by-products of anvil-supported production, suggest that on-site knapping activities likely took place. This interpretation is further supported by the presence of reused flakes repurposed as cores, also set on anvils. Fragmentation is consistently high across the entire assemblage, with artefacts reaching a maximum length of 35 mm. The majority of pieces weigh between 0.2 and 2 grams, with a few larger, thicker artefacts ranging from 3.2 to 3.7 grams. Additionally, one flake that was reused as a core weighs 6 grams.

The typological analysis of **Velika Humska Čuka** assemblage reveals that 41.9% of artefacts are secondarily modified blanks with retouch, while an additional 16% exhibit traces of use without initial edge modification (based on edge scaling). Only three pieces display traces that appears to be associated with post-depositional alteration rather than intentional use due to discontinuity and random orientation of little edge removals. The assemblage presents a diverse range of tool forms, with a notable emphasis on blade-based tools (fig. 5) although number of flake blanks in the assemblage was even higher (fig. 4). The most represented category consists of macroscopically used blades (without retouch), accounting for the highest frequency (n=5). Laterally retouched blades, with either one or both edges modified, are also well-represented (n=4). Bifacially retouched arrowheads (n=3) are the most chronologically sensitive category due to their fully covering retouch. One complete arrowhead is preserved, measuring 30 mm in length, while the other two are either laterally fractured or broken at the tip. However, further microscopic analysis is needed to determine whether these tip fractures are linked to impact damage from hunting or projectile-related activities, as macroscopic observations alone are not diagnostic. The presence of other tool types, such as truncations (n=2), end-retouched flakes (n=1), an end-scraper (n=1) for instance, can provide new insights into the use of tools on the site with the assistance of functional studies planned in the future.

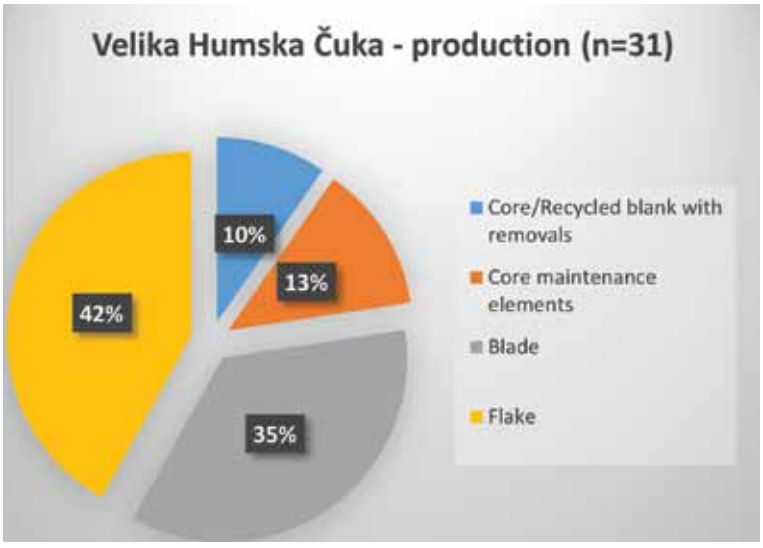


Fig. 4 - Obsidian technological categories and tool types at Velika Humska Čuka (© B. Milić).

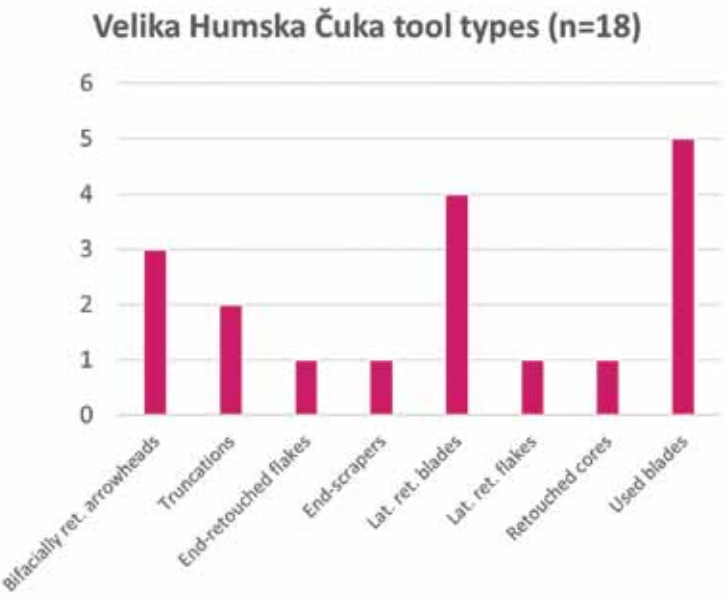


Fig. 5 Obsidian tool types at Velika Humska Čuka (© B. Milić).

Macroscopic observations of the **Velika Humska Čuka** obsidian assemblage reveal variability in raw material characteristics. The majority of the assemblage consists of glass-like transparent pieces (n=11), followed by regular grey transparent obsidian (n=10). Ad-

ditionally, a significant number of artefacts (n=8) exhibit semi-transparent grey attributes. Surface alterations are observed on two artefacts – one displaying grey transparent material with patina, and another showing semi-transparent grey material with minor patina and surface rubbing traces. These variations in macroscopic features – such as transparency, patina, and surface alterations can provide insights into raw material selection, potential exposure conditions, and post-depositional processes affecting the assemblage. However, apart from a certain number of glass-like translucent artefacts from the site, the assemblage contains many thin pieces resulting from the additional knapping of thicker flakes. This secondary reduction process makes the thinner artefacts appear more transparent compared to naturally thicker pieces, and are unlikely to be different in sources from the other studied assemblages that lack his features.

Finaly, the single obsidian artefact from the **Trnjane survey** is a thick flake measuring 30.8 mm in length, 20.7 mm in width, and 1.6 mm in thickness, with a weight of 13.84 grams. The flake retains cortex covering approximately 80% of its dorsal side, suggesting that it was initially brought to the site either as a cortical unprepared larger chunk or cortical flake. However, evidence of additional local knapping is indicated by small flake removals, marking a second phase of use as a recycled flake. The obsidian is black, shiny, and semi-transparent, likely due to its thickness.

Discussion and future directions

The initial study of obsidian artefacts collected within the FLOW research project confirms that obsidian continued to be exchanged across the Central Balkans long after the Neolithic period, persisting until the 2nd millennium BC. However, a gradual decline in quantities is observed after the mid-5th millennium BC, with a significant drop during the Bronze Age. This suggests a shift in material preferences and exchange dynamics over time, evolving in parallel with the introduction and intensification of metal use. While obsidian was often perceived as an exotic material valued for its aesthetic appeal, the assemblages analyzed in this study demonstrate that it was also intensively used and recycled on-site, indicating an additional utilitarian and economic value that extended its lifecycle alongside its symbolic significance. This long-term utilization highlights the adaptability and importance of obsidian beyond its initial procurement.

Post-Neolithic obsidian in the Central Balkans was not exclusively imported in the form of carefully selected blanks or ready-made blades; the assemblages under study also include cortical artefacts and core preparation by-products, potentially indicating indirect procurement of the raw material. The presence of crested and plunging flakes, as well as small bipolar and larger flakes, suggests that obsidian imports were then re-knapped at the sites, including also partially reduced cores and unmodified nodules that were arriving initially. This implies a flexible procurement strategy that balanced external acquisition with local reduction activities.

Evidence from Marjansko Brdo and Velika Humska Čuka reveals a clear pattern of on-site core reduction and recycling, despite the limited number of pieces (three) available from the former site, which come from completely different chronological contexts. Imported blanks were locally knapped, producing by-products that were further utilized or repurposed, extending the functional lifespan of the raw material. Flakes and blades were

reworked after primary use with additional but likely minimal preparation, suggesting a practical approach to resource management. In particular, the assemblage from Velika Humska Čuka provides compelling evidence for the full exploitation of obsidian, with flakes and blades being repurposed through secondary modifications and in several case re-knapping on anvils, for which both "cores" and by-products are recorded. The controlled reduction of small pieces, supported by anvil techniques, represents an opportunistic behavior rather than a culturally transmitted practice. This pattern of resource efficiency is consistent with other assemblages from Southwest Asia to the Balkans, spanning various periods, including the Epipaleolithic, Neolithic, and Chalcolithic.

The typological diversity within the Velika Humska Čuka assemblage suggests a mixed technological approach, combining formal tool production with expedient use. The presence of bifacially retouched arrowheads indicates specialized activities alongside everyday domestic tasks, which were likely maintained by retouched blades which appear in the assemblages most commonly among the varieties of tool types. However, these observations remain preliminary until further use-wear analyses are conducted.

The collections presented here highlight possible variability in exchange networks, particularly evident at Bubanj, where the "largest" blade fragments exhibit distinctive macroscopic characteristics – appearing matt grey and exclusively non-transparent. This differs from other assemblages and potentially suggests an alternative procurement network. The presence of obsidian in Early Eneolithic contexts at Bubanj, despite potential stratigraphic mixing, aligns with observations that the procurement of exotic raw materials, such as Balkan flint, continued after the Late Neolithic Vinča period.[11] This pattern underscores the sustained importance of specific raw materials in lithic production during the transition from the Neolithic to the Eneolithic.

The collections presented here highlight possible variability in exchange networks, particularly evident in the Bubanj site, where the "largest" blade fragments exhibit distinctive macroscopic characteristics – appearing matt grey and non-transparent. This differs from other assemblages and potentially suggests an alternative procurement network. The presence of obsidian in the Early Eneolithic contexts at Bubanj, despite potential stratigraphic mixing, aligns with observations that the use of cherts and opals, alongside procurement of exotic raw materials including other raw materials such Balkan flint in a way continued after the Late Neolithic Vinča period. This pattern highlights the sustained importance of specific raw materials in lithic production during the transition from the Neolithic to the Eneolithic. However, future studies will aim to determine whether these procurement patterns were exclusively linked to the same cultural connections, and in this case with communities in the Pannonian Basin, evidenced by the presence of ceramic forms typical of Pannonia found alongside Bubanj–Hum I materials as already suggested,[12] or if multiple exchange networks existed, therefore introducing new trade routes after the end of the Neolithic. Provenance analyses of obsidian artefacts will provide further insights into the complexity of exchange systems and the broader socio-economic dynamics of the Early Eneolithic in the Central Balkans. The presence of dark grey, semi-transparent, and banded obsidian material from Bubanj, which is at least macroscopically different from the Carpathian 1, but also Carpathian 2 sources, has the strongest potential to examine the existence of southern connections based on lithic raw materials.

[11] Šaric 2020, 390.

[12] Bulatović 2020, 32.

This study demonstrates that obsidian in the post-Neolithic Balkans was more than an exotic traded good; it held intrinsic value at the local level, being carefully curated, recycled, and used until its complete exhaustion. The evidence of on-site processing, core reduction, and secondary modifications reflects a complex *chaîne opératoire* that maximized the utility of this prized material. While this paper provides initial insights into the *nature of obsidian exchange*, future provenance analyses will refine our understanding of *exchange directions*, shedding further light on resource procurement strategies and the interconnectedness of the Balkans with surrounding regions.

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Imperialist, Colonialist and Nationalist Archaeologies in the Balkans: A Macedonian Perspective

Stefanos Gimatzidis[1]

Abstract: The construction of grand narratives in Balkan archaeology has been shaped in subtle yet profound ways by geopolitical agendas. This paper examines the impacts of imperialist, colonialist, and nationalist archaeology, using Bruce Trigger's foundational framework, with a particular focus on the Greek region of Macedonia. Archaeology in this region began to formalize in the first half of the 20th century, becoming a tool of colonial influence that reflected the cultural imperialism of the powers that prevailed after World War I. Following World War II, a distinctly nationalist archaeology arose – not as a direct response to previous colonial activities or external threats, but as a reflection of internal social tensions that surfaced after the Greek Civil War. These tensions were framed within patriotic archaeological narratives, a practice that persists today, albeit with declining effectiveness as the cultural and social landscape of regional archaeology has changed.

Key words: Balkans, Macedonia, Tells, World War I, Imperialism, Colonialism, Nationalism.

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Introduction

The focus of archaeological research is not always a matter of proper scholarly requests and queries. It is defined by geopolitics and is often subject to powerful socio-political biases that also shape archaeological interpretation. The starting point and most influential parameter is the choice of the research field, be it material documentation, landscape study, survey or excavation. The choice of the Near East, Egypt, Greece, Italy, and the Balkans as popular focal areas of European archaeological research during the past centuries reflects the colonial desires of the western European countries that fostered the rise of, and developed archaeology as a colonial discipline.

Many different aspects of foreign cultural heritage appropriation, generally expressed as an imperialistic practice, are well attested since the earliest historical periods. The first statues of the famous tyrant slayers Harmodios and Aristogeiton, with their important political symbolism for the Athenian democracy, were taken by Xerxes to his capital Susa after the seize of Athens in 480 BC. Their restoration several centuries later, probably by Alexander the Great, was a highly symbolic act with clear political implications as part of his mission against an old and powerful Greek enemy. The expropriation of this act at a later period by the Seleucids was probably part of their propaganda to earn the sympathy of Athens in difficult periods for their kingdom.[1] The Assyrian king Sargon II earlier plundered thousands of cultural artefacts from the cities he captured, exactly as did the Sicilian Governor Gaius Verres with the monuments of his domain many centuries afterwards. The looting by the Romans of the Greek sanctuaries and cities that were full of bronze, marble and other votives after the prosperous Classical and especially Hellenistic periods, some of this booty officially presented in Roman triumphs, is not only attested in the literary sources but also archaeologically through several shipwrecks that transported looted artefacts such as the bronze Riace warriors. Byzantine and other medieval emperors continued the previous Roman practice of elaborating their cities with bronze statues from Greece and granite obelisks from Egypt.[2] This practice was not abandoned but rather developed further in the modern era.[3] The acquisition or looting of antiquities – depending each time on the particular viewpoint – was not only the result of a successful military campaign, but also an integral part of any colonial mission. The enrichment of the large European museums in London, Paris and Berlin took place in this context, for example after military campaigns such as the French ones in Egypt and Syria, or colonial missions such as those in the Americas, Africa, South Asia and of course in the Orient, which included the collapsing Ottoman Empire.

The history of the so-called Horses of St. Mark's powerfully illustrates the political importance and social impact of cultural appropriation throughout European history.[4] Originally part of a votive offering at a Greek site, the horses were later removed—likely in the early Byzantine period—and relocated to Constantinople, where they adorned the entrance of the Hippodrome. Following the Fourth Crusade in 1204, they were seized by Venetian forces and installed on the façade of St. Mark's Basilica in Venice. In 1797, after Napoleon's campaigns in Italy, the horses were moved to Paris and placed atop the Arc de Triomphe du Carrousel as symbols of his victories. After the Bourbon Restoration in 1815, the originals were returned to Venice, with replicas remaining in Paris. The horses adorned St. Mark's Basilica until 1980, when they were replaced by replicas to protect them from pollution. Recently, Turkish authorities have argued for the return of the horses to Istanbul, claiming them as part of Turkey's cultural heritage, removed from

[1] Gafforini 1989, 17-23.

[2] Hassan 2003.

[3] Lindsay 2014.

[4] See Freeman 2004.

Constantinople in 1204. The story of the Horses of St. Mark's exemplifies not only how imperialist states across different eras have exploited foreign cultural heritage but also how emerging nation-states seek to legitimize nationalist claims.

Intersecting geopolitical and archaeological agendas

After the emergence of the first more or perhaps less 'sovereign' Balkan and Near East states that were formed out of the disintegration of the Ottoman Empire, western European countries found new ways to elevate their national prestige through the appropriation of ancient cultural heritage. The rivalry for the acquisition of precious ancient artefacts to augment the national European museums was partly replaced by scholarly antagonism in the field of archaeology, a discipline already born and shaped in a colonial context.

After Alexander the Great, Napoleon was perhaps the first to view his military campaigns in the Orient not only as political conquests but also as opportunities for cultural expansion. One of the primary goals of the French military campaign in Egypt and Syria, beyond safeguarding trade interests from British competition, was – aligned with Enlightenment ideals – to elevate France's global reputation. This was to be achieved by conquering one of the world's most storied civilisations, previously subdued by figures like Alexander the Great and Julius Caesar, and by expanding the academic horizons of French scholarship.[5] Napoleon's army was accompanied by over 150 scholars who examined every conceivable aspect of the region, including, of course, its ancient heritage, of which Napoleon himself was keenly aware.[6] Their mission was to amass knowledge on Egypt's geography, topography, economy, social organization, ethnography, and ancient culture.[7] This information was essential not only for transforming the occupied territory into a colony but also for consolidating control over its infrastructure and reshaping its identity to align with French imperial ambitions.[8] It was within this historical framework that Egyptology emerged as a distinct academic discipline.

Ever since, the struggle for cultural hegemony fostered scholarly antagonism in the rising discipline of archaeology. This was the era of 'The Great Game' ('Das Große Spiel') among the imperialist and colonialist powers aiming for cultural dominance, which was not only about scholarly prestige. This struggle was also motivated – to further quote Charlotte Trümpler – by nationalism (earned prestige by the acquisition of the right to excavate the most famous site), religion (visualization of the Bible), imperialism (strategic occupation of archaeological sites) and acquisition (elaboration of the National Museums).[9]

In other words, the countries that led the major colonial missions worldwide and considered themselves as integral parts of western European civilisation could not refrain from the construction of the narratives about its emergence. It was therefore a matter of prestige to be involved in the exploration of the most important archaeological sites in the territories perceived as cradles of 'global' civilisation, such as Mesopotamia, Egypt and Greece. This was the first objective of the western European passionate intervention in the archaeological research of distant Oriental countries. Another objective was the one that already triggered Napoleon's colonial enterprise in Egypt. Archaeological Missions and Schools were conceived as effec-

[5] Jeffreys 2003, 1-2; Hassan 2003, 23.

[6] Lesko 1999, 672-673.

[7] Said 2003, 81-92; Byrd 1992, 39-40.

[8] Cf. Bednarski 2010, 1088-1089.

[9] Trümpler 2010, 15-16.

tive mechanisms in crypto-colonising projects to create firm intellectual bases in the target territories; these institutions fostered the bonds between Indigenous 'colonized' populations and colonisers by functioning as cultural delegations, next to other institutions such as cultural councils, colleges, and universities.[10]

From the early 19th century, archaeological interest focused on renowned sites in the eastern Mediterranean, familiar through ancient literature and therefore attracting early attention. Scholarly rivalries during this period unfolded on multiple levels. Foremost was the drive to expand newly established public collections in major European national museums, symbolizing not only national prestige but also dominance over regions where political conditions favoured such pursuits, such as the Ottoman Empire. Iconic monuments like the Parthenon were stripped of sculptures, and entire structures, such as the Great Altar of Pergamon, were transported to European capitals, enhancing the cultural cachet of emerging European nations.

With the dissolution of the Ottoman Empire and the formation of new states in the eastern Mediterranean, colonial practices faced resistance from emerging local nationalism.[11] While European museums continued to compete for cultural supremacy, the struggle shifted to the scholarly sphere of archaeological research. Foreign schools competed for exclusive excavation rights at renowned sites in these often colonial or semi-colonial regions, positioning themselves as legitimate heirs to ancient civilisations.[12] Securing such rights frequently required complex diplomatic negotiations that were deeply intertwined with broader foreign and economic policies.

The case of Delphi exemplifies these dynamics: following protracted negotiations with Greek authorities and amid competition from American and German institutions, the Greek government awarded the French Archaeological School the right to excavate Delphi.[13] This decision was part of a broader diplomatic agreement that secured French support for Greece's annexation of Thessaly, favourable terms for Greek raisin exports (a vital economic product), and French funding to purchase and relocate the village occupying the sanctuary site. Through this exchange, French scholars and diplomats obtained exclusive excavation rights to one of antiquity's most revered sites, underscoring the political and cultural stakes inherent in archaeological patronage.

Similar arrangements allocated other major sites in Greece to colonial institutions of the 19th and 20th centuries. A somewhat divergent example is seen in Italian fieldwork in the Dodecanese, which commenced during the Italian occupation from 1912 to 1943. After the islands were formally annexed to Greece in 1947, the Greek state allowed the Italian Archaeological School of Athens to continue its research, reflecting the complexities of colonial legacies in the archaeology of the region.

Colonizing the Past: Political and Archaeological Influence in the Balkans

Building on earlier paradigms, archaeology in the Balkans was similarly shaped by the political affiliations of newly established nation-states during the 19th and 20th centuries. Colonial influence on Balkan archaeology is evident in several ways: first, through the dominance of

[10] For an in-depth discussion on the involvement of foreign archaeologists in political affairs in Greece, see Glogg 2017. A telling example of the concept and function of foreign Archaeological Schools in the Mediterranean and beyond is the fact that the global branches of the German Archaeological Institute fall under the jurisdiction of the German Ministry of Foreign Affairs. This underscores the diplomatic and cultural roles these institutions play, reflecting their integration into state-driven efforts to project influence and affect international relations through archaeology.

[11] See below the discussion of archaeology in the Greek region of Macedonia.

[12] Braemer 2012.

[13] Picard 1992, 11-12; Pentazos 1992, 64-65.

foreign institutions, which continue to lead major field projects in the region; and second, through the education of Balkan archaeologists in non-local institutions. Additionally, the term 'Balkan archaeology' itself carries colonialist connotations, having been coined by western European scholars from a distant perspective, aiming to define the region as a subject of study.[14] However, this term is culturally less cohesive compared to others, such as 'Mediterranean archaeology' or 'Near Eastern archaeology,' due to the vastly differing and insufficiently studied cultural features it seeks to encompass. [15]

Contrary to the perception of Greece, Italy, and the Near East as the cradles of European civilisation – whose archaeology was shared by colonial powers eager to claim Greco-Roman heritage for reasons tied to western European upper-class cultural prestige – the Balkans were viewed as a periphery, a liminal or buffer zone between major Mediterranean and central European cultures. As a result, Balkan cultural heritage was not claimed with the same fervour as Classical antiquity but instead attracted interest primarily for geopolitical reasons rather than cultural primacy.

In this context, while France, Germany, the United States, Great Britain, and other western European nations rushed to establish archaeological schools in Greece and Italy, German-speaking archaeology came to dominate the Balkans. This dominance largely aligned – though with some exceptions – with the region's geopolitics and alliances during World War I.

As a result, archaeology was overtly employed as a colonial tool in Bosnia during the 'Europeanization project' implemented after it became an Austrian protectorate. Similarly, the Habsburg monarchy used archaeology as a crypto-colonial project in other Balkan regions under its control, such as modern Slovenia and Croatia. In these territories, archaeology was established in the 19th and early 20th centuries as part of Austria's internal affairs, with museums being founded and archaeologists appointed from institutions in Vienna, which stood at the apex of the monarchy's hierarchical structure.[16]

The foundation of archaeology in other Balkan countries, such as Serbia, Albania, Bulgaria, and Romania, which were not part of the Austrian Monarchy, was nonetheless heavily influenced by leading institutes in German-speaking central Europe. Prominent figures considered founders of modern Serbian archaeology, such as Mihailo Valtrović, Nikola Vulić, and Miloje Vasić, were educated at German universities.[17] Bulgarian archaeology similarly took shape under the guidance of scholars of Czech origin, including the Škorpil brothers, Karel and Hermengild, as well as Konstantin Jireček and Wilhelm Tomaschek, all of whom were citizens of the Austro-Hungarian Empire. However, the true architect of Bulgarian archaeology was Bogdan Filov, who also studied in Germany. Filov later became prime minister of Bulgaria, but his career ended when he was executed after the collapse of the eastern German front due to his collaboration with the Nazi regime.[18]

Similarly, the founder of modern archaeology in Romania, Vasile Pârvan, studied in Germany, where his contributions were highly regarded. In Albania, some of the earliest archaeological investigations were carried out by Austrian scholars like Karl Patsch, as well as Theodor Ippen and Franz Nopcsa, who served as diplomats in Shkodra.[19] During World War I, Albania's

[14] Cf. Pina-Cabral 1989.

[15] See Gimatzidis 2023.

[16] For a comprehensive discussion of the emergence of archaeology as a discipline in the western Balkans, see Novakovič 2021 and Novakovič 2011.

[17] Novakovič 2021, 139-189; Novakovič 2011, 386-398.

[18] See Conrad, Krauß 2021.

[19] For the history of archaeological research in Albania, see Tsonos 2009.

territories were contested by nearly all its neighbouring nations, including Bulgaria and Austria, both of which were allied powers. In 1916, the Austrian army invaded Albania, accompanied by historians and geologists, including the renowned archaeologist Camillo Praschniker. Along with Arnold Schober, Praschniker initiated excavations at Apollonia, a major Corinthian colony, and Byllis, marking the first organized archaeological explorations in Albania. Some of their finds were taken to Vienna. Austrian interest primarily focused on the northern and central regions of Albania, which were predominantly inhabited by Catholic populations, a key area of interest for Italian imperial ambitions as well. Meanwhile, Greek archaeologists conducted fieldwork in southern Albania, an area inhabited by Orthodox Greeks and Albanians, and briefly occupied by the Greek army.

Imperialist, colonialist and nationalist archaeologies in Macedonia

Specific aspects of western European imperialism and colonialism are further illustrated in the early archaeology of Macedonia, distinguishing it from other contemporary agendas in the Balkans due to its unique political context. After World War II, these strategies were supplanted by a distinctive regional nationalism, shaped variably by two conflicting parts, which became deeply intertwined with the region's historical heritage.

The Macedonian archaeological landscape in the 19th and early 20th century

The newly emerging Balkan nation-states began taking action in the 19th century to prepare for the anticipated political changes that would follow the imminent dismantling of the Ottoman Empire, which included Macedonia. The primary political players in this geopolitical landscape were Greece, Bulgaria, and Serbia, each with aspirations to incorporate Macedonia into their respective territories. The complex and turbulent political climate in the Ottoman province of Macedonia during this period hindered any significant colonial intervention, instead fuelling the nationalist sentiments of the new Balkan states. Greece was the most active regional player, producing some of the earliest and most systematic studies on ancient Macedonia.

The first scholar to rigorously defend the history of Macedonia on behalf of the Greek state was Margaritis Dimitsas, a Greek philologist and historian from Ohrid in western Macedonia. He authored numerous studies, including two significant works – one focused on the historical topography of Macedonia and another on the ancient Greek and Latin inscriptions from the region. In the lengthy introduction to his 'Ancient Geography of Macedonia,' Dimitsas candidly states the objective of his study: to restore the truth about the origins and identity of the Macedonians. He elaborates on the political stakes of his essay, explicitly naming the rival dogma stemming from Bulgarian and Panslavist propaganda.[20]

The first Macedonian sites that attracted international scholarly interest were the tells. These prehistoric and protohistoric mounds were the most physically prominent monuments in Macedonia, like the obelisks in Egypt, that caught the eye of early travellers and adventurers. Unlike the latter, however, they were not removable artefacts but imposing sites, provoking the imagination about treasures in monumental Macedonian tombs or other concealed secrets. It was not accidental that the first European empire with an interest in the archaeology of the region was the Habsburg Monarchy, which expanded into south-eastern Europe while the Ottomans were retreating and which had an increasing interest in the western Balkans. It was in this socio-political context that the Anthropological Society in Vienna undertook the task to map the tells in south-eastern Europe.[21]

[20] Dimitsas 1874, ε-ιζ.

[21] v. Hochstetter 1870.

A defining moment in the archaeology of Macedonia was the research of Léon Alexandre Heuzey, an archaeologist at the Museum of the Louvre and a member of the French Archaeological School at Athens. In 1861 the French Emperor Napoleon III, who was particularly interested in the ancient battlefields of Caesar in the East, commissioned Heuzey to study the historical topography of that territory. The French scholar begins his report to the Emperor with the contrast between the well-studied Greek south and the neglected north, in this way introducing a dichotomy that will haunt Aegean and Balkan archaeology for the next centuries.[22] In contrast to earlier and contemporary essays on various historical and ethnographic aspects of the Macedonian territory conducted primarily by travellers, Heuzey's expeditions were the first real archaeological campaigns that resulted in the excavation of several monuments, particularly at Vergina, whose cultural heritage has gained fame in more recent times. Some of the earliest acquisitions of Macedonian antiquities by the Museum of the Louvre were owed to these first French campaigns in Macedonia.[23]

At the end of the 19th century the Germans undertook archaeological research in Macedonia for a short period. Following the topographical studies on the Macedonian landscape conducted by Adolph Struck, an intelligent young civil servant working for the railway of Thessaloniki, and later secretary at the German Archaeological School at Athens,[24] Paul Traeger recognised the tell-based settlements of central Macedonia as a crucial feature of the regional archaeology.[25] In his pioneering studies he produced the first typology of the tells, presented drawings of them and first discerned the funeral tumuli from the settlements. He also collected many artefacts from the Macedonian tells, especially pottery, that were published by Hubert Schmidt.[26]

Shortly afterward, Traeger's papers inspired and motivated Alan J. B. Wace and Maurice S. Thompson, who had previously conducted research in Thessaly. The British archaeologists published a paper that further developed the typology of the tells following a brief visit to Macedonia.[27] Around this time, the Macedonian Exploration Fund was established in Britain with the goal of exploring what was then considered a 'terra incognita,' as Macedonia remained under Ottoman control.[28] Among its members was Arthur Evans, who had already been deeply involved in the archaeology of the western Balkans, searching for traces of the Illyrian past.[29] However, the outbreak of the First Balkan War in 1912 disrupted further studies in Macedonia.

Colonial Archaeology on the Battlefields of Macedonia during the First World War

During the Great War, Macedonia became a key battleground where the Triple Entente (France, Russia, and Britain) and the Central Powers (Germany, Austria-Hungary, the Ottoman Empire, and Bulgaria) vied for strategic dominance. Greece, which remained neutral during the early years of World War I, faced invasions from both sides. The disembarkation of the 'Allied Army of the Orient' in Thessaloniki began in October 1915, comprising mainly English and French troops and totalling over 200,000 soldiers, all while Greece was experiencing a profound political divide. Following the German-Bulgarian invasion of eastern Macedonia in 1916, the French commander-in-chief of the allied forces, Maurice Sarrail, assumed near-complete control over the Greek portion of Macedonia, dividing it into occupation zones. The allied forces exhibited a distinctly colonial attitude both before and during the occupation, even toward the

[22] Heuzey, Daumet, 1876.
[23] See Descamps-Lequime 2011b.
[24] Struck 1908; Struck 1907.
[25] Traeger 1902; Traeger 1901.
[26] Schmidt 1905.
[27] Wace, Thompson 1909; see also Wace 1913-1914.
[28] Thornton 2013, 3-4.
[29] Novakovič 2021, 155, 221, 284, 327, 362.

Greek factions that supported cooperation with the Entente. In his autobiography, General Sarrail illustrates the mentality and methods of the French mission in Macedonia, drawing comparisons to earlier colonial expeditions. He notes that French generals under his command were able to operate in Thessaloniki in much the same manner as they had in Madagascar, China, and other colonial territories.[30]

As British and French troops, together with Greek and Serbian forces, advanced along the Macedonian Front under the banner of the 'Army of the Orient,' they initiated some of the first major organized archaeological explorations in the region. Following a longstanding colonial practice, British and French troops were accompanied by archaeologists and scholars, eager to explore the newly occupied territories. Many of the initial discoveries occurred as antiquities were uncovered during the construction of trenches, dugouts, and gun emplacements.

In a catalogue published on the occasion of a large exhibition on Macedonia at the Louvre a few years ago, the editor of the volume ascribes the founding of the 'Service Archéologique de l'Armée d'Orient' to the archaeological sensitivity of General Sarrail, and dates the initiative to the period after the establishment of the French forces in Macedonia, which is partly correct.[31] Gustave Mendel, a former director of the 'Service archéologique de l'armée d'Orient,' provides a detailed account of the French archaeological mission in Macedonia during World War I, writing in 1918. According to Mendel, archaeological explorations in Macedonia were planned by Sarrail prior to the army's departure from France, conceived as a national obligation rooted in France's colonialist tradition, which dates back to the late 15th century.[32] Sarrail aimed to uphold this tradition by continuing the legacy of earlier French expeditions, such as those led by Heuzey,[33] asserting that in this way, Macedonia 'était devenue et est restée une province de la science française'.[34] After their departure from France, Sarrail and his army were followed by a group of savants according to the example of Napoleon in Egypt, who would undertake the study of Macedonian culture.

One of the members of the 'Service Archéologique de l'Armée d'Orient,' which was officially established on May 20, 1916, was Léon Rey. It remains unclear whether Rey ever formally served as the Service's director, but he played a key role in documenting its work.[35] In 1919, he presented a comprehensive report on the French army's archaeological research in Macedonia in an exemplary monograph that continues to be an essential reference for scholars of the region's prehistory and protohistory.[36] This essay includes the most analytical catalogue available so far of the prominent Macedonian mounds with excellent plans, photos, and accurate descriptions. It also documents French excavations at tells such as Sedes (Therme), Gona (near Thessaloniki's airport), and Kapoutzedes (Pylaia), along with a discussion of the finds from these excavations and related surveys. French scholars prioritized the tells, well aware of their significance from travellers' reports and prior archaeological surveys.[37] This focus on tell excavation, which was shared by British archaeologists, represents a prominent colonial approach in non-local archae-

[30] Sarrail 1920, 18.

[31] Descamps-Lequime 2011, 58; see also Descamps-Lequime 2017.

[32] Mendel 1918, 9: 'Avant même de quitter la France, en septembre 1915, il s'était préoccupé de grouper autour de lui quelques archéologues.'

[33] Cf. 'Dans une instruction postérieure, le général indiquait les moyens de réunir les objets déjà recueillis par suite de découvertes fortuites et, 'fidèle à la tradition française d'Egypte et de Moréo' posait les premières bases d'une exploration scientifique' (from a letter by Léon Rey to the Minister of War, printed in the first pages of his book, Rey 1917-1919).

[34] Mendel 1918, 10.

[35] Descamps-Lequime 2017, 69-70.

[36] Rey 1917-1919.

[37] In fact, more emphasis was placed on the prehistoric mounds of Macedonia than on the Byzantine monuments of Thessaloniki, see Mendel 1918, 10-17.

ology across the Balkans. Likewise, burial mounds became the central focus of early Austrian archaeology in Slovenia, where, between 1905 and 1914, the Duchess of Mecklenburg excavated more than 700 such monuments, producing extraordinary finds that ended up in European and American museums.[38]



Fig. 1 – A tell (toumba) near a bridge over the Axios (Vardar) River. Printed on the reverse side of the postcard: Editeur Jacques Saul – Salonique. Stab. E.B. Giarmoleo – Milano no 3049. Handwritten on the reverse side: 'Le 15 août, Toujours rien de nouveau, la santé est toujours bonne et dans l'espoir que cette carte vous trouve. Je même, je vous embrasse, (Jimaney ?).

The French military expedition rapidly popularised archaeological research at Macedonian mounds, celebrating these sites as cultural trophies. During World War I, Macedonian tells, or 'toumbas', became the subjects of numerous French postcards (fig. 1), marking what appears to be the first – and perhaps the only – time these monuments were orientalised and commemorated in such a visual form.[39] Over the following century under Greek sovereignty, these mounds were never again depicted on Greek postcards or postage stamps.

At the beginning of his book, while addressing the Ministry of War, Rey states explicitly, that the primary objective of the French archaeological mission was to safeguard local antiquities under French protection, following an alleged but vaguely described request from the Greek government.[40] However, this could not have been the genuine motivation for French scholars' involvement in further archaeological research, including excavations at settlement sites like Gona and Sedes. Similarly, the British troops stationed in Macedonia alongside the French did not share this motive in their engagement with fieldwork during trench warfare and subsequent systematic excavation campaigns at cemetery sites, such as that of Chausitsa.[41]

The immediate archaeological engagement of British and French forces was clearly viewed as part of their broader 'civilising mission,' akin to their activities in other colonies. Through this, they demonstrated superiority not only in military matters but also in the cultural sphere, asserting their roles as innovators, modernizers, and civilisers. Alongside infrastructure projects such as building roads, bridges, and railways, they considered it their duty to place antiquities under the protection of their forces. Archaeological research in the territories they occupied became an integral part of their imperialist ideology and strategy for cultural dominance.

The focus on tells as a research priority was far from incidental. The more prominent and significant the monuments investigated, the greater the prestige for France and Great Britain. Archaeological research in Macedonia, therefore, became part of 'The Great Game' in European archaeology, driven by the rivalry among powerful European nations to achieve scientific prominence while simultaneously imposing cultural hegemony over the occupied territories.[42] In this sense,

[38] Polizzotti Greis 2006.

[39] See also Andreou, Efkleidou 2018, 15, 86, 87.

[40] Rey 1917-1919.

[41] Casson 1919/1920-1920/1921.

[42] See supra n. 9.

early archaeological work in Macedonia was part of a colonial project not unlike that carried out in Egypt during Napoleon's campaign over a century earlier. The goal was to gather comprehensive information on all aspects of social life and culture in the colonized territory, and to exert a lasting influence by shaping both its ancient and modern identity through these cultural interventions.[43]

Despite repeated claims by the allied French and British forces about the alleged objective of their missions to protect antiquities, there is also sufficient evidence that antiquities were actually systematically looted during the war by officers and soldiers of the British Army.[44] The first Greek archaeologists in charge of the region of Macedonia, Giorgios Oikonomou and Eustratios Pelekidis, denounced such lootings many times, and even reported quarrels between French and British soldiers, requesting the intervention of the Greek and allied authorities. Antiquities often ended up being sold between soldiers as souvenirs; such actions may finally have caused the release of a strict statement by General Sarrail for the protection of antiquities.[45]

The Allied forces viewed their entitlement to formally acquire archaeological finds in Macedonia similarly to how they approached acquisitions in colonial ventures of previous centuries. This practice was likely regarded as a form of tribute, a symbolic offering from the local cultural heritage to their perceived role as benefactors and protectors of the region. Officially, artefacts from the British surveys were collected in the White Tower, while the French collected their finds in Rotonda (Church of Agios Georgios) of Thessaloniki. Both museums operated under the surveillance of the foreign authorities and were directed by fellow officers.[46] Despite contrary claims about prior agreements and good cooperation with the Greek government,[47] it seems that the only authorities in charge of these collections – consisting mostly of artefacts from tell-based settlements and their necropolises – were the allied armies, who operated in a more or less arbitrary manner. The Greek Archaeological Service, which already established an official branch in Thessaloniki soon after the annexation of a large part of Macedonia in 1912 into the Greek state, could not help but cooperate with the allied troops that not only established their own museums but also immediately began to explore archaeologically the occupied regions.

The concerns of the Greek authorities regarding the management of antiquities in Macedonia are evident in an official request made by Eustratios Pelekides, Director of the Thessaloniki branch of the Greek Archaeological Service. Pelekides urged the Greek Ministry to apply pressure on the allied troops to relinquish the antiquities they had collected. Despite internal disagreements among British forces about how to handle these antiquities,[48] their official position was to transport the items to Britain for exhibition at the Imperial War Museum. This was intended to commemorate British participation on the Macedonian front, highlighting their cultural engagement alongside their military presence.

The matter soon escalated into a diplomatic dispute between the foreign offices of London and Athens. Initially, Greek authorities resisted the transfer of the 'British Salonika Force' collection to the United Kingdom, with the British Foreign Minister appearing to respect this stance. However,

[43] It is noteworthy that one of the most comprehensive studies of the geography and ecology of Macedonia, published shortly after World War I, was commissioned by the Geographical Section of the British Naval Intelligence Division: Admiralty Handbook 1920.

[44] Mazower 2005, 297.

[45] Romiopoulou 2014, 32.

[46] Private collections also existed, such as that of Major Alexander Gawthrop Wade, who was the last curator of the 'British Salonika Force' collection. In the 1930s, Major Wade donated his own private collection, consisting of fewer than 100 artefacts, to the Ashmolean Museum and the University of Oxford (see Galanakis 2017).

[47] Cf. Rey 1917-1919, letter by Léon Rey to the Minister of War (printed in the first pages of his book); Shapland 2012, 75; Descamps-Lequime 2011, 58.

[48] Gardner and Casson 1918-1919, 11.

the situation abruptly changed in 1919 when the Greek Foreign Minister unexpectedly granted full permission for the dispatch of – at least a significant portion of – the collection to Britain.[49] A letter from British General George Milne to the British Ambassador to Greece highlights the British persistence. While Milne acknowledged that Greek law prohibited the export of such items, he expressed hope that 'as…the exhibition of these antiquities would undoubtedly be of great interest to the general public of Great Britain…the Greek government may see their way to grant permission, as a very special case.'[50] Ultimately, the Greek authorities, under pressure to maintain diplomatic relations, found a way to bypass legal obstacles and allow the antiquities' export. At the time, Greece was in a precarious political situation, anticipating international support for the landing of Greek troops in Smyrna in 1919, with the goal of annexing Ionia. In the end, around 3,000 antiquities were shipped to London that same year and received by the British Museum.[51]

Remarkably, French-collected antiquities had already been transported to the Louvre in Paris with even less transparency and much earlier than the British artefacts sent to the British Museum. While the circumstances surrounding the reversal of Greek authorities' decision to allow the shipment of antiquities from British excavations to London remain unclear, the authorization for the export of French-excavated antiquities is even more opaque. During the French excavations, finds – sometimes from the same tombs – were arbitrarily divided, with one portion allocated to Greek authorities and another shipped to Paris in two separate consignments: 11 crates in October 1917 and an additional 19 crates, some of which also contained documentation materials, in March 1919.[52]

The Spoils of Victory: Macedonian Archaeology in the Interwar Years

After the First World War, the victorious British conducted extensive archaeological fieldwork in Macedonia, focusing once again on the region's most prominent monuments, such as tells and hilltop sites. Among the most active scholars was Walter Abel Heurtley, who excavated widely across central and western Macedonia, at sites including Vardaroftsa (Axiochori), Vardino, Saratse (Perivolaki), Agios Mamas, Molyvopyrgo, Kritsana, Boubousti (Platania), Servia, and Armenochori, before shifting his focus to Ithaca. Another prominent British archaeologist, Stanley Casson, also conducted significant fieldwork during and after the war at sites such as Chausitsa and Kilindir. Both Heurtley and Casson published numerous short excavation reports and authored major monographs on Macedonian prehistory and protohistory.[53]

A major objective set up already in the introduction to Heurtley's monograph entitled 'Prehistoric Macedonia', was to shed light on Macedonia as an integral part of the Aegean and to con-

[49] Kanatselou, Shapland 2014, 94; Stefani 2012, 30.

[50] Galanakis 2017, 188.

[51] Richard Clogg (2022) described this diplomatic manoeuvre as the '"weaponization" of antiquities'; see also Clogg 2017, 48–49; Galanakis 2017, 188-189; cf. Mazower 2005, 297. Many years after these events, it remains unclear what happened to some artefacts excavated by British archaeologists shortly after World War I. A recent study of the finds from the British excavation at Boubousti (Platania) revealed that the largest and most distinctive pottery fragments published in the preliminary report a century ago (Heurtley 1926-1927) are missing from the Archaeological Museum of Thessaloniki, which housed the finds from that excavation, as well as from other Greek museums in northern Greece. In response to relevant inquiries, Greek authorities indicated that some artefacts from the British excavations were reportedly donated to Great Britain; however, this statement may reflect confusion regarding the fate of finds from British excavations conducted before and after the end of World War I. Finally, a search for the missing artefacts at the British Museum and the Archaeological Museum of Edinburgh – both of which house finds from Macedonia retrieved during World War I – has not yielded any results.

[52] Descamps-Lequime 2017.

[53] Their work, particularly their synthetic monographs (Heurtley 1939; Casson 1926), has had a significant influence on Macedonian archaeology throughout the 20th century.

test the conviction that 'Macedonia goes with the North'.[54] Another influential theory of Heurtley, especially within the diffusionist historical context of the 20th century, was his so-called 'Lausitz invasion.' A burnt layer and a few sherds of fluted pottery in a couple of central Macedonian sites that he excavated were the evidence for a theory that argued for the invasion around 1150 BC of Illyrian people to Macedonia from central Europe and especially Bohemia, where pottery of similar type was also produced. This invasion interrupted and allegedly impeded for a long time Macedonia's assimilation into the dominant southern Greek cultural context. According to Heurtley, however, the arrival of the Aryan-speaking tribes from the north 'would introduce a fresh Aryan strain into the already Aryanized or Aryan stock' in Macedonia.[55]

In a volume commemorating 100 years since Macedonia's annexation to the Greek state, British archaeologist Kenneth Wardle, who worked extensively in central Macedonia in the 1970s and 1980s, remarked: 'I need do no more than marvel at a military machine which appointed officers to protect the antiquities and recognised the need to provide 100,000 allied troops far from home with leisure interests.' Wardle's observation accompanies a map pointing out all eleven British excavations conducted between the two World Wars, along with four more recent ones.[56]

De-colonization and Nationalism in Macedonian Archaeology after the Second World War

The outbreak of World War II abruptly interrupted the intense archaeological research in Macedonia. Following the invasion of Greece by Italian, German, and Bulgarian forces, northern Greece was divided into occupation zones. This radical political shift led to the expulsion of archaeological missions of the victors of World War I. Unlike in other parts of Greece, the Nazi occupation showed little interest in continuing British-led archaeological research, particularly at the tell-based settlement sites. Only a few, restricted excavations were conducted by the occupation forces,[57] and tells lost their significance as prominent archaeological markers in the Macedonian landscape.

After the defeat of the Axis powers and the retreat of German troops, Greece plunged into a brutal civil war, further devastating any remaining infrastructure. The post-war intervention by Greece's allies, particularly the British, echoed the colonial-style involvement seen during World War I. This time, the goal was to prevent Greece from joining the eastern European communist bloc.

These dynamics fostered a new form of northern Greek nationalism, shaped by two key factors: a perceived, ongoing Slavo-communist threat from the North, and an increasing awareness of foreign interference, which was often seen as having a colonialist character. In response, Greek authorities grew increasingly hesitant to grant foreign powers permission to carry out archaeological projects in Macedonia. The 1950s and 1960s were marked by ongoing political instability and internal strife, culminating in the establishment of a military junta in 1967. This regime, supported by some of Greece's western European allies, further entrenched the country's political isolation.

It was only in the 1960s that a few British/American excavations (Nea Nikomedeia and Sitagroi) and one French project[58] took place in northern Greece, all focusing on Neolithic sites. In contrast to earlier periods, when major archaeological work in northern Greece was driven by foreign initiatives, the Greek state had now fully taken charge of research at the major sites

[54] Heurtley 1939, xvii.

[55] Heurtley 1939, 127-129.

[56] Wardle 2014, 46, fig. 1.

[57] Romiopoulou 2014, 35.

[58] Dikili-Tash was excavated for the first time by the French in 1920-1922.

in Macedonia. This included not only classical and Hellenistic sites but also key pre- and proto-historic tells. The driving force behind regional archaeology had shifted from imperialist and colonial motivations to a nationalist framework.

During this period, a long-standing debate emerged regarding the identity of ancient populations in Macedonia, Thrace, and Epirus. This discussion often ran parallel to competing narratives from neighbouring countries, which also claimed the origins of these ancient groups, particularly the Macedonians and Epirotes. The concept of ethnogenesis, previously popular in eastern European archaeology, entered the Greek scholarly discourse at this time. Ethnogenesis referred to the process of forming ancient ethnic groups (ethne) and was used to project modern nation-states' ideas of identity formation onto the distant past. Culture-historical archaeology often linked this process to material culture, using it to trace the roots of ancient identities.[59]

The Bronze Age and Early Iron Age were typically regarded as the formative periods for such identities due to the diversity of material culture and their relative proximity to historical times. In Macedonia, the rise of nationalism reignited interest in these periods, bringing the Macedonian tells back to the forefront of archaeological research. These sites were seen as the places where Macedonian identity supposedly emerged and where the first Macedonian kingdom arose from a transhumant population. However, many of these tells, particularly in central Macedonia, were actually outside the early historical realm of the Macedonian kingdom and were part of Thrace. Despite this, they were paradoxically included in discussions about early Macedonian identity. In the ensuing years, modest finds of the Bronze and Early Iron Age from the Greek part of Macedonia frequently travelled around the world and were exhibited in major museums as part of the cultural heritage from the period of Macedonian ethnogenesis. Several catalogues were published on these occasions proclaiming the Greek identity of the ancient Macedonians and thus presenting the modern Greek state as its authorized heir.[60] Next to Classical and Hellenistic luxury artefacts made of precious metals that were found at major Macedonian sites, an emphasis was thereby placed on the less impressive Bronze and Early Iron Age finds, many of them deriving from old or more recent excavations in the Macedonian tells and their necropolises which cannot in fact be related to historical Macedonia of the pre-classical period.

The Yugoslav Socialist Republic of Macedonia (now North Macedonia), a prominent player in the regional heritage narrative, began promoting archaeological exhibitions early on, also producing multilingual catalogues to reach broader audiences.[61] These exhibitions prominently featured Bronze and Early Iron Age artefacts as representations of an alleged Macedonian ethnogenesis. Curiously, most of these artefacts originated from areas distant from the core region traditionally associated with the early Macedonian kingdom in the pre-Classical period.[62] Establishing a distinct Macedonian identity prior to the Classical era remains challenging, as literary sources provide limited reliable information on the early development of the Macedonian kingdom, making geographic associations speculative. However, if one were to approximate the heartland of the early kingdom, it would likely align with the area now recognized as western Macedonia, especially around Imathia and Kozani.

[59] On the perception of the concept of ethnogenesis in the Balkans, see Gimatzidis 2018.

[60] Vokotopoulou 1994; Vokotopoulou 1993; Braggioti 1988 ; see also more recently Galanakis 2011; Descamps-Lequime 2011b.

[61] See, e.g., Sanev et al. 1976; Simoska, Sanev 1976.

[62] The territory of the Republic of North Macedonia is often considered the homeland of various Illyrian and Thracian tribes, such as the Dardanians and Paeonians (see Delev 2018).

Archaeological fieldwork in the Greek part Macedonia during the past decades

After a long time the Macedonian tell-based settlements came into the focus of international fieldwork research again in the 1970s. Before that a British scholar, David French, published in 1967 a gazetteer of central Macedonian sites with useful topographical information and description. He also collected pottery from many sites that he visited, which now constitutes a collection given his name at the Aristotle University of Thessaloniki.[63] Three major non-local excavation projects, each pivotal to advancing the archaeology of the region, were initiated in 1975. It is not clear if this coincidence was incidental or was linked to some conscious change in the management of Macedonia's cultural heritage from the side of the Greek authorities.

The defeated side of the two World Wars reappeared in Macedonian archaeology after a very long time of British dominance with the excavation of a small tell in the lower Axios valley. The research conducted by the German archaeological mission at the toumba of Kastanas, led by Bernhard Hänsel from the Freie Universität Berlin between 1975 and 1979, had a stronger focus on Balkan rather than Aegean archaeology.[64] As a specialist in European and Balkan prehistory, Hänsel aimed to bridge the gap between Balkan and Aegean archaeology, contributing new insights into the cultural affinities and socio-economic interrelations of these regions. A key goal of the excavation was to establish a more robust correlation between Aegean and central Balkan/European chronologies, a long-standing objective in regional archaeology. The results of the excavation at Kastanas, with its 28 successive occupation layers spanning from the Early Bronze Age to 700 BC, were published in a long series of volumes that made Kastanas one of the most comprehensively documented excavation in Greece.[65]

The toumba of Assiros, located in the Langadas basin, differs from Kastanas not only in the notable variability of its material culture but also in its limited representation of Early Iron Age occupation phases, largely due to significant erosion. The site was excavated from 1975 to 1989 by Kenneth Wardle, a British classical archaeologist and prehistorian with a specialization in the Aegean, who published his findings in several extensive journal papers.[66]

Both the Kastanas and Assiros excavations introduced new perspectives in Aegean archaeology by highlighting the region's connections to its northern heritage. This academic field has long suffered from a persistent bias that views the archaeology of the area north of Mount Olympus as peripheral.

The third non-local project in central Macedonia was launched in 1975 at Torone in Chalkidike. Unlike Kastanas and Assiros, which may have been perceived by Aegean prehistorians and Classical archaeologists as marginal native settlements, Torone was a well-known Greek city during the Classical period, frequently mentioned in ancient historiography. The excavation project was conducted from 1975 to 1995 by Australian archaeologists under the auspices of the Greek Archaeological Society at least for the first years until the foundation of the Australian Archaeological School at Athens.[67] Subsequent archaeological studies at Torone have consistently focused on a southern Aegean perspective, often overlooking its Balkan cultural connotations.

With the exception of the three aforementioned projects that began in 1975, excavation at tells and primarily at the well-known Macedonian cities of the post-Archaic periods remained largely a Greek endeavour after World War II. Greek-led fieldwork rapidly and steadily intensified from the 1950s onward. Following the growth of excavation projects at major Classical, Hellenistic, and Roman sites in Macedonia, such as Vergina, Pella, and Dion – where some

[63] French 1967.

[64] See Hänsel 1989.

[65] The wheelmade pottery of the layers 1 to 10 remains only to be published.

[66] See Wardle, Wardle 2007.

[67] Cambitoglou, Papadopoulos, Tudor Jones 2001.

fieldwork had begun prior to the war – Greek archaeologists also concentrated on prominent Bronze and Early Iron Age tell sites, including Toumba Thessaloniki, Sindos, Archontiko Giannitson, and Karambournaki. In recent decades, alongside these systematic excavations, local branches of the Greek Archaeological Service have undertaken numerous rescue excavations across Macedonia.[68]

The contrast between Macedonia and other regions of Greece is striking concerning the origins of recent archaeological fieldwork. While numerous international projects have flourished across Greece in the past decades, foreign archaeological schools and non-Greek institutions are rarely involved in fieldwork in Macedonia. When international collaborations do occur, they typically entail close cooperation with local Greek authorities. A recent example is the resumption of excavations at Olynthos in Chalkidike, which began as an American archaeological project under David M. Robinson in the 1920s and continues today as a Greek-British collaboration.[69]

An anecdotal story about the resumption of excavations at Agios Mamas in Chalkidike, where British archaeologist Walter Abel Heurtley first excavated in 1928, highlights the persistence of colonialist approaches to the archaeology of Macedonia. Nearly two decades after the excavation at Kastanas, a German team from the Freie Universität Berlin returned to Macedonia with the aim of undertaking a new project. This time, the goal was to excavate a large, central site that could shed light on the internal organization of the complex tell-based settlement system in central Macedonia and to provide evidence for the Middle Bronze Age, a period underrepresented in the Kastanas deposits. Initially, the German university planned to excavate the tell at Axiochori (formerly Vardaroftsa). However, Ioulia Vokotopoulou, then director of the Ephorate in Thessaloniki, proposed instead that they focus on the toumba at Agios Mamas, aligning with her objective to foreground the early history of Chalkidike. The German excavation, carried out from 1994 to 1996 in collaboration with Greek authorities, soon encountered objections from British colleagues, who asserted claims over all sites previously excavated by their compatriots.[70]

Final Remarks: From British Imperialism to Greek Macedonism

The archaeology of Macedonia has been shaped by the intertwined and mutually reinforcing practices of imperialist, colonialist, and nationalist ideologies. As in other regions of the world, non-local institutions exerted a multi-dimensional influence on local archaeology, often engaging in regional affairs and producing narratives aligned with their own ideologies. Ultimately, these institutions played a key role in fuelling the rise of local nationalism.

A central feature of *imperialist archaeology*, as identified by Bruce Trigger and reflected in the practice of archaeology in Macedonia during the first half of the 20th century, was the discipline's implementation by powerful states, such as the Great Britain, which exerted political dominance over large parts of the world.[71] One of the most effective tools in such contexts was the education of local scholars in the theoretical approaches of the dominant archaeology or the introduction of its methods into local archaeological projects. Archaeologists like Heurtley and Casson, who extensively worked in Macedonia, came from a disciplinary tradition that viewed

[68] Preliminary reports on excavation projects in the Greek regions of Macedonia and Thrace have been presented at an annual conference in Thessaloniki and published in its proceedings since 1987 ('Το αρχαιολογικό έργο στη Μακεδονία και στη Θράκη').

[69] The British expressed an early interest in the exploration of Olynthos, dating back to before World War I, but could not commence their efforts due to bureaucratic issues (see Morgan 2017, 124-125).

[70] Personal information by Bernhard Hänsel.

[71] Trigger 1984, 363-368.

Britain – particularly England – as the intellectual and technological epicenter for assimilating diverse cultures and global ideas, as well as for generating major innovations more efficiently than elsewhere.[72] This sense of cultural primacy influenced their interpretation of cultural developments in the regions they studied, exemplified by the theory of 'Aryan' populations migrating into Macedonia from regions of Europe that were, at the time, more industrially advanced – regions that, in more recent history, also supplied settlers for Great Britain (Saxons).

Colonialist archaeology in the Greek part of Macedonia has manifested in several ways. A prominent example during the first half of the 20th century is the appropriation of research at distinguished archaeological sites, primarily tells, along with the management of cultural heritage as war booty. The perceived right to construct historical narratives through exclusive access to archaeological research at these sites, coupled with the expropriation of cultural materials sent to institutions such as the Louvre and the British Museum, exemplified colonial practices typical of imperial states publicly commemorating their overseas activities.

Another manifestation of colonialist archaeology in Macedonia during the same period was the predominance of archaeological practice by scholars who lacked historical or cultural ties to the local populations of the regions they studied.[73] The culture of the colonised people – unlike that of the colonizers – became the subject of anthropology, whose findings were often used to draw comparisons with ancient populations, reinforcing the idea of the static nature of local cultures across time.[74] For instance, Heurtley attributed the exchange of certain commodities to the transhumant economy in Macedonia, noting that 'a semi-nomad life is (still) the rule amongst a large part of the population in North Greece today.'[75] Despite the doubts raised in the 1950s against the idea of transhumant pastoralism in antiquity,[76] the renowned British historian Nicholas Hammond continued to uphold such views. He favored modern transhumant Sarakatsan and Vlach communities in northern Greece as the best ethnographic parallels for reconstructing Late Bronze and Early Iron Age socio-economic organization in the region.[77] Finally, a hallmark of colonialist archaeology – also evident in Macedonia – was the attribution of cultural change to migration, as local societies were presumed to be incapable of generating innovation.[78]

Nationalist archaeology in the Greek part of Macedonia manifested through an increase in fieldwork, exhibitions, and the promotion of national historical narratives, largely spearheaded by the Greek state in the aftermath of World War II. This shift in the affiliation and objectives of archaeological research has been commonly attributed to the geopolitical insecurity in the region following the onset of the Cold War, which created a divide between Greece, aligned with the European West, and the rest of the Balkans, which were aligned with the communist East. A particularly traumatic event for the Greek state that fueled nationalist archaeology was the establishment of the People's Republic of Macedonia as one of the six constituent republics of Yugoslavia

[72] Trigger 1984, 365.

[73] See above. For a brief overview of the relatively less influential Greek archaeological research and fieldwork in Macedonia during the first half of the 20th century, see Adam-Veleni 2017.

[74] See Trigger 1984, 360-361.

[75] Heurtley 1939, 131.

[76] See Kirsten 1956, 172.

[77] Hammond 1967, 267; Hammond and Griffith 1979, 23, 658-659. This rather simplistic interpretation faced criticism from Paul Halstead (1987; 1996) and John F. Cherry (1988) in the 1980s, who argued against the notion of transhumant pastoralism in prehistory on the Pindus, which would necessitate large flocks and well-organized urban markets. Furthermore, Claudia Chang and Perry A. Tourtellotte (1993a; 1993b) challenged the environmental and socioeconomic constraints of these theories using ethnoarchaeological evidence, deeming them archaeologically unsustainable.

[78] See, e.g., Casson 1926, 156-161.

at the war's end. This development was perceived as a threat to both the territorial integrity and cultural identity of the Greek part of Macedonia.[79]

However, viewing this political situation solely as a justification for the rise of nationalism – and, by extension, nationalist archaeology – may oversimplify the matter. The narrative of national insecurity was likely constructed within Greece during a time of internal strife, following a brutal civil war that deepened class divisions and tensions. In this context, nationalist archaeology served less as a response to external threats and more as a tool for the state to mask and manage internal conflicts.[80]

The recent Methone and Amphipolis projects, implemented during Greece's severe economic crisis in the 2010s, illustrate how archaeology was manipulated for domestic political purposes amid social instability.[81] Both projects failed to attract positive attention despite heavy state promotion, not only because of their flawed execution but also due to their outdated framing as national endeavors. Impressive finds were overshadowed by their manipulation for nationalist purposes. For instance, at Methone, a misleading narrative portrayed the settlement as Macedonian despite indications of its Thracian origin, as documented in ancient historiography. Based on pottery evidence, Greek archaeologists involved in the project claimed that the local population ('Macedonians') welcomed Euboean and other Greek immigrants as fellow 'Panhellenes.' Likewise, a baseless suggestion emerged that 'Macedonians' from Methone traveled to Pithekoussai, further reinforcing their supposed Greek identity.[82] At Amphipolis, a similarly tenuous narrative linked the grand but heavily looted burial monument to figures like Hephaestion or Olympias, despite a lack of substantive evidence.

The official and state-sponsored celebration of the archaeological discoveries at Amphipolis and Methone as symbols of national pride, clearly aimed to bolster public morale and divert attention from ongoing issues. This approach echoes earlier practices in Macedonian archaeology, particularly those established in the 1970s at Vergina. The discovery of a Macedonian tomb at that site was controversially attributed to Philip II, relying on the allure of elaborate burial goods rather than robust historical evidence. Had this discovery occurred in the 2010s instead of 1977, its interpretation would likely have faced similar challenges. In all cases, political objectives aimed at concealing social tensions, along with populist archaeology, have significantly shaped the narratives surrounding these sites.[83]

Finally, the convergence of nationalist and colonialist archaeology becomes particularly evident at Methone. After conducting regional fieldwork and framing a nationalist narrative for the site, Greek authorities extended an invitation to the Cotsen Institute of Archaeology at UCLA to join its excavation and study – a collaboration made especially appealing by Methone's significant archaeological discoveries. Despite the American scholars' strong academic reputation for critiquing orientalism, colonialism, and nationalism in other contexts, their comprehensive publication on Methone refrains from addressing the ethical implications of their Greek colleagues' interpretations and questioning the prevailing nationalist perspectives.[84] Thus, Methone emerges as a stage for both Macedonist and neo-colonialist archaeological agendas in northern Greece.

[79] See Danforth 1995.

[80] Cf. Trigger 1984, 360.

[81] Gimatzidis 2018, 40-45.

[82] Tzifopoulos, Bessios, Kotsonas 2012; cf. the critiques in the reviews by Gimatzidis (2013) and Chavela (2013).

[83] See Gimatzidis 2018.

[84] See Morris, Papadopoulos 2023.

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Long-Distance Networks in the Adriatic Balkans during the 3rd Millennium BCE

Maja Gori[1]

Abstract: This paper reviews current research on long-distance networks involving prehistoric communities in the Adriatic Balkans during the late 3rd to early 2nd millennium BCE, focusing on the "Cetina phenomenon." Characterized by distinctive tumuli and pottery, Cetina culture was prominent in the Adriatic and integrated with Bell Beaker, Aegean, and Balkan networks. Chronological studies are challenged by fragmented evidence, and absolute dating remains limited. Cetina pottery, found across Greece, Italy, and the central Mediterranean, suggests significant maritime connectivity. Two primary models explain Cetina expansion: one suggests a single and short mobility pattern, while the other proposes a complex, multi-phase network involving both Balkan and Greek groups. Recent research based on network analysis and community of practices used modularity to identify crucial hubs and segmented the network into distinct groups. This evolving view highlights Cetina communities' high mobility, including both maritime and land-based transhumance practices.

Key words: Bronze Age, Adriatic, Networks

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Adriatic networks

This paper presents an overview of the research undertaken so far on long-distance connections involving the prehistoric communities that inhabited the Adriatic Balkans during the second half of the 3rd and the early 2nd millennia BCE. Specifically, it examines the complexity of the "Cetina phenomenon", a widespread cultural pattern that integrated Bell Beaker, Aegean, and Balkan long distance networks throughout the Adriatic-Ionian region. The 3rd millennium BCE is characterized by the presence of different ideologically driven long distance networks that spread across Europe, marked by distinct archaeological assemblages and practices. What is known in the literature as Cetina culture,[1] was prominent in the Adriatic Balkans from the mid-3rd to early 2nd millennium BCE. It is characterized by the use of burial tumuli and by a distinctive decorated pottery style. These tumuli are usually built using dry stone technique. The burial sites are concentrated in Central Dalmatia (modern Split–Šibenik region, Croatia) and exhibit diverse burial practices, including inhumation in stone cists, unstructured graves, and cremations, often with few grave goods[2]. Because of their shape and height, a good number of these tumuli resemble rather large stone-built platforms. Furthermore, several of these structures do not contain human remains but only a large amount of fragmented pottery and can be defined cenotaphs. Contrary to what we know from burials, Cetina settlements remain poorly understood, with no known open-air sites, extremely limited evidence from hillforts, and most data coming from stratigraphies in karstic caves, suggesting a highly mobile lifestyle of these communities, with a preference for temporary, dispersed settlements.

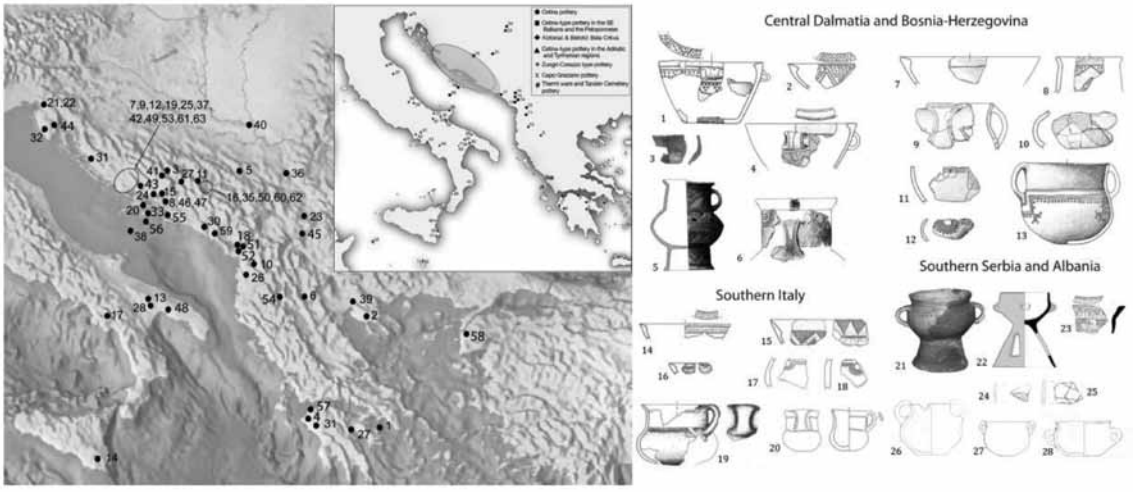


Fig. 1 – Distribution of the most relevant sites connected to the Cetina phenomenon and most widespread ceramic shapes (from Cazzella et al. 2020 and Gori 2020).

Disentangling complexity

Under the label "Cetina pottery" one can recognize at least three different sub-groups: one comprising Cetina pottery *stricto sensu*, the second comprises Cetina-like ceramics made with different technologies, the third comprises ceramics whose decorative patterns are inspired by Cetina ones. Cetina and Cetina-like ceramics have been discovered beyond the Balkans, particularly in the Peloponnese at sites such as Olympia and Lerna, highlighting Adriatic-Greek connec-

[1] Marović, Čović 1983; Govedarica 1989.

[2] Forenbaher 2023.

tions. Cetina pottery and Cetina-inspired pottery appear in southern Italy, concentrated mainly in Apulia, but with few noteworthy findings in the western part of the Peninsula, in Campania, and across the central Mediterranean, including Sicily and the Maltese archipelago, indicating broader Adriatic-Ionian maritime connectivity. These patterns stimulated research on Cetina's role in Mediterranean interactions.[3] Established model for the Cetina expansion interprets it as a network driven by the movement of small groups, possibly linked to metal trade. The two main proposed hypotheses to explain the spread of Cetina ceramics in the Central Mediterranean were the following: 1) According to Maran[4] followed by Broodbank[5], Cetina's spread to western Greece, southern Italy, Sicily, and Malta reflects a single, cohesive pattern of connectivity in the late 3rd millennium BCE, facilitated by Balkan "Argonauts" from Dalmatia who moved across the central Mediterranean. 2) Recchia and Cazzella[6] propose instead an earlier, two-phase process beginning already in the mid-3rd millennium BCE. This model suggests that both Balkan and Aegean groups contributed to the spread of Cetina features together with new economic strategies across the central Mediterranean, forming a complex socioeconomic network. Both models have the undoubtful merit to provide an explanation for the long distance spread of ceramic patterns, highlighting the distinctive maritime connectivity networks of Cetina communities and their reach across the Adriatic and Ionian regions. The most significant difference between these two models is the duration of the phenomenon. Both however see primarily an economic reason as a driver of mobility.

Recent research[7] has reframed the understanding of the Cetina phenomenon, shifting the emphasis from mobility primarily driven by resource procurement to the dynamics of intertwined communities of practice. This approach recognizes the complexity of cross-cultural and cross-regional connections within the Cetina phenomenon and underscores the significance of ritual practices in the formation and maintenance of these networks. Additionally, the role of spatial environments as facilitators of social interactions has been emphasized. The application of modularity analysis has further advanced the understanding of the network structure, enabling the identification of pivotal hubs and the segmentation of networks into distinct subgroups. This methodology facilitates a multi-scalar analysis, offering a more nuanced perspective on the Cetina phenomenon and its socio-cultural dimensions.[8]

Chronology

One of the main challenges in understanding the Cetina phenomenon is the lack of reliable chronology. Attempts to create a solid chronological framework for Cetina have been hampered by fragmented archaeological evidence, particularly as most Cetina ceramics are found scattered across stone tumuli rather than in closed, datable stratigraphic contexts. Cetina burial mounds often contain multiple burials spanning long periods, further complicating efforts to establish a clear sequence. Radiocarbon dating remains limited, with only a few dates from burial and settlement sites in the core Cetina area, Italy and the Aegean. An attempt to determine with radiocar-

[3] Della Casa 1995; Maran 1998; 2007; Cazzella 1999; Rambach 2004, 2007, Broodbank 2013; Cazzella and Recchia 2015; Arcuri et al 2016; Forenbaher 2018; Cazzella et al. 2020.

[4] Maran 2007; Maran 1998.

[5] Broodbank 2013.

[6] Recchia, Cazzella 2017.

[7] Gori 2020, Gori et al. 2022.

[8] Gori et. al 2021.

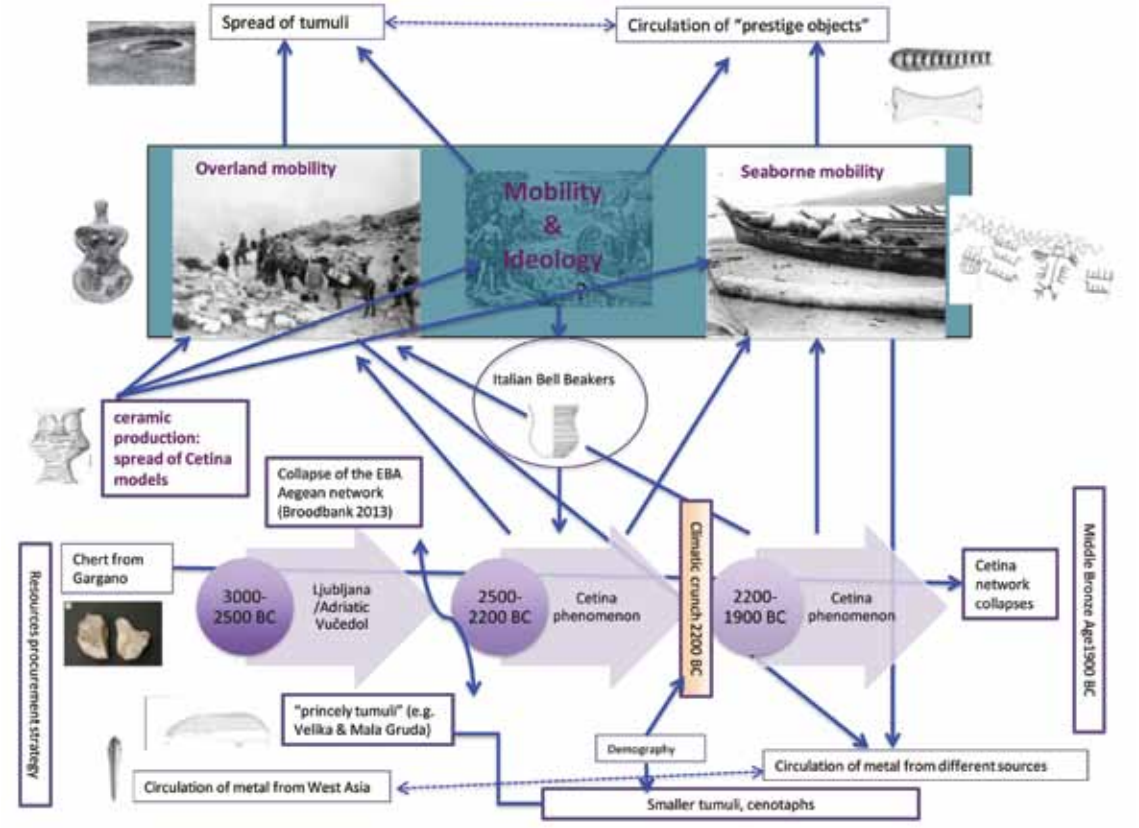


Fig. 2 – Cetina as complex phenomenon.

bon dates the length of the Cetina phenomenon was undertaken by Forenbaher,[9] who placed the chronological space occupied by Cetina style between the second half of the third millennium and immediately after year 2000 BC. The identification of distinct phases within the Cetina phenomenon remains highly speculative, including attempts to construct a relative chronology based on ceramic typology. This is also due to the lack of reliable stratigraphies, which makes it impossible to assess stylistic variability within stratigraphic sequences. Absolute dating from contexts in adjacent regions has yielded more reliable chronological sequences,[10] but they can loosely be comparable to those from the Adriatic, as Cetina material culture has also been documented in the interior regions of the Balkans but not from contexts in which absolute dating was undertaken. The chronological aspect remains one of the most problematic issues to date, and it is conventionally accepted that the Cetina phenomenon spans approximately 500 years. Although a division of the Cetina phenomenon into two phases has been proposed, this hypothesis is primarily based on few radiocarbon dates obtained from peripheral regions of the Cetina phenomenon (e.g., Tyrrhenian Italy and Greece) and on feeble typological classifications. Considering the geographic extension of the Cetina phenomenon and the absence of stratigraphically coherent contexts from Dalmatian sites that could be analyzed using Bayesian modeling, this proposed division remains at present speculative.

[9] Forenbaher 2018: 135-141.
[10] Bulatović et al. 2020.

Eastern Adriatic landscape

The shift from the investigation of single sites to the study of questions addressing regional change and variation is a key matter to understand patterns in the Cetina archaeological record. The adoption of a landscape approach to the study of the Cetina phenomenon can indeed provide a framework within which to evaluate and interpret diverse observations about spatial and temporal variability in the structure and organization of material traces. The term 'landscape' is used by a number of scientific disciplines with different concepts and definitions: as we know, even within the archaeological discipline there exist several and different approaches to Landscape Archaeology. The basic concept of landscape in prehistoric archaeology focuses on the relationship of past peoples with environments. Already in the 1990s B. Bender[11] argued that "*landscapes* are created by people—through their experience and engagement with the world around them [...] The landscape is never inert, people engage with it, appropriate and contest it. It is part of the way in which identities are created and disputed." Anschuetz, Wilshusen and Scheick proposed a landscape paradigm to help in defining patterns of inquiry for Landscape Archaeology. Landscapes are: 1) synthetic, with cultural systems structuring and organizing peoples' interactions with their natural environments; 2) worlds of a cultural production; 3) the arena for all of a community's activities; 4) dynamic constructions, with each community and each generation imposing its own cognitive map on an anthropogenic world of interconnected morphology, arrangement, and coherent meaning.[12]

The most abundant and visible archaeological item in the landscape pertaining to the Cetina communities consists of drystone tumuli, and for this reason they represent an obligatory starting point in comprehending how Cetina cultural landscapes were constructed and experienced.[13] Most of the tumuli that survive until today do not rise far above the ground level. This poses some questions of how high these tumuli were originally, and if they were able to serve as actual landmarks in the landscape. In the cases of two of the most outstanding funerary tumuli of the early 3rd millennium BCE, Velika Gruda and Mala Gruda, for example, one can argue that these structures had probably a character of monumentality, as their dimensions were quite significant in respect to the surrounding landscape. The multi-period tumulus of Velika Gruda[14] measures 26 m in diameter with a maximum elevation of 6 m and a volume of approximately 1600 m^2. Mala Gruda, which has a simpler stratigraphy since it was possibly used over a shorter period of time, has a maximum elevation of 4 meters above the flat valley floor.[15] Some other Cetina tumuli are also quite high, as for example in the Rudine cemetery, where gomila 13 measures 2.50 m in height[16] and gomila 19 at 2.40 m.[17] However, the majority of the tumuli excavated by Marović in the upper Cetina watershed are definitely lower and measure between 0.30 m and 1 m in height.[18] Probably several of these structures were taller, and have been modified by the concomitance of weathering and human action, but we cannot exclude that many were originally close to how they look now. If we assume that the height of some of these structures has not changed much over time, we can better interpret this architecture rather as a type of stone platform. We should also

[11] Bender 1993, 1 quoted in Förster et al. 2012, 171.

[12] Anschuetz et al. 2001, 160–161.

[13] On the appearance of burial mounds and the understanding of the symbol of the circle that defines the form and the idea of the mound see Govedarica 2012.

[14] Della Casa 1996, 17.

[15] Primas 1996, 11.

[16] Marović 1991, 36.

[17] Marović 1991, 39–40.

[18] Marović 1991.

consider that not all these tumuli/stones cairns were used for burials: several of these heapings of stones in which Cetina potsherds were recovered were not covering any grave. One of these is Brnjica, a structure currently being studied by G. Recchia and me, where no burial was recovered, only a bone dated to the Late Bronze Age and a medieval grave. There are several potsherds. The interpretation is likely that in Cetina times it was a platform for ritual rather than a burial structure. These differences suggest that when we consider all the possible functions of such monuments, we have to be more cautious.

Most scholars agree that a *funerary landscape* involves burials and, at some level, how they 'work' in the geographical landscape. However, Daróczi[19] reminded us that the sum of archaeological funerary finds placed in their natural environment does not constitute a funerary landscape but rather a burial landscape, i.e. one of burial habits. A funerary landscape is rather a cultural product and arena of presumably repetitive social activities, which are usually seen as involving specific types of ritual and often to be associated with some level of religious beliefs. Rituals often include seemingly costly actions that operate as trustworthy signals to convey commitment to the group, which in turn can promote trust and affiliation among group members.[20] Participation in ritual activities can be a significant component in the creation and maintenance of social and communal identity. Because costly rituals signal commitment to the group, the more rituals involved, the longer the groups tend to survive. In this way we can regard both the single and the groups of tumuli typical of the Cetina phenomenon as part of a proper funerary landscape, places of cultural significance, in which physical structures, features, and landscapes served as a stimulus for collective and individual memory and associations. Affinities and attachments to a place are transient and unstable. Since funerary landscapes are related to memory, they exist as markers of the "associated intense phenomenological experiences related to specific associations of environmental variables, e.g. light, wind, cold, and lived human experiences, e.g. sorrow, pain, pride, loss".[21]

The Cetina phenomenon overseas

The presence of Cetina pottery in southern Italy has been known for many years, beginning with the identification of Cetina vessels from the Laterza cemetery (Apulia) by Marović. Within a 25-kilometer radius of Laterza, two additional cemeteries—Pisciulo and Casal Sabini—have also yielded Cetina pottery, all situated inland in the Alta Murgia region of central Apulia.[22] In recent decades, a renewed interest in Mediterranean connectivity has facilitated the identification of Dalmatian pottery in Italian contexts. Cetina pottery has been indeed documented at several sites in Apulia, particularly near the Gargano promontory and on the promontory itself (Rodi Garganico). This is not surprising as research on Palagruža showed the presence of huge amount of Cetina potsherd together with chert from the Gargano promontory.[23] South of the Gargano, a few potsherds have also been recovered at Fontanarosa Castelletta and Coppa Nevigata. To the northwest of the Gargano, Cetina pottery fragments have been identified at several sites, including Serracapriola–Chiantinelle, Pedegarganica–Pescorosso, and Carlantino–loc. Fontana, as well

[19] Daróczi 2012, 200.
[20] Sosis, Alcorta 2003.
[21] Daróczi 2012:200.
[22] Recchia 2020; Cataldo 1999, 1996.
[23] Forenbaher 2018.

as Bisceglie–Lama Macina. All these fragments were recovered during surveys, and it is likely that these contexts represent settlements.[24] At present, Rutigliano–Le Rene is the only confirmed settlement in central Apulia where a small assemblage of Cetina-related pottery has been recovered. All of these sites are located relatively close to the sea, approximately 10–40 km from the coast. In the central Adriatic part of Italy, pottery that can be identified as Cetina comes from Sassoferrato in the Sentino valley (Marche), Fonti di S. Callisto – Popoli and Navelli (Abruzzo). Recent fieldwork on the Tyrrhenian side of the Italian peninsula has revealed Cetina-type pottery at three sites: Atena Lucana, Oliva Torricella, and Gricignano (Campania). Atena Lucana is a settlement situated about 130 km west of Laterza and Casal Sabini, while Oliva Torricella is a coastal settlement. Gricignano, possibly also a settlement, is located approximately 20 km from the Tyrrhenian coast. On the other hand, some identification of fragments that exhibit some similarities to the Cetina style is doubtful. For example, ceramics from Monti Lessini (Veneto) and the Alpine valleys (Trentino) have been attributed to the Cetina sphere, but Recchia has noted that, of all the purported Cetina potsherds, only one specimen from Monte Madrosa can be definitively identified as Cetina.[25] What is important to notice is that together with pottery that can be defined as "genuinely Cetina" for both decoration and shapes, there is what we can call "Cetina-inspired" pottery. The above mentioned northen Italian potsherds belong to the large body of evidence concerning the existence of shared styles that testfy connections throughout the Central Mediterranean. As already showed by several scholars, specific pottery styles signaled the existence of a long-distance network in the second half of the 3rd millennium BCE involving Dalmatia, the Italian Peninsula, Sicily, Malta, and the Peloponnese.[26]

The only category of evidence beyond pottery on the Italian Peninsula that may suggest connections with the Balkans is the Salve cemetery in Salento (Apulia), where approximately 90 mounds are dispersed across a plateau of about 1 km² immediately overlooking the coast.[27] To date, only 12 of these mounds have been excavated. Secondary cremation is the most prevalent funerary practice, though inhumation is also documented. The diagnostic pottery recovered from the site exclusively belongs to the Gaudo or Laterza pottery styles. Radiocarbon dates from the Salve cemetery predate those available for Adriatic contexts.[28] This prompted Forenbaher[29] to reverse the arrow of possible Balkan "influences" in Italy, during the late 3rd millennium BCE challenging the traits that traditionally defined the "Cetina expansion".[30] Instead of a unidirectional influence from the Balkans, these findings may reflect a more complex and reciprocal pattern of increasing connectivity across the region during this period.

The islands and long-distance networks

Another interesting aspect of the Cetina phenomenon is the role of the islands in connecting the two shores of the Adriatic. As already outlined above, a large number of prehistoric burial mounds dating back to the 3rd millennium BCE have been found throughout the Adriatic Balkans. Although a comprehensive mapping of all tumuli on the Adriatic islands does not

[24] Cazzella et al. 2020.
[25] Recchia 2020.
[26] Maran 1998; Cazzella et al. 2020.
[27] Aprile et al. 2018.
[28] Quarta et al. 2014.
[29] Forenbaher 2023.
[30] Maran 2007.

yet exist, systematic data collected from various islands provide an approximate estimate of the number of these structures in insular contexts. During the Adriatic Islands Project,[31] 242 tumuli were recorded on the island of Brač, an equal number on Hvar, 88 on Šolta, and 12 on Vis. These findings allow for the calculation of average tumulus densities per island, based on their respective areas: 0.6 tumuli per square kilometer on Brač, 0.8 on Hvar, 1.5 on Šolta, and 0.13 on Vis.[32] A systematic survey of the westernmost part of the Pelješac Peninsula recorded 92 tumuli over an area of approximately 35 square kilometers, resulting in a significantly higher density of 2.6 tumuli per square kilometer compared to the islands.[33] This discrepancy may be due to more thorough research conducted on the Pelješac Peninsula compared to the islands, or to particular cultural choices. It is true that only a very small number of the tumuli in insular contexts have been adequately excavated or studied, but it is noteworthy that, to date, none of the tumuli on the Adriatic islands have yielded artifacts dated to the third millennium BCE. This contrasts with the inland areas of Dalmatia, where tumuli from this period associated with the Ljubljana-Adriatic and Cetina ceramics are, with few exceptions, located relatively far from the sea. This observation is particularly striking given that in the 3rd millennium BCE there is a peak in maritime mobility, as evidenced by Ljubljana-Adriatic and Cetina-type ceramics found on the islands of Cres, Brač, Hvar, Korčula, Sušac, and most of all Palagruža, an islet between Italy and Dalmatia which lacks all basic resources such as water and fuel, and therefore is unsuitable for a permanent settlement. Here, the use of decorated pottery in ritual activities is suggested by the presence of typically decorated Cetina potsherds together with highly symbolic objects connected to Bell Beaker ideology, such as stone wrist-guards and flint arrowheads. This remote island occupied a significant place in ritual activities connected to the supply of raw materials. Forenbaher suggests that Cetina ceramics found at Palagruža were likely manufactured elsewhere and brought to the islet together with animals, water and other goods during expeditions.[34]

The apparent absence of 3rd-millennium BCE tumuli on the Adriatic islands can be hypothesized as primarily resulting from insufficient archaeological research. However, as a working hypothesis to be tested through future investigations, it is also plausible to infer that this absence may have been intentional. Such a scenario could indicate that the islands were not regarded as suitable locations for the ritual and funerary practices traditionally associated with the construction and use of tumuli.

Final remarks

The archaeological evidence suggests that Adriatic Balkan communities exhibited a degree of mobility comparable to that inferred for Bell Beaker communities.[35] Notably, Cetina mobility encompassed diverse interactive networks and multiple scales of movement, including both maritime and overland routes.[36] Preliminary findings from the ongoing excavation at Škarin Samograd, for instance, indicate mobility linked to transhumance practices,[37] contributing with valu-

[31] Gaffney et al. 1997.
[32] Barbarić 2012.
[33] Forenbaher 2023.
[34] Forenbaher 2018.
[35] Vander Linden 2024.
[36] Gori 2020.
[37] Gori et al. in preparation.

able data to the understanding of the interplay between long- and short-distance networks within Dalmatian communities.

While overland mobility is a critical aspect of the Cetina phenomenon, here I will focus on long-distance connections, examining material culture and the funerary landscape to elucidate these interactions.

The available archaeological evidence regarding material culture, strongly suggests a directionality in the interactions between the Balkans and Italy, as inferred from the spread of Cetina pottery, as has long been known to scholars. The diffusion of Cetina ceramic style appears to have moved east to west, with no evidence of "Italian" style ceramic sherds recovered in the Balkans from this period to date. This does not imply that Cetina pottery found in Italy were imports; rather, they were produced locally using local clays but employing foreign technologies and iconographic repertoires. This suggests that the pottery was likely crafted by individuals who recognise Dalmatian ceramic techniques and iconography as their own. Upon relocating to Italy, they applied this knowledge, possibly reflecting a continuation of Dalmatian cultural practices in new social or ritual contexts. The presence of Cetina pottery in Italian funerary contexts such as e.g. Laterza, alongside its occurrence in presumed settlement sites, offers compelling evidence for the movement of people from Dalmatia to Italy during this period.

Conversely, the presence of Gargano chert at Palagruža and other Dalmatian sites highlights an intensification of exchange activities built upon a long-established tradition. In addition to raw materials, specific stone objects demonstrate a clear directional flow. Notably, Palagruža has yielded a significant number of artifacts with high symbolic value, such as Italian Bell Beaker wrist guards and arrowheads.

These findings reflect complex networks of interaction involving the exchange of goods, technologies, and ideas, facilitated by maritime and overland routes.

The evidence from burial structures and ritual sites suggests the existence of a distinct funerary landscape in Dalmatia, where rituals were collectively performed and experienced. However, if we accept the hypothesis that the islands were not significantly involved in these funerary rituals, primarily focused on burial practices, it becomes possible to distinguish between at least two forms of rituality and two different types of ritually-based communities of practice. The first is tied to burial practices, constructing a funerary landscape that characterizes Dalmatia and has a more local type of connectivity, possibly linked to transumance. The second is more "international" in character, and is linked to voyages and maritime mobility, forming a ritual seascape where diverse ritual practices from different communities overlap and merge. This can be inferred by the presence of Cetina pottery on island such as Palagruza, and in other places like Castelluccio in Sicily, or Olympia and Lerna in the Peloponnese, that seem to have had the role of ritual hubs for the Central Mediterranean. This interpretation aligns with findings from our network analysis, which points to the existence of communities of practice centered on ritual behaviors, creating an international network that spans the central Mediterranean and partially includes the eastern Mediterranean. This long-distance maritime religious network would overlap to some extent with inland ritual practices but remain distinct, preserving two interconnected yet separate spheres of ritual activity.

I hope that further research will help in refining and test this hypothesis, providing additional data to clarify the interplay between these ritual landscapes and ritual seascapes.

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At Aegean Crossroads: Southern Euboea in the Bronze Age

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Abstract: This paper examines the Bronze Age Southern Euboea (Karystia), Greece, to discuss how large-scale longue durée processes were reproduced within small-scale regional sociopolitical entities. Drawing on data from our long-term research in the Karystia, as well as from other local projects and datasets from nearby regions, we compare how broader socioeconomic developments intersected with the biographies of prehistoric communities from the end stages of the Neolithic to the Late Bronze Age. During the Early Bronze Age (EBA), the Karystia followed similar trajectories to Attica, northern Euboea, and the Cyclades, reflecting both mainland and insular influences. However, in the later EBA, the Karystia behaved more like the Cyclades, showing no signs of EBA III occupation. Similarly, in contrast to broader Aegean trends, the Middle Bronze Age in the Karystia presents a distinctive lack of habitational evidence, with only one major site identified so far. Finally, unlike neighboring regions, the Late Bronze Age is notably absent from the Karystia. Considering the area's strategic maritime position, proximity to key Aegean centers, and rich resource base, we offer a diachronic assessment of the Karystian Bronze Age.

Key words: Bronze Age, Karystia, sociopolitical entities, Aegean, longue durée

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Contextualizing Southern Euboea – Defining the Karystia

The geographical focus of this paper is Euboea, the second-largest island in Greece. It specifically examines its southernmost region, identified here as the Karystia, for environmental and archaeological reasons. These factors, discussed below, justify its treatment as a distinct entity within the broader context of the island, presenting significantly different trajectories already from later stages of the Neolithic and through the Bronze Age (BA) compared to the central and northern regions of Euboea.

Euboea encompasses an area of approximately 3,680 km², bordered by the region of Volos and the Pagasetic Gulf to the north, and by the eastern shores of central Greece and Attica to the west. To the south, its coastline "meets" the northwestern Cycladic Islands. Oriented in a northwest-southeast direction with a long and relatively narrow form, Euboea is separated from the Boeotian mainland by the narrow Euripus Strait, which measures no more than 40 meters at its narrowest point. The island is traversed along its length by a mountain range of varying elevation, and based on its geography and morphology, it can be divided into three distinct zones: the forested north with extensive lowlands, the mountainous and forested central region, and the relatively hilly, barren south with limited arable land. Euboea is further characterized by numer-

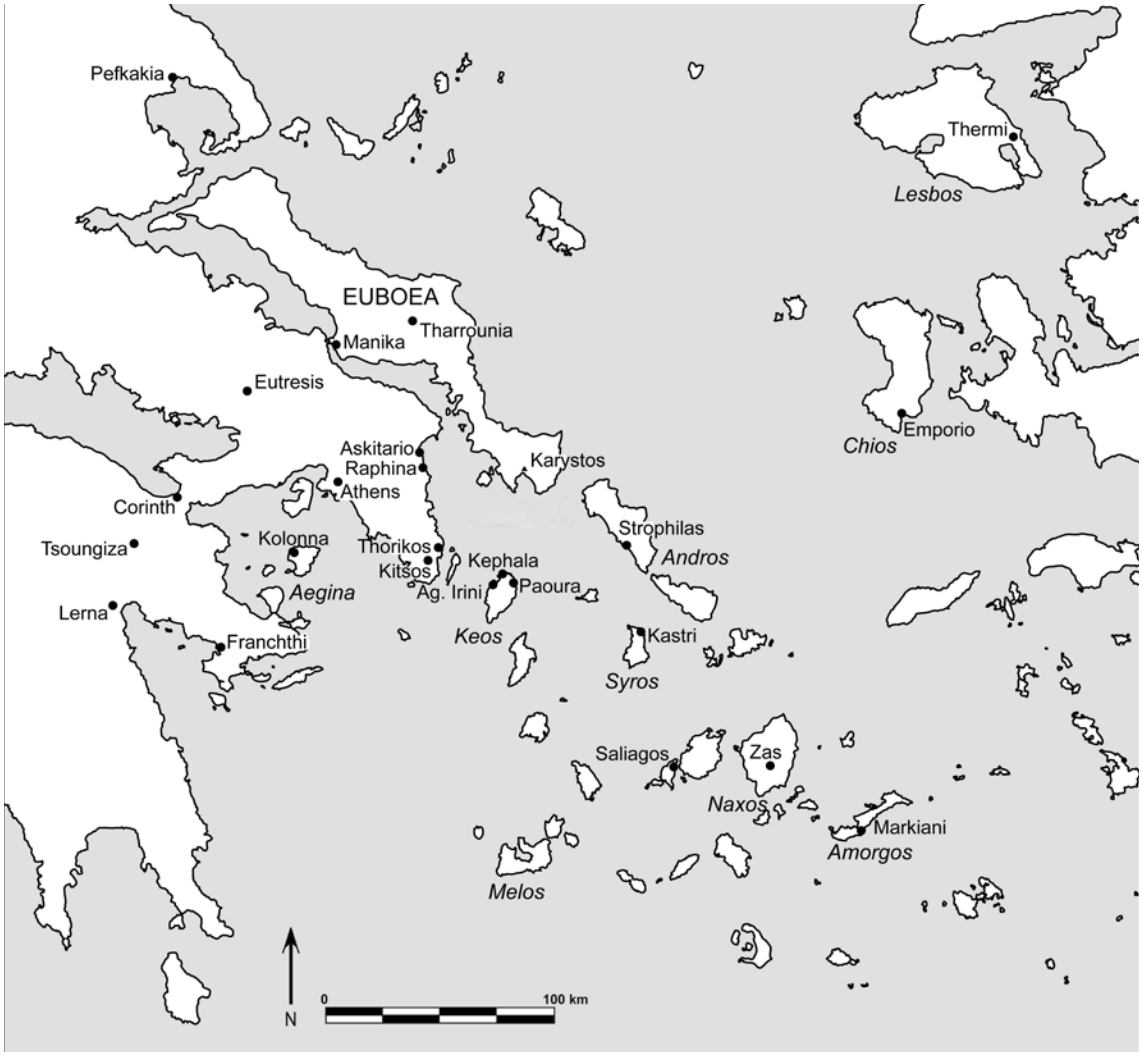


Fig. 1 – Location of the Karystia within the Wider Aegean (Author: Ž. Tankosić).

ous larger and smaller gulfs and natural harbors, which, despite challenges posed by strong local currents and winds, would have played a critical role in regional seafaring, connecting the island with both the mainland and the nearby Cyclades throughout its history.

This paper focuses on the Bronze Age archaeological remains from the southern region of Euboea (Fig. 1), commonly referred to as the Karystia in both academic discourse and general usage. The term, effectively functioning as a metonym for southern Euboea, originates from Karystos, the largest town in the area. The precise boundaries of the Karystia, particularly to the north, are often elusive, subject to varying definitions depending on the perspective—whether for state administrative purposes or modern emic territorial perceptions. In this study, we define the Karystia as the area enclosed by the mountain ranges of Ochi, Gresmi, Giannitsi-Figias, Pyrgos, and Koukouvayia, which we propose acted as a significant barrier to visual and physical communication with the rest of the island, due to their height and the difficulty of traversing their passes—though not entirely impassable, even with the means available during prehistoric times.[1]

The area enclosed by these mountain ranges presents a diverse landscape, consisting of mountainous and hilly terrains, relatively expansive plains by Aegean standards, and rocky, rugged peninsulas. Collectively, these features offered a varied geomorphological backdrop for its prehistoric inhabitants. This "bounded" region includes the Paximadi and Bouros-Kastri peninsulas, the Karystian (*Kampos*) and Katsaronio plains, and the foothills of Mt. Ochi, which border much of the area to the north. Beyond the two sizable plains, the geomorphology, geology, vegetation, and general appearance of the Karystia bear a closer resemblance to the Cyclades, showing marked contrasts to the fertile central and forested northern regions of Euboea.

Geologically, the Karystia forms part of the Attic-Cycladic Massif, characterized by crystalline metamorphic deposits,[2] and shares a comparable geological composition with the nearby Cycladic islands of Andros and Kea, as well as southeastern Attica.[3] Bounded by the sea on three sides and largely bordered by Mt. Ochi to the north and northeast, the Karystia enjoys a distinct microclimate, markedly different from that of the mainland and the rest of Euboea, and more closely resembling the milder climatic conditions of the nearby Cyclades.[4] The landscape, aside from a few forested niches north of the Katsaronio plain, is arid, rugged, and barren, with much of the area covered by the characteristic low Mediterranean maquis. This vegetation now spreads across the two large Karystian plains, Kampos and Katsaronio, with distinct areas dedicated to agricultural use.

The Cycladic-like environmental conditions, coupled with the maritime orientation of the Karystia and the limited access routes connecting it to the rest of the island, lend credence to its characterization as an "island within an island."[5] Yet, this region was far from insular in its interactions, displaying a marked outward orientation, at least throughout much of the archaeological periods covered in this paper. The Karystia's pivotal position between the Cyclades and the Attic coasts, alongside its potential function as a natural "bridge" linking these regions with the central and northern mainland through the island's interior, but also as the gateway to the Euboean channel, played a crucial role in shaping the sociopolitical organization and material culture of its prehistoric communities. As will be demonstrated, these communities exhibit a high degree of cultural hybridization, drawing influences from both the mainland and the Cyclades.[6]

[1] For the fluid definition of the Karystia and the definition of its boundaries, see Tankosić 2017, pp. 99-101; Tankosić and Katsianis 2017.

[2] Cullen et al. 2013, p. 2

[3] De Paepe 1982; For a detailed geological overview of the area, see Mavridis and Tankosić 2016, p. 210.

[4] Mavridis and Tankosić 2016b, p. 209.

[5] Talalay, Cullen, and Keller 2017, p. 52.

[6] See, for example, Cullen et al. 2013, Mavridis and Tankosić 2009a, 2009b, 2012; Tankosić 2011.

The influence of the Cyclades and the mainland on the Karystia was neither balanced nor constant through time. Current data indicates a stronger connection with the Cycladic archipelago during most of the periods discussed, as reflected in the local material culture.[7] This connection is not viewed merely as a consequence of geographical proximity[8] but rather as the material expression of identity-forming strategies adopted by the prehistoric Karystian communities, manifesting in their material culture.[9]

An Overview of Prehistoric Research in Southern Euboea

The favorable position of Euboea and its mentions in ancient Greek literary sources attracted the attention of archaeological research in Greece as early as the 19th century, with the Karystia included in both local and regional archaeological projects. Since the late 1970s, the southern part of the island, particularly the area surrounding modern Karystos, has been the focus of numerous systematic or targeted field surveys, making it one of the most intensively surveyed regions in Greece. These surveys have covered nearly all the subzones within the Karystia (Fig. 2), as defined in this study, except for the foothills of Mt. Ochi. They provide significant insights into habitation and settlement patterns during both prehistoric and historic periods. However, this growing body of knowledge from field surveys has not been matched by systematic excavations. To date, only two such excavations have been conducted on prehistoric sites—Ayia Triada Cave and Gourimadi—along with brief rescue excavations primarily undertaken by the Ephorate of Antiquities of Euboea.

The earliest recorded mention of prehistoric (Early Bronze Age) remains from the Karystia dates to 1891, when P. Wolters documented three Early Cycladic marble figurines near Styra.[10] Although Wolters did not provide the precise provenance of these figurines, which are now lost,[11] later surveys[12] have proposed the hill of Gkisouri or a nearby coastal site at Lefka as the potential place of origin. Recent rescue excavations carried out by the Ephorate of Antiquities of Euboea at Gkisouri revealed Cycladic figurines in the context of an Early Bronze Age II cemetery,[13] suggesting that Wolters' figurines may also have come from this location.

The earliest systematic research involving the Karystia was an island-wide survey led by the British School at Athens, beginning in 1939 and continuing through to the mid-1960s, with a significant hiatus due to the outbreak of World War II.[14] Similar surveys, encompassing the entirety of Euboea, were later conducted by D. Theocharis and subsequently by A. Sampson,[15] the latter focusing primarily on prehistoric sites. The first dedicated research specifically targeting the Karystia took place between 1979 and 1981, when D. Keller, as part of his PhD research,[16] sur-

[7] Tankosić 2017, p. 100.

[8] For example, the Karystia is located ca. 12 km from Andros, 30 km from Keos, and ca. 30 km from the coasts of Attica; see Tankosić and Mathioudaki 2011, p. 101. There is also the factor of visual proximity to the Cyclades, with Kythnos and Tenos being visible from the Karystia under specific meteorological conditions – see Tankosić 2017, p. 101.

[9] Tankosić 2017, p. 102 referring to Gerritsen 2004, p. 145 and Canuto and Yaeger 2000, pp. 5-9.

[10] Wolters 1891, pp. 54–55.

[11] Cullen et a. 2013, p. 6.

[12] I.e., Sackett et al. 1966 and Theocharis 1959.

[13] Kosma (2010, pp. 30-34) dates the Gkisouri figurines to the Early Cycladic II (EC II) period based on their typological characteristics (p. 31). The potential existence of an Early Bronze Age II (EBA II) site has also been suggested by Sampson (1980, p. 128). For this site, see also Theocharis 1959.

[14] Sackett et al. 1966.

[15] Theocharis 1959; Sampson 1980

[16] Keller 1985

veyed around the Bay of Karystos, identifying, among other, five sites dated to the later Neolithic stages, five Early Bronze Age, and one Middle Bronze Age site, namely the Ayios Nikolaos.[17]

The establishment of the Southern Euboea Exploration Project (SEEP) by D. Keller and M. Wallace as a non-profit research initiative under the auspices of the Canadian Institute in Greece in 1984[18] marked a significant shift toward the systematic exploration of Karystian archaeology. To date, SEEP has facilitated three field surveys, one rescue excavation, and more recently, a systematic excavation. These three surveys covered distinct but contiguous areas, and together with a recent survey conducted by the Norwegian Institute at Athens (discussed below), encompass most of the subareas constituting the Karystia (Fig. 2).

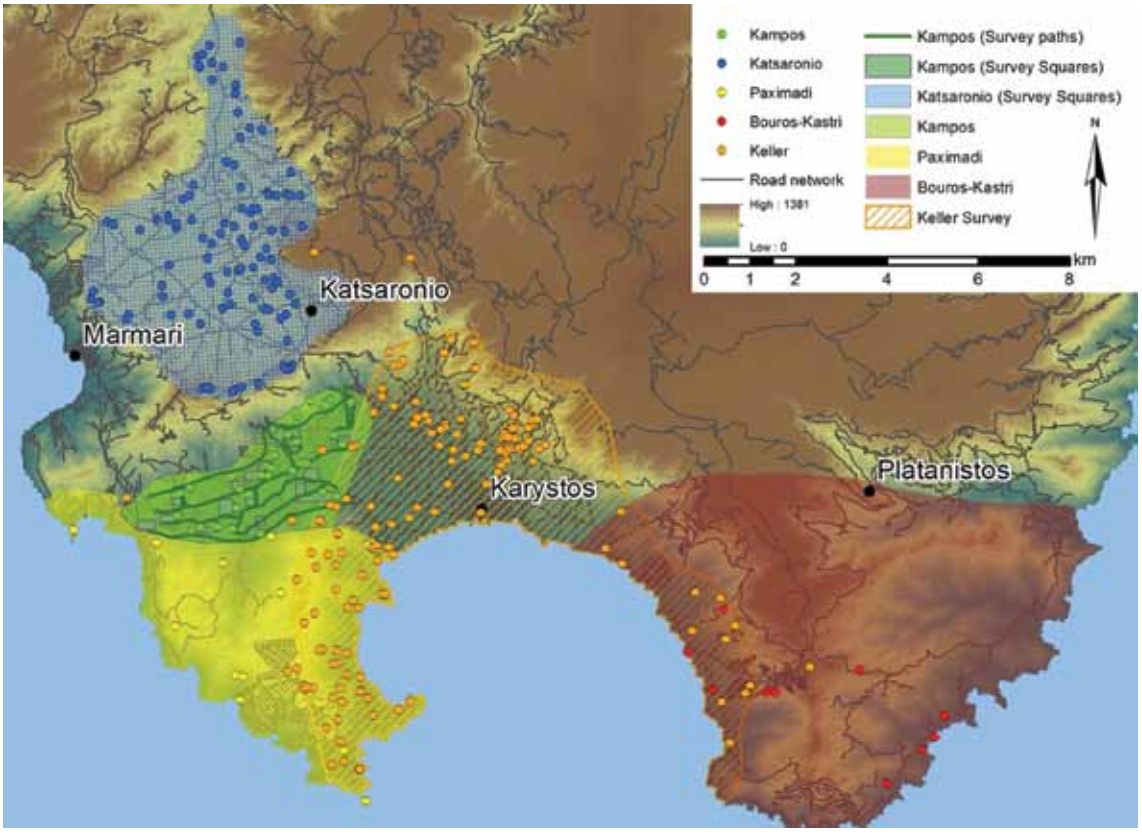


Fig. 2 – Field Surveys and Surveyed Areas in the Karystia Post-1970s
Showing Sites from All Known Archaeological Periods (Author: M. Katsianis).

The first SEEP survey[19] focused on the Paximadi Peninsula, known locally as Paximada, situated on the western side of the Bay of Karystos. The aim was to systematically explore the area, improving upon the earlier one-man survey conducted by D. Keller between 1979 and 1981.[20] Covering an area of approximately 22 km², the survey, carried out in 1986 and 1988, identified 142 sites and findspots[21] dating to historical periods, and 20 with surface material spanning the FN to

[17] Cullen et al. 2013, pp. 7-8.

[18] Cullen, Talalay, and Tankosić 2011, p. 30.

[19] Cullen et al. 2013.

[20] See Cullen et al. 2013, pp. 44-46 for the methodology employed in this survey.

[21] In this paper, as well as in the original publications of the discussed surveys, the term "findspot" refers to a locus that yielded a significant volume and density of finds during the surveys (primarily obsidian lithic tools and their reduction byproducts). However, these sites did not present the full range of surface materials, such as pottery or notable architectural remains. Based on the surface material, the authors interpret these locations as task-oriented sites rather than typical prehistoric settlements.

EBA II periods.[22] Among these, four sites—Plakari, Kazara, Ayia Pelagia, and Akri Rozos—were noted for substantial surface remains, including architectural elements. No sites or findspots could be dated as earlier than the FN, or as belonging to the EBA III, MBA, and LBA periods.

The same pattern of prehistoric habitation, confined to the FN–EBA periods (with the latest material assigned to EBA IIa), emerged from the subsequent SEEP project, which surveyed the Bouros-Kastri region on the eastern side of the Bay of Karystos in 1989, 1990, and 1993.[23] This survey identified 12 sites and findspots from these periods, again revealing no evidence of pre-FN occupation and equally lacking material that could be linked to the period between the mature EBA II phase and the LBA.[24] Among these, Ayioi 1, Kalamos 3, and Ayia Eirini 1 were distinguished as significant EBA sites located along the coastal zone of the Bouros-Kastri area.[25]

The third SEEP survey, conducted between 2006 and 2007, focused on the Kampos area, targeting approximately 10 km² of the plain west of Karystos, of which half of the area was sampled for survey.[26] This survey revealed distinctive landscape-use patterns, consistent with the results of the Katsaronio survey discussed below. It did not record any substantial prehistoric or other settlements, aside from 14 findspots yielding almost exclusively obsidian artifacts, though in large quantities.[27] These findspots were dated to the FN–EBA periods, based primarily on the technological aspects of the lithic material, as pottery finds were extremely scarce, worn, and non-datable. Aside from the previously known major EBA II site of Ayios Georgios (preserving substantial prehistoric architectural remains), which had been identified in earlier surveys and excavated by the local Ephorate of Antiquities,[28] no other significant settlements were discovered. Once again, the survey confirmed the complete absence of remains dating to the EBA IIb–LBA periods.

The most recent field survey in the area, the Norwegian Archaeological Survey in the Karystia (NASK; 2012–2016), focused on the Katsaronio plain and the surrounding low hills and mountain foothills, covering an area of approximately 20 km².[29] This survey identified 33 prehistoric findspots, displaying surface assemblages of varying volume and typological range, all dated to the FN and EBA periods. Most of the material was attributed to the FN/EBA I transition, with EBA II finds present but significantly less frequent.[30] No other prehistoric material was found that pre- or post-dated these periods. Three sites—Choni, Dexameni, and Gourimadi—located along the southern ridge of the Katsaronio plain, were distinguished as substantial prehistoric sites based on the large volume of surface pottery and obsidian scatters. The latter indicated intensive on-site manufacturing activities.[31] In total, the survey recovered approximately 9,481 lithic artifacts, predominantly obsidian, marking one of the largest such assemblages recovered through field surveys in Greece.[32]

The five systematic field surveys conducted after the 1970s, encompassing most of the subregions and environmental niches of the Karystia, presented an invaluable opportunity to reassess earlier surveys of the island's southern part and greatly expand our knowledge of diachronic settlement patterns, subsistence strategies, exchange networks, and the sociopolitical trajectories of prehistoric communities. Similarly, a comparative analysis of surface assemblages, particularly ceramics and obsidian, has allowed us to position the Karystia within the broader framework of

[22] Cullen, Talalay, and Tankosić 2011, p. 30.

[23] Cullen, Talalay and Tankosić 2011, p. 34 with references; Wickens et al. 2018.

[24] Wickens et al. 2018, pp. 39-41.

[25] Wickens et al. 2018, p. 48.

[26] Tankosić 2008; Tankosić and Chidiroglou 2010.

[27] Cullen, Talalay, and Tankosić 2011, pp. 35-36; Tankosić and Chidiroglou 2010, p. 14.

[28] See Blackman 1998, 64–65, Keller 1985, pp. 112–113, Sackett et al. 1966, p. 81 and Sapouna-Sakellaraki 1992.

[29] Tankosić et al. 2021a.

[30] Tankosić et al. 2021a, pp. 14, 16, 46.

[31] Tankosić et al. 2021a, p. 48.

[32] Tankosić et al. 2021a, p. 17.

Greek prehistory, especially in relation to the southern mainland and the Cyclades. Nevertheless, a fuller understanding of the prehistoric, and especially the Bronze Age, periods remains contingent upon systematic excavations, which would be essential for confirming or refining the interpretations of survey data discussed in the following sections.

Apart from numerous small-scale rescue excavations carried out by the Ephorate of Antiquities, and two similarly limited projects supported by the SEEP—one at Plakari (revealing predominantly FN and EBA I material alongside some architectural remains from the former period)[33] and another at Ayia Pelagia (yielding FN and EBA II material with architectural remains from the latter period)[34]—there has been a notable lack of systematic excavations focused on the prehistoric periods of the Karystia. To date, the only systematic prehistoric excavations are those at Ayia Triada Cave, which produced finds from the LN to the EBA IIa (including evidence of unique mortuary and symbolic behaviors in the latter period),[35] and the ongoing excavation at Gourimadi,[36] which investigates a LN–EBA IIa settlement with substantial architectural remains and a large volume of movable finds from these periods. Among the rescue excavations conducted by the Ephorate of Antiquities,[37] the excavations at Ayios Georgios in Kampos, which uncovered EBA II material and architecture,[38] and the more recent work at Gkisouri, revealing a cemetery linked to the nearby site of Lefka, are particularly noteworthy. The Gkisouri excavations also yielded EBA II architectural remains and Cycladic figurines from the same period.[39]

Ongoing research in the Karystia has revealed distinct patterns concerning the habitation of this area during prehistoric times—patterns that cannot be attributed solely to research bias. The Karystian archaeological record includes sparse LN remains, numerous FN/EBA sites and findspots, followed by abundant evidence of occupation and usage during the EBA IIa period. In contrast, EBA III material—as well as material from the later stages of EBA II—is entirely absent, and MBA remains are strikingly sparse. This perplexing picture is further compounded by the complete absence of LBA (Mycenaean) evidence, not only in terms of settlements but most notably in the material culture.

The Karystia in Prehistory: "Insularity," Connectivity, and Idiosyncrasies

Although the Karystia is treated here as a distinct entity within Euboea—an "island within an island"—its material culture and settlement history, from its earliest prehistoric occupation in the LN, reveal clear interconnections with neighboring and more distant regions. This reflects its active engagement with, or at times rejection of, regional and broader cultural trajectories from both the mainland and the Cycladic islands. We interpret these diachronic shifts in local material culture and settlement patterns as outcomes of the active identity production strategies adopted by Karystian prehistoric communities,[40] set against the backdrop of longue durée processes shaping

[33] Keller 1982.

[34] For the rescue excavations by SEEP and the local Ephorate of Antiquities in 1992 and 2000 respectively, see Cullen et al. 2013, pp. 51-77.

[35] The project was conducted as a collaboration between SEEP and the Ephorate of Palaeoanthropology and Speleology; see Mavridis 2009a; Mavridis and Tankosić 2016a and 2016b.

[36] Tankosić et al. 2021b.

[37] See Chidiroglou and Chatzidimitriou 2006 and Chidiroglou 2009 for an overview of the rescue excavations in the Karystia by the Ephorate of Antiquities in Euboea.

[38] Sapouna-Sakellaraki 1992.

[39] Kosma 2010; Kosma 2012.

[40] Tankosić 2017, p. 102.

the broader region. To contextualize the evolving Bronze Age connectivity patterns of these communities, a brief overview of the preceding LN and FN periods is warranted, with an emphasis on the formative stages of Karystian prehistory and its interactions with surrounding regions.

Chronological and Terminological Definitions

Any comparative assessment of prehistoric communities in the Aegean and Mainland Greece is complicated by issues related to the synchronization of local periodization systems and terminological designations. This challenge arises not only because local communities followed different trajectories in material culture and identity production, but also due to the structural compartmentalization of archaeological research, with various institutions—such as Ephorates of Antiquities, local universities, and Foreign Archaeological Schools—often operating independently. The material culture of the Karystia, heavily influenced by its position between two major "cultural spheres," the mainland and the Cyclades, reflects elements from both regions.[41]

<table>
<tr><th>Tomkins 2007, table 1</th><th>Renfrew 1972, table 5.1</th><th>Sampson 1985, table 1</th><th>Sampson 2008</th><th>Demoule & Perlès 1993, fig. 2</th><th>Coleman 1992</th><th>Johnson 1999</th><th>Merkyte 2007, fig. 40</th></tr>
<tr><td>LN I
ca 5300-4900</td><td>MN
ca 5900-5300</td><td>NAN 1</td><td>LN Ia
ca 5000</td><td>Phase 3/LN
ca 5300-4800</td><td rowspan="2">LN I
5300-4300/4200</td><td>–</td><td>Early Copper Age 5000</td></tr>
<tr><td>LN II
ca 4900-4500/4400</td><td>LN
ca 5300-4500/4400</td><td>NAN 2</td><td>LN Ib</td><td>Phase 4/LN
ca 4800-4500</td><td>–</td><td>Middle Copper Age 4600</td></tr>
<tr><td>FN IA
ca 4500/4400-4200</td><td rowspan="5">FN
ca 4500/4400-3100/3000</td><td>NAN 3</td><td>LN IIa</td><td>Phase 5/FN
ca 4500-3200</td><td>LN II
4300/4200-3200</td><td>FN
4500-3700</td><td>Late Copper Age 4400</td></tr>
<tr><td>FN IB
ca 4200-3900</td><td rowspan="2">NAN 4</td><td rowspan="2">LN IIb</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="2"></td><td rowspan="3">Transitional 4000</td></tr>
<tr><td>FN II
ca 3900-3600</td></tr>
<tr><td>FN III
ca 3600-3300</td><td>FN/EBA
3700-3300</td></tr>
<tr><td>FN IV
ca 3300-3000</td><td></td><td></td><td></td><td></td><td>EH I
3300-2800</td><td>EBA 3300</td></tr>
</table>

Table 1 – Example of Subdivisions and Periodization for the Later Neolithic Stages (after Mavridis and Tankosić 2016a, p. 420; Table 1).

Without seeking an easy resolution to the terminological complexities and fully recognizing the diversity of local and regional terms applied to the later stages of the Neolithic—such as LN I and II, Early/Middle/Late/Final Chalcolithic, and FN I and II, among others (Table 1)—as well as the necessity for further refinement and supra-regional synchronization, this paper adopts the term FN[42] to refer to the period between the end of the LN and the beginning of the EBA. Specifically, our LN generally aligns with LN Ia, while the FN encompasses the LN Ib and LN IIa-b phases.[43]

[41] For a comprehensive overview and discussion of the periodization, relative and absolute dating, local terminologies, and regional synchronizations of the later Neolithic stages in the wider area, see Mavridis and Tankosić 2016a, pp. 419-421, with relevant references and tables.

[42] The term was first introduced by Renfrew (1972, p. 72-76,) to discuss a vast chunk of time before the advent of the Early Bronze Age, ca. 4500-3200 BCE. FN is also used in recent publications concerning the prehistory of the Karystia, e.g., Cullen et al. 2013, p. 13.

[43] For a detailed discussion on the chronology and periodization at the end of the Neolithic in Southern Euboea and elsewhere see e.g., Mastrogiannopoulou and Sampson 2017; Mavridis 2006; Mavridis and Tankosić 2016a and the relevant references.

Bronze Age cross-regional synchronizations (Table 2),[44] while seemingly more straightforward, are not without challenges.[45] For the EBA, we adopt the tripartite division proposed by Rutter for southern Greece, with emphasis on the EB IIa and IIb distinction, where the latter is characterized by *Anatolianizing* influences primarily on pottery.[46] Similarly, we apply the broader

	Crete		Cycladic Islands	Greece
Early Bronze 1	Early Minoan IA Early Minoan IB	Early Pre-palatial period	Early Cycladic I—Lakkoudes, Pelos and Plastiras Phases/ Groups Kampos Group	Early Helladic I
Early Bronze 2	Early Minoan IIA Early Minoan IIB		Early Cycladic II—Keros-Syros Phase/Group Kastri Phase	Early Helladic II Lefkandi I Phase
Early Bronze 3	Eary Minoan III	Late	Early Cycladic III—Phylakopi I	Early Helladic III
Middle Bronze 1	Middle Minoan IA Middle Minoan IB		Middle Cycladic I Group/Phase	Middle Helladic
Middle Bronze 2	Middle Minoan II (A–B at main palaces)	Protopalatial (Old Palace Period)	Middle Cycladic II	
Middle Bronze 3	Middle Minoan IIIA Middle Minoan IIIB	Neopalatial (New Palace Period)	Middle Cycladic III	
Late Bronze 1	Late Minoan IA Late Minoan IB		Late Cycladic I	Late Helladic I Late Helladic IIA
Late Bronze 2	Late Minoan II	Monopalatial Period (Knossos only)	Late Cycladic II	Late Helladic IIB
Late Bronze 3	Late Minoan IIIA1 Late Minoan IIIA2 Late Minoan IIIB Late Minoan IIIC	Final Palatial Period	Late Cycladic III	Late Helladic IIIA1 Late Helladic IIIA2 Late Helladic IIIB (phases 1–2 in Argolid) Late Helladic IIIC (with 3 to 5 phases)

Table 2 – Example of Subdivisions and Periodization for the Bronze Age (after Manning 2010, p. 29; Table 2.1).

terms MBA and LBA for the subsequent periods. However, the substantial scarcity of material for the MBA and the near-total absence of relevant artifacts for the LBA limit any substantive discussions about internal subdivisions or cross-regional synchronization.

The Earliest Traces of Human Presence

Until recently, despite the extensive systematic surveys conducted throughout the Karystia and various rescue excavations, no settlements had been identified from periods earlier than the FN. This stands in contrast to the central and northern regions of Euboea, which show evidence of occupation from the EN and MN periods,[47] but is more consistent with the patterns observed in the Cycladic Islands,[48] where permanent settlements only begin to appear in the later Neolithic and expand significantly during the FN – early EBA timeframe.[49]

In this context, southern Euboea during the transition from LN to FN appears to align with the settlement patterns observed in the nearby Cycladic islands, with both regions, based on cur-

[44] See Manning 2010.

[45] Synchronizing regional Bronze Age material culture "traditions" remains a complex and often debated task in Aegean Prehistory. For the sake of clarity, we acknowledge the Early, Middle, and Late Cycladic framework and its subdivisions, as well as the equivalent divisions used for Bronze Age Crete (Early, Middle, and Late Minoan) and the mainland (Early, Middle, and Late Helladic). For an overview of regional sequences and synchronizations in the Aegean, see Manning 2010, p. 17, Table 2.1.

[46] Rutter 1993, p. 756, pl. 2.

[47] Mastrogiannopoulou and Sampson 2017, pp. 36-37; Sackett et al. 1966, pp. 82–86; Sampson 1981, pp. 50–79.

[48] Cullen, Talalay, and Tankosić 2011, p. 39. Cullen et al. 2013, p. 86-87

[49] Broodbank 1999; Broodbank 2000; Cherry 1990; Davis 1992.

rent evidence, experiencing a parallel process of establishing permanent settlements.[50] Although Euboea has often been seen as integral to the so-called "Cycladic Island colonization,"[51] potentially serving as a "stepping stone"[52] for the movement of mainland populations to the Cyclades,[53] it has thus far provided only limited evidence of this process during its initial stages.

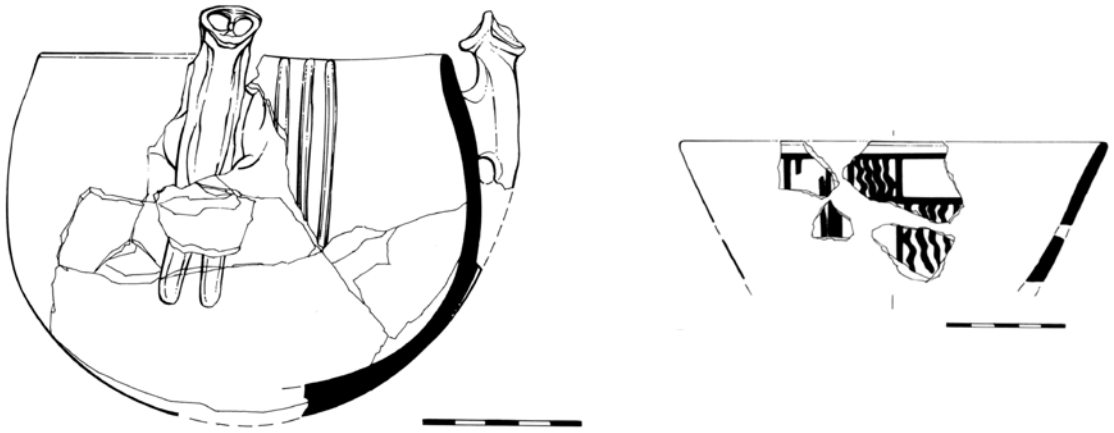


Fig. 3 – Indicative Late Neolithic Finds from Ayia Triada
(after Mavridis and Tankosić 2016a, pp. 425 [fig. 6] and 433 [fig. 14]).

The LN in the Karystia is only represented by pottery assemblages from the Ayia Triada Cave (Fig. 3) and a limited number of sherds from the lower levels of the ongoing excavation at Gourimadi. In specific, both sites have produced characteristic LN I white-on-dark pottery from the Cycladic Saliagos horizon[54] dating to the late 6th- early 5th millennium BCE, while Ayia Triada also lists an anthropomorphic protome with Cycladic affinities, emphasizing further the Cycladic connections during this period.[55]

The Infilling of the Karystian Landscape During the FN – EBA II

Following the limited LN remains,[56] the Karystia experienced an unprecedented peak in habitation from the FN to the advanced EBA (EBA IIa), roughly spanning from the late 5th to the late 3rd millennia BCE. This period is marked by the discovery of numerous sites and findspots scattered across various parts of the landscape. In total, over 60 prehistoric sites (Fig. 4) and findspots have been documented, with around 33 containing an FN component and 12 dated solely to the EBA.[57] Sites with chronologically diagnostic material almost exclusively date to the

[50] Davis 1992, p. 703 (especially for the FN period).

[51] Broodbank 1999.

[52] The proximity and strategic position of southern Euboea, situated near the Attic mainland and the northern Cyclades, are regarded as significant factors in this phenomenon (see Broodbank 2000, pp. 138–140; Davis 2001, p. 702).

[53] The role of Euboea as a gateway between the mainland and the islands has also been proposed for pre-Neolithic periods (e.g., Cherry 1985, p. 21), when islands such as Melos were visited by human groups in search of mineral resources like obsidian. See also Carter et al. 2014 for Stélida in Naxos. Furthermore, we should acknowledge the presence of maritime networks extending across the Eastern Mediterranean as early as the Epipalaeolithic and Mesolithic periods (e.g., Horejs et al. 2015, p. 289).

[54] Evans and Renfrew 1968. For this pottery in the Karystia, see Mavridis 2017.

[55] For Ayia Triada, see Mavridis and Tankosić 2009a, pp. 52-53 and Mavridis and Tankosić 2016a, pp. 433-434. For Gourimadi, see Tankosić et al. 2021b, pp. 20-21.

[56] The complete absence of LN material across all systematic surveys in the region is noteworthy. The unexpected discovery of LN material at Gourimadi, despite its lack of representation among the extensive surface ceramic assemblages, should be considered when discussing pre-FN habitation in the area. It is plausible that the invisibility of LN material in surface finds may be attributed to non-anthropogenic post-depositional processes.

[57] Tankosić and Katsianis 2018, p. 238.

FN–EBA II period. The remaining prehistoric sites and findspots are challenging to assign to a specific period or function due to the scarcity of surface material and the lack of datable pottery.

Relative dating issues also complicate the attribution of material between the late FN and EBA I phases in the local record,[58] with assemblages clearly belonging to the latter being rare (e.g., at Gourimadi). Nevertheless, it is evident that at least certain sites were indeed occupied during both the FN and EBA periods,[59] a pattern that contrasts considerably with the contemporaneous developments in central and northern Euboea.[60] Still, we can pinpoint certain traits in the settlement patterns of these two periods.

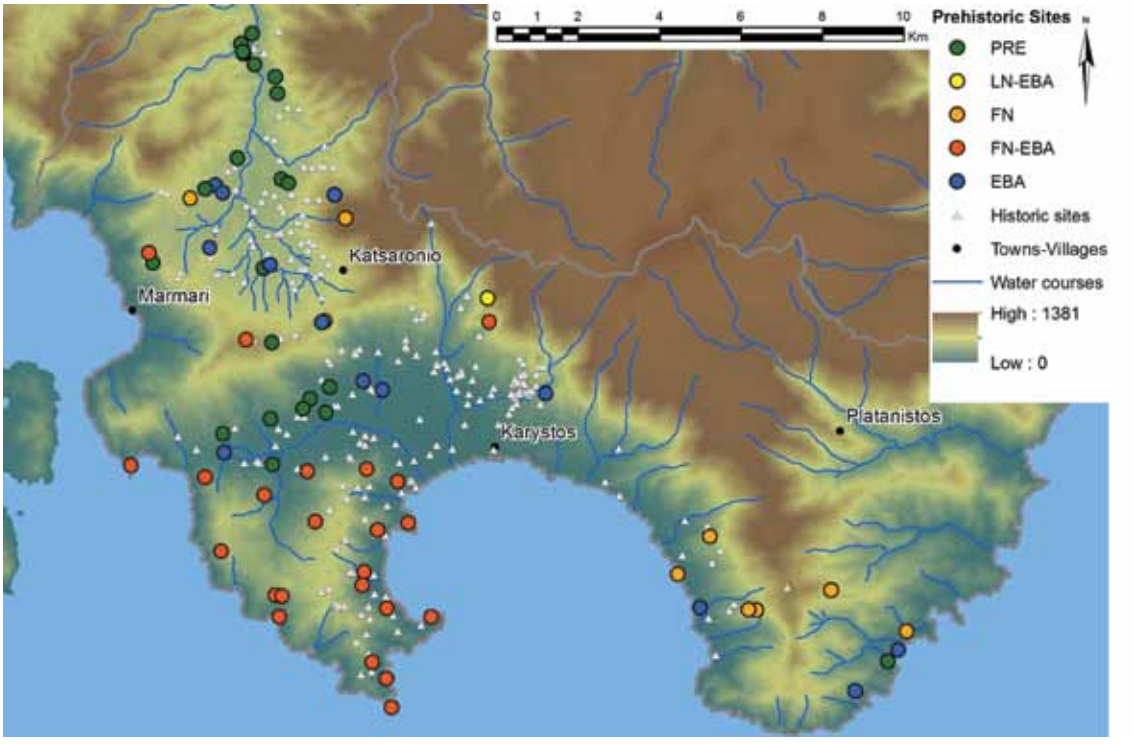


Fig. 4 – Distribution of Late Neolithic – Early Bronze Age Sites in the Karystia (Author: M. Katsianis).

In general, FN and EBA settlements and findspots across the Karystia share notable similarities in their material culture,[61] and key settlements tend to occupy strategic locations with easy access to upland areas and arable land, alongside unobstructed views toward Attica and the nearby islands, enabling the monitoring of their immediate surroundings.[62] Within each subregion, the settlement pattern appears dispersed, with sites distributed—though not always evenly—between upland and coastal areas, frequently situated near natural water sources. We can identify three primary settlement patterns: a) major settlements, marked by large surface scatters of lithics and pottery (and sometimes architectural remains), located almost exclusively in the Paximadi Peninsula and the Katsaronio plain, with notable exceptions such as Ayios Georgios, b) the absence of typical settlements from both the Kampos and Katsaronio plains, and c) numerous findspots, especially in the plains, consisting almost entirely of obsidian scatters, with little to no datable pottery.

[58] Cullen, Talalay, and Tankosić 2011, pp. 42-43; Cullen et al. 2013, pp. 71-74.
[59] Wickens et al. 2018, p.18; e.g., Gourimadi, Ayia Pelagia, and Akri Rozos.
[60] Cullen et al. 2013, p. 87.
[61] Cullen, Talalay, and Tankosić 2011, p. 40.
[62] Cullen et al. 2013, p. 87.

The research conducted in the Katsaronio plain has identified the highest number of prehistoric sites and findspots (minimum 21) in the Karystia, including the ongoing systematic prehistoric excavation at the LN-EBA II site of Gourimadi.[63] The survey recorded 18 findspots, primarily composed of obsidian lithic materials, with evidence for much of the reduction sequence.[64] These findspots were primarily concentrated within the plain, with five additional locations along its fringes yielding small quantities of pottery. More substantial finds were recovered from only three sites—Gourimadi, Dexameni, and Choni—situated on the fringes of the plain. These sites produced significant ceramic assemblages and large quantities of obsidian, alongside evidence of on-site lithic manufacturing activities.

The emerging pattern for the FN-EBA from the Katsaronio plain corroborates the coexistence of numerous offsite findspots inside the plain specialized in parts or all stages of lithic tool production next to the three possibly major sites which could have served as important nodes in the local or regional obsidian network.[65] Thus, it is very likely that the plain was intentionally kept free of habitation to maximize the arable land allowing only low material impact manufacturing activities, a pattern noticed already from previous research in the Kampos plain.[66]

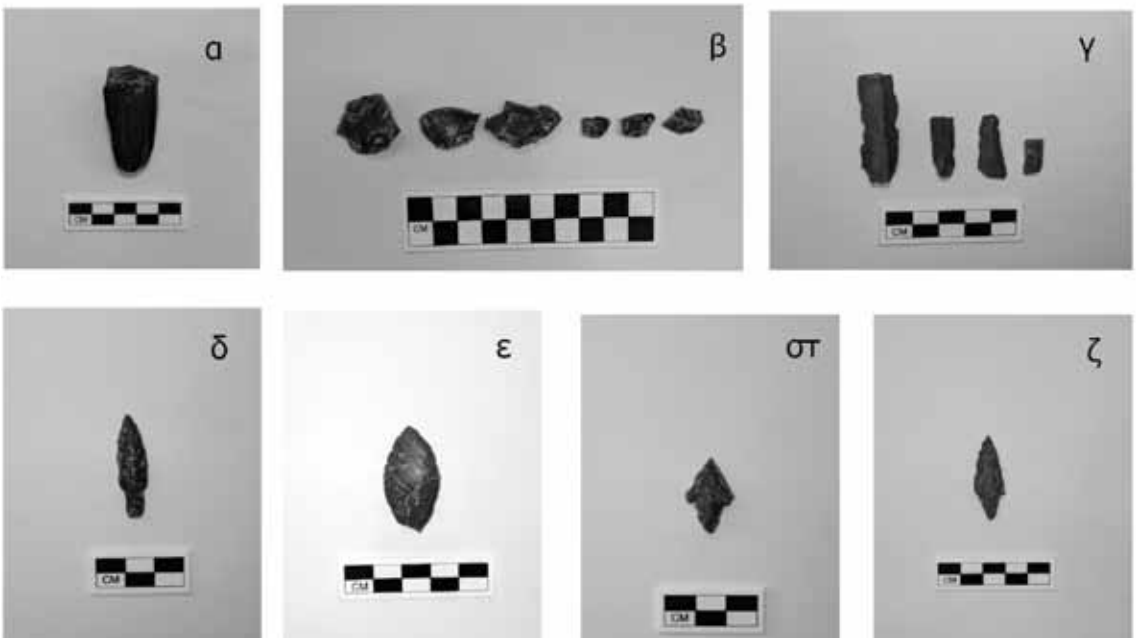


Fig. 5 – Indicative Obsidian Finds Recovered from Gourimadi (Author: Katerina Psoma).

The results of the ongoing excavation at Gourimadi reinforce the survey's interpretation regarding the major sites' potential role in the production and distribution of obsidian artifacts. The excavation has uncovered ample evidence for all stages of the reduction sequence used in the manufacture of lithic tools (Fig. 5), nearly all made from obsidian. Gourimadi has yielded the largest lithic assemblage in the entire region, with an extraordinary number of arrowheads (currently more than 400), a quantity unparalleled by any other known contemporary site.[67]

[63] The NASK project covered about 20 km^2 including the plain and the surrounding ecotones; see Tankosić et al. 2021a, p. 3.

[64] Tankosić et al. 2021a, p. 19.

[65] Tankosić et al. 2021a, pp. 48-49.

[66] Tankosić and Chidiroglou 2010, p. 14.

[67] Tankosić et al. 2021b, pp. 21-23.

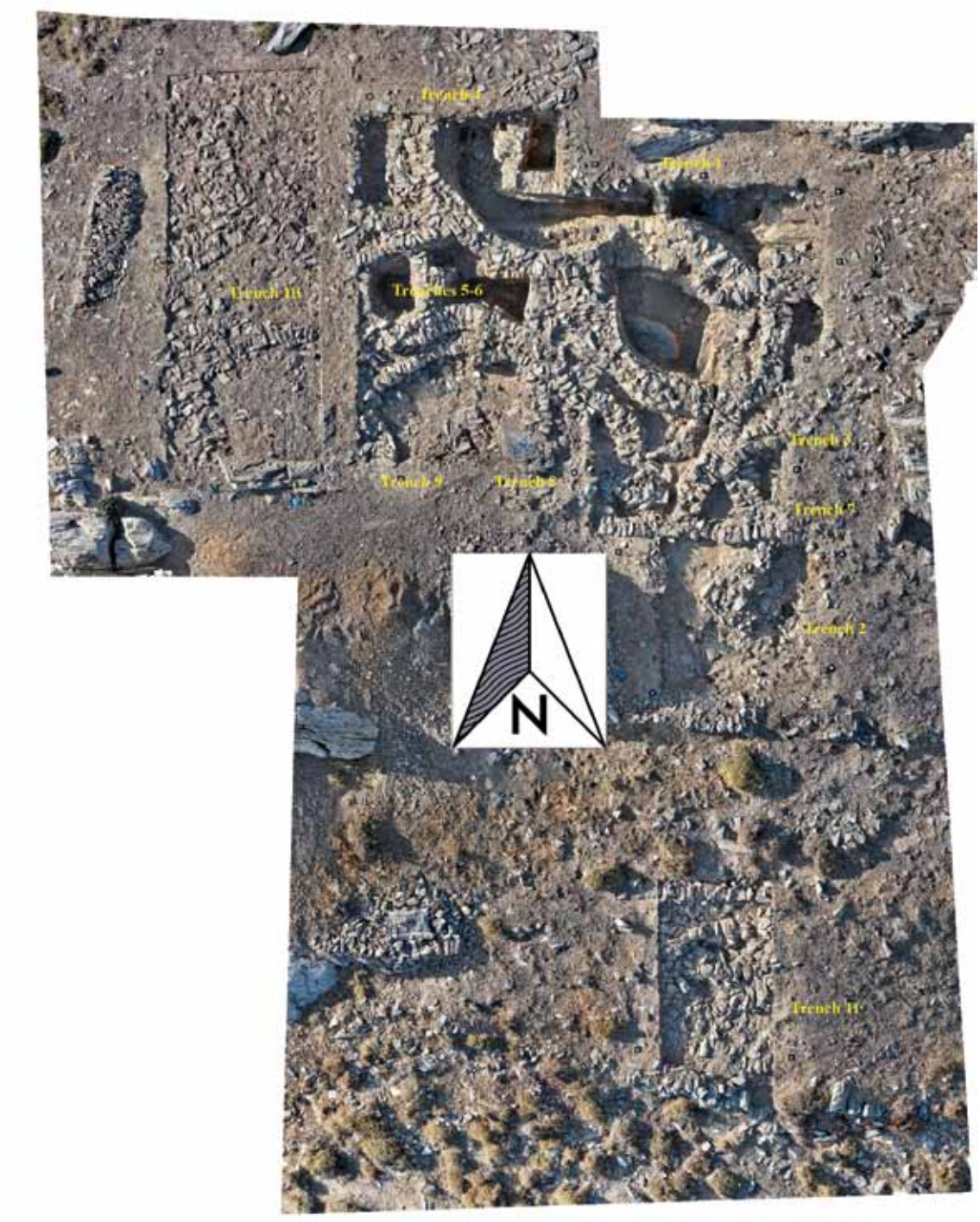


Fig. 6 – Orthophoto Depicting the Excavated Area and Architectural Remains at Gourimadi (Author: D. Nenova).

In addition to its remarkable obsidian assemblage, the site—situated on a rocky outcrop at the edge of the plain—stands out for the extraordinary preservation of its numerous and densely distributed architectural remains (**Fig. 6**). These remains offer a rare and detailed insight into the prehistoric habitation of the area. Spanning primarily the FN to EBA IIa periods,[68] the archi-

[68] We note the possibility that an adobe-made feature from Trenches 5 and 6 may predate the FN, based on its discovery in the lower levels of the site and the presence of a few matt-painted sherds found at a comparable depth in Trench 5.

tectural features include numerous stone-built curvilinear walls scattered across the flat top and southern slope of the hill,[69] with the surface scatter extending over approximately 4 ha.

Pottery finds from the Katsaronio survey include typical FN specimens, mostly attributed to the later phases of the period or even to the FN/EBA transition. EBA II pottery is scarcer and often features specifications that make secure relative dating problematic.[70] Similarly scarce are the EBA II sherds from Gourimadi, although the site does provide clearer indications of a distinct EBA I phase. This is suggested by the presence of vessels with T-shaped rims, *urfirnis*, and sauceboats.[71] Many cheesepot sherds are also attributed to EBA I, though some undoubtedly come from FN levels. The FN pottery is represented by a variety of decorative styles and shapes, reminiscent of contemporary material from Ftelia on Mykonos, such as crusted ware with patterns, scoops, and sherds falling within the FN Attica-Kephala culture. A macroscopic examination of the pottery from both Gourimadi and the Katsaronio survey indicates the local provenance of all the material. However, the strong affinities of the pottery with contemporary Cycladic assemblages should be viewed as indirect evidence of the participation of FN–EBA Karystian communities in regional networks and their active incorporation of external material culture elements into local repertoires.

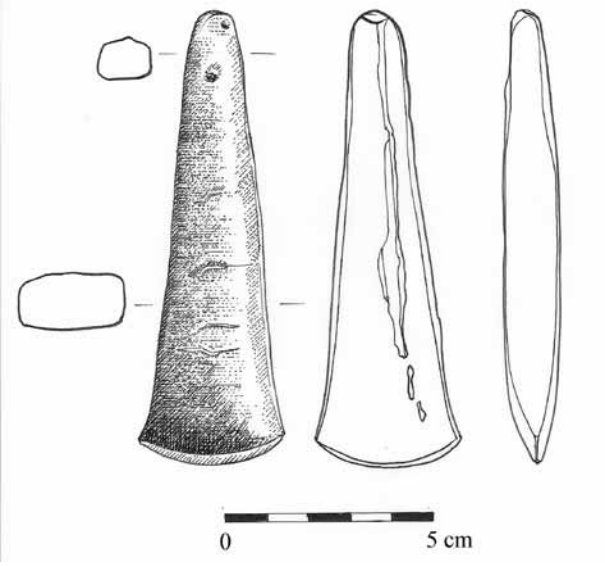


Fig. 7 – Copper Axe Recovered from Gourimadi (Drawing by A. Djordjević).

The Katsaronio survey has also yielded large quantities of slag from various parts of the researched area, though it has not been possible to assign these definitively to a specific period. However, a notable exception is a copper axe or adze (Fig. 7) collected from Gourimadi during the NASK survey.[72] This unique find, preserved in near-perfect condition, can be relatively safely attributed to the LN–EBA period based on its stylistic features and the results of the analysis, which indicated its composition of pure copper, i.e., predating the true bronzes that arrive to western Aegean during the EB IIb phase.[73] This timeframe aligns with the dating of the Gourimadi site, as suggested by its pottery assemblages. Additionally, the site has produced a stratified awl, most likely from the EBA, as well as a few unstratified pieces of slag that remain undated.

A similar pattern of limited substantial sites in the plain emerged from the survey of the Kampos plain,[74] the counterpart to Katsaronio in terms of extensive cultivable land in the Karystia. This survey identified at least 15 prehistoric findspots, located both on elevated ground and within the plain. However, none of these could be definitively classified as a typical settlement[75] apart from Ayios Georgios, an EBA II site that had already undergone a rescue excavation prior

[69] Comparable architectural remains, in terms of their specifications, have been documented at contemporary sites such as Strofilas on Andros and Ftelia on Mykonos; see Televantou 2019, pp. 154-155, and Sampson 2008, pp. 31-32.

[70] For a detailed analysis of the NASK pottery, see Tankosić et al. 2021a, pp. 14-17.

[71] For an overview of the Gourimadi pottery, see Tankosić et al. 2021b, pp. 15-20.

[72] Tankosić et al. 2021a, p.23.

[73] See Tankosić et al. 2021a, p.23 with references and Mastrotheodoros et al. 2019 and 2024.

[74] Tankosić 2008; Tankosić and Chidiroglou 2010.

[75] Tankosić and Chidiroglou 2010, pp. 14-15.

to the survey.[76] A characteristic feature of these findspots—most of which were in the plain—was the scarce and fragmented state of the pottery finds (mostly undatable), contrasted by a relative abundance of obsidian artifacts, which, based on their technical attributes, can be attributed to the FN–EBA periods.[77]

Ayios Georgios in the Kampos plain, much like Gourimadi in Katsaronio, likely served as a key hub within the obsidian exchange network, holding both local and regional importance for the distribution of Melian obsidian to the mainland.[78] Additionally, it may have overseen agricultural production in the Kampos,[79] especially considering the absence of other major settlements in the plain. Beyond its lithic assemblages, rescue excavations by the Ephorate of Antiquities at the site[80] —one of the largest in the region (1.5–2 ha)—revealed significant EBA IIa finds.[81] The architectural remains included robust wall foundations for rectangular multi-room structures, likely capable of supporting a second story, as well as pits and bothroi.[82]

The settlement patterns differ notably between the Paximadi and Bouros-Kastri Peninsulas, both defined by rugged landscapes and limited arable land located on the west and east parts of the Karystos bay. Despite these commonalities, distinctions emerge between the two areas, particularly in the presence of major sites that exhibit the characteristics of typical FN-EBA settlements. These prominent sites are mainly concentrated on Paximadi, including Plakari (hilltop), Akri Rozos (coastal and fortified site), Ayia Pelagia (coastal), and Kazara (hilltop).

FN – EBA sites in Paximadi[83] tend to favor ridgetops and other elevated locations, such as Kazara, which provide unobstructed views of Attica and the nearby Cycladic islands. These sites often occupy positions that allow for surveillance of the surrounding area or are situated in locales that offer natural defensibility, like Plakari, and access to water sources. While the four major sites cluster in the northern part of the peninsula, the overall settlement pattern mirrors that of the rest of the Karystia, characterized by a non-dense distribution of sites across the landscape.[84]

Plakari (1–2 ha), situated on a low ridge, has yielded predominantly FN material, with its pottery reflecting affinities to the Attica-Kephala horizon, along with substantial architectural remains from this period - EBA finds at the site, however, are limited to sparse EBA I pottery.[85] The nearby site of Kazara, also dating to the FN, is considered to have functioned in a complementary role to Plakari.[86]

Ayia Pelagia, situated south of Plakari, covers approximately 1.4 ha and is positioned on a rocky coastal promontory. The site preserves both architectural remains[87] and pottery spanning the FN to EBA II periods, including a yellow-mottled sherd likely imported from the mainland

[76] Sapouna-Sakellaraki 1992. Ayios Georgios was discovered during earlier surveys in the area; see Keller 1985, pp. 112–113 and Sackett et al. 1966, p. 81.

[77] Cullen, Talalay, and Tankosić 2011, p. 35.

[78] Cullen et al. 2013, p. 100.

[79] Tankosić 2011, pp. 243–244.

[80] Sapouna-Sakellaraki 1992; Blackman 1998, pp. 64–65.

[81] For a discussion on the finds from the site see Tankosić 2011, pp. 125–131.

[82] Sapouna-Sakellaraki 1992, p. 178; Talalay, Cullen, and Keller 2017, p. 56.

[83] The SEEP survey covered about 22 km2 of this area; see Cullen et al. 2013.

[84] Cullen et al. 2013, pp. 87-88.

[85] Cullen et al. 2013, pp. 21-26. The maximum size of the site is also suggested to reach 3 ha, see Wickens et al. 2018, p.18. For stylistic parallels in neighboring areas see Cullen, Talalay, and Tankosić 2011, p. 31 and Talalay, Cullen, and Keller 2017, p. 53.

[86] Cullen et al. 2013, pp. 49-51; Cullen, Talalay, and Tankosić 2011, p. 32. Keller 1985, pp. 100–101, 168; Talalay et al. 2005, pp. 27–28, 41; Talalay, Cullen, and Keller 2017, p. 54.

[87] Theocharis 1959, p. 284; Cullen et al. 2013; Sampson 1981, pp. 145–146; Keller 1985, pp. 94–95, 170–172.

and fragments of sauceboats associated elsewhere with commensality practices.[88] A survey identified double-faced narrow rubble walls, approximately 0.4 m wide, that define areas corresponding to at least two buildings located about 35 m apart along the shore. These structures may have had narrow corridors along their long sides, with the northern building containing several small rooms. The layout of these buildings is reminiscent of the EBA II architecture seen at Manika and resembles the "corridor houses" from mainland Greece,[89] such as those at Lerna, or more likely, the single-story examples from Zygouries and Lithares.[90] A cist grave excavated outside the northern wall of the site was also recorded.[91]

Akri Rozos, another large site covering roughly 1.4 ha on the opposite side of the peninsula, occupies a key position along the maritime route connecting southern Euboea with the southern coasts of Attica and the Cyclades. The site has yielded surface architectural remains, along with FN and EBA II material,[92] showing affinities with contemporary assemblages from both central and southern mainland Greece as well as the Cyclades, alongside certain localized traits.[93] A significant feature is a portion of what appears to be an enclosure wall, interspersed with towers or semicircular bastions that are still visible on the surface. Although the site has yet to undergo formal excavation, and the dating of the enclosure remains uncertain, the construction details closely resemble similar features from FN sites like Strophilas on Andros and EBA sites such as Kastri on Syros.[94]

The SEEP survey of the Bouros-Kastri Peninsula, situated on the eastern, more rugged part of Karystos Bay, identified 12 prehistoric sites and findspots dating to the FN-EBA. These sites displayed similarly dispersed habitation patterns as in other areas of the Karystia, with a preference for coastal, as exemplified by the EBA sites of Ayioi and Kalamos, or upland locations.[95] The sites yielded larger surface assemblages dated to one or both periods,[96] though, as in the rest of the Karystian region, finds from the EBA IIb and III, MBA, and LBA were notably absent.[97] For reference, it is noteworthy that sherds recovered from Ayioi include types with parallels from mainland Greece, along with other distinctive shapes such as saucers and fruitstand pedestals, highlighting the connectivity of the Bouros-Kastri communities with both their immediate and more distant surrounding regions.[98]

Recent excavations by the Ephorate of Antiquities in Styra, beyond the areas covered by the SEEP and NASK surveys, have expanded our understanding of the EBA and its connections with contemporary Cycladic sites. Specifically, rescue excavations at the site of Gkisouri uncovered EBA II material,[99] including marble Cycladic figurines (Fig. 8), obsidian blades, animal bones, fragments of sauceboats, and urfirnis sherds, all characteristic of the EBA II period.[100]

[88] Talalay, Cullen, and Keller 2017, p. 54.

[89] Cullen et al. 2013, pp. 51-57; Talalay, Cullen, and Keller 2017, p. 54.

[90] Pullen 1985, pp. 263–267; Alram-Stern 2004, pp. 238–243; Tzavella-Evjen 1985, p. 7; Blegen 1928, p. 25.

[91] Cullen et al. 2013, p. 95.

[92] Cullen et al. 2013, pp. 57-62; Cullen, Talalay, and Tankosić 2011, p. 33.

[93] Talalay, Cullen, and Keller 2017, p. 54.

[94] See Televantou 2008, pp. 44–45 and Bossert 1967, p. 57 respectively.

[95] Wickens et al. 2018, p. 42.

[96] Cullen et al. 2013, pp. 98-99; Wickens et al. 2018, pp. 39-41.

[97] Cullen, Talalay, and Tankosić 2011, p. 34.

[98] Talalay, Cullen, and Keller 2017, p. 54.

[99] The site's excavator noted the presence of a depas amphikypellon, which she attributed to the later stages of EBA II (Kosma 2019, p. 170), marking perhaps the latest securely dated artifact for the EBA in the Karystia. This vessel type in the Kastri group may also be attributed to the EC III phase (see, for example, Angelopoulou 2008, p. 149 with references).

[100] Kosma 2010, pp. 30-34.

These finds, discovered in three large cist graves, suggest Gkisouri functioned as a burial site possibly linked to a nearby settlement at Lefka.[101] The potential existence of a settlement at Lefka had already been noted by Wolters in his account of three Cycladic figurines found in the area and was later confirmed by surveys conducted by Sackett and Theocharis.[102] The presence of Cycladic figurines at Gkisouri, with affinities to the EC II Keros-Syros Culture, along with fragments of typical Cycladic marble vessels, such as a pyxis and a bowl with four lugs at the rim, further corroborates the site's strong connections to the Cyclades.[103] Of significance is also that this site is so far the only one in southern Euboea that contained the *Anatolianizing* EB IIb pottery as part of its assemblage.[104]

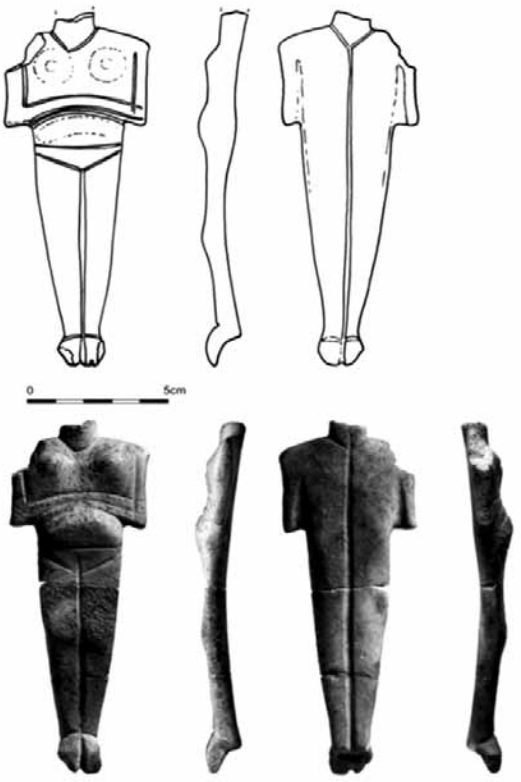


Fig. 8 – Cycladic Figurine from Nea Styra, Grave 1 (after Kosma 2019, p. 173; fig. 21.6).

Finally, Ayia Triada, located at the foot of Mount Ochi, provides invaluable insights into cave use during the FN and EBA periods, offering rare evidence of burial practices and related rituals during the EBA. The cave's movable finds also highlight the extensive contacts local communities had with the Cyclades, as indicated by objects such as an anthropomorphic protome with Cycladic affinities and a painted pyxis lid, as well as with the mainland, evidenced by yellow-mottled ware and sauceboats.[105] Additionally, there are indications of involvement in metallurgical practices and networks.[106] FN pottery from the site shows strong similarities to contemporary material from the Cyclades, such as Kephala, and also bears resemblances to finds from nearby Plakari,[107] suggesting active participation in regional and local cultural and material exchange.

The burial context at Ayia Triada[108] is entirely unique in the region, featuring EBA IIa burials that consisted of the disarticulated remains of at least seven individuals—both adults and children[109]—located in one of the cave's eastern and more inaccessible chambers. Mortuary offerings accompanying the burials included well-preserved food offerings, as well as prestigious grave goods such as metal artifacts (e.g., a dagger and a pair of tweezers), decorated bone tubes, and pottery with strong Cycladic affinities (Fig. 9). The remains, which appeared disturbed or possibly in secondary deposition, were found mixed with ovicaprid bones and fragmented pottery. Notably, they were laid out on the chamber floor above a layer of carbonized figs, lentils, and grains,

[101] Talalay, Cullen, and Keller 2017, p. 56.
[102] Wolters 1891; Sackett et al. 1966; Theocharis 1959.
[103] Kosma 2010, pp. 31-34.
[104] Kosma 2019, p. 170.
[105] For an assessment of Ayia Triada pottery, see Mavridis and Tankosić 2009, pp. 54–56.
[106] Cullen et al. 2013, p. 105; Mavridis and Tankosić 2009; Mavridis and Tankosić 2016a.
[107] Mavridis and Tankosić 2009, pp. 53–54; For Plakari, see Cullen, Talalay, and Tankosić 2011, p. 37.
[108] Mavridis and Tankosić 2016b, pp. 232–238.
[109] For Ayia Triada anthropological remains, see Prevedorou, Mavridis, and Tankosić 2019.

suggesting the possibility of a ritual meal or related offerings.[110] Based on the associated finds, it seems that the cave was specifically designated for burial and ritual purposes—at least during the EBA—catering to the preferential mortuary treatment of select individuals from nearby communities, with no evidence of domestic use.

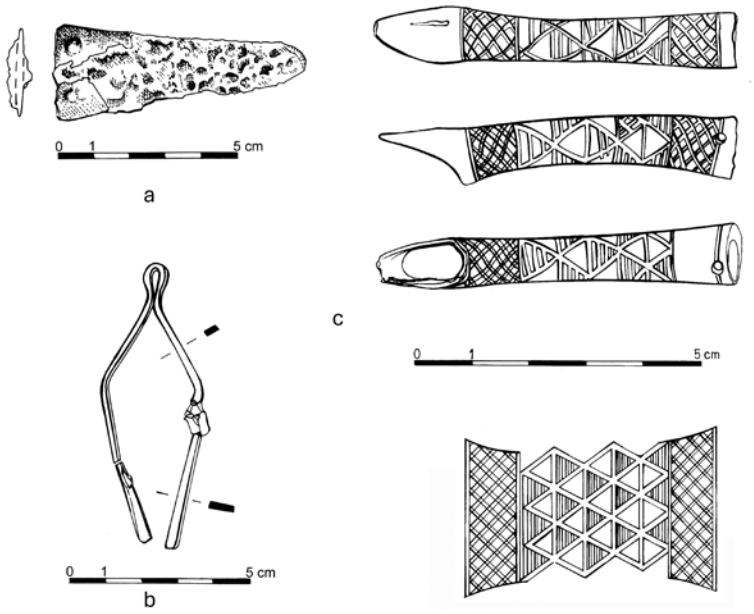


Fig. 9 – Early Bronze Age Finds from Ayia Triada:
(a) Bronze Dagger; (b) Bronze Tweezers; (c) Decorated "Bone Tube"
(after Mavridis and Tankosić 2016b, p. 229; fig. 18).

Aside from the finds at Ayia Triada and Gkisouri, evidence for burial or organized mortuary practices in designated settings is largely absent in the Karystia during both the FN and EBA periods. The limited available information comes from isolated finds recorded in field surveys, consisting of potential EBA II cist graves made of schist slabs, occasionally located near known sites.[111]

The Karystia from the late Early to the Late Bronze Age: Scarcity, Invisibility or Absence?

The dispersed yet increasing habitation and landscape use from the LN to EBA IIa, as evidenced by the few strategically located settlements and numerous findspots interpreted as specialized activity locales, is abruptly disrupted from EBA IIb onwards, continuing through EBA III and into the MBA, culminating to the almost total absence of LBA material. Despite systematic surveys covering a vast portion of the Karystia, no surface material has been attributed to the period spanning EBA IIb to LBA. This absence is puzzling, as no significant environmental factors have been identified that would affect the visibility of these periods in the archaeological record. This leaves the possibility that the region was either very sparsely inhabited or even "empty" for much of the EBA III – LBA periods. Regardless, the Karystia, despite its key location and active participation in regional networks during the FN to EBA IIa, appears to have become somewhat disconnected for the remainder of prehistoric times (at least based on current evidence).

The absence of EBA III habitation in the Karystia, despite earlier yet unverified references to its scarce presence,[112] is largely extrapolated from relevant material culture in neighboring mainland regions, such as the *Anatolianizing* elements characteristic of Lefkandi I or the material from Manika attributed to this phase, as well as relevant material from the Cyclades (e.g., Kastri group).[113] Alternatively, it has been suggested that the invisibility of EBA III in the local record

[110] Mavridis and Tankosić 2016b, pp. 225-230.

[111] E.g., see Cullen et al. 2013, pp. 53-54, 95 for the example in Ayia Pelagia and Wickens et al. 2018, p. 49 for a similar case in Kalamos in the Bouros-Kastri area.

[112] Keller 1985, pp. 170–176. However, we note here the discovery of a depas amphikypellon from Grave 3 at Gkisouri, which, as a type, may postdate the EBA IIb (for the relevant find, see Kosma 2019, p. 170).

[113] See Cullen et al. 2013, p. 101 and Sampson 1985, pp. 382–383 respectively. See also Angelopoulou 2008, p. 149, Kouka 2013 and Renfrew 2010, p. 89.

may be due to the continuation of EBA IIa pottery traditions, which complicates differentiation between periods that is based solely on the stylistic features of the archaeological material.[114]

The subsequent MBA period is represented by only one site: Ayios Nikolaos Mylon, which remains unexcavated. The lack of MBA finds from surveys remains puzzling and has been interpreted as either (or both) a result of settlement nucleation[115] or depopulation. Nevertheless, the site of Ayios Nikolaos Mylon provides the only significant evidence for this period, including surface architectural remains and material culture that reflect influences and connections with contemporary sites, primarily in the Cyclades and, to a lesser extent, the mainland.

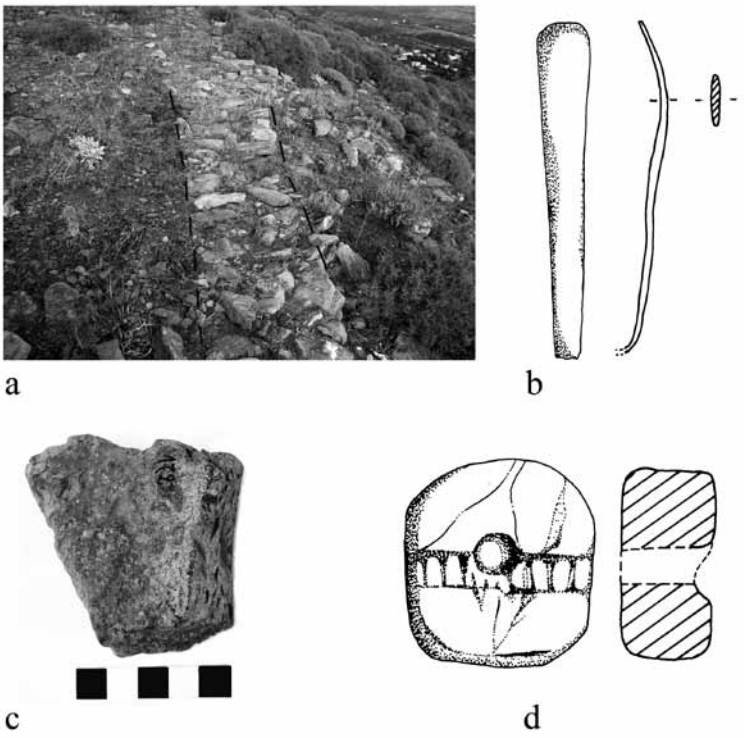


Fig. 10 – Ayios Nikolaos Mylon: a) Architectural Remains, b) Bronze Tweezers, c) Bronze Ingot d) Swage Block, (after Tankosić and Mathioudaki 2011, p. 105; fig. 5, p. 134; fig. 22, p. 136; figs. 23-24).

Ayios Nikolaos, in contrast to FN and EBA sites near the coast, is located further inland on a rocky ridge offering natural defensibility and elevated views of the surrounding landscape, which also includes arable land and water sources.[116] The surface material is predominantly from the MBA, though FN and EBA sherds are also present.[117] The scatter of surface material occupies a relatively small area of around 0.4 ha, in contrast to the nucleation tendencies observed in the contemporary Cyclades.[118] Despite this difference, the site shows close ties to the Cyclades, participating in the regional network, as seen from its pottery assemblages. Approximately 9% of the collected material is considered imported from the Cyclades, with parallels to Phase IV pottery from Ayia Irini on Kea.[119] In addition to pottery, the site yielded considerable metallurgical finds, including a fragmentarily preserved ingot, a pair of tweezers, some slag, and fragments of clay crucibles, although their date remains uncertain (Fig. 10).[120]

In addition to its movable finds, Ayios Nikolaos also preserves architectural remains (Fig. 10), surviving primarily as rubble but often with discernible wall outlines.[121] Notably, a double-faced curvilinear wall is visible on the western end of the plateau, following the natural contours

[114] Cullen et al. 2013, p. 101; Wickens et al. 2018, p. 22.

[115] Cullen et al. 2013, p. 101.

[116] Tankosić and Mathioudaki 2011, pp. 102-103. For a preliminary overview of the site and its finds, see also Tankosić and Mathioudaki 2009.

[117] Tankosić and Mathioudaki 2011, pp. 109–111. Based on parallels and suggested MBA divisions, the authors ascribe Ayios Nikolaos to the second half of the MBA.

[118] Cullen et al. 2013, p. 102 with references.

[119] Tankosić and Mathioudaki 2011, p. 127.

[120] Tankosić and Mathioudaki 2011, pp. 134–136.

[121] Tankosić and Mathioudaki 2011, pp. 104–106 with references concerning architectural typology and parallels.

of the ridge. Further remains of straight and curvilinear walls were recorded on the top plateau and the upper terraces of the ridge. Two walls running parallel in the central plateau may represent two adjacent buildings separated by a narrow space, while a larger curvilinear wall at the southeastern part of the plateau might correspond to an apsidal structure, a common architectural form in the MBA. Though further excavation is needed to clarify these architectural features, Ayios Nikolaos stands out as the only known site in the Karystia preserving finds from the FN, EBA, and MBA. However, given the current data, it is not possible to confirm whether habitation was continuous throughout these periods.

Ayios Nikolaos Mylon has also yielded the most reliable, though scant, information regarding the LBA in the Karystia. To date, no architectural remains or built features from this period have been identified, with the LBA represented only by a handful of movable finds. This lack of visibility for the LBA is particularly perplexing, given the Karystos' mention in the catalog of ships in Homer's Iliad and the reference to the toponym *ka-ru-to*, which is widely accepted to correspond to Karystos,[122] on a Linear B sealing from LBA Thebes in Boeotia.

Although the challenges of using Homer as a source for the LBA Aegean are well-known, with the Homeric epics containing inherent anachronisms, the mention of Karystos—alongside six other Euboean cities—in the *Iliad's* catalog of ships[123] has been employed as an indirect indication of LBA activity in the Karystia. More securely, the reference to Karystos (along with Amarynthos in central Euboea for animal pelts consignment) in a Linear B tablet from Thebes[124] offers clearer evidence of the region's connections with major LBA centers,[125] although there are opposing views regarding the interpretation of this evidence.[126]

The possible presence of an LBA site in the Karystia was first noted by Sackett and his team, who identified a location at Cape Philagra with potential LBA material, along with an isolated LH IIIC sherd mentioned in Styra.[127] Similarly sparse is the LBA pottery from Ayios Nikolaos,[128] consisting of three kylix stems dated to the LH IIB–LH IIIA2 period, and a rim fragment likely from a krater, comparable to examples from Keos. Additionally, a few finds possibly linked to metallurgical activities,[129] including a piece of amorphous lead, a possible swage stone, clay crucible fragments, a bronze ingot fragment, and some slag, could also tentatively be associated with the LBA.

Overall, the scarcity of LBA remains in the Karystia becomes even more perplexing when considering its strategic location along the north–south maritime routes, its extensive arable land, and its proximity to the Cycladic islands, which were flourishing during this period with intensified contacts with Minoan Crete and the Mycenaean mainland.

At Aegean Crossroads: The Karystia within a Bronze Age Perspective

The Karystia, strategically positioned between the mainland and the Cyclades, offers an insightful case of how communities actively shaped their identity within regional contexts, while local histories were influenced over the *longue durée* by broader developments in the area. Most

[122] Killen 1994, pp. 71-72 [Tablet TH Wu 55.β]

[123] Iliad ii. 536-545.

[124] Aravantinos 1987, pp. 36–38; Piteros, Olivier, and Melena 1990, pp. 153–154.

[125] Aravantinos (Aravantinos et al. 2001, pp. 355-357) has suggested the possibility that Karystos during the LBA was under the direct influence of Thebes.

[126] See Palaima 2011, pp. 54, 69, 72-73.

[127] Sackett et al. 1966, pp. 80, 83; first mentioned in Hankey 1952, p. 60.

[128] Tankosić and Mathioudaki 2011, p. 127 with references for parallels of the LBA elsewhere.

[129] Tankosić and Mathioudaki 2011, p. 106.

significantly, the prehistoric Karystian communities demonstrate varying degrees of interaction with surrounding regions in terms of habitation, settlement patterns, material culture, and socio-political structure. During certain periods, there is evidence of intense connectivity, particularly with the Cyclades, whereas links to mainland sites appear more intermittent. At other times, the Karystia exhibits a more "insular" or idiosyncratic character, indicating fluctuating degrees of engagement with its neighboring areas.

The Karystia appears to mirror the Cyclades not only in its geomorphological and geological characteristics but also in its habitational history and settlement patterns, particularly during the LN – EBA II periods, where strong Cycladic influences are evident in its material culture. However, for reasons that remain largely unclear, often attributed to significant depopulation or a habitation hiatus,[130] this connectivity and shared developmental trajectory are disrupted during the EBA IIb – EBA III periods. By the LBA, the Karystia seems almost devoid of habitation, diverging markedly from the bustling, interconnected world of its Minoan and later Mycenaean surroundings.

Using the LN as a starting point to discuss the Karystia is a deliberate choice, as this period not only marks the earliest evidence of permanent habitation in the area but also reflects the emergence of shared and connected pathways with the Cyclades. Moreover, the LN is significant as it signals the introduction of metallurgy in the Aegean,[131] setting the stage for subsequent technological advancements and wider distribution of metal objects especially during the EBA II.[132] However, no definitive metallurgical finds from the Karystia can be securely attributed to this period. The sole eligible artifact, the copper axe collected from the surface of Gourimadi, is typologically ambiguous and could belong to any period spanning the LN to the EBA.[133]

Despite the existence of two extensive plains, namely the Kampos and the Katsaronio, which would render southern Euboea an attractive setting for early agriculture, the Karystia does not exhibit any records of habitation before the advanced stages of LN I. This absence contrasts with the central and northern parts of the island,[134] as well as Attica,[135] which were already inhabited during the EN and MN periods. In this respect, the Karystia resembles the Cycladic Islands, where permanent settlement also begins during the LN. The question remains whether the establishment of permanent settlements in the Karystian landscape during the LN, and subsequently in the FN, as "colonization" of the Cyclades intensifies,[136] is linked to the region's role as a "steppingstone" for human movements towards the Cyclades.[137] Alternatively, it may relate to shifts in subsistence strategies suggested during these periods, such as a transition to rain-fed agriculture and an increased emphasis on pastoralism.[138]

The appearance of habitation in the Karystia during the LN coincides with a broader regional trend of settlement in more marginal environments for agriculture across the Aegean, such as the southern Larisa plain.[139] This context should be factored into considerations of the processes driving landscape infilling in the Karystia. Therefore, attributing this phenomenon solely to the colonization of the Cycladic islands would potentially oversimplify the broader socio-economic and environmental dynamics at play during this period.

[130] E.g., Cullen et al. 2013, p. 101; Tankosić 2017, p. 104; Tankosić et al. 2021a, p. 46.
[131] Poursat 2022, p. 13.
[132] Sherratt 2007, p. 245.
[133] Tankosić et al. 2021a, p.23; for typological considerations of such artifacts, see Branigan 1974.
[134] Sampson 1981, pp. 50-79.
[135] Pantelidou-Gofa 1997; Andrikou 2020.
[136] Davis 1992, p. 703.
[137] Broodbank 2000, p. 133.
[138] Demoule and Perlès 1993, p. 399.
[139] Broodbank 1999, p. 33.

However, these possibilities cannot be conclusively addressed based on the current limited data, primarily derived from LN ceramic assemblages at Ayia Triada—where relevant pottery was found alongside a series of hearths associated with a structure and a platform[140]—and Gourimadi. The pottery from these two sites, particularly the white-on-dark sherds characteristic of the Saliagos horizon, which is more prevalent in the southern Cycladic zone,[141] suggests that the Karystia was, in some way, connected to this area. Continued excavation at Gourimadi, particularly with the discovery of stratified LN material and the possible presence of an LN adobe structure,[142] holds the potential to shed further light on the relationship between the Karystia and the Cyclades.

Finally, post-depositional factors may contribute to the limited evidence for the LN, or even earlier phases, in the Karystia. For instance, typical LN pottery at Gourimadi only emerged during excavation, with no indication of its presence during the survey of the site. Also, the natural configuration of the Ayia Triada cave likely precluded its use as a habitation site in any period. Whatsoever, the deposits within the cave have been shaped by distinct and relatively stable formation processes compared to those at open-air sites. This may account for the visibility of LN pottery on the cave's surface, whereas more substantial LN evidence elsewhere in the Karystia might remain obscured from surface surveys, which are by far the most common archaeological reconnaissance method across the Mediterranean.

The FN–EBA periods mark a peak in prehistoric habitation in the region, with several larger sites and numerous specialized findspots recorded in the Karystia. This pattern of settlement expansion, marginal landscape exploitation, and the dispersal of smaller settlements across the landscape—particularly evident during the FN—mirrors broader trends seen across much of the southern mainland and the Aegean,[143] including the Cyclades and Attica.[144] Despite the challenges in synchronizing material culture sequences across different Aegean regions, by a certain point in the FN, we observe the beginnings of developments that, by EBA II, culminate in various forms of social organization and complexity within a framework of intensified regional and supra-regional exchange networks.[145]

The distribution of FN and EBA sites in the Karystia reveals dispersed settlement patterns across diverse landscape zones, with key sites from both periods strategically positioned to ensure convenient access to uplands, coastlines, arable land, and broad vistas of nearby and distant areas. FN sites typically occupy elevated features, such as ridges and hilltops, while EBA II settlements favor naturally sheltered areas closer to the sea.[146] These patterns closely resemble those observed in the LN and FN Cyclades, where site distribution includes relatively few settlements per island, the presence of smaller sites near larger settlements, and a preference for coastal locations in EBA contexts.[147]

Several FN–EBA sites in the Karystia display material evidence spanning both periods, though verified continuity of occupation remains elusive due to the reliance on surface scatters for most site identifications and relative dating. Broadly, the material culture in central Greece exhibits few signs of discontinuity between the FN and EBA, implying a degree of cultural continuity

[140] Mavridis and Tankosić 2009a, pp. 49-52.

[141] Mavridis and Tankosić 2016a, p. 435.

[142] As the pottery material is currently undergoing analysis and we await the relevant radiometric dating results, it is premature to refer to these finds with certainty.

[143] See for example Alram-Stern 1998; Cavanagh et al. 2002; Halstead 1994; Runnels and van Andel 1987.

[144] See for example Kalogiropoulou 2018, pp. 219-222 and Pantelidou-Gofa 1997, p. 83 respectively.

[145] E.g., Papadatos and Tomkins 2013; Tomkins 2014.

[146] Comparable patterns for these two periods are observed in other Aegean regions; see Cullen et al. 2013: 86-87 and references therein; Nowicki 2008: 77 for FN sites on Crete.

[147] Cullen et al. 2017, pp. 86-87; Kalogiropoulou 2018, pp. 219-222; Tankosić and Katsianis 2018, pp. 243-244.

rather than disruption across these phases. Current data complicates the interpretation of this pattern—whether it reflects deterministic aspects of the Karystian landscape that may have influenced settlement choices across both periods or suggests the resilience and regional significance of these communities, potentially linked to the area's strategic location along maritime routes between the mainland and islands. The proximity of the primary FN–EBA settlements to the coast, coupled with a geomorphology that limits natural connectivity with central and northern Euboea, has been posited as a key factor driving the seaward orientation of Karystian communities during these periods.[148]

Although the Karystia is considered in this paper within a framework similar to that of an island, the existence of two extensive plains, Kampos and Katsaronio, sets it apart from most of the neighboring Cyclades, which generally lack comparable tracts of arable land. Notably, the absence of substantial prehistoric settlements within these plains throughout the recorded periods could suggest a level of inter-site coordination among local communities.[149] Given no compelling environmental reasons that might account for this settlement void, it is plausible to interpret this distribution as a deliberate strategy by local groups, potentially aligned with socio-political and subsistence-related objectives.

The hypothesis that suggests a collective decision to maximize agricultural yield in the two plains by intentionally avoiding settlement construction within them,[150] offers valuable interpretative insight. This hypothesis gains further weight when considering the pivotal role of Karystian FN and EBA sites in the procurement, production, and at least regional distribution of obsidian raw materials and finished goods. To sustain this role and ensure access to the regional obsidian network—likely spanning the entire FN–EBA II period—the Karystian communities might have contributed agricultural produce alongside their strategic position within Aegean maritime routes. The relatively low number of sites, particularly those indicating significant occupation, positioned along the peripheries of these plains and near the coast, could point to their roles in managing local agricultural production and regulating access to maritime networks. This scenario suggests a locally coordinated structure characterized by inter-site social differentiation, potentially foreshadowing a more hierarchical settlement organization by EBA II. Specifically, obsidian finds from Ayios Georgios and Gourimadi, which display all stages of the reduction sequence, alongside obsidian findspots in the plains with a more restricted assemblage diversity, lend support to the notion of a broader strategy in which obsidian production activities were overseen by the larger settlements and then used for, presumably, agriculture-related activities in the plains. Some findspots, such as 07N35 in the immediate vicinity of Ayios Georgios suggest other forms of specialized use. The surface lithic assemblage from this location has a statistically significant number of notched tools and little evidence of in situ production, pointing towards the use of obsidian in manufacturing of objects of some type of soft material, potentially serving the nearby Ayios Georgios community.[151]

Marked by an abundance of obsidian finds across the surveyed area,[152] the Karystia shares parallels with the Cyclades and the central and southern Greek mainland, as lithic production during these periods relies almost exclusively on obsidian[153]—a feature indicative of the region's intensified connectivity and successful integration into regional exchange networks as obsidian had to be imported on relatively regular bases. Larger sites such as Gourimadi, where the full

[148] Cullen, Talalay, and Tankosić 2011, p. 39.

[149] Tankosić 2017, p. 103.

[150] Tankosić 2011.

[151] Tankosić and Chidiroglou 2010, pp. 14-15.

[152] Field surveys in the area yielded some scarce chert and flint finds; see Tankosić et al. 2021a, p. 17 and Cullen et al. 2013, p. 37.

[153] Cullen et al. 2013, pp. 105-106.

obsidian reduction sequence is evidenced for at least the FN–EBA I period, and Ayios Georgios, a significant EBA II site, likely held privileged access to obsidian procurement. These sites may have functioned as central nodes in local obsidian production and broader regional distribution, with the possibility that their role as obsidian distribution centers extended beyond southern Euboea, potentially reaching territories to the north, where this material was much more "exotic" and, potentially, more highly valued.[154] The strategic coastal locations of sites like Akri Rozos and Ayia Pelagia, possibly instrumental in receiving Melian obsidian,[155] may reflect a functionally organized site hierarchy. In this configuration, larger settlements would have coordinated the production and distribution of obsidian artifacts within the region.

Obsidian finds provide a valuable indicator of the Karystia's enduring connectivity with its broader surroundings, particularly with the Cyclades, where this raw material originates.[156] The discovery of stratified LN obsidian artifacts in the Ayia Triada cave[157] and at Gourimadi—including leaf-shaped points with parallels at LN Ftelia and Saliagos, as well as a rounded flake resembling the "disc" tool type from the latter site[158]—strongly evidences the integration of local communities into Aegean exchange networks from the (known) initial phases of settlement in the region. Obsidian volume in the Karystia increases during the FN–EBA periods, especially in EBA II, when Aegean-wide exchange networks intensify, with the Cyclades playing a pivotal role in the regional distribution of material culture and reaching more distant zones, marked also by the expanded circulation of metal artifacts.[159]

Regional contacts and exchange networks during these periods were closely tied to seafaring and maritime connections, with the Karystia's position between the Cyclades and the southern and central mainland likely granting it a notable role within established regional seafaring routes.[160] The growing body of evidence for maritime connectivity has prompted a reevaluation of the concept of "insularity."[161] Nonetheless, substantial archaeological evidence directly reflecting seafaring activities remains limited, and much of our understanding derives from imported material culture, pottery imitating non-local decorative styles and shapes, and depictions of seacraft—such as small canoes and larger vessels ("longboats")—in rock carvings, as for example those from FN Strofilas (Andros) and EBA II Vathy (Astypalaia),[162] and on the surfaces of EBA II "frying pan" ceramic vessels,[163] suggesting the dynamics of these interactions. It is noteworthy that no such depictions have yet been identified in the Karystia, despite clear indications of the region's involvement in maritime interactions.

Within these networks of maritime interaction, in addition to obsidian and pottery—alongside foodstuffs and people[164] —other raw materials, such as marble from Paros and Naxos and emery from Naxos,[165] circulated alongside prestige items like figurines, stone vessels, and jewelry.[166] The

[154] Cullen et al. 2013, p. 106.

[155] Cullen et al. 2013, p. 106.

[156] The principal source of obsidian in the Aegean originates from Melos, specifically from deposits at Sta Nychia and Demenagaki, while an additional, comparatively lower-quality source is located on Gyali near Nisyros.

[157] Mavridis and Tankosić 2016a, p. 423.

[158] Tankosić et al. 2021b, p. 21 with the relevant references.

[159] Broodbank 2000, p. 45.

[160] Cullen et al. 2013 with reference to Broodbank 2000, p. 239.

[161] For discussions on the concept of insularity in the Aegean, refer to Cherry (1981, pp. 49–50). For critiques on the term, see Dawson (2014, pp. 171–172), Patton (1996, pp. 180–181), and Rainbird (1999, pp. 172–173).

[162] See Televantou 2008, pp. 47-49 and Vlachopoulos 2012, p. 119 respectively.

[163] Broodbank 2000, pp. 96-98.

[164] Broodbank 2000, p. 364.

[165] Kouka 2008, pp. 311-312 with references.

[166] Broodbank 2000, p. 156.

discovery of marble Cycladic figurines at Lefka and Gkisouri, along with fragments of stone and marble vessels,[167] provides clear evidence that Karystian communities during the EBA were able to access prestigious objects through their participation in regional exchange networks. This circulation of high-value items may also suggest an intentional reproduction of Cycladic mortuary practices, potentially serving as a means of identity construction or the assertion of individual status.

Metallurgical knowledge and metal objects formed a significant part of Aegean exchange networks from the LN, with particular intensification during the EBA II period.[168] In the Karystia, securely datable metal artifacts from the FN–EBA periods remain limited, and evidence for local metallurgical production is ambiguous. However, given the region's proximity to the FN–EBA period mines in eastern Attica—such as those at Laurion, Thorikos, and Ovriokastro[169]—access to these resources by Karystian communities is plausible. Noteworthy metal finds include a copper axe or adze and a copper awl from Gourimadi, as well as a copper dagger, awl, and tweezers from the Eastern Chamber of the Ayia Triada cave, likely dating to EBA II.[170] Additional items include a mineral lump from Plakari,[171] inconclusive and largely undated metalworking finds from Akri Rozos,[172] and occasional metal artifacts from the EBA II context at Ayios Georgios.[173] Finally, it should be noted that local copper sources do exist in the Karystia and were exploited in historical times; however, there is currently no evidence to suggest that this exploitation began during prehistoric periods.

The pottery assemblages recovered from various FN–EBA sites across the Karystia reveal compelling interconnections with the Cyclades and, to a lesser extent, the mainland (especially Attica), illustrating how local communities articulated and conveyed their identities through material culture.[174] Ceramic finds from excavations and surveys throughout the Karystian landscape exhibit pronounced affinities with similar materials from the nearby Cycladic islands and, sporadically, with central Euboea and certain mainland areas, including the Argolid and, farther north, Thessaly.[175] Despite occasional regional variations, the ceramic evidence reflects a notable degree of uniformity and homogeneity, indicating the presence of consciously curated material expressions of identity throughout this period.[176]

For reference, we note the presence of FN black burnished pottery, a type commonly associated with mainland sites, as well as EBA pottery specimens from the Ayia Triada, such as a Cycladic-style sauceboat and additional vessels influenced by Cycladic forms, including a painted pyxis lid, a spouted jug, and a perforated footed cup with EBA (II) Cycladic parallels.[177] Additional connections to nearby Attic coastal sites are evident, with examples of FN pattern burnished pottery similar to that found at Kontra Gliate and Thorikos in Attica, and Kephala on Keos.[178] More distantly connected pottery types have also been retrieved, including talc ware from Ayia Paraskevi East and yellow-mottled pottery at Paximadi.[179] Furthermore, the discovery

[167] Kosma 2010, p. 30.

[168] Sherratt 2007, pp. 245-248.

[169] See Georgakopoulou 2005, p. 44, Nazou 2014, pp. 241-243, and Kakavogiannis and Kakavogianni, 2001, pp. 56-57 respectively. See also Nazou 2020 for a general discussion.

[170] Mavridis and Tankosić 2016b, pp. 229-230.

[171] Cullen et al. 2013, p. 41.

[172] Cullen et al. 2013, p. 94.

[173] Tankosić 2011.

[174] Tankosić 2017, pp. 101-102.

[175] Cullen et al. 2013, p. 104.

[176] Tankosić 2017, p. 103.

[177] Mavridis and Tankosić 2009b, p. 50; Mavridis and Tankosić 2016b, p. 227.

[178] Nazou 2017, p.114; Wickens et al. 2018, p.48.

[179] Cullen et al. 2013, p. 105.

of honey-flint arrowheads at Gourimadi and Plakari suggests that Karystian communities may have had direct or indirect access to networks extending as far as northwestern Greece.[180]

Due to the inconsistency of FN–EBA architectural data and the fact that only one site from these periods, Gourimadi, has undergone systematic excavation, any inter-site or cross-regional comparisons between settlements, as well as discussions regarding their social organization, remain speculative and limited by the occasional nature of the available data. The extensive architectural remains at Gourimadi, in conjunction with more fragmentary remains from Plakari, Akri Rozos, Ayia Pelagia, and Ayios Georgios, suggest the presence of communities during both periods with social structures that facilitated coordinated intra-site construction activities. This includes the occasional construction of buildings that could be characterized as monumental within the EBA II architectural context, as indicated by findings at Ayia Pelagia.

Community-coordinated building activities and large-scale landscape modifications are best evidenced at Gourimadi. Here, successive architectural phases involved the dismantling or partial reuse of earlier stone-built walls to create new structures on the same plots, a process likely requiring inter-household coordination. Preliminary findings from recent excavations on the southern slope further suggest that the extensive terrace system descending this slope may have been an element of prehistoric landscaping at the site. As the study of Gourimadi's architectural remains continues, partial similarities with contemporaneous structures at Ftelia (Mykonos) and Strofilas (Andros)[181] are tentatively noted. Should the southern slope's terraces be definitively proven as prehistoric, they could represent an occurrence comparable to the terraced slopes seen at EBA II Skarkos (Ios).[182]

The potential fortification walls observed on the surface at Akri Rozos provide additional insight into intra-site spatial organization, reflecting aspects of the social structures and levels of social complexity characterizing these periods.[183] Although systematic excavation at the site is lacking, preventing a secure dating of the fortification walls, comparable structures are observed in both FN contexts (e.g., Strofilas on Andros, Zagani in Attica) and EBA II contexts (e.g., Markiani on Amorgos).[184] Additionally, the visible yet unexcavated, tower-like constructions adjoining the external wall of the lowest southern terrace at Gourimadi—while also currently undated—suggest that the emphasis on defensibility, or at least the visual projection there of through architectural features, formed part of the spatial strategies of FN–EBA communities in the Karystia, as seen elsewhere in the broader region.[185]

Regarding the potential "corridor house" at Ayia Pelagia, any definitive interpretation of this architectural form[186]—primarily distributed across the central and southern mainland[187] and bearing significant implications for the emergence of social complexity[188]—must await systematic excavation of the site.

The absence of EBA IIb and EBA III remains in the Karystia, with the sole exception of Lefka near Marmari for EBA IIb, is particularly striking. While it is possible that methodological

[180] Cullen et al. 2013, p. 105 with references.

[181] See Sampson 2008, pp. 31–32 and Televantou 2019, pp. 154–155 respectively.

[182] Marthari 1997.

[183] Cullen et al. 2013, pp. 92-94.

[184] For the site of Zagani see Pantelidou-Gofa 1997, p. 123 and Steinhauer 2001, pp. 30-34. For Markiani see Marangou et al. 2006, pp. 84–87.

[185] Sotirakopoulou 2008, p. 545.

[186] For general information on corridor houses, see Shaw 1987 and 1990.

[187] Examples of corridor houses excavated in the Aegean include Lerna (Wiencke 2000), Akovitika (Themelis 1970), and Kolona (Walter and Felten 1981).

[188] For interpretations linking corridor houses to the rise of emerging elites or their function as communal buildings, see Pullen (2003: 34–35) and Weiberg (2007: 37–43) respectively.

biases account for some of this absence, it is nonetheless telling that none of the excavated EBA sites in the Karystia east of Marmari have yielded the distinctive pottery types typically associated with EBA IIb. Given that *Anatolianizing* pottery forms make up a relatively minor component of the overall pottery assemblages where they are documented, and that they are often produced from local clays, it is likely that such finds could be easily overlooked or misinterpreted in surface collections.[189] Nonetheless, these pottery forms are well-documented in regions bordering the Karystia, including central Euboea (e.g., at Lefkandi), highlighting the intriguing absence of such material within the Karystian record itself.

The most plausible explanation for this absence likely lies in the shifting networks of communication, trade, and alliances at the close of the mature EBA phase. During this transition, certain elements of new material culture were adopted selectively by communities engaging in emergent networks. These new pottery assemblages, predominantly comprising drinking and serving vessels, are commonly linked with the rise of elite culture and new commensality practices, potentially imported from the eastern Aegean. It is possible that such groups in the Karystia either remained unaligned with these emergent practices or were perhaps absent from the area altogether, as the archaeological record provides limited evidence of marked social stratification within EBA Karystia. Thus, the non-adoption of new practices, networks, and associated material culture could reflect a deliberate choice by Karystian groups rather than indicating a broad depopulation. However, further conclusions remain tentative in the absence of additional radiocarbon dates from securely stratified contexts.

The absence of EB III material in the Karystia is somewhat less perplexing as it mirrors similar patterns in the Cyclades. Researchers have long acknowledged a corresponding 'gap' in the Cycladic archaeological record, which has narrowed over time though not entirely eliminated.[190] In the Cyclades and the southern Greek mainland, ceramic assemblages display significant continuity from the FN through EB IIb, despite the incorporation of new 'foreign' elements in the latter phase. EB III ceramics, however, indicate a more pronounced break from traditional forms, potentially mirroring shifts in underlying socioeconomic processes. While the absence of this ceramic type in the Karystian excavation and survey assemblages remains notable, it reinforces the view that southern Euboea's connections were more deeply rooted with the Cyclades than with mainland Greece.

Settlement in the Karystia resumes in the MBA, currently represented by only one definite (Ayios Nikolaos Mylon) and one potential site (Lefka). Ayios Nikolaos departs from the earlier coastal settlement pattern by its strategic placement on a ridge at the foothills of Mount Ochi. This inland shift, along with Ayios Nikolaos' apparent dominance over the landscape, may imply a regional trend toward settlement nucleation or even depopulation, paralleling broader Aegean patterns at the beginning of this prehistoric phase,[191] where settlements became fewer and were often repositioned in defensible locations, perhaps reflecting the increased insecurity during the MBA in the wider region. Despite its unique status, Ayios Nikolaos exhibits material culture primarily associated with mainland traditions, though Cycladic connections are evidenced by about 9% of the collected pottery, identified as Cycladic imports.[192] Since this site remains unexcavated, it is difficult to use it as a linchpin of our understanding of the MBA Karystia. The archaeological survey work in the area has mostly focused on the plains and coastal regions, so it is possible that other MBA sites that follow the Ayios Nikolaos patterns have been overlooked.

[189] E.g. Wilson 1999, p. 95.

[190] Rutter 1983; Rutter 2013.

[191] Broodbank 2000, pp. 347- 349; Cherry 1979, pp. 43-46; see also Tankosić and Mathioudaki 2011, p. 133 with references.

[192] Tankosić and Mathioudaki 2011, p. 127.

Finally, the Late Bronze Age in the Karystia remains enigmatic due to the almost complete absence of sites and materials attributed to this period, despite the extensive spatial coverage achieved through the four major surface surveys conducted in the area. The Linear B reference to Karystos found in Thebes, alongside its strategically important position, and Homeric references, leaves open the possibility that LBA remains may yet be discovered, perhaps beyond the areas surveyed thus far or awaiting identification in future archaeological investigations in the Karystia. The LBA sherds found at Ayios Nikolaos testify to the fact that the Karystia was not entirely abandoned during the Mycenaean times. We also find the notion of empty LBA Karystia unlikely. In addition to more research, however, we suggest that a shift in perspective might be beneficial when thinking about the Karystia's 'missing Mycenaeans'. For example, whether we think of Euboea as part of the larger Theban polity during the LBA or adopt a more cautious view that palatial control rarely went beyond the boundaries of the immediately adjacent areas,[193] what we are lacking in the Karystia is the evidence for the Mycenaean elite culture (especially ceramics), which is usually used to define this period. If there was central control from Thebes, then it is possible that the Theban elites could have actively discouraged the formation of local political centers effectively tying the emergent elites to the palatial center. Alternatively, the elite-related material culture could have been focused in the areas closer to palatial centers, leaving the Karystia absent from the most-recognizable LBA ceramics. In this case, the local communities possibly would have continued to use the coarse utilitarian pottery, which would be much more difficult to assign as LBA, especially in unstratified surface assemblages.

Conclusions

The archaeological record of the Karystia during the FN - EBA periods affords a crucial window into the region's socio-economic integration within wider Aegean networks and offers substantial evidence for the complex dynamics of interaction, identity production, and social differentiation. The region's sustained engagement with Cycladic and, to a lesser degree, mainland exchange networks is eloquently demonstrated through the circulation of obsidian. The sites like Gourimadi or Ayios Georgios likely functioned as key nodes within a broader inter-regional system, reflecting a nuanced network in which obsidian procurement and production were both functional and socially significant. Similarly, the ceramic assemblages reveal preferential connections to Cycladic material traditions and illustrate how these communities adopted, adapted, and reproduced regional stylistic motifs and forms to signify cultural alignment, social differentiation, and, in some cases, the emulation of Cycladic funerary practices.

The MBA period is marked by a reorientation of settlement patterns, with Ayios Nikolaos Mylon suggesting a strategic inland positioning, distinct from previous coastal orientations, possibly aligning with regional trends of settlement nucleation and defensibility observed across the Aegean. The near-total absence of LBA sites and material culture, despite the mention of Karystos in the Linear B corpus, remains a critical lacuna, underscoring the necessity for further targeted research to clarify the Karystia's role within Mycenaean political and economic spheres.

In conclusion, while the Karystian prehistory presents notable gaps, it nonetheless offers a good case for understanding inter-regional connectivity, material expressions of identity, and social complexity in this liminal Aegean region. Further systematic investigation is essential to refine and expand upon these findings, position the Karystia within the broader interpretive narratives of Aegean prehistory and advance a more comprehensive understanding of its socio-economic and cultural transformations across the prehistoric periods.

[193] E.g. Knodell 2017, p. 201.

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Early Bronze Age Barrow Graves in North-West Bulgaria

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Abstract: Twenty-nine Early Bronze Age barrow graves from North-West Bulgaria are discussed in the paper. Presented are the essential characteristics of the mortuary practices – barrow fills, grave pits, method of disposal, grave inventory and use of red pigments. A significant enrichment of knowledge about the barrow burial rite in northwestern Bulgaria are the results of rescue excavations conducted in 2023-2024 near villages Butan, Kriva bara and Manastirishte (all in Kozloduy region). Twelve radiocarbon dates were obtained for graves from these barrows. They date to around 2900-2600 cal BC, apart from one cremation burial dated around 2500 cal. BC. The earliest graves from Tarnava, 'Glavchovska mogila' (related to the Coţofeni culture), Knezha (early Yamna phase), and Tarnak ('relaxed hocker', possibly dated to Pre-Yamna stage) are most likely of older age (approx. 3100-2900 cal BC). Then, the general chronological position of the graves from barrows in northwestern Bulgaria is set in ca. 3100 – 2500 cal BC. The chronological sequence of the burial mounds, as well as their cultural diversity, find close parallels in discoveries from neighbouring regions, including Oltenia, the Romanian Banat, Transylvania and Vojvodina.

Key words: Lower Danube, Early Bronze Age, Barrow graves, Yamna Culture, Coţofeni Culture

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Introduction

North-West Bulgaria is an area located in the western part of the Lower Danube region. Its northern, eastern, and western boundaries are marked by the Danube, Iskar, and Timok Rivers, respectively, and the Balkan mountain range marks the southern boundary. Until 2020, only seven Early Bronze Age (EBA) barrows have been excavated in that area. Two of them – Kozloduy and Leskovets – remained virtually unknown, with only five barrows being introduced to the public – the three barrows near Tarnava and the two near Tarnak and Knezha. Stray finds from three more sites – Popitsa, Altimir and Harlets - were related to EBA barrow graves as well. Thus, reliable information regarding mortuary practices, including sex-age determination, was accessible for only 16 EBA barrow graves from the region. No radiocarbon dates or isotope data were available as well.[1] In 2023 – 2024, a team led by the authors of the present article carried out rescue excavations of three EBA barrows near Butan, Kriva bara and Manastirishte, Vratsa district (fig. 1/2-4). A total of 13 graves provided new information regarding the EBA mortuary practices in the region, which are the main subject of the present paper.



Fig. 1 – Early Bronze Age barrows excavated in North-West and Central-North Bulgaria.
1 – Kozloduy; 2 – Butan; 3 – Kriva bara; 4 – Manastirishte; 5 – Tarnava; 6 – Knezha;
7 – Tarnak; 8 – Goran-Slatina; 9 – Vladinya; 10 – Kozlovets; 11 – Polsko Kosovo, 12 - Leskovets.
Map: https://map.bgmountains.org.

Currently, we have reliable information from eight barrows excavated – Butan necropolis (1 barrow with 4 EBA graves); Kriva bara necropolis (1 barrow with 6 EBA graves); Manastirishte (1 barrow with 3 EBA graves); Tarnava, necropolis-1 (1 barrow with 10 EBA graves); Tarnava, necropolis-2 (1 barrow with 1 EBA grave); Tarnava, necropolis-3 (1 barrow with 2 EBA

[1] Alexandrov 2019 with all the references for the investigations prior to 2020.

graves)[2]; Knezha (1 barrow with 1 EBA grave) and Tarnak (1 barrow with 2 EBA graves), or a total number of 29 EBA graves (fig. 1).

Geographic distribution

Before the 2023-2024 excavations, EBA barrows were only documented east of the Ogosta River. However, their possible existence west of the River was also suggested[3]. The last two archaeological campaigns proved that suggestion right, 'moving' the western border of that phenomenon west of the river. The field observations show that barrow necropolises with morphological characteristics similar to those already investigated are to be met in the present-day Montana district. Thus, the western border of their spread is probably the Lomska River (fig. 1). As already mentioned, the suggestion is supported by a stray find of Coţofeni Culture pottery coming from the fill of a barrow near Traykovo, Lom region (fig. 8/2, 4).[4]

The necropolises and their barrows

The EBA barrows were piled in well-visible places. Usually, they form necropolises that consist of several barrows placed at the hill's summit, forming a line that follows the summit's curve. The distance between the barrows varies from tens to several hundred meters (figs.

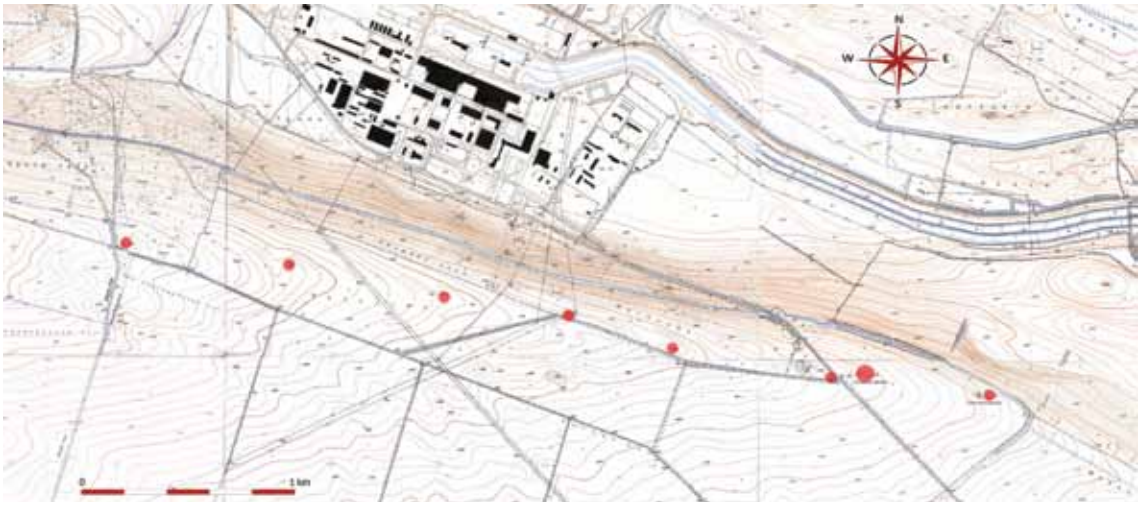


Fig. 2 – EBA barrow necropolis south of Kozlodui Nuclear Power Station.
Map: https://map.bgmountains.org.

2 and 3). The number of barrows in a necropolis also varies, reaching up to nine. Due to modern agricultural work with heavy machines nowadays, many barrows are not seen in the field, so the number of barrows in a necropolis could be even higher. Rarely do the EBA barrows stay single in

[2] The three excavated barrows north of Tarnava village in fact belong to three different necropolises labelled here with nos. 1, 2 and 3. Barrow 1 from the original publication ('Glavchovska' barrow) is part of a necropolis (no. 1) with at least nine barrows (fig. 3). Barrow no. 2 is part of a smaller necropolis (no. 2) located some 4 km south-west of 'Glavchovska mogila' with at least 2 barrows; barrow no. 3 is part of another necropolis (no. 3) located some 2 km south of 'Glavchovska mogila' with of at least six barrows (Alexandrov 2019, Plate II/1).

[3] Alexandrov 2019, 90.

[4] Alexandrov 2019, 90.

the landscape (Knezha barrow, for example), but this fact could result from the already mentioned modern agricultural activities.

The barrows themselves had different dimensions. The highest barrows reach 3.5 – 4 m in height ('Glavchovska mogila', Tarnava-1 necropolis, for example), and the smallest ones had a height of around 0.5 m. The diameter of the barrows is relatively small, even in the highest ones not exceeding 20-25 m. The necropolises usually consisted of one or two 'big' barrow/s, the rest

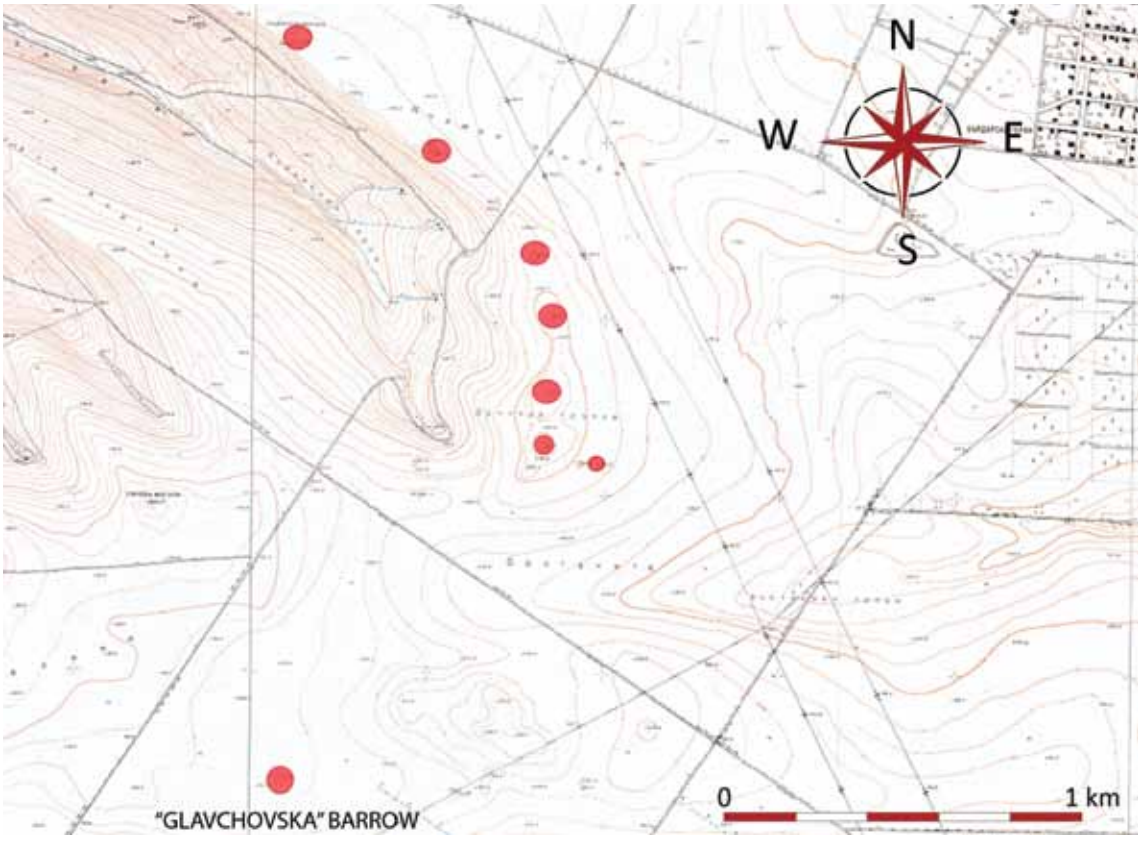


Fig. 3 – EBA barrow necropolis (no. 1) north of Tarnava with "Glavchovska barrow".
Map: https://map.bgmountains.org.

having an average (height around 1 m) or smaller dimensions. The number of graves in a barrow differs as well. The most significant number so far provided the 'Glavchovska mogila' near Tarnava, with ten EBA graves explored (fig. 4). It is worth mentioning that two barrows only – Tarnava-2 necropolis and Knezha, had only one EBA grave, the rest of the investigated ones had two to six graves: Tarnava-3 and Tarnak – two graves each; Manastirishte – three graves; Butan – four graves, and, Kriva bara – six graves (fig. 5). Currently, it is hard to establish a certain correlation between the dimensions of a particular barrow and the number of graves in it. For example, while Kriva bara barrow (0.5 m height) had six EBA graves, Knezha (1.4 m height) provided only one EBA grave. Considering the barrow construction, so far, in only two barrows, Tarnava – 'Glavchovska mogila' and Tarnak, additional piling of fills above some of the secondary graves has been observed.

Method of disposal

Twenty-four EBA graves provided inhumation as a method of disposal of the dead, and five graves – cremation outside the barrow area. The skeleton in Tarnak barrow, grave no. 1, had traces of burning of the lower limbs, but considering the fact that a Middle Age grave has partly destroyed the grave facility, it is not quite sure whether that burning was related to the EBA mortuary practices or to later ones.

Grave pits were rectangular, most with a depth around and less than 1 m. All grave pits east of Ogosta River were covered with wooden planks; from the 13 graves west of it, only one – the primary grave pit from Butan was covered. Tarnava, necropolis-1 barrow provided two elaborated grave facilities. The constructions, described as 'tombs', had rectangular shapes and approximately five meters in length of the walls. The walls were built of stones, the construction of the preserved ones (graves nos. 5 and 6) were covered with 5 – 6 m long wooden planks.

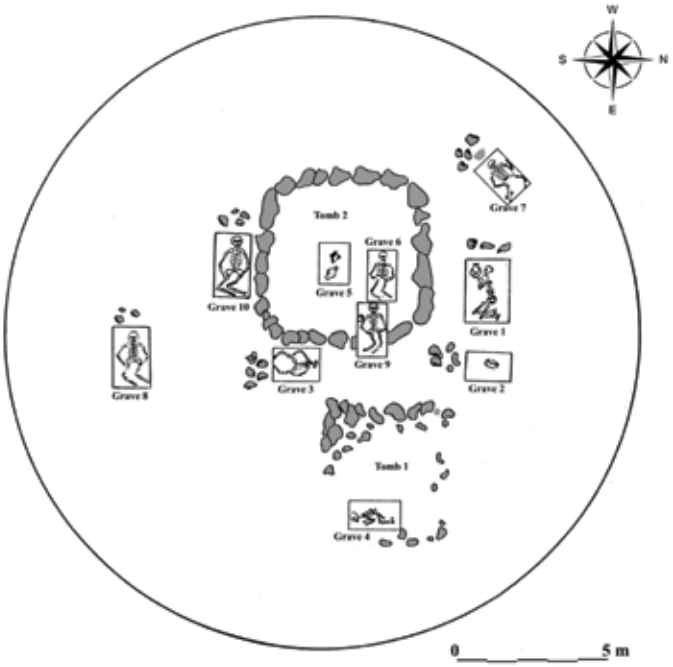


Fig. 4 – Tarnava, 'Glavchovska' barrow. Horizontal plan of the EBA graves. After Alexandrov 2019.

As mentioned above, in 24 graves the method of disposal was inhumation. All graves were single. The deceased were buried in anatomical order: in 20 graves, in supine/semi-supine position with flexed legs, and 3, in relaxed hocker position. In supine/semi-supine inhumations, the arms were placed alongside the body, slightly bent at the elbow or with palms at the abdomen/pelvis area or, rarely - at the chest; in relaxed 'hocker' inhumations - with palms in front of the face. The heads of the buried individuals in relaxed hocker positions were placed in the western sector. Of 20 graves with supine inhumation positions, 15 were with heads in the western sector, four – to the South and one – to the North. Thus, although the number of graves investigated is not considerable, a variety of the orientation of the bodies is to be noticed, with a predominance (75% of graves) of the western orientation. Considering the sex–age relation of the individuals in inhumation burials,[5] it should be mentioned that predominantly adult individuals were buried (in approximately 60% of the graves), the rest being infants or adolescent age groups. However, the presence of a primary grave with a child's burial in the Kriva bara barrow, as well as the central position of another child's burial (grave no. 3) from 'Glavchovska mogila' in Tarnava, draws attention. The ratio between male-female burials is approximately 2:1. Cremation was practised outside the barrow area. In four graves, the burnt bones were arranged at the bottom of the grave-pit. Only in Tarnava, necropolis-2 barrow, were they placed in a container – a clay vessel (fig. 8/3).

Grave inventory was found in ten graves (figs. 7 and 8). Personal adornments (metal hair-rings) were found in six inhumation graves: four made of gold (Tarnava 1, grave 8, Tarnava

[5] Only one cremation grave has been the subject of anthropological analyses so far.

3, grave 1 and Butan, feature no. 2), one made of silver (Tarnak, grave 2) and three made of copper (Tarnava 1, graves nos. 7 and 9). In two relaxed hocker graves and the two cremation graves from Tarnava, necropolis-1 'Glavchovska mogila' (graves nos. 1, 2, 4 and 5), clay vessels were placed. It should be mentioned as well that during the burial ceremony and piling of the barrow fills, vessels were ritually broken and scattered around the grave and in the fill (Tarnava, necropolis 1, 'Glavchovska mogila', near graves no. 3 and 7, for example). Animal bones, predominantly from *Bos taurus*, were also found around the graves and in the barrow fills. Finally, the use of red pigments in mortuary practices should be mentioned; the pigments were applied over the skull and long bones of the buried individuals or placed as lumps in the skull area.

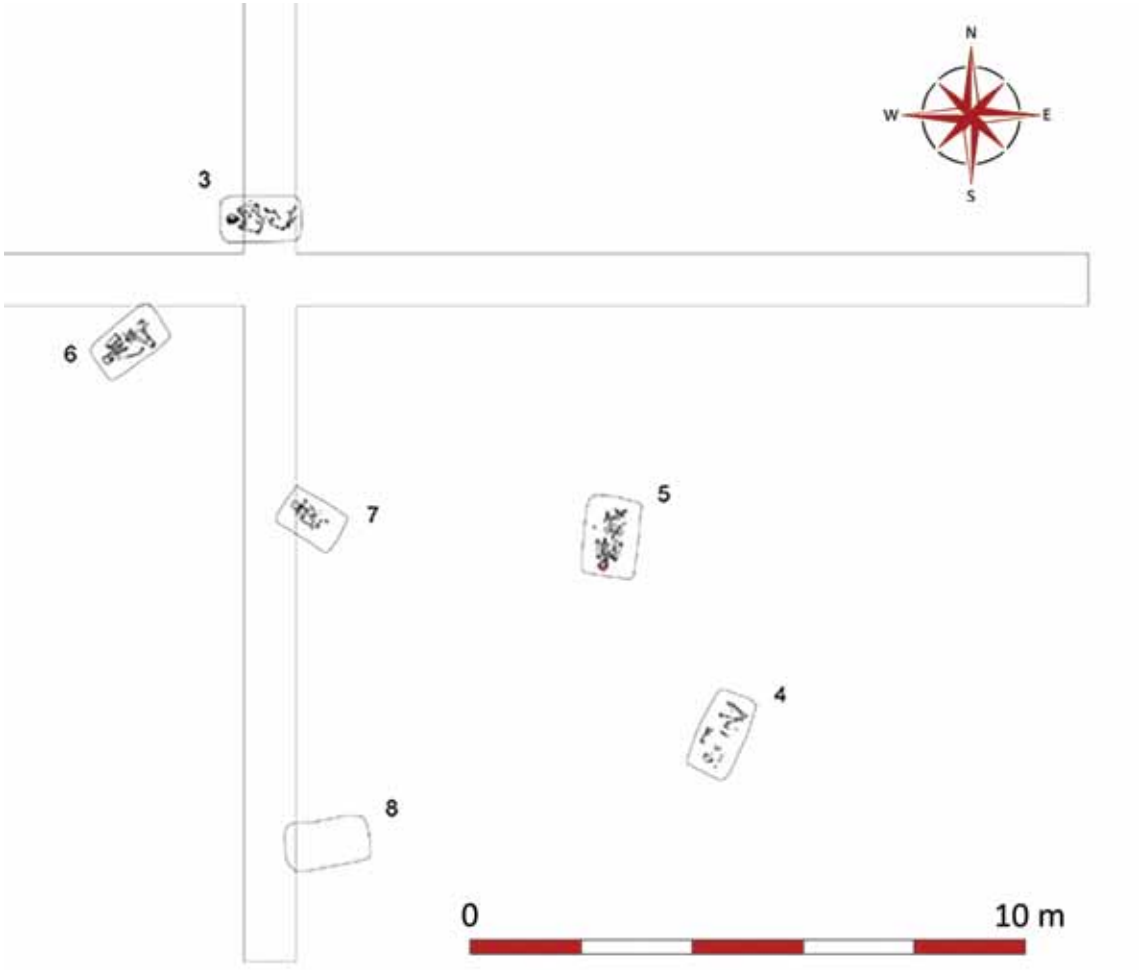


Fig. 5 – Kriva bara barrow. Horizontal plan of the EBA graves. Drawing Michał Podsiadło.

Stratigraphic observations and relative chronology

So far, 'Glavchovska mogila' from Tarnava, necropolis-1 and the barrow near Tarnak present the main stratigraphic sequence of the barrow graves in North-West Bulgaria. In both barrows, the primary was relaxed hocker inhumation graves, stratigraphically followed by supine inhumations with flexed legs and additional barrow fill piling. In Tarnava, relaxed hocker inhumation (grave no. 4) and a cremation grave (grave no. 2) also enter this group. In graves 1, 2, 4, 5 and

near grave 3, clay vessels were found, all bearing the characteristics of Coţofeni Culture, phases II-III pottery production[6]. Graves nos. 7-10 - dug into the existing barrow fills without additional piling (all - inhumations in supine position with flexed legs) form the latest stratigraphic group in 'Glavchovska mogila'. The grave inventory consists of a copper ring in grave no. 7, two copper hair rings in grave no. 9 and a golden hair ring in grave no. 8. A chronological position after Coţofeni Culture, phases III, in the EBA-3 period, '…*quite possibly to the very beginning*', was proposed for that group[7]. According to the pottery shapes published, such chronological position could have the graves from Altimir and Harlets as well (fig. 7/5, 6). In the rest of the barrows with two or more graves investigated, primary inhumations are in the supine position with flexed legs, followed by inhumations in the supine/semi-supine position.

Absolute chronology

So far, we have disposed of twelve radiocarbon dates from the three recently excavated barrows west of Ogosta River. The dates from Butan, Kriva bara and Manastirishte generally enter the chronological period between 2900 – 2600 cal BC. The cremation grave from Kriva bara is later dated around 2500 cal BC (fig. 6). Considering the chronological position of the Coţofeni Culture, phase III in North-West Bulgaria (radiocarbon dates from the sites from Gradets and Rasovo) is set in 3100 – 2900 cal BC period, Tarnava graves no. 1 to 6 should generally be positioned in the same time span[8].

Concluding for the chronological position of the barrow graves in the region. The earliest graves (inhumations in supine position with flexed legs and relaxed hockers as well as cremations) appear around 3100 cal BC. The 2900 – 2600 cal BC period presents inhumations in supine/semi-supine position with flexed legs and cremations. The latest grave (the cremation from Kriva bara) is dated around 2500 cal BC. It is not excluded that the relaxed hocker from Tarnak barrow dates earlier than 3100 cal BC, but this presumption needs additional arguments.

The connection of most of the graves to *Yamna* Culture is a common belief for the region investigated, presenting bi-ritualism and various positions of the skeleton in the inhumation graves. However, the Coţofeni Culture pottery in EBA-2 graves and in the fills suggests a co-existence of '*Yamna*' and local populations in different micro-regions during that period[9]. To understand the relations between the allochthonous steppe population and the autochthonous communities of the Coţofeni Culture, data from the period c. 3100–2900 cal. BC are crucial. However, for northwestern Bulgaria, we still do not have good confirmation for the early phase of the Yamna culture, which falls precisely in this time interval[10]. Typical burials of the early Yamna culture[11] seem to be presented by graves from Knezha and Tarnava, necropolis-3 (grave 2)[12]. Unfortunately, details of the burial rite and closer information on their stratigraphic position are unknown. It can only be assumed that in the case of the Tarnava 3, grave 2 (presenting a body position typical of the early Yamna culture) was primary, and grave 1 (with arrangement characteristic of the late Yamna culture) was a secondary burial in the barrow's body. In the

[6] Alexandrov 2019, 82-86.
[7] Alexandrov 2019, 87.
[8] Alexandrov 2023, 142.
[9] Панайотов 1989, 48-51.
[10] e.g., Preda-Bălănică et al. 2020, 87.
[11] for the Balkans – see Alexandrov, Włodarczak 2024, 314–317.
[12] Николов 1976, 50, fig. 17.

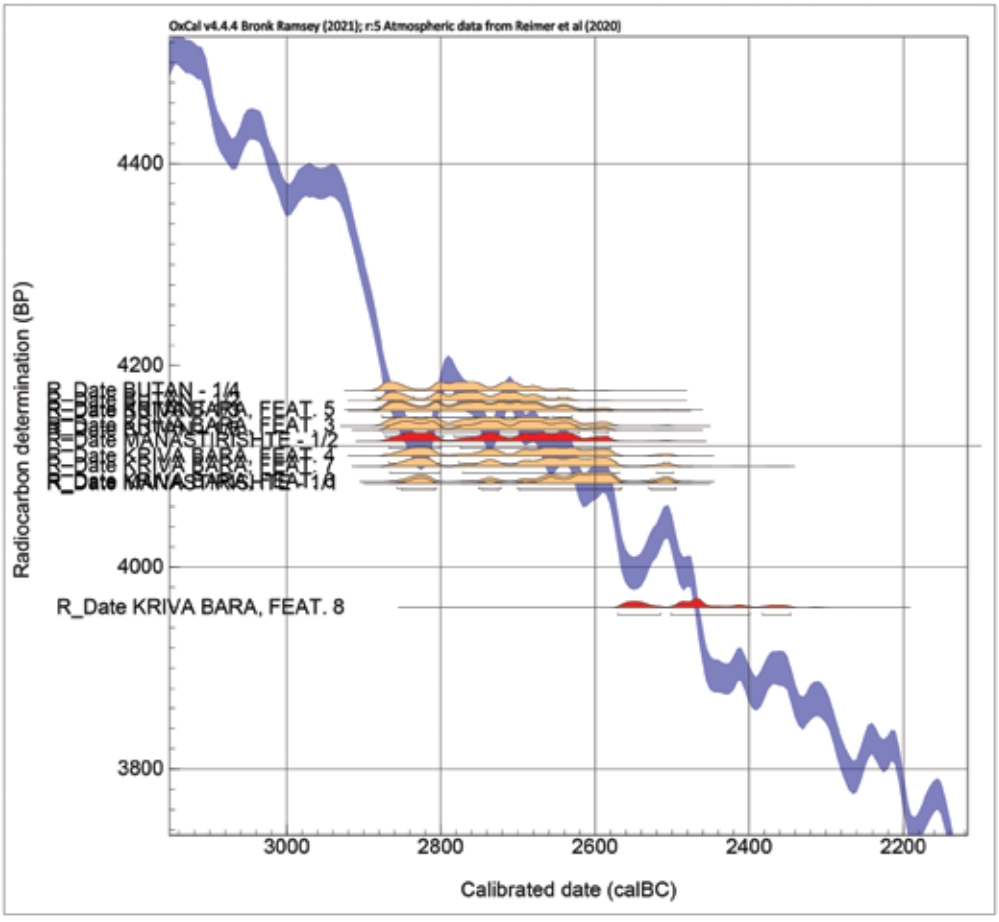


Fig. 6 – Radiocarbon dates from Butan, Kriva bara and Manastirishte graves. Illustrated by S. Alexandrov.

case of 'Glavchovska mogila', attention is drawn to the early stratigraphic position of graves 3 and 6, where the body was placed in a supine position. It is very likely that these burials date to the early Yamna phase and are associated with the stage of significant enlargement of the kurgan's size.

A clue to the contemporaneity of the Coţofeni and early Yamna rituals is the burial from Tarnava, necropolis-2. Cremated human remains were deposited there in a cord-decorated beaker – a vessel characteristic of the steppe people. An analogous example is a cremation burial discovered with a cord-ornanented amphora in 'Slatinska humka' near Srpski krstur in northern Banat[13]. The relationship between the ideological systems of the two mentioned communities could have led to the syncretisation of the burial rite. An example is the cremation burials in pits dug into barrows, dated to the 3rd millennium BC (Kriva bara, grave 8; Manastirishte, grave 2). In the case of the newly excavated barrows above the Ogosta River, the primary graves are dated to the interval c. 2900–2600 cal BC (Butan, grave 3; Kriva bara, grave 7; Manastirishte, grave 1 – fig. 9/3, 4). Since they occupy an earlier stratigraphic position than similarly dated graves dug secondarily into barrows' fills (fig. 9/1, 2), their age can be around 2900–2800 cal. BC, i.e. the transitional period between the early and late Yamna culture (simultaneously: EBA-2/EBA-3).

[13] Nadlački 1950.

EBA Barrow graves in North-West Bulgaria in a broader context

It is well known that in Prehistory, the cultural development in North-West Bulgaria is not to be distinguished from the one north of the Danube River. The EBA mortuary practices discussed here follow this 'rule', the morphological characteristics, and the chronological and spatial patterns of the barrow graves presented are to be seen in Oltenia (South-West Romania) as well. Recent investigations allowed two cultural and chronological phases in the development of the 'barrow mortuary practices' to be distinguished. The earlier one, the *Coțofeni phase, is presented by the graves from Basarabi, Cârna and Suharu,* all with Coțofeni pottery assigned to the third phase of the culture. Such graves appear further north, in Transylvania as well[14]. This '*…phase of graves with Coțofeni pottery*' was generally dated between 3300 and 2900 cal BC[15]. However, recent investigations in Transylvania allowed the timespan of the Coțofeni III phase to be placed between 3100 and 2900 cal BC, which fully corresponds to the Bulgarian dates presented here.



Fig. 7 – EBA golden hair-rings from barrow graves in North-West Bulgaria. 1 – Tarnava - necropolis no. 1, barrow 1, grave 8 (= Alexandrov 2019, Pl. X/3); 2 – Butan, barrow 1, grave 2; 3-4 – Tarnava - necropolis no. 3, barrow 3, grave 1 (= Alexandrov 2019, Pl. IV/1,2). No scale. Photo Krassimir Georgiev.

The second stage, the Yamna phase, presented inhumation graves in a supine position with flexed legs. Grave inventory consisted of metal hair rings and pottery related to the local Glina environment. The graves from this phase were related to the *'...standardized Yamna burial ritual*'. Two radiocarbon dates (from Plenița/1950, Rast-Măgura Barbului) set this phase in the 2900 – 2600 cal BC period, covering '*…the second phase of the Yamna presence in south-eastern Europe'*[16].

Studies of materials from Vojvodina[17] and the Romanian Banat[18] also indicate a chronological sequence of changes in the barrow burial rite similar to that in northwestern Bulgaria. On

[14] Diaconescu 2020.

[15] Preda-Bălănică et al. 2023, 23-24.

[16] Preda-Bălănică et al. 2023, 24-26.

[17] Włodarczak 2021.

[18] Gogâltan 2021.



Fig. 8 – EBA pottery from barrows in North-West Bulgaria. 1 – Tarnava - necropolis no. 1, barrow 1, grave 1 (= Alexandrov 2019, Pl. VI/3); 2, 4 – Traykovo, stray find (= Alexandrov 2018, Pl. X/3); 3 - Tarnava - necropolis no. 2, barrow 1, grave 1 (= Alexandrov 2019, fig. VII/9); 5 – Altimir, stray find (= Alexandrov 2019, Pl. X/11); 6 – Harlets, stray find (= Alexandrov 2019, Pl. X/9). No scale. Photo Stefan Alexandrov.

the western side of the Iron Gate, in Banat, at the end of the 4th millennium BC, examples of cremation burials appear, although – so far – they are poorly documented (Mokrin, 'Arađanska humka'; Srpski krstur, 'Slatinska humka'). Cremations are also present in the ritual from the first half of the 3rd millennium BC, as well shown by the Batajnica, 'Velika humka' and Vojka, 'Humka kod Velikog Begeja' kurgans in Srem[19]. Similarly to northwestern Bulgaria, no classic burials of the early Yamna phase have been discovered so far. On the other hand, narrow primary graves referring to the tradition of 'extended inhumations' have been dated to the period 3100–2900 cal BC (Padej, 'Humka u Barnahatu', grave 2; Šajkaš, Ciganska humka, grave 2)[20]. On the other hand, the grave from Vojlovica, Rafinerija nafte, shows features of the end of the late phase/beginning of the early phase of the Yamna culture. Most of the barrow burials from Vojvodina show features of the late Yamna culture (e.g. graves from Jabuka, 'Tri humke', Perlez, Vuna or Žabalj, Med-

[19] Spasić 2016.

[20] Włodarczak 2021, 225–227.

isova humka), which is confirmed by absolute dating[21]. The difference – compared to the area of northwestern Bulgaria – is the lack of barrows with numerous burials in Vojvodina. Only two graves were discovered in relatively large barrows, such as Šajkaš, Ciganska humka or Žabalj, Medisova humka. Considering the still insufficient state of research, one can indicate a tendency for fewer burials in barrows from the Pannonian Plain compared to the area located east of the Iron Gate.

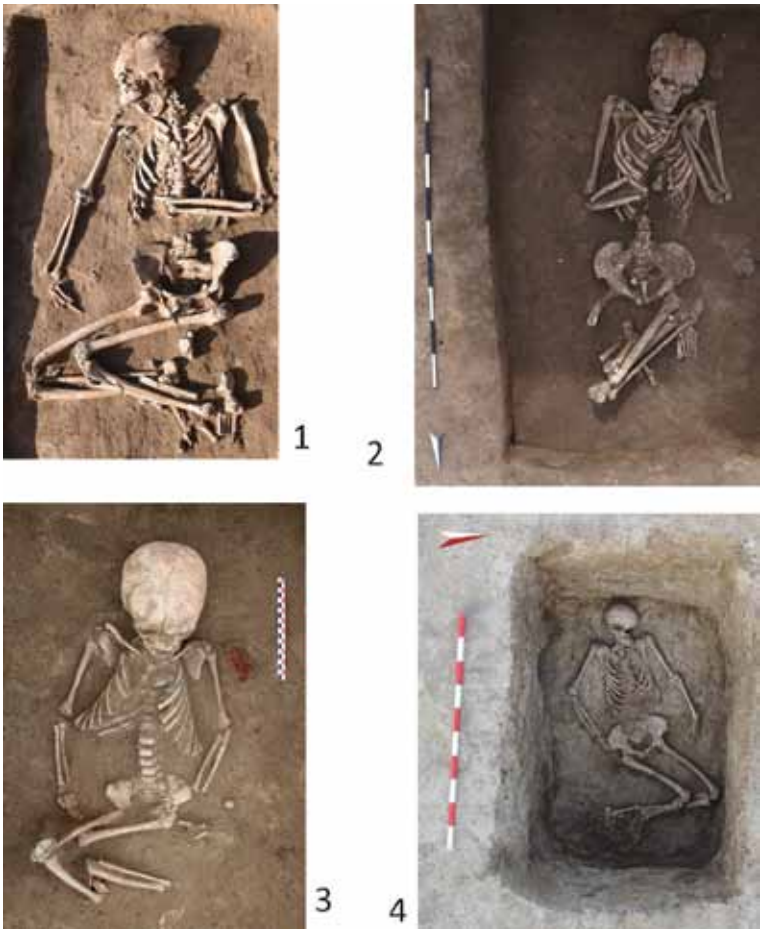


Fig. 9 – EBA barrow graves from North-West Bulgaria. 1 – Kriva bara, grave no. 6; 2 – Kriva bara, grave no. 5; 3 – Kriva bara, grave no. 7; 4 – Manastirishte, grave no. 1. Photo Michał Podsiadło.

Conclusion

The excavations carried out in 2023-2024 on three barrows near Kozloduy are a good addition to the knowledge of barrow burial rites in northwestern Bulgaria. The first radiocarbon dating results for this area were also obtained. All newly discovered graves are dated to the first half of the 3rd millennium BC. Most of them show features of the late Yamna culture rite. The examples of cremation graves dug into the mounds are noteworthy. They represent a continuation of the tradition of cremation present in the barrows of the Coţofeni culture, dated to around 3100-2900 cal BC (Tarnava, 'Glavchovska mogila'). The above-mentioned period also defines the earliest currently recognised barrow horizon in northwestern Bulgaria. In this period, the kurgans of the steppe tradition (early Yamna) were contemporary with the kurgans of the local Coţofeni culture. Such cohabitation became the reason for mutual borrowings in the funeral rituals of both cultural systems. This influences the diversity of features of the funeral rite recorded in the barrows from both the 4th and 3rd millennium BC.

[21] Włodarczak 2021, 230–244.

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Mobility and Trade: Long-distance Connections in the western part of the Carpathian Basin at the dawn of the 2nd Millennium BC

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Abstract: At the beginning of Central European Early Bronze Age, parallel with the final phase of the Early Bronze Age in Hungary, during the turn of the 3rd and 2nd millennium BC (between 2200–2000/1900 BC), the population groups of the Kisapostag or earliest Encrusted Pottery culture settled down in Western Hungary. The paper summarizes the former and recent studies of this population, based on typochronology, radiocarbon dating and a new bioarchaeological case study, including aDNA and strontium isotope analyses of the cemetery excavated at Balatonkeresztúr. Results of the re-analyses of a high status male burial of the same population, discovered in the 1960s at Balatonakali are completed here by non-destructive metal analyses of his bronze tools and gold hair ring, suggesting connections with the elite of the Aunjetitz/Únětice culture.

Key words: Early Bronze Age, Carpathian Basin, bioarchaology, metal analysis

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Introduction

This paper present case studies which provide important information concerning trade connections and population movements in modern-day Western and Central Hungary during the turn of the 3nd and 2nd Millenium BC. The studies were conducted by the research project entitled "From bones, bronzes and sites to society" and launched in 2015, due to the support of the Momentum programme of the Hungarian Academy of Sciences.[1] The aim of our Momentum Mobility Research Group was to gain a better understanding of the transformation of the societies living during the first thousand years of the Bronze Age in the Carpathian Basin by multidisciplinary methods. Three main topics were integrated: bioarchaeology of cemeteries, archaeometallurgy of bronze finds and analyses of settlement network and hierarchy. The presented case studies concern interactions in the period of the Early and the Middle Bronze Ages, according to Hungarian terminology, contemporaneous with the Central European Early Bronze Age (Fig. 1).[2]

cal BC	Central Europe	Hungary	Western Hungary	Danube River region	Eastern Hungary
1500/1450	RB B	MBA 3	Encrusted Pottery (Balatonkeresztúr) Gáta-Wieselburg II	Vatya	Füzesabony-Gyulavarsánd/ Otomani Hatvan Maros
	RB A2	MBA 2			
2000/1900		MBA 1			
	RB A1	EBA 3	Kisapostag (Balatonakali, Balatonkeresztúr) Gáta-Wieselburg I	Late Nagyrév Kisapostag	Late Nagyrév Hatvan Nyírség/Szaniszló Otomani I Maros
2200/2100					
2300/2200	RB A0	EBA 2	Late Somogyvár/Proto Kisapostag Somogyvár-Vinkovci	Bell Beaker Late Makó Proto and Early Nagyrév	Late Makó Nyírség Early Nagyrév Early Maros
2500/2400	Eneolithic	EBA 1	Late Vučedol/Early Somogyvár-Vinkovci	Makó	Makó

Fig. 1 – Overview of Early and Middle Bronze Age chronology and cultures/groups in Hungary with the case studies mentioned in the text (modified after P. Fischl et al. 2015, Fig. 1b).

Early Bronze Age population movements

At the beginning of Central European Early Bronze Age, parallel with the final phase of the Early Bronze Age in Hungary during the turn of the 3rd and 2nd millennium BC (between 2200–2000/1900 BC), the population groups of the Kisapostag or earliest Encrusted Pottery culture settled down in Western Hungary.[3] This culture was first described by its pottery decoration characterised by the imprints of a thin "reeled stick" (animal hair coiled up a bone or wooden stick). This technique was represented on vessels in wide bands during the later phase of the culture.[4] The 1st phase of this pottery style was described as reeled stick decoration without encrustation by István Torma, while the 2nd phase characterized by reeled stick decoration with encrustation, and the appearance of this technique in wide bands (the so called "rolled stick" technique) was

[1] Kiss 2016.
[2] P. Fischl et al. 2013; P. Fischl et al. 2015.
[3] P. Fischl et al. 2013; P. Fischl et al. 2015.
[4] Mozsolics 1942.

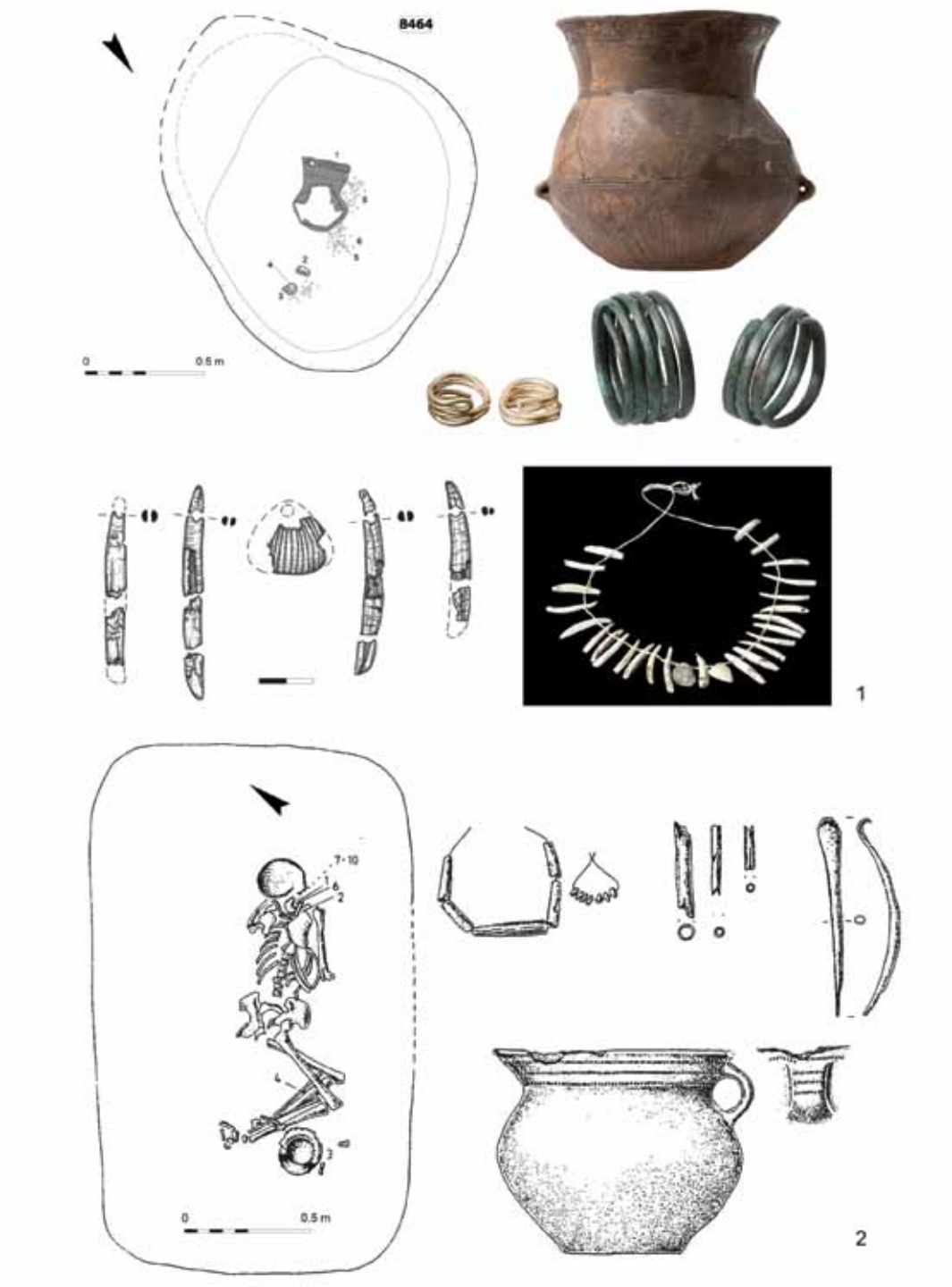


Fig. 2 – 1. Győr-Ménfőcsanak-Széles-földek, Feature 8464 (after Melis 2014);
2. Kaposvár-Road 61/Site 14. Feature 9 (after Bárdos 2000).

identified as the 3rd development phase of the Kisapostag culture.[5] New publications suggest to use "string-wrapped stick imprint" technique for this pottery decoration.[6] Recently the Kisapostag type pottery is also mentioned as the earliest Encrusted Pottery style.[7]

[5] Torma 1972; Torma 1978; see also Vicze 2011; Kiss 2012; Melis 2023, Tab. 1.

[6] Melis 2023.

[7] Szabó 2010; Kiss et al. 2019.

This special decoration technique was originated from the Middle Dnieper culture, the formative phase of the Corded Ware culture, dated between 2800 and 1800 BC,[8] from where population groups headed west following the northern side of the northwestern Carpathians. Epi-Corded Ware (Chłopice-Veselé or Nitra) groups were also mentioned as the original source of this decoration technique.[9] Similarities and differences of the Kisapostag type decoration and the twisted cord impressions of the contemporaneous Litzenkeramik was recognised, too.[10]

Former research associated the practice of urn cremations with the Kisapostag culture nearly exclusively,[11] along with a very few inhumations. In the last decades, in addition to urn burials and scattered cremations, larger amount of inhumation burials of this population has been documented (Fig. 2).[12] Today we have knowledge of about nearly one hundred inhumations.[13] The results of new excavations and radiocarbon dating prove that the dominant burial tradition in the earlier phase was inhumation, often without pottery or other remaining grave furnishing (Fig. 2. 2; Fig. 3). This period can be dated between the 22nd and the 20th century BC.[14] In a later period of the culture, around 1900 BC cremation began to be practiced and became dominant.[15]

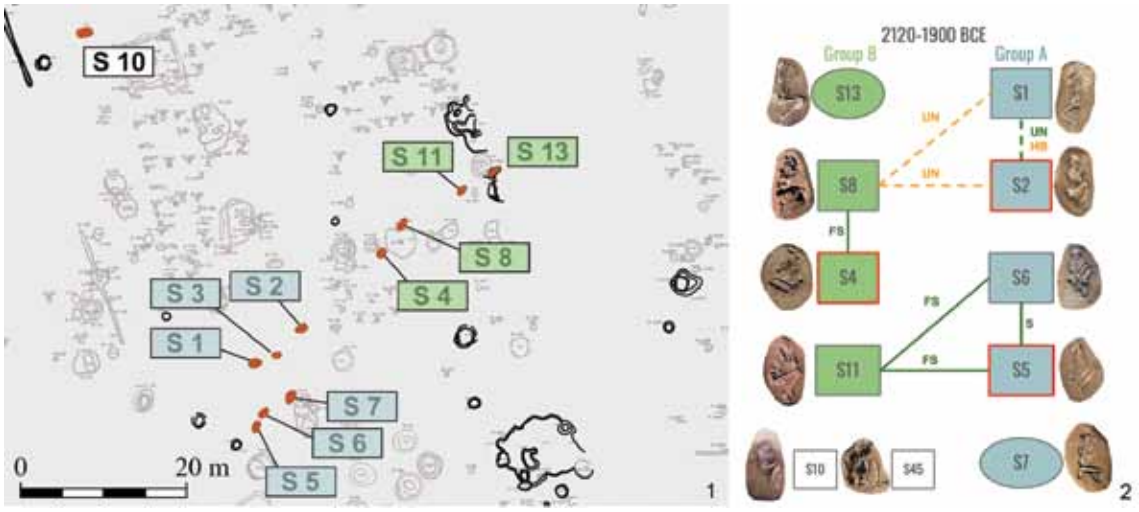


Fig. 3 – 1. Balatonkeresztúr-Réti-dűlő Early Bronze Age burials, 2. results of kinship analysis of the Early Bronze Age grave groups (solid lines represent first degree, dashed lines second degree relationships; green line represents proven, orange unproven but possible relationships; FS: father–son, UN: uncle–nephew, S: siblings, HB: half brother; after Kiss et al. 2023).

In a recent case study, an Early Bronze Age cemetery of the Kisapostag culture from Balatonkeresztúr, discovered in the southern side of lake Balaton, with 11 inhumation burials was investigated. According to the results of radiocarbon analyses the cemetery was used between 2120–1900 BC. The aDNA results draw attention to the fact that the Kisapostag or earliest Encrusted Pottery population had an outstandingly high (up to ~47%) Mesolithic hunter–gatherer genetic ancestry level, compared to other Bronze Age groups of the region. The origin of this genetic ancestry can be traced back to regions in Eastern Europe, such as today's Ukraine, Molda-

[8] Bóna 1961; Nordqvist–Heyd 2020.

[9] Bándi 1984.

[10] Patay 1938, 38; Neugebauer 1994, Abb. 77; Črešnar 2010; Kiss 2015; Leghissa 2015.

[11] Torma 1972; Szathmári 1983; Somogyi 2004; Melis 2013.

[12] Honti 1996; Pásztor 1993; Bárdos 2000; Somogyi 2004; Szabó 2010.

[13] Kiss 2020.

[14] Kiss et al. 2015; Hajdu et al. 2016; Szabó 2017; Kiss et al. 2019; Melis 2024.

[15] Kiss et al. 2015; Hajdu et al. 2016; Szabó 2017; Cavazzuti et al. 2022; Melis 2024.

via, Romania or Belarus.[16] This result is in line with the above mentioned, former archaeological assumptions based on the so-called "reeled stick" or "string-wrapped stick impression" pottery decoration technique, which was originated from the Eastern European Corded Ware groups of the Middle Dnieper area.[17] The newcomer population was settled down in Transdanubia around 2200 BC. The aDNA study also revealed that grave groups were established along family relationships, and kinship was arranged by patrilinear social structure (Fig. 3). This is supported by more various mitochondrial haplogroups compared to Y-chromosome haplogroups, as an evidence of female exogamy. Radiogenic strontium isotope data of the dental enamel samples of the individuals were consistent with local values of the biologically available strontium ratio. Based on these data we can suppose that inhabitants of this settlement, buried in two grave groups, do not represent the first generation of the newcomers and that exogamy may have been limited in distance, most probably occurred between communities of the same population living in distant villages but within similar environmental conditions.[18]



Fig. 4 – 1. Reconstruction of the burial from Balatonakali (the skeletal remains are marked in brown, while bones with traces of patina on them are green (graphic by Zsolt Réti); 2. gold hair ring, 3. bronze and pottery grave goods of the burial (photos by Péter Hámori).

Interactions at the turn of the 3rd and the 2nd Millennium

Re-analyses of the high status male burial of the same population, discovered in the 1960s at Balatonakali, in the northern side of Lake Balaton also provide interesting data concerning trade networks. According to AMS radiocarbon dating, the 55–60 year-old male was buried at the beginning of the 2nd Millennium (DeA-8219: 3579±20 BP; 1950–1900 cal BC, 68%; 1975–1885 cal BC, 95.4%).[19] Based on the dagger, axe, flanged axe, awl and spiral bracelet, as well as a heavy, 16 g gold hair ring *(Lockenring)* the grave can be interpreted as the burial of a high status male (Fig. 4).[20]

[16] Gerber et al. 2023; see also Chyleński et al. 2023.

[17] Bóna 1961.

[18] Gerber et al. 2023; Kiss et al. 2023, Fig. 3-7.

[19] Kiss 2020

[20] Torma 1978; Kiss 2020.

Non-destructive prompt gamma activation analysis (PGAA) experiments were performed at the PGAA facility of the Budapest Neutron Centre[21] on four metal objects from the Balatonakali burial to determine their bulk alloy composition. The PGAA experiments followed the protocol described earlier in more detail.[22] Neutron slit was set to 5–44 mm^2 to have moderate count rate while collecting the spectra, and the spectrum acquisition time was between 3000 and 6000 seconds. Spectrum evaluation was completed using Hypermet PC[23] and PeakFit[24] software, the quantitative analysis was performed using the ProSpeRo program[25] and was based on the PGAA nuclear data library.[26] PGAA results revealed that the material of the dagger, axe, flanged axe and awl of the Balatonakali burial contain 5.6–11 wt% tin, with other elements, such as antimony, arsenic and silver (Table 1; Fig. 5). Nickel was not detected in the samples, its detection limit was 0.07 wt% with the present measurement conditions. Significant amount of chlorine was detected at two different parts of the dagger, close to the hole of the rivets, and the upper part of the awl (Table 2). This may indicate still ongoing corrosion processes within the metal.



Fig. 5 – Location of PGAA experiment on four artefacts of the Balatonakali burial (photo: Péter Hámori, analyses data: Boglárka Maróti).

According to the results the weapons and tools of this high status male burial are among the first real tin bronze artefacts of the Carpathian Basin, which appeared around 2000 BC in Europe.[27] The antimony, arsenic and silver component of the copper raw material suggest connections with the copper sources of the Garam/Hron Valley and Spiš–Gemer Ore Mountains, which was a widespread raw material in the period under study.[28]

[21] Szentmiklósi et al. 2010; Szentmiklósi et al. 2016
[22] Maróti et al. 2018.
[23] Révay et al. 2005.
[24] Szentmiklósi 2018.
[25] Révay 2009.
[26] Révay et al. 2004.
[27] Pare 2000; Kiss 2020.
[28] Duberow et al. 2009; Kiss et al 2009; Kiss 2020.

		Cu		Sn		Ag		As		Sb	
		D.L. (1.0)		*D.L. (1.5)*		*D.L. (0.02)*		*D.L. (0.15)*		*D.L. (0.6)*	
Inv.nr.	**Measured part**	**m%**	±	**m%**	±	**m%**	±	**m%**	±	**m%**	±
65.408.5	special axe, close to the blade	**89.0**	*0.4*	**8.3**	*0.3*	**1.10**	*0.06*	**0.40**	*0.04*	**1.0**	*0.2*
65.408.5	special axe, socket	**90.0**	*0.3*	**7.3**	*0.3*	**1.11**	*0.04*	**0.45**	*0.04*	**0.7**	*0.2*
65.408.6	axe, edge	**94.0**	*0.3*	**5.6**	*0.3*	**0.32**	*0.01*	<D.L.		<D.L.	
65.408.2	socketed awl, edge	**92.0**	*0.3*	**7.7**	*0.3*	<D.L.		<D.L.		<D.L.	
65.408.2	socketed awl, upper part	**91.4**	*0.4*	**8.4**	*0.4*	<D.L.		<D.L.		<D.L.	
65.408.4	dagger, fragmented blade	**89.4**	*0.4*	**10.3**	*0.4*	**0.08**	*0.007*	<D.L.		<D.L.	
65.408.4	dagger, upper part, close to the handle	**89.0**	*0.4*	**10.9**	*0.4*	**0.09**	*0.007*	<D.L.		<D.L.	

Table 1 – Results of non-destructive PGAA analyses of the bronze finds of the Balatonakali burial (by Boglárka Maróti).

		Cl		H	
		D.L. (0.01)		*D.L. (0.005)*	
Inv.nr.	**Measured part**	**m%**	±	**m%**	±
65.408.5	special axe, close to the blade	<D.L.		**0.049**	*0.002*
65.408.5	special axe, socket	<D.L.		**0.083**	*0.003*
65.408.6	axe, edge	<D.L.		**0.028**	*0.002*
65.408.2	socketed awl, edge	<D.L.		**0.009**	*0.002*
65.408.2	socketed awl, upper part	**0.160**	*0.006*	**0.048**	*0.002*
65.408.4	dagger, fragmented blade	**0.210**	*0.005*	**0.096**	*0.004*
65.408.4	dagger, upper part, close to the handle	**0.190**	*0.006*	**0.090**	*0.003*

Table 2 – Results of non-destructive PGAA analyses of the bronze finds of the Balatonakali burial (by Boglárka Maróti).

The grave furniture show links with the second and third level of the reconstructed Únětice social pyramid.[29] The gold hair ring is also similar to the *Lockenring* discovered in the burial of the Helmsdorf chief (Fig. 6), who was buried a bit later, around 1840 BC, while the Leubingen chief had another type hair ring, the so-called *Noppenring*.[30] The large stone slabs covering the burial of the Balatonakali burial may have had a similar role, to sign the prominent position of the leader, as the wooden and stone burial chambers built over the chiefly graves of the Únětice culture.

The gold hair ring with its weight of 16 grams is outstanding among the hair ring finds from Hungary, weighing usually 2-3 grams. The combined weight of the four hair rings from Grave 55 of the Nagycenk cemetery of the Gáta–Wieselburg culture (Western Hungary), weighing 12.6 g, or the 10 g weight of the gold pectoral disc from Beba Veche (Romania) burial 'B' can be mentioned as a comparison from burials.[31] In larger gold assemblages, e.g. in the hoard

[29] Meller 2019.

[30] Kiss 2012; Meller 2014; Meller 2019.

[31] P. Fischl–Kulcsár 2011; Gömöri et al. 2018.

excavated at the tell-settlement of Jászdózsa-Kápolnahalom (Eastern Hungary) the hair rings are also of lower weight, they are between 1.7 g and 9.6 g; the whole assemblage with 37 gold hair rings, 30 small gold studs and one gold disc altogether weighing a bit more than 150 g.[32] The Balatonakali hair ring also occupies a prominent place even when compared to the gold finds of the Aunjetitz/Únětice culture burials from Germany: larger amount of gold finds are found only in three princely graves[33] and in the Nebra hoard.[34] Gold hair rings of similar type are concentrated in the wider area of the Carpathian Basin, so the place of their production was probably within this region.[35] The non-destructive metal analyses of the gold hair ring from Balatonakali, provided by the PIXE facility of the Laboratory for Heritage Science of ATOMKI,[36] revealed that it was made of high purity (94 ± 1 %) gold; in addition to 4.4 ± 0.1 % silver, and other trace elements: copper in 2040 ± 50 ppm, iron in 1010 ± 40 ppm, nickel in 60 ± 18 ppm, and arsenic in 120 ± 40 ppm. It is a remarkable coincidence that the gold hair rings of the princely burials in Leubingen and Helmsdorf have similar, 92 and 93% gold content, however the ratio of minor and trace elements are different from the Balatonakali *Lockenring*: beside 6.6-6.8% silver, various amounts of copper between 0.9 and 0.79%, and iron between 46 and 350 ppm were detected.[37] This type of gold with silver content below 10% can be associated with Hartmann's *Berggold* or native gold, and B group. The silver content varies largely between 8 and 49 wt% in the Transylvanian ore deposits,[38] but usually these gold sources are characterized by 20-30% silver content, which is the most frequent material of Bronze Age gold finds in the Carpathian Basin.[39] So the small concentration of silver suggest that this gold raw material probably cannot derive from the sources of the "Golden Triangle" of the Transylvanian Ore Mountains (Romania). More detailed trace element and isotopic analyses are needed to determine where exactly the raw material of the Balatonakali chiefs's hair ring comes from, considering the numerous European gold ore deposits.[40]



Fig. 6 – 1. Gold hair rings from Helmsdorf, 2. Balatonakali (1. modified after Meller 2019, Fig. 4; 2. photo by Péter Hámori).

Summary

Bioarchaeological studies, as well as metal analyses all confirm that the period of the 2nd Millennium BC in the Carpathian Basin and Central Europe was characterized by various connections: from individual and group mobility, connected to female exogamy, to trade relations. The exploitation of copper ore deposits in the Garam/Hron Valley and Spiš–Gemer Ore Mountains in the north-western Carpathian mineral associations were significant driving force of exchange

[32] Kiss et al. in print.
[33] Dieskau, Leubingen, Helmsdorf.
[34] Meller 2014.
[35] Hänsel–Weihermann 2000; Meller 2014.
[36] Török et al, 2015.
[37] Lockhoff–Pernicka 2014.
[38] Hartmann 1968, Abb. 4; Tabelle 2; Hartmann 1970, 41; Lehrberger 1995, 135-137; Csedreki et al. 2010, 45; Pop et al. 2011; Lazarovici et al. 2015.
[39] Dani–Kiss 2024; Szathmári et al. 2024; Dani et al. in print.
[40] Lehrberger 1995; Borg et al. 2019.

network in the region.[41] Based on new results due to the analyses of the Magyaregres hoard the extraction of this fahlore metal may have developed by the turn of the fifth-fourth millennia, during the Middle Copper Age in Hungary,[42] and in the 2nd Millennium it became the most important trade item in Central Europe, reaching the western part of the Carpathian Basin[43] and even northern Europe and Scandinavia.[44] In this exchange system amber[45] and gold may have been an important commodity, too. As we have seen life histories of Bronze Age individuals can reveal a more detailed understanding of network relations between various regions of Europe.

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[41] Duberow et al. 2009; Radivojević et al. 2018; Guba et al 2024.

[42] Siklósi et al. 2022.

[43] Duberow et al. 2009; Kiss 2009.

[44] Nørgaard et al. 2019, Fig. 2; Brozio et al. 2023, Fig. 8; Ling et al. 2023.

[45] Jaeger et al. 2023.

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Arheolozi u svojim istraživanjama najčešće klasifikuju nalaze keramike na osnovu stila, boje, oblika i teksture. Međutim, u nauci o materijalima je opšte prihvaćeno da su karakteristike nekog predmeta određene njegovim sastavom i strukturom što je rezultat korišćenih polaznih sirovina i primenjenog procesa proizvodnje. Dakle, mikro-hemijska i mikro-strukturna analiza arheoloških artefakata može dati informacije o tehnologiji proizvodnje, a u širem kontekstu i o razvoju društva, migracijama, interakcijama između naseobina, itd. Dodatno, poznavanje sastava i strukture predmeta je od izuzetne važnosti pri rešavanju problema restauracije, konzervacije, datiranja i utvrđivanja autentičnosti umetničkih predmeta.

Arheometrija, kao interdisciplinarna naučna oblast koja podrazumeva primenu metoda prirodnih nauka za ispitivanje arheoloških artefakata, na Fakultetu za fizičku hemiju Univerziteta u Beogadu ima tradiciju dugu dve decenije. U obrazovnom procesu je zastupljena od 2008. godine kroz izborni predmet "Fizičkohemijske metode u arheometriji" na master akademskim studijama. Mada interesovanje studenata za predmet nije veliko, svega deset studenata je do sada položilo ovaj ispit, interesovanje za ovu oblast naučnih istraživanja postoji. Do sada je na Fakultetu za fizičku hemiju Univerziteta u Beogadu odbranjeno ukupno 22 diplomska rada sa temama iz arheometrije, od toga je 9 radova odbranjeno u periodu 2014-2024. godina. Ukupno je odbranjeno i pet master radova koji se bave istraživanjima iz ove oblasti, od čega jedan u periodu od 2014. godine. Takođe, nastavnici Fakulteta za fizičku hemiju angažovani su kao predavači na studijskom programu Konzervacija i restauracija integrisanih akademskih studija Fakulteta primenjenih umetnosti, Univerziteta umetnosti u Beogradu na predmetima Primenjena hemija u konzervaciji i restauraciji i Metode konzervatorskih ispitivanja.

Rezultati naučno-istraživačkog rada grupe za arheometriju Fakulteta za fizičku hemiju Univerziteta u Beogadu do sada su objavljeni u ukupno 15 radova u međunarodnim naučnim časopisima na kojima su ili prvi ili autor za korespondenciju sa Fakulteta za fizičku hemiju, od čega je 12 radova publikovano u periodu 2014-2024. godina. Pored toga u poslednjoj deceniji su nastavnici sa Fakuleta za fizičku hemiju održali četiri predavanja po pozivu na međunarodnim naučnim konferencijama iz ove oblasti. Rezultati istraživanja su saopšteni u formi izvoda na ukupno 19 međunarodnih i 7 nacionalnih naučnih konferencija, od čega je 6 saopštenja u periodu od 2014-2024. godine. Arheometrijska istraživanja se uspešno realizuju u bliskoj saradnji sa Arheološkim institutom u Beogradu, Narodnim muzejom u Beogradu, Rudarsko-geološkim fakultetom Univerziteta u Beogradu, Institutom za nuklearne nauke "Vinča" Univerziteta u Beogradu i Fakultetom primenjenih umetnosti Univerziteta umetnosti u Beogradu. Uz uspešno uspostavljenu saradnju sa nacionalim institucijama, razvija se i saradnja sa institucijama iz inostranstva. Jedna od aktivnosti u okviru međunarodne saradnje je učešće na projektu"SMACH – Sustainable Management of Cultural Heritage in the Balkans in response to Climate Change. Best practices for adaptation and intercultural cooperation". (Ref. No. 304.4.41-20), CEI Know-how Exchange Programme (KEP), 1. februar 2021. – 31. januar 2022. godine, na kojem su članovi arheometrijske grupe bili koordinatori Univerziteta u Beogradu. Realizacija projekta je bila uspešna pa se saradnja nastavlja kroz projekat "EU-SEE forum for intercultural exchange on Sustainable MAnagement of Cultural Heritage - SMACH forum". (Ref. No. 304.4.2023.051), CEI Know-how Exchange Programme (KEP), 1. april 2024. – 31. oktobar 2025. godine.

Predmet naučno-istraživačkog rada grupe za arheometriju su identifikacija pigmenata i tehnika izrade slika na platnu, ikona slikanih na drvetu i na platnu, zidnih freski, kao i keramički

ulomci iz praistorijskog perioda. Za istraživanja se primenjuje multianalitički pristup, odnosno kombinovanje rezultata dobijenih većim brojem tehnika kao što su optička mikroskopija, difrakcija X-zračenja na prahu, rendgenska fluorescentna analiza, induktivno spregnuta plazma povezana sa masenom spektrometrijom, skanirajuća elektronska mikroskopija sa energetski desprzivnom analizom X-zračenja i multivarijantna statistička analiza. Ovaj pristup primenjen je za sistematsku karakterizaciju srednjevekovne keramike kao i keramike iz ranog modernog doba nađenoj na teritoriji Republike Srbije. Cilj istraživanja je bio određivanja porekla, tehnologije izrade, uticaja susednih zemalja i specifičnih karakteristika različitih radionica. Ukupno je analizirano 134 uzorka glaziranih i neglaziranih keramičkih ulomaka, koji datiraju od XII do XV veka, sa arheoloških nalazišta tvrđava Ras, tvrđava Novo Brdo, Beogradska tvrđava i manastir Studenica koji je UNESCO proglasio svetskom baštinom.[1] Potvrđena je lokalna proizvodnja u srednjevekovnoj srpskoj državi koja je bila pod jakim uticajem vizantijskog stila u proizvodnji keramike. Takođe, do sada je okarakterisan ukupno 81 uzorak keramike iz ranog modernog doba (XVII i rani XVIII vek) nađenih na Beogradskoj tvrđavi, i to 50 uzoraka glazirane bojene keramike[2] i 6 keramičkih ulomaka boca austrijskog stila, kao i 25 keramičkih ulomaka nastalih pod osmanskim uticajem. Rezultati ovih istraživanja analiziraju se u bliskoj saradnji sa arheolozima i geolozima i doprineće boljem razumevanju prošlosti kao i promociji našeg izuzetnog kulturnog nasleđa u svetu.

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[1] Damjanović 2011, Damjanović 2016, Damjanović-Vasilić 2020, Stojanović 2019.
[2] Gajić-Kvaščev 2018.

Стратегије машинског учења у области проучавања и заштите културног наслеђа, науци о материјалима и уметности

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Истраживачи се у различитим областима срећу са великим бројем података са којима покушавају да дођу до неких нових сазнања. Често су ти подаци засновани на искуству истраживача и на тај начин буду класификовани, често се неки трендови могу чинити нејасни или потпуно скривени. Када се говори о таквим ситуацијама прва помисао је да постоје компјутери који могу да складиште и обраде те податке, али како се говори на почетку учења програмирања компјутер може веома савесно да уради низ операција са подацима, али те операције мора да му зада оператер који је човек. Један од начина да се операционализују ови приступи јесте и машинско учење о коме се често говори[1]. Машинско учење је субјекат вештачке интелигенције који се усмерава на развијање алгоритама и статистичких модела који омогућавају компјутерима да поправе њихове перформансе кроз претходно искуство. Уместо да се експлицитно програмирају да обаве задатак ови алгоритми користе шаблоне или обрасце и интерференцију да донесу одлуке и предвиђања на бази доступних података. Машинско учење користи моделе за тренинг добијене из великог броја података да би се добиле корелације или обрасци који са касније користе за предвиђања на новим подацима[2].

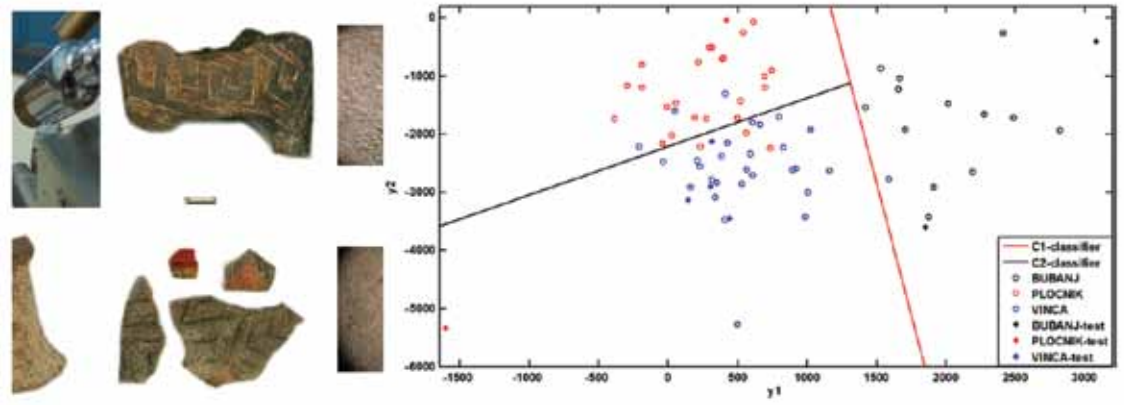
Откуда интересовање да се машинско учење користи баш у проучавању културног наслеђа. То је област која постаје све више интердисциплинарна и има потребу да се укључе истраживачи из различитих области. Како је културна баштина општи појам који имамо задатак да сачувамо, упознамо и податке учинимо што видљивијим како би се за њих сазнало у широким друштвеним круговима од великог интереса је да се укључе истраживачи са различитим образовањем. Проучавање културног наслеђа било да се ради о утврђивању порекла, било да се ради о намери да се неки предмети конзервирају или рестаурирају укључује са једне стране искуство археолога, рестауратора, конзерватора, историчара уметности и кустоса а са друге стране долазе подаци од инструмената који генеришу податке о саставу, изгледу, кристалној структури, облицима уоченим на предметима. Комбинацијом ова два извора информација добија се материјал за употребу машинског учења.

[1] "Machine Learning" by Tom M. Mitchell (1997) – where machine learning is defined as a computer program's ability to improve its performance on a task with experience.

[2] "Pattern Recognition and Machine Learning" by Christopher M. Bishop (2006) – which describes machine learning in the context of identifying patterns and making predictions based on data.

Утврдити да ли се може EDXRF користити за препознавање порекла узорака керамике са различитих налазишта

Са овим питањем појавили су се истраживачи из института у Винчи пре 11 година и питање које се поставило је да ли је могуће искористити сазнања археолога која су стечена на основу њиховог дугогодишњег искуства у класификацији налаза од грнчарије за класификацију узорака по географском пореклу. Три групе керамичких налаза који су са географски различитих удаљених локалитета из доба неолита. Претходно искуство за класификацију добијено је од археолога који су узорке класификовали и оно је представљало основу за знање које је искоришћено за формализациију ове класификације. Научни метод који је примењен за занализу био је портабилни уређај за спектроскопско одређивање елементарног састава и анализа спектара. Добијен је велики број спектара који су анализирани употребом неуралних мрежа. Улазак машинског учења у интерпретацији спектара, припреми улазних података за статистичку анализу и коначно примена анализе података на класификацију узорака. Резултат је био да се спектри добијени минимално инвазивним припремама узорака могу искористити за класификацију узорака по њиховом пореклу коришћењем статистичких техника које су тако велики број података успеле да изанализирају и интерпретирају.



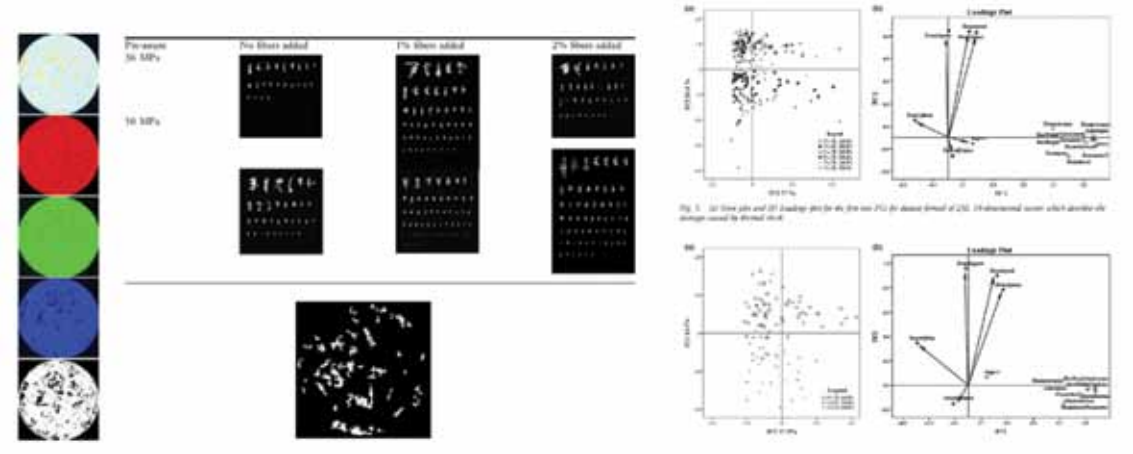
Слика 1 – Изглед узорака и класификација узорака на основу спектара који су анализирани методама машинског учења. Види се да су комбинацијом аналитичке технике и статистичког приступа успешно раздвојене три групе узорака.

Да ли може да се искористи овај метод за класификацију оштећења на материјалу изложеном термошоку?

Пошто је знање добијено на класификацији археолошких узорака усвојено поставио се нови задатак. Метод испитивања отпорности на термошок поразумева загревање керамичког узорка на 900°C и потапање у воду да би се изазвало разарање узорка. При томе се површина постепено оштећује па се појављују оштећења. Класични приступ каже да се испитивање обуставља када се оштети половина површине узорка или када узорак пукне. Приступ који је био усвојен јесте праћење развоја облика оштећења применом софтвера за анализу слике. Идеја је да се идентификују оштећења на површини и да се прати како се она мењају у зависности од природе узорка. Да би се побољшала отпорност узорака на оштећење приликом припреме додата су кратка керамичка влакна и поређени су узорци са и без додатка влакана[3]. Осим тога узорци су пресовани на два различита притиска. Ис-

[3] Dimitrijević et al. 2015.

поставило се да се приликом сваког циклуса термошока оштећења на површини мењају и да се њихови облици могу пратити коришћењем анализе слике.



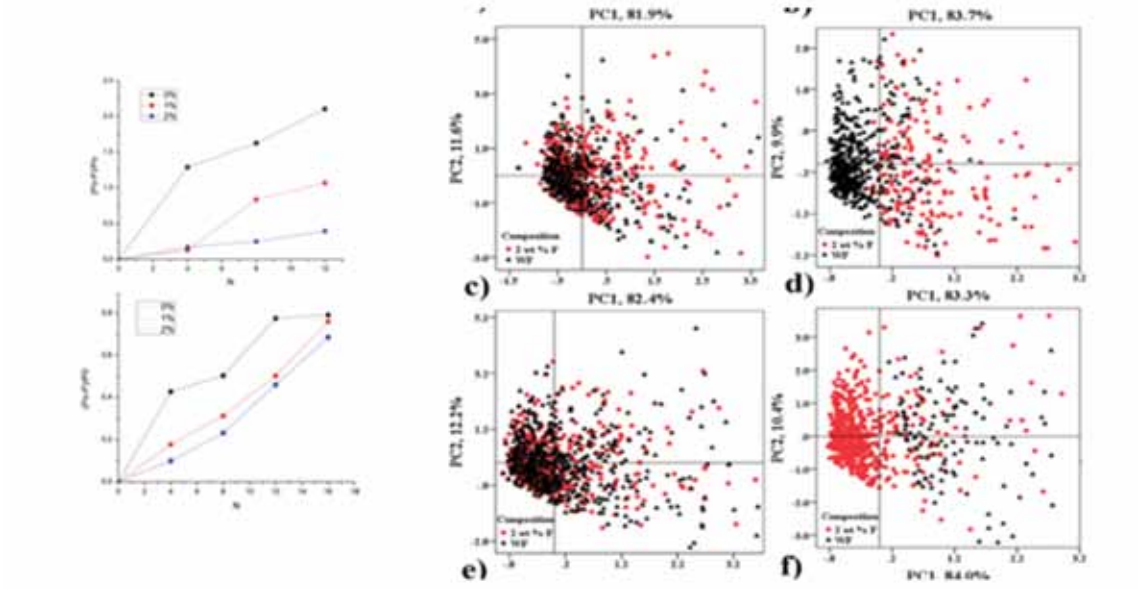
Слика 2 – Кораци у издвајању оштећења и резултат примене анализе слике на издвајање оштећења са површине узорака, резултати класификације узорака оштећења добијених испитивањем узорака на термошок на основу облика оштећења на површини.

Очигледно је да се оволики број слика не може анализирати класичним приступима па је применом машинског учења издвојено који су то параметри који су кључни за даљу анализу. Резултат је класификација узорака изложених истом третману у зависности од сета параметара који су описивали оштећења а они су везани за њихов облик.

Отпорност површине керамичког узорка на кавитацију

Да ли састав узорка може да утиче на облике оштећења на површини керамичког узорка? Поређени су узорци керамике са и без ојачања изложени кавитацији као што су били узорци изложени термошоку у претходном испитивању. Кавитација је процес у коме се површина узорка излаже ултразвучним таласима при томе разарајући његову површину. Та оштећења такође су праћена током времена излагања кавитацији. Класичан приступ представља праћење промене масе узорака изложеног кавитацији, док се овим приступом омогућава да се оштећења квантификују и да се размотри праћење утицаја кавитације по дубини оштећења[4]. Као значајни параметри облика издвојили су се *Axis major, Diameter major*, *Box width* and *Perimeter,* и они показују највећи пречник и обим уочених оштећења и повезују их са укупним оштећењем површине. Анализом ових оштећења показано је да је могуће пратити како се мењају облици и по површини и по дубини узорка и зашто је ојачавање керамике допринело бољој отпорности на кавитацију (слика 3).

[4] Vuksanović et al. 2021.



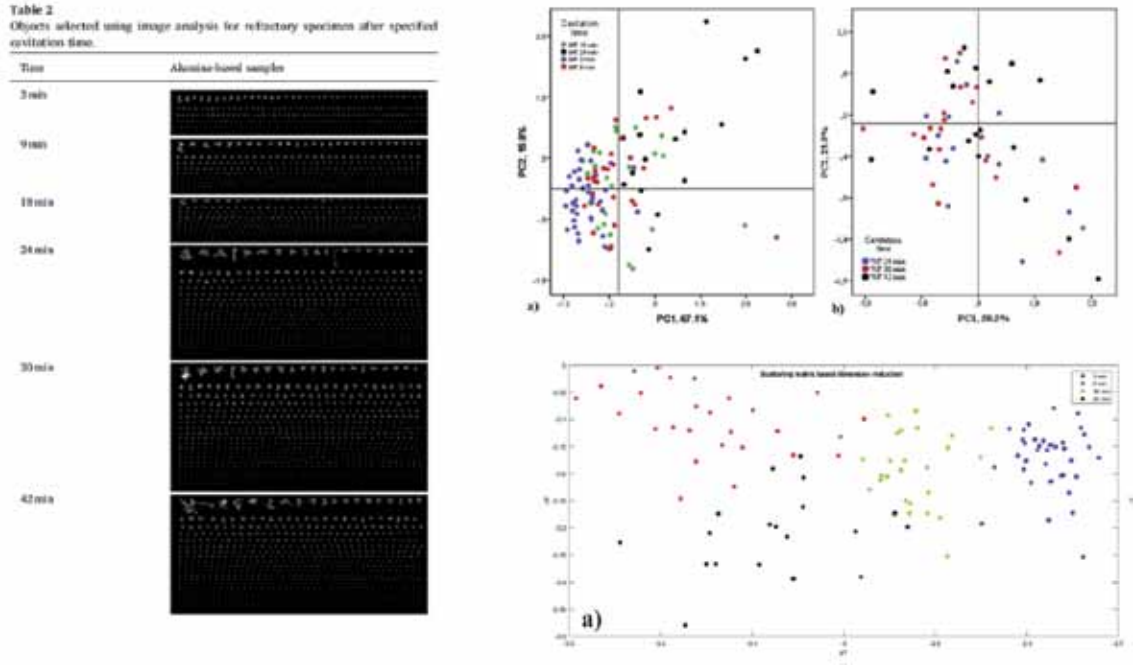
Слика 3 – Поређење класичног и статистичког приступа приказу резултата добијених посматрањем оштећења кавитацијом за керамички узорак.

Квантификација утицаја кавитације на композитни материјал са полимерном матрицом

Следећи корак у примени ових метода какатеризације било је испитивање композитног материјала са полимерном матрицом изложеног кавитацији[5]. Опште је познато да се материјали који се користе у стоматологији заснивају на акрилатној основи и да се њима као ојачање додају честице оксидних керамичких материјала. Испитивање кавитацијом пружа податке о томе како се може доћи до података који материјал се боље опире површинским оштећењима што је од кључног значаја за даљу употребу тих материјала. Поново је коришћена анализа слике за анализу површине материјала и добијен је огроман сет података који су квантификовани преко параметара облика примењених на уочена оштећења. Даљом анализом упоређени су материјали различитих састава и добијени су закључци о томе који од испитиваних материјала је оптималан са гледишта коришћења у стоматолошкој пракси.

Показало се да се могу издвојити најзначајнији фактори облика оштећења и да је као најважнији обим оштећења као и да се као значајни параметри издвајају дужина, односи највеће ширине и најмање ширине као и површина оштећења. Резултат је да се могу карактерисати све фазе кавитације преко промене ових параметара.

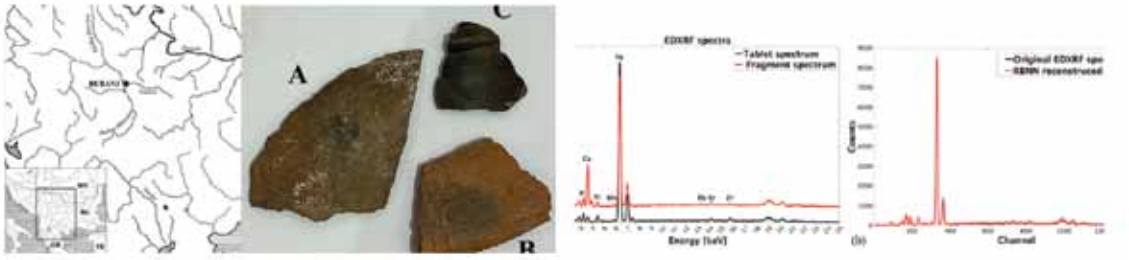
[5] Vuksanović et al. 2021.



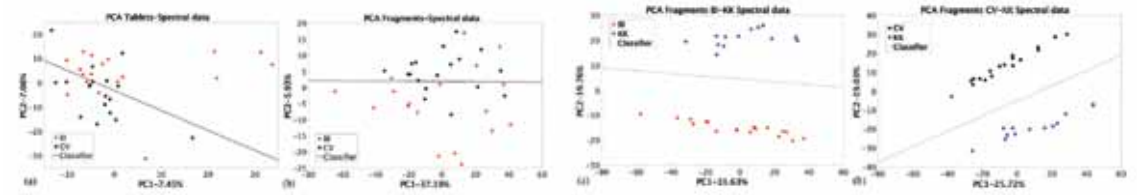
Слика 4 – Изглед уочених оштећења и резултати анализе параметара оштећења добијени применом метода машинског учења.

Поређење узорака из различитих периода са истог налазишта

Следећи корак јесте да се примене методе машинског учења на класификацију налаза за које се претпоставља исти извор сировине. Како се показало да се метод може успешно применити на анализу географског порекла археолошких налаза и како је тај исти метод искоришћен у науци о материјалима покушај је направљен да се користи анализа спектара добијених елементалном анализом за датирање налаза са истог налазишта. Овде је одабрано налазиште Бубањ и два историјски различита периода. Утицај који је могао да доведе до разлике у налазима је свакако различита технологија примењена на сировине које су по свој прилици биле локалне.



Слика 5 географска локација и анализирани спектри који потичу од инструмента и спектар који је анализиран неуралном мрежом.



Слика 6 – Успешност раздвајања узорака из два различита периода, и тестирање успешности модела употребом узорака са потпуно различите локације који се јасно одвајају од тестиране групе.

Примена метода машинског учења у уметности

Уметност делује као подручје у коме ће се људска креативност развити до бесконачности, али проучавање уметности може да се изведе коришћењем алгоритама везаних за машинско учење. Табела 1 даје преглед могућх коришћења метода машинског учења у анализи уметничких дела.

Табела 1. Преглед области у којима је могуће користити машинско учење у уметности

Анализа и аутентификација	Алгоритми могу да анализирају визуелне елементе, потезе четкице, текстуре и да открију патерне који могу бити превише детаљни за људско око. Ово може помоћи у аутентификацији, идентификацији фалсификата или идентификацији аутора или периода настанка дела.
Конзервација и рестаурација	Конзервацији и рестаурацији оштећених уметничких дела тако што ће се симулирати и(или) предвидети ефекти чишћења, као и предвидети и реконструисати недостајући или избледели сегменти дела. Алгоритми могу такође анализирати податке и предвидети будуће.
Препознавање стила и класификације	Аутоматска идентификација и категоризација дела, као помоћ *online* галеријама и музејима, у организацији дела, као и персонализованим препорукама публици.
Генерисање уметничких дела	Модели машинског учења могу да креирају дела учећи из постојећеих стилова. Ови модели могу да производе слике, музику и поезију и да подражавају стилове познатих аутора чак и да потпуно генеришу њихов стил.
Дигитализација и анализа културног наслеђа	Машинско учење може да анализира велике сетове података, колекције уметничких дела, литературу или музичка дела да открије трендове, утицаје или историјске податке. Ово помаже историчарима уметности и радницима у области културне делатности да дубље уђу у суштину и да сагледају већи број детаља који би им можда промакли.
Интеракција са публиком	Интеракција с публиком може да се прати преко праћења покрета, израза или емоција и могуће је добити анализу реакције публике. Такође могуће је користити је за онлајн платформе учења базиране на преференцијама корисника.
Анализа музичких и литерарних дела	...

Један пример јесте примена машинског учења на иконама, фрескама и уметничким сликама, односно њиховим дигиталним приказима. На сликама се током времена формирају кракелуре, које се сматрају за нормалан след старења неког уметничког дела. Међутим, премда се оне могу сматрати делом визуелног идентитета дела, оно није настало са њима и могуће је применом алгоритама машинског учења те кракелуре идентификовати и ретуширати без итнтервенције на самом уметничком делу и на тај начин га учинити доступним публици у оригиналном облику. Детекција мреже кракелура може се користити у анализи затеченог стања и служити као податак битан за превентивну конзервацију, на основу кога се прати даља деградација бојеног слоја. Дигитална идентификација мреже пукотина може се искористити за теоријску анализу начина њиховог настанка и разматрање контакта бојеног слоја и подлоге. Употреба машинског учења подразумева тренирање алгоритама на основу сета унапред анотираних слика и примена истог на новом сету слика од интереса. Ова истраживања могу се проширити и на друге области науке о материјалима где је интегритет превлаке од примарног интереса.



Слика 7 – Примена анализе кракелура на сегменту слике и добијена мрежа идентификованих кракелура на сегменту слике.

Закључак

Машинско учење иако пре 10 година тек у назнакама присутно у проучавању културног наслеђа све више добија на значају у његовој анализи и интерпретацији. Осим тога могуће је ове методе учинити софистицираним и додати искуствене параметре тако да се знање које се преноси са особе на особу учини доступним већој публици, да се подаци сачувају и да се на тај начин добије велика количина података који будућим истраживачима могу бити од интереса.

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Laboratorija za ispitivanja materijala u kulturnom nasleđu (Heritage lab) i njena uloga u konzervatorskoj nauci u Srbiji i regionu

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Uvod

Naučno-stručni skup pod nazivom „Metode utvrđivanja i otklanjanja posledica dejstva vlage na kulturna dobra“ u Novom Sadu 2004. iniciranom od strane Društva konzervatora Srbije i Pokrajinskog zavoda za zaštitu spomenika kulture Petrovaradin (PZZSK), predstvaljao je inicialnu kapislu za nabavku moderne opreme za nedestruktivna ispitivanja i razmenu znanja i iskustava sa kolegama iz Evrope u oblasti kulturnog nasleđa. Ovaj događaj bio je početni impuls koji je naveo prof. Jonjau Ranogajec da osnuje Laboratoriju za materijale u kulturnom nasleđu – **Heritage Lab** na Tehnološkom fakultetu, u okviru Departmana za inženjerstvo materijala kojom danas rukovodi prof. dr Snežana Vučetić. Iako je tadašnji tim radio u oblasti kulturnog nasleđa, Laboratorija se formalno osniva u godini kada je održan prvi skup Lanterna, 10 godina kasnije od pomenutog skupa o vlazi, 2014.godine, na temelju sporazuma o saradnji između Pokrajinskog zavoda za zaštitu spomenika kulture, Petrovaradin, Galerije Matice Srpske i Tehnološkog fakulteta u Novom Sadu. Upravo u period 2011-2015, HeritageLab učestvuje u evropskom FP7 projektu HEROMAT, koji je značajno ojačao ekspertizu tima i omogućio nabavku najsavremenije opreme. U periodu od 2015. godine do danas Laboratorija je nastavila sa opremanjem, edukacijom i učestvovanjem i rukovođenjem nacionalnim i međunarodnim projektima.[1]



Slika 1 – Potpisivanje sporazuma o saradnji i osnivanju HeritageLab-a: Zoran Vapa, nekadašnji direktor Pokrajinskog zavoda za zaštitu spomenika kulture, Petrovaradin, prof. dr Daniela Korolija-Crkvenjakov, Galerija Matice srpske i profesor na Akademiji umetnosti, smer Konzervacija, prof. dr Jonjaua Ranogajec nekadašnji rukovodilac i osnivač HeritageLab-a, dr Slavica Vujović, Pokrajinski zavod za zaštitu spomenika kulture, rukovodilac projekta Vekovi Bača i prof. dr Snežana Vučetić, tadašnji saradnik prof. J. Ranogajec (sa leva na desno)

[1] Balvanović et al. 2023.

Oprema i delatnost

Tim Laboratorije je izrazito multidisciplinaran (inženjerstvo materijala, fizika, mikrobiologija, inženjerski menadžment, prehrambeno inženjerstvo), a ispitivanja kojima rukovodi Laboratorija obuhvataju detaljnu analizu materijala, utvrđivanje dijagnostike stanja, uzroka, mehanizama i stepena degradacije, uz davanje preporuke za optimalne postupke sanacije, konzervacije i restauracije.



Dijagnostika stanja slike Blagoveštenski sabor, Vlaho Buhovca: Dr Bojan Miljević, rukovodilac za kvalitet, Msc Vesna Miljić, Tehnički saradnik i student doktorskih studija, Msc. Marija Kovač, student doktorskih studija, prof. dr Snežana Vučetić, rukovodilac, Msc. Milica Pankov, student doktorskih studija i Msc. Nenad Laketić (sa desna na levo)



Dijagnostika stanja i predlog čišenja i zaštite, Kompleks Banovine u Novom Sadu sedište Pokrajinske vlade Vojvodine i Skupština Autonomne Pokrajine Vojvodine : Prof. dr Jonjaua Ranogajec, osnivač i nekadašnji rukovodilac HeritageLab, Dr John Milan Van der Bergh, nekadašnji saradnik Laboratorije, prof. dr Snežana Vučetić, rukovodilac HeritageLab i Dr Bojan Miljević, rukovodilac za kvalitet HeritageLab (sa desna na levo)

Slika 2 – Tim HeritageLab-a

Danas se HeritageLab bavi ispitivanjima konstitutivnih elemenata i produkata degradacije materijala nepokretnog kulturnog nasleđa, uključujući materijale neorganskog, organskog i biološkog porekla. Pored navedenog vrši ispitivanje umetničkih dela, pokretnog i nepokretnog kulturnog nasleđa: identifikuje slikarske tehnologije i tehnike izvođenja zidnog i štafelajnog slikarstva. Pored navedenog danas se u HeritageLab-u obavlja naučno-istraživački rad na polju razvoja novih funkcionalnih materijala za čišćenje i zaštitu kulturnog nasleđa, kao i na polju razvoja savremene metodologije ispitivanja njihove funkcionalnosti. Danas je HeritageLab opremljena modernom opremom kako za laboratorijska ispitivanja, tako i za in-situ nedestruktivna ispitivanja , koji su posebno značajni da se na licu mesta identifikuju problemi i dobiju odgovori bez uzorkovanja i dodatnog oštećenja istorijskog materijala koji je često od neprocenjive vrednosti, posebno kada govorimo o slikama i umetničkim delima. HeritageLab vrši uzorkovanje, a zatim laboratorijska i in-situ ispitivanja upotrebom sledećih tehnika: rendgenska fluorescentna spektroskopija (XRF), rendgenska difrakcija (XRD), skenirajuća elektronska mikroskopija sa elementarnom analizom (SEM-EDS), infracrvena spektroskopija sa Furijeovom transformacijom (FTIR), Raman spektroskopija, optička spektrofotometrija u ultraljubičastoj i vidljivoj oblasti elektromagnetnog spektra (UV-VIS), infracrvena (IR) termovizijska snimanja, ispitivanja korišćenjem Zeta-metra, merenja otpornosti prodiranja u materijal (DRMS), Hg-porozimetrija i mikro-indentacija, merenje brzine UZ pulsa. Pored navedenog laboratorija poseduje i komoru za starenje u kojoj simulira forsirano starenje što je od neprocenjivog značaja za sipitivanje kompatibilnosti originalnih i novih materijala.

Tim HeritageLab-a je u protekloj deceniji učestvovao i rukovodio na velikom broju nacionalnih i međunarodnih projekata iz oblasti inženjerstva materijala, od kojih se vezano za zaštitu nasleđa posebno izdvajaju: 2021-2024: Evropski projekat Eureka, Napredno čišćenje i zaštita материјалног kulturnog nasleđa / Advanced CleAning and Protection of TANgible culture heritage, број пројекта E!13805 (rukovodilac S. Vučetić, HeritageLab), 2020-2022 Promis projekat, finansiran od strane Fonda za nauku, Mortar Design for Conservation - Danube Roman Frontier 2000 Years After број пројекта#6067004 (rukovodilac projekta Dr Emilija Nikolić, Arheološki institute Beograd), 2022-2024: Projekat finansiran od strane Ruske federacije Self-healing phenomenon in mortar and concrete structures assessed by neutron computed tomography JINR-Serbia P20 (rukovodilac Dr Bojan Miljević, Tehnološki fakultet Novi Sad), 2016-2019: Evropski projekat COST Action 15202 "Self-healing As preventive Repair of COncrete Structures". Navedeni Eureka projekat je veoma značajan u oblasti razvoja novih multifunkcionalnih materijala jer su u okviru njega razvijena dva nova proizvoda dostupna na tržištu. Jedan proizvod predstavlja sistem za uklanjanje rastvorljivih soli iz objekata kulturnog nasleđa na bazi bakterisjki kultura – **BioSaltAway**, dok je drugi proizvod razvijen za samočšćenje unutrašnjih površina – **CleanVisi**.[2]

Posebno značajno za HeritageLab bilo je učešće na projektu na navedenom projektu Dizajn maltera za konzervaciju – rimska granica na Dunavu 2000 godina kasnije (Mortar Design for Conservation – Danube Roman Frontier 2000 Years After) - MoDeCo2000, kojim je rukovodila Dr Emilija Nikolić, Arheološki institu Beograd. Ciljevi projekta MoDeCo2000 bili su sticanje znanja o korišćenim sirovinama i tehnologiji proizvodnje istorijskih maltera iz rimskog perioda na teritoriji današnje Srbije uz reku Dunav, i uspešna primena ovih znanja u projektovanju konzervatorskih maltera, uz promociju upotrebe lokalnih sirovina i postizanja kompatibilnosti materijala kao principa od najveće važnosti u zaštiti spomenika. Aktivnosti projekta uključile su istraživanje literature, uzorkovanje istorijskih maltera, njihovo laboratorijsko ispitivanje i pripre-

[2] U okviru FP7 Heromat projekta razvijen je proizvod za samočišćenje spoljašnjih površina dejstvom UV zračenja, dok je Proizvod CleanVisi razvijen da bude aktivan i funkcionalan u vidljivom delu spektru, što znači da je potrebno imati samo standardno unutrašnje osvetljenje. Sličan proizvod na tržištu još ne postoji. Postoje samošistive površine, prethodno fabrikovane i samočistivi malteri, fasadne boje za spoljnu upotrebu, međutim ne postoji suspenzija u vidljivom delu elektromagnetnog spektra koja bi bila pogodna za unutrašnje prostore u smislu samočišćenja i antimikrobnog dejstva.

mu modela maltera za konzervaciju, a zatim i probe ovih modela na terenu. Izvršen je pokušaj da se kroz ispitivanje istorijskih uzoraka oživi veliki broj varijanti ovog kompleksnog i izuzetno značajnog građevinskog materijala, koje bi se mogle pripremiti uz pomoć lokalnih sirovina i primeniti na spomenicima u procesu njihove konzervacije[3],[4],[5].

Osim međunarodnih i nacionalnih projekata HeritageLab je učestvovao u velikom broju istraživanja i radio kako na razvoju kompatibilnih sistema, tako i na ispitivanju pokretnog i nepokretnog kulturnog nasleđa kako u Srbiji tako i u regionu: Sveobuhvatno istraživanje tehnologija za čišćenje, konsolidaciju i zaštitu kamenih fasada zgrade **Pokrajinske vlade (Banska palata) i Skupštine (Banski dvor)** Autonomne Pokrajine Vojvodine, Karakterizacija **keramičkih fragmenata iz Stobija, Severna Makedonija, 197. p.n.e.** , **Terazijska česma**, simbol Beograda iz 1860. godine – sveobuhvatna studija tehnologija za čišćenje, konsolidaciju i zaštitu, 19. vek, Ispitivanje originalnih materijala i izrada konzervatorskog maltera kompatibilnog s izvornim materijalima, **arheološko nalazište Skelani** – antički mozaik, 3. vek., Karakterizacija kamenih materijala sa „Mračne kapije", **Tvrđava Kalemegdan**, Beograd, 18. vek., Istraživanje fresaka svoda crkve **Rođenja Svetog Jovana Krstitelja u Bačkoj Palanci,** 18. vek., Analiza uzoraka maltera iz **manastira Petkovica**, 16. vek., Istraživanje zidnog slikarstva **manastira Krušedol**, 16. vek., Istraživački radovi na ostacima zidnih struktura **bazilike Arača**, 12. vek., Spektroskopska analiza uzoraka iz **manastira Žiča**, 13. vek., Ispitivanje, Dijagnostika stanja i predlog konzervatarskog tretmana **SPC Ratkovo, SPC Sremska Kamenica.** U pogledu pokretnog kulturnog nasleđa, naročit izazov predstavljalo je ispitivanje i utvrđivanje slikarskih tehnologija Legata Petra Lubarde (Spomenik park Šumarice, Kragujevac I Nikšić Crna Gora), slika Milana Konjovića, portreta Grofa Andraša Hadika i velikog broja drugih istorijskih i modernih umetničkih dela privatnih kolekcionara, ali I islamsih zapisa i slika iz regiona. Ispitivanja **kalupa za livenje iz bronzanog doba** i **fudbalske lopte** sa potpisima igrača sa utakmice Zvezda – Bari, samo su neki od materijala ispitani u Laboratoriji.

Pored projekata i svakodnevne saradnje sa institucijama zaštite saradnici laboratorije su u protekloj deceniji kontinuirano išli na edukacije u partnerske međunarodne insitutcije, ali su i sami prezentovali rezultate na nacionalnim i međunarodnim konferencijama.

Edukacija

Saradnja Laboratorije sa institucijama zaštite kulturnog nasleđa dovela je i do pokretanja novog predmeta **Materijali u zaštiti kulturnog nasleđa** na master studijama Tehnološkog fakulteta, koji je počeo da se predaje 2014. godine kada je održan i prvi skup Lanterna. Danas se pored ovog predmeta obrazovanje u oblasti kutlrnog nasleđa odvija kroz još dva dodatna predmeta **Nedestruktivne metode ispitivanja materijala** na master studijama tehnološkog fakulteta, kao i kroz predmet **Forenzika umetničkih dela i boja**, master studije Forenzike na Univerzitetu u Novom Sadu. Pored formiranja navedenih predmeta važno je istaći da su u okviru gore pomenutog projekta Modeco2000 izdate dve knjige *Metodologija ispitivanja istorijskih maltera* i *Istorijski malteri. Od karakterizacije do konzervacije* [6]. Navedene knjige predstavljaju udžbeničke materijale za sve student koji se bave kulturnim nasleđem.

Takođe, Laboratorija je od 2017. do 2019. godine potpuno besplatno organizovala i realizovala projekat Škola ispitivanja materijala u kulturnom nasleđu sa ciljem edukacije i postizanja što boljeg razumevanja sa svim strukama koje učestvuju u procesima zaštite. Tokom trajanja

[3] Delić-Nikolić et al. 2022

4 Vučetić et al. 2022

[5] Nikolić 2021

[6] Vučetić, Ranogajec 2022.

Škola učesnici su učili i radili zajedno upoznajući se sa opremom i metodama, prvo u Laboratoriji za ispitivanje materijala u kulturnom nasleđu na Tehnološkom fakultetu, a zatim i na terenu na nekoliko značajnih lokaliteta nasleđa u Baču (Tvrđava Bač, Franjevački samostan i Manastir Bođani) i Novom Sadu na ikonama i slikama iz kolekcija Galerija Matice Srpske. Laboratorija je za uspešno izveden prvi u nizu ovih edukativnih projekata, koji je realizovan sa kolegama iz oblasti konzervacije tokom 2017. godine, dobila Godišnju nagradu Društva konzervatora Srbije, što je za tim Laboratorije predstavljalo posebnu čast i priznanje za trud u polju edukacije profesionalaca.



Slika 3 – Polaznici Škole za ispitivanje materijala u kulturnom nasleđu, Tehnološki fakultet Novi Sad, 2019.

Zaključak i izazovi

Tim Laboratorije, pored učešća u nastavnom i naučnom procesu, uvek entuzijastično pristupa korišćenju kapaciteta mobilne opreme i ekspertize tima za in-situ istraživanja u kulturnom nasleđu primenom naučnih metoda i radujemo se što ovakav pristup saradnje nauke i prakse polako postaje standard u zaštiti spomenika kulture. Ovakva saradnja omogućava konzervatorima i izvođačima radova da dobiju pouzdane i naučno zasnovane odgovore na brojne probleme i dileme u pogledu čišćenja, konzervacije i zaštite istorijskih materijala. Laboratoriji takvi projekti pružaju priliku da kontinuirano unapređuje svoje kompetencije.

Održavanje i unapređenje rada laboratorije za ispitivanje materijala u kulturnom nasleđu suočava se sa nizom značajnih izazova, kako na nivou finansiranja i opremanja, tako i u zadržavanju stručnog kadra. Iako kulturno nasleđe predstavlja važan segment društva, u domenu naučnog finansiranja ono nije prepoznato kao prioritetna istraživačka oblast. Fond za nauku često ne uključuje konzervatorsku nauku i istraživanja u oblasti kulturnog nasleđa u svoje programe, što značajno otežava pristup sredstvima za nabavku neophodne opreme i sprovođenje istraživačkih projekata. Nabavka specijalizovanih instrumenata predstavlja ozbiljan problem. Pored visokih troškova nabavke, još veći izazov je obezbediti redovan servis i održavanje opreme. Usluge servisa su skupe, a često nije moguće pronaći stručnjake u zemlji koji mogu da reše tehničke probleme. U pojedinim slučajevima, oprema mora biti poslata u inostranstvo na popravku, što zahteva dodatno vreme i finansije, čime se rad laboratorije usporava i ograničava.

Pored tehničkih i finansijskih izazova, laboratorija se suočava i sa problemima vezanim za zadržavanje stručnog kadra. Iako ulažemo značajan trud u edukaciju i profesionalno usavršavanje

mladih saradnika, oni se često odlučuju za odlazak na druga, bolje plaćena radna mesta, čim steknu potrebne veštine i iskustvo. Ovaj trend stvara kontinuitet kadrovskih problema, zbog čega je teško održati kvalitet istraživanja i usluga koje laboratorija pruža.

Uprkos ovim izazovima, laboratorija ostaje posvećena svojoj misiji očuvanja kulturnog nasleđa i pružanju podrške konzervatorskoj zajednici. Međutim, za dugoročni uspeh neophodna je veća podrška nadležnih institucija i razvoj strateških politika koje će prepoznati značaj arheometrije, kao nauke u službi kulturnog nasleđa.

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Активности лабораторије Народног музеја Србије 2014-2024

Милица Марић Стојановић, Народни музеј Србије, Београд

За поновно успостављање рада физичко-хемијске лабораторије Народног музеја, након десет година паузе између 1993-2003, најзаслужнија су била два догађаја. Један је курс који је организовало Министарство културе Републике Италије у сарадњи са Министарством културе Републике Србије са предавањима из области конзервације, упознавањем са најновијим методама рестаурације и примерима мултидисциплинарне праксе у примени најмодерније научне опреме током припрема за поступак рестаурације. Друго је био пројекат RER/1/006 Међународне агенције за атомску енергију ИАЕА, започет 2003 године као Регионални технички пројекат за промоцију примене јонизујућег зрачења у заштити културних добара, настављен кроз пројекат RER/8/015, где су се чланови из области природних наука и чланови из области заштите културних добара на конкретним примерима и кроз курсеве у нуклеарним институтима могли ближе упознати са свим врстама техника у којима се примењује јонизујуће зрачење. Кроз ове контакте и размене искуства, створена је добра основа за осмишљавање рада будуће лабораторије.

Основна опрема је набављена 2003. године и састојала се од опреме за припрему узорака и микроскопа за њихово посматрање као почетне фазе код испитивања предмета , почевши од слика, преко керамике, метала итд. За све остале анализе обраћали смо се другим институцијама, пре свега универзитетским, како у Београду тако и у Новом Саду и Институту за нуклеарне науке Винча, које су излазиле у сусрет и од својих актуелних пројеката одвајале средства за рад на предметима културне баштине. Тек реконструкцијом зграде Народног музеја Београда који је након тога променио име у Народни музеј Србије, створени су услови за набавку нове опреме. Тако је 2018. године набављен преносиви EDXRF инструмент (енергетски дисперзивна рендгенска флуоресцентна спектроскопија), хиперспектрална камера и SWIR инфрацрвена камера која може да снима на таласним дужинама од 1000 nm доо 1700 nm чиме су капацитети лабораторије, бар што се тиче испитивања бојених слојева у великој мери постали задовољавајући. Додатно, још пре Народног музеја у Републичком заводу за заштиту споменика културе, кроз јапанску донацију, прибављена је опрема за лабораторију тако да су сада обједињени капацитети институција културе у великој мери оспособљени за самосталан рад. Свеједно, сарадња са осталим институцијама и институтима из земље и иностранства се и даље развија чиме се умреженост наших институција позиционира на видљиво место у овој области.

Током протеклих десет година, трудили смо се да резултате наших испитивања приближимо широј јавности. У Народном музеју, организована су предавања за ширу публику и стручну јавност о мултидисциплинарним испитивањима у склопу конзервације. Учествовало се у радионицама за младе типа Ноћ истраживача и Фестивал науке и на конференцијама из области археометрије. Као резултат, можемо навести 15 научних радова објављених у страним и домаћим часописима са СЦИ листе. Такође, постала је уобичајена пракса да је за веће изложбе, у оквиру каталога изложбе, један сегмент посвећен мултидисциплинарним испитивањима или да се за саму изложбу приреди постер или видео о току истраживања приликом припреме изложбе, најчешће праћено и предавањима за публику као што је био случај приликом излагања Рембратове слике Дијана у лову или слике Влаха Буковца *Ружичасти сан* у галерији Српске академије наука и уметности 2020. године . Колико је претходно испитивање материјала ушло у скоро свакодневну праксу Одељења за конзервацију, може се видети и по томе што је објављена самостална монографија колегинице рестауратора Софије Кајтез, под називом *Холандски пејзаж Јана Ван Гојена под*

лупом рестауратора, у којој колегиница излаже своја детаљна запажања о техници аутора а на основу анализа савременим методама[1]. Такође, колегинице рестауратори су имале независна излагања на домаћим конференцијама као што је СМАРТАРТ 2020 и 2021 године.

Понекад се дође и до значајних открића као што је рецимо случај са сликом Породични портрет у пејзажу са беседом Св. Јована, која се до сада водила као дело непознатог холандског аутора из 17 века. Током чишћења слике, колегиница Сања Илић је открила ауторски потпис и установила да је реч о делу холандског сликара Claes Jacobsz van der Hecka, 1580-1652. Како до сада нису рађена систематска испитивања слика овог аутора, ово је била јединствена прилика да се то уради. Спроведена су снимања под ултраљубичастим и инфрацрвеним светлом, урађена су снимања на више места са преносивим EDXRF инструментом у сарадњи са Институтом Винча и узети узорци за израду попречног пресека, који су даље анализирани на скенирајућем електронском микроскопу, куплованом са EDXRF. Урађена су такође и рендгенска снимања слике како би се открио сликарски рукопис тј. цртеж и други детаљи и оштећења на слици. Рад је у припреми.

Од испитивања археолошких предмета, интересантно би било поменути испитивање компонената колица са четири точка из римског периода откривених у близини Пирота (1-2 век). Установљено је да се велики број украсних компонената на самим колицама или делова коњске опреме састоји од месинга или оловом обогаћеног месинга [2]. Уз неколико примера из Велике Британије и Немачке за коњску опрему из истог периода, ово је први пут да се месинг као легура може са сигурношћу потврдити као украсни део на колима, поред још једних двоколица из истог региона (Станичење) и из истог периода (Марић Стојановић, 2015, 83-89)[3].

Такође сматрамо великим доприносом ахеометрији, налаз позлате на фрагментима фресака из Жиче које су биле похрањене у јамама у цркви. Ови фрагменти припадају свакако првом осликавању манастира Жича са почетка 13 века и вероватно, је да су ту похрањени током прве рестаурације након што је манастир био спаљен и девастиран услед најезде племена са истока. На овим фрагментима, констатована је позлата која је изведена применом позлаћених калајних листића. До сада се сматрало да се најранија употреба ове технике може наћи на иконама Ђотоа ди Бондонеа, међутим овде имамо за један век ранију примену позлаћених калајних листића на фрескама, до скора познату само у ерминијама. Рад који обједињује разноврсне начине и квалитет позлаћивања фресака који се могу наћи у касно Византијским споменицима у Србији презентован је на конференцији СМАРТАРТ 2021 и објављен у зборнику радова[4].

Још један важан сегмент рада лабораторије при Народном музеју, представља одређивање аутентичности сликарских дела и издавање мишљења о аутентичности. До заједничког мишљења се долази комисијски, при чему у састав комисије улази један конзерватор, један историчар уметности и једна особа задужена за спектроскопију. Поређењем пигмената са испитиване слике и других техничких детаља као рецимо постојање ретуша, затегнутости платна и слично и поређењем са познатом палетом претпостављеног сликара долази се до закључка о ауторству дела.

За утврђивање порекла сировина, нарочито за предмете од метала али и за стакло и минералне пигменте, керамику, кости итд., поред класичних и већ поменутих аналитичких метода, важна су и утврђивање изотопског састава појединих елемената. Када су метали у питању, најчешће се одређује изотопски састав олова. Ову врсту испитивања, започели смо у сарадњи са Хемијским факултетом у Београду, међутим како је инструмент недовољно осетљив када је у питању разврставање руда које потичу са Балкана, започета је сарадња са

[1] Кајтез, 2022, 55-106.

[2] Maric Stojanovic, 2021, 341-354

[3] Марић Стојановић, 2015, 83-89.

[4] Maric Stojanovic, 2022, 148-167

Геолошким институтом из Берна. Анализе за сребрне посуде из Јабучја су у току али први резултати дају индиције да су сировине пореклом из Француске или са подручја Космаја.

Међународна и домаћа сарадња се непрестано проширује тако да је последњих година успостављена сарадња са Археолошким институтом при Академији наука у Москви, факултетом лепих уметности у Фиренци и са Техничким институтом при академији наука у Београду.

Можемо рећи да се питањем анализе органског материјала за сада нико није систематично бавио. Анализе везива, текстила, дрвета, ћилибара и других органских материјала рађене су само спорадично при појединачним случајевима конзервације и сматрамо да ту има пуно простора за даљи развој и сарадњу са институцијама које за то имају потребну опрему. За сада, сарађује се са Технолошким факултетом у Београду, везано за карактеризацију текстила као и на испитивању материјала за конзервацију текстила и са Хемијским факултетом у Београду, где се раде анализе везива. Микробиолошки материјал као део превентивне заштите, обрађује се у Биолошком институту у Београду.

У овој презентацији, надамо се да смо дали кратак али свеобухватан приказ делатности које обухватају област археометрије и показали важност мултидисциплинарне институционалне сарадње без које сви ови резултати не би били могућ.

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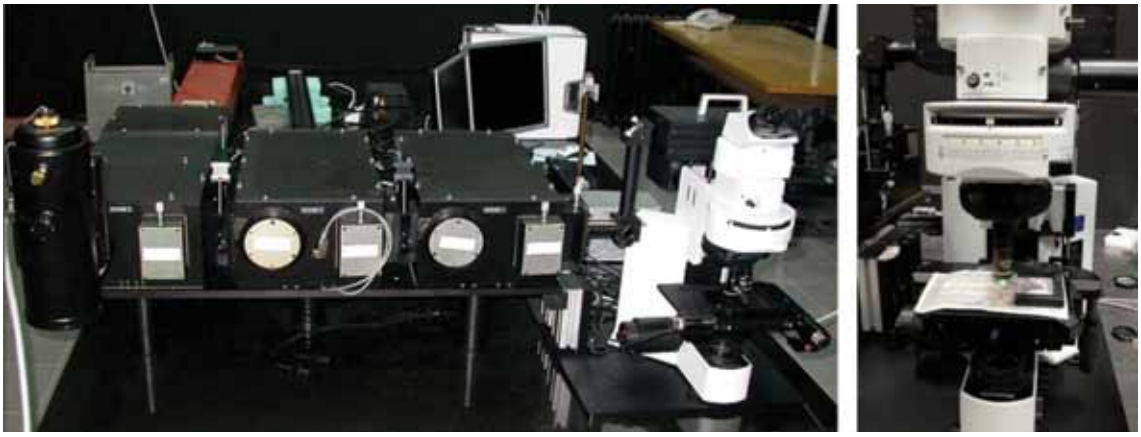
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Ispitivanje pigmenata na istorijskim novčanicama primenom Ramanove spektroskopije

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Ramanova spektroskopija je neinvazivna i nedestruktivna tehnika, koja se koristi za precizno ispitivanje predmeta kulturnog nasleđa bez direktnog kontakta i prethodne pripreme uzorka. Izbor snage i talasne dužine lasera omogućavaju da se izbegnu lokalno zagrevanje uzorka i njegova termička degradacija. Mogućnost dobijanja jedinstvenog spektra, koji precizno odgovara organskom ili neorganskom materijalu u njegovom trenutnom stanju, čini je posebno pogodnom i elegantnom metodom za ispitivanje pigmenata na umetničkim delima, rukopisima i štampanim materijalima.



Slika 1 – Trostruki Raman spektrometar TriVista TR557 sa mikroskopom (levo) i mikroskop sa uzorkom - novčanicom (desno).

Ramanova spektroskopija je izuzetno osetljiva na sastav, hemijske veze, hemijsko okruženje, faze i kristalnu strukturu, odnosno simetriju materijala koji se ispituje. Svaki molekul, funkcionalna grupa molekula ili jedinjenje može se prepoznati unutar kompleksne mešavine materijala, pomoću karakterističnog „potpisa“ ili „otiska“ (*fingerptint*) koji ostavlja u Ramanovom spektru.[1]

Novčanice predstavljaju posebno pogodnu vrstu uzoraka za ispitivanje primenom Ramanove spektroskopije, pre svega zbog svojih dimenzija, jer se mogu nesmetano ispitivati primenom sofisticiranih laboratorijskih instrumenata, bez potrebe za mobilnošću instrumenta. Samim tim, mogu se dobiti veoma kvalitetni i precizni rezultati.[2] Mikroskop, kao sastavni deo aparature za Ramanova merenja (Slika 1) omogućava da se detaljno proučavaju veoma mali domeni materijala, tj. da se veoma precizno, sa vrlo visokom prostornom rezolucijom (do 1 μm), pristupi kako pojedinačnim ili grupisanim zrnima pigmenata, koji su nastali kao rezultat procesa štampanja, tako i odabranim homogenim delovima bojene površine. Poređenje pigmenata na istoj ili različitim novčanicama, identifikacija prirodnih i sintetičkih pigmenata, različitih istorijskih

[1] Dohčević-Mitrović et al. 2011; Edwards, Vandenabeele 2012; Smith, Clark 2004.

[2] Colomban et al. 2012; Dohčević-Mitrović et al. 2011; Edwards, Vandenabeele 2012.

perioda ili proizvođača itd., omogućavaju praćenje tragova tehnološke evolucije i proizvodnje pigmenata i novčanica, međunarodne saradnje i trgovine, kao i autentičnost samih novčanica.[3]

U okviru ovog istraživanja, pored opsežne istorijske i arhivske građe, proučavane su i štamparske tehnike, sa posebnim osvrtom na postupke sigurnosne štampe i izvršena karakterizacija pigmenata metodom Ramanove spektroskopije, kako bi se utvrdili faktori značajni za

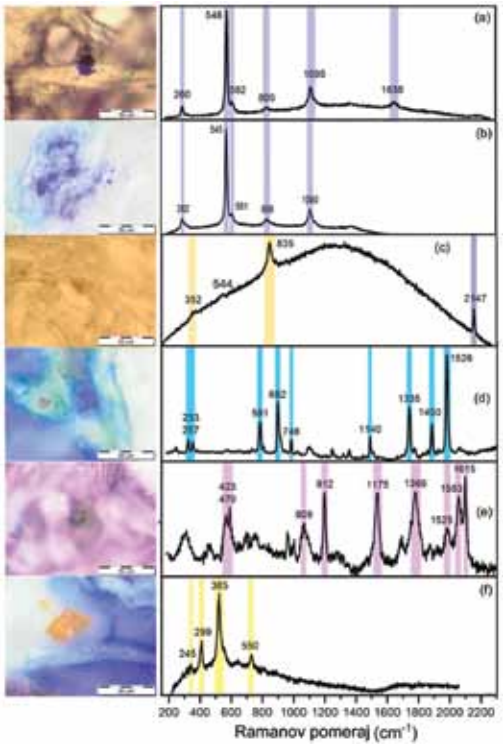


Slika 2 – Primer novčanice od 100 dinara.

monetarnu kulturu i zaštitu novčanica u Srbiji.[4] Ispitane su 53 novčanice iz perioda od 1898. do 2018. godine, koje su korišćene na teritoriji današnje Srbije. Proučavani su pigmenti (plavi, ljubičasti, zeleni, crveni i žuti) i predstavljena njihova zastupljenost na ispitivanim istorijskim novčanicama na vremenskoj skali. Vremenska raspodela registrovanih pigmenta prati pojavu, upotrebu i masovnu proizvodnju sintetičkih pigmenata, koja počinje u XIX veku i nastavlja se kroz prvu polovinu XX veka. Masovna upotreba sintetičkih organskih pigmenata, karakteristična za početak XX veka, reflektuje se i kroz ovaj izbor ispitivanih novčanica.[5]

Posebna pažnja posvećena je grupi novčanica od 100 dinara, koje su proizvedene u saradnji Banque de France i Kraljevine SHS (1925-1929), a kasnije Narodne banke Kraljevine Jugoslavije (1931-1941) i korišćene na teritoriji Srbije tokom tri državne i monetarne transformacije (Slika 2). One pripadaju grupi prvih višebojnih novčanica proizvedenih u Banque de France i njihov značaj sa aspekta tehnologije i zaštite od falsifikovanja leži u korišćenju više od dve boje, kao i specifičnim štamparskim tehnikama.[6]

Iako bogata i složena, bojena površina novčanice je zbog svoje strukture i dimenzija veoma pristupačna za ispitivanje Ramanovom spektroskopijom. Na Slici 3 prikazani su primeri mernih lokacija karakterističnih obojenih površina sa zrnima pigmenta i odgovarajućih Ramanovih spektara. Ramanova spektroskopija u ovom istraživanju korišćena je za proučavanje plavih, ljubičastih



Slika 3 – (levo) Odabrane merne lokacije na novčanicama od 100 dinara sa karakterističnim pigmentima snimljenim mikroskopom sa uvećanjem 50×. (desno) Odgovarajući Ramanovi spektri pigmenata: (a, b) ultramarin, (c) hrom žuto i prusko plavo, (d) bakar-ftalocijanin plavo, (e) kristal violet i (f) getit.

[3] Jauković 2021.

[4] Jauković 2021.

[5] Caggiani et al. 2015; Fremouth et al. 2012.

[6] Jauković 2021.

i zelenih pigmenata. Na osnovu preko 400 Ramanovih spektara identifikovani su prirodni i sintetički pigmenti i ustanovljena je nedvosmislena razlika između pigmenata korišćenih u proizvodnji ovih novčanica u saradnji Banque de France sa dvema kraljevinama - SHS (1925-1929) i Jugoslavijom (1931-1941). Podaci dobijeni Ramanovim rasejanjem uspešno su korelisani sa istorijskim dokumentima.

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Наука и технологија у заштити културних добара: Седам деценија физичко-хемијске лабораторије Републичког завода за заштиту споменика културе

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Физичко-хемијска лабораторија је део сликарско-рестаураторског департмана Републичког завода за заштиту споменика културе (РЗЗСК) из Београда и једина у систему заштите споменика културе на територији Републике Србије. Основана је као атеље са хемијском лабораторијом 1949. године, убрзо након оснивања Завода за научно проучавање споменика културе Народне Републике Србије. Током седамдесет пет година постојања неколико генерација стручњака остваривало је значајне резултате у области примене природних наука у истраживачком раду и развоју добре конзерваторске праксе на културним добрима Републике Србије и некадашње Југославије. Главне активности физичко-хемијске лабораторије РЗЗСК-а су све врсте физичко хемијских анализа разних врста узорака са непокретних и покретних културних добара. Значајан део истраживања представља и мониторинг микроклиматских услова у којима се налази споменик и испитивања садржаја и порекла влаге. Од 2014. године физичко-хемијска лабораторија је постепено опремана софистицираном аналитичком опремом без које су модерна археометријска испитивања незамислива. Као последица побољшаних капацитета уследила су значајна истраживања многобројних културних добра, унапређена методологија конзервације и објављен велики број научних и стручних радова.

Републички завод за заштиту споменика (РЗЗСК)

Републички завод за заштиту споменика културе евидентира, истражује, штити и презентује наслеђе од најстаријих праисторијских и античких споменика, средњовековне сакралне и фортификационе архитектуре, народног градитељства до споменика новије историје и савременог стваралаштва, што данас представља драгоцену културно-историјску, уметничку, образовну и естетску вредност Србије и српског народа. Основан је 1947. године под именом Завод за научно проучавање споменика културе Народне Републике Србије. Године 1960. назив му је промењен у Републички завод за заштиту споменика културе-Београд а 1971. године припојен му је Југословенски институт за заштиту споменика културе.[1] Републичким заводом руководи директор а организационо је подељен на четири одељења:

- Одељење за истраживање, заштиту и документацију
- Архитектонско одељење
- Сликарско-рестаураторско одељење са физичко-хемијском лабораторијом
- Одељење општих послова

[1] https://heritage.gov.rs/cirilica/istorija_zastite_u_srbiji.php

Историјат лабораторије Републичког завода за заштиту споменика културе

Физичко-хемијска лабораторија је део сликарско-рестаураторског департмана Републичког завода за заштиту споменика културе из Београда и једина у систему заштите споменика културе на територији Републике Србије. Основана је као атеље са хемијском лабораторијом 1949. године, убрзо након оснивања Завода за научно проучавање споменика културе Народне Републике Србије. Тадашња служба заштите се у организационом смислу угледала на совјетски модел што значи да је у једној установи било потребно упослити различите профила стручњака способне да реше постављене задатке. Формирањем лабораторије, конзерваторска пракса подржана је знањима природних наука. Новоосновану лабораторију водила је Вера Вуловић (Радосављевић), инжењер хемије. Радила је у Републичком заводу до 1960. године а након тога до пензије у Народној библиотеци Србије.[2] Рад у лабораторији настављају дипломирани хемичари, Невена Димитријевић (1960-69.) и Јовица Васић (1969-2001.). Годину дана касније је у Савезном институту за заштиту споменика културе септембра 1950. године формирана Технолошка лабораторија која је имала за циљ да се бави хемијским анализама материјала споменичких објеката. На челу лабораторије су били Михајло Вуњак (1954-72.) и Нада Стојановић, дипломирани хемичари.[3] Након реструктурирања организације службе заштите 1971. године, Југословенски институт и Републички завод за заштиту споменика културе се интегришу. Лабораторије две институције обједињене су у једну. Атеље Завода са лабораторијом и постојећом опремом премештен је из Конака кнегиње Љубице у простор у коме се и данас налази, односно у просторије тадашњег Југословенског института.

Борећи се са почетним тешкоћама и недостатком опреме и специјалиста за ову врсту посла, резултати рада непосредно након оснивања ове две лабораторије нису могли бити значајни. Због тога су стручњаци слати на специјализације у најпознатије иностране установе те врсте, првенствено у Лондон, Брисел и Париз где су се упознали са савременим методама испитивања и конзервације споменичких објеката. Истовремено са обуком кадрова, предузети су кораци у опремању лабораторије. Обезбеђена су финансијска средства и постепено набављани инструменти, опрема и реагенси. Харвардски Музеј Фог у граду Кембрицу је 1954. године са још две партнерске установе у оквиру пројекта ICA опремио технички студио за конзервацију и анализу. О томе је објављен чланак у часопису „Studies in Conservation“ 1956. године са препоруком и циљем да се охрабре слични подухвати и на другим местима.[4] Наши стручњаци су по том узору набавили идентичну опрему и постали једна од најбољих лабораторија на свету. Део те опреме још увек се чува у Републичком заводу (стерео, поларизациони, и металографски микроскопи, микротом, рендген апарат, рефрактометри, Дибосков колориметар, спектрофотометар, поларограф, pH метар, библиотеке пигмената и сликарског материјала и сл.) Истовремено је брижљиво попуњавана специјализована библиотека књигама из области аналитичке хемије, инструменталних метода и конзервације споменика и сродних дисциплина. Лабораторија је врло брзо могла да одговори захтевима постављеним и стала раме уз раме водећим и малобројним установама те врсте. Назив је промењен у „Лабораторија за физичка и хемијска испитивања“ који је боље одговарао њеним циљевима и задацима. Стручњаци су вршили истраживања на најзначајнијим споменицима Србије и Југославије али су ангажовани и на другим пројектима у свету: у Старој Нубији, Египту, Помпеји. Позивани су да формирају лабораторије у земљама Јужне Америке.[5] Њихови радови су цитирани у светским часописима а неки кон-

[2] Павловић-Лончарски at al. 2022, 47.

[3] Павловић-Лончарски at al. 2022, 61.

[4] Buck 1956, 101-109.

[5] Павловић-Лончарски et al. 2022, 61.

зерваторски третмани као што је на пример екстракција соли са зидног сликарства изводе се по процедурама које су они први пут увели.

После реформе службе заштите 1971. године Михајло Вуњак наставља рад у Народном музеју а Нада Стојановић и Јовица Васић воде лабораторију Републичког завода. Након одласка у пензију г-ђе Стојановић 1993. године, Војин Николић, дипл. технолог почиње да ради у лабораторији заједно са господином Васићем до 2001. године а затим самостално до фебруара 2005. године када су му прикључена два дипломирана хемичара, Алекса Јеликић и Татјана Трипковић са циљем да наставе започете активности и раде на даљем унапређењу и модернизацији лабораторије.

Активности лабораторије РЗЗСК-а

Најопштије формулисани, циљеви и задаци лабораторије јесу да применом егзактних научних метода хемије и физике ради на конзерваторским испитивањима споменичких објеката и да унапређује методе и средства конзерваторске праксе. Тај рад обухвата идентификовање материјала, испитивање стања очуваности и утврђивање узрока који су довели до његовог оштећивања. Другим речима, главне активности физичко-хемијске лабораторије РЗЗСК-а су све врсте физичко хемијских анализа разних врста узорака са непокретних и покретних културних добара. У лабораторији се обављају испитивања бојених слојева зидних и штафелајних слика, позлате, мозаика, икона и других уметничких предмета. Анализирају се различити грађевински материјали од којих је изграђен споменик. Врше се пробе чишћења и формулације средстава за уклањање лакова, премаза и других депозита и нечистоћа. Анализирају се врсте везива и испитује њихово порекло. Такође се врши квалитативна елементарна анализа, анализа соли и микроскопирање узорака. Значајан део истраживања представља и мониторинг микроклиматских услова у којима се налази споменик и испитивања садржаја и порекла влаге. Истраживачи у области културног наслеђа запослени у лабораторији РЗЗСК-а обављају послове из домена истраживачког рада. У лабораторији се истражују својстава материјала, развијају материјали, креирају и спроводе експерименти, врши се истраживање боја, пигмента, лакова, испитивања грађевинских материјала, организују се и спроводе испитивања и снимања стања културних добара, утврђује се степен оштећења и одређују методе у сарадњи са стручним одељењима за успоравање, заустављање и спречавање деструктивних процеса. Примењују се недеструктивне методе у процесу конзервације и рестаурације, води документација о изведеним испитивањима и истраживањима. Стручњаци запослени у лабораторији РЗЗСК-а такође издају услове по којима се могу изводити мере техничке заштите на културним добрима, врше надзор над извођењем радова, учествују у раду комисија за пријем конзерваторско-рестаураторских радова, у другим пројектима, организовању радионица и ангажовани су на пројектима међународне сарадње. Хемичари лабораторије били су укључени у бројне истраживачке радове на скоро свим споменицима културе од изузетног и великог значаја Републике Србије који су извођени у претходном периоду као и у изради елабората и пројеката конзервације и рестаурације, њиховом праћењу и решавању конзерваторске проблематике. Активности лабораторије биле су усмерене и на бројне анализе узорака за потребе других установа културе као што су музеји, библиотеке, архиви, регионални и локални заводи и Факултет примењених уметности.

Аналитичка опрема физичко-хемијске лабораторије

Након оснивања лабораторије, почетног узлета и остваривања добрих резултата, уследио је период стагнације узрокован кризом на простору бивше Југославије тј. немогућношћу обнављања и куповине нове и модерне лабораторијске опреме каква се у сваком времену сматрала стандардом у сличним лабораторијама развијених земаља. Постојећа аналитичка опрема и инструменти набављени половином претходног века нису одговарали траженим захтевним анализама изузетно малих узорака узетих са културних добара које је требало анализирати на савремен начин. Развојем оптоелектронике и рачунарске опреме појавили су се преносни аналитички инструменти и развијане технике и методологија рада недеструктивним и неинвазивним методама на културним добрима. Стручњаци физичко-хемијске лабораторији Републичког завода направили су план обнове и развоја лабораторије у неколико фаза како би је унапредили и учинили достојном њене претходне репутације. Опремање је изведено етапно. Финансијска средства обезбеђена су од стране Министарства културе Републике Србије у партијама током три године. У првој фази (2014. година) реновиран је простор лабораторије и набављен део лабораторијског намештаја, столови и судопере, столови за ваге и ормани за складиштење хемикалија, киселина, база и органских растварача. Набављен је део аналитичке опреме: инфрацрвени спектрометар (FTIR) са ATR модулом и преносни рендгенски флуоресцентни спектрометар (XRF). У другој фази (2015. година) набављен је Раманski микроскоп са одвојеним преносним портабл спектрометром за рад на још једној таласној дужини и инфрацрвени микроскоп (μ-FTIR) добијен кроз програм донација владе Јапана. Током треће фазе (2016. година) прибављен је системски оптички микроскоп са додацима за рад у пропуштеном и одбијеном видљивом делу спектра, поларизационом и UV светлу, као и термовизијска камера. Поред наведене капиталне аналитичке опреме, физичко хемијска лабораторија располаже UV-Vis спектрофотометром , камером са проширеним опсегом CCD детектора од 350-1200 nm и инфрацрвеном камером са InGaAs детектором (1700 nm) за извођење хиперспектралних анализа тј UV,UV флуоресцентних и IR рефлектографских снимања као и инструментима за мерење садржаја влаге недеструктивним микроталасним методом на различитим дубинама зида, сензорима за on-line снимања и праћење микроклиматских параметара, pH-метром, кондуктометром, машинама за полирање и осталом додатном класичном лабораторијском опремом за припрему узорака. Избором поменуте опреме омогућен је већи део анализа и истраживања која се захтевају од физичко хемијске лабораторије. Део анализа које није могуће урадити у лабораторији због недостатка специфичних аналитичких инструмената или знања из стручних специјалистичких области обавља се у сарадњи са другим научним институцијама и стручњацима Републике Србије.

Сарадња са другим установама

Стручњаци Физичко-хемијске лабораторија Републичког завода за заштиту споменика културе остварују сарадњу са многим реномираним научним институцијама Републике Србије као што су Хемијски факултет, Физичко-хемијски факултет, Рударско-геолошким факултет, Биолошким факултет, Институт за испитивање материјала, ИХТМ, Грађевински факултет, Институт безбедности, Институт Винча, Технолошки факултет у Новом Саду, Лабораторија Народног Музеја и другим научним установама и истраживачима Републике Србије.

Резултати рада

Резултате својих истраживања на најзначајнијим српским споменицима културе стручњаци тренутно запослени у физичко хемијској лабораторији објавили су у преко 60 радова у бројним домаћим и страним научним и стручним часописима и презентују их на скуповима и конференцијама из области конзервације у земљи и иностранству.

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Arheometrija u Institutu Vinča 2014-2024

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Počevši od 2005. godine preko prve konferencije Lanterna koja je održana 2014. godine razvoj i primena arheometrijskih istraživanja u Institutu Vinča i Laboratoriji za hemijsku dinamiku i permanentno obrazovanje 060 je neprekidan i konstantnog intenziteta. U periodu 2005-2014. godina postavljene su dobre i sa današnjeg stanovišta čvrste osnove za ovakav razvoj.

Ovaj rad obuhvata prikaz arheometrijskih aktivnosti realizovanih u Laboratoriji za hemijsku dinamiku i permanentno obrazovanje 060 u proteklom periodu za koje smatramo da predstavljaju veći deo arheometrijskih istraživanja koja se realizuju u Institutu. U nastavku rada prikazan je segment arheometrijskih istraživanja u Laboratoriji za fiziku 010.

U vreme kada je održana prva konferencija Lanterna u novembru 2014. godine skoro da je prošlo 10 godina od prvog rada u kojem su publikovane naše aktivnosti u oblasti arheometrije i proučavanja kulturnog nasleđa. Te početke primene nedestruktivnih analiza možemo svakako okarakterisati kao pionirske jer je Laboratorija 060 bila jedina koja je imala i koristila EDXRF spektrometar (sa Si(Li) detektorom bez obzira što nije imao karakteristike mobilne opreme) u svrhu analize materijala od kojih su napravljeni predmeti kulturnog nasleđa. U tom trenutku se njegova nedestruktivnost i neinvazivnost u radu činila dovoljnom za primenu bez obzira na ograničen kvalitet dobijenih rezultata ispitivanja. Vremenom su naša znanja, veštine i iskustva omogućili projektovanje i izradu prvog prenosnog EDXRF spektrometra koji je postizao mnogo bolje rezultate ispitivanja, odličnu površinsku rezoluciju uz očuvanu neinvazivnost merenja i postignutu mobilnost i realizaciju merenja na terenu. Od tog trenutka, kreće intenziviranje arheometrijskih istraživanja u Laboratoriji 060 i realizacija brojnih zajedničkih projekata sa značajnim kulturnim institucijama poput Narodnog muzeja i Muzeja Savremene umetnosti u Beogradu, Galerije Matice srpske i Galerije Pavle Beljanski u Novom Sadu. Analiziran je veliki broj umetničkih slika i ikona iz njihovih depoa čime su dobijeni prvi podaci o korišćenim materijalima (pigmentima) što je omogućilo kvalitetnije procese restauracija i nova saznanja o slikarskim tehnikama značajnih nacionalnih autora. U tih prvih 10 godina našeg rada znanja smo sticali i kroz učešća u međunarodnim projektima koje je finansirala IAEA u okviru kojih je ostvarena poseta nekim evropskim laboratorijama koje se bave sličnim istraživanjima.

Nakon 2014. godine, saradnici Laboratorije intenziviraju aktivnosti na promociji arheometrijskih istraživanja istovremeno unapređujući broj dostupnih analitičkih usluga kao i kvalitet dobijenih rezultata. Poseban segment rada predstavlja primena hemometrijskih postupaka čime se postiže značajno bolje iskorišćenje dobijenih analitičkih podataka i postižu kvalitetniji zaključci koji prate ispitivanja. Na taj način se naučnim metodama potvrđuju klasifikacije, atribucije i autentifikacije predmeta kulturnog nasleđa. U periodu 2004-2014. godine saradnici Laboratorije u svoj rad uključuju i druge instrumentalne tehnike poput FTIR spektrometrije koja je takođe dostupna kao prenosna neinvazivna instrumentalna tehnika čime se upotpunjuju informacije koje se prikupljanju EDXRF tehnikom. Pored toga, saradnici Laboratorije uspevaju da kompletiraju i novi prenosni EDXRF uređaj sa usavršenim detektorom (SDD detektor pored već dokaznog Si-PIN detektora) i novom rendgenskom cevi čime je unapređen tehnički potencijal Laboratorije za realizaciju neinvazivnih terenskih istraživanja. Obavljaju se ispitivanja u prostoru Galerije Matice srpske, Narodnog muzeja u Beogradu, Centralnog instituta za konzervaciju, Viminacijumu, Gamzigradu, Muzejima u Nišu i Požarevcu uz značajnu promociju tih aktivnosti kroz prisustvo studenata i učenika tim aktivnostima kao i profesionalaca iz oblasti konzervacije, restauracije,

arheologije. Izvršena su ispitivanja pigmenata i ostalih materijala na delima Nadežde Petrović, Katarine Ivanović, Save Šumanovića, Paje Jovanovića, Milene Pavlović Barili, Petra Lubarde, Lazara Vozarevića, na zografskim ikonama kao i ikonama čiji su autori Longin, Dimitrije Bačević, Teodor Kračun i Arsa Teodorović. U saradnji sa Narodnim muzejom analizirani su pigmenti na slikama holandskih majstora (Cornelis de Vos, Peter Paul Robens, Hijeronim Boš, Jan Brojgel stariji i dr) iz fundusa muzeja u cilju restauratorskih aktivnosti. Analizirani su pigmenti na freskama koje su izložene u Viminacijumu i Muzeju u Požarevcu kao i veliki broj ostalih arheoloških uzoraka (keramika, oruđe i alati, nakit, zgure, perlice i sl).

U Laboratoriji je razvijena metodologija rada koja uključuje i dokumentovanje analitičkog postupka u cilju boljeg tumačenja rezultata i formiranja odgovarajućih baza podatak za korisnike. Saradnici Laboratorije su izradili baze podataka sa rezultatima ispitivanja određenih predmeta kulturnog nasleđa (ikone, arheološka keramika) čime je omogućeno da korisnici imaju pristup analitičkim podacima na jednostavan način. Danas saradnici Galerije Matice srpske i Arheološkog instituta imaju mogućnost pristupa bazama podatka sa rezultatima ispitivanja, fotodokumentacijom kao i objašnjenjima za predmete kulturnog nasleđa koje smo analizirali za potrebe tih institucija.

Uporedo sa ovim načinom promocije, saradnici Laboratorije u skladu sa dostupnim mogućnostima učestvuju u medijskim kampanjama i novinskim prilozima kao i značajnim angažovanjem na društvenim mrežama. Pokrenuta je internet stranica www.arheometrija.rs kao i instagram stranica arheometrija_vinca. Saradnici Laboratorije su održali brojna predavanja u različitim institucijama u zemlji kao i u inostranstvu (Univerzitet u Peruđi, Univerzitet La Sapienza u Rimu, Istituto Restauro Roma-IRR u Rimu, Fakultetu likovnih umjetnosti, Univerziteta Crne Gore). U okviru akademskog obrazovanja u Laboratoriji 060 su realizovane doktorska i master teze u oblasti proučavanja predmeta kulturnog nasleđa savremenim analitičkim i hemometrijskim tehnikama.

Od 2020. godine dolazi do značajnog pomaka u organizacionom pogledu jer su sada saradnici Laboratorije 060 angažovani na poslovima proučavanja kulturnog nasleđa u okviru posebne naučno-istraživačke teme u Institutu VINČA – *Razvoj i primena neinvazivnih, nedestruktivnih i prenosnih spektrometrijskih tehnika (XRF, FTIR, XRD, multispektralna analiza)* čime su po prvi put ove aktivnosti institucionalno finansirane i arheometrijska istraživanja postala sastavni deo naučnih istraživanja. Pored toga, dr Maja Gajić-Kvaščev je deo tima koji uključuje i saradnike Arheološkog instituta na projektu *THE FLOW* koji je finansiran od strane Fonda za nauku Republike Srbije i u okviru kojeg je Laboratorija 060 dobila prenosni XRD instrument čime je otvoreno još jedno novo polje rada i unapređen analitički potencijal Laboratorije. Pored analize hemijskog sastava materijala, saradnici Laboratorije sada mogu da na osnovu rezultata XRD analiza procene temperature pečenja keramike čime se stiču nova saznanja o tom segmentu arheoloških istraživanja.

Deo navedenih aktivnosti u oblasti proučavanja kulturnog nasleđa je u proteklih 10 godina publikovan u međunarodnim časopisima i saopšten na međunarodnim konferencijama na kojima saradnici Laboratorije redovno učestvuju. Broj publikacija je značajno veći u odnosu na prvu dekadu aktivnosti i obuhvata spisak od 12 radova kategorije M20, 25 saopštenja na međunarodnim i domaćim konferencijama kao i jedno tehničko rešenje na međunarodnom nivou (izrada protokola za kompaniju *Ars Mensurae* iz Rima koja se bavi proučavanjem kulturnog nasleđa).

Pored uloge i aktivnosti u akademskoj i naučnoj zajednici, Laboratorija 060 je stekla značajan ugled i u krugovima privatnih kolekcionara i galerista u zemlji pa čak i u inostranstvu. Na osnovu toga je Laboratorija uradila veliki broj analiza i ekspertiza materijala na predmetima kulturnog nasleđa što uključuje više od 50 umetničkih slika raznih domaćih i stranih autora kao i nekoliko ikona i metalnih predmeta i nakita u skladu sa zahtevima korisnika. Na taj način saradnici Laboratorije 060 su uspeli da naučna znanja i protokole ponude tržištu.

Arheometrijska istraživanja u Laboratoriji za fiziku Instituta za nuklearne nauke Vinča: dosadašnji rezultati i planovi za budućnost

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Istorijat

Ideja o naučnim istraživanjima u oblasti kulturnog nasleđa u Laboratoriji za fiziku 010 Instituta za nuklearne nauke Vinča, rodila se u okviru dogradnje postojećeg postrojenja FAMA (Facility for Modification and Analysis of Materials) [1], u okviru koje je predviđena izgradnja kanala C6 za analizu materijala jonskim snopovima u vazduhu [2]. Projektovana oprema omogućava nedestruktivnu analizu materijala, što je čini pogodnom za ispitivanje artefakata kulturnog nasleđa. Projekat u prvoj fazi obuhvata metod PIXE (Proton Induced X-ray Emission), a u drugoj PIGE (Proton-Induced Gamma-ray Emission) sa snopovima protona od 1-3 MeV, 10 – 100 nA. Kombinovanom metodom PIXE-PIGE u načelu se mogu meriti koncentracije elemenata u opsegu od Z=11(Na) do Z=82(Pb).

U okviru priprema za planirana arheometrijska istraživanja, Laboratorija je stupila u neformalnu ali veoma plodnu saradnju sa Narodnim muzejem Srbije i Institutom Jožef Stefan iz Ljubljane. U okviru ove saradnje, napravljeno je više arheometrijskih istraživanja artefakata sa teritorije Srbije. Težište je bio na arheološkom staklu. Generalno, odabir artefakata i priprema uzoraka obavljana je u Narodnom muzeju Srbije, elementna analiza metodom PIXE-PIGE vršena je u Institutu Jožef Stefan, a analiza i interpretacija rezultata u Laboratoriji za fiziku, uz učešće svih autora. Obrađeni su uzorci arheološkog stakla sa deset lokaliteta u Srbiji: Gradina na Jelici (81 artefakt), Viminacijum (27), Egeta (11), Pontes (13), Diana (10), Hajdučka vodenica (2), Svetinja (7), Braničevo (24), Morava (17), Sirmium (44), ukupno 236 pojedinačnih artefakata.

Deo ovih istraživanja, sa analizom rezultata i arheološkom interpretacijom, predstavljeni su u pet radova u vrhunskim međunarodnim časopisima [3-7], jednom poglavlju u knjizi [8] i na sedam međunarodnih skupova. Takođe, u okviru ovog istraživanja, Laboratorija za fiziku je u oktobru 2022. godine u saradnji sa Narodnim muzejom Srbije organizovala veoma uspešan Osmi međunarodni simpozijum iz arheometrije (BSA 8), na kojem je učestvovao do sada najveći broj naučnika iz najvećeg broja zemalja, petnaest, uključivši i devet ne-balkanskih zemalja [9]. Predstavljen je četrdeset i jedan rad, a odabrani i ocenjeni radovi objavljeni su u tematskom broju međunarodnog časopisa IANSA, čiji je urednik bio R. Balvanović [10].

Treba istaći da je broj do sada izmerenih uzoraka arheološkog stakla u okviru ove aktivnosti znatno veći od svega što je do tog trenutka izmereno sa teritorije Srbije [11-14] . Već sada, ovi rezultati čine osnovu za objavljivanje velike monografije o arheometriji stakla u Srbiji u periodu 1 – 12 veka, o čemu je već postignut načelan dogovor među saradnicima.

U okviru ovih napora da se uđe što dublje u problematiku arheometrije, a dok se čeka završetak kanala C6 za analizu materijala Vinči, R. Balvanović je rukovodio dvama projektima u okviru međunarodne saradnje Dubna – Srbija. U okviru ovih projekata (aktuelni ističe krajem tekuće godine) obavljena su merenja trace elemenata i lantanoida metodom Analize nuklearnom aktivacijom (NAA – Nuclear Activation Analsyis), ukupno 20 artefakata, a trenutno se čekaju i rezultati novog merenja još dvadeset artefakata. Takođe, od sredstava preostalih sa BSA 8, plaćena su izotopska merenja dvadeset uzoraka na Univerzitetu u Firenci, veoma značajna za utvrđivanje porekla artefakata, što je u arheologiji od prvorazrednog značaja. Treba napomenuti da se neophodna osetljivost merenja izotopa Sr i Nd ne može dobiti ni u jednoj laboratoriji u Srbiji.

U sadašnjem periodu završavaju se započeti poslovi, što podrazumeva analizu već obavljenih merenja artefakata sa Braničeva, Morave i Sirmiuma, te pisanje radova. Ovi rezultati treba da budu objavljeni u najmanje naredna tri rada. Takođe, jedan broj uzoraka je u okviru tekućeg projekta sa JINR na analizi u JINR (metode Differential scanning calorimetry i elektronski mikroskop), sa ciljem odgovora na pitanje da li se radi o delovima staklarske peći ili ne, što je pitanje značajno za arheologiju. Ova merenja tek treba da se urade, a podaci analiziraju i objave.

Planovi za budućnost

Rukovodilac ovih istraživanja i dosadašnji rukovodilac Laboratorije za fiziku, R. Balvanović, od nedavno u je penziji. Pošto u Laboratoriji nema više nikoga ko se bavi arheometrijom, a Institut Vinča ne želi da mu da odgovarajući ugovor koji bi mu omogućio završavanje tekućih i vođenje daljih poslova, pojavljuje se problem rukovođenja budućim poslovima, odnosno već planiranim i u načelu dogovorenim projektom arheometrijskih istraživanja, a u okviru saradnje Dubna – Srbija. Preliminarna saglasnost o ovome jeste postignuta, ali ostaje da se ove stvari i operacionalizuju.

Naredno pitanje, koje smo zapravo već postavili posebnim radom u Zborniku sa BSA 8 [15], jeste pitanje budućnosti arheometrije u Srbiji. U navedenom radu predložili smo osnivanje Arheometrijskog društva Srbije, kao ključnog instrumenta u definisanju ciljeva i programa arheometrijskih istraživanja u budućnosti, koordinacije rada, deljenja postojeće naučne opreme i nabavci nove, naporima da se arheometrija podigne na punopravni naučni nivo u Srbiji, da uđe u nastavne planove i programa pojedinih visokoškolskih institucija kao redovni ili izborni predmeti, master i doktorski program. Dalji cilj – od koga smo u Laboratoriji za fiziku zapravo davno i počeli – bio bi osnivanje posebne, namenske arheometrijske laboratorije, koja bi postala vučna lokomotiva cele arheometrije u Srbiji. Naša izvorna ideja bila je da to bude postrojenje C6 na FAMI, ukoliko se ono završi, sa idejom da se na već planirane metode dodaju i ostale komplementarne metode kao što su LA-ICP-MS, datovanje pomoću C-14 i druge. Ovakav predlog uzima u obzir i činjenicu da se i sestrinska laboratorija iz Instituta Vinča takođe bavi arheometrijom već duže vreme (prenosivi XRF).

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Mogućnosti povezivanja humanističkih i prirodnih nauka kroz obrazovanje

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Naučna oblast arheometrije obuhvata aktivnosti usmerene na naučne, empirijske i sistematske načine prikupljanja, analize i tumačenja podataka koji se odnose na neorganske i organske materijalne zapise ljudske istorije. Tehnike različitih prirodnih i tehničko-tehnoloških nauka ukrštaju se sa humanističkim disciplinama poput arheologije, istorije, istorije umetnosti, koje korpusu znanja proisteklog iz naučnih analiza dodaju arhivske podatke, istorijske analize i sagledavanje problema iz sasvim drugog ugla.

Specifični studijski programi usmereni na arheometriju ne postoje u Srbiji. Studenti prirodnih nauka imaju malo dodira sa humanističkim naukama i umetnostima. Studenti istorije umetnosti imaju nedovoljno znanja o tehnologiji materijala, i gotovo nimalo o arheometriji. Studije konzervacije su obično u okviru umetničkih akademija i fakulteta umetnosti. Iako obavezno uče i o prirodnim naukama, studenti konzervacije su pre svega fokusirani na stručni konzervatorski aspekt rada na predmetima kulturnog nasleđa.

Kakva je situacija u Evropi? Kada se malo pogleda panorama multidisciplinarnih studija u Evropi koje teže formiranju stručnjaka koji imaju kompetencije za ispitivanja umetničkih dela i drugih predmeta kulturnog nasleđa, uočavaju se dve grupe programa. Prvu grupu čine oni koji polaze od osnove u humanističkim naukama i umetnosti, na koju nadograđuju kompetencije prirodnih nauka. Takav je, na primer, master program Univerziteta u Amsterdamu, koji je startovao 2023. godine.[1] To je jedna od devet specijalizacija na master studijama konzervacije, u trajanju od dve godine, pod nazivom *Technical Art History*. Zanimljivo je pogledati spisak predmeta na ovom dvogodišnjem masteru:

Prva godina mastera:

- *Technical Art History. Defining the field*
- *Skill Building for Conservation I: Imaging and Documentation*
- *Chemistry of Materials in Art*
- *Theory, Ethics, and Approaches in Technical Art History/ Conservation*
- *Art Technological Source Research*
- *The World of Materials I*
- *Imaging, Sampling, and Microscopy*
- *Historical Reconstructions*
- *The World of Materials II*
- *Preventive Conservation: Risk Assessment*

Druga godina mastera:

- *Analytical Tools and Techniques*
- *Object Analysis: Scientific Analysis and Interpretation*
- *A Material History of Art*
- *Technical Art History: Field Work*
- *Electives*
- *Master Thesis Conservation and Restoration of Cultural Heritage*

[1] https://www.uva.nl/shared-content/programmas/en/masters/conservation-and-restoration-of-cultural-heritage/study-programme/technical-art-history/technical-art-history.html?origin=znSrDUT%2BQ5uz6dso72fBmw (pregledano 19.10.2024.)

Nešto drugačije koncipirane studijske programe usmerene na ispitivanja kulturnog nasleđa čine oni u kojima dominiraju prirodne nauke, za šta ima primera u Italiji, na univerzitetima u Rimu, Milanu, Firenci i drugim gradovima Italije.

Uzmimo za primer studijski program Tehnologije za konzervaciju i restauraciju kulturnog nasleđa (*Tecnologie per la Conservazione e il Restauro dei Beni Culturali*) Univeziteta *La Sapienza* u Rimu.[2] Nakon trogodišnjih osnovnih studija, postoji dvogodišnji master, koji se nudi na italijanskom i engleskom jeziku, sa malim razlikama u popisu predmeta:

- *Advanced Physical Methods Applied to Cultural Heritage*
- *Organic Chemistry and Dyes*
- *Geomaterials for Cultural Heritage*
- *Advanced Chemical Methods in Archeological Material Science*
- *The Bioarcheology of Food*
- *Advanced Biological Methods Applied to Cultural Heritage*
- *Climate Risk Assesment of Cultural Heritage*
- *Stone Tool Technology Laboratory*
- *Experiment and Experience in Archeology*
- *Human Paleobiology and Bioarcheology*
- *Archeometry and Laboratory of Archeometry*
- *Master Thesis*

Ipak, najčešći način dolaska to specijalizacije u arheometriji je kroz rad na projektima. Takvih primera ima mnogo više, na svim kontinentima. Jedan od njih, dat ovde samo kao primer, je *Art Institute of Chicago Center for Scientific Studies in the Arts*[3], koji ima kolaborativni program u nauci o konzervaciji i koji se bavi naučnim istraživanjima kako bi se unapredila uloga nauke u istoriji umetnosti, kustoskim naukama, arheologiji i konzervaciji.

Članovi timova se uključuju sa različitim prethodnim znanjima i iskustvima i zajedno, kroz rad, sve više prepliću znanja, dolazeći postepeno do interdisciplinarnosti u pravom smislu te reči.

Kakvi programi postoje u formalnom obrazovanju u Srbiji, u pravcu uvođenja tema vezanih za naučna ispitivanja predmeta kulturnog nasleđa?

Na umetničkim fakultetima i akademijama, multidisciplinarni programi u kojima postoji obuka o ispitivanjima materijala u nasleđu vezani su za studijske programe konzervacije i restauracije. Ovakvi predmeti postoje na Fakultetu primenjenih umetnosti u Beogradu i Akademiji umetnosti Univerziteta u Novom Sadu. Na fakultetima humanističkih nauka, kao fundamentalnom polju koje se bavi istraživanjem i vrednovanjem nasleđa, materijalnim aspektom nasleđa najviše se bavi arheologija. U polju tehničko-tehnoloških nauka ispitivanjem materijala u nasleđu bave se na tehnološkim fakutetima. U polju prirodnih nauka, takođe, ima nekoliko inicijativa za uvođenje veze prirodnih nauka i materijala kulturnog nasleđa.

U nastavku su dati neki primeri predmeta u okviru akreditovanih studijskih programa na Univerzitetima u Beogradu i Novom Sadu, u kojima je bar jedan deo vezan za ispitivanje materijala predmeta kulturnog nasleđa, s mogućnošću a lista nije konačna:

- Fakultet primenjenih umetnosti u Beogradu - odsek Konzervacija i restauracija - predmeti: Nauka i inženjerstvo materijala u konzervaciji i restauraciji 1 i 2, Metode konzervatorskih ispitivanja, Metode naučno-istraživačkog rada u konzervaciji i restauraciji.
- Akademija umetnosti u Novom Sadu - studijski program konzervacija i restauracija (master) predmeti Ispitivanja materijala u konzervaciji, Metodologija naučno-istraživačkog rada.
- Filozofski fakultet u Beogradu - studijski program Arheologija - predmeti Osnove metodologija arheoloških istraživanja; Fizička antropologija - osteoarheologija; Datovanje za

[2] https://corsidilaurea.uniroma1.it/it/corso/2024/28702/home (pregledano 19.10.2024)

[3] https://www.mccormick.northwestern.edu/materials-science/research/areas-of-research/art-conservation-science.html (pregledano 19.10.2024.)

arheologe,
- Fakultet za fizičku hemiju u Beogradu - master studije - predmet: Fizičkohemijske metode u arheometriji,
- Tehnološki fakultet u Novom Sadu - master Inženjerstvo materijala, predmet Materijali u zaštiti kulturnog nasleđa;
- Na Prirodno-matematičkom fakultetu u Novom Sadu - Departman za hemiju, biohemiju i zaštitu životne sredine - Master Analitička hemija, predmet Hemija u umetnosti.
- Na Univerzitetu u Novom Sadu - interdisciplinarne master studije Forenzike - predmet: Forenzika umetničkih dela i boja.

Pored ovih predmeta, obaveznih ili izbornih, koji su deo akreditovanih studijskih programa, postoje i različite inicijative neformalnog obrazovanja i promocije nauke u konzervaciji i arheometrije, kroz letnje škole, radionice i slično. Navešćemo ovde dva primera saradnje visokoškolskih ustanova i ustanova kulture:
- Letnje škole Ispitivanja materijala u kulturnom nasleđu koje organizuje Tehnološki fakultet Univerziteta u Novom Sadu, i gde su tradicionalni partneri Tehnološki fakultet, Pokrajinski zavod za zaštitu spomenika kulture i Galerija Matice srpske;
- Praksa studenata istorije umetnosti iz Beograda u Galeriji Matice srpske, na predmetu Heritološke tehnike, gde studenti istorije umetnosti i studenti konzervacije zajedno rešavaju pitanja analize i atribucije umetničkih dela.

U zaključku može se konstatovati da potencijali za formiranje interdisciplinarnih studijskih programa na visokoškolskim ustanovama u Srbiji postoje, ali oni još nisu iskorišćeni. Neophodan preduslov za akreditaciju takvih programa je, osim stručnjaka sa adekvatnim kompetencijama, i postojanje laboratorija sa odgovarajućom opremom, kao i podrška više ministarstava za razvijanje oblasti arheometrije. U suprotnom, razvoj studijskih programa u oblasti arheometrije ostaje na entuzijaznu malobrojnih stručnjaka, u različitim ustanovama, pod ingerencijom različitih ministarstava, kao što je bilo i u protekloj deceniji koju ovde sumiramo.

Istraživanje istorijskih maltera - multidisciplinarnost, interdisciplinarnost ili transdisciplinarnost? Nije svejedno.

Emilija Nikolić, Arheološki institut, Beograd

Projekat *Mortar Design For Conservation – Danube Roman Frontier 2000 Years After (MoDeCo2000)*, sproveden od 2020. do 2022. godine, objedinio je rad tri naučne institucije u Srbiji[1] sa osnovnom namerom da istraživanjem istorijskih maltera na studiji slučaja *Granice Rimskog carstva – Dunavski limes u Srbiji* doprinese *multidisciplinarnom* naučnom poznavanju istorijskih građevinskih materijala i tehnologija, u cilju podrške održivoj zaštiti i upotrebi predela iz Rimskog perioda na teritoriji Srbije. Specifični ciljevi projekta uključili su: razvoj sveobuhvatne naučne baze iz oblasti arheologije, arhitekture, nauke o konzervaciji, tehnologije, geologije i hemije lokalnih sirovina sa pucolanskim svojstvima, kao i antičkih tehnologija spravljanja maltera; dizajn i testiranje maltera za konzervaciju zasnovanih na lokalnim sirovinama i tradicionalnim tehnologijama proizvodnje u svrhu dugoročne zaštite i rehabilitacije istorijskih spomenika; kreiranje seta preporuka i mera za očuvanje, zaštitu i upravljanje spomenicima, a za potrebe nominacionog dosijea koji se predaje za Uneskovu listu svetskog nasleđa na osnovu smernica Ikomosa, i; doprinos savremenom održivom građevinarstvu i arhitekturi upotrebom tradicionalnih tehnologija i promocijom razumnog korišćenja prirodnih resursa, unapređujući život lokalnih zajednica. Naučni koncept projekta zasnovan je na nekoliko ideja: savremena nauka o konzervaciji zahteva holistički *multidisciplinarni* pristup, pa zato koncept polazi od sveobuhvatnog *kros-disciplinarnog* istraživanja o sirovinama i građevinskim tehnologijama iz doba rimske dominacije u regionu, koje će pružiti vredne naučne informacije za praktičnu konzervaciju građevina; istraživanje pomenutih tema veoma je važno za procese savremene gradnje jer može dati korisne informacije za razvoj novih industrijskih rešenja oslanjajući se na prošlost uz očuvanje prirodnih resursa; zaštita istorijskih građevina podrazumeva i očuvanje tradicionalnih veština potrebnih za ovaj proces, postajući tako jedan od načina očuvanja nematerijalnog kulturnog nasleđa, i; prikupljene informacije o građevinskim tehnologijama i potrebama poboljšavaju naučno razumevanje pojedinačnih zajednica i njihovog svakodnevnog života na jednoj teritoriji kroz istoriju[2].

Vidimo da se u opisu namera, ciljeva i koncepta projekta *MoDeCo2000* nalaze termini *multidisciplinarnost* i *kros-disciplinarnost*. U daljem tekstu predloga projekta pojavljuje se i *transdisciplinarnost*. Naime, priprema predloga je započela stidljivo, ali uz čvrstu veru članova tima u značaj njegovih ciljeva, prirodno se uklapajući u savremene trendove neophodnosti saradnje naučnih i stručnih disciplina, jednostavno ih primenjujući na temu istorijskih maltera. Nakon završetka projekta, pokazalo se da nijedan od danas prihvaćenih vidova individualnih istraživanja, a zatim i saradnje među disciplinama ljudskog delovanja, opisanih često kroz termine *disciplinarnost, intradisciplinarsnot, kros-disciplinarnost, interdisciplinarnost*, *multidisciplinarnost* i *transdisciplinarnost*, nije bio samostalno primenjen u nekoj od mnogobrojnih projektnih aktivnosti kako bi zadati ciljevi bili postignuti. Njihovo stalno preplitanje bilo je uobičajeno i podrazumevalo se.

Jedan od materijala čije istraživanje spaja oblasti *arheometrije* i *nauke o konzervaciji* u neraskidivu vezu kroz međusobnu saradnju disciplina upravo je istorijski malter. Iako možemo pojednostavljeno reći da arheometrija kroz primenu nauka o materijalima vrši karakterizaciju istorijskih materijala, a nauka o konzervaciji primenom inženjerstva materijala deluje u muzejskoj i

[1] Истраживање спроведено уз помоћ Фонда за науку Републике Србије, #6067004, MoDeCo2000, PROMIS, #6067004. Nosilac projekta: Arheološki institut; partneri projekta: Tehnološki fakultet Novi Sad Univerziteta u Novom Sadu i Institut za ispitivanje materijala a.d.; rukovodilac projekta: dr Emilija Nikolić; članovi projekta: dr Mladen Jovičić, dr Snežana Vučetić, dr Jonjaua Ranogajec, Ljiljana Miličić, Ivana Delić-Nikolić, dr Nevenka Mijatović i dr Biljana Ilić.

[2] Delić-Nikolić i dr. 2024, 4–5.

arhitektonskoj konzervaciji i restauraciji, međusobna granica delovanja ove dve blisko povezane oblasti često je nejasna. Obe stvaraju dragocenu vezu humanističkih i umetničkih disciplina sa prirodnim i inženjerskim disciplinama, rešavajući probleme razumevanja prirode istorijske građe i načine njene interpretacije, istražujući ljudsku istoriju i pružajući pomoć u očuvanju građevina i predmeta[3]. Međutim, upravo ovo složeno preplitanje više oblasti, ali i opravdana potreba da se nasleđe ne samo prouči, već i razume i prikaže javnosti, dovelo je do imenovanja nove oblasti koja bi prethodne objedinila - *nauke o nasleđu*. Ona obuhvata sve oblike naučnog istraživanja dela koje je samostalno stvorio čovek ili u zajednici sa prirodom, a koja su od važnosti za čovečanstvo, podstičući razumevanje, brigu i održivo korišćenje i upravljanje materijalnim i nematerijalnim nasleđem, kako bi obogatila naš sadašnji i budući život[4]. Kao naučna oblast, predstavlja niz različitih naučnih izazova koji su postavljeni pred nama u očuvanju kulturnog nasleđa, tokom upravljanja stalnim promenama kroz koje ono prolazi.[5]

Zajedničku karakteristiku svih navedenih oblasti, bez obzira na njihovo imenovanje, predstavlja neophodnost simultanog individualnog rada i saradnje između velikog broja naučnih i stručnih disciplina tokom aktivnosti. Nekada je važno da ideja prođe svoj celokupan put u mislima jednog istraživača i onda svoju primenu nađe kroz rad grupe. S druge strane, nekada jedino rad u zajednici može dovesti do ideje kod nekoga od nas. Putanje sticanja naučnog znanja su nekada jasno utvrđeni, ali često oni slučajni i pojedinačni izleti sa utabane staze doprinose njegovom istinskom unapređenju, koje na kraju kroz zajedničko putovanje dovodi do ispunjenja naučnih ciljeva.

Istraživanje istorijskih maltera je vezano za naučna istraživanja iz oblasti arheologije i nauke o materijalima, kao i za praktičnu konzervaciju. Cilj karakterizacije maltera tokom arheoloških istraživanja je dobijanje saznanja o poreklu, distribuciji i transportu sirovina, kao i o građevinskim tehnologijama i društveno-ekonomskom kontekstu u kome su one primenjivane. Nauka o materijalima karakterizaciju maltera sprovodi kako bi se dobila znanja o njihovoj proizvodnji, ponašanju i procesima koji se u njima odvijaju, a u cilju unapređenja tradicionalnih materijala ili razvoja savremenih materijala. Uz pomoć rezultata karakterizacije vrši se izbor sirovina i njihovih međusobnih odnosa u malteru, kao i tehnologije njegove pripreme, za potrebe konzervacije, uz prethodno utvrđivanje stanja istorijskog maltera i uzroka eventualnih problema u okviru struktura kojima pripada.[6]

Upotreba maltera utiče na sve karakteristike jedne građevine – od strukturnih do estetskih, odnosno na njenu stabilnost, ali i način na koji je koristimo, posmatramo i vrednujemo. Stoga bi odluku o odabiru maltera u procesu konzervacije, odnosno o vidovima kompatibilnosti koje moramo ispuniti, trebalo doneti na osnovu karakterizacije istorijskih materijala i tehničkih zahteva konzervacije, ali i istraživanja svih vrednosti građevine[7]. Konzervacija predstavlja i jedan od načina očuvanja tradicionalnih veština i zanata, jer njihova primena nije samo preduslov za njeno uspešno sprovođenje, već i način da budu sačuvane kao vredno nematerijalno nasleđe.[8] U okviru višednevne radionice projekta *MoDeCo2000* na arheološkom nalazistu Viminacijum u leto 2022. godine okupili smo istraživače – geologe, hemičare, arheologe, biologe, istoričare umetnosti, tehnologe, fizičare, ali i konzervatore, restauratore, arhitekte i zidare. Upravo je ova šarolikost pripadnika naučne i stručne zajednice kroz predavanja i praktičan rad na primeni naučnih i stručnih znanja uz pomoć alata i zanata radionicu učinila kompaktnom i celovitom, dajući joj smisao i prikazujući vrednosti i ciljeve projekta.[9]

[3] Artioli 2010, 1–5; Николић 2021, 88.

[4] ICCROM 2024.

[5] House of Lords 2006, 8.

[6] Hughes, Callebaut 2002, 71; Elsen 2006, 1417; Delić-Nikolić i dr. 2024, 33–35.

[7] Delić-Nikolić i dr. 2024: 35–38.

[8] Isto, 5.

[9] Isto, 309.

Da li je profesor Arhitektonskog fakulteta u Beogradu dr Slobodan Nenadović (1915-2004), tokom zapisivanja da savremeni metodološki pristup očuvanju spomenika počiva na „svestranoj naučnoj analizi svih elemenata“[10] i upotrebe termina *svestranost*, mislio na neki od danas aktuelnih vidova saradnje između disciplina, napred pomenutih kroz engleske termine? *Svestran* je onaj ko „obuhvata svu složenost pojava, problema“, *svestrano* je ono što se „ispoljava u svoj složenosti, višestruko, potpuno“, *svestrano* proučiti, ispitati ili pregledati znači sprovesti to „u svim pravcima“.[11] Ova jednostavna reč zaista obuhvata sve ono što je najznačnije postići tokom očuvanja spomenika – metodološki pristup i saradnju više oblasti ljudskog delovanja u rešavanju problema.

Tokom arheoloških iskopavanja često se dešava da pronađemo predmet koji je neko slučajno ispustio, zaboravio i koji nam govori o svakodnevnim aktivnostima čoveka iz prošlosti. U Viminacijumu je pre više godina pronađen trag jednog zidara – mistrija sa ostacima krečnog maltera, ostavljena na tek izgrađenom zidu. Da li gledajući ovaj izuzetan arheološki nalaz možemo zamisliti ruke zidara koje su kombinovale zrna agregata sa krečom i vodom, a zatim mešavine primenile upotrebom alata? Da li su istraživanja istorijskih maltera celovita ako otkrivamo njihov sastav, a ne i rad zidara koji su ih pripremali i koristili?[12] Studenti arhitekture često se pitaju zašto uče istoriju ili teoriju arhitekture kada će “biti arhitekte, a ne teoretičari ili istoričari“. Jedan od odgovora pružila je jedna profesorka istorije i teorije arhitekture: „Ono što je lepo u proučavanju građevina, teorija i ideja iz prošlosti jeste to što iznenada shvatimo da su stvari bile, i mogu da budu, potpuno drugačije...“[13] Upravo kroz istraživanje istorijskih maltera i primenu rezultata istraživanja koristimo znanja i veštine iz prošlosti, shvatajući da je neko pre nas imao iste suštinske dileme dok je projektovao građevinu, birao sirovine ili zidao konstrukciju, a da je njegovo iskustvo – materijalizovano kroz ono što je za nas danas deo nasleđa – pruženo nama da ga upotrebimo i dalje razvijamo.

Projekat *MoDeCo2000* ujedinio je arheologiju, arhitekturu, geologiju, hemiju i inženjerstvo materijala. Kroz učešće na brojnim međunarodnim i nacionalnim skupovima, kao i brojne publikacije,[14] prikazao je ciljeve, metodologiju i neke od rezultata istraživanja dobijenih tokom zajedničkog rada. Obaveza projektnog tima ostaje da celokupna projektna istraživanja interpretira i objavi, kako bi služili svima onima koji učestvuju u procesima istraživanja i zaštite kulturnog nasleđa. Verovatno jednu od najvećih vrednosti projekta predstavlja njegova *svestrana* priroda koja je prošla put od disciplinarnosti i intradisciplinarnosti, preko kros-disciplinarnosti i multidisciplinarnosti, do interdisciplinarnosti i transdisciplinarnosti. Bilo bi lepo kada bi svaka od ovih vidova saradnje u nauci imala svoj jedinstven naziv na sprskom jeziku. Možda je upravo *svestranost* ona vredna osobina naučnika koja objedinjuje radoznalost, želju za znanjem i otkrivanjem, širinu u sagledavanju problema, ali i sposobnost deljenja, razvijanja i promena ideja u saradnji sa drugima, kako bi rezultate zajednički i sistematično primenili u opštem interesu širenja saznanja i napredovanja nauke.

[10] Nenadović 1980, 30.

[11] Николић 2011, 1177.

[12] Nikolić and Jovičić 2022, 9; Delić-Nikolić i dr. 2024, 310.

[13] Vatum 2020, 162-163 u Delić-Nikolić i dr. 2024, 311.

[14] Balvanović et al. 2023; Вучетић и др. 2021; Николић 2021; Vučetić et al. 2022; Vučetić. Ranogajec 2022; Nikolić, Jovičić 2022; Vučetić i dr. 2023; Jovičić i dr. 2023; Mijatović et al. 2023; Nikolić et al. 2023; TFNS i dr 2023; Unković et al. 2023; Delić-Nikolić i dr. 2024; Nikolić et al. 2024; Delić-Nikolić et al. 2024; Miličić et al. 2024.

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