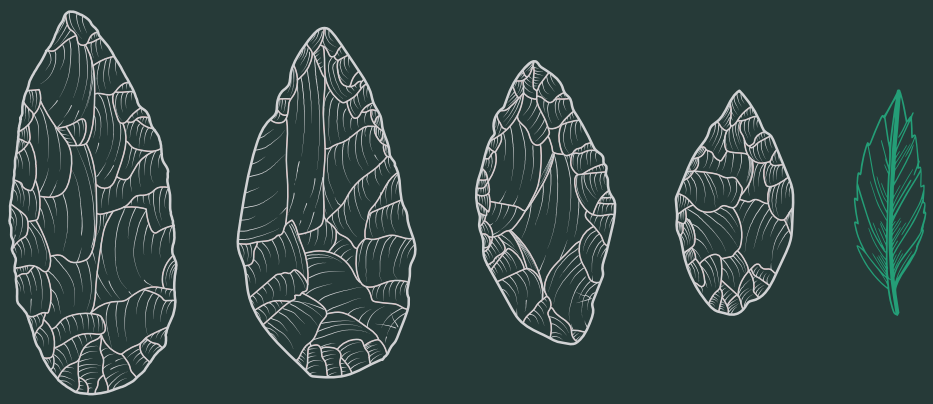
From tea leaves to leaf-shaped tools

STUDIES
IN HONOUR OF ZSOLT MESTER
ON HIS SIXTIETH BIRTHDAY



LITIKUM KÖNYVTÁR 2

EDITED BY
ATTILA KIRÁLY

LITIKUM KÖNYVTÁR 2

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Editor:

Attila Király



ELTE
EÖTVÖS LORÁND
UNIVERSITY



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INSTITUTE OF ARCHAEOLOGICAL SCIENCES,
ELTE EÖTVÖS LORÁND UNIVERSITY,
BUDAPEST, HUNGARY,

2023



LITIKUM KÖNYVTÁR 2

FROM TEA LEAVES TO LEAF-SHAPED TOOLS
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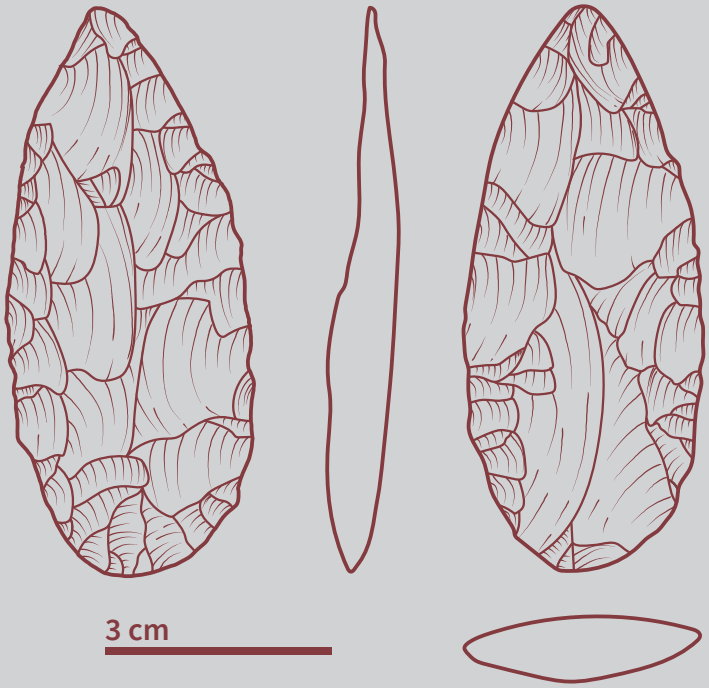
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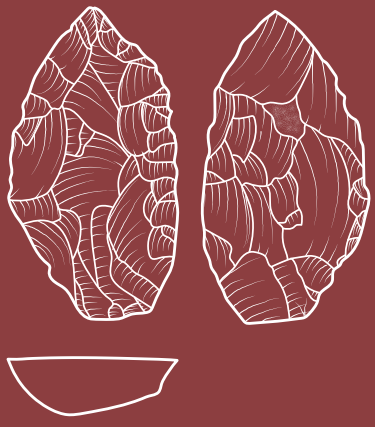
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JÁNOS GÁBOR TARBAY



Szeletian leaf-shaped tool.
After Kozłowski *et al.*, 2009, Planche 11.



Sajóbábony-Méhésztető, 2019. Zsolt and Agnès Lamotte from the University of Lille, carried out excavations at the eponymous site of the Bábonyien culture. In this case, the ever-smiling Zsolt shows the camera a bifacial tool freshly extracted from the profile with the seriousness that matches the find. To the great joy of the French-Hungarian team, this was not the only such specimen that we found during the excavation. To be continued…
Photo: Attila Király; drawing: after Kozłowski* et al.*, 2009.



Greeting Zsolt Mester

Dear Zsolt!

More than a decade ago, when you joined the Faculty of Arts, Institute of Archaeological Sciences of the ELTE Eötvös Loránd University, the educational palette of our institute, from the appearance of man to the archaeology of the early modern period, became complete with the field you represent. There have always been significant, internationally respected researchers of our country's rich Palaeolithic record. However, previously, museums gave space for their research, such as was the case with László Vértes and Miklós Gábori. You were already involved in the university-level education of the Palaeolithic at Miskolc University, but your teaching and research work gained a novel area and momentum in our institute. As a result, not only a special field closely intertwined with the natural sciences was introduced to our research site, but also its methodology and questions, which are somewhat different from the archaeological research of later historical periods. So far, you have mainly gained experience in cooperation with French and Polish researchers, thanks to which your research and teaching are permeated by a modern approach that interprets physical residues of the past in processes.

It also became apparent how the new investigation methods developed in Palaeolithic research can enrich the study of later archaeological periods. In our institute, we can directly experience as the *chaîne opératoire* concept (of which you and your colleagues were the first presenters in Hungary and the creators of the Hungarian term: "*műveletsor*"; see Holló *et al.*, 2001), the material tests, the meticulous observation of traces of tool making and use, all become widespread practice.

Dear Zsolt! You already came to us as an internationally recognized researcher and brought with you your academic network, and as a result, domestic and foreign students and researchers constantly give each other the door handle in your room. You promote the regular scientific exchange of ideas by organizing more and more conferences and workshops.

Another consequence of your arrival was that spectacular piles of rocks appeared in various corners of the institute, the beauty of which arouses the interest and admiration of any student or researcher dealing with a later era, even when simply trying to get across them. I am happy to support your proposal to create a lithic collection that will facilitate teaching and research.

However, what captures all of us the most is the way you see and present people behind the objects and phenomena, who created and developed their tools and transformed their environment, who continuously fought for their survival. Based on the Palaeolithic archaeological record, which can only be appreciated by the initiated today, you get to know and explain the lifeways of the people who once lived, their adaptation to the environment, their battles with rival communities or even their cooperation, and last but not least, their beliefs that elevate people above the ordinary, material world. In recent years, many of us have been able to enjoy your various lectures on human evolution and struggles for survival.

In addition to piles of rocks, domestic and foreign researchers, there are groups of interested and engrossed students surrounding your table and studying the lithic blades, waste, and other worked stone and bone tools for hours. The multitude of enthusiastic students shows the true meaning and appreciation of your work.

Dear Zsolt! I congratulate you on your achievements so far and behalf of the staff of the Institute of Archaeological Sciences of the ELTE Eötvös Loránd University, Faculty of Humanities, I wish you a lot of joy, perseverance and all the best for your further successful teaching and research work.

God bless you!

Ad multos annos!

Budapest, December 6, 2023

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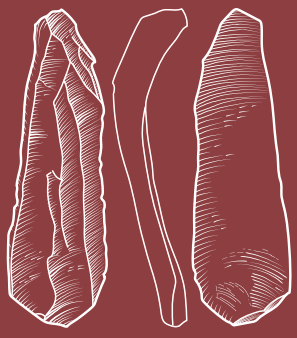
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Zsolt Mester (r) and Jacques Tixier (l) in Boldogkőváralja at the beginning of the 2000s. The two researchers examined a blade deposit, which came to light at the nearby site of the Neolithic Bükk culture, Boldogkőváralja-Erdészház. More than half of the 1,083 knapped lithics found during the excavation were stashed in a pot, which was sunk into the former ground between the houses. According to their careful interpretation, blades made by experienced craftsmen were placed in the depot, which was accessible to more members of the community. This phenomenon proves craft specialization and the social organization that presupposes it. As a result of another revision of the finds, Zsolt and his colleagues consider them to be interpretable as a trace of a community ritual.

Photo: György Lengyel, drawing: after Jean-Georges Marcillaud.



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The problematic role of fossilized mollusc shells in the Upper Palaeolithic of Hungary

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Abstract. Within the context of the Palaeolithic of Hungary, the most abundant finds that do not bear any obvious practical function are tertiary fossil molluscs. The scientific consensus is that these were used as personal ornaments expressing social identity. This paper's goal is to shed light on the problems related to the mollusc shell find assemblages. This study touches on the discussed finds' raw material sources and their role in the settlement of a specific region, the differences and relations between the mollusc shell assemblages, the importance of certain form preferences, and the problem of the possible function of these items. This work also raises attention to the question of geographical location. The mollusc shell find assemblages are concentrated in the Danube Bend area. Its overall conclusion is that assemblages with diverse form preferences imply different social identities. Their situation within a relatively small territory could indicate a refuge area where the meeting of groups with distinct self-identifications was commonplace.

Keywords: Upper Palaeolithic, Art, Jewellery, Carpathian Basin, Gravettian

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Within the Upper Palaeolithic of Hungary, the most numerous archaeological finds lacking clear practical function are fossilized mollusc shells mostly originating from the Tertiary geologic period. Despite the fact, that an overwhelming part of these finds doesn't show obvious signs of use or modification by humans, the long-standing scientific consensus is that these items were collected as raw material intended for the manufacture of personal ornaments (Gábori, 1969, p. 8). Their presence in the Upper Palaeolithic archaeological material raises questions beyond the problem of uncertain function. A study of this find category can potentially open up new dimensions in research and expand our understanding of the period. The goal of this paper is to shed light on what roles could these items play in the life of contemporary people based on the following questions:

Did the proximity of fossilized mollusc shell sources factor in the settlement of the region? How did this closeness affect the regarded value of these items for these communities?

Based on the spectrum of forms can a pattern be discerned overarching different sites? Further on that notion, can groups with similar preferences be outlined?

Can these finds be considered to be the raw material for ornaments or can any other practical functions be considered?

Why do fossilized mollusc shells concentrate in a small geographical area of Hungary?

In answering these questions I rely greatly on parallels of the find material from other areas of Europe and on the results of previous research.

1. The discussed material

From Hungary, we know fourteen sites almost exclusively of the Gravettian cultural entity, where fossilized mollusc shells collected by humans were found. Of these, eleven are located next to the Danube Bend or within its 30-km radius (Fig. 1). Exceptions are the Tarcal-Citrombánya, Jászfelsőszentgyörgy-Szunyogos, and Ságvár-Lyukas-domb sites. Most of these fossils were found at the site of Szob-Ipolypart, with 398 pieces (Dulai, 2007, p. 24, Table 1 – the chart details 398 pieces, however, the chart in Markó *et al.*, 2018, p. 234, Table 3 only mentions 397 pieces) (Fig. 2). Sites with nearly a hundred pieces are Mogyorósbánya-Újfalusi-dombok (95 pieces) (Fig. 3) and Esztergom-Gyurgyalag (91 pieces) (Fig. 4). The material of Pilismarót-Pálrét contains 11 pieces. Ten or fewer pieces were found at five sites (Pilismarót-Bitóc, Verseg-Kertekalja, Ságvár-Lyukas-domb, Csővár cave, Tarcal-Citrombánya) and only one piece is known from five more sites each (Jászfelsőszentgyörgy-Szunyogos, Vác-Kishermányi street, Bivak cave, Pilisszántó I rock-shelter, Nagykovácsi, Remete-Felső cave) (Markó *et al.*, 2018, Table 1, Table 3; T. Dobosi & Vörös, 1987; T. Dobosi, 1985; Gáboriné-Csánk, 1984). Considering that the three sites farthest from the Danube Bend (Tarcal, Jászfelsőszentgyörgy, Ságvár) are geographically isolated even from each other, altogether had only 8 pieces (T. Dobosi, 1985, 1993; Lengyel, 2010; Markó *et al.*, 2018, Table 3), this study onward will only concentrate on the material found in the Danube Bend area (Fig. 1). This region, located in north-central Hungary has numerous Tertiary outcrops containing floral and faunal fossils. Some of these were likely utilized as raw material sources during the Upper Palaeolithic (Dulai, 2007, Table 1; Markó *et al.*, 2018). It should also be noted that in many cases it is hard to determine if mollusc shells found at Upper Palaeolithic sites are actually Tertiary fossils or sub-recent pieces collected on seashores. The date of origin for these items can only be ascertained by natural scientific measures (Vanhaeren *et al.*, 2004). Regarding the material from Hungary, there is little doubt that due to the great distance from seashores, it mostly contains fossil specimens. However, based on

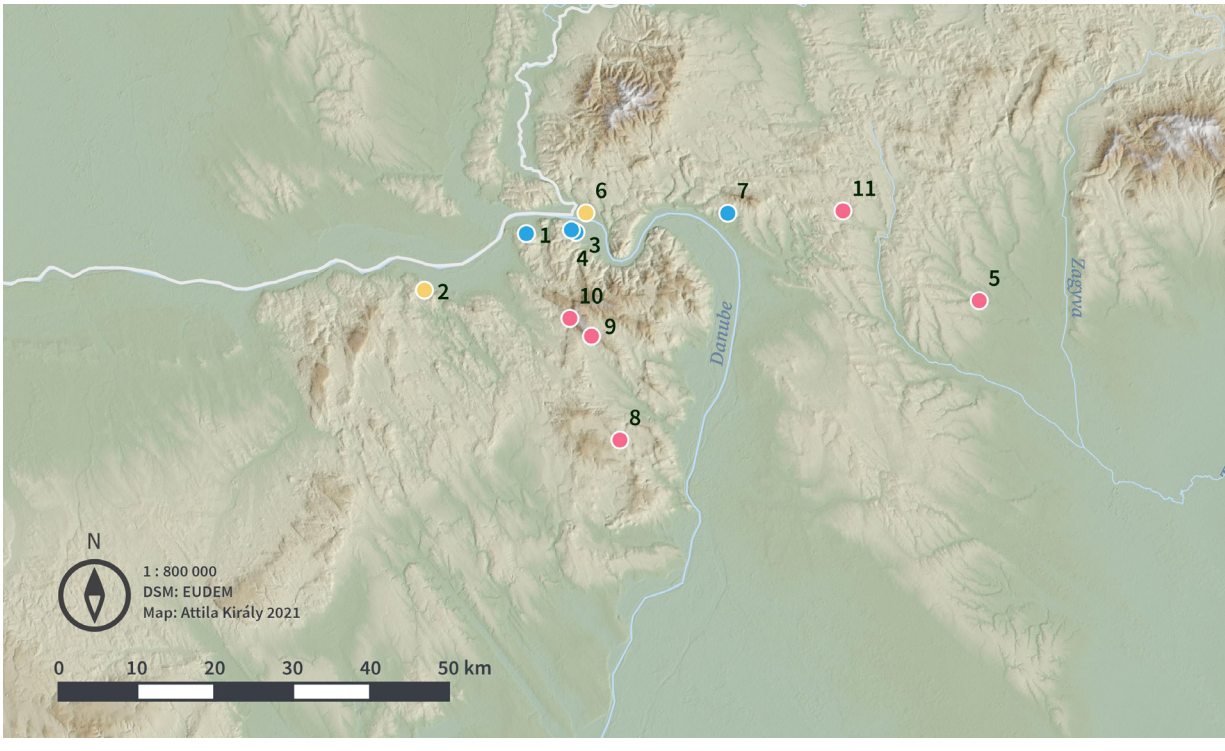


Figure 1. Upper Palaeolithic sites with fossil mollusc shells in the Danube Bend area. 1: Esztergom-Gyurgyalag, 2: Mogyorósbánya-Újfalusi-dombok, 3: Pilismarót-Bitóc, 4: Pilismarót-Pálrét, 5: Verseg-Kertekalja, 6: Szob-Ipolypart, 7: Vác-Kishermányi út, 8: Nagykovácsi-Remete cave, 9: Pilisszántó I rock-shelter, 10: Bivak cave, 11: Csővár cave. The colours indicate the classification of T. Dobosi's 2009 chronological system. Blue marker: Epigravettian, green: Pebble Gravettian, white: Pavlovian culture or uncertain. (Map: Attila Király).

analogies, it is viable that a few pieces got to the discussed sites from sub-recent, far-off sources.

According to the cultural-chronological system of V. T. Dobosi for the Upper Palaeolithic of Hungary based on lithic assemblages, most of the sites can be classified into the Pebble Gravettian (19,000–17,000 BP) and the Epigravettian or a younger blade (18,000–16,000 BP) cultural-chronological horizons (T. Dobosi, 2009). Szob and Mogyorósbánya are part of the former, and Esztergom and Pilismarót-Pálrét are part of the latter horizons. According to present research, we hardly know of any sites that could be attributed to the older blade entity (28,000–26,000 BP) in the Danube Bend area (T. Dobosi & Holl, 2013). In the vicinity of the Carpathian Basin, for example in South Moravia, these items were already popular during the Pavlovian culture (Hladilová, 2005). Based on this, we can reason that concerning this period the sources located in the Danube Bend area are yet to be discovered.

The newer chronological framework by Gy. Lengyel paints a different picture of the Gravettian entity in Hungary. Regarding our sites, the older blade entity (also referred to as Pavlovian culture) is not to be taken into count in this system, only the Late Gravettian dated between 25000 and 21000 BP. In Lengyel's chronology, Szob,

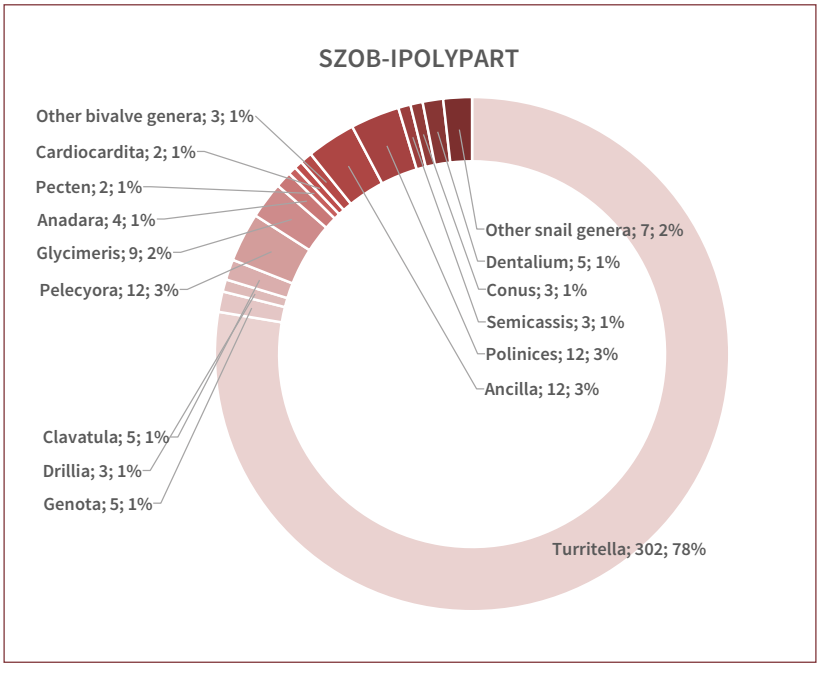


Figure 2. Distribution of mollusc shell finds from Szob-Ipolypart by genus; genera represented by only 1 piece are combined (prepared by the author, based on Dulai, 2007, Table 1)

Mogyorósbánya and the Pilismarót sites are placed into the Early Epigravettian, corresponding to the Last Glacial Maximum (LGM, 21,000–17,000 BP) and Esztergom is placed into the Late Epigravettian (17,000–13,000 BP) (Lengyel, 2018).

In terms of the genera of the mollusc remains the fossil shells testify to a striking diversity (Table 1, Fig. 2–4). In each material containing a hundred or more shells, the dominant mollusc genera are different. The difference is obvious even in the case of sites close to each other (circa 20 km), like Szob and Mogyorósbánya, which are, in addition, considered to be part of the same cultural niche, the Pebble Gravettian (Markó *et al.*, 2018).

2. Availability of the mollusc shell sources

Arguably, one of many motives for the habitation of a given region in the period was the proximity of the mollusc shells sources used as raw material for bead manufacture. This concept arose in the case of foreign sites, like in the case of Franchthi cave in Greece (Baysal, 2019). Due to the closeness of the raw material sources, this factor could have played an important role at the sites of Szob-Ipolypart, Esztergom-Gyurgyalag, Pilismarót-Pálrét and Mogyorósbánya-Újfalusi-dombok. For the relatively dense settlement of the Danube Bend area, this association has already been suggested by V. T. Dobosi and E. Kövecses-Varga (1991). At Szob, the large number of unmodified shells can be explained by the closeness of raw material sources. Based on the case of Mogyorósbánya, part of the settlements of the region exploit more than one of the nearby sources of mollusc shells (Markó *et al.*, 2018).

Drawing on the material from Hungary, Upper Palaeolithic communities possibly used mollusc shells only from local sources. However, similar to the erratic flint materials, we also know of instances from other European sites, where fossil or sub-recent mollusc shells were brought to sites from distant regions. Transporting these items, considering their size and meagre weight, is simpler than moving flint material. Located

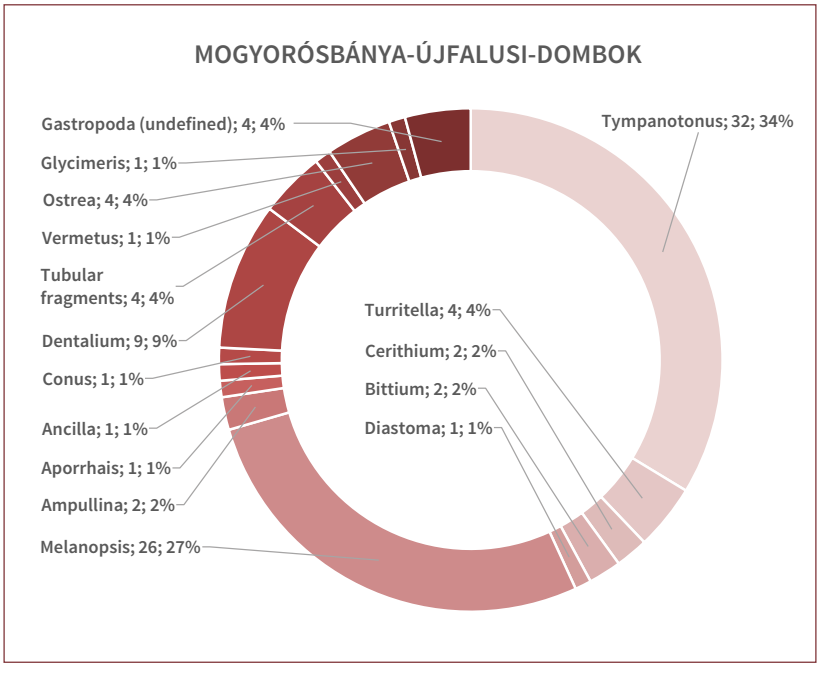


Figure 3. Genus distribution of the Mogyorósbánya-Újfalusi-dombok mollusc shell finds (prepared by the author, based on Markó *et al.*, 2018, Table 1).

on the Eastern Carpathian foothills, Poiana Cireşului-Piatra Neamț site's Gravettian III layer (26000–27000 uncal. BP) contains bore-drilled mollusc shells that originated at least 800 km away from the settlement at the Aegean coast. They were likely transported there as finished goods (Nițu *et al.*, 2019). Fossil and sub-recent mollusc shells found at Magdalenian sites in Southwestern Germany originate from sources of various distances (Eriksen, 2002, Fig. 12). In addition to the relatively nearby sources, pieces arrived there from the 250-km distant Mainz Basin, the 500-km distant Paris basin and even further, from the Atlantic and the Mediterranean coastal areas. One of B. V. Eriksen's possible explanations of the connections with the Mainz Basin is that the suggested base camps in Southwestern Germany were occasionally visited by communities arriving from a northern direction. Part of the long-distance connections were organized along networks spanning through different regions in which firstly neighbouring communities were communicating with each other (Eriksen, 2002, Fig. 12). Mollusc shells, for example, *Dentalium* and *Glycymeris*, that were excavated at the French Magdalenian site of Peyrazet arrived there from the Mediterranean and Atlantic coasts. Due to the lower sea levels, these sources were located 300 km away at the least. As S. Rigaud and co-authors suggest, the procurement of these pieces could also have happened due to extensive networks (Rigaud *et al.*, 2019).

According to B. V. Eriksen, direct procurement of such small items meant too great of an investment. The collection of mollusc shells from local and extralocal sources in the case of Southwestern Germany could have happened embedded into other procurement activities (Eriksen, 2002). This picture could be further nuanced keeping in mind the value that various mollusc shells could have represented for contemporary groups. It is feasible, provided that given shells meant such high value in the life of a community, that in some instances (e.g. special events in a group's life) their

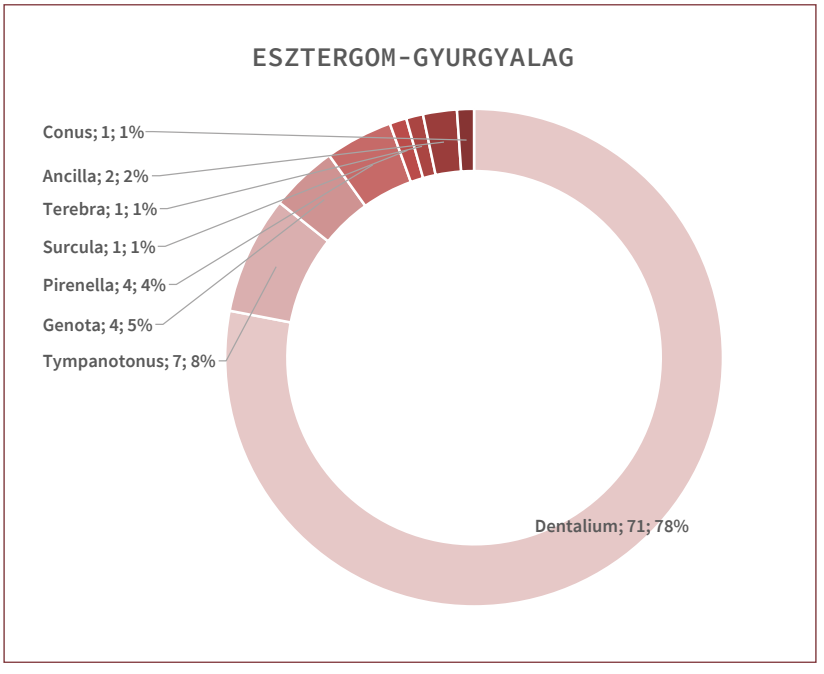


Figure 4. Genus distribution of the Esztergom-Gyurgyalag mollusc shell finds (prepared by the author, based on Magyar 1991, p. 265).

procurement was an investment worth undertaking. The concept of value, of course, is highly tangible and is dependent on many factors be it distance, the difficulty of acquiring the mollusc shells, their colour, form, and other groups' demand for them, etc. (Baysal, 2019). There are examples of communities, when having two sources available, they choose to exploit the one further away. M. Vanhaeren and co-authors used strontium isotope analysis to determine that in the case of La Madeleine's child grave, excavated in 1926, the raw material of the shell beads did not originate from the previously suggested closer Miocene outcrops of 80 km distance, but from the Atlantic shoreline 50 km further from that location. The reasons behind choosing the more distant source seem to be morphometrical. The Miocene *Dentalium* shells are not wide enough for piercing with bone needles found at the site which are probably used for stringing up the beads (Vanhaeren *et al.*, 2004).

Another possible factor in the evaluation of these shells is their mode of acquisition, i.e., directly at the source or through intermediary groups. In this regard, for groups that had easy access to sources and traded either the unmodified shells or the finished products, the value would have meant the cultural interactions that came to be with the act of trade and the goods received in return. Perhaps the small number of finished beads in the Danube Bend area is due to a similar situation. In that case, even the role of intended trade goods can be considered.

In regards to the habitation of the Danube Bend area, it is worth considering the various extent of mobility Upper Palaeolithic groups had (Lengyel, 2018). The question is whether these settlements close to the raw material sources were marginal, periodically visited ones compared to areas regarded as central refugia like South Moravia. The Gravettian sites of northern-central Hungary do not match all the criteria that A. Wiśniewski and co-authors have described

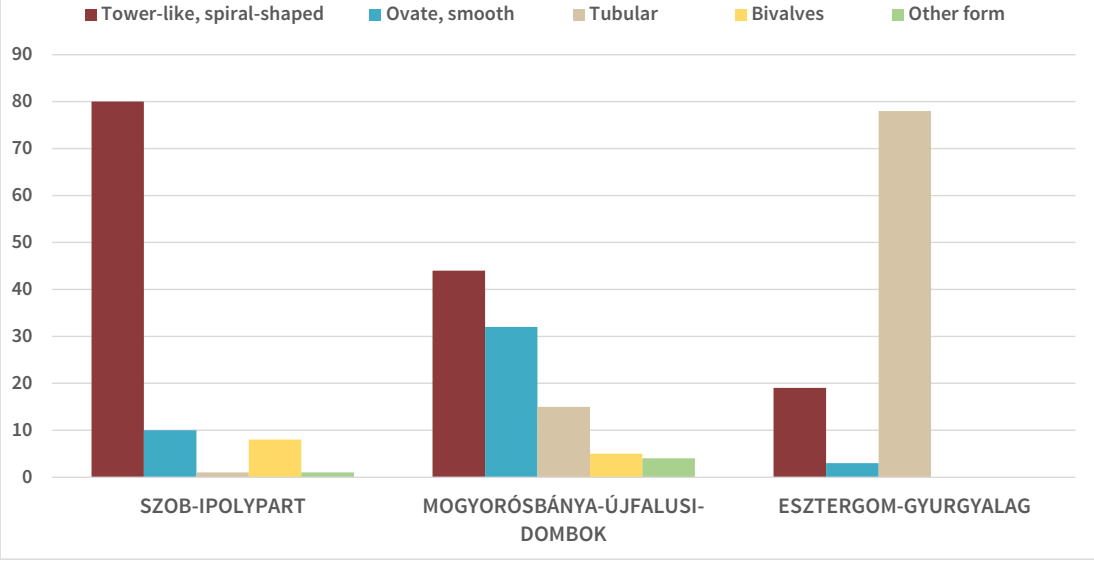


Figure 5. Distribution of the mollusc shell finds of the studied sites according to shape. In the case of Szob-Ipolypart, the *Charonia*, *Murex* and *Strombus* pieces are spiral-shaped, however, based on their shorter, stubby shape, I did not place them in the „tower-like spiral-shaped" category containing elongated pieces (Magyar Nemzeti Digitális Archívum n.d. a; n.d. b; n.d. c). Szob-Ipolypart data: Dulai, 2007, Table 1. Mogyorósbánya-Újfalusi-dombok data: Markó et al., 2018, Table 1. Esztergom-Gyurgyalag: Magyar, 1991, p. 265. Prepared by the author.

to be features of settlements within refugia, like burials or geometric art (Wiśniewski *et al.*, 2015, Table 6). Gy. Lengyel, however, takes into account that in the Early Epigravettian, due to the greatest extent of the Eurasian glaciation, the Carpathian Basin might have transformed into a refugium, as suggested by the presence of distant (Transcarpathian) flint material in large percentages as well (Lengyel, 2018). The permanent settlement of the region during the LGM could also be in connection with most of the discussed sites being dated to the Early Epigravettian according to Gy. Lengyel's chronology.

As A. Wiśniewski and co-authors pointed out, it is hard to tie the settlement of a region to one specific factor as it was dependent on various environmental, climatic and social features (Wiśniewski *et al.*, 2015). To a certain degree, the procurement of mollusc shells probably played a role in populating the Danube Bend area. The value of these items could have transformed with time, depending on their availability. As Gy. Lengyel suggests high mobility, spanning large distances became characteristic of groups during the Late Epigravettian, therefore we should mostly consider short-term camps in the region (Lengyel, 2018, p. 148). This indicates that fossil mollusc shell (and flint material) access did not play a crucial role for the people of the period in such a way that it would influence mobility.

3. Aspects of form

For the sake of getting closer to aspects by which Upper Palaeolithic people might have regarded mollusc shells, we need to apply simple categories that are vaguer than our modern taxonomical classifications. A grouping based on similar notions was already implemented by Š. Hladilová when discussing the fossil shells of the Moravian Pavlov I site (Hladilová, 2005). In her

system, the general types were determined by shape and surface. The first group is of the smooth surfaced, ovoid shells, like *Conus* and *Melanopsis*, both of which are found in the Hungarian material. The second group contains shells with a tower-like shape like *Turritella*, a genus that is abundant in the material of the Szob-Ipolypart site. The third group are of the tubular-shaped ones, which consist most notably of *Dentalium* which is present in large numbers in the material of Esztergom-Gyurgyalag. The fourth category contains radial built pieces, mostly bivalves, for example, *Anadara* and *Cardium* which are also known from the Szob-Ipolypart site.

This grouping implies the preference of past communities in the Danube Bend area (Fig. 5). The system of Š. Hladilová, especially the first group, can be further nuanced based on aspects of shape because the genera included in it bear conspicuously different forms that were probably evident for people of the period as well. These subgroups can be represented by, for instance, shells belonging to the *Conus* genus that, from the side view have deltoid shapes with rounded edges (Peters *et al.*, 2013, Fig. 1 based on illustration) while the shells belonging to the *Ancilla* genus have more elliptic or lentil-like shape (Kilburn, 1981, Fig. 71–78 based on illustration). Although further categorisation can be made based on shape, surface or even size, with the lack of extensive malacological expertise I would not attempt to establish a different system. A. Markó and co-authors use the above-mentioned categories in a somewhat simplified way for the material from Hungary and the first two categories are used only based on surface as simple and ornamented shell groups. In their system, the bivalves with radial surfaces category are expanded to include all bivalves (Markó *et al.*, 2018, Table 3). Going forward I will apply the four categories established by Š. Hladilová with the fourth group used for all bivalves as done by A. Markó. The break-up of the three largest mollusc shell assemblages from the Danube Bend area by categories of shape is displayed in Table 1.

4. Separation of groups based on the assemblage

Considering that items used as personal ornaments were part of necklaces or (based on Upper Palaeolithic burials) attached to headgear or other attire elements, it is worth viewing them as parts of larger units (Bahn, 2016, p. 131). Based on this, the contemporary form preferences in the find material can be particularly important.

The Gravettian fossil mollusc shell assemblages in the Danube Bend area show high heterogeneity compared to each other. The question may rightly arise as to what causes this large difference in shape preferences between relatively close sites. Chronological differences between certain sites can play a role. However, if we look at sites from Southern Europe with a continuous settlement record, such as Riparo Mochi or Klissoura, we see that during the Upper Palaeolithic, the ornamental shell assemblages remained mostly unchanged in terms of shape and genus within a given site, or showed only slight changes (Stiner, 2014, p. 55, Fig. 4). The already mentioned difference in the fossil mollusc shell assemblages of Szob and Mogyorósbánya may give rise to further questions.

A level of heterogeneity similar to that of Hungarian sites can also be seen in the case of the Pavlovian settlements of South Moravia (Table 1). In Pavlov I's material, the tubular pieces, such as the *Dentalium* make up 56% of the assemblage. In the case of Pavlov II the tower-like ones dominate with 60%. The material of Pavlov VI is much more balanced, the tower-like and the oval, smooth-surfaced ones account for the same proportion, around 30%. These sites are extremely close to each other, at a distance of a few hundred meters, and the assemblages consist of different amounts of mollusc shells (Pavlov I has 672 pieces

without fragments, while Pavlov II only 67 pieces) (Hladilová, 2005, p. 384, Table 1, 2011, Table 1). Š. Hladilová explains the different ratios with changes in the availability of raw material sources due to geological conditions, rather than with cultural transformation (Hladilová, 2011, pp. 58–59). Of course, it cannot be ruled out that the change in the availability of raw material sources contributed to the change in certain cultural habits. M. C. Stiner also shares the view that the availability of raw materials fundamentally influenced the custom of making ornaments (Stiner, 2014, p. 54). In the case of Moldavian sites along the Prut and the Dniester rivers, dated around 26,000–27,000 uncal. BP and 17,000 uncal. BP, there is also a great degree of heterogeneity among the ornamental find material. The raw material of some of these items are not mollusc shells, but animal teeth and mammoth bone, among other things. The differences are particularly striking when compared to the ornaments from the aforementioned Poiana Cireşului-Piatra Neamț site, originating from the Mediterranean (Cârciumaru *et al.*, 2019). The sub-recent and fossil mollusc shells of the Magdalenian sites in southern Germany (Table 1), contemporaneous with the Epigravettian of Hungary, also show different proportions in composition. Although, the preference for bivalves, especially *Glycymeris* is a discernibly common feature (Eriksen, 2002).

Based on the example of the almost permanently inhabited Southern European sites, such as Riparo Mochi, it is assumed that the ornament-making traditions of a given community hardly change over several millennia. C. Perlès also emphasizes, drawing on Upper Palaeolithic and Mesolithic material, that personal ornaments are items that are most resilient to change on a long-term scale (Perlès, 2012). As a result, the reason for differences within a geographical area may be the presence of communities with different customs. Their relationship with each other might have depended on their mobility. As E. Baysal pointed out, contacts among the highly mobile communities of the Upper Palaeolithic were organized based on routes and not permanent settlements. Our modern understanding of proximity might not have been a primary aspect for the people of the period (Baysal, 2019, p. 55). This can also be an important aspect concerning the sites discussed, especially if we take into account geographical obstacles, such as the Danube separating Szob and Mogyorósbánya from each other. As a result, it is not necessarily surprising if we do not see generally common features between the assemblages with a larger amount of mollusc shells in terms of shape. One notable characteristic that we see based on the Esztergom and Pilismarót-Pálrét sites, and the upper layer of Pilismarót-Bitóc is the preference for tubular pieces, mostly *Dentalium*, but this is consistent with the general trend seen at the end of the Upper Palaeolithic (Markó *et al.*, 2018, Table 3; Stiner, 2014).

5. The function of the fossil mollusc shells

The most common interpretation of fossil and sub-recent mollusc shells found in Upper Palaeolithic sites is that they were used as ornaments due to their decorative properties, or were intended for such use (Bar-Yosef Mayer, 2005; T. Dobosi, 1985; Eriksen, 2002). This can be a matter of debate in the case of Hungarian finds, considering that none of them were found in a context (for example as grave goods) that would prove their ornamental function. Their use as ornaments is mostly indicated by indirect evidence.

If we assume that they were collected to make personal ornaments, the large number of unmodified fossil mollusc shells in the material of Hungary can be interpreted as unworked raw materials. In the case of Szob-Ipolypart, the bulk of such shells were found during the excavation of M. Gábori in 1964 in three piles, which can be in-

Table 1. The mollusc shell finds from the Pavlovian sites from South Moravia, Gravettien sites around the Danube Bend and Magdalénien sites in Southwestern Germany, arranged in the form system outlined by Š. Hladilová (I classified the snail genera not mentioned by him into one of the existing categories based on their general forms. This may change with a direct examination of the find material) (T. Dobosi, 1985, 25, 28. o.; Hladilová, 2005, Table 1., 378–384. o., 2011, Table 1, Table 2; Dulai, 2007, Table 1; Markó et al., 2018, Table 1; Magyar, 1991, 265. o.; Eriksen, 2002, Table 2).

Region	Site	Tower-like elongated, spiraled		Tubular		Ovoid, smooth surface		Radial forms (bivalve shells)		Other forms		Total
		db	%	db	%	db	%	db	%	db	%	db
Southern Moravia (Pavlovian)	Dolní Věstonice	8	15	35	66	10	19	0	0	0	0	53
	Pavlov I[a]	124	18	377	56	64	10	94	14	13	2	672
	Milovice IV[b]	6	17	11	30	10	28	5	14	4	11	36
	Pavlov II	40	60	19	28	9	9	2	3	0	0	67
	Pavlov VI[b]	55	39	43	31	40	29	0	0	2	1	140
Danube bend (Pebble Gravettian, Epigravettian)	Szob, Ipolypart	317	80	5	1	41	10	32	8	3	1	398
	Mogyorósbánya, Újfalusi dombok	41	44	14	15	31	32	15	5	4	4	95
	Esztergom, Gyurgyalag	17	19	71	78	3	3	0	0	0	0	91
	Pilismarót, Pálrét	2	17	9	75	0	0	0	0	0	0	11
Southwestern Germany (Magdalenian)	Monruz	1	3	0	0	30	79	7	18	0	0	38
	Kohlerhöhle upper layer	20	50	0	0	2	5	18	45	0	0	40
	Hohlenberg höhle 3	14	41	0	0	0	0	20	59	0	0	34
	Petersfels (1927-32 excavation)	4	3	0	0	0	0	115	82	21	15	140
	Petersfels (1974-76 excavation)	18	16	18	16	40	37	31	29	2	2	109
	Felsställe IIIb	0	0	0	0	44	76	5	9	9	15	58

a – without fragments; b – without fragments, only Tertiary shells;

terpreted as depots. According to the excavator's interpretation, based on their context, the piles were originally stored in small bags and were waiting for transportation (Gábori, 1969). Their lack of modification is probably due to an early, post-collection phase of an ornament-making process. In the case of the stockpiled, unmodified mollusc shells from Franchthi Cave in Greece, the idea that some shells were attached to clothing without modification has already been suggested (Baysal, 2019). This notion should not be ruled out in the case of the material from Szob.

A mark of suspension or attachment, most commonly human-made boreholes, is one of the most obvious indicators that a particular fossil mollusc shell was worn as an ornament, or at least

was intended to be used as one. In the Hungarian material, the amount of shells modified by humans is scarce. The phenomenon is not unique, many mollusc shells excavated at several Upper Palaeolithic sites in Central Europe are unworked (Eriksen, 2002; Nițu *et al.*, 2019). Holes drilled by parasites or other predatory molluscs can often be found on some pieces (Magyar, 1991; Dulai, 2007). These natural holes could also be used for suspension. This idea has already arisen in connection with some foreign and domestic finds (Eriksen, 2002; Markó *et al.*, 2018). According to some researchers, it was these non-anthropogenic holes that gave rise to the concept of suspending mollusc shells during the Palaeolithic (Baysal, 2019, p. 83). Arguably, the aesthetic sense of the Upper Palaeolithic man factor in on whether the wearing of shells dotted with randomly placed holes created by predators was acceptable as ornaments. The research of A. M. Kubicka and co-authors can provide a partial answer to this, according to which there is a high probability that the holes created by predators are located in a particularly favourable part of the shell for suspension (Kubicka *et al.*, 2017). It may be worthwhile to examine the Hungarian material with this in mind. Out of the 302 pieces of *Turritella* found in the Szob-Ipolypart site, 24 pieces had holes drilled by predatory molluscs (Dulai, 2007). According to the research of Y. Taborin, the *Turritella* beads of the French Upper Palaeolithic were almost exclusively perforated on the last, widest whorls of the shells (Taborin, 1993, p. 250). Preliminary examination of the *Turritella* shells of Szob shows that the holes drilled by predators are found mostly on the middle whorls of the shells. Considering the French parallels, we assume that the predatory boreholes on the shells from Szob were not regarded as viable marks of suspension for the collectors. Further research on the find material is of course necessary to conclude this claim.

Traces of paint can also hint at the ornamental use of these items. We know several examples of finished personal ornaments from the Upper Palaeolithic where the surface of the beads was painted, predominantly with ochre (Baysal, 2019; Cârciumaru *et al.*, 2019; Fernández & Jöris, 2008; Hromada, 1998). In the Danube Bend area, traces of ochre paint could be detected on some *Dentalium* shells in the material of Esztergom-Gyurgyalag, although according to V. T. Dobosi and E. Kövecses-Varga, this could be due to the soil layers contained the items (T. Dobosi & Kövecses-Varga, 1991, p. 239). If dyeing was one of the requirements of the ornamental function, it can also support the notion that the Szob shell depots were being prepared for further transport, since no ochre or other material suitable for colouring was found at the Szob-Ipolypart site (Markó, 2007, pp. 7–21). However a large number of ochre lumps were found at Mogyorósbánya-Újfalusi-dombok, so it is possible that the dyeing of ornaments could have taken place there (T. Dobosi, 2015; Markó *et al.*, 2018). Taking into account that the Mogyorósbánya material contains some worked mollusc shells, including pieces on which the perforation was not completed, and pieces that broke during modification, we assume that a considerable part of the chaîne opératoire of ornament-making was carried out at the site (Markó *et al.*, 2018). The fact that the function of the Szob and Mogyorósbánya sites, which represent a similar chronological horizon and the same cultural unit, can be separated by ornament making and raw material procurement can also be justified by the amount of retouched stone tools and the differences in their typological composition (T. Dobosi, 2002, 2014). At the same time, the already mentioned discrepancy regarding the composition of the mollusc shells by genus does not indicate that the two sites were used by the same community.

Concerning the *Dentalium* shells of Esztergom-Gyurgyalag, V. T. Dobosi also suggests a currency function, relying on the ethnographic analogues from the northeastern coastal areas of North America (T. Dobosi, 1985, p. 29). This custom is not unique among indigenous peoples. We also know of another example from the Americas. The Chumash people living in California in the 12th and 13th centuries CE used *Olivella* shell beads as currency, although this kind of "money" only became widespread during a more developed socio-economic phase (Nigra & Arnold, 2013). Regarding Upper Palaeolithic mollusc shells, the currency or exchange function is more difficult to prove than the ornamental/decorative function. Based on the means of exchange among the Chumash, the condition in which these items function as money is that their form is standardized and their use is widespread within the given society (Gamble, 2020). These criteria are not met for the mollusc shell material of the Danube Bend area.

Due to their shape, clamshells and snail shells of a simpler form could also be used to perform various practical functions. Unfortunately, as we don't have direct evidence from the Hungarian material for ornamental use, we are lacking evidence for possible uses as tools as well. Keeping this in mind, we can draw parallels as a reference for the proposed functionalities. At Pavlov I site, a *Spondylus* shell was used as a type of vessel for the production of paint (Svoboda, 1999, 196, Obr. 79). *Pecten* and *Ostrea* shells recovered from the Epimagdalenian layers of Nerja Cave in southern Spain may have been used as lanterns, judging by their burnt surfaces (Pardo *et al.*, 2016). The larger shells in the French Perigordian culture complex, especially those of the *Pecten* and Cardium genera, were primarily utilitarian objects, as evidenced by the visible damage on certain pieces (Hladilová, 2005).

In some cases, mollusc shells could also serve as the raw material for tools. In the Gravettian layers of Fuente de Salín cave in northern Spain, traceological studies indicate that tools made from the shells of *Patella vulgata* were found to have been used for ochre processing. Also from this find material borers, made from *Patella vulgata* shells were used to work leather (Cuenca-Solana *et al.*, 2013). We know several recent ethnographic examples of mollusc shells serving as tools or as raw materials for tools. The Selk'nam of Tierra del Fuego made knives from *Mytilus* shells, and in the Amazon basin, the drained sap of the rubber tree was traditionally collected in *Ampullaria gigas* snail shells (Cuenca-Solana *et al.*, 2013). Although we do not know of any tools from the Palaeolithic of Hungary that were made from fragments of mollusc shells, the intention can be suggested for some better-preserved pieces. This is also can be the case with the bivalves from the assemblage of Szob, as they show heterogeneity (eight different bivalves were found in small quantities) (Dulai, 2007, Table 1). If these modern systematic differences meant a striking difference for the people of the period, practicality may have been more important than uniform shape in everyday use.

Notably, a truncated cone-shaped cup fashioned from a moose antler burr, thought to be of Pleistocene age, found in the sediments of the Tisza River at Tiszaörvény-Varjashát can serve as indirect and at the same time debatable parallel (T. Dobosi, 1985). If this item was made, based on the examples above, to store paint material or animal fat suitable for lighting, then this function can also be suggested in the case of shells with a similar capacity. Similarly sized to the cup from Varjashát is the fossil *Glycymeris obovata* bivalve shell that was found in the Late Middle Palaeolithic layers of Remete-Felső cave (Gáboriné-Csánk, 1984).

Despite the existence of clear evidence, based on the data above, the probable function of most of the mollusc shells found in the Upper Palaeolithic Hungarian sites was decorative, possibly as per-

sonal ornaments, or at least it was intended to be used as such.

6. Conclusion

Regarding the Upper Palaeolithic finds of Hungary, an additional question may arise regarding why mollusc shells are concentrated in a relatively small geographical area. An obvious explanation for this is the proximity of exploited raw material sources, which can be supported by the large proportion of unmodified pieces. Interestingly, there are several regions in Europe where mollusc shells (or ornaments made from other materials) used as personal ornaments are found in large quantities. Examples are South Moravia and Southwest Germany, which are considered central areas where several different groups met and cultural interactions took place (Eriksen, 2002; Svoboda, 2007). Thus, in the Hungarian context, these objects make the most sense when we consider them as intended personal ornaments. According to one of the most widespread professional views, their use is related to the expression and mediation of social and individual identity (Baysal, 2019). The opinion of S. L. Kuhn and co-authors is that, as a form of visual communication, people primarily adorn themselves in areas where there is a high chance of meeting strangers, and where it is advantageous to demonstrate identity and status (Kuhn *et al.*, 2001, p. 7645). If we assume that different social identities can lie behind the different form preferences, it is conceivable that the Danube Bend was an area where groups with different socio-cultural identities interacted and exploited the local raw material sources. This may be especially true if we take into account Gy. Lengyel's theory that during the Early Epigravettian, the Carpathian Basin functioned as a refugium, as this could justify the close presence of communities with different self-identifications.

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10 mm

Murex partschi mollusc shells from the Szokolya, Hagyigácsó site.

Source: Department of Palaeontology and Geology, Hungarian Natural History Museum, Budapest.

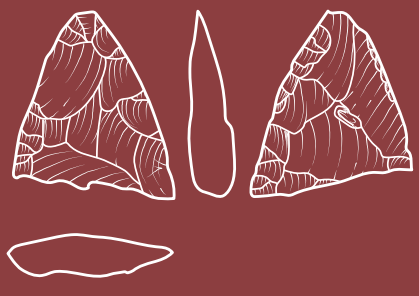
URL: https://mandadb.hu/tetel/702942/Murex_partschi

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May 9, 2002, Sopron. Zsolt and his students support the medieval city wall. Zsolt taught history and cultural anthropology students majoring in prehistory at the University of Miskolc as an associate professor. The study trip was organized together with Erzsébet Jerem by the Palaeolithic Self-Active Group (later known as the Herman Ottó Public Benefit Association), of which most of the students in the picture, as well as the writer of these lines, the creator of the picture, were members. The tour covered the Lake Fertő region and Lower Austria, and it was the first time that, as young Borsod students, we could see "western" excavations and heritage management. Teacher Erzsébet Jerem presented the early Iron Age sites, and Zsolt gave lectures on the Palaeolithic sites of the famous loess region of Lower Austria. Needless to say, what a great experience it was for all of us.

Photo: Attila Király; drawing: after Kozłowski et al.*, 2009.*



2

Etwas tierisch: *the* chaîne opératoire *and animal studies*

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Abstract. The concept of *chaîne opératoire* has provided a framework for interpreting lithic technologies. How is it being used in archaeozoology? Consuming animals is at the end of a series of tasks that follow a sequence: some steps in carcass processing cannot precede others. This lies at the core of the *chaîne opératoire* approach. Discrepancies in epistemological and linguistic communication, however, have impeded the adaptation of the *chaîne opératoire* to animal studies, although technological analysis, experimentation, and social anthropology provide excellent tools for the interpretation of animal remains. This paper is a review of similarities and differences between reconstructing production sequences for stone artefacts and animals. It is a summary of the potentials and limitations of using the *chaîne opératoire* concept on various levels in animal studies.

Keywords: Archaeozoology, Taphonomy, Butchery, Bone manufacturing, Animal studies

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"There are more ways than one to skin a cat."
(Smith, 1856, p. 178)

1. Introduction

Problems concerning the relationship between collecting evidence and decoding past human behaviour pose an inevitable challenge in archaeology. Such questions permeate research and conceptual arguments tend to lead to broader problems of interpretation. The study of animal-human relationships is no exception, with animals being studied as both objects and subjects in variegated ancient cultural settings. The exploitation of live animals, their killing, processing and use after various transformations have recently attracted increasing attention in humanities. This is not independent of the recognition that the relative marginality of studying animals in the realm of humanities stimulates re-thinking settled assumptions (Ritvo, 2007, p. 122).

The anthropologist and prehistorian André Leroi-Gourhan introduced the concept of *chaîne opératoire* (operational sequence) in 1964, aimed at drafting a theoretical framework for processes within which technical acts also functioned as social acts (Leroi-Gourhan, 1964). Proponents of this approach recognized the human body as a means of expression and a source of meaning, power, and symbol, beyond mere action. His work inspired other concepts and criteria, as well as new ways of observation, experimentation and a search for viable ethnographic parallels.

Although the concept of *chaîne opératoire* as such developed in French social anthropology, the idea of "lithic reduction sequences" (Holmes, 1894) was a similar model propagated in the New World, shortly after archaeology became consolidated as an independent discipline in close cooperation with natural sciences such as zoology and geology (Shott, 2003, p. 98; Kristiansen, 2014, p. 14). The reduction sequence concept resurfaced in Anglophone research with the onset of New Archaeology in the United States during the 1960s, along with an interest in the archaeological study of animal remains (e.g., Binford & Bertram, 1977; Binford, 1978). Theoretical discussions also revolved around issues such as the Middle-range theory and the critical application of ethnographic analogies in archaeology (Ascher, 1961) initiated by Kleindienst and Watson (1956) who first coined the term "action archaeology" for the study of living communities.

In addition to the evident differences between the historical and intellectual contexts in which reduction sequence and *chaîne opératoire* conceived, a linguistic barrier may have played a role in their parallel developments. At least until 1990, archaeology in Europe was divided by language as much as by Cold War political borders (Bartosiewicz, 2001, p. 84). As the concept began to gradually spread beyond the community of Francophone archaeologists (e.g., Bar Yosef *et al.,* 1992), the English translation of Leroi-Gourhan's 1964 classic was at last published in 1993. The idea of studying processes, rather than their static outcome regularly occurred in the English language literature as well (e.g., Schiffer, 1983; Jones, 1980; O'Connor, 1993; Gifford-Gonzalez, 1993). However, these insightful works in the age of processual archaeology looked independent of Leroi-Gourhan's: reference lists in these important studies tend to include titles exclusively in English.

In addition to entailing largely the same ideas (Shott, 2003, p. 98), the concepts of "reduction sequence" and *chaîne opératoire* are similar in that neither considered their application to animal remains at the onset. Fig. 1 reveals interesting patterns in the language of related terminology. In French publications (Fig. 1: a), the relative frequencies of *chaîne opératoire* and *archéozoologie* peaked during the early 2000s. The occurrence of both sharply dropped thereafter (the use of *zooarchéologie* seems negligible in works written in French). When the usage of *chaîne opératoire* is

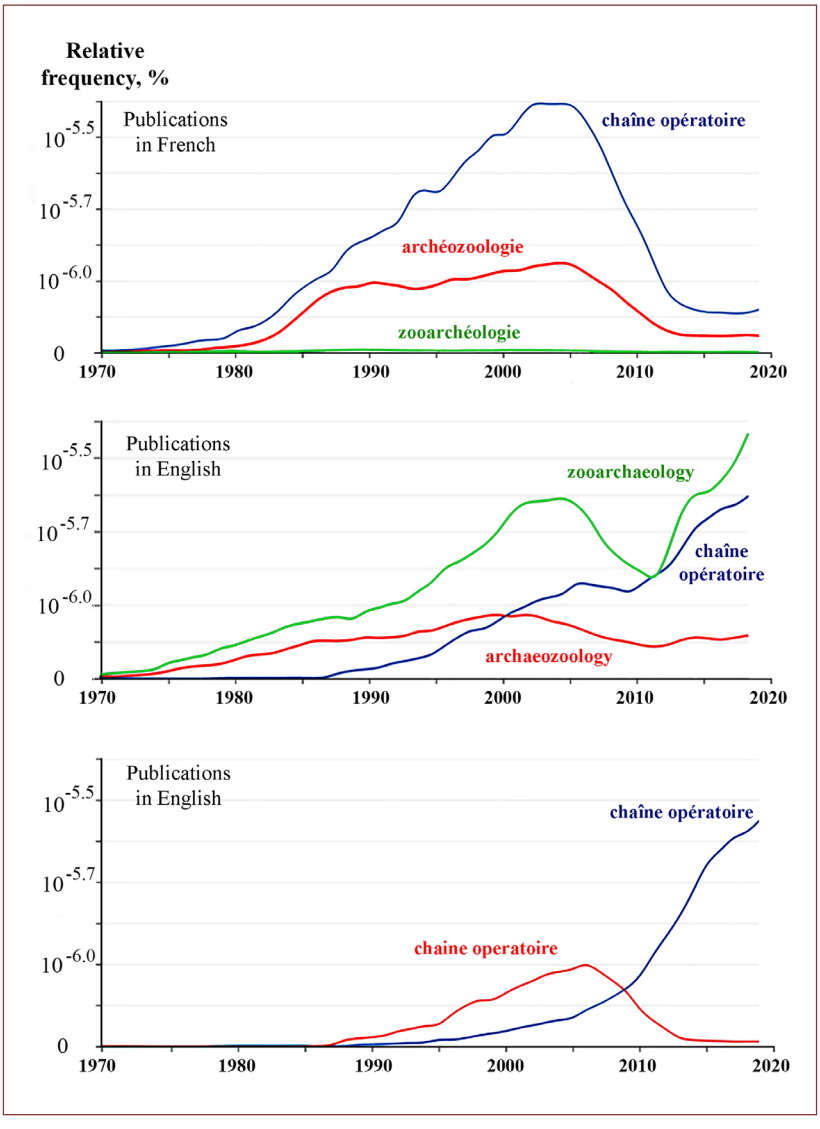


Figure 1. The relative frequency of mentions of the *chaîne opératoire*, archaeozoology and zooarchaeology in works published in French and English. Explanation in the text (Google Ngram Viewer, prepared by the author).

appraised in combination with zooarchaeology in English language publications (Fig. 1: b), both expressions show a clear, parallel increase approximately after 2010, while the rise and decline of the word archaeozoology mirror the diachronic trend seen in French works. The in-depth analysis of research policy and fashion behind these trends is far beyond the scope of this short paper. However, a thought-provoking phenomenon becomes visible in the spelling of *chaîne opératoire* in texts written in English. While earlier French diacriticals were often neglected in English texts (paralleling the apparent decline in works produced in French), proper French spelling rapidly took over in English studies around 2010. This is the phase when using the concept coincides best with frequent occurrences of the term zooarchaeology. The phenomenon may result from the ten-

dency that an increasing number of Francophone scholars began publishing in English. This has not only increased the awareness of proper spelling among non-native-speaking authors. It also promoted the cross-fertilization of related content.

Quantitative tendencies coincide with a qualitative trend. As the *chaîne opératoire* approach gained in popularity, the diversification of applications by extension to neighbouring domains is evident (Pelegrin *et al.,* 1988; Audouze & Karlin, 2017, p. 44). The concept has gradually been adapted to a wide range of archaeological materials. They range from pottery (Wallaert-Pêtre, 2001; Varela *et al.,* 2002; Vitelli, 2007; Kreiter *et al.,* 2017) to osseous raw materials (Averbouh, 2001; D'Errico *et al.,* 2003; Boisvert, 2018), animal bone refuse (Miracle, 2002; Horard-Herbin & Vigne, 2005; Broderick, 2017; Kjällquist, 2020), metals (Berranger & Fluzin, 2007; Verly *et al.,* 2021), and the archaeology of mortuary practices (Larsson, 2009; Sellier, 2016). The examples cited here are only a small, random sample of the rich repertoire of applications to a broad range of materials and processes. Recently *chaîne opératoire* has taken a prominent place among the "conceptual tools" within the zooarchaeological toolkit recommended for use in elucidating social relations through animal remains (Gifford-Gonzalez, 2018, p. 569). This approach has also become one of the key concepts in the step-by-step practical analysis of ancient butchery practices (Seetah, 2019, pp. 33–38).

2. Studying lithic and animal technologies

The *chaîne opératoire* has spread most widely in prehistoric lithic studies closely tied to the emergence of the French school of prehistoric technology. Transforming natural materials into cultural products is the essence of this model. Whether that material is stone or an animal, converting it from one category to another carries social meaning. The refitting of flint artefacts, the systematic reconstruction of knapping sequences, and the interpretation of the resulting refits, however, are difficult to apply to animals and the variety of products derived from them. The main reasons are as follows:

1) Live creatures are evidently not comparable to stone, as they play active roles in their entirety long before being reduced to raw material, the starting point in stone tool production. This also touches upon a fundamental taphonomic difference: resistant stone raw materials offer a good start in reconstructing the *chaîne opératoire*. In the case of animals, hard osseous materials are typically the only part of a complex living system that survives in the archaeological deposit following a complex process of both human-induced and natural decomposition.

2) On a fundamental technical level, archaeozoologists benefit from the knowledge of the skeleton, a perfect natural template to guide the reconstruction of any human action performed on live animals and, more commonly, on their lifeless bodies. Using standardized anatomical nomenclature is a major advantage in positioning bone fragments within this template, thereby weakening the analytical significance of refitting, and limiting it to the technical conservation of special finds.

3) Of all animal studies, the manufacturing of osseous materials is most comparable to lithic studies. The importance of understanding degrees of production and use as processes have duly been recognized (Choyke, 1997, p. 68). In the meantime, contemporary knowledge, i.e. the use of standardized anatomical nomenclature interferes with the interpretation of established prehistoric typologies (Bartosiewicz & Choyke, 1994, p. 264). There are also minor differences between anatomical and lithic terminology. For example, proximal is the section of a limb or bone that is close to the trunk in contrast to the body's periphery. In a stone tool, it is the part of the site of

human impact, close to the user. This can create confusion when lithic typologies are mechanically adapted to implements made of long bones.

4) The identification of workshops is of fundamental importance in the archaeological study of ancient crafts. In the case of lithic analysis, it is in connection with refitting, as the area of activity is the source of key information in reconstructing tool production on location. Although identifying butchering areas is sometimes also possible based on special bone accumulations (Bartosiewicz, 1988), many animal bones were circulated in connection with meat, ending up at numerous sites of consumption and, ultimately, in nearby areas of discard. In later periods, better-defined buildings and documentary as well as iconographic sources can be of help in locating real workshops, tanneries or slaughterhouses (Csippán, 2010, p. 35).

In spite of these epistemological difficulties, one can profitably apply the concept of *chaîne opératoire* to the study of animal remains. Understanding dynamic processes and the structure of the relationship between the technical sphere and human involvement are of interest when the objects of these processes were animals. Although there has been an increasing need to see animals as individuals in reciprocal interaction with human society and even exhibiting agency (Birke *et al.,* 2004), their technological study remains by definition anthropocentric as *chaîne opératoire* was developed by social anthropologists with an understandable focus on socially embedded human individuals with identities, skills, and responsibilities. The anthropological background has always been implicit among French prehistorians. However, it became increasingly explicit along with the introduction of ethnoarchaeological information (Audouze & Karlin, 2017, p. 43).

Last but not least, there is a fundamental similarity between the aims of studying lithic materials and animal remains. The treatment of live and dead animals, the preparation and consumption of their products and modes of discarding body parts thus reduced to refuse are all culturally idiosyncratic, and well worth observing in a structured manner. Distinguishing skill levels, from those of apprentices to experienced specialists, is also of interest in the handling of animal bodies as it may reveal ancient forms of understanding animal corporeality or the neglect thereof. In addition, as with lithic studies, analytical work needs to be rooted in rigorous and in-depth empirical research (Audouze & Karlin, 2017, p. 43)

3. Chronological aspects

In comparison with lithic studies, applications of the *chaîne opératoire* to animals show diverse approaches depending on the authors' interests and aims of their research. There is a clear separation between analysts studying prehistoric versus historic materials. There seems to be a preponderance of prehistoric, often hunter-gatherer examples and scenarios in the archaeozoological literature, intimately related to pioneering lithic studies behind the *chaîne opératoire* concept. The focus of such early works tends to be cut marks and associated tools, typical primary evidence in decoding human technological development. This trend also falls in line with the traditionally close cooperation between natural scientists and prehistorians in want for documentary sources or, in fact, any information beyond the frequently meagre material record. In contrast to history, ever since its nineteenth-century consolidation, prehistoric archaeology almost by definition functioned as a scientifically informed, strongly international discipline (Bartosiewicz *et al.,* 2011, p. 282). Due to this natural reliance on analytical results in prehistoric research, the study of animal remains is sometimes mistaken for a solely prehistoric pursuit.

With the advancement of time, however, archaeozoologists interested in later, ancient village or state societies began also profitably adopting

the *chaîne opératoire* approach. Thereby they also increased the spectrum of its influence in discussing economics and more complex cultural issues, a strong tradition in butchery studies concentrating on later, historical periods (Audoin-Rouzeau, 1987; Lignereux & Peters, 1996; Seetah, 2007).

Dismembering animal bodies is not easy. It takes strength, knowledge and the possibly best tools. As Seetah (2008, p. 137) argues "*butchery in its conceptual form begins only when we see evidence of tools created specifically for this activity.*" Chronological differences between the resulting *chaînes opératoires* would reflect Thomsen's (1836) three-age system (the Stone-, Bronze-, and Iron Ages), that "*underpins the archaeology of most of the Old World*" (Rowley-Conwy, 2007, p. 1). Archaeological periods characterized by these materials determined the complexity and quality of as well as the access to tools employed in butchery. This diachronic difference is not simply technical. In historical societies, development in practice required a shift of focus to the use of metal instead of stone implements: cognition and behaviour in metal-tool butchery completely differ from butchery observed at the onset of human evolution (Seetah, 2019, p. 17). This chronological division is actually an unusual limitation in archaeozoology as the study of animal remains, in most respects, can cross-cut specializations in different archaeological periods.

4. Taphonomy vs. the *chaîne opératoire*

The carcass is reduced in a time-sequenced order, based on the butchers' knowledge of anatomy, and the quality of their tools as well as several socially determined practical decisions during the process. However, it is worth repeating that in contrast with lithic raw materials, the carcass itself becomes invisible in archaeology: inferences are drawn from its modified, fragmented and usually commingled osseous remains that could hardly ever be refitted.

On the other hand, it is eminently important to emphasize that in contrast to lithic tools that can stand as *bona fide* artefacts themselves, animal bone refuse represents only the preserved and possibly least important fraction of the animal products that motivate butchery. This raises questions about the relationship between the *chaîne opératoire* and the taphonomic process. In the case of the latter, the decay of organic components of composite stone tools (e.g., wooden handles with sinew binding) would represent taphonomic loss, but such events fall beyond the traditional scope of the *chaîne opératoire* in lithic studies.

Analysing the *chaîne opératoire* is based on the stepwise distinction between the acts driving the creation, use and discard of any object. This process spans the time interval between the acquisition of raw material and the product's embedding into the archaeological deposit. In taphonomic terms, it corresponds to the cultural component within biostratinomy, an apparently similar process between the animal's death and the deposition of its remains that underwent *post mortem* modifications. Thus, it may look surprising that the *chaîne opératoire* has not been more widely applied in animal studies, where the analysis of pre-depositional effects has been successfully exploring comparable tropes since the emergence of processual or "New Archaeology" (O'Connor, 1996). The reason, however, is more subtle than the aforementioned linguistic isolation of local schools of thought.

According to Efremov (1940, p. 92) taphonomy, a new branch of palaeontology (*sic!*), is the "*transition … of animal remains from the biosphere into the lithosphere*" that is, "*the science of the laws of embedding*". In its archaeozoological applications, taphonomy has been an indispensable critical tool in understanding the reduction of animal bodies to the find material brought to light during excavations. As his concept originated in palaeontology, in its original definition Efremov

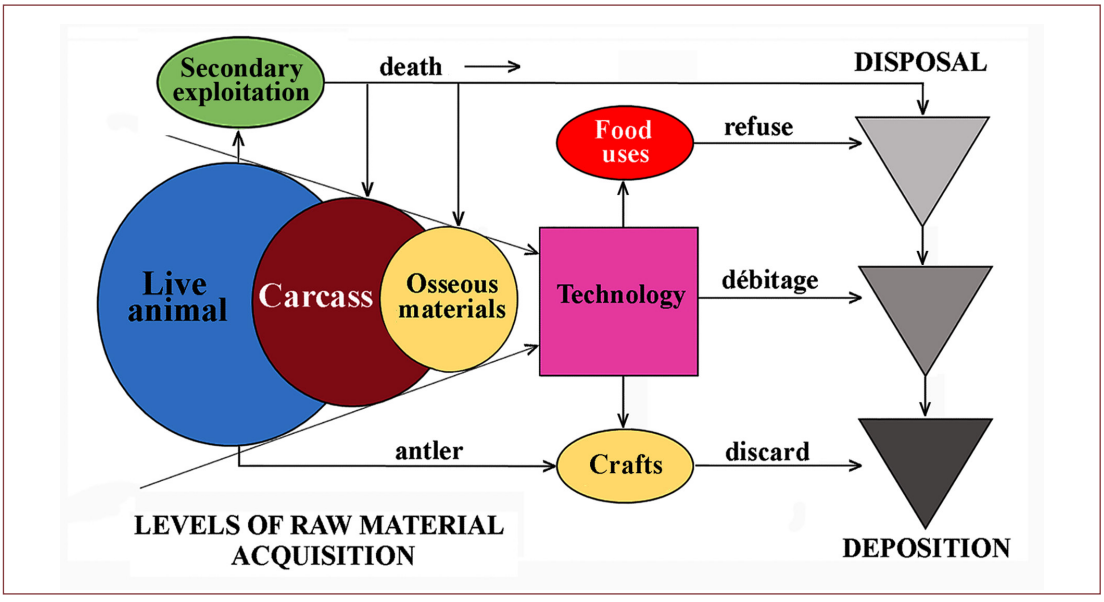


Figure 2. Flow chart summarizing the application of the *chaîne opératoire* to animal remains of various complexities. Prepared by the author.

did not reckon with ancient human influence. Cognition, however, always needs to be taken into consideration in archaeology. When humans process animal bodies, the resources a carcass should yield are defined by culturally predetermined expectations. This means that they identify the product from the outset, dictating various steps in carcass partitioning. According to Seetah (2019, p. 18), this is why taphonomy may not be the best approach to the study of behaviours evidenced by butchering marks on excavated bones.

Ritual slaughter can be described in taphonomic terms. Magnell (2013, pp. 117–118) provides a sequence for consecutive steps that, with some cognitive aspects added, could be used as a blueprint for drafting the *chaîne opératoire* of ritual killing.

The critical taphonomic analysis of animal bone assemblages is of help in targeting dilemmas of equifinality, the appearance of bone modifications not immediately attributable to either natural agents or human activity. This is a distinction of eminent significance before archaeological interpretations can proceed. The *chaîne opératoire* then helps drafting the interpretive framework for discussing cultural elements in biostratinomy based on quantitative and qualitative carcass representation stemming from patterns observed in the bone deposit. Taphonomy is instrumental in tracking trends and deviations in the ebb and flow of animal materials that characterize societal conditions during any studied archaeological period (Broderick, 2017, p. 154).

5. Adapting the *chaîne opératoire* to animal studies

Fig. 2 shows the ways animals might be utilized in ancient societies. It is a simplified summary, emphasizing the multiple ways the general model of *chaîne opératoire* can be fit within the broader subject, depending on where acquisition

begins, and how one defines the raw material as the starting point. "*Levels of raw material acquisition*" are determined by the degree of reduction between the live animal and its bare bones. Is it a complete, live animal, a dressed carcass or an ever-diminishing specific part of it? The *chaîne opératoire* posits that each consecutive step in production is driven by similar sets of concepts of the butcher, as opposed to merely representing a sequence of mechanical reduction (Seetah, 2019, p. 33).

Strictly speaking, live animals fall outside the scope of technological studies. The secondary exploitation of animals (Sherratt, 1983) for renewable material products (milk, wool etc.) as well as work and companionship, is not detailed in Fig. 2. It would fragment the picture in a multitude of details, many leading to their own *chaînes opératoires*. Dairy production or animal work could be described in terms of consecutive analytical stages when human or even animal decisions influence the outcome (Bartosiewicz, 2006, p. 259, Fig. 2). However, by breaking down secondary exploitation into stages, the focus of resulting *chaînes opératoires* would no longer be on the animals themselves. Beasts of burden often serve as components in complex technological setups such as tillage or milling (Farkas & Bartosiewicz, 2009). Scant evidence in the form of paleopathological lesions characterizing these roles is more difficult to interpret than the tangible products of meat procurement represented by quantities of consumption refuse surfacing at many settlement excavations. The *chaîne opératoire* concept is readily applicable to the narrower, product-focused approach, uniting the steps of primary and secondary butchery with food processing.

It is worth considering, however, that even in the case of meat processing, live animals belong to the history of the end product. Arguably, entering the *chaîne opératoire* is the only phase where animals may have any conscious agency. Beyond their direct acts and gestures as living creatures, animals can also have indirect, secondary agency. This is what survives animals in material culture as animal parts preserve semiotics related to animals (Choyke, 2010). Animals evoke emotions and memories in people that influence human decisions. Secondary animal agency is thus reflected not only in various steps of the *chaîne opératoire* but also in the end product. The best example is the use of animal body parts as trophies, amulets and talismans (Choyke, 2010; Daróczi-Szabó *et al.*, 2020). However, the culturally different appreciation of various cuts of meat associated with certain species or body parts is also influenced by animal agency in this secondary manner (Bartosiewicz, 1997, p. 176). Although the once widely held notion that dogs, or even horses, might bear a closer resemblance to people than other animals has largely disappeared (Ritvo, 2007, p. 121), it still strongly influences the way their carcasses are being processed in contemporary "western" cultures. Additional emotions include culturally acquired tastes and the aesthetics of meat presentation that likewise influence the *chaîne opératoire* of meat products (Seetah, 2008, p. 140).

Whether by hunting or slaughter, meat acquisition requires killing, entailing rituals integral to subsistence and animal husbandry (Magnell, 2011, p. 192). Spectacular animal offerings in Antiquity may have followed theatrical scenarios fostering remembrance, burdening the participants with guilt, counterweighed by bonding through shared aggression (Burkert 1972; Price 2010, p. 136). Among the methods of slaughter considered merciful, slitting the throat with a single stroke of a perfect blade is the first step of the *chaîne opératoire* of meat processing in Judaism and Islam of the known religions (Bartosiewicz, 2021, p. 64, Fig. 4A).

Seetah (2008) also proposes butchery as the first step in approaching the dynamic relationships between production, utilitarian consump-

tion and symbolism. He considers the *chaîne opératoire* beginning with an entire animal as raw material and ending with various consumable parts, although the meaning of butchery may differ between authors even within the short sequence followed between the carcass and the end products (Lyman, 1994, p. 294).

If the carcass is transported, its movement through space and time may result in the first steps of reduction taking place at different locations. Wild animals are killed at a distance from settlements to which hunters ultimately return. When off-site butchering of large carcasses takes place, some bones will be left behind, while others are taken to the home base with the meat and hide to be further processed (Perkins & Daly, 1968, p. 104; Binford, 1978). This "*Schlepp*" effect is a function of individual animal size and the distance between the kill site and settlement. Therefore, it is not a universal rule, but its recognition in archaeology marks the first step in the carcass reduction process. This was not a strictly utilitarian exercise. Some body parts of little practical value may have also been transported e.g. as trophies.

Once the animal is reduced to a carcass it is dressed to separate its edible/usable parts and those considered disposable, depending on the technology available and the end-products targeted. The surviving osseous remains serve as proxies for meat, fat and marrow in archaeological interpretation (Fig. 2). "Food uses" in the flow chart were singled out as the most common function for animal products. Binford (1981, p. 142) and Seetah (2019, p. 154) suggest additional stages, such as purposely breaking bones as a separate step, also understood to be behind this summary concept.

The processing of other organic soft tissue such as skins, hides and horns can usually also be reconstructed using only proxy evidence: tools (Rašková Zelinková, 2010) or terminal bones and horn cores typically attached to hides after flaying (Bartosiewicz, 2009; Csippán, 2010). However, for the sake of visual simplicity, they were not included as separate items in Fig. 2 but fall under the umbrella term "Crafts". Another important item within this topic is the manufacturing of osseous tissues, bone, antlers and teeth. With the rare exception of exotic animal parts, these were readily available in the food refuse, thus representing yet another level of raw material acquisition. Mundane bone manufacturing fits within this process as it utilizes butchery waste. The next step of modification thus reduces butchering waste and generates another product (O'Connor, 1993, p. 65). Importantly, among all osseous materials, deer antler represents a special case: it can be unrelated to meat provisioning. Although it may originate from the same hunt, shed antler can also be gathered, a form of procurement that does not involve butchery, more exactly, killing the stag. Based on this and other biological-physical properties, antler tends to follow a different pathway in tool making and use than ordinary skeletal bone (Choyke, 1998, pp. 168–169).

6. Conclusions

Truly interdisciplinary research needs to integrate ideas and practices from all corners of scholarship based on a perpetual dialogue between different specialists (Fig. 3). It may be of interest here, that Leroi-Gourhan's (1964) scientifically informed approach was in part inspired by vertebrate palaeontology.

Systematically recording the diversity of decisions involved in dismembering animals and creating any product is one of the greatest strengths of the *chaîne opératoire* approach. In an effort to familiarize Hungarian archaeologists with this concept, Zsolt Mester was one of the authors who illustrated its universal applicability. They drafted the *chaîne opératoire* for the apparently simple act of brewing tea. Their model ended up with no fewer than 17 possible outcomes of this simple-looking mundane process (Holló *et al.,* 2001, p. 52).



Figure 3. Krish Seetah and Zsolt Mester (right) engaged in a consultation on flint knapping during a butchery workshop organized in the Aquincum Museum of the Budapest History Museum on 19 June, 2009 (Photo: Anna Biller).

The utilitarian processing of animal bodies plays a central role in creating and maintaining material culture. However, the concept of *chaîne opératoire* in animal studies is nested amidst the plethora of research questions posed in archaeozoology. While the concept should not be seen as an aim in itself, advancing its proper application to technological aspects of handling material animal products will evidently benefit the overall agenda of understanding past human behaviour on a broad scale by clarifying complex connections between animal raw materials, technology, practitioner, and commodity.

When adopting the *chaîne opératoire* approach to animal bodies emphasis has so far been laid on carcass processing (butchery, food preparation, preservation, consumption, eventual manufacturing and discard). This means that studying the *chaîne opératoire* on animals is not for the faint-hearted. Conceived in the 1960's it can become a heavily empirical-positivist exercise that in its current state largely ignores the fact that animals are living, sentient beings with active roles to play in human culture beyond being objectified, treated as mere resources and products connected by technology. Contemporary experience and ethnographic examples show, that attitudes toward animals are inseparable from broader polit-

ical, economic and socio-cultural shifts (Franklin 1999, p. 175). Human-animal encounters have always created a discursive process by mutual action, becoming and performing (Armstrong Oma, 2010, p. 180) that have little to do with the chopping block, even if the majority of animals end up getting consumed by humans. Expanding the *chaîne opératoire* approach to ancient tasks that involved live animals would open a treasure trove of cultural information through revealing new avenues in reconstructing animal-human relationships. Consider, for example, the operational sequence of falconry, a socially complex activity based on cooperation with diurnal raptors of various qualities (Bartosiewicz, 2012, p. 180, Tab. 1). The raw material is a chick, picked up on a beautiful early June day to be tamed and trained during the summer for yourself or sale...

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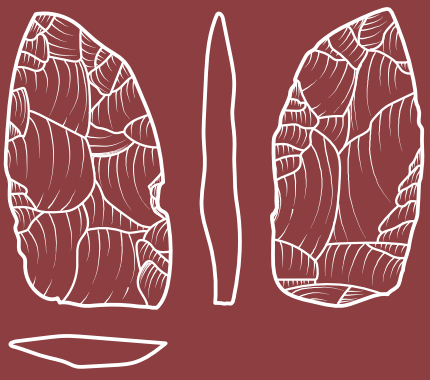
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Eger-Kőporos-tető, August 2003. Zsolt in his element, the Palaeolithic sites in the Eger area. The participants try to collect a sample from concrete-hard sediment with a drill. Everyone had their turn of manual labour that day. From left to right: Wisconsin archaeologist William J. Eichmann; Róbert Kertész, an archaeologist from Szolnok, Sándor Béres, an enthusiastic collector in the Eger area and one of the authors of our volume, and with the tool in hand – Zsolt. It is not visible in the picture, but archaeologist Krisztián Zandler also took a good part in the work that year.
Photo: Attila Király; drawing: after Kozłowski et al.*, 2009.*



3

The Demjén-Szőlő-hegy III Early Upper Palaeolithic site

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Abstract. Szőlő-hegy is located in Northeastern Hungary in the vicinity of Demjén. The archaeological potential of the plateau has been discovered by Viola Dobosi in 1975. However, the Szőlő-hegy III site was only identified during a field survey in 2017.

The main goal of the article is to determine the period and the cultural attribution of the finds by comparing the assemblage with similar archaeological materials. Therefore, a comprehensive technological and typological analysis was carried out. According to the comparison with the Szőlő-hegy I and II sites, Szőlő-hegy III is classified as Aurignacian. The archaeological material contains tool types characteristic of Early and Typical Aurignacian, but their proportion, technology, and closest analogies might leave the possibility open to an Early Aurignacian origin.

Keywords: Aurignacian, Raw material economy, Technology, Typology

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1. Introduction

According to our present knowledge, the beginning of the Upper Palaeolithic in Europe is associated with the appearance of anatomically modern humans on the continent. The first central European Upper Palaeolithic industries (Bohunician, Bachokirian, Proto-Aurignacian) are similar to assemblages made by modern humans in the Levant at an earlier date and represent movements into Europe from the Near East that took place in multiple waves via multiple routes around 48–46 cal ka BP (Hublin, 2015; Mellars, 2004). While some industries are more widespread, others are less apparent. The Proto-Aurignacian occurs in most parts of the Carpathian Basin, including a subcarpathian site cluster near Beregovo and Romania (Banat or Bánát region) with the sites of Coşava, Tincova, and Rumâneşti Dumbrâviţa (Demidenko & Noiret, 2012).

In the Carpathian Basin, the Bohunician was only identified near Nižný Hrabovec in Slovakia (Kaminská *et al.,* 2009; Škrdla, 2017, pp. 80–82); besides, the *Macrolaminaire* assemblages (Initial Upper Palaeolithic, IUP) from the southern Bükk that may be related to the younger stage of the "Bachokirian". However, the emergence of the Aurignacian is still unclear and a subject of long-lasting debate. Nevertheless, dating of the Early Aurignacian layer of Willendorf II AH3 in the Carpathian Basin yielded remarkable old dates: 34,100 + 1200 – 1000 BP (GrN-11192) and 37,930 ± 750 BP (GrA-896) (Nigst, 2006).

The Early Upper Palaeolithic in the Bükk Mountains is represented by several Aurignacian and three *Macrolaminaire* (IUP) sites, where excavations were carried out (Egerszalók-Kővágó-dűlő, Eger-Kőporos-tető, Andornaktálya-Gyilkos-tető). No *Macrolaminaire* lithic artefact was found *in situ*. Therefore, no dating was ever conducted at these sites.

So far, we only know two sites in Hungary, which, based on the culture's "*fossile directeur*" (split-based bone points), can be classified as Early Aurignacian. It is also important that the dates obtained from the split-based bone points from the Istállóskő cave are younger (Davies & Hedges, 2008–2009; Hopkins, 2018) than the ones from Willendorf II AH3 (Nigst, 2006; Nigst *et al.,* 2014). Furthermore, Aurignacian assemblages are also known from Andornaktálya-Gyilkos-tető (Mester *et al.,* 2021), Egerszalók-Kővágó-dűlő (Kozłowski *et al.,* 2009) and Eger-K*őporos-tető (*Kozłowski *et al.,* 2012) around the area of Demjén, but the Upper Palaeolithic material from Ostoros-Rápca, based on its typology, may also belong to the culture (Dobosi, 2005). However, the late Aurignacian is also present in the region at sites like Andornaktálya-Zúgó-dűlő, where only an OSL date (30,180 ± 330 BP) is available (Kozłowski & Mester, 2003–2004; Mester, 2010). As a result, based on its topographical location, Demjén-Szőlő-hegy can play an important role in future research, which is further amplified by the high variety of stone tools known from the sites.

2. The Demjén-Szőlő-hegy site

Szőlő-hegy is located on the left bank of the Laskó stream, directly above the village of Demjén. The current landscape has been developed in the Quaternary. The tufite covering the foothill region of the Bükk Mountains was formed as a result of Tertiary volcanism and during its tectonic uplift in the late Pleistocene, north-south-facing valleys were formed in the area. This was the cause of the uplift of smaller plateaus like Szőlő-hegy (Pentelényi, 2002).

The research on Demjén-Szőlő-hegy started in 1975 (Dobosi, 1976), during the excavation of Demjén-Hegyeskő-bérc, when Viola Dobosi also conducted field surveys on the Szőlő-hegy plateau (Zandler, 2012). The material she collected in the area was sent later to the Hungarian National

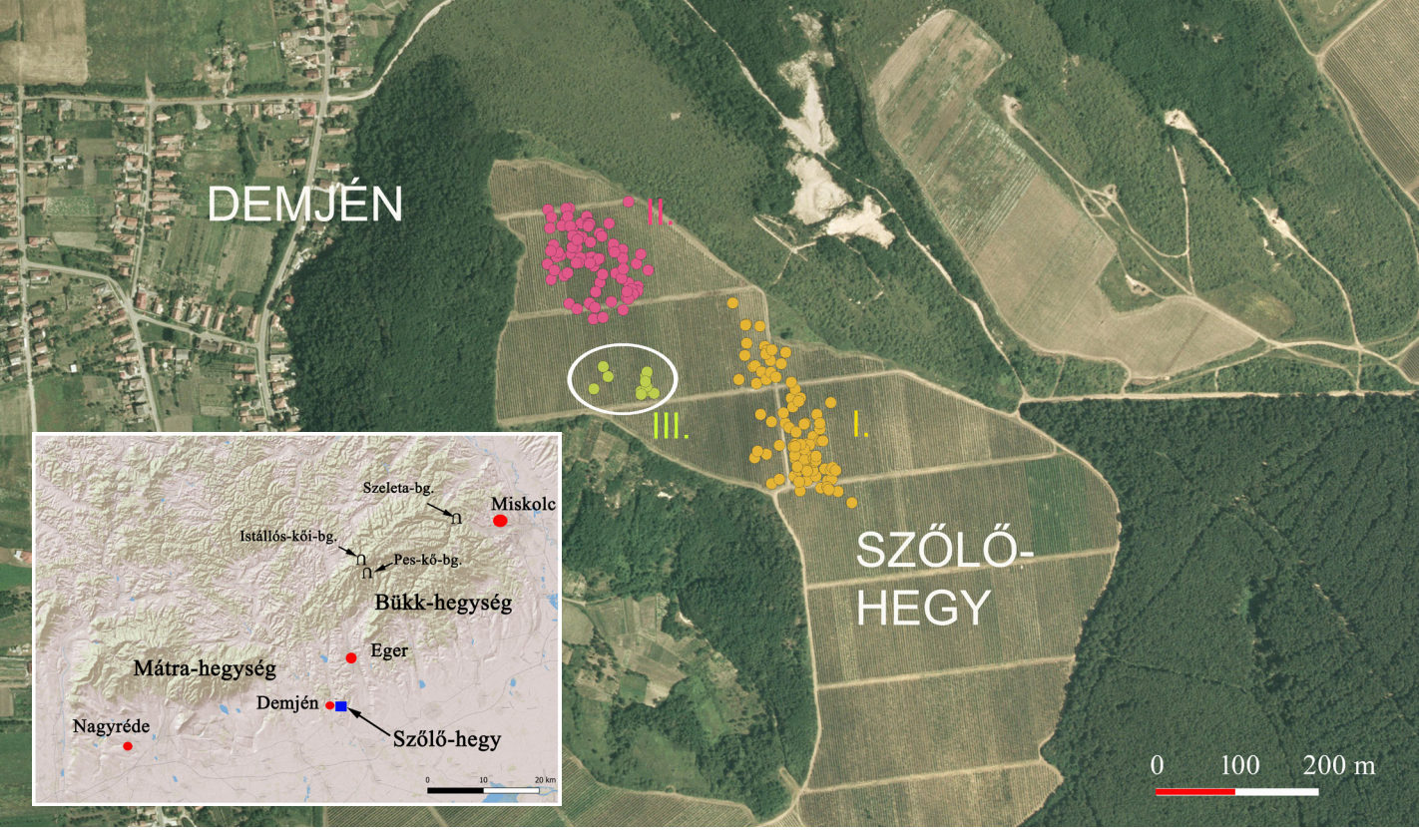


Figure 1. Archaeological sites of the Szőlő-hegy plateau in Demjén. Basemap: Google Earth (prepared by Sándor Béres).

Museum, where it is still being kept today. After 1975, the site was only visited again in 1999–2000, however, the investigation only affected the western part of the plateau (the area above the village, now called Szőlő-hegy II). The research became more intensive after 2005, when the current location and extent of the Szőlő-hegy I and II sites, and their cultural attribution were determined. Furthermore, in the spring of 2017, it was possible to locate the Szőlő-hegy III site on the southern slope of the plateau (Fig. 1).

The archaeological material is concentrated in smaller patches at 218 m above sea level. The coordinates of the centre of the site (covers an area of approximately 120 × 100 m) are 47° 49′ 53″ N; 20° 20′ 26″ E. It is still not clear whether the settlement was originally located on the slope or if the archaeological material had been redeposited during the destruction of the culture layer.

3. Materials and methods

Every studied artefact was collected during field surveys from 1999 on. Those pieces that were found earlier by Viola Dobosi are not included, because the exact location of the finds cannot be determined.

Currently, on the Szőlő-hegy plateau, we can distinguish three Palaeolithic settlements, but no archaeological excavation has been carried out on any of them yet (it is currently ongoing). Every field survey we conducted in the area was documented, and after 2015, GPS coordinates of the finds were also recorded. However, most of the GPS data derive from Szőlő-hegy III, since that is the most recently discovered site. The spatial data of find distribution are presented here with the help of the open-access QGIS software.

A variety of methods were used to document every lithic artefact, including raw material, typological, and technological examinations. The more detailed research allowed us to determine

Table 1. Szőlő-hegy III. Distribution of artefact types by raw materials.

Find type	Carpathian radiolarite	Volhynian flint	Obsidian	Limnosilicite	Radiolarian marl	Silicified sandstone	Local radiolarite	Other	Total
Raw material nodule				1	1				2
Core	2				1				3
Blade	3			3	1				7
Flake	17	1	1	2	2	1	1		25
Debris	1			2	2				5
Chips	10								10
Tools	21		1	3	3			1	29
Total	54	1	2	11	9	1	1	1	81

various raw material categories based on the distance of their geological source (local, regional, long-distance). During the evaluation, the T. Biró–Dobosi model was used (T. Biró & T. Dobosi, 1991), supplemented with our observations. In the case of long-distance raw materials, we also paid attention to the direction of the source area (procurement zone) (Mester, 2009).

During the classification, the Dermars–Laurent typology was used (Demars & Laurent, 1989) in conjunction with the Sonneville-Bordes typology (De Sonneville-Bordes & Perrot, 1953). In the technological analysis, we followed the Inizan–Reduron-Ballinger–Roche–Tixier conceptual system and test methods (Inizan *et al.,* 1999).

4. Raw materials of Szőlő-hegy III

The lithic raw materials have been divided into three groups (T. Biró & T. Dobosi, 1991, p. 8). Based on this, every raw material that can be found within a radius of 25 km is considered local, while regional lithic sources occur within a distance of 25–100 km. Moreover, raw material sources farther than 100 km are classified as long-distance materials.

The local raw material group includes every raw material that occurs in the western and southern *Bükk* Mountains. Among these, the radiolarian marl is considered to be the most significant, because retouched artefacts were only made from this local lithic. Presumably, its main geological source is located around the southwestern Bükk pediment area where it is also present in pebble form in secondary deposits (gravel beds, e.g., Monósbél, Bükkzsérc) (Pelikán, 1986). From this raw material, mostly high-quality variants are present at the site.

Other local raw materials (from the south Bükk area), such as Egerbakta-type silicified sandstone and local radiolarite, are also present in the assemblage. However, based on the few pieces we found, they probably played a secondary role in tool production. The pieces made of these raw materials bear pebble cortex in many cases, which indicates that they were collected from gravel beds as well.

Moreover, materials like silicified sandstone, silicified tuff and local opals, which also occur in the Laskó stream valley, were placed into a subgroup called “Local 1”, while other lithic sources

Table 2. Szőlő-hegy III. Distribution of tool types by raw materials.

Tool type	Carpathian radiolarite	Volhynian flint	Obsidian	limnosilicite	Radiolarian marl	Silicified sandstone	Local radiolarite	Other	Total
Endscraper on blade	4								4
Endscraper on flake	1		1	1					3
Carenoid endscraper	1								1
Borer	1								1
Dihedral Burin	1				1				2
Burin on truncation	1								1
Retouched blade	5			1				1	7
Truncation	2				1				3
Notch	1								1
Denticulate	1								1
Sidescraper	1								1
Other	2			1	1				4
Total	21	0	1	3	3	0	0	1	29

from within the 25 km radius, such as radiolarian marl and local radiolarite were classified as "Local 2". The categorization is based on the experience that some Palaeolithic cultures (e.g., Aurignacian) rarely used "Local 1" raw materials, while others preferred them in large quantities over other high-quality materials.

Regional raw materials are usually non-local limnosilicite variants originating from the North Hungarian Range, although their geological source in most cases cannot be determined. High-quality materials such as flint pebbles were also identified, however, the cortex and the patina on their surface make it harder to distinguish them from limnosilicite (e.g., nummulitic chert).

Carpathian obsidian is also present, although only one retouched artefact and one fragment were discovered. Unlike limnosilicite, these raw materials can easily be linked to a specific source in Hungary (Zemplén Mountains). According to the two most common microscopically recognizable obsidian variants (T. Biró, 1981), only the Carpathian I type occurs on the site, in contrast with Szőlő-hegy II, where the Carpathian II type was identified.

The long-distance raw material group includes the most important raw material of the assemblage, the Carpathian radiolarite because 72 % of the tools and 68% of all finds were made of this rock. It is also important to mention that pebble cortex seldom occurs on these artefacts, which means the raw material had been collected from its primary source and carried from a great distance to the site. Unfortunately, the exact geological source cannot be determined, because Carpathian radiolarite occurs over 250 km along the Pieniny Klippen Belt formation in the Central Western Carpathians (intra-Carpathian source

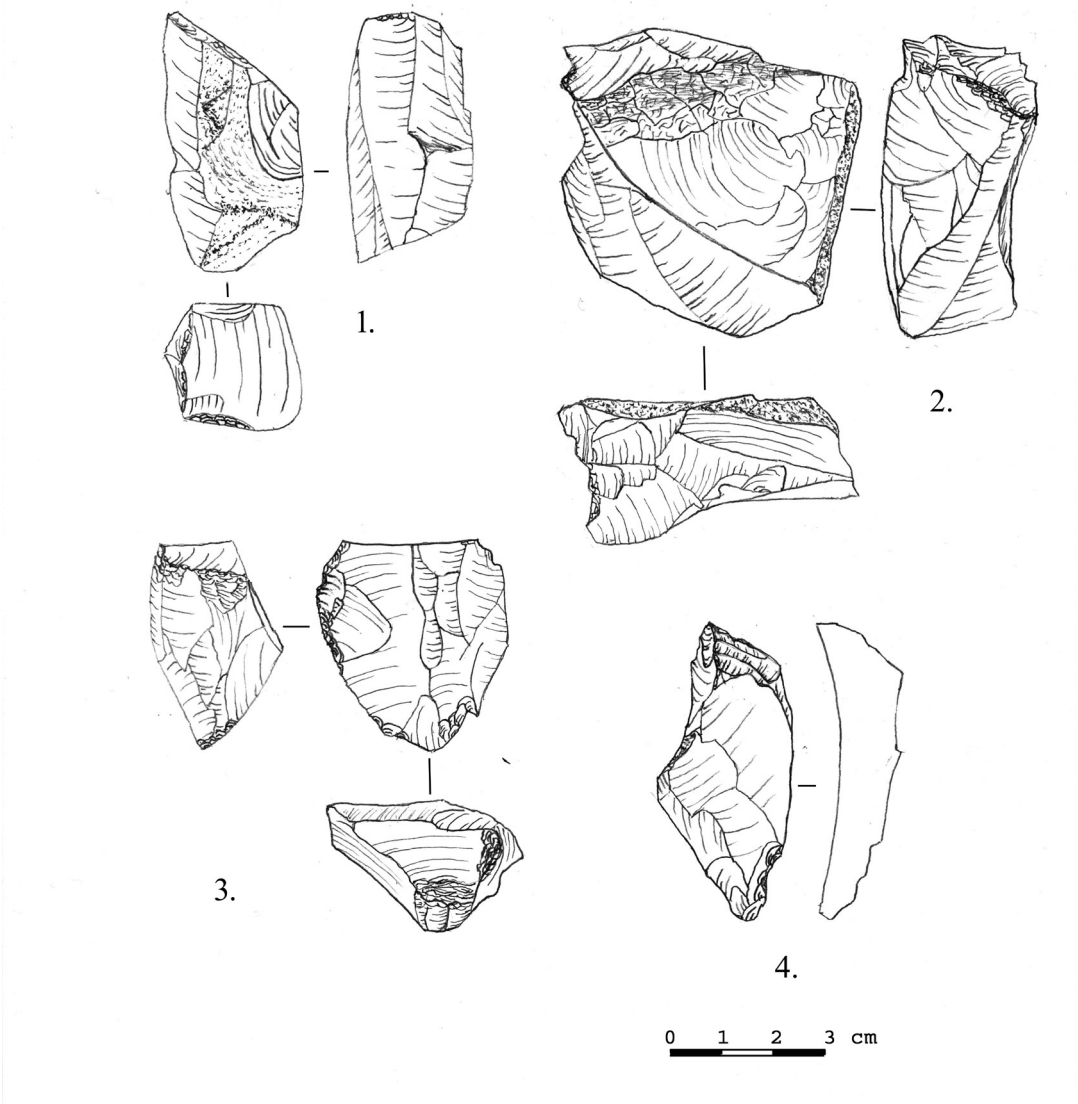
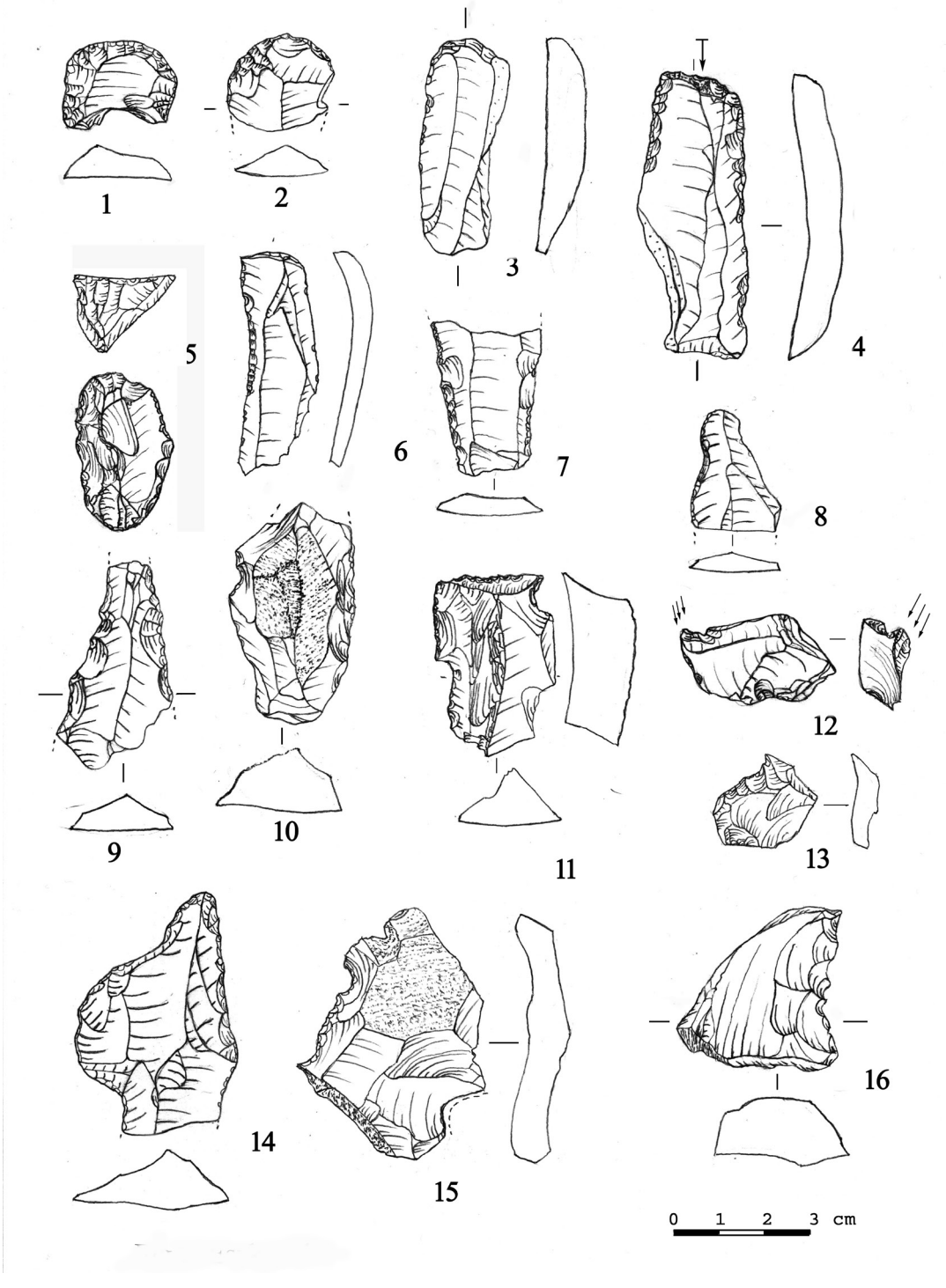


Figure 2. Szőlő-hegy III. Cores. Prepared by Sándor Béres.

Figure 3 (next page). Szőlő-hegy III. Tools. Prepared by Sándor Béres and Dalma Kerekes.


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zone) (Plašienka, 2018). However, the closest primer source to Demjén is located northwest of Prešov (Eperjes) in the Torysa (Tarca) river valley (Voľanská, 2014, p. 175).

Volhynian flint can also be found in the collection (extra-Carpathian source zone). The raw material is also present over a large area along the Dniester in western Ukraine, but its closest occurrence to Demjén is 300 km away near the town of Halych (Halics, *Галич) (*Sytnyk *et al.,* 2009, pp. 241–171). Throughout the research, only one artefact was identified, however, its great distance makes it important during the interpretation.

5. The composition of the archaeological assemblage

The archaeological material counts a total of 81 pieces. 29 were identified as tools (36%), and 2 as raw material nodules, which represents the initial stage of tool production. In addition, 3 cores, 7 blades and 25 flakes were also found. Five raw material chunks and 10 small chips are included in the knapping debris category (Table 1).

Raw material nodules: One is presumably a tested limnosilicite pebble, but its geological source cannot be determined. The other one is a radiolarian marl block. Each was collected within 25-50 km of the site.

Cores: One was made of radiolarian marl (Fig. 2: 1), two of Carpathian radiolarite. One Carpathian radiolarite core (Fig. 2: 2) and the radiolarian marl core were classified as prismatic blade cores with negatives of unidirectional blade debitage. The radiolarian marl core has plain striking platform, but the striking platform of the Carpathian radiolarite core shows signs of preparation.

The other radiolarite core (Fig. 2: 3) has been rejuvenated and its original structure can no longer be seen. After the removal of the lower part (foot preparation), blade and bladelet production was continued in the opposite direction until the core became exhausted. However, a new crest was made on the exploited core edge, although the blade detachment ceased. The rejuvenated core's striking platform is plain and unprepared, the flaking surface shows unidirectional debitage.

Blades: Out of the seven blades, three were made of Carpathian radiolarite, three of limnosilicite (or flint pebble) and one of radiolarian marl. Four of them are mesial fragments, one is proximal, one is distal, and one is unbroken. Only two pieces display the method of detachment, which was soft hammer percussion. The length of the blades varies between 36–46 mm.

Flakes: The total number of flakes is 25. Their main raw material is Carpathian radiolarite (17 pieces, 68%), but radiolarian marl (2 pieces), limnosilicite or flint pebble (2 pieces), local radiolarite (1 piece), Egerbakta-type silicified sandstone (1 piece), Carpathian obsidian (1 piece) and Volhynian flint (1 piece) are also encountered (Table 1). The cortex is only visible on two pieces. Except for two artefacts, hard hammer percussion was used for flake detachment. Their size varies between 61 × 48 mm and 21 × 16 mm.

6. Retouched tools

The low number of retouched pieces (29) prevents us from statistical evaluation, however, certain tendencies can be observed and can be compared to similar lithic assemblages (Table 2).

Retouched blades: It is the most frequent tool type category (9 pieces). Seven of them are retouched, while two are classified as truncated-retouched fragments. One blade fragment was made of limnosilicite, one fragment's raw material is an unidentified black flint, and Carpathian radiolarite was used for five pieces. Two of them are proximal, one is distal and four are mesial fragments. Their size ranges between 47 × 26 × 14 mm to 18 × 20 × 2 mm.

Retouch in two cases is bilateral (Fig. 3: 7, 9), and in four cases it is unilateral (Fig. 3: 8).

However, Aurignacian retouch is only visible on one massive blade (Fig. 3: 10). One mesial fragment of a massive crested blade is retouched and shouldered on the left edge and notched on the right edge (Fig. 3: 11) (size: 40 × 25 × 13 mm).

Truncated pieces: Truncation were observed on three artefacts. One is a Carpathian radiolarite retouched blade fragment (Fig. 3: 6) (size: 47 × 15 × 4 mm); one is a radiolarian marl blade with ventral, partial retouch on the left edge (size: 52 × 25 × 10 mm); one is an unretouched Carpathian radiolarite flake, the distal end of which has been truncated after a fracture (size: 50 × 28 × 13 mm).

Endscrapers: It is the second most significant tool type category (8 pieces) besides retouched blades. Four were made on blades, three on flakes. At the site, only one carenoid double endscraper was discovered. Except this, all pieces have thin supports.

Endscrapers on blade: Opposed endscraper made of Carpathian radiolarite (Fig. 3: 4). The right edge is partially retouched and the left edge was formed by alternating retouch. The working edge is at the proximal end. The distal end is broken and partly truncated (size: 62 × 23 × 10 mm).

Endscraper made of Carpathian radiolarite. The right edge is retouched. The butt was removed during shaping (truncation) (size: 36 × 16 × 6 mm).

Endscraper made of Carpathian radiolarite (Fig. 3: 3). The left edge is ventrally retouched. The butt is partially removed. The dorsal face is mostly covered with cortex (size: 45 × 16 × 5 mm).

Endscraper made of Carpathian radiolarite (Fig. 3: 1). The support is a short blade fragment. Both edges are retouched. The proximal end is notched (size: 16 × 22 × 5 mm).

Endscrapers on flake: Endscraper made of limnosilicite. The support is an irregular flake with broken base. The left side of the distal end is ventrally retouched. The 20-mm wide endscraper front was formed on the right edge (size: 46 × 39 × 8 *m*m).

Endscraper made of dark-grey (Carpathian?) radiolarite (Fig. 3: 2). The support is a round flake. The left edge is retouched, the base is broken and the working edge has a rounded shape (size: 17 × 22 × 7 mm).

Endscraper made of Carpathian I obsidian. The left edge is partially retouched and the base is missing. The endscraper front was formed by ventral retouch (atypical) (size: 20 × 20 × 4 mm).

Only one carenoid endscraper was found at the site (Fig. 3: 5). The support may have been a thick Carpathian radiolarite blade fragment, which was bilaterally retouched. Typologically, it is a double carenoid endscraper with a carinated distal end and a nosed proximal end. Microblade negatives are also visible on both ends (size: 33 × 19 × 16 mm).

Borer: One borer has been identified in the assemblage (Fig. 3: 14). It was made on a Carpathian radiolarite flake. Both edges are retouched and the base is absent (size: 48 × 34 × 10 mm).

Burins: The collection contains three burins. These are the following:

Dihedral burin on a Carpathian radiolarite flake (Fig. 3: 12). The left edge is retouched. The base was removed by fracture (size: 38 × 19 × 6 mm).

Burin on a Carpathian radiolarite flake (Fig. 3: 13). Probably a transverse type (size: 17 × 33 × 8 mm).

Dihedral burin on a radiolarian marl blade. The burin edge is unfinished. The dorsal surface is partially covered with cortex (size: 46 × 13 × 8 mm).

Sidescraper: One sidescraper was found at the site. It is a simple sidescraper made of Carpathian radiolarite. The support is a flake with straight working edges. The base is broken (sizes: 30 × 22 × 6 mm).

Denticulated and notched tools: Two pieces were identified at the site from these tool categories altogether. Notched tool made on a Carpathian radiolarite flake (Fig. 3: 15). The notches are located in three different parts of the artefact: one on the right edge, and two on the left edge where traces of denticulation can also be observed (size: 54 × 42 × 12 mm). Denticulated tool on a Carpathian radiolarite flake (Fig. 3: 16) with ventral retouch and a convex working edge (size: 41 × 34 × 13 mm).

The assemblage also contains 4 unclassified retouched pieces: A small Carpathian radiolarite flake bears retouch on its distal end (Fig. 3: 13). Presumably, the main goal was to make an endscraper, but the tool remained unfinished.

A radiolarian marl flake has an alternate retouch on the left edge, and at the distal end, an unfinished nosed endscraper front is visible (size: 34 × 23 × 8 mm).

A Carpathian radiolarite core-edge removal flake bears microblade negatives (atypical carinated core?) (Fig. 2: 4). The distal end is partially retouched and its proximal part is shouldered.

A retouched limnosilicite flake is quite similar to an endscraper in its morphology. On the left edge partial retouch can be observed (size: 29 × 20 × 6 mm).

7. Technological observations

According to our morphological observations on the three cores and on one other artefact with bladelet negatives, the production was mainly focused on producing blades and bladelets. No flake cores were found at the site, however, only 48% of the retouched artefacts were made on blades, the rest on flakes. The same can be observed among the unretouched artefacts, their ratio compared to blades is 25:7 (76%: 24%). On the other hand, bladelets and microblades are completely absent from the assemblage, while cores and artefacts derived from core reduction show several instances of lamelle negatives. The lack of these supports can be attributed to the difficulty of noticing small pieces on the ground during field surveys.

As previously mentioned, mostly Carpathian radiolarite was used in tool production. However, the raw material has a low proportion among the unretouched blades (3 out of 7, 37%), while there is a significant predominance among the unretouched flakes (17 out of 25, 68%). The difference is even more striking if we compare the number of unretouched Carpathian radiolarite blades to the total count of retouched radiolarite blade tools (3 out of 13). Therefore, we can state that 81% of all found radiolarite blades were selected for further shaping and then were used as tools.

In the blade debitage group, butts were identified only in two cases, one linear and one dihedral. Both of those blades were made of limnosilicite and were struck with a soft hammer. However, among blade tools, the butt is visible in five cases. Four of them were detached by a soft hammer, while a hard hammer was used only for one Carpathian radiolarite blade with Aurignacian retouch and a plain butt (Fig. 3: 10). The other two Carpathian radiolarite blades have plain and prepared butts, the radiolarian marl truncated blade tool has a punctiform butt and the radiolarian marl dihedral burin has a plain butt.

The dorsal negatives were observed on 11 blade and blade tools. Unidirectional dorsal scar patterns were recognized in 10 cases (all were made of Carpathian radiolarite), while one radiolarian marl artefact bears opposed bidirectional scars.

According to our observations, the majority of flakes were likely produced during the shaping and transformation of cores. Four flake tools with plain butts were detached with a hard hammer. Unretouched flakes are more varied in this aspect. Four out of six Carpathian radiolarite flakes were detached with a hard hammer (two faceted, one dihedral, one winged), and the remaining two

with a soft hammer (plain butts). Furthermore, the radiolarian marl flake dorsal surface is fully covered with cortex which extends to its butt, while the Egerbakta-type silicified sandstone has a faceted butt with a dorsal cortex coverage varying between 50%-25%.

8. Palaeolithic sites at Demjén-Szőlő-hegy

Next to Szőlő-hegy III, two other sites are also known on the plateau (Fig. 1). Szőlő-hegy I is located near Szőlő-hegy III. The assemblage contains 414 lithics with 140 tools, 6 cores, 2 core fragments and 2 tested raw material fragments. The proportion of the retouched tools in the archaeological material is significant (33%) and its find material is also dominated by Carpathian radiolarite (56% among retouched tools). In addition, the assemblage yielded a considerable amount of carenoid endscrapers, which is the "*fossile directeur*" of the Aurignacian. For this reason, we classify Szőlő-hegy I as an Aurignacian base camp, where only moderate workshop activity took place.

Szőlő-hegy II is located on the edge of the plateau, above the Laskó stream. The site is surprisingly rich in archaeological material. In the assemblage, the total number of the retouched pieces is 197, accompanied by 1049 other artefacts, including 49 cores. Apart from limnosilicite, the archaeological material is dominated by various other "Local 1" lithic raw materials, such as the Egerbakta-type silicified sandstone. The high number of cores, blanks and waste indicates significant workshop activity, with primary production based on "Local 1" raw materials.

Unlike at Szőlő-hegy I, emblematic Aurignacian types are missing at Szőlő-hegy II, thus the archaeological material does not belong to this culture. Assemblages, that might be similar to the Szőlő-hegy II material, are exceedingly rare. A non-Aurignacian Early Upper Palaeolithic industry mixed with material of other cultures was only identified at the Eger-Kőporos-tető, Egerszalók-Kővágó-dűlő and Andornaktálya-Gyilkos-tető sites (Kozłowski & Mester, 2003–2004; Kozłowski *et al.,* 2009; Kozłowski *et al.,* 2012; Mester *et al.,* 2021). The Szőlő-hegy II collection seems relatively homogeneous and the absence of Carpathian radiolarite indicates that no admixture happened with the Szőlő-hegy I and III assemblages, despite their proximity. Only a few bifacial tools raise questions about the homogeneity of the Szőlő-hegy II assemblage.

Szőlő-hegy III, which is the main topic of this paper, is located on the slope, just below Szőlő-hegy II. Although its archaeological material is significantly more modest than the other assemblages, the raw material spectrum is remarkably similar to Szőlő-hegy I. This is important because none of the known EUP sites from the North Hungarian Range show similar Carpathian radiolarite dominance. However, there is an apparent difference in raw material utilisation between Szőlő-hegy I and II. At Szőlő-hegy II retouched tools made of Carpathian radiolarite or other long-distance raw materials were not identified, however, the presence of Egerbakta-type silicified sandstone is significant, which was not used at the other sites on the plateau.

9. Discussion

Based on our analysis, the Szőlő-hegy III archaeological material, like the Szőlő-hegy I assemblage, can be classified as Aurignacian. The collection contains both Early and Typical Aurignacian retouched tool types, but close analogies are might known in Austria and Germany, e.g., Vogelherd, layers AH IV and AH. However, a large number of characteristic burins have been found in Vogelherd, which is quite rare in the Szőlő-hegy archaeological materials.

It also should be emphasized that the Typical Aurignacian assemblages from the Carpathian Basin are bear some similarities with the Szőlő-hegy sites, but the proportion of the tools and the

lithic technology show some difference. This is particularly evident in the quantity of retouched blades, as their ratio in the Nagyréde-Öreg-hegy and Nagyréde-Vájsz assemblages are 5% and 15%, while in the Szőlő-hegy assemblage 31%. The Nagyréde archaeological materials are mostly characterised by flake debitage and opposed blade detachment, which is rare at Szőlő-hegy. In addition, characteristic Early Aurignacian tool types, such as Aurignacian endscrapers and points on retouched blades (*Spitzklinge*) are present at Szőlő-hegy I, but the pointed blades are absent in the Typical Aurignacian assemblages of Nagyréde (Lengyel *et al.,* 2006).

The results are similar if we compare the Szőlő-hegy assemblages to the Late Aurignacian materials. The lack of narrow-nosed endscrapers (e.g., Lhotka type), busked and carenoid burins (Which is the "*fossile directeur*" of the late phase) are noticeable. Therefore, a late Aurignacian interpretation can also be excluded.

Similar blade dominated Aurignacian assemblages currently are only known from the Bükk mountains in Hungary (Istállóskő, Peskő caves), however, the archaeological material at these sites are poorly represented and does not contain characteristic tool types (Vértes, 1965; Adams, 1998; Markó, 2015; Patou-Mathis *et al.,* 2016). Another interesting analogy of Szőlő-hegy III might can be found in Austria, at Willendorf II (AH 3), where P. Nigst summarized the technological aspects of the Early Aurignacian (Nigst, 2006). According to his research, the blades were made on unidirectional prismatic cores, which can also be observed by the dorsal scare pattern in the Szőlő-hegy material. Moreover, Bladelets and microblades were also most likely produced at the site, despite their absent.

However, it is important to mention that at this stage of our research we cannot emphasize the Early Aurignacian origin of the Szőlő-hegy assemblages since more research is needed. Our goal was to just simply provide information of the newly discovered sites in the vicinity of Eger by comparing them with other similar archaeological materials that can give us opportunity to understand the above mentioned phenomena better.

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4

Animal "body techniques"

PROCESSING AND CONSUMPTION OF ANIMALS IN A LATE COPPER AGE SETTLEMENT IN BUDAPEST (HUNGARY)

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Abstract. A significant number of bone finds were uncovered from the LCA settlement located on the outskirts of Budapest, Hungary. The majority of the finds originated from domestic species, but some wild game remains were also discovered. In this study, the author attempts to apply the method of chaîne opératoire to gain a deeper understanding of contemporary meat processing and waste disposal practices. On the other hand, for interpreting the consumption of these animals, the author also focuses on Binford's functionalist approach, which includes utility curves and indices

Keywords: Archaeozoology, Late Copper Age, Meat processing, Utility curves, Utility indices, MAU%, FUI

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1. Introduction

In this case study, the author seeks to reconstruct processes of meat consumption in the Late Copper Age settlement of Rákoscsaba, Major-hegy. This experiment aims to capture the potential decisional or behavioural hubs which led to the known results: these animals were kept or hunted – killed off – skinned – butchered – cooked, fried – eaten and their bones were deposited as refuse.

The research question is: What is reconstructible from these activities above? Can we prepare an algorithmic table which includes all of these hubs like in the „simple" case of preparing tea (Holló *et. al.,* 2001, p. 53)?

Furthermore, we focus on another important problem of communal butchery. The author hypothesizes that butchery was not an "individualistic" activity of past contemporary households. The killing of one cattle produced approximately 250 kg of beef (Vörös, 1987, p. 28), more meat than a family of five could have consumed before it became rotten. So, we have to think that butchering these animals was a joint venture of more households or even the whole settlement. This hypothesis seems plausible, but what about smaller animals like sheep or pigs? Their small size suggests their exclusive consumption by single households. The present paper focuses on consumption and butchery patterns through the commonly used Food Utility Indices by Binford.

2. The site and its environment

Archaeologists of the Budapest History Museum (BTM) conducted a rescue excavation accompanying the M0 ring road construction in 2004 and 2005. The excavation was managed by Zsuzsanna M. Virág, László Reményi, Anita Korom and Anikó Tóth.

The Rákocscsaba, Major-hegy site was located on the southwestern side of the Major hill, east from the North-South anabranch of the Rákos



Figure 1. Location of the Rákoscsaba, Major-hegy site. Prepared by the author.

creek (Fig. 1). The extent of the site was approximately 2.5 hectares and it had three different phases: Ludanice period (Middle Copper Age), Protoboleráz period (Late Copper Age, LCA) and Roman imperial period.

The author of this study hereinafter will focus only on the LCA materials because the quantity of the other materials wasn't enough for a relevant archaeozoological observation.

Among the sparse archaeological features, simple refuse pits and beehive-shaped storage pits were dated to the LCA (M. Virág, 2009, p. 7). The excavators hypothesized that the contemporary buildings were positioned in empty spaces encircled by these storage and refuse pits. These buildings may have been light-frame houses with a breastsummer, which did not leave any structural traces (M. Virág, 2009, p. 7).

A trench system with traces of a palisade also came to light in the southern part of the settlement (M. Virág, 2009, p. 7).

3. Animal bones from the site

4344 pcs of animal bone fragments came to light from the LCA period in the Rákospalota, Major-hegy site (Fig. 2 and see Appendix). Based on their analysis, the most important species in the meat consumption of the Protoboleráz settlement was cattle. Almost all kinds of bones were

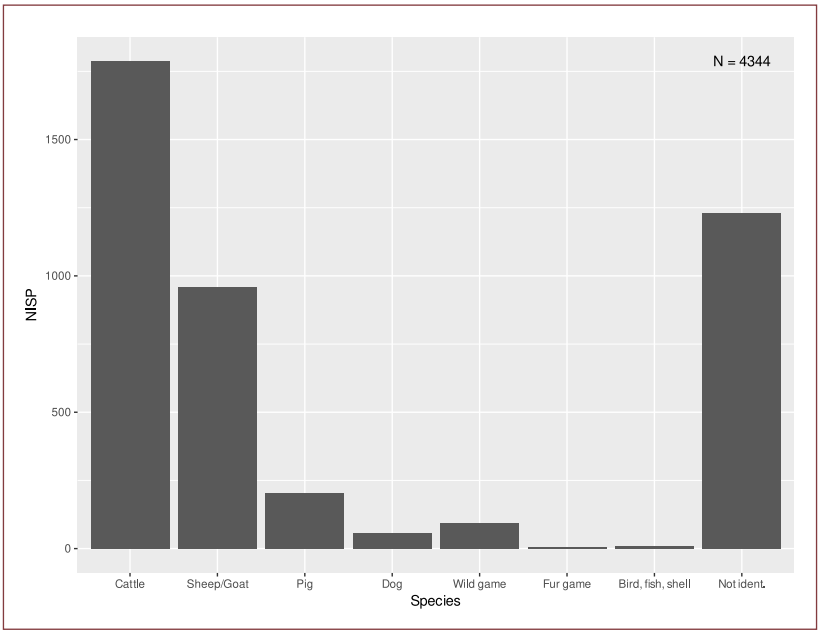


Figure 2. Distribution of the main species from the site. Prepared by the author.

found in the refuse and storage pits. This phenomenon reflects not only the consumption of the animals but also the techniques of butchery practices in the settlement. Furthermore, the small ruminant (sheep or goat) and pig bone fragments were also frequent.

*3.1. Cattle (***Bos taurus** *L.)*

1786 pcs of cattle bone fragments were encountered, which is 60.5% of all fragments from the main domestic species (excluding dogs). This considerable percentage indicates their dominance in the meat-eating of the inhabitants of the settlement. However, we do not have a clear picture of these animals, because we were able to ascertain withers height and sex based on metapodials only in six cases (Matolcsi, 1970; Nobis, 1954). The calculated withers heights fit perfectly to the minimum-maximum body height range of LCA cattle in the Carpathian Basin, indeed they were a little bit higher than average (Fig. 3).

With Nobis's method, all individuals were identified as cows. This phenomenon is possibly connected with the exploitation techniques and keeping methods of this species. So, the consumption of dairy products was possibly significant also in the settlement.

Only a few pathological lesions were found from the whole LCA material, but almost all of them were on cattle bones. The first lesion was an abnormal abrasion on the neck of a mandibular incisor of a cattle. This lesion is a common phenomenon on the teeth of grazing animals, but it doesn't mean that their environmental condition was worse than average in the period (Bartosiewicz & Gál, 2013, p. 176).

The second case was arthritis on the proximal epiphysis of a secondary phalanx, which symptom correlated with the possible usage of the animals. However, increased body weight or cold temperature can also result in joint inflammation (Bartosiewicz & Gál, 2013, p. 109).

The third case was a healed fracture on a diaphysis of a humerus. The breakage of this important bone probably restricted the mobility of the animal, but the fully healed bone is evidence that

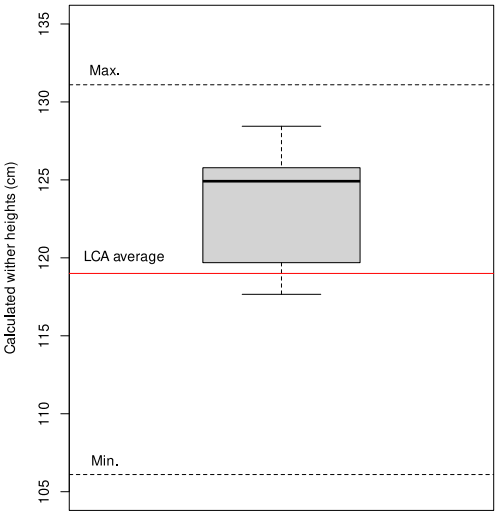


Figure 3. Calculated withers heights of cattle from the site. Prepared by the author.

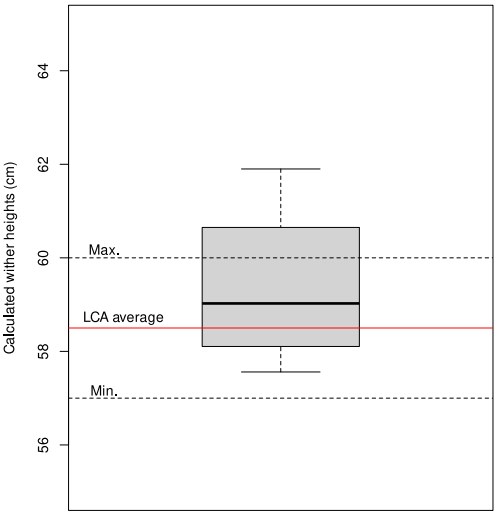


Figure 4. Calculated withers heights of sheep from the site. Prepared by the author.

the animal survived the trauma and was probably attended by its owner (Bartosiewicz & Gál, 2013, p. 219).

Finally, the last case was an enlargement of a distal epiphysis of a right metacarpus III–IV. These lesions are usually connected to the straining of the legs and the usage of the animals (Bartosiewicz & Gál, 2013, p. 145).

*3.2. Sheep (*Ovis aries *L.) and goat (*Capra hircus *L.)*

The number of small ruminant bones was approximately half of the cattle bones, 959 pcs which is 32.52% of the bones of the main domestic species. Because of their similar shape, sheep and goat bones could be distinguished only in a few cases, but the majority of the bones are assumed to be sheep. Based on the measurable sheep bones, the withers heights of a few animals were calculated with the Teichert 1975 method (Teichert, 1975) (Fig. 4). Their mean was 59.4 cm, slightly above the average of the period (Bökönyi, 1974, p. 171). During the transition from LCA to the Bronze Age, sheep sizes increased, possibly in correlation with a change of breeds in the Carpathian Basin. These animals fit the picture of gracile sheep in the Neolithic and Copper Age (Vörös, 2005, pp. 212–213).

Only one lesion has been identified on sheep bones, arthritis on a proximal phalanx. This disorder was a possibly painful inflammation, restraining the mobility of the animal.

*3.3. Pig (*Sus domesticus *Erxl.)*

Based on the number of fragments, the importance of pigs in meat consumption was lower. The 204 pieces of pig bones constitute 6.92% of the main domestic species' assemblage.

Because of their fragmentation, the body size of the animals couldn't be reconstructed. No lesion was observed on pig bones.

*3.4. Dogs (*Canis familiaris *L.)*

Although dog bones were infrequent (58 pcs, together with a dog coprolite, they testify to the presence of dogs in the settlement. No informa-

tion is recorded about Copper Age dog meat consumption in the Copper Age, but Bökönyi suggested its possibility in the Bronze Age (Bökönyi, 1974, p. 320).

3.5. Hunted animals

Bones of hunted animals were extremely rare compared to domestic species but the number of prey species indicates diverse – at the same time, undirected and not intensive – hunting practices.

*3.6. Aurochs (*Bos primigenius *Boj.)*

Although the ratio of auroch remains was 32.25% in the entire wild game bones, they indicate the important role of this species in meat consumption. In two cases the withers heights of the animals could be calculated due to complete metapodials, by Matolcsi's method (130.7 cm and 136.5 cm). All bones originated from bulls, which is significant because, on the one hand, their body sizes were quite huge, hence hunting these animals should not have been a lone venture. And from the other hand, these animals could be dangerous also for domestic stocks and cultivated fields.

*3.7. Red deer (*Cervus elaphus *L.)*

In the bone assemblage, 28 red deer bones were encountered. The hunting of these animals was a common phenomenon in the LCA due to benefits like meat, bone, antler, and fur. Albeit the bones were highly fragmented, we assume that these animals completely fitted to the general picture of the LCA red deer population of the Carpathian Basin (Vörös, 1979, p. 641).

*3.8. Roe deer (*Capreolus capreolus *L.)*

The number of roe deer bones was 11, so their role in meat consumption was less prominent than that of aurochs or red deer. Hunting of larger-bodied animals could be a better investment than the small-bodied roe deer. Based on the whole bones, only one wither height could be calculated (85.6 cm) by the method of Godynicki (Godynicki, 1965).

*3.9. Wild boar (*Sus scrofa *L.)*

The number of wild boar bones was the lowest from the prime wild games (6 pcs, so their consumption couldn't have an important role. Bone fragmentation prevented us to calculate body size.

*3.10. Wild horses (*Equus *sp.)*

The number of bone fragments from unidentifiable wild equids (18 pcs is higher than the number of fragments from wild boars. Albeit the presence of these animals is not exceptional in LCA materials, it is not observed so often. We hypothesize that before the massive spread of domestic horses, these animals were hunted for their meat.

Other wild animals were also hunted over the prime game, mainly for fur, such as the common beaver (*Castor fiber* L.), the ground squirrel (*Spermophilus citellus* L.), and the brown bear (*Ursus arctos* L.), the latter being a rare prey in the LCA (Gál, 2005, p. 167).

The remains of wild birds were also remarkable, the few bones of grey cranes (*Grus grus* L.) and wild ducks (*Anas sp.*) suggest a wetland environment.

The information encoded in wild and domestic animal bones allows us to draft the environment around the settlement as a freshwater swamp milieu.

Based on the bones, the inhabitants of the settlement mainly ate their domestic stocks and exploit less of their natural meat resources.

4. Algorithmic reconstruction of processing animal bodies (*chaîne opératoire*)

Meat consumption in ancient societies is strongly connected to the technologies by which bodies of slaughtered or hunted animals were processed. These techniques are well known in

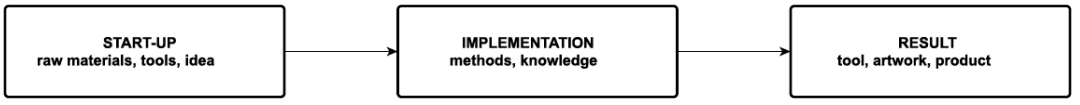


Figure 5. Pillars of *chaîne opératoire*. Figure: Péter Csippán, After Holló *et al.*, 2001.

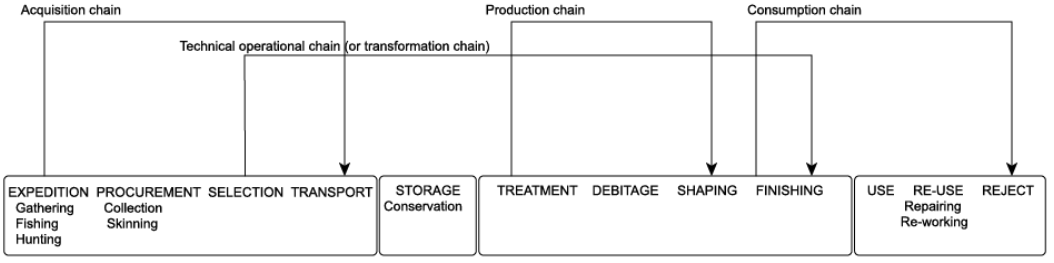


Figure 6. Techno-economic scheme of worked osseous materials: extensions of the different chains. Prepared by the author, after Averbouh, 2001.

the antique and medieval periods, based on written sources (e.g., Csippán, 2007a; Patou-Mathis, 1997; Seetah, 2018; Vörös, 1992). Compared to these sources, our data about the processing of animal bodies in prehistory are more humble, due to the lack of metal tools, which can make an identifiable and massive mark on the surface of the bones, and the long-term effects of taphonomic processes.

The technological repertoire of this period differs from other archaeological periods. The identification of battering marks that open the cavum of long bones is very difficult.

Thus, the main research question is, how can we reconstruct the processing of animals and how can we build an algorithmic model to describe it?

The functional-technological investigation of stone tools is a well-known process in the study of prehistoric lithic artefacts. These process analyses help to understand not only the manufacturing techniques and use of prehistoric stone tools but also imply the intention(s) of the toolmaker.

The study about body techniques of Marcel Mauss in 1934 changed the approaches of ethnologists and sociologists about movements and their functions. He stated that the human body is explainable like a tool, so some acts and their functions can be different from culture to culture (Mauss, 1979, p. 73).

The so-called body techniques are specified that they have to help the person executing them to his or her aims. The methods are learned and culturally specified as well. As Mauss said: *"The constant adaptation to a physical, mechanical or chemical aim (e.g. when we drink) is pursued in a series of assembled actions, and assembled for the individual not by himself alone but by all his education, by the whole society to which he belongs, in the place he occupies in it."* (Mauss, 1979, p. 76)

The theory of Mauss was applied to tools by Marcel Maget. He introduced ideas of the chain of fabrication (*chaîne de fabrication*) or elemental gestures (*gestes élémentaires*) (Pelegrin *et. al.,* 1988, p. 57).

Maget reminded the different quality and working phases of the tools. His observations were modified by Leroi-Gourhan as he said that the working technique through tools and move-

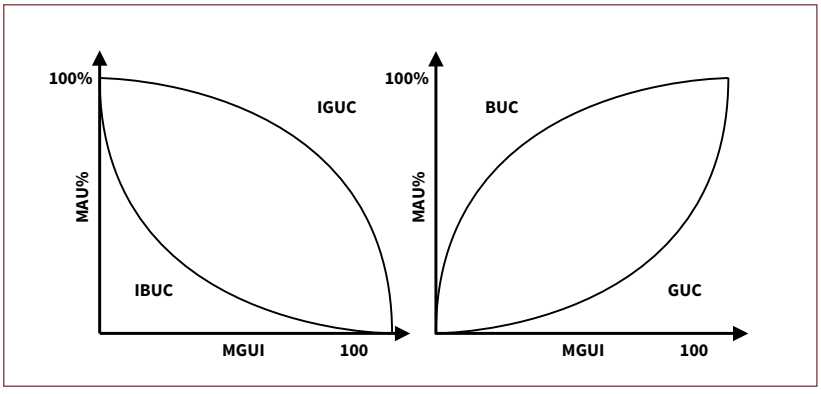


Figure 7. The inverse and normal forms of the bulk and utility curves. Prepared by the author.

ments is organized into a chain with real syntax. This chain of operations shows its stability and adaptivity (Pelegrin *et. al.,* 1988, p. 57).

The concept of *chaîne opératoire* is based on the production phases of artefacts (Holló *et. al.,* 2001, p. 51). P. Lemonnier suggests three approaches for the analysis of tool production (Pelegrin *et. al.,* 1988, p. 58):

Tools (*objets*) that are defined by a special raw material or manufacturing technique.

Order of movements (*suites de gestes ou d'opérations*), which means the sequence of acts or movements.

Special knowledge (*connaissances spécifiques*) of what is needed for tool production.

Similar approaches aren't unknown in the Hungarian archaeological literature, mainly in the case of stone tools (e.g., Antoni, 1990). In the Hungarian literature, the usage of the concept of *chaîne opératoire* was introduced in the pioneer studies of Zsolt Holló, György Lengyel and Zsolt Mester (Holló *et al.,* 2001, 2002, Holló *et al.,* 2004). In these methodological papers, the authors summarized the main steps of the *chaîne opratoire* (Fig. 5).

The *chaîne opératoire* itself includes the following steps in the case of stone tools (Holló *et al.,* 2001, p. 54):

1. *acqusition*
2. *production*
   (a) *débitage*
   (b) *façonnage*
   (c) *retouch*
3. *consommation*
4. *abandon*

The authors suggest that the sum of these technical activities above constitutes a special technological system (*système technique*), which was different from culture to culture. In contrast, various *chaîne operatoires* could also lead to similar results (Holló *et al.,* 2002, p. 99).

In the case of animal bone finds, the concept of *chaîne opératoire* can be applied to animal body processing and bone tool production (Averbouh, 2001; Patou, 1987; Patou-Mathis, 1997; Choyke & Tóth, 2013). In the case of bone tools, the *chaîne opératoire* is complemented with further phases such as conservation or re-use, which the original concept did not contain in the case of stone tools.

To apply the *chaîne opératoire* concept on bones as kitchen waste, we have to re-interpret it, especially in the case of the bones from Rákoscsaba, Major-hegy, where cut- and butchery marks were rare on such items. To solve this problem we focused on animal body part representation. This way, the consumption of animal species could be reconstructed not only by butchery marks but also by the over- and under-representation of the different body regions (Csippán, 2007b, p. 93).

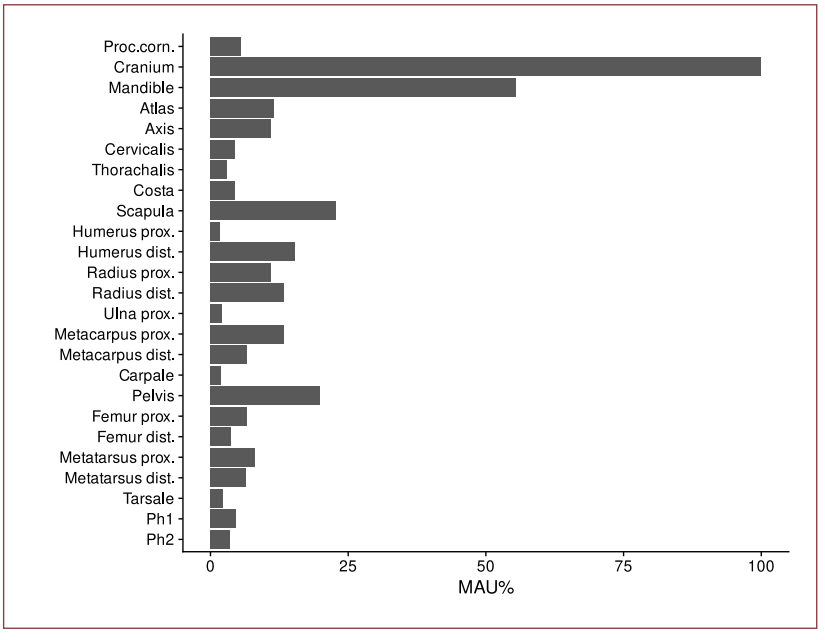


Figure 8. MAU% distribution of cattle. Prepared by the author.

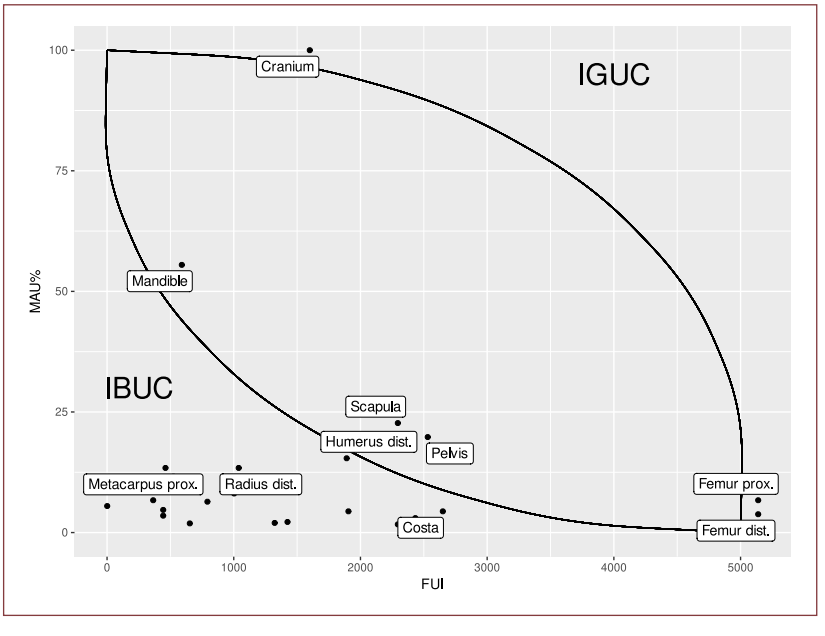


Figure 9. Utility curves of cattle. Prepared by the author.

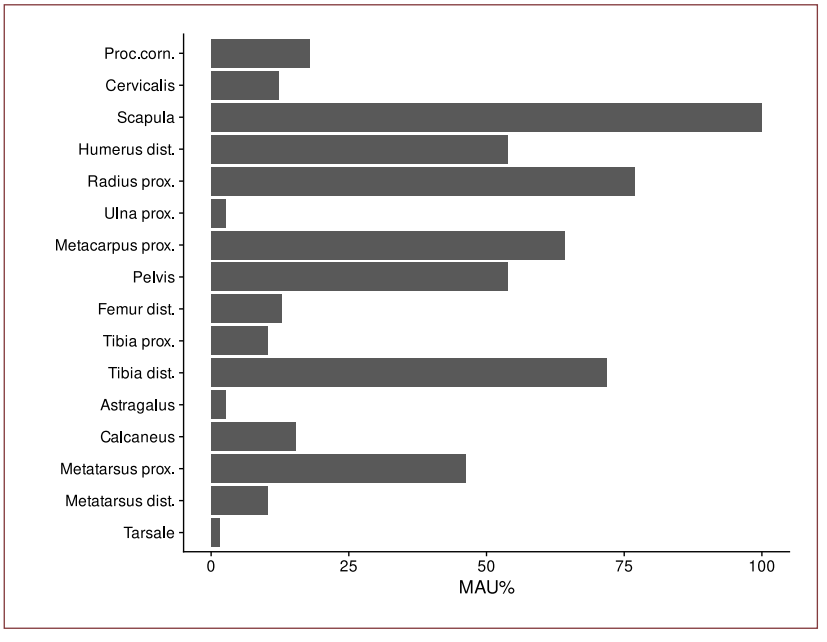


Figure 10. MAU% distribution of small ruminants (sheep/goat). Prepared by the author.

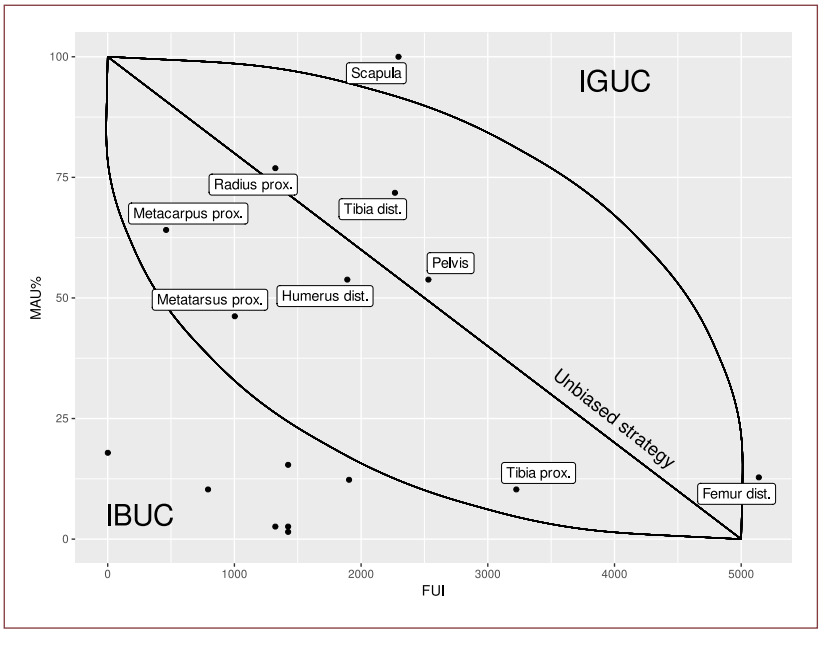


Figure 11. Utility curves of small ruminants (sheep/goat). Prepared by the author.

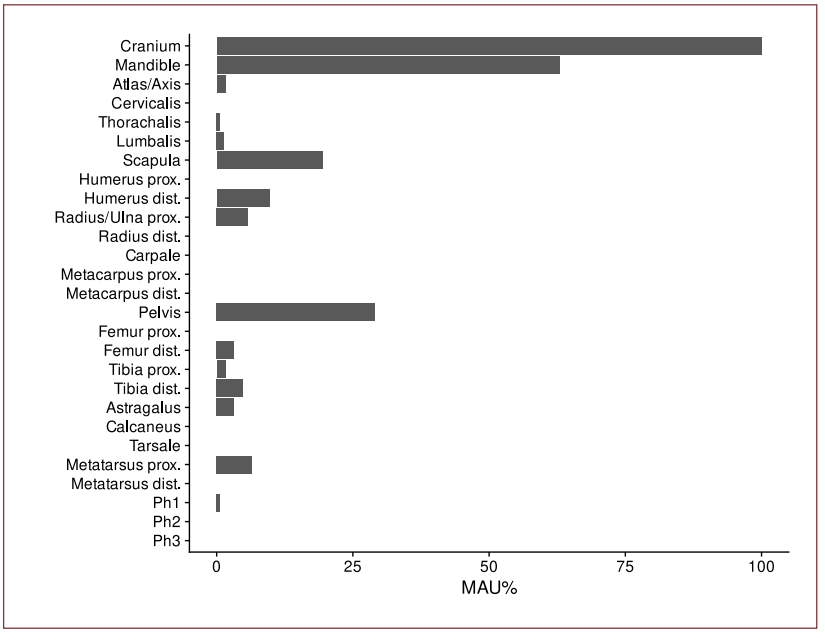


Figure 12. MAU% distribution of pig. Prepared by the author.

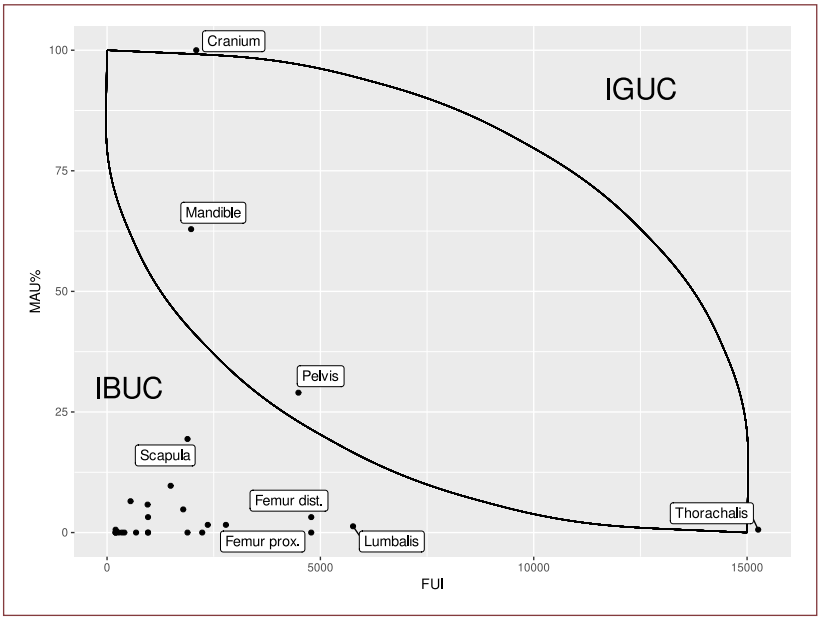


Figure 13. Utility curves of pig. Prepared by the author.

Based on the above, the concept of *chaîne opératoire* will be modified in the case of animal bones as kitchen waste:

1. acquisition – The killing of both domestic and wild animals.

2. production – It is equal to the processing of animal bodies. The sub-processes of these phases are equal to dismembering the body into smaller/larger or useable/unusable portions.

(a) *débitage* – Primal cuts.

(b) *façonnage* – Portion cuts.

(c) *retouch* – Direct kitchen preparation.

3. *consommation* – The consumption of meat.

4. *abandon* – Deposition of bones and unusable parts as kitchen waste.

Consequently, understanding the *chaîne opératoire* of animal processing seems impossible without exact observations of butchery marks and analysis of the number of bones or parts of the bones. The reason is that they are strongly dependent on different body regions. Apart from anatomy, these body parts represent different meat values and energetic investment in their preparation for consumption.

Utility Indices in archaeology were applied first by Lewis R. Binford in his 1978 monography titled Nunamiut Ethnoarchaeology (Binford, 1978). In this influential work – based on the traditional processing of one reindeer and two sheep – Binford set down the standards to show the utility of the different animal body parts.

Later Binford defined these indices not according to the number of individuals or bone fragments but by special units, which he called the Minimum Number of Elements (MNE) and the Minimum Animal Unit (MAU) (Binford, 1984, pp. 50–51). He admitted that he introduced these units to diminish ambiguities. The MNE is nothing else but the number of anatomical units used for the analysis (Binford, 1984, p. 51), by which Binford did not consider sides, sex or age, only the anatomical parts.

Binford's indices can be divided into two main groups. The first group contains Modified Utility Index (MGUI) and the indexes that belong to it: Meat Utility Index (MUI), Marrow Index (MI), White-Grease Index (WGI) and General Utility Index (GUI). MGUI is a calibration of the GUI, considering the so-called „riders" meaning terminal parts joined to the regions of the most meat value. In light of all this, it also represents a sort of predictive transferring value in connection with the given body part (Metcalfe & Jones, 1988, p. 487).

Binford presumed that seasonal or other environmental conditions played a role in the processing of hunted animals on the killing site (Gifford-Gonzalez, 2018, p. 438). On this basis, he attempted to define regularities, which, he thought could indicate the rational decisions of the hunters. To illustrate, Binford created so-called Utility curves to show MAU% as MGUI values function. On these curves the number of body regions with lower MGUI values is determinant. Because these fragments reflect intensive butchering, according to Binford their density describes the place of mass butchering, as opposed to body regions with higher MGUI values which indicate direct consumption (Gifford-Gonzalez, 2018, p. 438). The diagrams of the bones from these sites result in a so-called Inverse Bulk Utility Curve (IBUC), while more selective butchery techniques show a higher number of low- and middle-valued body regions. The latter, according to Binford, implies a gourmet-type of meals, which can be illustrated by an Inverse Gourmet Utility Curve (IGUC) (Binford, 1978, p. 81). The differences between the place of butchering and the actual consumption can be seen as the functions of MAU% and MGUI, by which Binford, similarly to the ones above, defined the Bulk Utility Curve (BUC) and the Gourmet Utility Curve (GUC) (Binford, 1978, p. 81). (Fig. 7)

Although Binford also discusses the limited utility of his indices (Binford, 1978, p. 473), the

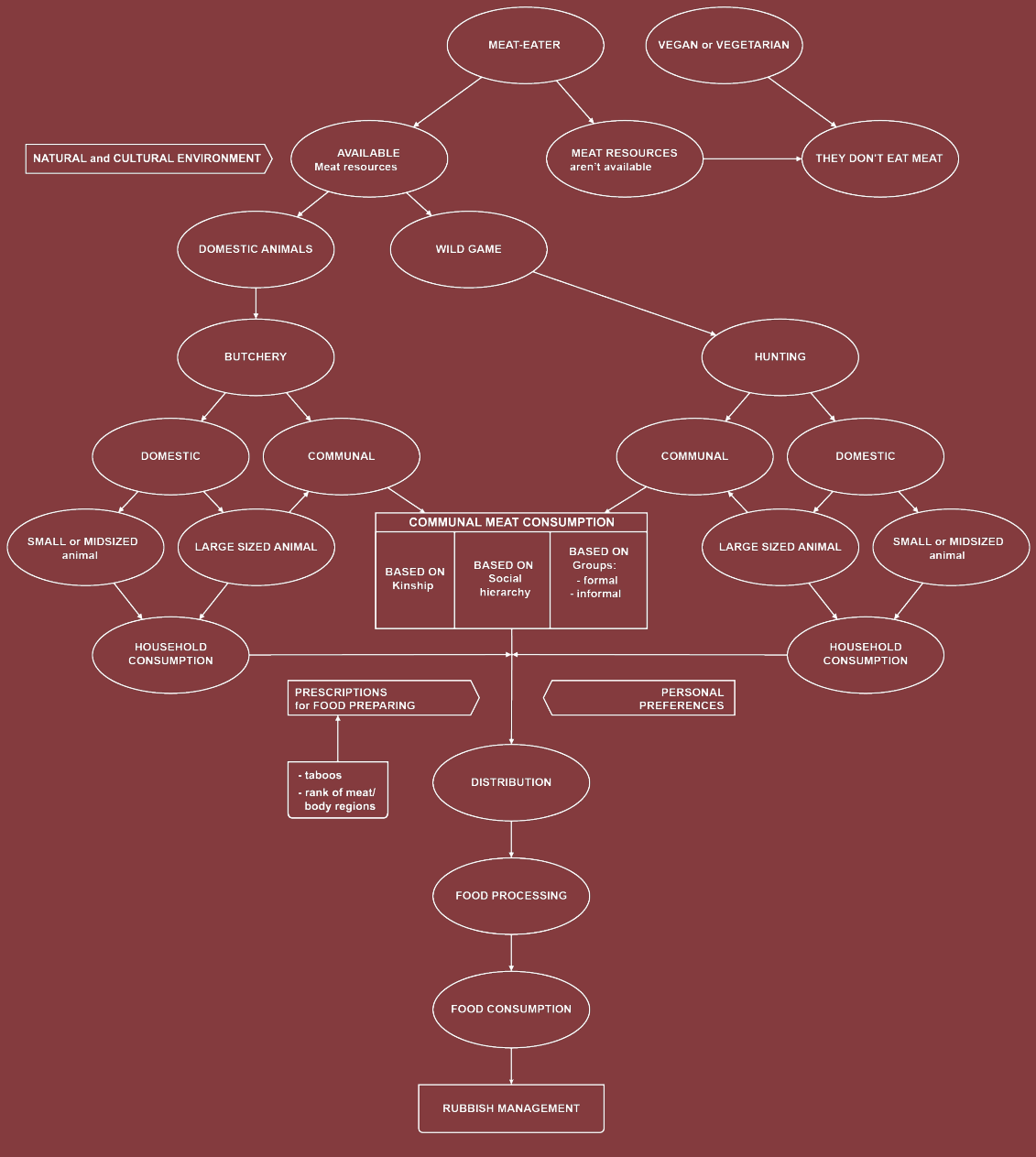


Figure 14. Algorithmic approach of meat consumption at the site of Rákoscsaba, Major-hegy. Prepared by the author.

indices he defined have since been revised by several researchers. Metcalfe and Jones, in their 1988 paper, point out that the correlation between their economic indices and human behaviour is determined by three fundamental aspects of Binford's method:

1, the extent to which the management of reindeer body regions is related to economic efficiency and their use accordingly

2, the extent to which Binford's indices are indicative of the actual utility of each body region.

3, Binford's observations are restricted only to the Nunamuit's reindeer utilization (Metcalfe & Jones, 1988, p. 487).

Metcalfe and Jones, among others, referring to the above problems, have introduced the Food Utility Index (FUI), which can be interpreted as a simplification, taking into account economic considerations, but which is also more appropriate to the anatomical parts represented (Metcalfe & Jones, 1988, pp. 491, 493). A derivation of this index has also been carried out by Rowly-Conwy and colleagues, for wild boars specifically (Rowley-Conwy *et. al.,* 2002).

Based on the MAU% distribution of cattle bones, the bones of the head and mandibles display extreme importance. However, head bones are more fragile than other bones, so their fragmentation may be a consequence of taphonomic effects.

Following the head region, the meaty body parts gained importance. Interestingly, the cranial part of the animal seems to be more preferred than the caudal part (Fig. 8).

In light of the FUI, the distribution of MAU% shows a typical IBUC curve, almost all of the animal body parts are represented in the bone assemblages, so their butchering took place close to the households (Fig. 9).

The picture of the MAU% distribution of small ruminants seems different than the other domestic species, however, their MAU calculation method does not include the whole skull, just the horn cores and mandibles. Despite this, the differences are obvious, the regions of the front leg and the tibia were more preferred than others (Fig. 10).

Focusing on the MAU% from the point of FUI, instead of a typical IBUC consumption pattern, an unbiased strategy can be reconstructed. It means that the animals were slaughtered near the households (Fig. 11).

The MAU% distribution of pigs seems similar to that of cattle. A significant difference between the consumption of cattle and pigs is the importance of the pelvic region. However, a lot of bones weren't represented in the bone assemblages (Fig. 12).

The FUI values distribution shows a more or less similar curve than the cattle's (Fig. 13).

5. Conclusions

In conclusion, the Protoboleráz bone assemblage of the site of Rákoscsaba, Major-hegy shows typical LCA meat consumption patterns. Meat-eating is mainly based on domestic species (cattle, sheep, goat, pig) and it was sometimes complemented by wild game such as red deer, aurochs, roe deer, and wild boar in different proportions. Fur animals were also hunted by the inhabitants of the settlement.

Considering the consumed MAUs, the main domestic species show more or less similar patterns, but the slaughtering and body part distribution of small ruminants seem different than those of other species. This phenomenon may be connected to the number of animals and/or their value.

The processing of these animals clearly shows special knowledge and a mechanism which was regulated by both social and individual decisions. This regulation can be described as the *chaîne operatoire* of animal body processing. But this kind of processing is rooted in another decision mechanism, which is connected to other segments of

the culture and/or to the affordances presented by the natural environment. The draft of this decision (yes/no) algorithm is in Fig. 14.

On this flowchart, decision-making is apparently influenced by a lot of effectors (e.g., natural environment, social regulation, size of the animal) from the choice of eating meat to waste management. Using this algorithmic table we can understand the complex system of meat eating better in the future.

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Appendix

Animal bones from the LCA site:

Species	NISP
Cattle (*Bos taurus* L.)	1786
Sheep/Goat	953
Sheep (*Ovis aries* L.)	5
Goat (*Capra hircus* L.)	1
Pig (*Sus domesticus* Erxl.)	204
Dog (*Canis familiaris* L.)	58
Domestic animals:	**3007**
Red deer (*Cervus elaphus* L.)	28
Roe deer (*Capreolus capreolus* L.)	11
Wild boar (*Sus scrofa* L.)	6
Aurochs (*Bos primogenius* Boj.)	30
Wild horse (*Equus* sp.)	18
Brown bear (*Ursus arctos* L.)	1
Common beaver (*Castor fiber* L.)	2
Ground squirrel (*Spermophilus citellus* L.)	1
Wild mammals:	**97**
Grey crane (*Grus grus* L.)	1
Wild duck (*Anas* sp.)	4
Bird (*Aves*)	1
Shell (*Unio* sp.)	4
Other:	**10**
Large ungulate	882
Small ungulate	338
Dog-sized mammal	10
Total:	**4344**

Calculated withers heights from the LCA site:

Bone	Measure-ments (in mm)	Sex	Withers height (in cm)
Cattle			
metacarpus III-IV sin.	GL=198.5; BP=55.8	cow	119.69
metacarpus III-IV sin.	GL=213.0; BP=58.1	cow	128.44
metacarpus III-IV sin.	GL=206.6; BP=55.3	cow	124.58
metatarsus III-IV sin.	GL=215.1; BP=48.2	?	117.66
metatarsus III-IV dex	GL=235.0; BP=45.8	cow	125.25
metatarsus III-IV dex	GL=236.0; BP=51.1	cow	125.78
Sheep			
metatarsus III-IV sin.	GL=126.8; BP=18.8		57.18
metatarsus III-IV dex	GL=129.2; BP=19.5		58.27
radius sin.	GL=148.0		59.2
radius dex.	GL=154.2		
Aurochs			
metacarpus III-IV sin.	GL=206.5; BP=63.9	bull	130.71
metacarpus III-IV dex.	GL=215.7; BP=71.0	bull	136.53
Roe deer			
metatarsus III-IV dex.	GL=210.1; BP=23.0		85.68

The Lincombian-Ranisian-Jerzmanowician with new sites in South Moravia and the Initial Upper Palaeolithic record of East-Central Europe

5

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Abstract. This study proposes a new look at the Lincombian-Ranisian-Jerzmanowician (LRJ) industry based on four recently excavated open-air sites in South Moravia, (Líšeň / Podolí I, Želešice III / Želešice-Hoynerhügel, Líšeň I / Líšeň-Čtvrtě and Tvarožná X / Tvarožná, 'Za školou'), and two cave sites in Bohemia (Nad Kačákem Cave) and South Moravia (Pekárna Cave), in the Czech Republic. We suggest considering the LRJ as a late Initial Upper Palaeolithic (IUP) industry starting from the period right before Heinrich Event 4 (HE-4) and the Campanian Ignimbrite (CI) super-eruption event, ca. 42–40 ka cal BP. We propose that the LRJ was made by *Homo sapiens* as an 'industrial result' of a smooth, and mainly technological transition from Bohunician into LRJ. As a result, a place of origin for the LRJ industry is seen in Moravia, in East-Central Europe, from where modern humans (*Homo sapiens*) spread all over the vast northern altitude territory in Central and Western Europe. Thus the IUP "Bohunician package" did not disappear in Europe but did give rise to another IUP industry successfully adapted for the contemporary steppe-tundra belt in Northern Europe. Finally, to the long-lasting tripartite archaeological division of the IUP period (Bohunician, Szeletian, Proto-Aurignacian) with a duration of ca. 6–8,000 years in East-Central Europe, the LRJ industry should be added. This is a late IUP industry geochronologically coeval with the Proto-Aurignacian, and post-dating both the Bohunician and the Szeletian.

Keywords: Initial Upper Palaeolithic, Lincombian-Ranisian-Jerzmanowician, East-Central Europe

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1. Introduction

The Initial Upper Palaeolithic (IUP) period in East-Central Europe was always considered by us in a rather traditional way, with the presence of three Upper Palaeolithic (UP) techno-complexes, Szeletian, Bohunician and Aurignacian, the latter of which was represented by the initial Proto-Aurignacian industry (Škrdla, 2017; Demidenko *et al.,* 2017; Demidenko et al., 2021). In geochronological terms, the IUP represents a period between ca. 48–46 and 40 ka cal BP, between Greenland Interstadials (GI) 13/12 and 9, preceding the pronounced geochronological markers of Heinrich Event 4 (HE-4) and the Campanian Ignimbrite (CI) super-eruption at the beginning of Greenland Stadial (GS) 9, ca. 39.85 ka cal BP (Giaccio *et al.,* 2017).

One of the most important recent development in the study of the region's IUP is a change in Szeletian geochronology and its origin in archaeological terms (Tostevin, 2012; Škrdla, 2017; Demidenko & Škrdla, 2022). Presently, it is well established that the beginning of the Szeletian and the Bohunician geochronologically coincide in GI-13–GI-12, ca. 48–46 to 45 ka cal BP. This chronology has an important implication for the long-lasting ideas about the role of Middle Palaeolithic (MP) Mousterian / Micoquian Neanderthal acculturation to Aurignacian *Homo sapiens* in the cultural genesis of the Szeletian (e.g., Prošek, 1953; Valoch, 1968; Kozłowski, 1988). Now it is clear that the first Proto-Aurignacian assemblages in East-Central Europe, at ca. 42–40 ka cal BP (GI-10–GI-9), are predated by both Szeletian and Bohunician assemblages, this is why the Proto-Aurignacian *Homo sapiens* had no chance to meet Szeletians (whatever types of humans they were). However, Szeletians could meet *Homo sapiens* in Central Europe, the bearers of the archaeologically valid IUP artefact-making tradition, the Bohunician. Indeed, Szeletian "*is now recognized as chronologically overlapping with the early appearance of the Bohunician*" in South Moravia where "*both the Szeletian and Bohunician occupied the same or almost the same regions, shared similar site locations (the same settlement strategy), and shared the same raw material outcrops – the characteristic Szeletian raw materials including Krumlovský les-type chert*" (Škrdla, 2017, pp. 34–35). Thus, if *Homo sapiens* newcomers had "archaeologically progressive influence" on local late Neanderthals of the Szeletian in Central Europe, that happened through the Bohunician, not the Proto-Aurignacian.

The mentioned tripartite archaeological scheme of the IUP period with a duration of ca. 6–8,000 years in East-Central Europe seemed "crowded" enough to prevent the addition of more possible industries. However, a new research topic of one author concerning Moravian UP studies is the recognition of so-called Lincombian-Ranisian-Jerzmanowician (LRJ) industry sites and the inclusion of this industry in the East-Central European IUP record. This paper aims to review our LRJ data from Moravia and their significance in the reconsideration of this industry's status.

2. The LRJ industry: an overview

The LRJ is a European UP industry with the longest research history accounting for almost 200 years since it was first discovered in England, with the help of the most characteristic lithic artefact type recognized then, the distinct leaf points on blades or blade points bearing partial dorsal and ventral retouch. "*The first blade point to be preserved from a British find-spot comes from Kent's Cavern (S. Devon). It was found by Mac Enery in 1825 or 1826*" (Jacobi, 1990, p. 272). However, the LRJ was finally acknowledged to be an Early UP (EUP) industry only after ca. 150 years of sporadic research in the 1960s–1970s, after the consideration of the

stratigraphy and absolute dates from Ilsenhöhle (Germany) and Nietoperzowa (Poland) cave sites (Hülle, 1977; Chmielewski, 1961), and the re-evaluation of the relevant find material from Great Britain and Belgium (Campbell, 1977, 1980; Otte, 1979, 1981). Also, only after the publication of Chmielewski's book in 1961, many colleagues started naming the industry's distinct points "Jerzmanowice-type point" or "J-type point" using the Nietoperzowa Cave as a reference site. Here it is worth citing R.M. Jacobi on the J-type points from the Beedings site in England, and the different names that were proposed for this tool.

"*All of the leaf-points from Beedings take the form of what I have elsewhere (1990) termed simply 'blade points' (cf,* pointes lamellaires*: Chmielewski 1961). These are what other workers have called partially bifacial leaf-points (*pointes foliacées partiellement bifaciales*: Bordes 1961, pl. 49),* 'Jerzmanowice points*' (Bordes 1968, 183), unifacial leaf-points (Campbell 1971; 1977), points with partial inverse flat retouch (*pointes à retouches plates inverses partielles*) or points with flat retouch, group B (*pointes à retouches plates, groupe B*: Otte 1974),* 'pointes de Spy*'(Otte 1979, 275),* 'Lincombe points*' (Campbell 1986, 13), unifacial leafpoints (Allsworth-Jones 1986), unifacial blade points (*pointes laminaires à face plane*: Desbrosse and Kozlowski 1988, 35), incompletely retouched leaf points (Debénath & Dibble 1994, 120) or blade leaf-points with partial flat bifacial retouch (*pointes foliacées laminaires à retouches plates bifaciales partielles*: Flas 2000-2001, 167)*" (Jacobi, 2007, p. 245).

Regional studies led to the recognition of three similar local EUP industries or "cultures" in England ("Lincombian", the name proposed by J. B. Campbell after Lincombe Hill, Torquay in southwestern England, where Kent's Cavern is located), Germany ("Ranis-Mauern" and then "Ranisian", the name originated after Ilsenhöhle in Ranis town in eastern Germany, according to Kozlowski & Kozłowski, 1979; Kozłowski, 1983; Desbrosse & Kozłowski, 1988) and Poland ("Jerzmanowician", the name was introduced by W. Chmielewski referring to Jerzmanowice village where the Nietoperzowa Cave is located in southeastern Poland). At the same time, related finds from Spy Cave in Belgium did not get a special industry name being simply called a "*blade leaf-points industry*" comparable to Lincombian and Jerzmanowician (Otte, 1979, 1981). On the whole, adding also some more work done on the three industries' sites and finds (e.g., Jacobi 1999, 2007; Otte, 1990, 2000), all the related sites and their assemblages from the northern belt of Europe (North European Plain) stretching from Great Britain in the west to Poland in the east were understood as having the same cultural unit, the best known today as "Lincombian-Ranisian-Jerzmanowician" (after Kozłowski, 1983; Desbrosse & Kozłowski, 1988). The LRJ site distribution in northwestern Europe led to hypotheses about LRJ adaptation to cold environments with resource exploitation of '*steppe-tundra or tundra of the Lowlands*' in Europe and the respective production of '*improved kinds of hunter's weapons*' (Kozłowski & Kozłowski, 1979, p. 23). This site distribution also resulted in ideas on the origin of the LRJ artefact-making tradition in this part of Europe and neighbouring Germany. Even today, opinions vary about its origins between the various Late Middle Palaeolithic (LMP) industries with bifacial leaf points, such as the Evolved Mousterian in Belgium, and the Altmuehlian in Germany (e.g., Chmielewski, 1961; Allsworth-Jones, 1986; Flas, 2000–2001; Kozłowski, 1990; Otte, 1990, 2000; Ulrix-Closset, 1995), although a recent re-evaluation of the "Altmuehlian" makes it a part of the southern German Late Micoquian (Richter, 2008–2009).

Recently, D. Flas has reviewed the discussion of the EUP "Lincombian-Ranisian-Jerzmanowician" industry in a series of detailed studies (Flas, 2006, 2008, 2011, 2012, 2014, 2015), in which he usually

uses the shortened "LRJ" name for the industry, that we also adopted. Today, almost all colleagues, including ourselves, use the Flas publications as one of the basic reference datasets for the understanding of the LRJ.

However, despite its long research history and a great amount of published hard data from several sites and their find assemblages in Europe, the LRJ remain to be rather poorly and uncertainly understood. The three main issues with the LRJ industry are the following. First, most LRJ sites were excavated before modern field research standards, often in the 19th century. Second, many old excavated sites are multi-layered with the presence of different Palaeolithic techno-complexes and/or industries within their artefact-bearing sediments. These sites often contain archaeologically mixed LRJ assemblages, as one would expect. Third, the techno-typological characteristics of the probably homogeneous LRJ assemblages are based upon a limited set of artefact classes and types. It is frequently represented by leaf-shaped blade points, such as, for example, the recently published material from Kirchberghöhle in Bavaria, Germany (Uthmeier *et al.,* 2018). The latter "artefact type lacuna" problem is strongly connected to the type of habitation of all (*sic!*) LRJ sites. They are usually ephemeral hunting camps, mostly caves, grottos or rock-shelters, including the Glaston open-air site in England, a horse hunt's killing and butchering station, which was also a hyena's den (Cooper *et al.,* 2011). The only "regular" LRJ living site known for a long time was the Beedings open-air site in England. However, after we analysed all its published data (Jacobi, 2007; Pope *et al.,* 2013) we propose that it was again a short-term hunting station. Its strategic topographical location enabled periodic visits by LRJ hunters, who tracked and hunted ungulate herds at nearby streams and consumed the killed animal (ungulate?) bodies (Demidenko & Škrdla, 2023).

All in all, LRJ sites are characterized by limited on-site lithic production, mostly rejuvenation or re-shaping, and production of J-type points on blades brought to the site. Besides, some blades bear irregular retouches and probably served for dismembering carcasses after a successful ungulate hunt near the site. Rarely, on-site primary flaking is attested by the presence of a few cores, which were usually probed and prepared before they were brought to the site; except for this, both core and debitage data are scarce. As a result, the LRJ industry's main flaking processes are still rather poorly understood. Thus, the EUP LRJ industry appears to be the only known UP industry in Europe and probably in the entire Old World (*sic!*), which was defined based on ephemeral or short-term hunting camps, without workshops, site workshops, and "regular" living stations. Without exaggeration, this makes the LRJ a unique industry in the European EUP. On the other hand, the series of morphologically and typologically distinct points on usually large and elongated blades still allow us to propose a discrete taxonomic status for the LRJ within the European EUP.

Recognizing the issues concerning the LRJ industry, we have thoroughly and critically analysed all the available published data. In our study, the above-mentioned lithics from the Beedings site served as a reference assemblage for the entire LRJ industry. In conclusion, we propose the LRJ to be viewed in the following way.

Geochronologically, the LRJ covers a period before (from ca. 44–43 ka cal BP) and after (maximum up to ca. 36 ka cal BP) the HE-4 and the CI event, from the GS-12/GI-11 to the GI-8/GS-8 (see data in Jacobi *et al.,* 2006; Jacobi, 2007, pp. 278–307; Flas, 2011, pp. 608–609; Cooper *et al.,* 2011, pp. 83–85, 88–90; Krajcarz *et al.,* 2018, pp. 396–398; Kot *et al.,* 2021). Thus the LRJ was partly coeval with the Proto-Aurignacian, the only Aurignacian which began in the IUP. As such, the LRJ is also considered an IUP industry.

Technologically (see data in Jacobi, 2007; Flas, 2011), the LRJ demonstrates several primary reduction methods. The main one is aimed at the serial production of long and wide blades, that were generally used for the distinct J-type points. The blade technology is based upon the central *lame à crête* technique and permanent faceting of the striking platforms. The platforms were often abraded due to opposed-platform bidirectional flaking, as the core tablet technique was unknown yet. Two supplementary *ad hoc* bladelet reduction methods are evidenced by cores on flakes or truncated-faceted pieces, and burin-cores (but no true bladelet cores on nodules or chunks). The resulting bladelets have been used probably for cutting, not for hunting as projectiles. Thus, LRJ primary reduction methods correspond to some Eurasian industries archaeologically bracketing the time range from the Early MP / Middle Stone Age (MSA) to a time no later than the IUP.

Typologically (see data in Chmielewski, 1961; Hülle, 1977; Richter, 2008–2009; Jacobi, 2007; Flas, 2011, 2012), the LRJ is poorly "equipped by tools" due to the short-term and ephemeral character of the industry sites as hunting stations. That's why most of the tools are J-type points with partial retouch both on the dorsal (flat or semi-steep retouch) and ventral (flat retouch) surfaces of blade supports (mostly 9–10 cm long, 3 cm wide, 1 cm thick blanks, see Flas, 2011, p. 610). These were most likely projectile points, probably a blade variant of the Levallois-type Emireh point. Instead of purposefully made bifaces, most of the few bifacial points could be significantly reworked or repeatedly rejuvenated blade points. At the same time, "domestic tools" are represented by a few simple endscrapers and burins, as well as slightly more frequent retouched blades and flakes including notches and denticulates. Accordingly, the LRJ tool-kits are rather neutral in typological terms if the J-type blade points and bifacial points are not considered, the latter of which attest to certainly not MP but UP technological characteristics. This typology again places the industry to the IUP archaeologically.

The absence of bone tools and personal ornaments in LRJ assemblages (Flas, 2011, p. 613) should be probably explained by the hunting station site function and not by the "primitive" nature of the industry.

Concerning the human species creating the LRJ industry, Neanderthals at Spy Cave in Belgium (e.g., Otte, 1990, pp. 248–249; Jacobi, 1999, p. 37; Flas, 2011, pp. 616–618; Hublin, 2015, pp. 198–200) or *Homo sapiens* at Kent's Cavern in England (e.g., Swainston, 1999, pp. 41–42; Higham *et al.,* 2011) are both discussed. This discussion once again underlines the early IUP attribution for the LRJ, with statistically identical AMS dates as the GS-12–GI-10 period, clearly preceding HE-4 and the CI event. We believe that the LRJ "anthropological puzzle" can be resolved only through more archaeological data.

Based on the data we are aware of, the LRJ industry can belong to the late IUP in archaeological and chronological terms, thus its origins should lie in earlier IUP industries, not LMP industries as was proposed earlier.

The LRJ certainly needs more research. Besides several complex and multi-disciplinary studies of the already known LRJ sites and their results, two more topics give us perspective on the LRJ. First, the re-evaluation of possible LRJ sites that were later removed from the site list (e.g., Flas, 2011, p. 608). Second, a search for LRJ sites that indicate more than just hunting, namely, sites with actual traces of occupation and on-site activities, including domestic artefact types, can bring us about a full-range of data for the LRJ. These two study directions became the key approaches in our UP studies in South Moravia, Czech Republic. Besides, we made additional observations about some assemblages in other Central European regions.

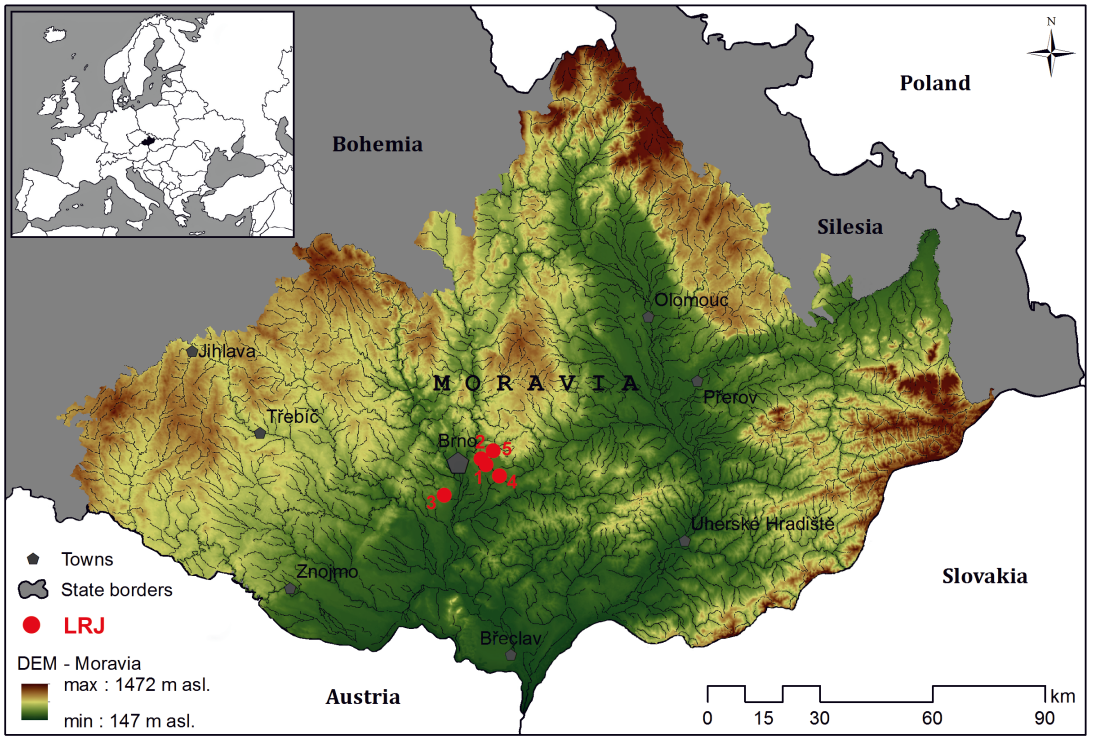


Figure 1. Map of Moravia with the location of LRJ sites in South Moravia mentioned in the article: 1 – Líšeň / Podolí I, 2 – Líšeň I / Líšeň–Čtvrtě, 3 – Želešice III / Želešice-Hoynerhügel, 4 – Tvarožná X, "Za školou", 5 – Pekárna Cave. Prepared by the authors.

3. New IUP and EUP studies in South Moravia in the 21st century

Since 2005, one of us (P. Š.) conducts new research on the IUP and EUP in South Moravia, the southeastern part of the Czech Republic, which continues today. The region is well-known for ca. 100 Szeletian (Oliva, 1991), ca. 100 Aurignacian (Oliva, 1993) and ca. 10 Bohunician (Svoboda *et al.,* 2002) loci with, however, not stratified but almost exclusively only surface lithic artefacts. This wealth of surface sites together with less than 10 (!) *in situ* sites for the three techno-complexes indicated a good perspective for more research on the IUP and EUP in South Moravia, with a focus to find stratified sites near the surface find spots. Accordingly, a respective project started together with G. Tostevin in 2005. After 10 years of field surveys "*the result of this project has been the discovery and excavation (mostly test pits and small scale-excavations) of 14 stratified sites including two Szeletian, three Bohunician and four Aurignacian sites*" (Škrdla, 2017, p. 15). Thus, less than ten survey seasons in Moravia resulted in more than the double of *in situ* IUP and EUP sites that were known before. Our success in the field was mainly due to a new method for finding new stratified sites in South Moravia (e.g., Škrdla *et al.,* 2011a, 2011b, 2016a). The project was further continued after Tostevin left and started Palaeolithic research in Montenegro in 2016, with new excavations at the Líšeň/Podolí I and Ořechov IV sites in 2015–2018 (e.g., Škrdla *et al.,* 2017).

The other author of the present article (Yu. D.) joined P. Škrdla's Moravian UP research in 2015,

aiming at the study of the LGM "Epi-Aurignacian" (e.g., Demidenko *et al.,* 2016, 2018a, 2019), the Aurignacian (e.g. Demidenko *et al.,* 2017), and also a specific late EUP industry with both Aurignacian-like and Szeletian-like techno-typological features (Demidenko *et al.,* 2018b). At this stage of research, a book was published summarizing the current developments with the Moravian IUP and EUP, with an emphasis on the results of new investigations in the past 12 years (Škrdla, 2017).

Of course, the IUP and EUP research continued since then. Besides the topic called Aurignacian *sensu lato*, we compared South Moravian IUP, Szeletian, and Bohunician materials, together with a strange-looking assemblage from the newly excavated Líšeň/Podolí I site (e.g., Demidenko *et al.,* 2021). Furthermore, during the lithic analysis of the Líšeň I/Líšeň-Čtvrtě site, interpreted as Aurignacian (Demidenko *et al.,* 2017, pp. 10–14), we noticed technological features not fitting into the known characteristics of the Aurignacian (Fig. 1). Thus, an idea of Moravian LRJ has arisen using both recently found and excavated sites, together with some previously received lithic materials.

4. Some LRJ-like finds discovered in the 20th century in the Czech Republic

Flas already mentioned isolated J-type points in two caves, "*pointes de Jerzmanowice isolées en grotte*" (Flas, 2008, p. 184) in the Czech Republic, "*for which chronocultural attributions are debated (Nad Kačákem and Pekárna Caves)*"; also, in connection with the "*surface collections from Dubicko, Ondratice and the Brno region*", he was equally doubtful (Flas, 2011, pp. 607–608).

Two caves, Nad Kačákem, in the Bohemian Karst, western Czech Republic (Prošek, 1947; Ernestová, 2006), and Pekárna Cave, in the southern part of Moravian Karst, South Moravia (Valoch, 1960, 1999), are known for their Magdalenian finds, the latter of which is a key Magdalenian site in Moravia (Svoboda, 2000, p. 182). At the same time, some typical J-type blade points were also found in these two caves. The now lost but published and illustrated flint J-type point from Nad Kačákem Cave (Fig. 2: 1) was extracted together with a yellow limnoquartzite blade from loess sediment in the late 1940s by F. Prošek (1947, pp. 9–11; Obr. 13). Besides, Valoch (1999, Obr. 4, 8–10, 14) illustrated which we recognize as four J-type points (Fig. 2: 2–5) among Magdalenian lithics, excavated by K. Absolon in the Pekárna Cave in the 1920s. Unfortunately, the typologically distinct J-type points cannot be associated with other possible LRJ lithics in the two cave assemblages. However, these points are no less LRJ types than several similar blade points in northwestern Europe, accepted by many of our colleagues as such. Therefore, the two Czech caves should be included in the list of LRJ sites in Europe.

Surface find spots in Moravia were always a problem due to their often multi-component UP artefact composition. Regarding the LRJ, pieces looking like J-type blade points are the only typological indicators of the industry's presence at such sites. These points were indeed noticed in Moravian UP surface sites, such as the loci situated in Bobrava River Valley in South Moravia – Ořechov (Valoch, 1956, Tab. III, p. 25), and Želešice I (Valoch, 1956, Tab. VI, pp. 78–79), Želešice (Hahn, 1977, Tafel 133, p. 12); the Ondratice I–X sites in the Olomous region of Moravia – Ondratice IV-Syrovátky (Valoch, 1967, Tab. V, 2, 4); Ondratice (Svoboda, 1980, Obr. 39, 9; Allsworth-Jones, 1986, Fig. 39, 2); the Neslovice sites in South Moravia, ca. 15 km to west-southwest of Brno (Valoch, 1958, Tab. VIII, 1, 3). The most noteworthy are two sites, Podolí I and Líšeň in the vicinity of Brno, attributed previously to the Bohunician industry (Valoch, 1962, Tab. VII, 4; Oliva, 1981, Abb. 5, 2–3, 7; 9, 2–4, 8; Svoboda, 1987, Obr. 32, 1–12; 33, 1, 4; 34, 14). These are of particular interest, as they have a series of proper J-type-looking points, account-

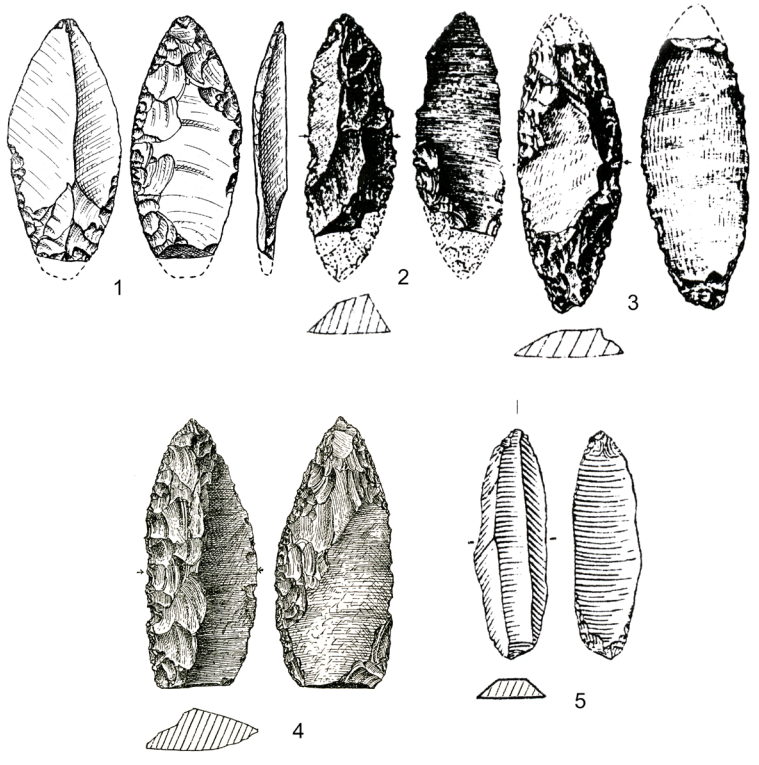


Figure 2. Nad Kačákem Cave, Bohemian Karst, Bohemia, Czech Republic: 1 – J-type blade point (modified after Prošek, 1947); Pekárna Cave, southern part of the Moravian Karst, South Moravia, Czech Republic: 2–5 – J-type blade points (modified after Valoch, 1999).

ing for no less than 4 pieces in Podolí I and at least 20 pieces in Líšeň – Figs. 3 and 4. J. Svoboda called them more than 30 years ago as proper J-type points, "čepelové hroty s ventrální retuší omezenou na bazální a terminální část. Tyto artefakty označuje W. Chmielewski (1961) jako hroty typu Jerzmanowice" (Translation: "*blade points with ventral retouch restricted to their proximal and distal ends. W. Chmielewski (1961) determined those artifacts as Jerzmanowice-type points*") (Svoboda, 1987, p. 86).

The Podolí I and Líšeň J-type points were, however, considered by Moravian archaeologists as integral to the Bohunician and Szeletian techno-complexes, and not to a proper LRJ industry in the region. M. Oliva (1981) used the Podolí I finds as the key assemblage for the identification of the Bohunician in South Moravia. Comparing the Líšeň surface lithics, which we consider a mixture of Bohunician and Evolved Aurignacian artefacts, to the *in situ* and industrially homogeneous Bohunician lithic assemblages from the nearby Stránská skála III and IIIa, excavated by Svoboda in the 1980s, Svoboda (1987, p. 86) also noted that the *in situ* assemblages only contained a single atypical J-type point at Stránská skála IIIa (Svoboda, 1987, Obr. 26, 12). However, that particular piece is not a J-type point in our view, but

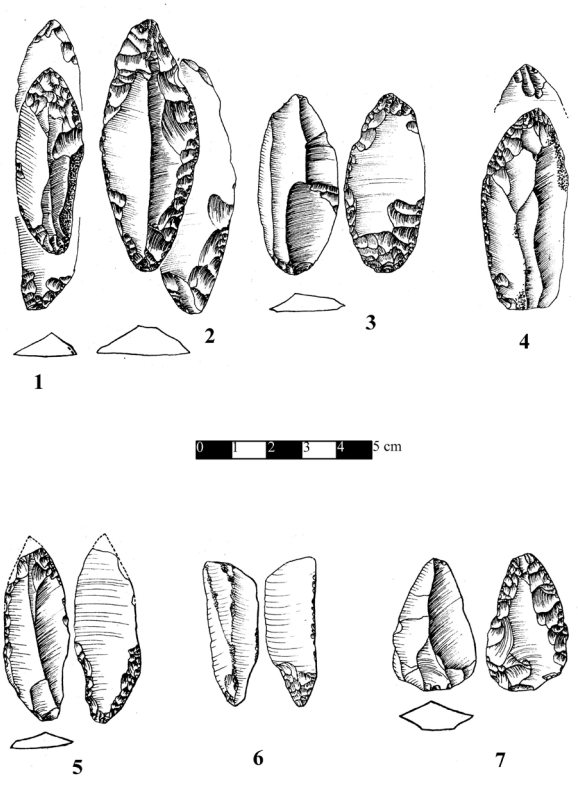


Figure 3. Líšeň surface loci, South Moravia, Czech Republic: 1–4– J-type blade points (modified after Oliva, 1981); Podolí surface loci, South Moravia, Czech Republic: 5–7 – J-type blade points (modified after Oliva, 1981).

a Levallois point with ventral-terminal retouch (Svoboda, 1987, Obr. 24, 4). Furthermore, no Stránská skála III Bohunician site contained any more pieces similar to J-type points either (Valoch *et al.,* 2000). Thus, the homogeneous Bohunician find material does not contain any proper J-type points in the Stránská skála – Podolí/Líšeň site cluster. The same inconsistency in the presence or absence of J-type points in Bohunician surface find spots and *in situ* lithics have been noticed long ago (Kozłowski, 1990, p. 132).

Thus, the role of J-type points in the Moravian IUP or EUP techno-complexes and industries is not clear and Flas was correct more than 10 years ago, to be careful with J-type points in Czech sites and surface loci.

5. LRJ sites and assemblages found and excavated in the 21st century in South Moravia

After an intensive 4-weeks artefact study of some recently discovered and excavated South Moravian IUP and EUP *in situ* sites in 2019 in Brno, we propose that four sites and their finds represent LRJ "living" sites, in addition to the Pekárna Cave and Nad Kačákem Cave (Fig. 1). Two sites are already informative enough to us (Želešice III / Želešice-Hoynerhügel and Líšeň / Podolí I), while the two other sites (Líšeň I / Líšeň-Čtvrtě and

Tvarožná X / Tvarožná -'Za školou') are less informative yet, due to different reasons. All the available artefact data for these four South Moravian LRJ sites are published in another article (Demidenko & Škrdla, 2023) and here we present a summary.

Previously, two sites (Líšeň / Podolí I and Tvarožná X / Tvarožná, 'Za školou') were attributed to the Bohunician, Želešice III / Želešice-Hoynerhügel to the Szeletian, and Líšeň I / Líšeň-Čtvrtě to the Evolved Aurignacian. Except for Líšeň I, each of the other three sites had several J-type points. Based on some similarities, surface lithic sites with heterogeneous composition and secondary position were often attributed to the Bohunician and Szeletian. In these assemblages, J-type points often escaped attention and were considered part of the Bohunician or the Szeletian.

The Líšeň / Podolí I site example represents a trick with Bohunician techno-complex recognition. The techno-complex was defined following the excavations of the Brno-Bohunice site in the 1970s. Previously, this techno-complex was named "*Szeletian of Levallois facies*" (Valoch, 1976a), after several surface sites with Levallois cores and points, together with bifacial leaf points (e.g., Valoch, 1962). However, the Brno-Bohunice *in situ* site itself was a palimpsest of both Bohunician and Szeletian artefacts in the same archaeological layer (Tostevin & Škrdla, 2006; Škrdla, 2017, pp. 91–92; Demidenko & Škrdla, in preparation). Then, the Podolí I surface spot was said to be the Bohunician type-site (Oliva, 1981). In this latter assemblage, we recognize Bohunician Levallois bidirectional cores and points, bifacial tools and LRJ J-type points. Thus identifying a type-site for the Bohunician is not straightforward today. From our point of view, the recently investigated Ořechov IV site with "living occupation characteristics" would be the best representative for Bohunician, considering the workshop character of the famous Stránská skála Bohunician sites. At the same time, our 2019 re-evaluation of the Líšeň / Podolí I assemblage from the *in situ* site allowed us to consider it to belong to the LRJ.

Our data show that the Tvarožná X site contains a few possible Bohunician Levallois cores and points, while all other artefact features, including several J-type points, render the assemblage into the LRJ.

The Želešice III *in situ* site was related to Szeletian due to the presence of some possible bifacial shaping/thinning flakes and chips indicating on-site bifacial tool production. The occurrence of several definite J-type points here was still considered to be a regular part of both Bohunician *in situ* (Stránská skála sites) and surface (Líšeň-Čtvrtě) sites, and the Szeletian *in situ* Vedrovice V site (Škrdla *et al.,* 2014, pp. 99–100). However, the unexpectedly high number of blades, some of them with faceted butts, and other characteristics of the assemblage set Želešice III apart from other *in situ* Moravian Szeletian sites. As was noted above, the Stránská skála *in situ* Bohunician sites do not contain proper J-type points. The Líšeň-Čtvrtě surface sites are characterized by both Bohunician Levallois elements and LRJ J-type points in addition to some bifacial leaf points and Aurignacian carinated endscraper-cores and burin-cores. In the Vedrovice V *in situ* Szeletian material J-type points are missing but Szeletian partially bifacial leaf points are present (Valoch, 1993, Abb. 24, 1, 5–6; 25, 3). Thus, these data remove J-type points from Bohunician and Szeletian archaeological contexts, leaving no other option for us than to restrict their presence only to the LRJ in Moravia.

The Líšeň I / Líšeň-Čtvrtě site was first attributed to Evolved Aurignacian (Demidenko *et al.,* 2017), mainly due to the absence of J-type points in that *in situ* assemblage. The absence of typical Bohunician Levallois cores and points, as well as the presence of double-platform bidirectional cores and bidirectional debitage pieces in the col-

lection, propelled us then to recognize a technologically peculiar Aurignacian assemblage in the context of the Evolved Aurignacian Stránská skála and Líšeň-Čtvrtě site cluster. However, our 2019 re-evaluation testified to the similarity between this assemblage and the Líšeň / Podolí I site.

All four assemblages are technologically similar concerning cores and debitage pointing towards bidirectional core reduction. These artefacts confused us during the initial interpretation of the two Bohunician sites (Líšeň / Podolí I and Tvarožná X), and the one site with an Aurignacian affiliation and some possible Bohunician admixture (Líšeň I). This example should be taken seriously when thinking about the industrial attribution of IUP and EUP assemblages in Moravia, including the possible LRJ sites. To some extent, it is what was done in northwestern Europe, Belgium and Great Britain when the LRJ was carved out of the Aurignacian (Flas, 2009).

6. The LRJ in the Moravian IUP and EUP industrial-chronological context

Having the LRJ industry established in Moravia, now we need to place it in the regional IUP and EUP industrial and chronological context, to find room for it among the Bohunician, Szeletian and Aurignacian "crowd". Indeed, LRJ artefacts are often mixed with lithics of the other three techno-complexes in Moravian surface sites, which implies a tight position of the now four archaeological units in the region.

Geochronology. Radiocarbon dates for Líšeň / Podolí I and Želešice III sites put the Moravian LRJ in the period of ca. 42 ka cal BP, preceding the HE-4 or CI event at 40 ka cal BP (GI-11–GI-10). This means that the Moravian LRJ should be included in the regional IUP record and not the EUP. At the same time, a series of new absolute dates render the *in situ* Bohunician and Szeletian sites in South Moravia earlier than we thought before. Both of them start in the GI-13 and/or the GI-12, at ca. 48–46 ka cal BP, and last possibly until GI-10, at ca. 42–40 ka cal BP. However, at the Ořechov IV site, some late radiocarbon dates, if not contaminated, may indicate an Upper Bohunician during GI-9, at ca. 40 ka cal BP (Škrdla, 2017, pp. 129–130). If our proposed geochronology is right, then the LRJ should be considered a late IUP industry both in South Moravia and East-Central Europe.

Industrial features. On one hand, the LRJ is very different from the Szeletian both technologically and typologically (see Valoch, 1993; Neruda & Nerudová, 2009; Nerudová & Neruda, 2017). On the other hand, it shows clear techno-typological similarities to the Bohunician. Interstingly, bifacial leaf points are not documented in Moravian *in situ* LRJ sites yet, although some bifacial tools were collected at the Líšeň surface loci (Svoboda, 1987, Obr. 31, 1–4, 6–10; 33, 2–3, 6). These tools can be associated with the LRJ and not the Szeletian, however, more research on this topic are needed. The following comparison between the Moravian LRJ and Bohunician technological and typological data demonstrates some different and similar traits.

Technologically, the LRJ does not feature *sensu stricto* Levallois methods, instead, it is characterized by parallel unidirectional and bidirectional reduction, targeting rather large and elongated flakes or blades. However, many blades were technologically supplementary debitage items within the Bohunician Levallois bidirectional pointed blade technology. At the same time, the *lame à crête* technique was applied in both industries for core preparation and re-preparation. The absence of the core tablet technique both in the Bohunician and the LRJ suggests an IUP status for the latter as well. The presence of striking platform edge abrasion, bipolar-on-anvil core splitting method and bladelet core technology in the LRJ testifies to significant differences in the main

reduction methods between the Bohunician and the LRJ.

Typologically, besides the regular presence of true J-type points in the LRJ, and the occasional presence of retouched true Levallois points in the Bohunician, there are no significant differences between LRJ and Bohunician tool classes or types.

Thus, the main difference between the LRJ and the Bohunician is the LRJ point concept which presumes bidirectional blade reduction from opposed-platform cores, although the two additional core reduction methods (bipolar-on-anvil and bladelet cores), missing in the Bohunician, are also notable. However, some similarities remain between the two industries which hinder their differentiation. These are a shared toolkit, the occasional absence of J-type points in LRJ assemblages, and common bidirectional core reduction methods with striking platform preparation.

The Moravian LRJ is considered an IUP industry closer to ca. 42–40 ka cal BP which coincides well with the beginning of the European LRJ established before the HE-4 / CI event. At the same time, the Moravian LRJ is further characterized by numerous common features with the Bohunician.

7. The Moravian LRJ and its comparison with the European LRJ.

The Moravian LRJ settlement pattern. In addition to the previously known J-type points at Nad Kačákem and Pekárna caves in Bohemia and South Moravia, exemplifying the northern European LRJ, the four open-air sites in South Moravia represent long-awaited *in situ* "living sites". Data from these four sites also enable us to differentiate site functions and evaluate their variability in the South Moravian landscape.

Two of the sites are connected to Stránská skála-type chert outcrops. Líšeň / Podolí I was a residential base camp, and Líšeň I was mainly a workshop for blade production and their "export" to special task camps, e.g. hunting stations. Personal ornaments (pierced mollusc shells) were recovered in abundance in Líšeň / Podolí I, where probably their production also took place. The presence of one such item in Líšeň I may indicate that somebody lost it accidentally at the site. The third site, Želešice III, could be a hunting station near a Krumlovský les-type (KL) chert outcrop with a lot of lithics from primary and secondary flaking activity. The function of the fourth site, Tvarožná X, is not yet clear due to the preliminary character of its lithic collection analysis. However, the unique location of the site should be mentioned. It was some distance (ca. 7 km) from the lithic raw material outcrop they used most, Stránská skála, in a rather hidden topographic location near a stream, at a relatively high elevation than, near the entrance to the Vyškov Gate connecting the Brno Basin with the northern areas, such as the Moravian Gate. Therefore, Tvarožná X could be a task-specific site, which we can establish with more certainty after the lithic study. The location of the Pekárna Cave in the southern part of the Moravian Karst, ca. 7.7 km northeast of Stránská skála III, with its four J-type points made of an unrecognised raw material, indicates a hunting station, like many other LRJ sites in Europe. In sum, there is a sort of logistic / foraging / radiating mobility settlement pattern (e.g., Marks & Freidel, 1977; Binford, 1980), with functionally variable LRJ sites connected to the Svratka and Bobrava River valleys in South Moravia, ca. 25 km away from the Brno Basin and the southern part of Moravian Karst in the north, and the Bobrava Highland in the south, as the crow flies. Furthermore, a certain network of relations between the LRJ industry's different human groups had to exist in South Moravia.

Industrial similarities and differences between the European and Moravian LRJ assemblages. The Moravian LRJ sites and their artefact assemblages should certainly demonstrate differences from lithic artefacts of the European LRJ "hunting sta-

tions". Furthermore, the European LRJ toolkits almost exclusively consist of J-type points and some bifacial leaf points, whereas "domestic tools" are well represented in South Moravian LRJ open-air sites.

Technological similarities and differences. The primary blade reduction and all its technological supplementary features (a central *lame à crête* technique, permanent faceting of striking platforms and frequent edge abrasion, and the absence of the core tablet technique) make the two industry facies similar, although Beedings burin-cores are not recognized yet in Moravia, and Moravian proper bladelet cores are unknown in the European LRJ. However, there the two blade core reduction schemes differ in some aspects. While a few LRJ Beedings cores on nodules are opposed-platform bidirectional cores for blades, the Moravian LRJ cores on nodules are more frequently single-platform unidirectional, not opposed-platform bidirectional cores, the latter of which results in numerous flakes beside blades. So, in the Moravian LRJ, parallel flake cores for elongated flakes and unidirectional blade cores are quite common. The core characteristics correlate well with debitage data in South Moravia. Here, flakes outnumber blades and unidirectional scar pattern prevails over bidirectional both on flakes and blades, although exact data on this feature has not been calculated yet. This observation resonates with our 2016 opinion about double-platform cores from Líšeň I, namely, that "*all double-platform cores experienced a 'double single-platform reduction'*" (Demidenko *et al.,* 2017, p. 11). This means that proper bidirectional flaking, with alternating detachments from the opposed striking platforms, is not characteristic at the site. Thus, the Moravian core and debitage data seemingly differ from the European LRJ data (bidirectional blade supports for J-type points) but taking site data from Moravia into consideration, the differences become diminished between the two facies.

The Moravian open-air sites are characterized by easily available local cherts for core reduction, which prevented the South Moravian LRJ humans to execute long reduction sequences for each particular core. Instead, short reduction sequences were realized in many cases, which resulted in numerous single-platform unidirectional cores, often with flake detachment negatives. However, both facies show an intensive reduction of some secondary flaking artefacts, cores on flakes / truncated-faceted pieces, and splintered pieces / bipolar-on-anvil cores. Some bladelet cores on nodules in Moravia testify to the importance of proximity to raw material outcrops for the "Czech LRJ humans".

In sum, "subjective factors" may have had some influence on primary flaking processes both at Moravian and European LRJ sites, but their significant similarity is still evident.

Typological similarities and differences. A basic difficulty in typological comparison is the paucity of "domestic tools" in European LRJ toolkits. Nevertheless, the "absence criteria" is worth noting for some of such tool categories, classes and types. First, the almost total absence of MP tool classes, and the absence of both Aurignacian and Gravettian tool types can indeed serve as typological markers placing the LRJ after the MP and before the EUP period, that is, to the IUP period. The presence of a few simple endscrapers, non-multi-faceted burins and some general retouched blade and flake types correlates well with an IUP typological status for the European LRJ. Simple endscrapers, together with other UP types represented by only a few pieces in the Moravian toolkits correspond to the European LRJ "domestic tool" data. Bifacial leaf points, known from a few European LRJ sites are not useful for comparison with the Moravian LRJ sites. However, the above-mentioned bifacials from the Líšeň sur-

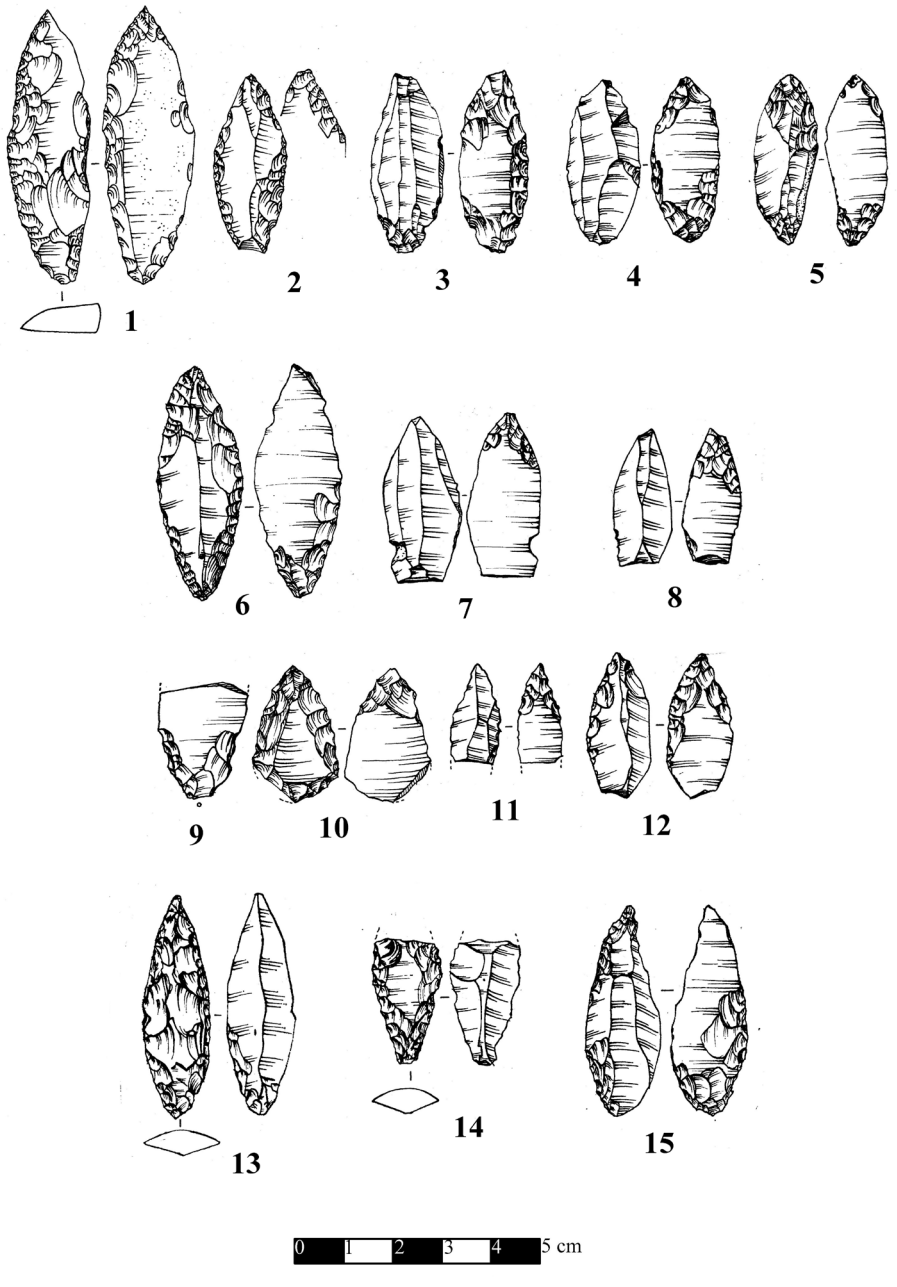


Figure 4. Líšeň surface sites, South Moravia, Czech Republic: 1–15 – J-type blade points (modified after Svoboda, 1987).

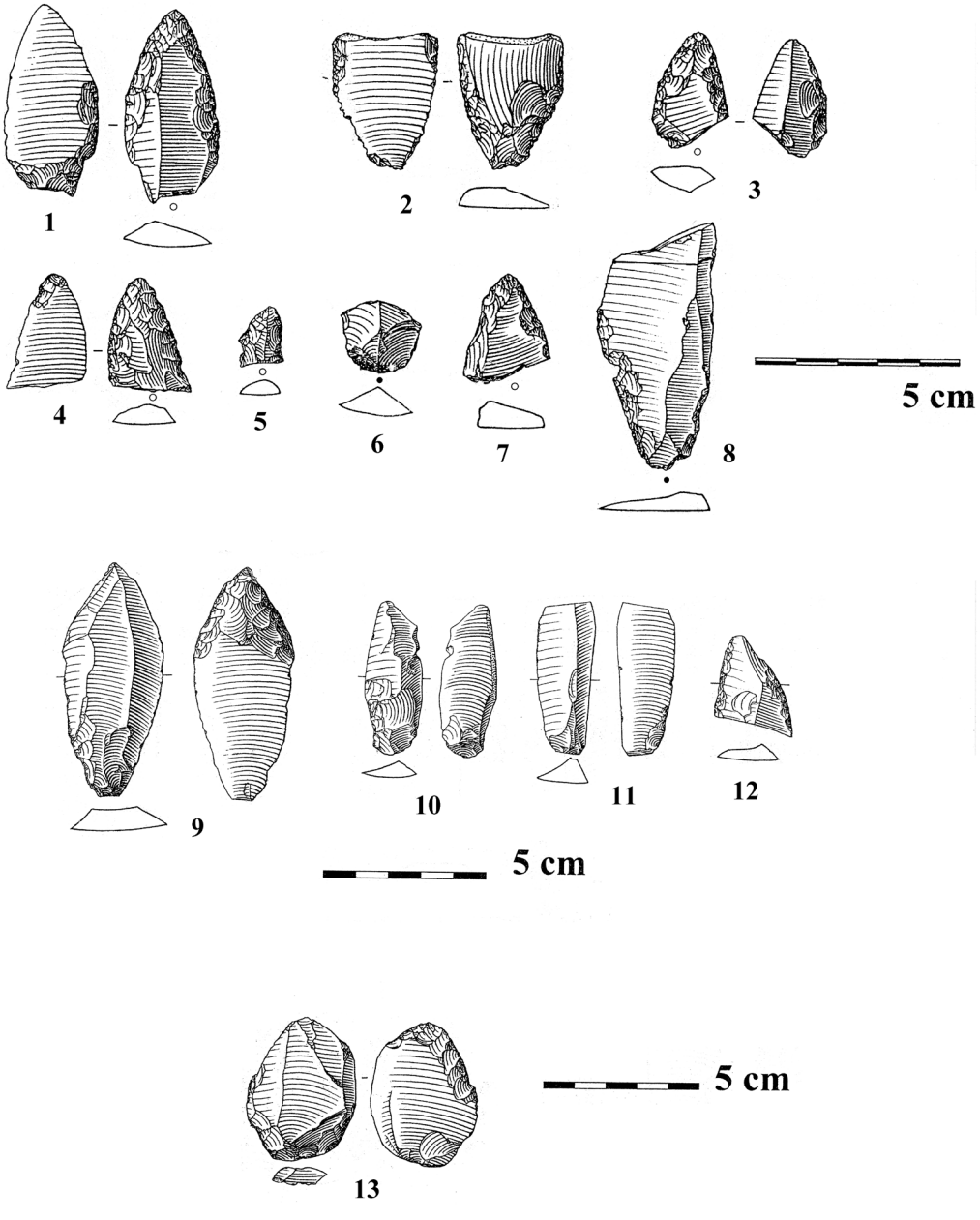


Figure 5. Želešice III / Želešice-Hoynerhügel site, South Moravia, Czech Republic: 1–8 – J-type blade points; Líšeň / Podolí I site, South Moravia, Czech Republic: 9–12 – J-type blade points; Tvarožná X, "Za školou", South Moravia, Czech Republic: 13 – J-type blade point (modified after Škrdla, 2017).



Figure 6. Líšeň / Podolí I site, South Moravia, Czech Republic: J-type blade point with two refitted chips (modified after Škrdla, 2017).

face sites keep a "door open" for such research in Moravia.

Overall, the only comparable tool type in the South Moravian open-air and European LRJ sites is the industry's "*fossile directeur*", the J-type point. Again, there are some problems with it. While most of the European J-type point fragments were very likely broken during use as hunting projectile weaponry, many of the Moravian J-type point fragments (Fig. 5: 2–7, 12) were broken during on-site point production (see the Líšeň/Podolí I site – Škrdla, 2017, Fig. 4.5, 24, 43–44; the Želešice III site – Škrdla *et al.,* 2014, 12, 1, 23, 29), although some J-type point fractures in Želešice III could also be "hunting damage" (Škrdla *et al.*, 2014, 12, 3–5) (Fig. 5: 1, 3–4). This is why the latter Moravian site is regarded as a hunting station at a Krumlovský Les chert outcrop. Of all 13 *in situ* J-type points and their semi-products from three Moravian open-air sites (Fig. 5: 1–13), their breakage prevents precise recognition of the used blanks' scar pattern. The scar patterns of the three complete J-type points (Fig. 5: 1, 9, 13) are bidirectional in two cases (Škrdla, 2017, 4.5, 42 – Líšeň/Podolí I site; 3.8, 40 – Tvarožná X site), and unidirectional in one case (Škrdla *et al.*, 2014, 12, 5). At the same time, two almost complete semi-finished J-type points from Líšeň/Podolí I have unidirectional scar patterns (Škrdla, 2017, 4.5, 43–44) (Fig. 5: 10–11). Two J-type points, which broke during their manufacture, have unidirectional-crossed (Škrdla *et al.,* 2014, 12, 7) (Fig. 5: 2) and unidirectional (Škrdla *et al.,* 2014, 12, 23) scar patterns (Fig. 5: 8). Thus, whereas the European J-type points almost always have bidirectional scar pattern, the Moravian J-type points possess a variety of scar pattern types. At the same time, the European J-type points were produced on blades at least in 99% of the cases, as the name variant "J-type blade points" describes. Also, all Moravian J-type points were made on blades in cases where the support can be recognized, except a point on a flake in Tvarožná X, which is bidirectional. Also, the blade blanks used for J-type point production at the Moravian sites are usually the largest blades in the debitage. Adding to the blanks' morphological and metrical data, the retouch characteristics of the European and Moravian J-type points are also similar. Most blade blanks were retouched dorsally and ventrally at the proximal and distal ends to achieve a general leaf shape of the points. Our refits of retouch chips onto J-type points from Želešice III and Líšeň/Podolí I (Fig. 6) confirm this characteristic retouch. The lateral edges of the blade blanks were barely or lightly retouched. Heavy scalar and/or even wide stepped retouch on the lateral edges which expands to the centre of the surface, are significant corrections of blank shape and irregular thickness. Furthermore, intensive retouch can be the result of re-shaping and rejuvenation. In this regard, it has to be underlined once again that J-type points from two Moravian sites were probably never used (Líšeň/Podolí I, Tvarožná X) and only a part (!) of the

J-type points from Želešice III were used for hunting. This explains the rather light retouch of the Moravian J-type points in comparison with J-type points from many European LRJ sites. So, considering again some J-type points' "subjective data" on their production and/or use, some differences in scar patterns, overall size, length, and retouch may be explained by site function in Moravia and other European sites. In Moravia, points were produced on-site, including the parallel detachment of blades and elongated flakes. In the European sites, only the best and largest finished points were brought to the camp, which were then used in short hunting events near the site. Thus, these are the same point types in both cases, with almost identical *chaînes opératoires* in their primary (debitage blank production) and secondary (retouch treatment peculiarities) stages of production.

Overall, the above-discussed typological data and interpretation allow us to include the presented toolkits from Moravian open-air sites in the European LRJ toolkits without hesitation.

8. The possible origin of the LRJ in Europe using the South Moravian IUP data: short preliminary suggestions and their implications

Regarding the LRJ origin hypotheses out of northwestern European late MP industries with bifacial leaf points, and the proposed makers of the LRJ, the Neanderthals, the new South Moravian LRJ material allow us to propose a "reverse geographical order" for the origin of LRJ in Europe.

A straightforward "birth" of the LRJ from the MP is doubtful since no MP techno-typological features are known on artefacts from the Moravian LRJ open-air sites and the European LRJ sites. Moreover, this scenario would have been possible only if *Homo sapiens* groups, bearing IUP / EUP artefact-making traditions, had some acculturation/trans-cultural diffusion/stimulus diffusion effect on the MP Neanderthals when they arrived in northwestern Europe. An IUP / EUP industry like that should have several MP artefact traits. Therefore, an MP "generic base" for the IUP LRJ in northwestern Europe does not seem convincing to us.

Instead, we propose another scenario for the origin of the LRJ and its status in Europe, using new LRJ data from Moravia.

1) As was already argued before (e.g., Flas, 2011, 2014), our Moravian data indicate that the beginning of the LRJ just precedes the HE-4 / CI event, ca. 42–40 ka cal BP, thus it falls in the IUP time range.

2) By all archaeological criteria, the LRJ is an IUP industry which correlates to its geochronological position.

3) Several technological and typological similarities are observed between the Moravian LRJ and the Bohunician. This suggests the development of the LRJ from the Bohunician, with the following single basic artefact change. The Bohunician Levallois point concept for the production of projectile hunting weaponry was replaced by the J-type point concept for the same hunting purpose in the LRJ. It was not a radical conceptual change. The bidirectional Levallois core reduction for the production of pointed blade elements in the Bohunician does not differ fundamentally from the non-Levallois *sensu stricto* unidirectional/bidirectional blade technology in the LRJ. The latter was based on several Bohunician-like techniques, together with an organic soft-hammer technique that often caused edge abrasion on the cores' striking platforms. Compared to the somewhat wasteful Levallois point production in the Bohunician, this technological shift resulted in more targeted products, namely, elongated flakes or blades, in the LRJ. So, it was a matter of improving core reduction efficiency for the new LRJ industry. Further technological developments in the

LRJ are seen with the appearance of bladelet core production and bipolar-on-anvil core technology. At the same time, almost the same tool classes and types are present in the two industries. So far, the only difference in this respect is the presence of thick non-carinated endscrapers in the LRJ. The fine Bohunician Levallois point method produced thin blanks which were used for tool making, whereas the non-Levallois LRJ elongated flake/blade method often produced more robust blanks. Some of them with thick terminations were also transformed into endscrapers. The supposed smooth Bohunician–LRJ technological transition would have been beneficial for people in the northern latitudes, where most of the European LRJ sites are known. Here, in the open steppe-tundra landscape, efficient lithic technology and projectile weaponry facilitated quick movement. Furthermore, the LRJ social network could be responsible for the appearance of personal ornaments (pierced mollusc shells), with which they could easily identify different human groups in this harsh environment. If so, then it is understandable why the "newborn" LRJ industry with its humans and sites is well represented in Northern Europe. That was the suitable natural environment for the survival of LRJ people, who probably pursued targeted hunting of large-sized ungulates. This distribution is especially valid if we take a look at more southern regions of Europe, where the Proto-Aurignacian, then, after the HE-4 / CI event, Early Aurignacian *Homo sapiens* groups became widespread. Considering this scenario, it appears that the "advanced Bohunicians", i.e., the LRJ groups, had no other choice than to move to more northern territories and master the circumstances there.

4) The suggested IUP Bohunician "industrial roots" for the LRJ and its late IUP status have significant implications in terms of their makers. Only *Homo sapiens* are assumed to represent IUP Emiran and Emiran-like industries in Eurasia, including, of course, the Bohunician (e.g., Škrdla, 2017, pp. 9–11, 133; Hublin *et al.,* 2020). This is why we propose *Homo sapiens* as the makers of the LRJ artefacts as well.

5) There is another consequence of the Bohunician–LRJ succession. After its appearance in Central and Eastern Europe (with the Kulychivka "Stránská skála twin site" in Western Ukraine, see Demidenko & Usik, 1993a; Demidenko, 2018, p. 271; Škrdla & Nikolajev, 2014; Škrdla *et al.,* 2016b; Škrdla, 2017, pp. 83–86), the Bohunician had transformed into the LRJ and distributed all over the northern territories of Central and Western Europe up to Great Britain, thanks to its newly developed adaptation to cold and open environments. As a result, the IUP Bohunician with its *Homo sapiens* did not disappear in Central Europe but left the LRJ after itself.

6) Of all known LRJ sites including the presented Czech ones, half of them are found in Great Britain. This distribution may represent the culmination of the LRJ, the end of the road of its northern expansion. To us, comparable cases are prevalent in Palaeolithic and Prehistoric archaeology. One is the Early Aurignacian/Aurignacian I, the sites of which are known best from the industry's westernmost distribution area, in the European "cul-de-sac", France. Another example is the Tripolye-Cucuteni Chalcolithic culture (e.g., Menotti & Korvin-Piotrovskiy, 2012), known for the vast territories of present-day Romania, Moldova and Ukraine. This culture reached the climax of its development and prosperity in its easternmost region, Ukraine, characterized by so-called giant settlements. LRJ site distribution may have the same character, i.e., the industry's place of origin is at the opposite end of its range from its best-represented area.

9. Some concluding considerations

The presented overview of the LRJ industry with its lithic artefact data, site characteristics, as

well as its distribution in Europe, geochronology and the issue of its makers, either Neanderthals or *Homo sapiens,* allow us to conclude the following. First of all, the limited data set of the industry comes almost exclusively from ephemeral/temporary hunting stations with really restricted artefact information. The LRJ is the only European UP industry identified and characterized with the help of these specific sites and the one-sided information they provide. At the same time, it is still clear that the LRJ represents an IUP industry following the late MP but preceding the EUP Early Aurignacian.

With this background, we conducted an intensive analysis of four open-air sites which were recently investigated in South Moravia. We presented their geochronology, lithic artefacts (in a preliminary fashion but with enough data for their technological and typological characterization), lithic raw material use, and settlement pattern. We propose the recognition of these as LRJ sites related to the IUP right before the HE-4 / CI event, ca. 42–40 ka cal BP. In addition, we attribute the previously known J-type points at Nad Kačákem Cave in the Bohemian Karst, and Pekárna Cave in the southern part of the Moravian Karst to the LRJ industry. Altogether we propose six sites with LRJ artefacts in the Czech Republic that would now compose ca. 13% of all the known 46 LRJ sites in Europe. The most important is that the newly recognized Moravian open-air sites are *in situ* stations with traces of habitation, not just hunting. These occupation characteristics are variable and allowed us to propose a logistic / foraging / radiating mobility settlement system with the following site types: a sort of residential base camp near a Stránská skála-type chert outcrop (Líšeň/Podolí I site); a workshop near a Stránská skála-type chert outcrop for blade production, aiming at blade "export" to some special task camps, e,g, hunting stations (Líšeň I / Líšeň-Čtvrtě site); a sort of hunting station by a Krumlovský Les chert outcrop (Želešice III / Želešice-Hoynerhügel site); a special task site near the entrance to the Vyškov Gate (Tvarožná X / Tvarožná -'Za školou' site), and finally, an ephemeral hunting station in the Moravian Karst area (Pekárna Cave). During our study, we noticed many technological and typological features in the Moravian LRJ assemblages that are similar to the Moravian IUP Bohunician assemblages. After a direct comparison of these two industries, we propose a smooth and mainly technological transition from the Bohunician to the LRJ, based on mostly a conceptual change in a single artefact type (from Levallois points to J-type blade points). As a result, a Central European, Moravian origin of the LRJ is also proposed, from where the bearers of this industry, the modern humans (*Homo sapiens*) dispersed all over the vast territories in the northern latitudes of Central and Western Europe.

Finally, the LRJ industry is added to the long-lasted tripartite archaeological composition (Bohunician, Szeletian, Proto-Aurignacian) of the IUP period with a ca. 6–8,000 years duration in East-Central Europe. The geochronological age of the LRJ industry is late IUP, thus it was coeval with the Proto-Aurignacian and post-dates both the Bohunician and the Szeletian.

Our Moravian studies are still in the preliminary stage. We plan to analyze and publish data site by site, with more emphasis and details on their artefact assemblages. Accordingly, we hope to gain new information about these first European LRJ assemblages and the adaptation of their *Homo sapiens* makers in the IUP environment. Lastly, more LMP and IUP materials in East-Central Europe deserve a re-evaluation in terms of their attribution and relation to the LRJ. These are Korolevo II, layer II in Ukrainian Transcarpathia (Gladilin & Demidenko, 1989) and the so-called Jankovichian assemblages (Gábori-Csánk, 1993; Markó, 2013, 2019), which seem promising candidates of LRJ representation in the

region. Eventually, more work connected to the LRJ in various regions of East-Central Europe is hoped to be realized soon.

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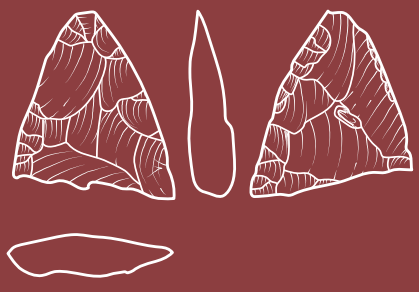
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In the Szeleta cave in the summer of 2021. An important part of Zsolt's scientific work is the issue of the Szeletian. He carried out excavations at the site, thanks to which many of his students also were introduced to Palaeolithic archaeology there. Next to Zsolt, the leader of this excavation, one of Zsolt's first students, György Lengyel stands, who is now an associate professor at the University of Miskolc and curator of the Palaeolithic collection in the Hungarian National Museum. Master and student discuss the professional removal of a larger piece of rock, Zsolt wears his now iconic sweater. In the background, Sándor "Szása" Béres works tenaciously.

Photo: Attila Király.



Using geological, geomorphological and soil science description data in archaeological research

6

ANDORNAKTÁLYA, GYILKOS HILL AS A CASE STUDY

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Abstract. Nowadays, geological, Quaternary sedimentological, soil science and geomorphological research can give new information for analysing and describing archaeological sites. In this article, we have investigated the ancient environmental and landscape conditions in the case of the Upper Palaeolithic archaeological open-air site situated on Gyilkos Hill in Andornaktálya, Hungary. We have analysed the geological situation, Quaternary sediments, soil and geomorphological conditions. Our results show that ancient people lived in a higher but separated and lowered pediment area surrounded by the Eger and Ostoros streams during the Aurignacian culture in the Upper Palaeolithic period (Würm glaciation). Slopes were dissected by dells and the heads of erosional valleys and this territory could be covered by cool continental steppe and tundra vegetation. Soil data show that medium-fertile Chernozem brown forest soil developed here later which is the remnant of the new forested Late Glacial warmer period. This high, separated hilly territory could be well protected suitable for inhabitants to settle down. That is why archaeological surveys found a Palaeolithic open-air site here. We aim to use this complex research survey method at other archaeological sites.

Keywords: Quaternary sediments, Geomorphology, Soil science, Archaeology, Landscape geography, Bükkalja

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1. Introduction

The new period began when the ancient people appeared on the Earth because they knew their environment continuously, they adapted to the real-life conditions, and living places and they became more conscious of building up community and society they reformed their environment and they always had a basic connection with Nature. Environmental factors always determine people's appearance and spreading. That is why, the knowledge of the environmental conditions can bring us closer to knowing the first processes and understanding of first inhabited places.

The Palaeolithic epoch is the first and the longest period of mankind lacking written documents to reconstruct its history. It lasted from approximately 2.6 Ma ago to ca. 11.7 ka ago based on the geological column (Gutay, 2019). From an earth scientific point of view, this period contains the end of the Pliocene epoch of the Neogene period and the Pleistocene epoch of the Quaternary period until the beginning of the Holocene epoch (Gutay, 2019; Martonné Erdős, 2003; Pelikán, 2002). We can recognize continuously more climate changes, the changes in the landscape and the natural environment and the appearance of new landforms, and living places during this long period. During the Palaeolithic period, stone, bone and other organic raw materials were used for tool production but not metals. We can divide the Palaeolithic period into the following phases: (1) Early Palaeolithic period (2.6 Ma ago–1.7 Ma ago) Lower Palaeolithic period (1.7 Ma ago–250 ka ago); Middle Palaeolithic period (250 ka ago–35 ka ago) and Upper Palaeolithic period (35.0 ka ago–11.7 ka ago). These long phases witnessed the evolution of the *Homo* genus until the appearance and global distribution of *Homo sapiens* (e.g., Langdon, 2022).

In the case of Palaeolithic open-air sites, a question arises: Why did ancient people prefer these well-known territories to settle down? What kind of landscape, and landscape conditions (geological, geomorphological, soil science, climatological, water system, botanical and zoological factors) could be characteristic of these territories? We can point out earlier development phases of the investigated area or landscape by analysing Quaternary sediments, soil conditions and geomorphological mapping. We need to see that the conditions and habitats of different landscapes could be changed significantly from 2.6 Ma ago to 11.7 ka ago because there were different tectonic movements and climatic change periods characteristic in Hungary (Hevesi, 1978). The place of rocks and sediments building up the landscape or the appearance and types of former landforms could be changed during that time (Borsy, 1993; Lóczy, 2008; Lóczy & Veres, 2005; Martonné Erdős, 2003; Mezősi, 2011, 2017). Different tectonic movements and climate changes could cause the development of new landforms (for example new fluvial terraces, floodplains; cryoplanational walls and debris developed by frost activity). This long period was that time when the pediments, fluvial terraces, cryoplanational and gelisolifluctional landforms, patterned grounds and cryoturbation forms, mass movements and karst landforms developed in the Bükk Mts. in Hungary (Dobos, 2002; Fábián *et al.,* 2014; Hevesi, 1978; Kleb, 1978; Pecsmány, 2020; Pecsmány *et al.,* 2020; Pinczés, 1955, 1957a, 1977, Pinczés *et al.,* 1993; Székely, 1958, 1972, Vágó, 2003). In Palaeolithic open-air sites, the local environmental conditions determined always the people's inhabited actions and activities. In this article, we look for the answer to how we can reconstruct the former landscape conditions of a chosen Palaeolithic open-air site by surveying sediments, soils and landforms. What kind of landscape factors did determine the settled-down activity for people? We chose such a territory to investigate where the archaeologist discovered a well-known site, age and culture type in the Bükkalja Microregion like in

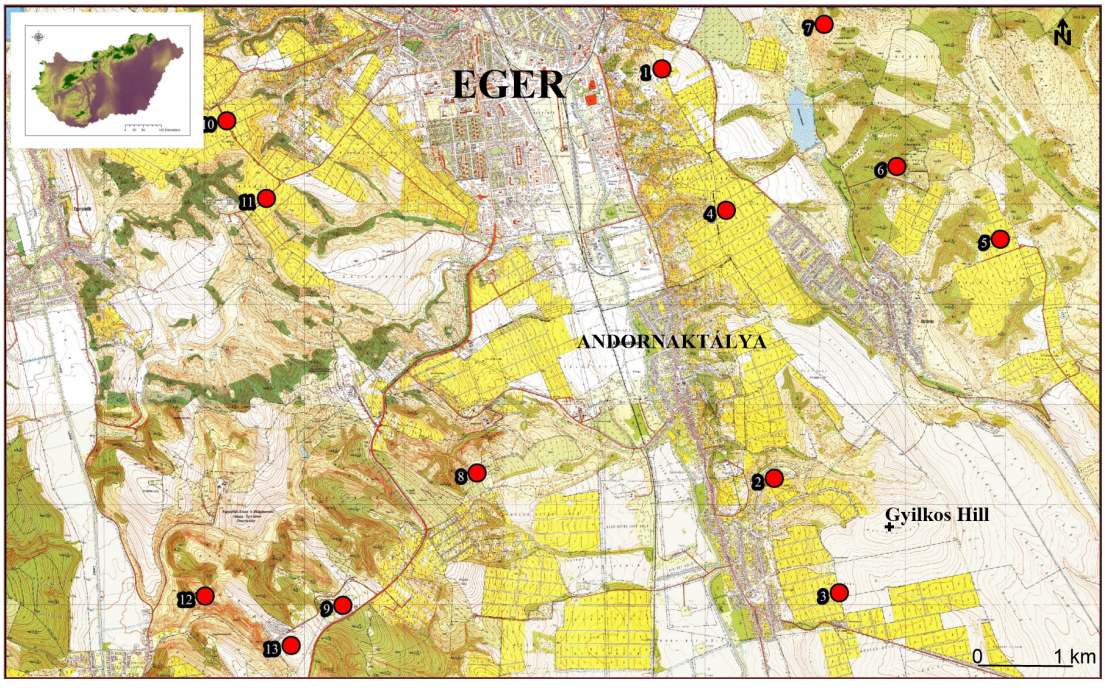


Figure 1. The topographical situation of the larger study area with investigated Palaeolithic sites (based on Mester, 2010; Zandler, 2006, Fig. 1. Source: 1:10,000 EOTR Cadastrai map of Hungary, 1990). Prepared by the author.

the Eger-Kőporos site, Egerszalók-Kővágó site and Andornaktálya site (Zúgó-dűlő) (Budek *et al.,* 2013; Chu *et al.,* 2017; Hevesi & Ringer, 2003–2005; Kozłowski *et al.,* 2012; Mester, 2010; Zandler, 2006).

2. Literature Review

In Hungary, the most important archaeological site from the Lower Palaeolithic is Vértesszőlős. Middle Palaeolithic archaeological sites were discovered in Tata, Lovas, Érd and the Subalyuk cave in the Bükk Mountains. The most known archaeological sites from the Upper Palaeolithic are Ságvár, Istállóskő cave and Szeleta cave in the Bükk Mountains (Kovács & Szigeti, 2007).

In the Bükk Mountains, the Palaeolithic archaeological sites are situated in the Bükk Plateau (Palaeolithic cave sites) and the Egri-Bükkalja Foothill Area Microregion (Palaeolithic open-air sites) (Budek *et al.,* 2013; Dövényi, 2010; Gutay, 2019; Mester, 2002, 2010, 2014; Ringer, 2002). The open-air sites in the Egri-Bükkalja Microregion are in the following settlements: Eger, Egerbakta, Andornaktálya, Egerszalók, Ostoros, and Demjén (Budek *et al.,* 2013; Gutay, 2019; Kozłowski *et al.,* 2012; Mester, 2010; Zandler, 2006).

According to the Archaeological Database of the Hungarian National Museum (Archaeology Database n.d.), the most detailed Palaeolithic open-air sites are known as the following (Fig. 1): 1. Demjén, Hegyes-kő-tető; 2. Demjén, Pünkösdhegy; 3. Andornaktálya, Szukszerdomb; 4. Andornaktálya, Zúgó-dűlő; 5. Andornaktálya, Gyilkos; 6. Andornaktálya, Marinka; 7. Eger, Nagygalagonyás-tető; 8. Eger, Kőporos-tető; 9. Eger, Nyerges-tető; 10. Egerszalók, Kővágó-dűlő; 11. Ostoros, Csúnyamunka-tető; 12. Ostoros, Rápca l.; 13. Egerbakta, Láptavak; 14. Egerszalók,



Figure 2–3. Topographical position of the soil profiles No. S1 and S3 with former deepened soil profiles and archaeological sites. (based on topographic map of 1990 and Google Earth Map, 2012) Legend: S1 – Andornaktálya – Gyilkos hill, S3 – Andornaktálya – Gyilkos hill, AR – Andornaktálya-Rózsa hill, AZ – Andornaktálya-Zúgó. Prepared by the author.

Hegyeskő-tető (Budek *et al.,* 2013; Gutay, 2019; Kozłowski *et al.,* 2012; Mester, 2010; Zandler, 2006).

From these archaeological sites (Fig. 1), the Andornaktálya, Gyilkos Hill Palaeolithic open-air site was discovered by numerous researchers. There was organised an archaeological field trip to this area by Viola T. Dobosi in 2004 and there was a field excavation by Zsolt Mester (2013) and Mónika Gutay (2015) here. Krisztián Zandler could determine a living place of a settlement belonging to the Aurignacian culture from the Upper Palaeolithic Period at the centre top of the Gyilkos Hill in 2003 and in November of 2004. Numerous ancient pieces of equipment originating from the Palaeolithic period were discovered there. The used raw materials could originate from the Bükk and the Zemplén Mountains (hydro and limnoquartzite) and the surrounding of Mátraháza-Felnémet (opal) (Zandler, 2006).

3. Methodology

3.1. Study area

In this article, we would like to give detailed information about the landscape and environmental conditions of Andornaktálya, Gyilkos Hill open Palaeolithic archaeological site. Archaeologists determined some find materials of Aurignacian culture dating from the Upper Palaeolithic period here (Zandler, 2006). The Gyilkos hill is situated in Andornaktálya settlement, in Heves County, in the territory of Egri-Bükkalja Foothill Area Microregion (Macroregion: North Hungarian Mountain Range; Mesoregion: the Bükk Mts.) in Hungary (Dövényi, 2010). The Gyilkos hill is situated in the eroded younger Villanyium pediment surface of the Bükk Mountains, which is dissected by erosional valleys and derasional valley heads (in the east: Gólint-dűlő, Kenderföld, Középső-dűlő; in the north: Nagy valley, Zúgó valley; in the south: upper part of the Hotel-dűlő; in the west: wide erosional valley of the Eger Stream). Dells and erosional valley heads tend to the top of the Gyilkos Hill, so they can reduce and lower the area of the hill (Dobos & Mester, 2018, p. 63, Fig. 1; Fig. 2–3).

Two soil profiles were discovered in this territory and they gave new information for the geological and soil scientific surveying. We could point out the soil profile No. S1 next to the triangulation point (227.6 m), some meters toward the south, while the soil profile No. S3 was deepened in the upper part of a dell, 3.75 m toward the north from the triangulation point (Fig. 2–3). Our study




Figure 4–5. Field research works at the summit of the Gyilkos Hill (Photos: Anna Dobos and Bence Gábor Szladky, 2015).

area was arable land during the last 210 years, and vineyards appeared here after 1990 based on the 1st, 2nd, 3rd and 4th Military Survey Maps, the topographic map of 1990 and the aerial photograph of 2012, and 2022.

3.2. Sampling Methods

3.2.1. Procedure

We wanted to discover the Palaeolithic archaeological site of Gyilkos Hill by complex landscape geographical research methods. As the landscape development reconstruction of different types of landscapes can be discovered by geological, soil scientific and geomorphological research methods in the best way, we have concentrated our methods on these three different disciplines. We described soil profiles of No. S1 and S3 on the 1st of September in 2015. These soil profiles gave a basis for the analysis of Quaternary sedimentological and soil conditions. The soil profiles were deepened by Bence Gábor Szladky, who was our student at the Department of Environmental Science and Landscape Ecology at Eszterházy Károly University (Fig. 4–5). We organized physical geographical field trips in September 2015 and digitised the gathered field data and we structured different geomorphological maps in October 2015 and 2018.

3.3. Data Analysis

During our research, first, we described the geological situation in a larger study area based on former geological maps (Pelikán, 2002; Gyalog & Síkhegyi, 2005; Fig. 6) and we investigated Quaternary sediments using the deepened soil profiles of No. S1 and S3 in detail (Fig. 2–3). We have discovered different materials of sediments, sediment types and development processes in the horizons of soil profiles. After that, we surveyed our soil profiles of No. S1 and S3 using international Guidelines for Soil Description (FAO, 2006; Novák, 2013; Pető *et al.,* 2013) and we structured profile sections using by SURFER 9 and 13 programme. We observed soil formation factors; the appearance of genetic soil horizons; the soil colour, mottling, texture, soil structure, consistency, cementation and compaction, the rate of concentrations and carbonates; pH data of different horizons, the rate of biological activity and Human-made materials (Fig. 4–5). After summarizing of records, we determined the main soil types, soil types and soil subtypes in the case of investigated soil profiles. We took some photos from soil profiles as well. The data on soils were presented by using Microsoft Excel and Microsoft Word software (Dobos, 2015). Zsolt Mester and his colleagues took some soil samples for dating from these soil profiles in 2015.

We structured Digital Elevation Maps, slope category maps, terrain aspect maps and geomorphological cross sections based on SURFER 9 and 13 programs to analyse relief conditions and geomorphological levels in the wider study area. Sándor Molják (our young GIS colleague from Innoregion Knowledge Centre) prepared the digital maps for creating new ones and Anna Dobos structured GIS maps using Golden Software SURFER 9.0 and 13.0 software and ArcGIS 10.3 programme in 2015. The 1:10,000 scaled geomorphological map of the larger study area and Gyilkos Hill was structured in 2018 (Dobos & Mester, 2018). We used numerous symbols for different landforms, genetic types and landscape processes during structuring the geomorphological map. The tendency of changing land use system was pointed out using the 1st, 2nd, 3rd and 4th Military Survey Maps, the topographical map of 1990 and Google Maps of 2021, and 2022.

4. Results

4.1. Survey Data

4.1.1. Results of geological survey and Quaternary sediments, Geological fundamentals in the study area

First, we analysed the geological conditions for a larger study area among Eger, Andornaktálya, Egerszalók and Demjén settlements (Fig. 1) and after that, we investigated the geological built-up of the Gyilkos Hill so that we could understand connections among landscape factors better (Fig. 6).

The Egri-Bükkalja Foothill Area is built up with mainly Miocene volcanic rocks, acid rhyolite tuff series (Felnémet Rhyolite Tuff Formation, Gyulakeszi Rhyolite Tuff Formation, Harsányi Rhyolite Tuff Formation). The Gyilkos Hill is situated at the southern boundary of these volcanic series (Gyalog & Síkhegyi, 2005; Pelikán, 2002). The western part of the larger study area consists of mainly Miocene Felnémet Rhyolite tuff Formation and the eastern part of the study area is built up with Miocene Gyulakeszi Rhyolite tuff Formation and Oligocene Eger Formation. The territory is mostly built up with volcanic rocks (Fig. 6). From the centre of Andornaktálya settlement, the Pannonian sediments (clay, sand) being the remnants of the Pannonian sea appeared along valley slopes. The Pannonian sediments appear on western parts of the Gyilkos Hill and the southern parts of the study area (Gyalog & Síkhegyi, 2005). Quaternary proluvial and deluvial deposits appear in the southern parts. Holocene fluvial sediments (gravels, sands, silts, clays) are along Laskó Stream, Eger Stream, Ostoros Stream, Novaj Stream and bigger tributaries. At the summit of Gyilkos Hill, we can find Lower – Middle Pleistocene slope sediments and proluvial sediments. Slope sediments were accumulated by mass movements and characterized by unsorted, non-wheeled and mixed sediments. The proluvial sediments accumulated by streams changed their water level in the channel bed strongly during the periglacial climatic situation. There were torrents and they created a series of alluvial fans in front of the pediments. These sediments are coarse, non-sorted and non-wheeled, but they can contain finer grains as well (Gyalog & Síkhegyi, 2005).

Fluvial Quaternary (Pleistocene) sediment can be pointed out in the 175 cm thick layer investigating the geological and sedimentological conditions in the upper part of Gyilkos Hill, in the soil profile of No. S1 (Fig. 7). There is fluvial clay, rubble and bigger rounded fluvial gravel on the surface (0–15 cm in depth). The colour of the clay is dark grey (10YR 4/1), and the rate of carbonates is 0–2%. In the depth between 15 and 45 cm, we could find fluvial clay and rubble, their colour is very dark grey-brown and dark brown (10YR 3/2–3/3). The rate of carbonates in this layer is 2–10%. In the depth between 45 and 80

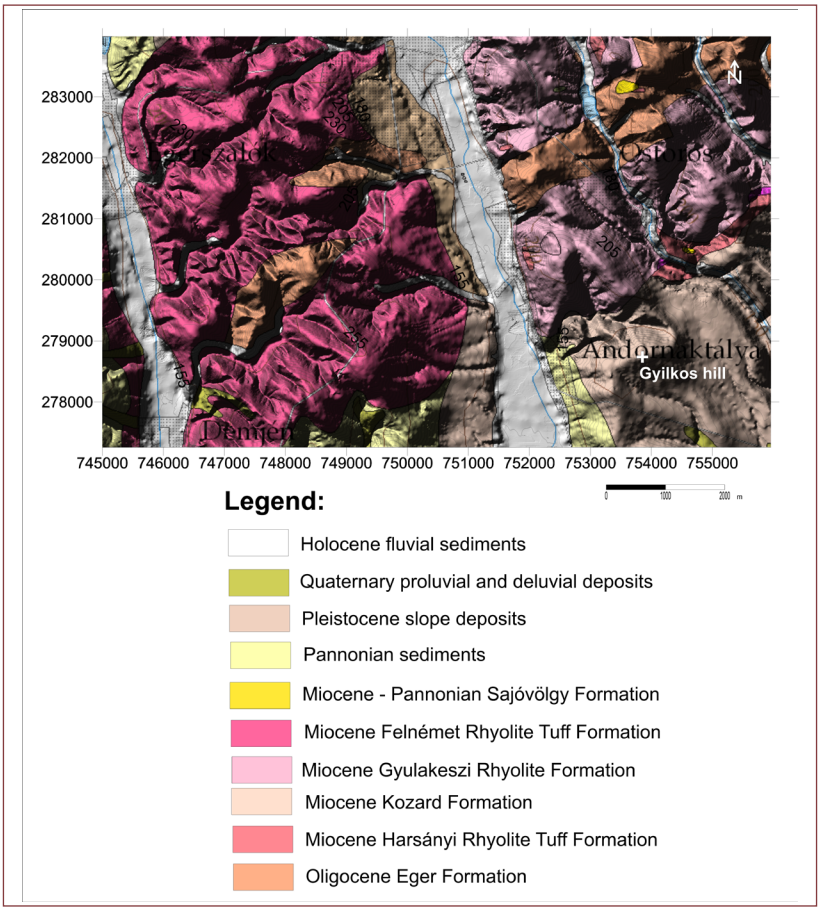


Figure 6. Geological map of the larger study area (prepared by the author, based on Gyalog & Síkhegyi, 2005, source: https://www.mbfsz.gov.hu)

cm, there are very dark greyish brown coloured (10YR 3/2) fluvial clay and rubble with a rate of carbonates of 10–25%. In the depth between 80 and 152 cm, we could find dark brown and very dark greyish brown (10YR 3/3-3/1) coloured fluvial clay, rubble and fluvial gravel. The rate of carbonates is 2–10%. At the bottom of the geological section, in a depth between 152 and 175 cm fluvial clay, rubble and fine-grained sand appear with a colour of dark yellowish brown (10YR 3/4). White-coloured (10YR 8/1) carbonate crack infillings can be found in this layer and its rate of carbonate is higher than 25%. These carbonate crack infillings and patterned ground inside the soil could show the effects of Würm periglacial processes. The upper 15 cm thick layer is a cultivated, damned layer. The mixed colours in the depth between 15 and 45 cm showed that this layer was affected by deep ploughing.

In the case of the geological and sedimentological conditions of the soil profile No. S3 situated in the upper part of the northern slope in a dell in Gyilkos Hill, we could point out fluvial Quaternary (Pleistocene) sediments (Fig. 8). There is finer-grained fluvial clay in the 180 cm thick geological section. We can find brown and very dark greyish brown coloured (10YR 4/3–3/2) silty clay in the upper, 19 cm thick layer. Its rate of carbonate is 0–2%. In depths of 19 and 40 cm, there is dark brown coloured (10YR 3/3) clay. The rate of car-

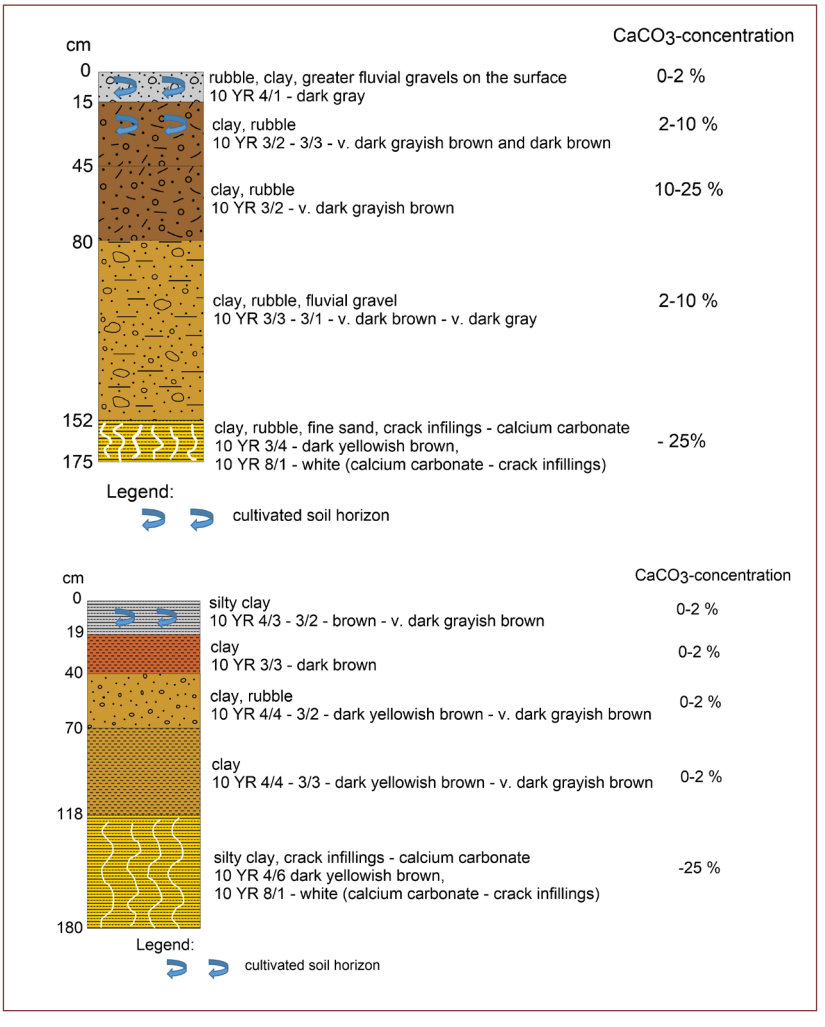


Figure 7 (top). Quaternary sediments and geological conditions of the soil profile No S1.

Figure 8 (bottom). Quaternary sediments and geological conditions of the soil profile No S3. Prepared by the author.

bonates is 0–2%. In the depth between 40 and 70 cm, there are dark yellowish brown and very dark greyish brown (10YR 4/4–3/2) fluvial clay and rubble. The rate of carbonates is 0–2%. In the depth between 70 and 118 cm, dark yellowish brown and very dark greyish brown (10YR 4/4–3/2) clay appears. The rate of carbonates is 0–2%. At the bottom of the section, in the depth between 118 and 180 cm, there is silty clay in which there are some white-coloured (10YR 8/1) carbonate crack infillings. The colour of the silty clay is dark yellowish brown (10YR 4/6). The rate of carbonates inside this layer is more than 25%. The carbonate crack infillings and the patterned ground inside the soil could show periglacial processes. The upper 19 cm thick layer of the section was cultivated, we can recognize some anthropogenic effects of the agricultural activity and this layer was mixed and disturbed.

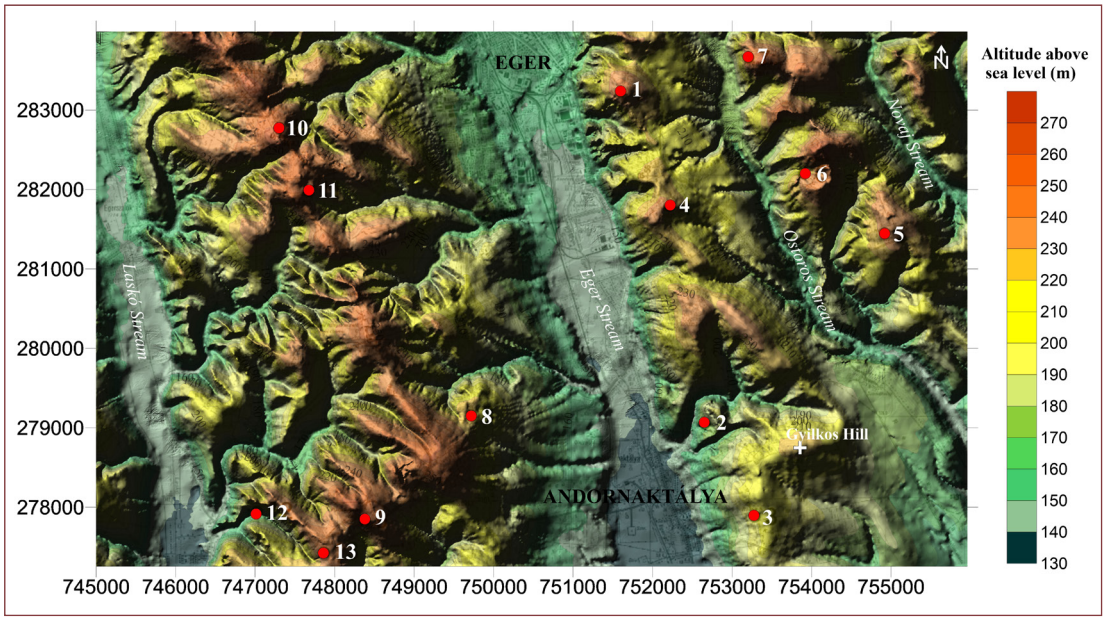
4.1.2. Results of geomorphological mapping

From a geomorphological point of view, the larger study area (Fig. 1, 9) is characterized by dual pediment surfaces, Pleistocene terraced flu-

vial valleys and wide Holocene alluvium in front of the Bükk Mountains (Dobos & Mester, 2018, p. 63, Fig. 1; Hevesi, 1978; Kleb, 1978; Pinczés, 1957a; Pinczés *et al.*, 1993). A dual, dissected pediment surface (Bükkalja region) can be found at the southern boundary of the Bükk Mountains in Hungary. There was more opportunity for the pedimentation at the margin of the Bükk Mountains in some periods, for example in the Miocene and at the boundary between Pliocene and Pleistocene periods too (Dobos, 2000, 2001; Hevesi, 1978, 1986, 1990; Martonné Erdős, 2000; Pinczés, 1968, 1970, 1980; Pinczés *et al.,* 1993; Vágó & Hegedűs, 2011). In the dual pediment surface of the Bükkalja, the older and more shattered pediment can be seen only at the summit of the hills (Sümegium-Bérbaltavárium period, 8.0–5.5 Ma ago), while the lower, extended and younger pediment surface (Villányium period, 2.0–1.8 Ma ago) gives the basis for the Quaternary landforms here (Dobos, 2001, 2002; Dobos & Mester, 2018; Pinczés *et al.,* 1993; Vágó & Hegedűs, 2011). During the Pleistocene period, main erosional valleys were created by fluvial erosion (Laskó Stream, Eger Stream, Ostoros Stream and Novaj Stream). The fluvial erosion was more intensive during the interglacial periods (Fig. 9). Two larger valleys are the Laskó and Eger valleys, they are developed under the geological fault line effects. While derasional tributaries were developed during the cooler glacial periods. They are smaller-sized and small u-shaped valleys. At that time, the gelisolifluction, frost activity and mass movements created steeper slopes along main valleys. The main erosional valleys are NW and SE direction and their tributaries are oriented along SW and NE direction. The basis for this valley development type is the geological conditions, different rock quality and effects of climate changes.

We have structured the digital relief map of the study area as well (Fig. 9). Here, we can see that there is a wide, young, Holocene alluvium along the Stream of Laskó and Eger and there is a smaller and narrow one along the Ostoros and Novaj streams. In some places, there are some alluvial fans next to the boundary of the Holocene alluvium. Here, the territory is accumulated with new younger sediments. Above the Holocene alluvium, we can find three Holocene and Pleistocene fluvial terraces along slopes (I. – Early Holocene terrace (H), II.a. – Holocene/Würm terrace (Q3w) and II.b. – Riss/Würm terrace (Q3) (Dobos & Mester, 2018, p. 63, Fig. 1). At the top of hills, there are younger pediments or older pediment surfaces. In the western part of the study area, the higher and older pediment surface (Sümegium or Bérbaltavarium pediment) is more characteristic. In the eastern part of the study area, the younger and lower pediment surface (Villanyium pediment) is relevant. Valleys were deepened into the younger pediment surface and it shows that our valleys were developed at the boundary of the Pliocene and Pleistocene periods. In this geomorphological system, the summit of the Gyilkos Hill is an eroded and lowered remnant of the younger pediment surface (the Villanyium pediment developed ca. 1.8 Ma ago) (Dobos & Mester, 2018, p. 63, Fig. 1; Fig. 10).

The slope angle map of the study area (in case of map precision is 110.69 m) shows that we can find slopes of 0–3° along main valleys (in the Holocene alluvium and lower Pleistocene fluvial terraces) and the southern part of this territory (Fig. 11). Slopes are characterized by slopes of 3–7° and at the top of hills can be found steeper slopes than 7–10° or 10–14°. Soil profiles No. S1 and S3 are in an area characterized by slopes of 3–7°. After creating a slope angle map of the study area (Fig. 11, in case of map precision is 5 m), we can find more dissected slope characteristics. In the whole study area, the territory of slopes of 0–3° is 25.1 km²; the territory of slopes of 3–7° is 23.1 km²; the area of slopes of 7–10° is 10 km²; the area of slopes of 10–14° is 7.8 km²; the area



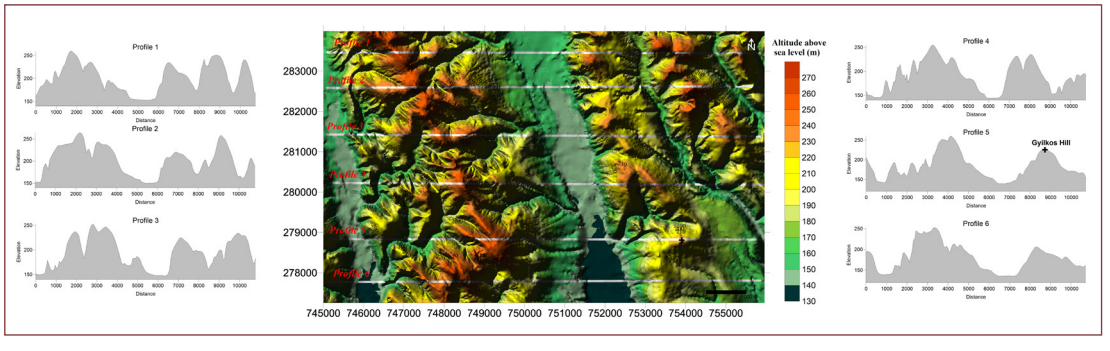


Figure 9 (top). Relief map of the study area with investigated soil profiles and Palaeolithic sites based on Mester 2010 research work by SURFER 13.0 (map precision is 5 m) (Dobos, 2015, based on topographic map from Institute of Geodesy, Cartography and Remote sensing). **Figure 10 (bottom)**. Cross sections of the study area by SURFER 13.0 (map precision is 5 m) (Dobos, 2015, based on topographic map from Institute of Geodesy, Cartography and Remote sensing).

of slopes of 14–24° is 7.1 km² and the territory of steeper slopes than 24° is 0.5 km².

Using the ArcGIS 10.3 programme, we structured another terrain aspect map (Fig. 12), where we can find that the most frequent slope types are slopes faced towards to east (19%), northeast (18%) and southwest (16%) direction. After that, slopes faced towards to south (12%), southeast (12%) and west (11%) directions are the second most frequent slope types in this area. The less frequent slope types are slopes facing towards to northwest (5%) and north (7%). The distribution of territory for different terrain aspect types belongs to the following. North: 5.4 km², Northeast: 12.8 km², East: 14.1 km², Southeast: 8.8 km², South:

9.0 km², Southwest: 11.6 km², West: 8.1 km², Northwest: 3.7 km².

According to Fig. 13, we can see, that there is a high–medium to high rate of soil erosion in the steep northern, northwestern, western and southwestern slopes. There is a low to medium rate of soil erosion along the gentle southwestern and western slopes and no erosion in the Holocene alluviums of main erosional valleys and lower and higher Pleistocene fluvial terraces. Nowadays, in case of the Gyilkos Hill, there is low and medium rate erosion along dells and heads of the erosion valleys and there is no erosion at the top of the hill.

4.1.3. Results of the description of soil profile No. S1 and S3

In the case of soil profile No. S1, which was covered by archaeologists, we could find a soil profile categorized as Chernozems based on the WRB soil classification system and Brown forest soils (main soil type), Chernozem brown forest soil (soil type), Carboniferous chernozem brown forest soil (soil subtype) and Carboniferous chernozem brown forest soil with medium humus layer (soil division) based on the Hungarian soil classification system (Dobos, 2015; Dobos & Mester, 2018).

In the soil profile No. S1. (Fig. 2, 15), the Asz-horizon (0–15 cm in depth) is a dark grey-coloured, arable horizon (10YR 4/1) without mottling. The soil-water status is dry. Its grain size composition is mainly fluvial clay with rubble and bigger fluvial rounded gravels on the surface. The soil structure is clay. The type of soil structure is mainly nutty subangular blocky type, the size of soil structure is very coarse/thick (>50 mm), and the structure of pedal soil material is weak. The granular, fine/thin (5–10 mm) sized soil structure can be found in the layer as well. The consistency of soil mass is soft, and the rate of cementation is non-cemented and non-compacted. The rate of the carbonates in the soil is 0–2%, slightly calcareous.

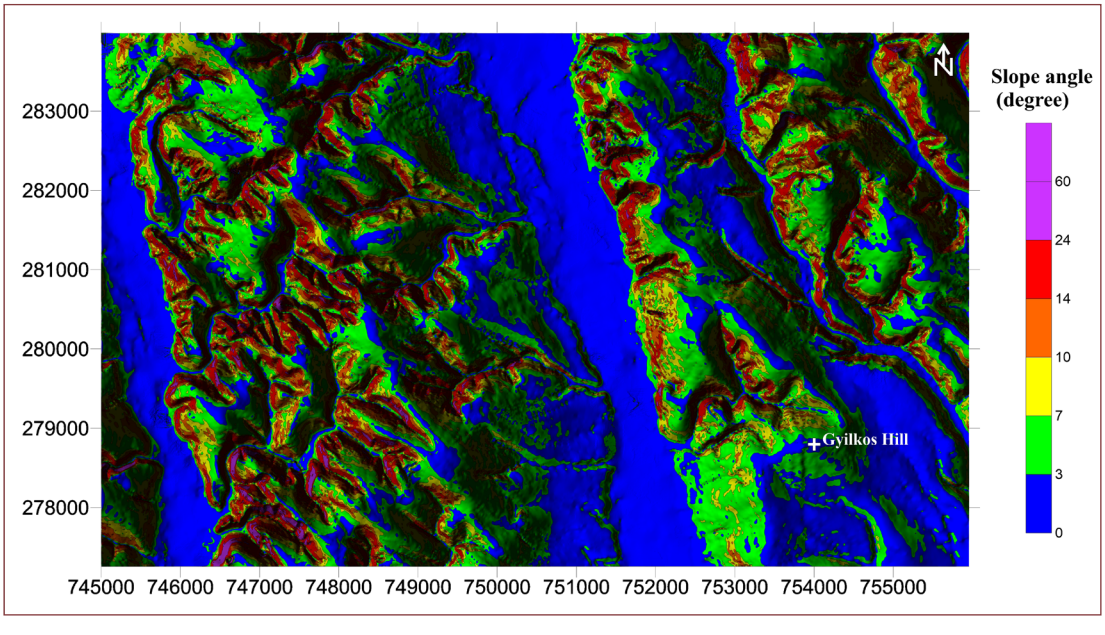


Figure 11. Slope angle map of the study area by SURFER 13.0 (degree/°) (map precision is 5 m) (Dobos 2015, based on topographic map from Institute of Geodesy, Cartography and Remote sensing).

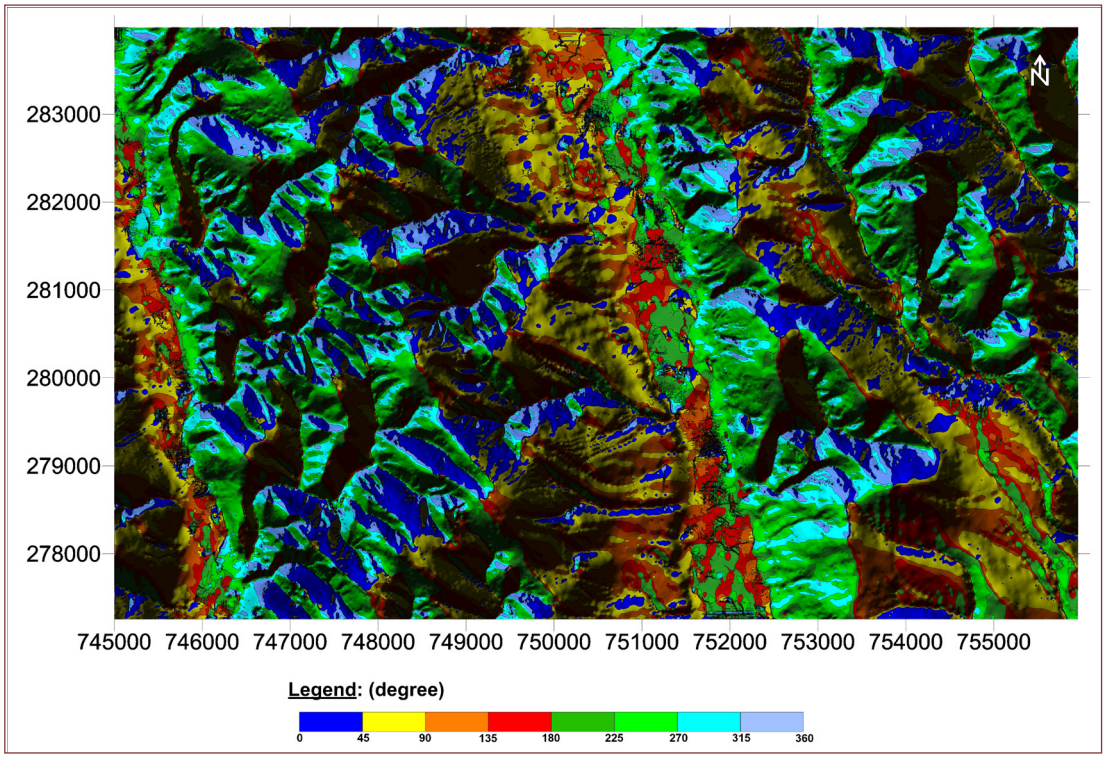


Figure 12. Terrain aspect map by ArcGIS 10.3 (degree/°) of the study area (map precision is 5 m) (Dobos, 2015, based on topographic map from Institute of Geodesy, Cartography and Remote sensing)

The A-horizon (15–45 cm in depth) is a very dark greyish brown and dark brown horizon (10YR 3/2–3/3) with few, very fine-sized (<2 mm), spotted mottles. The soil-water status is moist. Its grain size composition is fluvial clay with rubble. The soil texture is clay. The types of soil structure are blocky with coarse/thick (20–50 mm), medium (10–20 mm) and very fine/thin sized (<5 mm). The structure of pedal soil materials is moderate. The consistency of soil mass is hard. The horizon is weakly cemented, and the cementation materials are carbonates and clays. The rate of soil carbonate is between 2% and 10%. There are soft concretions: few carbonates (2–5%) and many clays (15–40%).

The B_1-horizon (45–80 cm in depth) is a very dark greyish brown coloured (10YR 3/2) horizon with few (2–5%) very fine-sized (<2 mm) spotted mottles. The soil humidity is moist and the grain size composition is fluvial clay with rubble. The soil structure is clay, and the structure of pedal soil materials is moderate. The type of soil structure is blocky with medium (10–20 mm) and very fine/thin sized (<5 mm). The soil mass consistency is slightly hard. The horizon is weakly cemented with carbonates. The rate of carbonates is 10–25%, strongly calcareous classified by soft carbonate concretions. The abundance of mineral concentrations by volume is common (5–15%).

The B_2-horizon (80–152 cm in depth) is a dark brown and very dark grey-coloured (10YR 3/3–3/1)

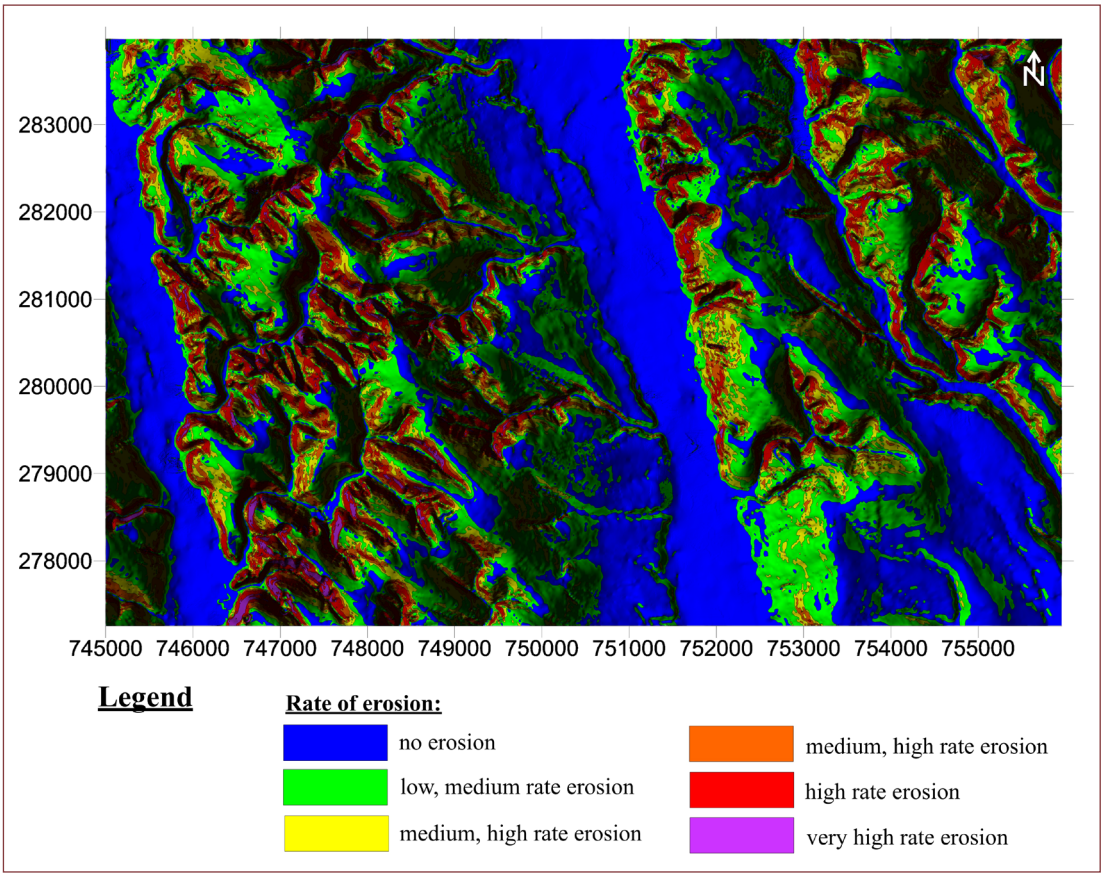


Figure 13. Rate of soil erosion by SURFER 13.0 (degree/°) (map precision is 5 m) (Dobos, 2015, based on topographic map from Institute of Geodesy, Cartography and Remote sensing)

soil horizon with many (15–40%), fine (2–6 mm) spotted mottles. The soil-water status is moist. The grain size composition is mainly fluvial clay with fluvial rubble and gravel. The soil structure is clay. The classification of the structure of pedal soil materials is without structure. The types of soil structures are medium-sized (10–20 mm) blocky and medium-sized platy (2–5 mm). The consistency of soil mass is hard. The horizon is weakly cemented by carbonates. The rate of carbonates is 2–10%, moderately calcareous. There are few (2–5%) soft carbonate concretions and abundant (40–80 %) clay inside the soil layer.

The C_k-horizon (152–175 cm in depth) is a dark yellowish brown coloured (10YR 3/4) soil with white (10YR 8/1) carbonate infillings in soil fissures. There are many (15–40%) very fine-sized (<2 mm), striped mottles. The soil water is moist. The grain size composition is mainly fluvial clay with rubble and fine sand. The soil texture is sandy clay. The structure of pedal soil materials is weak. The types of soil structure are fine-sized (5–10 mm) blocky and very fine-sized (<1 mm) granular. The consistency of soil mass is slightly hard. The rate of cementation is moderately cemented with carbonates. There are abundant (40–80%)

soft concretions, pore infillings and crack infillings in this layer (patterned ground). The rate of carbonates is more than 25%, extremely calcareous. There are abundant (40–80%) carbonate soft concretions, pore infillings and crack infillings and common rate (5–15%) clay.

In the case of soil profile No. S3, we could find a soil profile (01.09.2015) categorized as Chernozems based on WRB category and as Brown forest soils (main soil type), Chernozem brown forest soil (soil type), Carboniferous chernozem brown forest soil (soil subtype) and Carboniferous chernozem brown forest soil with medium humus layer (soil division) based on the Hungarian soil classification system too (Dobos, 2015; Dobos & Mester, 2018).

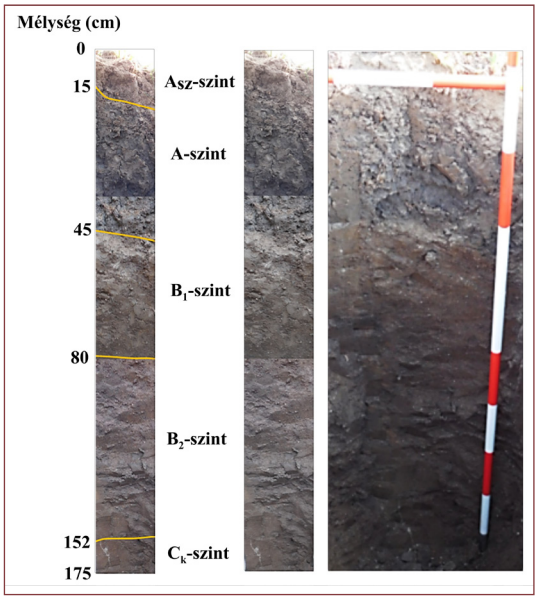
In the soil profile No. S3. (Fig. 14, 15), the Asz-horizon (0-19 cm in depth) is a brown and very dark greyish brown coloured (10YR 4/3–3/2) and arable layer. There are common (5–15%), very fine-sized (<2 mm) spotted mottles. The soil water is slightly moist. The grain size composition is fluvial silty clay. The soil texture is silty clay as well. The soil structure is weak with medium-sized (10–20 mm) nutty subangular blocky; fine-sized (5–10 mm) blocky and fine-sized (1–2 mm) granular types. The consistency of soil mass is soft. The soil layer is non-cemented and non-compacted. The rate of carbonates is 0–2%, slightly calcareous. There are very few (0–2%) carbonate soft concretions in this layer.

The A_1-horizon (19–40 cm in depth) is a brown and very dark greyish brown coloured (10YR 3/3) soil horizon with common (5–15%) and fine-sized (2–6 mm in diameter) spotted mottles. The soil water is moist. The grain size composition is mainly fluvial clay. The soil texture is clay. The soil structure is moderate type with fine-sized (5–10 mm) blocky types of soil structure. The consistency of soil mass is hard. This horizon is compacted but non-cemented. The rate of carbonates is 0–2%, slightly calcareous. There are very few (0–2%) carbonate soft concretions in this layer.

The A_2-horizon (40–70 cm in depth) is a dark yellowish-brown and very dark greyish brown (10YR 4/4–3/2) horizon. There are common (5–15%) very fine-sized (<2 mm) spotted mottles inside this layer. The soil-water status is moist. The grain size composition is mainly fluvial clay with rubble. The soil texture is clay. The soil structure is moderate type with fine-sized (5–10 mm) blocky type. The consistency of soil mass is hard. The rate of cementation is compacted but non-cemented. There are many (15–40%) carbonate concretions in this horizon. The classification of carbonate reaction in the soil matrix is 2–10%, slightly calcareous. The forms of secondary carbonates are soft concretions, in very small proportions (0–2%).

The B horizon (70–118 cm in depth) is a dark yellowish brown and dark brown coloured (10YR 4/4–3/3) soil layer with white carbonate infillings in soil fissures. There are common (5–15%) very fine-sized (<2 mm) spotted mottles inside this layer. The soil-water status is slightly moist. The grain size composition is fluvial clay. The soil texture is clay as well. The soil structure consists of it without structure type. There are very coarse-sized (>10 mm) platy types of soil structure. The consistency of soil mass is hard. The material of this layer is compacted but non-cemented. There are many (15–40%) carbonate concretions inside this layer. The classification of carbonate reaction in the soil matrix is between 0 and 2%, slightly calcareous. The forms of secondary carbonates are soft concretions here in very small proportions (0–2%).

The C_k horizon (118–180 cm in depth) is a dark yellowish-brown soil layer (10YR 4/6) with white (10YR 8/1) carbonate infillings in soil fissures. There are many (15–40%) very fine-sized (Ø<2 mm) spotted and striped mottles inside this layer. The soil-water status is moist. The grain size composition is fluvial silty clay with carbonate



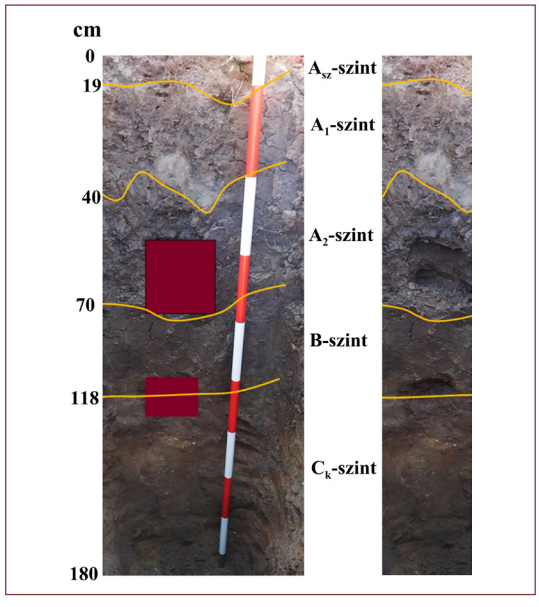


Figure 14 (left) and 15 (right). Soil profiles No. S1 (left) and No. S3 (right) (Chernozem brown forest soil – Chernozems) deepened on 1 September 2015. Prepared by the author.

infillings in soil fissures. The soil texture is sandy clay. The types of soil structure are very coarse (Ø>10 mm) platy types. The classification of the structure of pedal soil materials is weak type. The consistency of soil mass is slightly hard. The layer is weakly cemented with carbonates. Carbonate concretions (5–15%) and manganese soft segregation (5–15%) are present in usual proportions, and carbonate crack infillings or pore infillings are abundant (40–80%). The classification of carbonate reaction in the soil matrix is extremely calcareous (>25%). The forms of secondary carbonates are abundant (40–80%) concretions and pore infillings (patterned ground).

4.2. Interview Data and Discussion

We have investigated such landscape conditions in detail with a complex point of view which could determine the occupation at the Palaeolithic open-air site of Gyilkos Hill. During our research work, we have analysed a larger study area around Eger and Andornaktálya and the Gyilkos Hill site in detail as well. Look at what kind of new results appear according to our investigations. From a geological point of view, Gyilkos Hill is situated southward from the Miocene volcanic territory in the Bükkalja Foothill Area where Lower and Middle Pleistocene slope sediments and proluvial sediments were accumulated at the summit of the hill and its surroundings. We have discovered Pleistocene fluvial sediments in the deepened soil profiles situated next to the summit. There was patterned ground (a relict permafrost feature) with white carbonate crack infillings at the bottom of the soil profile of No. S1 (152–175 cm in depth) and fluvial clay, rubbles and gravel (80–152 cm in depth) then clay and rubble (15–80 cm in depth) accumulated above it. Rubble, clay and bigger gravel covered the surface (0–15 cm in depth). We could recognise the effects of agricultural activity (deep ploughing) in the upper 45 cm thick layer. In the case of the soil profile of No. S3,

patterned ground with white carbonate crack infillings appeared at a depth of 118–180 cm where the rate of carbonate was more than 25%. Above this layer, fluvial clay (70–118 cm depth), clay and rubble (40–70 cm depth) then fluvial clay (19–40 cm in depth) were deposited. There was silty clay in the upper 19 cm thick layer where the effects of agricultural activity were recognized as well. At the bottom of soil profiles, patterned ground with white carbonate crack infillings was characteristic (Fig. 7–8) and it was covered by fluvial sediments. The patterned grounds show cold periglacial climatic conditions, while fluvial sediments show warmer climatic conditions here. The fluvial sediments were dated with 38.2±3.8 ka (120 cm) and 24.4±2.5 ka OSL data (Budek *et al.,* 2013). The periglacial effects of the Würm glaciation could be pointed out in this territory (Fábián *et al.,* 2014, p. 723, Fig. 1, p. 727, Fig. 3; Mester, 2010, p. 43, Fig. 4).

In the geomorphological system, the Gyilkos Hill is an eroded and lowered remnant of the younger pediment surface (Pl/Q) (the Villanyium pediment developed ca. 1.8 Ma ago) (Dobos & Mester, 2018). We can see in Fig. 9–11 and 13 that the surface with a gentle slope situated in the Gyilkos Hill and the northern pediment areas was the basic level for the valley deepening processes and development of younger Pleistocene terraced valleys. The erosional tributary system situated north-northwestward from Gyilkos Hill was dissected at this basic level too. The summit of the Hill is not eroded nowadays (Fig. 13). The mixed and disturbed soil layer was caused by agricultural activity (Fig. 7–8). Along the slopes, dells and erosional valley heads show low or middle-rate soil erosion (Fig. 13). Dells were developed under the cold periglacial conditions while erosional valley heads appeared under the warmer and wetter climatic situation. The northern and southern slopes of the Gyilkos Hill were formed by headward cutting erosion of tributaries of Eger Stream and Ostoros Stream. Along the north slopes, we could recognise smaller erosional cuts showing a more intensive Holocene erosion rate. The Palaeolithic site of Andornaktálya, Zúgó-dűlő is situated next to the Gyilkos Hill (Mester, 2010). Its landform is a fluvial terrace No. II.b. (Riss/Würm: ca. 160–110 ka BP, Gábris, 2013; Hevesi & Ringer, 2003–2005). The archaeological findings showed the Epi-Aurignacian culture with dates of 28.0–24.5 ka BP in the upper 50 cm thick layer. The age of the A-horizon of paleosoil found at 50–150 cm in depth was 30,180±330 BP (Budek *et al.,* 2013). In the C-horizon, we could see the patterned ground indicating cold periglacial climatic conditions. The mapped fluvial terrace of No. II.b. gave a basis for the recognition of different geomorphological levels, and summits in the larger study area (Dobos & Mester, 2018, p. 63, Fig. 1).

Described soil profiles (soil profile of No. S1 and S3) deepened in the Gyilkos Hill categorized as Chernozems based on the WRB category and as Carboniferous chernozem brown forest soil with medium humus layer (soil division) based on the Hungarian soil classification system. This soil type has a medium fertility rate. This soil type could be the remnant of the forested processes from the Late Glacial warmer period.

From an archaeological point of view, the archaeological raw materials and other finds were found at the surface and in the ploughed soil layer. The findings show the remnant of the Aurignacian culture (35–28 ka BP; OSL data: 9.6±0.1 ka; Upper Palaeolithic period/Würm glaciation). According to the vegetation, the area of Gyilkos Hill could be covered by cool continental steppe and tundra vegetation (Molnár *et al.,* 2018).

5. Conclusion

In this article, we have investigated the Gyilkos Hill Palaeolithic open-air site based on a more detailed landscape-geographical point of view. The applied geological, Quaternary sedimentologi-

cal, soil-science and geomorphological research methods have given new results in this theme. We could survey the local site from a wider perspective because we analysed a larger study area so that the connections among different landscape factors became clearer. Our results have shown that people living here during the Aurignacian culture (Upper Palaeolithic period / Würm glacial period) settled down in a higher, separated, lowered pediment surface surrounded by Eger Stream and Ostoros Stream where slopes were dissected by dells and erosional valley heads. This summit could be well protected, was safe and could give suitable conditions for living place for ancient people. The larger environment could ensure the possibility of getting enough food and the lifeblood water was near because of streams. The surrounding area was foreseeable enough from the summit of the hill so this place was a good strategic point as well. That is why, the archaeological field trips and works could discover well-recognizable and used Palaeolithic open-air sites here.

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In August 2012, in a gravel mine near Mokrzeszów, Silesia, searching for Baltic erratic flint. Thanks to the International Visegrád Fund, in 2011 and 2012, within the framework of international cooperation, it was possible to get up close and personal with the sources of siliceous rocks found in domestic prehistoric sites, in the countries bordering the Carpathians, Hungary, Poland, Slovakia and Ukraine. The project led by Zsolt Mester turned out to be extremely fruitful, the 21 research trips organized in four countries, the 64 days spent in the field, the 20,000 kilometres travelled and nearly 100 raw material deposits resulted in a lithic collection, which still forms the backbone of education and research focusing on knapped lithics in the ELTE Institute of Archeological Sciences. *Photo: Norbert Faragó.*



Technological observations on the bifacial point from the Copper Age cemetery of Rákóczifalva

7

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Abstract. The subject of this study is a bifacial point found in the symbolic grave no. 218/230 at the Copper age site of Rákóczifalva-Bivaly-tó 1/C. In the lack of use-wear analysis the denomination „bifacial point" seemed more accurate, as other terms, such as arrowhead, spearhead, or dagger are rather functionally determined. Besides the description of the find, its archaeological context, and the outline of the possible analogies, the study focuses on an exhaustive technological analysis.

This analysis relied on the detailed observation of the consecutive steps and techniques realized during production. The main goal was to directly shed light on the circumstances of the preparation, the location, and the maker of this artefact. Indirectly, the study offers additional clues on the extended contacts and the technological innovation of the bifacial technique experienced during the Copper Age. According to the results, it is more probable that this point was manufactured off-site, because not just its raw material, but high-quality craftsmanship, and cultural tradition manifested in its find context represent strong connections with Northern Bulgaria.

Keywords: Knapped stones, Bifacial technology, Balkan flint, Copper Age, Bodrogkeresztúr culture

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1. Introduction

The end of the Late Neolithic saw fundamental changes in the area's economic, social and cultural characteristics. Significant new features in the knapped stone material could be observed with the abandonment of tells and the appearance of large-scale cemeteries (Kaczanowska, 1985; T. Biró, 1998; Kaczanowska & Kozłowski, 2015). Some of these phenomena, which became general in the Copper Age, had already appeared in traces in the Carpathian Basin in earlier periods of the Neolithic.

1.1. Stone tools in Neolithic graves in Hungary

The first of these phenomena is the placement of knapped stones in graves, as grave goods, especially intact blades and blade fragments. Although it seems natural, given the increasing frequency of cemeteries during the Copper Age, that the place where artefacts were found is more likely to be linked to graves, this is not an obvious cultural element in the case of the knapped stones. Yet, in the Great Hungarian Plain, this custom can be dated as early as the Middle Neolithic period, and in a rather distinctive and consistent form (Whittle *et al.,* 2013, p. 75; Oravecz, 1996; Faragó *et al.,* 2015). In the Transdanubian region, a similar trend emerged in the *Linearbandkeramik* (LBK) period (Oross & Marton, 2012; Fábián *et al.*, 2007). In the next period, during the Lengyel culture, the use of cemeteries with a large number of graves became a prominent feature west of the Danube, and the practice of placing knapped stones in the grave became more common (Bácskay, 1989, 1990; Zalai-Gaál, 2010, pp. 114–122; Zalai-Gaál *et al.*, 2011). So far, little is known about the characteristics of the stone grave goods from the Great Hungarian Plain, and in most cases, only the presence or absence of such objects, or their raw material, is known from the literature (Siklósi, 2013). The exception is Polgár-Csőszhalom, where 20 graves from the outer settlement have shown that the knapped stone is an attribute of young middle-aged men (30–40 years) and that trapezes, truncated or simple blade fragments and intact blades were typically placed next to them (Faragó, 2017, 2019).

1.2. The Volhynian/Prut flint

The second phenomenon, which is specific to the Hungarian Copper Age stone assemblages, is the widespread occurrence of a specific raw material, the so-called Volhynian/Prut flint. It would be necessary to distinguish between the two names since although both raw materials originate from similar Cretaceous environments, they occur in somewhat different geographical areas and there are differences in their origin (Rhyzov *et al.,* 2005, Fig. 3; Crandell & Vornicu, 2015, Fig. 1–2). Macroscopically, both are very similar, ranging in colour from dark grey to whitish, and may be translucent, homogeneous or even banded, but they are uniformly fine in texture, with a white crust consistent with Cretaceous limestone. As no attempt has yet been made to separate the sources of these two raw materials in Hungarian finds, it is worth referring to them as Volhynian/Prut flint. Although this raw material is already found among Palaeolithic finds in Hungary (T. Dobosi & Kövecses-Varga, 1991; Kozłowski *et al.,* 2009, p. 418; Mester & Kozłowski, 2014, p. 356), the data dating to the middle Neolithic are important for our purposes.

Examples of these are Gerla-Kászmán, Felsővadász-Várdomb, Ináncs-Dombrét, Szécsény-Ültetés (T. Biró, 1998, pp. 39, 44, 45), and Borsod-Edelény (Kaczanowska, 1985, p. 59). In Late Neolithic research, the name of the Volhynian/Prut flint is now associated with the Berettyóújfalu-Herpály site and the culture it marks (Kaczanowska, 1985; T. Biró, 1998; Raczky *et al.*, 2020). This also indicates the intensification of the trans-Carpathian links, as this raw material constitutes more than half of the knapped

stone assemblage at this site. At other Late Neolithic sites in the Great Hungarian Plain, such as Polgár-Csőszhalom, Polgár-Bosnyákdomb, Öcsöd-Kováshalom, Pusztataskony-Ledence or Hódmezővásárhely-Gorzsa, this intensity is not even comparable, yet it is a common component of these assemblages also (Kaczanowska *et al.,* 2009; Kaczanowska & Kozłowski, 2015; Starnini *et al.,* 2007, 2015; Faragó 2017, 2019, 2021; Sebők & Faragó, 2018). From the Early Copper Age onwards, this raw material became an indispensable accompaniment to the ensembles of male graves (Bognár-Kutzián, 1963), although the domestic recognition of the source area was somewhat later (Kaczanowska, 1985).

1.3. Points made with bifacial technology

The third prominent feature that can be associated with the Copper Age stone assemblages is the emergence of bifacial tools and technology. This type of object and tool-making tradition has no clear local antecedents in the Carpathian Basin, but paradoxically it can be said to have been reinvented, since bifacial stone tool-making, along with pebble and flake industries, was present in Europe and our narrower region for thousands of years (Gábori, 1976, pp. 157–185). At the peak of the last glaciation, even the leaf points that were typical of our country gradually disappeared, and this tool type and tool-making method were completely forgotten for almost 20,000 years (Lengyel & Mester, 2008; Lengyel *et al.,* 2016). Stone tools that functioned as points during the Epipalaeolithic and Mesolithic in Western and Northwestern Europe showed a very diverse pattern, but they were not made using bifacial technology (Rozoy, 1989). Geometric microlith points were later traced back to the LBK of Western Europe (Gronenborn, 1997, pp. 100–102; Marton, 2011, p. 175).

For us, however, it is the bifacial points that are of interest, which seem to have re-emerged in Eastern Europe and the Balkans in the Late Neolithic along two different traditions (Marton, 2011, pp. 169–175). Of these, the rhombic-shaped, tanged tools were largely distributed in the Western Balkans and along the Adriatic and Aegean, and date mainly to the Butmir period (Marton, 2011, p. 173). Another tradition, associated with elongated triangular and larger leaf-shaped points, links the Bulgarian-Romanian areas with the northern Pontus, i.e. the Kodžadermen-Gumelniţa-Karanovo VI complex is closely associated with the Sălcuţa and the Pre-Cucuteni, Cucuteni-Tripolje circle (Marton, 2011, p. 169). In both spatial and temporal terms, Serbia formed the borderland between the two regions, where tanged, shouldered pieces dating to the Late Neolithic and associated with the Vinča culture still show the influence of the Adriatic (Šarić, 2005, p. 14, Fig. 2). At the beginning of the Early Copper Age, this trend was reversed and similar leaf-shaped points without tang began to appear in the Serbian assemblages.

1.4. Basics of the technological analysis

Technological analysis is in practice the deconstruction of the steps in the making of an object based on the recognisable features of the object. In the case of stone tools, we are in the fortunate position that each step leaves behind marks, so-called stigmata, which can be read by the specialist (Inizan *et al.,* 1999; Holló *et al.,* 2004). For this analysis, therefore, it is not necessary to have all the pieces in place, it is enough to study only the remaining removals and negatives. The reconstruction that occurs in the mind of the researcher is called mental reconstruction, refitting. More importantly, such an investigation does not only mechanically reveal and record the steps of making, but also interprets the intention behind these steps, which is equally constrained by the physicochemical characteristics of the raw material, the defining characteristics of the

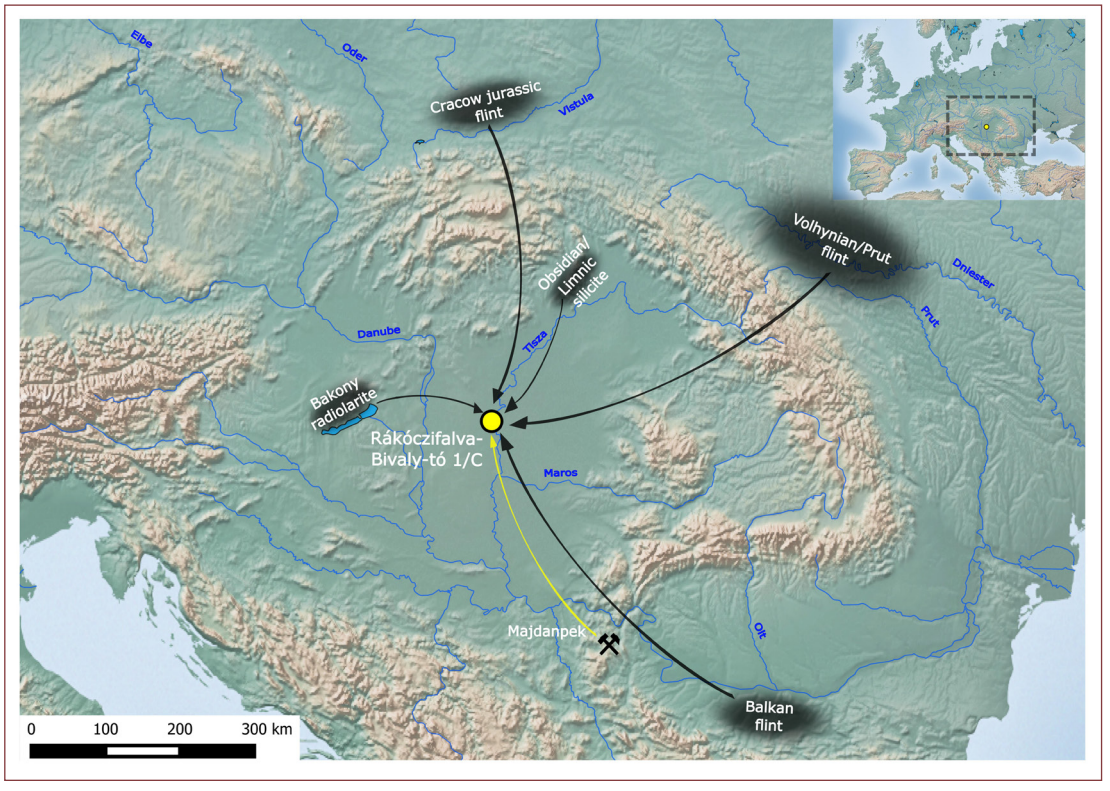


Figure 1. Location and connectivity of the Rákóczifalva-Bivaly-tó 1/C site with regions outside the Carpathian Basin based on the raw materials of the knapped stone and copper artefacts (prepared by the author after Siklósi *et al.*, 2022).

maker (motor skills, acquired experience), and the customs of the community that includes him (Tixier, 2012, pp. 39–42).

The theoretical background developed by the so-called paleoethnological school from the 1960s onwards (Delage, 2017) helps to reveal the intention behind each step. Accordingly, the process of transforming an idea into the physical reality of an instrument can be examined through several phases. The first phase is to examine the concept, the idea, to which the future object must resemble. The mental image that exists in the mind of the maker of the object, its size, its shape is the conceptual scheme (*schéma conceptuelle*) (Inizan *et al.*, 1999, pp. 14–15; Holló *et al.*, 2004, p. 78; Mester, 2014, p. 43). The next phase is the set of theoretical and practical knowledge that is available to the members of the community to manufacture the product. It contains the different stages of making and the practical knowledge associated with them and is called the operative scheme (*schéma opératoire*). Ideally, a tool should be made according to the two stages described above, but in reality, few such cases exist. The actual sequence of events is to be revealed by the examination of the sequence of operation (*chaîne opératoire*). In archaeological practice, all three phases have their typical research methods: morphometric statistical methods are intended to reveal the conceptual scheme, the study of the different technological categories and their proportions helps to reconstruct the operational scheme, and the meticulous study of

individual finds and their stigmata provides important information about the sequence of operations (Mester, 2014, pp. 45–47).

When analysing an archaeological artefact, we follow the same path as its maker, but backwards. First, we have to look at the specific sequence of operations, with all its steps. The more related objects we can examine, and the more phases they show, the more we can approach the community's theoretical toolmaking method, the operational schema. Finally, if we look at the tools made, their formal and morphological characteristics and common features, we can see the theoretical schema in practice.

2. Materials

2.1. The site and the finds

Starting in 2005, for two years, in connection with the Vásárhelyi Plan, the Institute of Archaeological Sciences of ELTE and the archaeologists of the Damjanich János Museum in Szolnok jointly excavated the border area southwest of Rákóczifalva, called Bagi-föld (Csányi *et al.,* 2009, 2010; Siklósi *et al.,* 2022). In the 100–120 m wide and about 200 m long zone of the site 1/C (Fig. 1–2), Marietta Csányi and Judit Tárnoki succeeded in excavating a contemporaneous settlement and a cemetery, which together can be classified as belonging to the Early-middle Copper Age. It is a fortunate circumstance that both the settlement and the cemetery were well separated in space so that practically both were fully excavated. The settlement was located in the northwest corner of the relevant strip, the cemetery was excavated to the southeast of it, after a gap of about 120–140 metres. Here, 79 graves, arranged in two regular groups in the central part of the section, were uncovered. Of the two groups of graves, the western one is the larger, with more or less regular NE–SW alignments. The eastern group was much smaller, with about a dozen graves. The most recent results suggest that the two groups of graves were established at different times, one after the other, the western being the earlier (used between 4345 (68.2%) 4270 cal BC and 4300 (68.2%) 4225 cal BC), while the eastern was later (used between 4250 (68.2%) 4100 cal BC and 4150 (68.2%) 4015 cal BC) (Siklósi & Szilágyi, 2020, p. 605). The settlement was probably used between 4380 (68.2%) 4285 cal BC and 4295 (68.2%) 4125 cal BC, so it is more likely to be contemporaneous with the Western group.

Generally speaking, the number and nature of the grave goods presented a mixture of the Copper Age Tiszapolgár and Bodrogkeresztúr culture, both have already been discussed in detail in previous research for decades (Bognár-Kutzián, 1963; Patay, 1974; Siklósi & Szilágyi, 2021; Siklósi *et al.,* 2022). From this point of view, it is important to mention the characteristic net-patterned 'milk jug' shaped vessel, which was found in about half of the graves, or the gold plate pendants, copper picks, daggers and bracelets (Csányi *et al.,* 2009, pp. 22–24). The latter finds were also subjected to archaeometallurgical analysis, which proved that their raw material originated from the Majdanpek mine area in Serbia (Siklósi & Szilágyi, 2019).

Moving on to the knapped stone finds, here too there was ample evidence of long-distance links. Almost 60 per cent of the 108 knapped stones found were made of the Volhynian/Prut flint already mentioned. A further blade could be made of Cracow Jurassic flint or Chocolate flint, which represents a distance of about 350-450 km from the source of the raw material (Krajcarz *et al.,* 2012; Lech *et al.,* 2011; Werra & Siuda, 2022). The rest of the finds, about 30 pieces, are from the North Hungarian Range, with a mixed raw material of limnic silicite or obsidian (Mester & Faragó, 2016; Szepesi *et al.,* 2018), while four pieces represented radiolarites from the Transdanubian Bakony Mountains (Szilasi, 2017). A total of two finds suggest southern connections, one of them

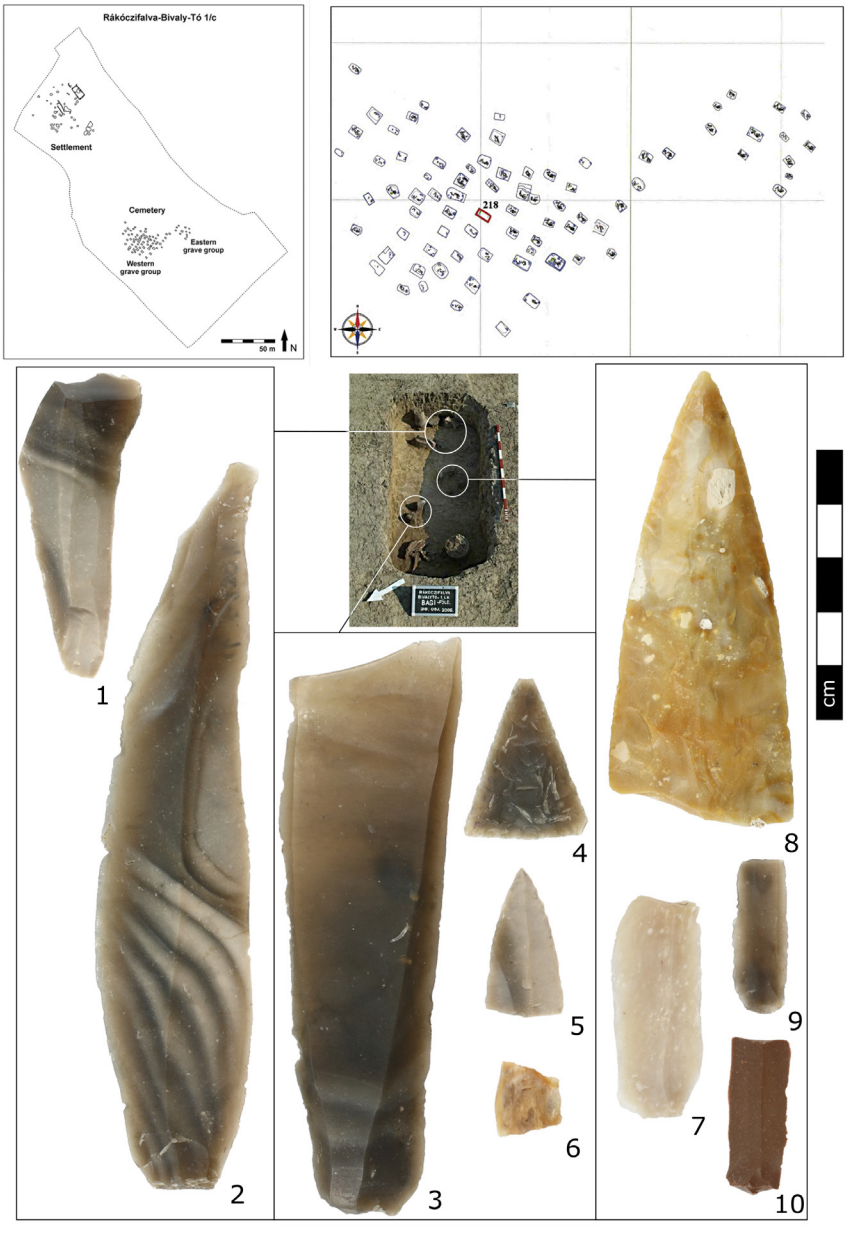


Figure 2. Location of the settlement (top left), burial groups and the symbolic grave (top right). The knapped stone grave goods of the latter are (bottom): 1 – laterally retouched blade, 2 – unretouched blade, 3 – laterally retouched blade fragment, 4 – bifacial point, 5 – laterally retouched blade fragment (point), 6 – trapeze, 7 – unretouched blade, 8 – bifacial leaf point, 9 – unretouched blade fragment, 10 – laterally retouched blade fragment. (prepared by the author after Csányi *et al.*, 2009 and Siklósi & Szilágyi, 2019).

made of Banat flint and the other of Balkan flint. The natural occurrence of the former is more than 200 kilometres away (Băltean, 2011), while the latter my be from 450 up to 650 kilometres away from Rákóczifalva (Gurova *et al.*, 2016a, Fig. 1).

A brief description of the technological characteristics of the pieces found in the cemetery and the site shows that neither site reflects intensive stone tool making. Nowhere were cortical pieces characteristic, just as there were no cores or core remnants throughout the site. However, in two cases, broken blades were placed in the graves that bore the marks of a *languette* break, so they were almost certainly the product of the same workshop and process.

According to the classical typology, the vast majority of the 63 artefacts in the assemblage can be classified as tools. Among them, the most common type is the retouched blade, of which 26 were found. The second largest group is that of bifacial points (13 specimens), which may have a straight or concave base, but with a few exceptions are made of obsidian. One of them is unique in Hungary, as a large bifacial point made of Balkan flint was found in the symbolic grave mentioned above.

The grave itself was located in the centre of the western group of graves, roughly in the middle of a small space left between two rows of graves (Fig. 2). The eastern side of the rectangular grave pit contained a net-patterned milk jug and a small cup, as well as a Jászladány-type copper axe-adze (Siklósi & Szilágyi, 2019), a copper awl, animal remains, a large blade (Fig. 2: 2) and a smaller retouched blade (Fig. 2: 1). The other knapped stone tools were found roughly along the central axis of the grave pit, of which, together with the aforementioned bifacial leaf point (Fig. 2: 8), a total of 10 were placed in roughly three distinct groups. These included an additional bifacial point made of Volhynian/Prut flint (Fig. 2: 4), a triangular point (Fig. 2: 5), a trapeze (Fig. 2: 6), and retouched and intact blades (Fig. 2: 3, 7, 9, 10). The greater part of the artefacts was of Volhynian/Prut flint objects, but in some cases, there were also pieces of limnic silicite and radiolarite. On the western side, a pot with a knob ornament and additional animal bones were excavated. No human remains were found, but the copper objects and the stone tools suggest a symbolic male tomb (Csányi *et al.*, 2009, p. 25). Generally, stone tools were buried with three exceptions only with men, and only four men are known to have been buried without such objects. A bifacial point, however, was an attribute of men only, and two such objects were found in the corresponding grave. One of them is a small point, which is common for the period, while the other, a large bifacial leaf-shaped point, is unique for the Hungarian Copper Age.

2.2. Description and classical typo-chronological definition of the subject

Identification: fragment of a bifacial leaf-shaped point made of yellowish-coloured, white-spotted flint (Balkan flint) (Fig. 2–3).

Description: Fragment of an elongated, regular triangular leaf-point, oval in cross-section, both edges slightly curved, convex, diagonally broken at the base, partially worked, with bifacial retouch on both the dorsal and ventral sides. Raw material: flint (Balkan stone)

Dimensions: (length × width × thickness): 86 × 35 × 7 mm.

The denomination of the artefact throughout this paper is deliberately not arrowhead, spearhead or even dagger, as these terms already indicate a specific usage. However, the definition of the actual function is problematic even with the analysis of the traces of use, and the boundary between arrowheads and spearheads is not clear typologically or metrically (Boyadzhiev, 2015, pp. 108–109). The position in the grave may give some indication of its former use, but it could also add to the confusion, as this bifacial point was found

close to the axis of the grave, in the middle. If we accept the interpretation that our grave symbolizes a male grave, then our point was placed at the waist, with the point towards the feet.

Until the last decade, the name of Balkan flint, the raw material of the bifacial point, gave rise to many misunderstandings (Biagi & Starnini, 2010, p. 124; Gurova, 2012, pp. 15–19, Gurova *et al.*, 2016a). The raw material, which appears under various names in the literature (Pre-Balkan platform flint, Balkan flint, honey-brown flint, Banat flint, silex blond), containing honey-yellowish, white specks and patches, was not necessarily understood by all researchers to mean the same thing, while the exact origin of the rock was also questionable until the 2000s. According to research carried out in recent decades, Bulgaria is home to several types of calcareous rocks, of which Balkan calcareous rocks are those from the Upper Cretaceous (Campanian and Maastrichtian) period (Moesian flint), which occur in the area of the Bulgarian plate in the pre-Balkan region. On the other hand, in the same area of the Bulgarian Plate, macroscopically very similar but different geological age Lower Cretaceous (Aptian Era) rocks (Ludogorie/Dobrudzha flint) are also present (Gurova, 2012, pp. 27–28). The geochemical and instrumental investigations carried out so far have demonstrated that the Moesian flint rocks from the wider region of Nikápoly/Nikopol on the Danube were certainly used from the Early Neolithic in Bulgaria until the Late Neolithic, and thus, according to some opinions, can be called Balkan flint (Gurova *et al.*, 2016a, Gurova, 2018). At the same time, the 'super-blades' of the Bulgarian Copper Age, produced by pressure techniques, which are widespread in the Bulgarian Copper Age and which are characteristic of both the Varna graves and the sites belonging to this period, can be linked to the more distant Ludogorie/Dobrudzha flint of northeastern Bulgarian origin (Biagi & Starnini, 2010; Gurova *et al.*, 2016b). The question as to which raw material variant is associated with the bifacial point of Rákóczifalva cannot be decided now, so it is best to keep the definition simply Balkan flint.

The typological classification of the artefact is also problematic, since the different Bulgarian types serving as parallels were separated based on purely morphological features (Boyadzhiev, 2015, pp. 173–174; Lichardus & Lichardus-Itten, 1993, pp. 24–26). The object of our study, however, is fragmented, so one of the most important typological traits, the nature of the base and the formation of the lateral edges near the base cannot be fully investigated. Still, there are several arguments in favour of placing the bifacial point in Kamen Boyadzhiev's typological system in Group IV or VI. On the one hand, the convexity and general curvature of the edges of these types are identical to those of the Rákóczifalva specimen, and on the other hand, Group IV is the most frequent in Bulgaria in terms of the total number of bifacial points found (30%).

2.3. Technological study of the bifacial leaf-point

When examining the operational chain, the chronological order of the removals on both sides of the bifacial point was determined (Fig. 4). The colours shown in the figure represent a chronological order, i.e. the darker the tone of removal on the tools, the later it may have occurred. For adjacent, side-by-side separations, this means the exact sequence of steps, where the exact order of shaping can be determined. However, the further apart the negatives are, the more difficult it is to establish their relationship in time. In the case of unrelated, distant removals, the colours are indicative only, indicating the earliest possible time of the removal. Accordingly, distant negatives of the same colour do not necessarily imply simultaneity. From this point of view, the chronological relationship between the two faces of the object cannot be clarified.

Starting the analysis from the left face in Fig. 4, the negative of the earliest removal (in a light colour) is diagonally positioned in the lower third of the piece, starting from the right side in the middle. Although this flake was struck from the direction of the right edge, all subsequent detachments were made from the left edge, i.e. the maker gradually moved towards the tip of the artefact. On the other side, continuing in the opposite direction along the right-hand edge, a more definite timeline emerged, with the negatives following each other more clearly until the middle of the edge. Here it is apparent that further adjustments were needed, so here there was a lot more negative following each other. At the same time as these removals, further thinning of the point near the base of the right-hand edge also took place. Starting from the centre, the central curve of the edge was formed, with the final retouching towards the tip. On the left-hand edge, partly at the same time and partly a little later, a completely different strategy unfolded, where the earliest, larger removals seem to have thinned the bifacial point to just the right shape, so that only short, staged adjustments were necessary, which could be broken down into three stages. Two of these were clearly from the top towards the base. The final retouching on this side also involved only short sections and was *ad hoc*.

The design of the other face follows the same method at first glance and in broad outline, which suggests a practised, learned pattern of the knapper. However, a closer look reveals the high degree of skill with which the knapper has adapted to changing circumstances in the making of the tool, drawing on what is presumably decades of experience. Here again, the direction of progression started from the left edge and then continued on the right side closer to the tip, until the current base. Adjustments were again made to the middle section, with a long and then a shorter thinning section starting from the tip. Thirdly, the middle section had to be retouched again and the distal end had to be shaped to its final form. The left-hand edge also took its final shape a little later, here a little more shaping was needed near the apex than on the previous side, but in any case, the discontinuous, fan-like thinning is again observed. Near the base, this edge shows the fine interventions of the previous side, and the final, phased retouching of the edge completes the finishing of the instrument.

To reconstruct the operational scheme, we would need additional artefacts that would reveal the exact process of making. These could be pieces of raw material, semi-finished and spoiled pieces left unfinished at various stages of manufacture, small or large removed fragments and worn broken points. At this site, neither in the graves nor on the settlement, we have no such removals at all. Taking the total number of negatives visible on both sides of this piece (269!) and adding those that are no longer visible, it is easy to see that the production of such a bifacial point would have involved a considerable amount of by-products. At the same time, the more or less static process required to produce a bifacial point is known from published examples of other regions and sites that are richer in this respect, as well as from experimental archaeology. One operational scheme, based on experimental archaeology related to Scandinavian bifacial artefacts, is as follows (Apel, 2008, p. 103, Fig. 3–4). The first phase requires suitable pieces of raw material with a defined shape and size. In the second phase, a circumferential edge is formed around the raw material piece. In the third phase, we need to make the piece take on a lenticular cross-section, i.e. we need to thin it sufficiently. The better this condition is met, the easier it is to continue in the fourth phase, when we continue to thin our piece proportionally, so that it acquires its final cross-section and symmetrical contour, while maintaining a width-to-thickness ratio be-

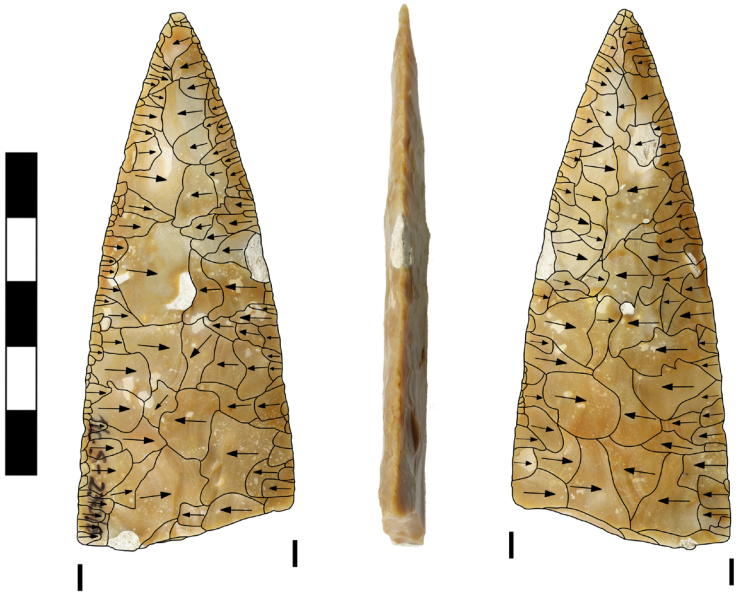


Figure 3. Bifacial leaf point made of Balkan flint. Prepared by the author.

tween 4:1 and 5:1. Practical experience shows that this phase is one of the most difficult to master, requiring decades of practice. The final stage in our case - as these pieces usually have no tang and no surface elaboration with parallel removals - is to fine-tune the edge to the desired shape, which requires retouching.

The first and second phases are understandably absent from the bifacial point from Rákóczifalva, as subsequent modifications have removed all traces of them (Fig. 3). The thinning effect of the third phase can be identified by looking for removals on the respective piece that extend beyond the object's midline. Although the earliest negatives on both sides have this feature, they may also be part of the thinning steps of the fourth phase. The maker of the specific instrument was generally moving towards the tip in this phase, at least given the few large removals, this seems the most likely. Subsequent negatives are already traces of removals directly aimed at symmetrical form. In the fourth phase, the knapper moved more towards the base from the tip, carefully thinning the bifacial point to its final shape with short, fan-like clusters of removals, while avoiding a loss of width rather than thickness. The success of the method is also evident in the fact that the final, fifth phase of retouching was only a final smoothing of the edges, not necessarily everywhere. In the end, if one looks at the width-to-thickness ratio of our particular object, it yields exactly the 5:1 ratio.

To approach the theoretical scheme, we should look at the metric proportions and shape of the bifacial point. In most cases, we also need several objects to do this, as we may not be sure that the finished product is exactly as the maker intended. In the case of serial objects, however,

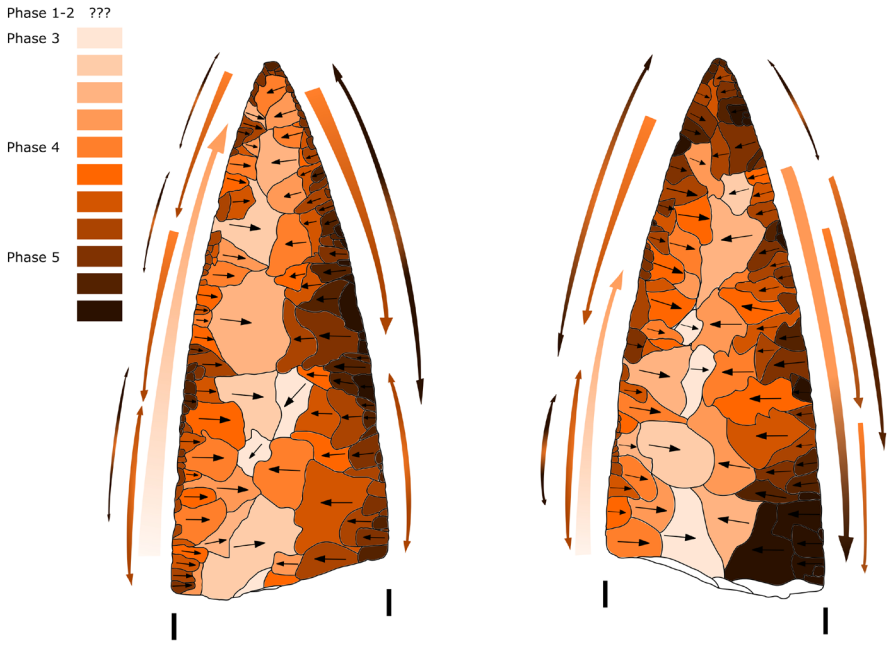


Figure 4. The phases of preparation (1 – selection of suitable raw material, 2 – formation of a concentric edge, 3 – obtaining a lens cross-section, 4 – thinning, 5 – final design) and the chronological order of the removals. Prepared by the author.

the finish will be close to a theoretical average, which in turn will reflect the theoretical pattern. In this case, we have no other similar objects from the site, but we can be almost certain that the finished form will faithfully reflect the image in the mind of the maker. This is evidenced by the shape of the point, which is perfectly symmetrical with almost all sides (Fig. 3). The only exception is from a side view, in which case we observe a slight bend towards one of the sides so that the bifacial point shows a slight asymmetry from this angle. Of course, this does not mean that the asymmetry cannot be the result of conscious intention, but the symmetry is almost certainly not accidental.

3. The parallels of the find in the Carpathian Basin and beyond

The bifacial points, which, based on the finds, are exclusively arrowhead-sized objects, are traditionally dated to the Bodrogkeresztúr culture (Patay, 1979, p. 37). The only enigmatic exception is the perfectly preserved obsidian point with bifacial elaboration recovered from object 4 at Bükkábrány-Bánya VII, which can be dated to the earliest, emerging phase of the Alföld Linear Pottery culture of the Great Hungarian Plain (Faragó *et al.,* 2015, Fig. 9). Its uniqueness is only enhanced by the fact that, not only in Hungary, but also in the wider region of Central and Eastern Europe and the Balkans, similar points of similar workmanship are only observed from the end of the Neolithic, and the very beginning of the Copper Age (Csongrádiné Balogh, 2000, Boyadzhiev, 2015, pp. 121–123; Lichardus & Lichardus-Itten, 1993, pp. 47–48).

In general, the domestic Copper Age bifacial points are typical of the Bodrogkeresztur culture, almost all of them occur in burials and almost all

of them are made of obsidian (Patay, 1979, p. 37; Marton, 2011, pp. 167–168). Despite the raw material being local to the Great Plain, this type of object and technology, as we have seen, has no local antecedents. The only find from Hungary that is related to our bifacial point from Rákóczifalva is a scatter find of Volhynian/Prut flint from Szelevény-Öthalom (Patay, 1958; Csongrádiné Balogh, 2001, pp. 94, 98).

Taking a broader view of similar points, in northwestern Bulgaria, closer to Hungary, type IV, mentioned above, together with type V, occurs almost exclusively (90%) (Boyadzhiev, 2015, p. 122). Here, especially in the Lovech region, several scattered finds have been found in recent decades, suggesting a local production centre. What is certainly interesting, however, is the context of occurrence of our finds, since throughout Bulgaria these pieces were almost always found outside cemeteries, in caves, settlements or even in tells (Boyadzhiev, 2015, p. 174). The few exceptions are graves 43 and 97 in Varna I cemetery, grave 597 in Durankulak cemetery (Boyadzhiev, 2015, p. 123), the grave at Reka Devnja (Lichardus & Lichardus-Itten, 1993). Further two pieces came from the cemetery area without further indication at the Kozareva tell in Bulgaria (Gurova, 2021). All of these are located in northeastern Bulgaria, and among them, grave 97 at Varna was identified as a cenotaph. Chronologically, most of the bifacial points date to the late part of the Bulgarian Copper Age (4500/4400-4100/3800 cal BC), and more to the middle and last third of it. Culturally, it can be paralleled with the Krivodol-Sălcuţa-Bubanj Hum 1a and Kodžadermen-Gumelniţa-Karanovo VI periods.

4. Summary

The conditions under which the bifacial point from Rákóczifalva was found, its raw material, its typo chronological parallels and its technological analysis all suggest that this object was not made in the Carpathian Basin, but somewhere in northern Bulgaria. At the same time, despite the remoteness of the making, the high level of knowledge required to produce such a bifacial point was encountered in the Great Hungarian Plain, in the same cultural and social context in which these objects made sense. Thus, this bifacial point was given the same prominence in the former community as similar objects left in Bulgaria. All this, here in the Carpathian Basin, could only be due to the European scale of contact that has been repeatedly demonstrated in the period (Pétrequin *et al.,* 2017, Fig. 12), as a consequence of which the bifacial point from Rákóczifalva was part of the life of the community in a similar design and with a similar cultural interpretation, almost at the same time as related objects from Bulgaria.

Numerous studies in international (Jakubczak *et al.,* 2022; Kot & Gryczewska, 2021; Kot, 2017) and even domestic (Szolyák & Lengyel, 2014) Palaeolithic research show that it is worthwhile to examine the making of bifacial tools or cores from the perspective of the operational chain approach. Indeed, it is the steps of shaping that can show the true power of this method in a truly demonstrative way, on a single piece of knapped stone, at least if we want to understand prehistoric toolmaking. From a raw material and typological point of view, several analyses have already dealt with these objects (Csongrádiné Balogh, 2000), but detailed aspects of the preparation technology have so far only been explored to a limited extent (Marton, 2011). Such a study may shed new light on the place and person of making, since until now the cautious view in domestic research has been that the local, i.e. Carpathian Basin, raw material (obsidian) means that these bifacial points cannot be imported pieces, and thus perhaps the bifacial technology was reinvented locally (Marton, 2011, pp. 168–169). Detailed technological analysis of additional artefacts will also make it possible to

reconstruct different tool-making traditions or even to isolate regions of manufacture.

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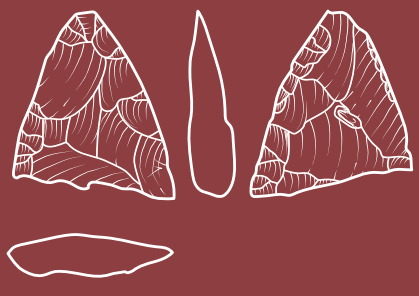
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A team picture of the Sajóbábony excavations from 2022, one of Zsolt's ongoing projects. In addition to the generations of students, his colleagues are seen – Agnès Lamotte (the lady on the left) and Pierre-Gil Salvador (in the middle, in a cap). Dalma Kerekes stands next to Agnès in pink, she is one of Zsolt current students, as well as Máté Miklós Beke, who holds the sign from the right. Péter Szolyák on the right in a red shirt, director of the Herman Ottó Museum in Miskolc, is one of Zsolt's first students. *Photo: Agnès Lamotte, drawing: after Kozłowski* et al.*, 2009.*



8

Öcsöd-Kováshalom and the Neolithic ceramic technological tradition in Hungary

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Abstract. The Early and Late Neolithic artefact assemblages of Öcsöd-Kováshalom represent 700 years of nearly continuous local development during the Neolithic period. This study focuses on the temporal dynamics of ceramic transformations, that occurred in different paces concerning the forms, forming techniques and decoration of vessels. Decoration, as a device of social communication, displayed great variability in space and time. Vessel forms, constrained partly by function, rather responded to periodically occurring regional trends. The technological system had been following new claims and challenges only partially; it preserved archaic elements that eventually contributed to the formation of the Late Neolithic Tisza Culture. The character of the examined ceramic material prohibits us from reconstructing entire *chaînes opératoires*. The samples offer a set of identified technological markers, that refer to several characteristics of the manufacturing process within the technological system, represented by the artefacts.

Keywords: Techniques of pottery manufacturing process, Neolithic ceramic development, Great Hungarian Plain

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1. Öcsöd-Kováshalom and the Neolithic development of the Great Hungarian Plain

The history of food-producing communities of the Carpathian Basin began in close association with the Anatolian-Balkanic Neolithisation process, albeit somewhat later, at the beginning of the 6th millennium BC. This closed basin with its ecologically complex regional structure played a pivotal role in the Neolithic development of Europe, due to its strategic location (Tringham, 1971; Sherratt, 1983; Bánffy, 2006; Müller, 2010; Raczky, 2019). Moreover, an extensive system of relationships between the local cultures and communities ensured the importance of this region in the past, as it does for us today. The complex hydrological structure of the Carpathian Basin acted on this communication network, enabling low-effort maintenance of long-distance relationships (Kovács, 2013a). Among the manifold directions of these relationships, research favoured connections between the Balkans/Southeast Europe (Vinča) (Raczky, 1988, 1992a; Horváth, 2006) and West/Central Europe (*Linearbandkeramik*, LBK) (Bánffy & Oross, 2009; Jakucs *et al.*, 2016), corresponding the mainstream of the Neolithisation process. Exploration of the northern (in the direction of Poland) (Sebők, 2007, p. 113) and eastern (towards Romania and Ukraine via Transylvania) (Virag, 2015) directions became a priority issue in research only recently.

The Great Hungarian Plain occupies the lowest-lying central area of the Carpathian Basin. A mosaic of natural habitats (Sümegi *et al.*, 1998; Sümegi *et al.*, 2005) had been emerging in this waterlogged, seemingly closed region, which was also reflected in its past cultural diversity, especially during the Neolithic (Raczky & Anders, 2003, p. 157; Raczky & Anders, 2009, pp. 40–43). Concerning this period, three territorial units can be delineated along the River Tisza, with different dynamics of developments, different inner transformations and external impulses (Fig. 1). The Upper Tisza region located North-Northeast from the estuary of the Sajó/Hernád rivers, characterized by intensive transformations and connections with Northern Transylvania and Poland (Chapman, 1995; Sebők, 2007; Kozłowski & Nowak, 2010; Virag, 2015; Sebők & Faragó, 2018, p. 152). Extensive contacts lent a unique character to the Middle Tisza area: right and left tributaries (Zagyva, Körös, Berettyó) with rich and diverse microregions spliced far-fetching communication networks together in this confluence region. One such microregion is the widely recognized Körös-Berettyó area due to the Esztár group (Kalicz & Makkay, 1977, pp. 52–54; Goldman & Szénászky, 1995) and Herpály culture (Kalicz & Raczky, 1987a, 1987b; Kalicz, 1995; Kalicz *et al.*, 2011). Along the western tributaries, microregional groups are known with connections towards the North Hungarian Range and Transdanubia (Kalicz & Makkay, 1977, pp. 159–162; Bánffy, 1999; Csengeri, 2014; Domboróczki, 2018). A thorough investigation of these sites has to be undertaken. The Lower Tisza region began at the estuary of the Körös River with strong ties to the South during the entire Neolithic era (Banner, 1960, pp 36–55; Horváth, 1994, pp. 99–100; Horváth, 2006; Paluch, 2011).

Öcsöd-Kováshalom is located in the middle part of the Great Hungarian Plain, next to the Körös River. This Late Neolithic settlement was excavated between 1980–1987 (Raczky *et al.*, 1985), becoming a widely known site both in Hungarian and in international research (Raczky, 1987, 1992b; Lichardus & Lichardus-Itten, 1997; Link, 2006). Öcsöd represented a special settlement type, the so-called tell-like settlement, which is characteristic of the northern zone of the Southeast European tell distribution (Kalicz & Raczky, 1987a; Raczky, 1987, 2015). The 45.5-hectare area of the open site integrated smaller settlement nuclei of half hectares. According to the magnetic survey, a triple enclosure system was

built around and within the settlement. The inner section was about 150 meters in diameter, while the outer one terminated a 500-meter-wide area (Füzesi *et al.,* 2020). At the nucleus with the most intensive surface scatter, a multilayered settlement was excavated by Pál Raczky and his colleagues. 160 cm thick strata contained two main settlement horizons. The structure of this central residential area was defined by 12 buildings with post structures and trench foundations. Distinct activity areas and two groups of burials were aligned to the buildings. In the excavated assemblage, there were more than 80,000 ceramic sherds (Raczky, 2009; Raczky & Füzesi, 2016a; Raczky *et al.*, 2018).

Apart from the well-recognized Late Neolithic remains, the site revealed material of a previous occupational horizon, which has barely been investigated so far (Raczky, 1986; Éva Marton's MA thesis in 1987, unpublished). These Körös culture settlements were implemented evidently into the European Neolithization process, they played an important role at the regional scale of the Carpathian Basin (Anders & Siklósi, 2012; Bánffy, 2013). The first settled communities created an intensive settlement network in the central part of the Great Hungarian Plain. To the north of this zone, pioneer Neolithic communities also were identified by Hungarian research in recent years (Domboróczki *et al.,* 2010; Domboróczki & Raczky, 2010; Domboróczki, 2012). The site of Öcsöd-Kováshalom was located at the northern periphery of this coherent and intensive occupational area (Bittner, 2012). The size and structure of the Early Neolithic settlement are less explored at the site because of the dense cover of Late Neolithic remains. At the main part of the excavation, artefacts of this early period appeared sporadically in the features of the multilayered Late Neolithic settlement. Intact Early Neolithic features occurred in one trench at the site margins, where three excavated pits provided 1140 ceramic

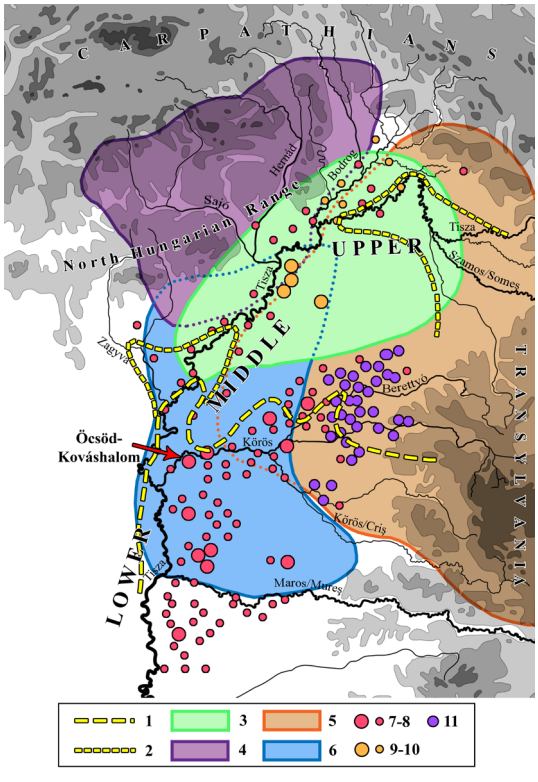


Figure 1. Dynamics of Neolithic development in the Upper, Middle and Lower Tisza Regions, based on the main cultural entities. Early Neolithic (after Anders & Siklósi, 2012): 1: intensive settlement area of the Körös culture, 2: pioneer Neolithic communities north of the primary zone. Middle Neolithic (after Raczky, 1989; Raczky & Anders, 2003): 3: early ALPC, 4: Bükk culture, 5: Esztár group and painted ceramic assemblages of Transylvania, 6: Szakálhát culture. Late Neolithic (after Raczky & Füzesi, 2016a): 7–8: tells and horizontal settlements of the Tisza culture; 9–10: tells and horizontal settlements of the Csőszhalom group; 11: tells of the Herpály culture (prepared by the author).

sherds. According to these observations, the early settlement was located in a narrow zone along an old meander of the Körös River. This situation corresponds to the general settlement pattern of the period (Sherratt, 1983; Makkay, 1982, pp. 116–119).

The chronological framework of the present summary rests on data of uneven quality. On typo-chronological grounds, the Körös assemblage can be dated to the classical phase of the Körös culture, which means three hundred years between 5850 and 5650 cal BC (Oross & Siklósi, 2012, pp. 152–154). The Late Neolithic assemblage is framed by radiocarbon dates, spanning between 5210 and 4850 cal BC (Raczky, 2009, p. 103; Raczky & Füzesi, 2016a, pp. 31–34). Middle Neolithic (Alföld Linear Pottery culture, ALPC) artefact scatters are also known from the excavation, indicating continued use of the site and its surroundings. However, archaeological features were not found from this period. The hypothesized continuity in settlement activities (Raczky & Füzesi, 2016a, p. 18; Kovács *et al.,* 2017) does not equal to the continuity of the excavated assemblages through the periods. Despite the lack of continuity, these two assemblages represent a significant section of Neolithic development, which can be modelled in the above-mentioned three regions.

The nested complexity of social, ecological and technological developments forms a distinct topic of research. The conceptual framework of archaeological cultures grasps these far-fetching processes together, by which we can interpret the ever-growing pool of data about these phenomena. In the southern zone of the Great Hungarian Plain, the development is characterized by a succession of archaeological entities such as Körös, ALPC, Szakálhát, and Tisza. There were two crucial facts in this succession. The first fact is the contact between the late Körös groups with their southern origins, and the ALPC communities with their northern origins, who had been spreading to the south (Kalicz & Makkay, 1977, pp. 26–29; Makkay, 1982, pp. 51–52; Raczky, 1989, pp. 234–235, Fig. 6, 8; Horváth, 1994). The second fact is that the Late Neolithic Tisza culture emerged in the context of a gradual internal transformation within the Szakálhát group (Makkay, 1982, pp. 60–63; Kalicz, 1989, p. 104; Raczky, 1992b, p. 164). The Late Neolithic assemblage of Öcsöd-Kováshalom testifies to these cultural transformations (Raczky, 1992b, pp. 164–167; Füzesi & Raczky, 2018, pp. 91–94). Among the recovered artefacts, ceramic sherds with their technological, functional and stylistic aspects represent the spectrum of variables pertinent to an effective analysis of cultural change. The analyzed assemblages represent the two above-mentioned facts of change, hence we can interpret the ceramic development of the Neolithic based on these artefacts.

2. Dynamics of changes in Neolithic ceramic forms and decoration

The traditional approach to the study of spatiotemporal patterning among archaeological sites utilized the formal and stylistic variability of pottery. Interpretation of ceramic vessels as functional items and material imprints of human decisions only appeared in the mid-20th century. This paradigm shift is attributed to Anna O. Shepard and her new methods of ceramic analysis (Shepard, 1956 (1995); Tite, 2017, pp. 8–9). Although ceramic technology became the most dynamic field of investigation (Rice, 1987, pp. 113–163; Orton *et al.*, 1993, pp. 113–131; Hunt, 2017, p. 5), still, multifaceted criticism against the typo-chronological approach (Meier-Arendt, 1994; Rück, 2009. p. 175, Fig. 15) that forced change in formal-stylistic studies. These transformations in international research during the 1990s (Tite, 2017, pp. 11–12) affected Hungarian ceramic analysis only after the turn of the millennium, in the past few years. The assemblage and microregional perspectives of these new studies set the stage for a reinterpretation of Neolithic developments, and the role of pottery in it (Sebők & Kovács, 2009; Kovács, 2013b; Marton, 2013; Csengeri, 2015; Füzesi, 2016; Füzesi *et al.*, 2017; Raczky & Füzesi, 2016b, 2018; Sebők, 2018a; Füzesi & Raczky, 2018; Jakucs *et al.,* 2018). This

article focuses on ceramic technology, but for the sake of a balanced picture of the changes in the course of the Neolithic period, I also will sketch formal and stylistic processes that are connected (Hodder, 1981, pp. 215–216; Rice, 1987, pp. 244–245, 274–275; Sinopoli, 1991, pp. 84–85; Santacreu *et al.*, 2017, p. 189; Sebők, 2018b).

The first synthesis about the Körös as the pioneer food-producing culture was published by Ida Kutzián in 1944 (Kutzián, 1944). Since then, the number of sites and assemblages has multiplied, hence the editorial board of the 2012 British Archaeological Reports (BAR) volume could offer a significantly more complex synthesis of this culture and its owner society (Anders & Siklósi, 2012). Nevertheless, the assemblages investigated so far are moderate or the editors did not aim for an exhaustive publication, except for a few inventories from the region of the Körös rivers (Oross, 2007; Makkay & Starnini, 2008). Besides the thoroughly reported Ecsegfalva, János Makkay and Elisabetta Starnini published assemblages of six sites from the territory of Szarvas and Endrőd. The publication contains drawings of 500 whole profiles and several other sherds. Evaluation of these artefacts yet has to be undertaken, apart from a detailed formal-typological table of the publication. Consequently, we have only a partial understanding of the pottery sets in use during the Early Neolithic period. The Körös assemblage of Öcsöd-Kováshalom is too restricted to represent the whole spectrum of Early Neolithic pottery forms. To gain a more complete picture, I assembled a diagram of individual vessels of the other published Körös assemblages. From the Körös and Middle Tisza region, the nearest sites are Szajol-Felsőföldek, Szolnok-Szanda (Raczky, 2012) and Ecsegfalva (Oross, 2007), 30 and 50 km away from Öcsöd respectively.

The analysis compares 44 vessels from the three mentioned sites (Oross, 2007; Raczky, 2012), which can not be considered a statistically significant sample but it allows the identification of several basic tendencies concerning vessel types (Fig. 2: 1). Identification of ceramic forms was based on rim diameter, height and type of profile. The five basic form types represent different size ranges, and the individual vessels also significantly differ in their proportions. For example, the heights of biconical bowls (A) are almost constant, while their diameters are extremely variable. The inner proportion of conical and ovoid bowls (B–C) is distributed between 1:1 and 1:2. Even wider dispersion can be seen in the proportions of spherical closed vessels (D), which otherwise have a relatively closed size range. Globular and biconic pots (E) display great variability of proportions and sizes, similar to conical bowls. The individual vessel types delineate loose sets on the diagram by their metrical and formal attributes. The insufficiency of the Körös assemblage from Öcsöd is well-illustrated by the low number of firmly identified variants, compared to the vessel inventory of Ecsegfalva (Oross, 2007, pp. 505–509, 535–536). The recognizable forms typically were conical and ovoid bowls, or globular pots and storage jars (Fig. 2: 2–6). Although the Öcsöd-Kováshalom assemblage fits well in this picture, its extremely fragmented nature (only 3 whole profiles were possible to reconstruct) renders its form data irrelevant.

However, the Late Neolithic assemblage contains 240 vessels which could be reconstructed into complete shapes of the Late Neolithic community's ceramic inventory. Data on this throughout published assemblage (Füzesi & Raczky, 2018) were analyzed by variables similar to the previous ones (rim diameter, height, type of profile). This diagram (Fig. 3) displays not only a more complete but a more regular pattern than the same graph for the Early Neolithic. Divergence in the proportions of individual vessels is restricted, even at the higher end of the size range. As all the detailed data are published, on this graph, I

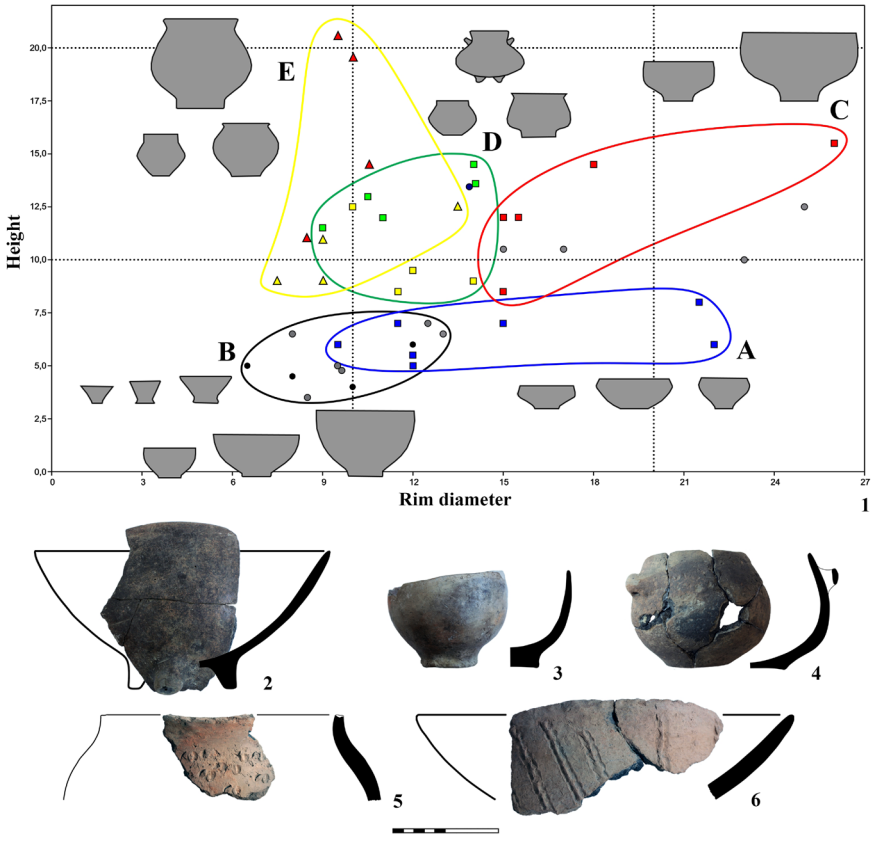


Figure 2. Ceramic forms in the Körös culture. 1: Vessel types based on height, rim diameter and profile type. Data from Szajol-Felsőföldek, Szolnok-Szanda, and Ecsegfalva. 2–6: Typical ceramic forms of the Öcsöd-Kováshalom site (prepared by the author).

emphasized only five technologically significant vessel types, whose radial arrangement also mirrors the regularity of the vessel spectrum. In comparison with the Early Neolithic spectrum, there are not only new categories (vessels with 2–3 mm wall thickness) but the enlargement of the formal – supposedly the functional – spectrum is also detectable. The consistency of vessel forms was a new phenomenon at the beginning of the Late Neolithic, testifying to a more regulated ceramic production.

Nevertheless, local and microregional regularity is a relative phenomenon, different spatial and temporal tendencies occurred in Late Neolithic ceramic assemblages of the Great Hungarian Plain. There are significantly more assemblages of this age known from preliminary reports, ready for comparative study (Füzesi & Raczky, 2018, pp. 89–91). Although decoration was the prime variable in the definition of archaeological cultures (Tisza, Herpály, Csőszhalom), regional differences in vessel forms

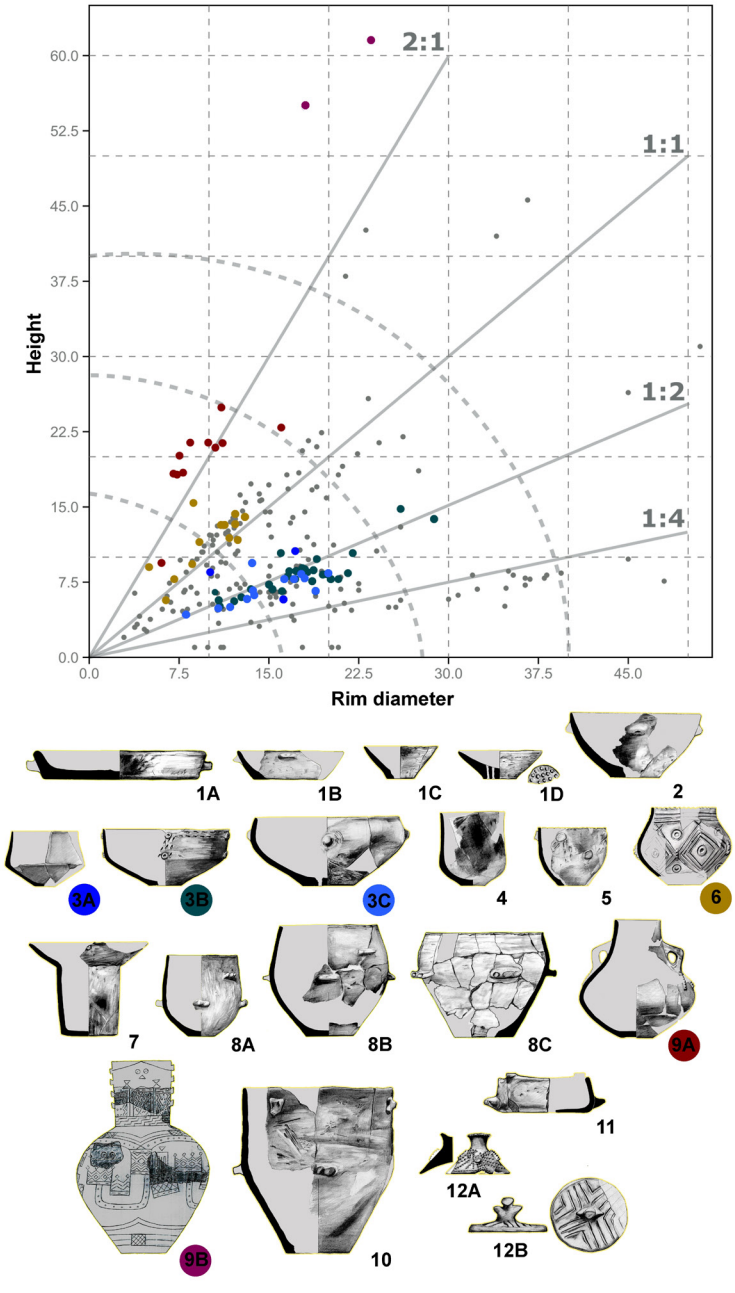


Figure 3. Ceramic forms of the Tisza culture at Öcsöd-Kováshalom. 1: Vessel types based on height, rim diameter and profile type, compiled after 240 reconstructed vessels. 2: Vessel types of the Late Neolithic assemblage. The forms highlighted with different colours were suitable for technological observations (prepared by the author).



Figure 4. The main decoration techniques of the Early (1–8) and Late Neolithic (9–16) assemblages from Öcsöd-Kováshalom. 1–2: barbotine, 3–4: pinched decoration, 5–6: finger and nail impressions, 7–8: incised and grooved decoration, 9: plastic implementation, 10: engraved decoration, 11–12: incised decoration, 13: black painted, 14–15: incision together with red painting, 16: resin and straw decoration (prepared by the author).

also played a prominent role in those distinctions (Bognár-Kutzián, 1966; Kalicz & Raczky, 1987a; Kalicz, 1989, pp. 104–105). The formal variation can be traced back to different microregional traditions (Raczky & Anders, 2003, pp. 155–158), that were strong enough to pervade the changing material culture (Kalicz *et al.,* 2011, pp. 48–55; Sebők, 2012; Sebők & Faragó, 2018, pp. 152–153, 170–171). The coherence in the wide area of the Tisza-Herpály-Csőszhalom complex was displayed by new, special vessel types, e.g. the so-called flowerpot-shaped vessels. These new forms, as well as their decorations, became hallmarks of the Late Neolithic material culture on the Great Hungarian Plain (Sebők, 2018a, Fig. 11; Füzesi & Raczky, 2018, p. 92).

Based on the formal development of Neolithic ceramics, an ever-expanding, periodically renewing vessel set can be reconstructed, in which regional differences slowly increased through time. Despite these changes, the assemblages give an impression of constant transformation of the ceramic inventory. The comparison of decoration techniques shows radical changes, which is an organic feature of the most important stylistic attribute. The three main functions of style, defined by Prudence M. Rice (Rice, 1987, p. 267), are evident in the 1500-years-long Neolithic period in the Alföld. The changing settlement patterns (Makkay, 1982; Sherratt, 1983; Domboróczki, 2009; Raczky & Anders, 2009; Gyucha *et al.,* 2015; Füzesi, 2016, pp. 387–388; Raczky & Füzesi, 2016a, pp. 15–19), the increasing social complexity (Siklósi,

2013) and the stylistic change in ceramics (Füzesi, 2016, pp. 378–380; Sebők, 2018a) were parallel, connected processes, during which pottery decoration fulfilled its role, the strengthening of group cohesion, emphasized social differentiation and intergroup demarcation. Because of these functions, the decoration is one of the most dynamic datasets that can be investigated by archaeology.

In the Early Neolithic assemblages the dominant techniques (Fig. 4: 1–8), like classic barbotine, "*Schlickwurf*", and various impressions or incisions, were used for filling the surface (Kutzián, 1944, p. 6; Trogmayer, 1964, pp. 68–70; Trogmayer, 1968; Makkay, 1978, p. 25; Raczky, 1983, pp. 162, 169, 181, 187; Kalicz, 2000, p. 298; Oross, 2007, pp. 537–540). The individual decoration elements were often ordered in rows or arched bands. The signalling value of these techniques and patterns was exceedingly low. Communicative functions must have been fulfilled by other artefacts and phenomena, as pintaderas with complex decorations testify (Kutzián, 1944, p. 8, Tab. XLVI; Tringham, 1971, pp. 83–84; Makkay, 1984, pp. 22–23; Makkay, 2005; Raczky, 2012, pp. 93–94). The role of ceramics in social communication intensified during the Middle Neolithic period, probably due to the growing appreciation of feasting (Kalla, *et al.*, 2013; Hayden, 2014; Hastorf, 2017, pp. 194–204), implied by the invasive and complex decorations on vessels connected to consumption (Sebők, 2007, pp. 109–111; Füzesi, 2016, pp. 381–382; Sebők, 2018b, pp. 19–21). Following this trend, in the Late Neolithic, a complex and colourful system has been appeared, in which the decoration techniques, styles, and vessel forms tightly intertwined (Fig. 4: 9–16). Besides incision, which originated in ALP traditions, other techniques also appeared on Late Neolithic sherds, like painted, impressed and applied decorations (Sebők, 2007, 2018b, 2022; Sebők & Faragó, 2018; Füzesi & Raczky, 2018, pp. 79–81). A particular decoration technique of the Late Neolithic used special materials – resin and straw The settled term of this complex technique (Kalicz and Raczky, 1987a, p. 20; Sebők, 2007, p. 109) in archaeology is only partially substantiated for the moment. The matrix is proven to be a resin (Raczky & Sándorné Kovács, 2009); scientific investigations into the inlay material are currently in progress. Patterns constructed of straw sticks were applied to a special type of cup of small size and fine quality (Fig. 4: 16). The use of standard traditional techniques also had changed, they were all ordered into different decorative patterns suitable for broadcasting messages (Wiessner, 1989; Rice, 1987, p. 267), even the most simple applied implementations, as opposed to the Early Neolithic filling patterns. The complex decorative patterns available since the second half of the Neolithic were able to communicate similarly complex messages. Together with the central message carried by the main motif, other sophisticated details and patterns can be observed that gave way to the expression of individual or group identities (Hoyer, 2005, Abb. 2; Pechtl, 2015, pp. 566–567).

3. Technological observations in Neolithic ceramic material from Öcsöd-Kováshalom

After this short introduction of the Neolithic formal and decorative ceramic traditions in the Great Hungarian Plain, we can not synthesize a similarly comprehensive view of ceramic technological traditions, since this kind of research does not have a long history in Hungary. Instrumental ceramic studies began in Hungary after an archaeometry conference held in 1998 (Jerem & Bíró, 2002), although with moderate success, as only a few experts took up these methods later on (Pető *et al.*, 2010, pp. 66–77; Kreiter *et al.*, 2012, pp. 9–10). Among them, Attila Kreiter earned international recognition (Kreiter, 2007; Kreiter *et al.*, 2017; Kreiter *et al.*, 2019). Apart from instrumental methods, experimental archaeology provided the first studies in Hungary about production and

formation technology. A Hungarian potter and restorer, László Gucsi, had experimented with vessels from the Copper and Bronze Ages (Gucsi, 2000, 2006, 2009). His studies engaged in the technical and practical requirements of vessel production (Gucsi & Szabó, 2018, pp. 223–226). His early views anticipated the results of Louise Gomart who established the French research traditions. Gomart's 2014 publication contains a technological analysis of two Early and two Middle Neolithic sites from Transdanubia and the Great Hungarian Plain (Gomart, 2014; Gomart *et al.,* 2020). She had identified several pottery-manufacturing processes based on forming techniques, that widened the earlier, anecdotal observations in ceramic research. Concerning pot-building, János Makkay and Elisabetta Starnini reached similar conclusions as László Gucsi, although they published their results only as interpreted drawings (Makkay & Starnini, 2008, pp. 87–89). The past few years also witnessed new complex studies which combine stylistic analysis, material tests and the investigation of forming techniques. A published case for the Neolithic is the site Balatonszárszó-Kis-erdei-dűlő (Kreiter *et al.,* 2017). The insufficient cases in technical analyses cause a lack of comparative data, rendering our preliminary results hypothetical, imperfect and regional in scope. The assemblages analyzed by Louise Gomart could be used as an analogy and starting point for our research. In recent years, further significant advances have been made in the ceramic research in Hungary. In the Transdanubian region, a project on a broad spectrum of Neolithic ceramic production and use is being coordinated by Tibor Marton (Marton *et al.,* 2020). In the Alföld region, Eszter Solnay has started to work on ceramic technology under the mentorship of L. Gomart (Solnay, 2021, 2023).

Our first important experience is, that relatively more technological observations are required for the Early Neolithic sample, in comparison with the Late Neolithic one. The early collection contains 1,285 sherds altogether, while of the nearly 80,000 pieces strong late sample, we analyzed 11,000 sherds during our technological study (Füzesi, 2019). The great discrepancy in quantity between the Early and Late samples is mainly caused by the difference in tempering materials. The popular organic tempering in the Early Neolithic sample allowed more observations, but the overall improvement in the manufacturing process through the Neolithic also has to be taken into account during interpretation. This latter phenomenon can support our hypothesis about the long-term inheritance of pottery-producing traditions (Shepard, 1956 (1995), p. 357; Arnold, 1985, pp. 220–224; Rice, 1987, pp. 459–466; Lathrap, 2010, pp. 32–33, Fig. 3: 4–5). Our observations are based on poorly realized joinings and "fortunate" breakages. The majority of cases displayed horizontal and vertical breakage surfaces, broken or disconnected handles and plastic elements. Most data were recorded on the base of vessels. This crucial region of stability served as the basis of the evaluation in both assemblages. The other avenue of observation, i.e. surfaces of sherds provided more restricted information. The often unfinished inner surfaces of vessels have proven to be good indicators but almost exclusively in cases of closed forms (globular vessels, biconic vessels, and jugs). Several surface treatments and surface filling decorations had been used in both examined periods (slip, burnishing, Schlickwurf, barbotine, resins, and different incised patterns), which obscured traces of forming.

The fragmentation of the Early Neolithic ceramics and the character of the Late Neolithic artefacts in our samples prohibit us from reconstructing whole *chaînes opératoires* (Roux, 2017). Instead, the samples offer a set of identified technological markers, that refer to several characteristics of the manufacturing process within the technological system represented by the artefacts

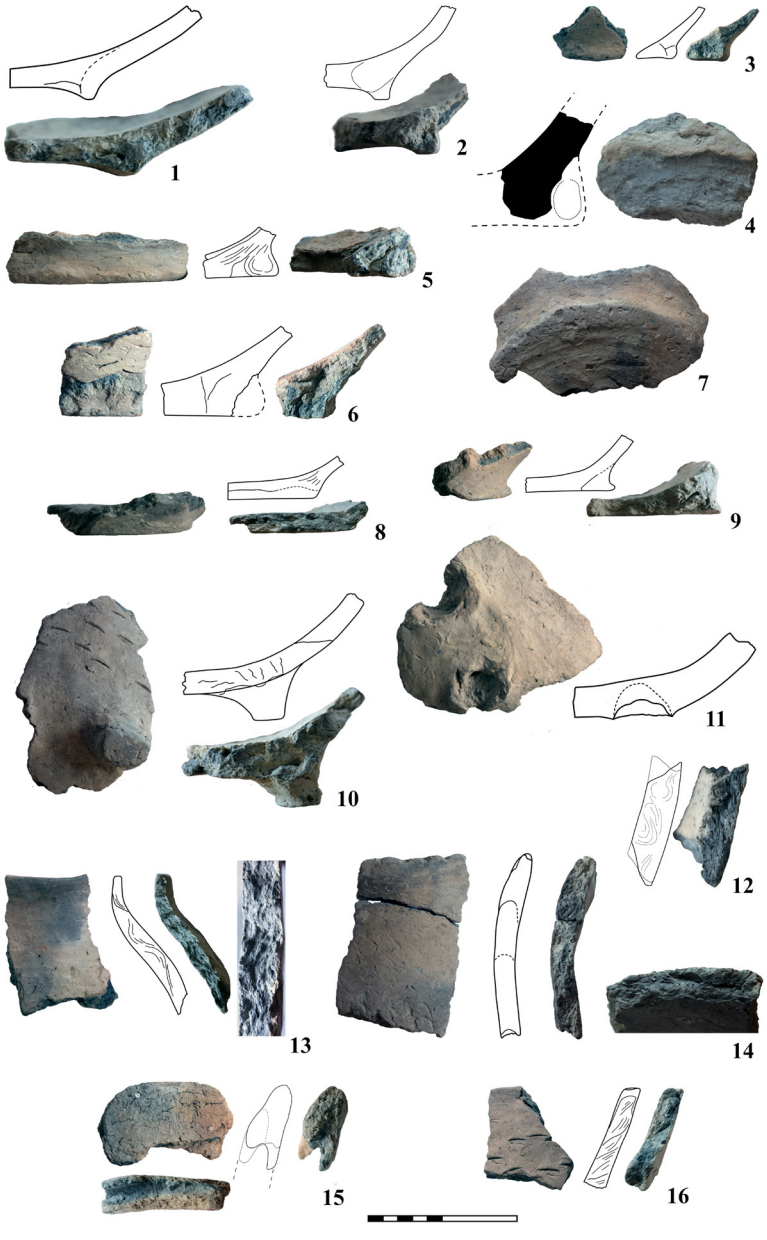


Figure 5. Forming techniques of the Early Neolithic assemblage from Öcsöd-Kováshalom. Modelling of the base (1–11), coiling of the body (12–14) and shaping of the rim (15–16) (prepared by the author).

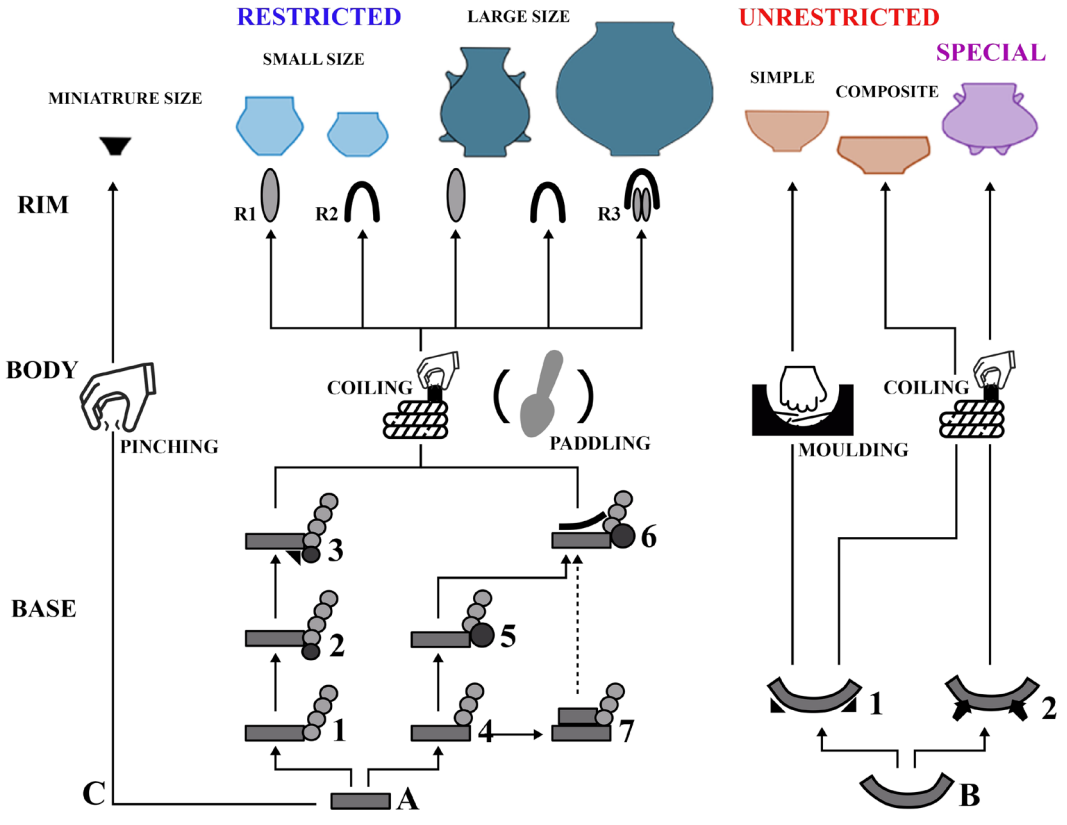


Figure 6. Characteristics of the pottery manufacturing process. Set of identified technological markers in the Early Neolithic assemblage of Öcsöd-Kováshalom (prepared by the author).

(Gomart, 2014, pp. 155–157; Kreiter *et al.,* 2017, pp. 117–120; Gomart & Ilett, 2017; Květina *et al.,* 2017; Neumannová *et al.,* 2017, pp. 173–174).

3.1. Forming techniques of Early Neolithic ceramic material

We present our results following the steps of vessel forming, from bottom to top (Fig. 5: 1–16). In the Early Neolithic sample, wall fragments dominate, the 99 basal sherds and 141 rim fragments add up only to 7.8% and 11.0% respectively. This distribution suggests that our data concern mostly the bodies of vessels, but due to the distorting effect of technological characteristics and possibilities of observation, the bases had been found more informative. János Makkay and Elisabeta Starnini observed similar tendencies (Makkay & Starnini, 2008, pp. 79, 87)

Forming the base was the first step in vessel manufacture, divided the sherds into two groups. In the majority of cases, the initial element equals a clay disk (A; Fig. 5: 1–6), more rarely, the base was formed by moulding (B; Fig. 5: 10–11). The most frequent base type was built by coiling on a

clay disk of one (A1–6) or two layers (A7; Fig. 5: 8). The second factor in this evaluation was the position of the first coil: beside/around (A1–3; Fig. 5: 1–2) or above the disk (A4–7; Fig. 5: 4–5, 8). In some cases, it could be proved that this coil was the first step of the manufacturing process and the disk was a closing element. It is proven by the fingerprints on the bottom (Fig. 5: 7). The second type built above the disk had more complex versions. Its typical element was a large coil placed on the outside of the base (A5–6; Fig. 5: 4–6). This has resulted in a high, profiled basis, characteristic of the Körös culture (Kutzián, 1944, p. 69; Oross, 2007, p. 496; Raczky, 1983, p. 181; Makkay & Starnini, 2008, p. 78). Cohesion was ensured by finger impressions (Fig. 5: 4, 6), as earlier mentioned in other cases. The complex versions occurred more frequently in both disk-based types (A3, 6; Fig. 5: 1, 5). The third type is connected to the moulding technique (B). This occurred not only in the case of unrestricted bowls but in special vessels with legs too (B2; Fig. 5: 10). The legs were fixed in holes punctured into the moulded part of the base (Fig. 5: 11).

The building of the body was made by the coiling technique exclusively. All three basic coiling types (U, S, N) (Neumannová *et al.,* 2017, p. 174, Fig. 1) were identified in the Körös assemblage (Fig. 5: 12–16), but the N-type coiling was the most frequent. Only a few pieces of data could be gathered about the forming of the body. Traces of the paddle-and-anvil technique (Rice, 1987, pp. 136–137) appeared on some sherds. The follow-up covering and filling of the surface (for example with barbotine or impression) made it difficult to identify this technique. The shaping of the rim in most cases meant the application of the last coil (R1; Fig. 5: 13–14). Nevertheless, in some cases, complementary elements were used, which resulted in an extra, largely folded band around the last coil (R2; Fig. 5: 15) (Gomart & Illett, 2017). In one case, a complex rim was built from several overlapping coils (R3).

Summarizing our observations into one figure (Fig. 6), we applied a flowchart-like model in which we marked not only the manufacturing steps listed above but the most important categories of vessel sets also. The episodic nature of our observations and the high degree of variability allowed us to present only the most important, regularly occurring types. Besides those, several unique or unrecognized variants can be represented in the fragmentary collections.

The pinching technique (Rice, 1987, p. 125) (C) is usually used for the smallest, miniature-sized vessels. The disk-based shaping of the vessel base was specific to the restricted vessels. The body was built exclusively by the coiling technique in this group. The moulding technique appeared mostly in unrestricted vessels. A special section of the ceramic material was constituted by vessels with legs, which appeared in both restricted and unrestricted forms. The different forming techniques were implemented in the production of distinct vessel types, hence it is not unequivocal whether they represent different manufacturing traditions within Early Neolithic communities. For this, several techniques should be applied parallel to each other, as alternatives. Such alternative application is manifested only in the different disk-based type variants.

3.2. Forming techniques of Late Neolithic ceramic material

72 sherds of the Early Neolithic artefacts provided technological marks in connection with forming (5.8%), while in the Late Neolithic sample, we observed 381 cases, although these were only 3.5% of the 11,000 sherds. One-third of the identified technological marks referred to the application of handles and plastic elements in the latter sample. The Early Neolithic material lacked this kind of marks, hence there is an

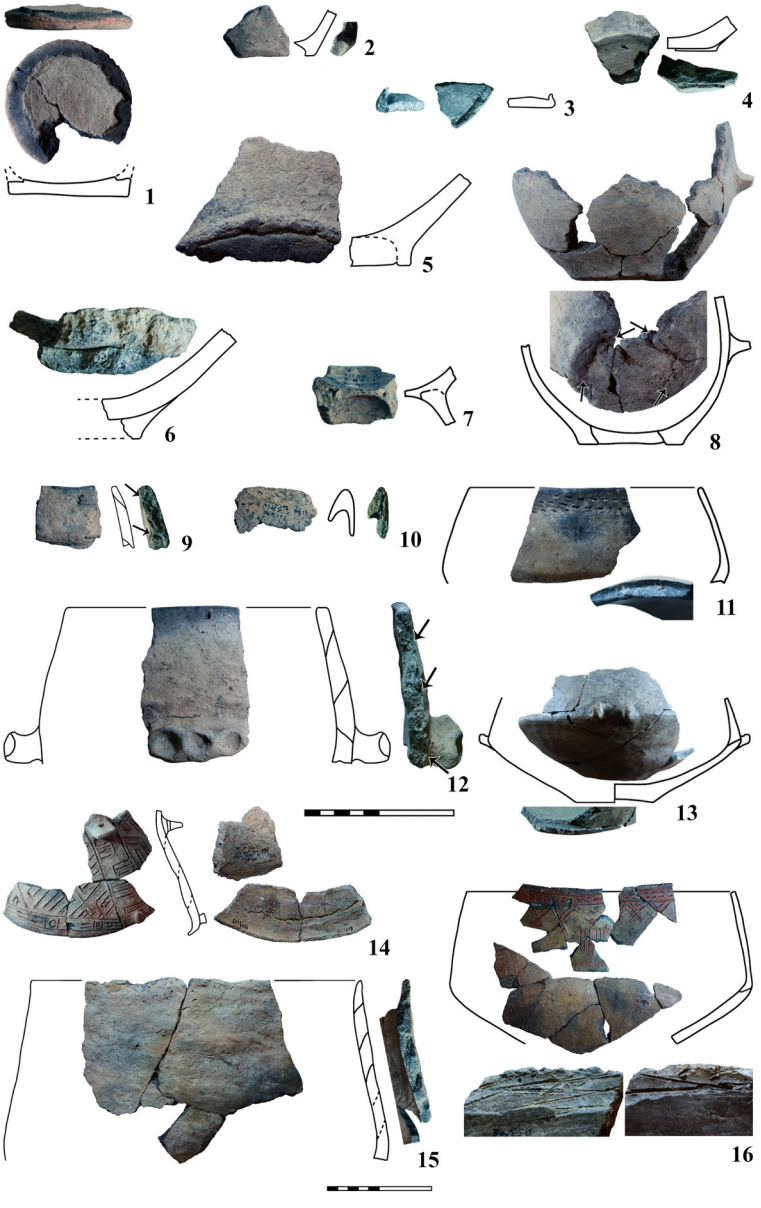


Figure 7. Forming techniques observed in the Late Neolithic assemblage from Öcsöd-Kováshalom. Modelling of the base (1–8), shaping of the rim (9–10), coiling of the body (12, 14–15) and joining interfaces along the belly (11, 13, 16) (prepared by the author).

even more pronounced difference between the two compared periods (5.8% vs. 2.2%). This difference goes beyond quantitative. Theoretically, reconstruction of an entire chaîne opératoire of vessel forming became feasible with the help of the 240 reconstructed Late Neolithic vessels. Still, we could not reach such a conclusion because the additions during restoration obscured the possibilities of technological observations on breakage surfaces. Consequently, we command more data about ceramics of the Late Neolithic settlement, but our results are displayed only on hypothetical flowcharts about *chanîes opératiores*, just like in the previous case (Fig. 8).

Modelling of the base was executed mainly by disk-based techniques (A). Both disk-base types appeared, the first coil beside (A1; Fig. 7: 2, 5, 8) and above from disk (A2–3; Fig. 7: 1, 3). Opposite the Early Neolithic assemblage, complex versions were missing in Late Neolithic ceramic. The composite base was represented by a two-disks-based version (A3; Fig. 7: 6). New elements of the assemblage were the pedestalled vessels (A4; Fig. 7: 7). The lower part of this type was formed with coils fitted to the bottom and disk. The introduction of pedestals at the Early-Middle Neolithic boundary was not without antecedents (Kalicz & Makkay, 1977, pp. 20–21; Raczky, 1983, pp. 171; Makkay & Starnini, 2008, pp. 79–80). The small- and ring pedestals made their appearance in late Körös assemblages, they are considered not only as formal but as technological antecedents of these vessel accessories. The A2–3 type base formation, present in the Körös material from Öcsöd, is comparable to the later pedestals, which are prevalent in variable sizes north of the River Körös (Füzesi & Raczky, 2018, pp. 92–93).

Similar to the Early Neolithic assemblage the N-coiling was also a frequent body-forming technique in the Late Neolithic (Fig. 7: 9, 12, 14–15), however, the U-coiling was present as well. Due to the bigger sizes of the shreds, we could identify not only parts of 1–2 coils but also longer sequences. In one case we observed a directional reverse of the joining interfaces along the belly line of a biconical bowl (Fig. 7: 12). When more sherds were reconstructed into a vessel unit, patterns of breakage helped in identifying the coiling technique. One such reconstruction pieced together 86 adjacent sherds into a 72 cm tall storage jar with special face decoration and a peculiar biography (Raczky, 2009, p. 105; Raczky & Füzesi, 2016b, pp. 26–29; Raczky *et al.*, 2018, pp. 124–130). Special storage jars with human face representations can be traced back to the Middle Neolithic ALP tradition (Kalicz & Koós, 2000; Raczky & Anders, 2003; Sebők & Kovács, 2009; Csengeri, 2011; Sebők, 2018a). The breakage pattern on this specimen suggests the use of coils which were transformed into 6–8 cm strips.

A new technological attribute among the Late Neolithic finds was indicated by straight break surfaces on the belly lines (Fig. 7: 11, 13). This breakage usually is associated with carinated forms and sharpened bellies. The moulded base was in use already in the Early Neolithic; the novel trait by the ALP tradition originated in the northern part of the Great Hungarian Plain, was the use of moulding for the entire vessel section under the belly line or greatest diameter (D) (Gomart, 2014, p. 157). After forming the conical lower part of these vessels, they allowed the ware to dry, in order to gain sufficient structural strength. The following, third manufacturing step was to build the upper part of the vessel, usually in a cylindrical shape. This forming process was carried out in different scales, from smaller bowls to larger pots. In some occasions, the joint interface along the belly line was articulated by incision and impression to ensure better cohesion (Fig. 7: 16). The upper part was always built up with the coiling technique, while the lower part was probably formed by moulding. This manufacturing process differed from other solutions for vessel manufac-

ture in the Early Neolithic technological system. A large globular jug offers an appropriate example of this dissimilarity (Raczky, 1987, p. 75, Fig. 28). Along the belly of this black-painted vessel, a straight break surface was present, just as in the case of the previously mentioned bowl and pot, which testified the coiling of the upper section. Moulding up until the maximum diameter, then coiling – this special technique set the ALPC apart in the northern part of the Great Hungarian Plain (Gomart, 2014, pp. 158–159).

One of the typical vessels of this period was the above-mentioned cup, with fine quality and a special resin-and-straw decoration technique (Kalicz & Raczky, 1987a, p. 20; Raczky, 1987, p. 68; Sebők, 2007, p. 109). Forming these types of vessels must have required a different technique as their walls were thin (2–3 mm) and their matrix was pure. According to our hypothesis, the applied technique involved moulding or casting, but we need further data to verify this claim. Vessels with the same quality appeared at the end of the Middle Neolithic in the Carpathian Basin, in the territory of the Bükk culture (Lichardus, 1974, p. 22; Kalicz & Makkay, 1977, p. 45; Csengery, 2001, p. 75). This ware then became widespread due to its high quality and special decoration (Strobel, 1997, pp. 77–79; Virág, 2009, pp. 13, 24, Fig. 2; Szilágyi *et al.,* 2011, p. 160, Fig. 1; Lazarovici & Lazarovici, 2015, pp. 11–13). A similar ceramic type also appeared at the same time, in Late Szakálhát contexts in the central-southern Alföld region – and also in the Öcsöd-Kováshalom assemblage (Kalicz & Makkay, 1977, p. 89). The degree of technological similarity between these two wares still has to be determined (Technological studies on Bükk fineware: Szilágyi *et al.,* 2011).

The identified set of technological markers unveils a ceramic production system which both retained archaic traditions and followed contemporary technological innovations (Fig. 8). We observed a considerable number of technological traits, mainly among rough-ware ceramics, which were already in use during the Early Neolithic period. Concerning the execution of vessel bases, only the basic types survived (EN A1, 4, 7 = LN A1–3), while complex forms either disappeared or set the stage for pedestalled vessels (EN A2 ≈ LN A4). Characteristic technological attributes of the Late Neolithic assemblage were the partial drying during the forming phase, and the specific moulding technique typical for ALP ceramic tradition. Both traits are associated with composite vessel types that were determining features of the archaeological assemblages by their forms and decorations as well.

4. Summary of changes in Neolithic technological traditions

The two analyzed assemblages represent 700 years of almost continuous development during the Neolithic period, at the location of Öcsöd-Kováshalom, in the regional frames of the Great Hungarian Plain. A comparative technological study of Early and Late Neolithic ceramic assemblages from this site revealed the considerable time-depth and several connections of pottery craft traditions. At the same time, stylistic and formal analysis of these assemblages testified explicitly to a transformative process.

Taking a broader interpretative scope, this study focused on the temporal dynamics of these transformations, which occurred at different paces concerning the forms, forming techniques and decoration of vessels (Campbell, 2012, p. 319, Fig. 6). Formal and stylistic traits that are traditionally used to identify archaeological culture-units had been changed to a high degree. Decoration, as a device of social communication, also displayed great variability in space and time (Wiessner, 1989, pp. 56–58; Parkinson, 2006, p. 36; Whittle, 2009, p. 104). Vessel forms, constrained partly by function (Rice, 1987, pp. 274–275; Sinopoli, 1991, pp. 84–85; Füzesi & Raczky, 2018, pp. 70–79), rath-

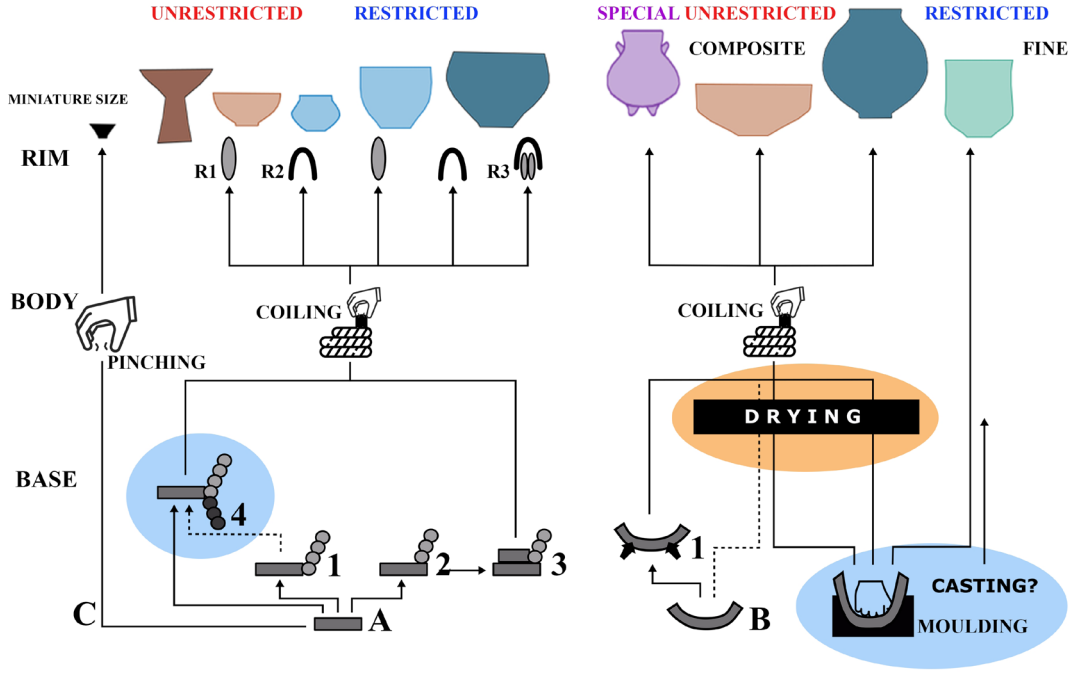


Figure 8. Characteristics of the pottery manufacturing process. Set of identified technological markers in the Late Neolithic assemblage of Öcsöd-Kováshalom. Details highlighted with colours represent technological innovations in the course of the Middle Neolithic (blue) and at the beginning of the Late Neolithic period (red) (prepared by the author).

er responded to periodically occurring regional trends (Raczky, 1988, pp. 20–21, 28; Raczky, 1989, p. 234; Budja, 2015, pp. 536–538, 544), the appearance of local variants was less typical. At the same time, the technological system only partially followed new claims and challenges; it preserved archaic elements that eventually took part in the formation phase of the Late Neolithic Tisza culture (Fig. 8).

The combined analysis of the three basic aspects of ceramics and the comparison of their different transformation dynamics at Öcsöd-Kováshalom highlight the differences in the underlying content and social connotations of these phenomena.

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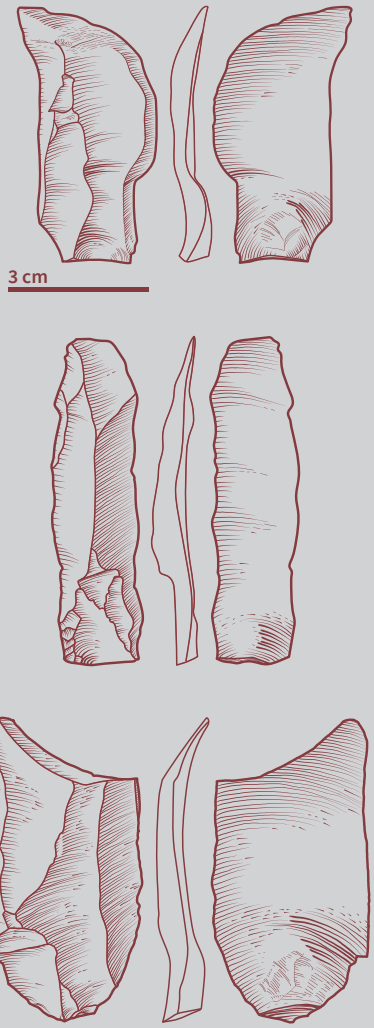
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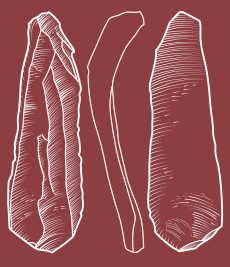
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Blades from the Neolithic Boldogkőváralja depot.
Drawing after Jean-Georges Marcillaud.



Sajóbábony 2021: open-air education at an open-air site, surrounded by a curious crowd. Zsolt's courses and excavations are not only visited by students specializing in the Palaeolithic, the rich knowledge material and methodology have become popular among students and researchers of other periods as well. *Photo: Agnès Lamotte, drawing: after Jean-Georges Marcillaud.*



9

Settlement research of the Late Copper Age Baden complex in Hungary

NEW EVIDENCE FROM THE PAST TWO DECADES

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Abstract. In this paper, I summarise the lessons learned from the Late Copper Age settlement archaeology of the last 20 years, largely based on my research. The aim was to revise the existence, distribution and internal chronology of the classical Baden pottery style groups established by János Banner in 1956, using new evidence from modern settlement pattern research.

Keywords: Late Copper Age, Baden complex, Regional pottery groups after János Banner

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To the trailblazer Zsolt Mester to his 60th birthday, who sacrificed almost a lifetime to introduce a new research methodology in Hungarian prehistory research.

1. Introduction[1]

I have been engaged in the research of the Late Copper Age since 2001, when I excavated Balatonőszöd, the currently largest excavated and published site of the Boleráz–Baden cultures (Horváth, 2014). Later, in 2005, I investigated a Pit-grave kurgan near Hajdúnánás (Dani & Horváth, 2012), and in the next year, I participated in a Hungarian-Russian research project that focused on the investigation of a kurgan field near Buzuluk in the Orenburg region, Russia (Pető & Barczi, 2011). In 2016, I received a two-year Lise Meitner scholarship, providing the opportunity to compare Austria and Hungary in the Late Copper Age (Horváth, 2022). In this article, I will describe and discuss my settlement research in Hungary as well as my new research projects undertaken as part of the Lise Meitner scholarship. My excavations and assessments: Balatonőszöd-Temetői-dűlő, Csécse-Nagyréti oldal, Salgótarján-Baglyas-kő, assessments excavated by others: Hódmezővásárhely-Gorzsa-Sandpit V, Ózd-Kőalj-tető, Salgótarján-Pécs-kő, Szombathely-Kőszeri-dűlő, Szombathely-Reiszig erdő alatti dűlő, Szombathely-Újperint, Szurdokpüspöki-Hosszú-dűlő, Tatabánya-Delphi, Vámosgyörk-Motorhajtóanyag-tároló (Fig. 1).

In Hungarian prehistoric studies, the period between 3700 and 2800 BC is called the Late Copper Age, unlike in other European countries where the same period is known as the Late Neolithic, the *Jungneolithikum*/*Spätneolithikum*, or the *Jungsteinzeit*. The Baden complex is one of the determinant cultures of this long period, spanning almost a thousand years.

The autonomy of the Copper Age of the Balkans was acknowledged in the wake of Colin Renfrew's studies in the 1960s–1970s (Renfrew, 1969). More recently, a similar advance has been made regarding the independent Copper Age of the Iberian Peninsula (Bartelheim & Krauss, 2012). Irrespectively of the fact that one of the main pillars of the change in terminology was the magnificent metalwork in these regions, Hungarian prehistorians have used this label for the Boleráz and Baden cultures whose metal finds are barely known, from the very beginning, from the 1890's (Pulszky, 1883; Hampel, 1895).

In many respects, Baden is much more than an archaeological culture, a point that was first raised in the 1960s, this is the reason that Baden is designated as a culture complex in several studies written by Viera Nemejcová-Pavúková, Evžen Neustupný and József Korek (Němejcová-Pavúková, 1981; Neustupný, 1968; Korek, 1983). In fact, early scholars of this period already sensed something of the culture's complexity since, for example, Joseph Bayer, who excavated one of the very first Baden sites at Ossarn (Au), called it a *Mischkultur* (Bayer, 1928). Baden eclipses the average prehistoric archaeological culture not merely owing to its vast distribution from the Black Forest to the Black Sea and its long sequence. The irradiation of its material culture and its impact on other cultures was the most salient feature that led to its designation as a cultural complex (Furholt, 2008, 2009).

Some prehistorians traced this cultural irradiation as far as Troy in Anatolia in the light of the anthropomorphic vessels found at Troy and Ózd-Center (Kalicz, 1963), and the wagon models brought to light at Budakalász-Luppacsárda (Soproni, 1954). It has been suggested that the Baden culture can be linked to immigrants from

1 The oral presentation was given at the ÖGUF (Österreichische Gesellschaft für Ur- und Frühgeschichte) lecture session in 12, December 2017.



Figure 1. Researched sites/areas mentioned in the text (prepared by the author, basemap: Google Earth).

Troy – conversely, other prehistorians tend to highlight the culture's local roots in its emergence (Neustupný, 1968). In fact, the culture's cradle and the circumstances of its emergence are still unknown.

In Hungary, the term Baden complex covers Boleráz, the early Baden phase, the classical Baden phases, as well as the Cernavodă III, Kostolác and Vučedol cultures, which share many similarities with classical Baden and are partly or wholly contemporaneous with it (Horváth, 2016). These cultures and groups are regarded as populations with a material culture that is related to Baden. The archaeological terminology of these cultures is not uniform, reflecting the many uncertainties which, at the current state of research, cannot be resolved or confirmed. Following Martin Furholt, the more neutral term "pottery style" is used for their designation and for distinguishing between them instead of group, culture or phase.

A wholly intrusive population, the communities of the Pit-grave culture arriving from the Far Eastern steppe, occupied the Great Hungarian Plain during the same period as the cultures of the Baden complex. In the trans-Tisza region, the Pit-grave areas were wedged into the Baden territory, mostly in the grassland unoccupied by Baden (Horváth, 2011).

A clarification of the nature of the interactions between these two markedly different populations remains a task for future research. While the Baden heartland is located inside the Carpathian Basin (mainly Hungary), the core distribution of the Lower Danubian Cernavodă III, Kostolác and

Vučedol cultures as well as of the eastern steppic Pit-Grave culture lies beyond Hungary, and only a small portion of their population infiltrated the region. In their case, their integration into Baden, the autochthonous culture in Hungary, represents one intriguing issue, while another is the changes in the culture of the groups who moved away, split off or simply drifted to the fringes compared to their brethren who remained in the heartlands of their respective cultures.

2. General research history

While the relationship between the period's archaeological cultures, groups, styles and phases, and their chronological position relative to each other has since long been broadly established, much less is known about the sites owing to the small size of the investigated areas and, perhaps even more importantly, because most of these have not been published. Over fifty years elapsed between the excavation and the publication of two unique burial grounds, the Boleráz cemetery at Pilismarót-Basaharc and the Baden cemetery at Budakalász-Luppacsárda, despite their being well known in international scholarship (Bondár & Raczky, 2009; Bondár, 2015a). These circumstances were hardly conducive to Late Copper Age studies.

Meanwhile, the exploration of the settlements has been even less successful. Small details were required by law to be excavated, with no attempt to relate them to a larger picture or to fit them into a contemporary settlement network. More excavations before the 2000s did not even have a topographical field survey, except in a few cases where the excavating archaeologist had a higher-than-average affinity for field survey or drawing. Thus, it is very difficult to evaluate them on their merits from today's point of view.

In the meantime, the growing number of radiocarbon dates and the advances made in radiocarbon dating led to a wide gap between the period's absolute and relative chronological position. The gap between the two spanned some 1500 years in terms of the Baden culture, whose onset was traditionally dated between 2200 and 2000 BC – the emergence of Baden was pushed back to 3700 BC in the light of the dates from Arbon Bleiche 3 (Leuzinger *et al.*, 2002) and other new sites.

While the clash between the short and the long chronology ultimately ended with the adoption of the long chronology, prehistorians largely failed to address the implications of this chronological shift. For a very long time, any discussion of the impossibility of any contact between Baden and Troy was studiously avoided. (Given that the occupation of Troy began around 3000 BC, Baden could hardly be synchronised with Troy levels II–V between 2200 and 2000 BC if the culture emerged in 3700 BC and terminated in 2800 BC.)

Neither was it examined how, in the wake of the period's changed chronological position, the late Middle Copper Age cultures preceding Baden may have impacted the emergence of Baden, or how Baden faded into Early Bronze Age cultures succeeding it. This chaos principally affected the Balkans and Anatolia, until Joseph Maran clarified the main issues in a comprehensive study (Maran, 1998).

The large-scale excavations from the 1990s onward in Hungary (and the changes in the legal climate) finally enabled the investigation of previously unimaginable extensive areas with various techniques that had not been employed earlier as well as the primary assessment of the finds. Although a final report on most of these excavations is still unavailable, some patterns could nevertheless be identified regarding the nature and internal layout of the sites, as well as the overall settlement network and the complex's lifeways and chronology. In this study, I do not discuss the proto-Boleráz (Phase Ia) sites because I am convinced that these are multicultural sites from the previous Middle Copper Age (see, for exam-

ple, Horváth & Svingor, 2015, pp. 22–30), the integration of which into Baden would mislead fundamentally well-defined trends. The single Late Copper Age site that has been fully assessed and published is Balatonőszöd-Temetői-dűlő (Honti & Horváth, 2013; Horváth, 2014).

In the first part of my work, I shall describe and discuss my excavations at Balatonőszöd, a site that differs and stands out from the other known Baden sites in terms of both its size and its nature. I shall focus on those cardinal points that have significantly changed our perception of the Baden complex and can be set against the so-called Fonyód group, the Baden group distributed in the southern Balaton region.

In the second part of this presentation, I shall review the preliminary findings from various special Late Copper Age sites that will probably advance our understanding of this period.

3. The Balatonőszöd-Temetői-dűlő site

The Balatonőszöd site lies some two km from the current southern shoreline of Lake Balaton. The stable isotope analysis of the molluscs from the site revealed that Lake Balaton had covered a much greater area in the Late Copper Age and that its extent was about one and half times larger than today, meaning that the settlement had lain directly on the lakeshore, beside a smaller river – currently an artificial canal – flowing into the lake. This would suggest that the Late Copper Age was wetter than today and this influenced the region's permanent and intermittent hydrological system (Horváth, 2014, Sections 3.3.6–7).

It is therefore hardly surprising that the extensive lake and the rivers flowing into it represented a marked environment that offered favourable conditions for the communities settling here and, at the same time, also determined their culture that was shaped by adaptation to the specific conditions.

The number of Baden sites in Hungary has been estimated as being around 2000 sites (Horváth, 2016, p. 53: database of the national register). However, my estimates, based on the published data that can be checked, indicated a figure of around 600 (Horváth, 2016, p. 83). Only in the case of ten sites identified during the past decades could it be assumed that a Baden building had been uncovered – however, as it turned out during the review of the evidence, these sites could all be assigned to another period. Contentions regarding the lifestyle of the Baden culture were all based on this paradoxical picture: on the one hand, the high number of Baden sites compared to previous periods suggested a population growth or a more intensive settlement pattern, while on the other, not one single building was found on any of the settlements, which rather implied a more mobile or a semi-sedentary population often on the move. This, then, was the main argument behind the conceptualisation of the Baden culture as a stockbreeding, semi-nomadic population from the 1950's onward.

The Balatonőszöd site was the first and currently still is the only Baden site where any buildings have been brought to light. The four buildings had a similar size and groundplan, three were arranged in a row and they had been erected on the site's highest point, on the hill ridge. The house type uncovered during the excavation recurs among the site's archaeological finds: house models representing the same building type can be found among the ritual devices, while the refuse pits beside the houses contained burnt daub from the building's one-time floor, walls and roof. Back in 2001, however, the house plans uncovered during the excavation came as a surprise because similar structures had never been uncovered in Hungary. During the site's assessment, when I searched for possible parallels, I realised the similarity between these buildings and pile-dwellings, and in my discussion of the Baden lakeside

dwellings, I reviewed the evidence from southern Germany, Switzerland and Bulgaria, as well as from Austria, although the latter had no connections with Baden. Considering the prominent spatial and geographic role of Lake Balaton, the appearance of this building and settlement type is immediately quite understandable. It seems likely that similar buildings had been uncovered on another Baden site near Esztergom on the Danube, in a location similarly characterised by capriciously fluctuating water levels, the implication being that it proved possible to demonstrate the presence of a special waterfront settlement type of the Baden culture and its typical buildings in Hungary too (Horváth, 2014, Section 3.1.1).

We investigated an area of roughly 100,000 m^2 at Balatonőszöd, which is outstanding even among the large-scale excavations (most of which cover an area of 10,000 to 20,000 m^2 on average). Luckily for us, the greater portion of the excavated features could be assigned to the Late Copper Age, another unique trait of the site since most of these large-scale excavations are conducted on sites occupied during various periods. However, the other sites were not dominated by Baden features. The nature of the features uncovered at Balatonőszöd is much more diverse than on other known Baden sites: some 1000 pits of various forms and fills, suggesting different functions, roughly 100 hearths and ovens of various types, the already mentioned 4 buildings, 2 wells, human and animal deposits, as well as a destruction layer covering the greater part of the settlement, which contrast markedly with the other average Baden sites made up of pits (Horváth, 2014, Chapter 3.1).

Quite amusingly, the truly interesting aspect of the site was its cultural duality, which might seem quite obvious at first sight. Although Boleráz was recognised as the first, initial phase of Baden already in the 1960's and assigned to the Baden complex, this significant cultural ordering was based on meagre data from field surveys. Not one single site occupied by both Boleráz and Baden was excavated in Hungary and thus any assertions concerning the relationship between them were essentially based on observations and data from Slovakia and the Lower Danube region, and not on Hungarian archaeological evidence. Unbelievable as it may sound, the first jointly occupied Boleráz–Baden sites were uncovered in this century at Balatonőszöd and a few other sites investigated along the planned line of the M7 Motorway – of these, only the data from the completely excavated and assessed Balatonőszöd site can be seriously considered in a site- or culture-level critical overview.

A very interesting occupation pattern was noted at the site. We identified a Boleráz occupation area in a lower-lying area closer to the lakeshore, which we initially believed to be earlier, and a classical Baden occupation slightly farther from the lake on somewhat higher-lying ground, which was believed to be later, according to the conventional relative chronological framework. The assessment of the finds revealed that there was some interaction between the two settlement parts: we found a few Baden sherds in Boleráz pits and a few Boleráz vessel fragments in Baden pits, suggesting that the communities we labelled Boleráz and Baden had interacted and had co-resided in some form. I did not initially have any doubts because I assumed that this horizon would be what is labelled the IIa Baden phase, representing the Boleráz–Baden transition. However, a closer look at the site's spatial organisation revealed that there was a 70-meter-wide zone between the two occupation areas or villages, even though the two lay extremely close to each other and could easily have merged. What we have here is a striking paradox: while the Late Copper Age settlement continued both spatially and chronologically, a spatial divide conforming to the Boleráz and Baden pottery styles could nevertheless be observed.

The series of dates obtained from the systematic sampling of the site further complicated this issue, for the dates indicated that the IIa transitional phase was not a brief period as earlier believed, but a rather long one falling between 3350 and 3000 BC, characterised by a chronological overlap between Boleráz and Baden at this site. Our two communities with their differing identities were neighbours during this 350-year-long period, they adapted to each other during their interactions, as a result of which Boleráz, which had settled at the site around 3500 BC, gradually ceased to exist, while Baden, which appeared around 3350 BC, continued to thrive until 2800 BC, until the close of the Late Copper Age and even after it. The settlement model elaborated for Balatonőszöd was the first to describe the genuine spatial and chronological relation between the two pottery styles on one particular site, which yielded a rather surprising picture compared to the previous cultural tableau (Horváth, 2014, Sections 3.3.14–15).

The most intriguing issue was to determine what had taken place between the neighbouring Boleráz and classical Baden villages, and whether there are any archaeologically visible traces of the interaction between the two communities. In other words, how did Boleráz evolve into Baden? Was it a peaceful transition, a voluntary submission, or, conversely, an unavoidable surrender coerced by brute force, an aggressive seizure of power? The striking proximity of the two villages would suggest that their communities were close to each other not only spatially, but in other respects too. Similar subsistence practices are indicated by the raised domestic species, which only differ in their finer details: for example, pig, a species more widespread during wetter periods, had a higher proportion in Baden than in Boleráz (Horváth, 2014, Section 3.3.3). At the same time, the growing proportion of pigs could also be a reflection of a more sedentary lifestyle. It also became clear that the co-residence of the two communities was fairly long, a favourable circumstance in the sense that this long period saw more activities, actions, reactions and interactions, which have a greater chance of including ones that would leave a trace in the archaeological record that we can detect even after five thousand years using the modest tools of basic archaeological research.

Is it possible to paint a picture of a 5000-year-old settlement based on the excavation record? Although this might seem somewhat bold, the evidence provided by this site warrants an attempt. The most prominent and noteworthy features, artefacts and phenomena, which in my view most saliently express human nature and conflicts between individuals, can be found in the ritual sphere – and if anything, this site was extremely rich in ritual locations and ritual devices (Horváth, 2014, Chapter 3.2).

The remains of 76 human individuals were recovered from 46 settlement features; compared to the number of graves in the culture's formal cemeteries, more Baden burials were recovered from settlement pits than in the completely excavated Alsónémedi cemetery which had 43 graves (Korek, 1951).

This was the first site where we tried to identify and carefully distinguish between the funerary customs of the Baden complex. The few formal burial grounds such as the Baden cemeteries uncovered at Budakalász-Luppacsárda and Alsónémedi, and the Boleráz cemetery at Pilismarót-Basaharc, represent but one, and not even the largest dimension of the culture's funerary rites. Additionally, these burial grounds are spatially isolated in the sense that they are not associated with any settlements and cannot be easily interpreted on the level of the one-time settlement network. At least as many or even more burials have been uncovered on the partially excavated settlements of the Late Copper Age as in the formal cemeteries, the implication being that the analysis of cemeteries is insufficient for Late

Copper Age population estimates or for modelling funerary customs.

At the same time, the burials found at Balatonőszöd show an astonishing diversity. Some of the dead were accompanied by grave goods and were interred in grave pits dug specifically for this purpose and carefully laid to rest. These interments probably shared a similar ritual background as the cemetery graves, but since they were uncovered in settlements, they nonetheless differ from each other. I have termed these burials as settlement burials.

Some burials lacked grave goods and were deposited in pits whose primary function was not funerary but of another nature, meaning that these burials were secondary. I have termed these burials bloody sacrifices and I also strove to identify the sacrifice type, if possible, based on the nature of the sacrifice. The first instance when we could be quite certain that the deceased individual had met a violent death came to light at Balatonőszöd: a chipped stone arrowhead found lodged in-between the vertebrae of female skeletons No. 37 in the mass grave No. 1489. We identified traces of clashes or violence on the male skull from Burial 41. Mass graves and single or multiple burials suggesting kinship or family ties could be distinguished, in whose background we can assume social or kinship conflicts, or even perhaps sudden mass deaths (caused by an epidemic or a battle). Traces of burning in a pit can be associated with white or celestial magic, while the dark, wet depth of the well 1099 suggests black or chthonic magic (Horváth, 2014, Sections 3.2.1–2).

Given that the majority of the interments were child and female burials, one possible explanation is that they were not accorded a place in the cemeteries owing to their social position – they had perhaps not attained the necessary status in life, or the circumstances of their death diminished the status achieved in life. It seems to me that this was the case because some sort of pathological deformation could be noted on most of the interred individuals, both among the settlement burials and the bloody sacrifices – although these were not the cause of death, the individuals were in all likelihood stigmatised because of these physical disabilities (for example lameness, pigeon-breastedness, humpbacked, bucktoothed, blindness, deafness: Horváth, 2014, Section 3.3.1).

The inarticulate bodily parts are particularly noteworthy. Arms, legs and skull fragments came to light in isolation, in pits, sometimes with traces of burning. The post-mortem manipulation of the body perhaps also involved some kind of smoking ritual, which ensured the preservation and conservation of the body, perhaps because it was not interred immediately after the onset of death. There were additional manipulations of the body after the primary interment: the head and limbs of certain individuals were removed and then used in other rituals, indicated by the incidence of various types of ritual vessels and ritual devices in or beside sacrificial pits containing human and animal deposits (Horváth, 2014, Section 3.2.4). In one case, we also uncovered a complex ritual area with a sacrificial pit, fireplaces, postholes and refuse pits.

The funerary rites involving the manipulation of the head and the limbs show a surprising correlation with certain ritual devices, among them the distinctive headless figurines of the Baden complex which were modelled without arms or legs, and have an opening, or several openings, for inserting one or more heads, which are assumed to have been made from some organic material, explaining why they have not been found (Horváth, 2014, Section 3.2.5). The post-mortem manipulation of the dead specifically affected the head and the limbs, perhaps as part of an initiation rite, and since traces of this manipulation are generally found in settlements, it seems obvious that these rites were conducted on the settlement and not in the cemeteries.

The Balatonőszöd settlement was the first site where interments from the Boleráz period were also brought to light. These were all settlement burials. In contrast to the cremation cemetery uncovered at Pilismarót-Basaharc, these were, at long last, the first inhumation burials, meaning that they were suitable for demographic and metric comparative analyses, and for describing the Boleráz population, an undertaking for which cremations are unsuitable. Compared to the gracile, lepto-dolichomorphic, Mediterranean anthropological type of the classical Baden, the Boleráz burials represented an Alpine-Dinaric brachycranic type, whose survival in Baden reflects the continued presence of this anthropological component as well as its increase, suggesting a slow, continuous infiltration from the Alpine region (Horváth, 2014, Section 3.3.1).

In addition to their incidence in human burials, animal remains were recovered from 87 other features, some together with human remains, which I interpreted as appeasing sacrifices repeatedly presented by the community, and some without any human remains. Several types could be distinguished among the latter too, in part according to species, and in part according to the animals' age, sex and body placement. The cattle sacrifices share the most similarities with human internments, mirroring the body placement of human burials and the grave goods accorded the dead, the implication being that as one of the most important livestock species of the Baden complex, cattle were equal to humans, for whom they could be substituted in the case of certain bloody sacrifices. Anthropologists have reported similar practices among several cattle-breeding African peoples. In other cases, the age of the animal indicates the sacrifice of the firstborn, while its sex is possibly a reflection of whether it was sacrificed in the course of a male or female fertility rite. Most animal sacrifices can be assigned to fertility rites, and agrarian and calendrical rites, again reflecting a colourful diversity (Horváth, 2014, Sections 3.2.1, 3.2.3, 3.2.6).

It is very telling that human and animal sacrifices, in other words, bloody sacrifices, are only documented in classical Baden, but not in Boleráz. How should this be interpreted? It is possible that Boleráz lacked bloody sacrifices, that there were no conflicts which called for these types of rites, or that, unlike Baden, conflicts were resolved peacefully. It is also possible that the victims of the human sacrifices uncovered in the Baden settlement part had been chosen from the neighbour Boleráz community, which eventually led to the disappearance of Boleráz and its assimilation into Baden. Unfortunately, the basic archaeological and physical anthropological analyses are unsuitable for resolving this issue – further isotope and DNA studies are needed to obtain meaningful results.

The large size of the settlement is quite surprising and singular, especially considering that the occupants were part of a mobile community characterized by non-sedentary arable farming, they were stockbreeders rather than peasants. Although the excavations did not uncover the settlement's entire territory, we estimated that some 60% was investigated – even so, the discovery of such a large settlement occupied by a population regarded as having a mobile lifestyle was highly unusual and surprising.

The most recent excavations suggest that Balatonőszöd was not an isolated case, but a typical dispersed Baden settlement. It seems likely that there were several similarly large settlements of which only a much smaller portion fell into the excavated area than at Balatonőszöd.

Despite the settlement's astonishingly large size, no more than four buildings were uncovered, all of which had a small floor area and had been occupied by four nuclear families, who were perhaps related to each other, forming an extended family or clan. The settlement attained its gi-

gantic extent not owing to the high number of its occupants, but because of the long duration of its use-life.

Although the only Baden site where four buildings with internal structures were excavated, the life of the settlement was not organized around the buildings but around the sacral spaces. It was not possible to delineate the external work area belonging to the house or the row of buildings consisting of three buildings, and with the help of this, the rules of household archaeology could be applied.

The settlement's relative chronology shows that it remained occupied until the onset of the latest Baden IV phase, but did not see the end of that phase (IVb?). However, contradicting the relative chronology, the absolute chronological dates indicate that the settlement was occupied even after 2800 BC, the date marking the close of the Copper Age, during the transitional period between the Copper and the Bronze Age, and that its use-life extended into the Early Bronze Age, making it the first settlement where the post-Copper Age survival of Baden and its relation to the subsequent Early Bronze Age cultures could be studied.

It would appear that in this region, the emergence of the Somogyvár-Vinkovci culture between 2750 and 2550 BC, had possibly coincided with a few post-Copper Age Baden groups – the real question is whether there was any interaction between them, for example on one particular site, or whether any interaction can be wholly ruled out (Horváth, 2014, Chapter 5).

In terms of its relative chronology, the site lies on the territory of the northern transdanubian so-called Fonyód-Úny group, including the southern shore of Balaton after Banner (Banner, 1956, pp. 40–42, Abb. 35) (Fig. 2: 1). Later Fonyód territorial group was correlated with the IIa transitional phase in her conventional typo-chronological schemes ("Fonyód/Tekovský Hrádok": Němejcová-Pavúková, 1981, p. 262), while the associated group Úny was placed into the Phase IVa.

As we can see, the large-scale excavations have revealed that the ceramic inventories from several sites lying close to Balatonőszöd include vessels not only from Phase IIa but from Phases Ib to IVa, calling for a critical re-assessment of the Fonyód-Úny (territorial or chronological?) group(s).

The long life-span both in terms of relative and absolute chronology does not, in itself, explain the appearance of these huge sites, often conglomerates of sites or settlement networks, in the southern Balaton region in the case of small communities organised along nuclear families and kinship ties. An alternative explanation was necessary, which raised the possibility that the lack of archaeologically visible buildings can perhaps be attributed to the fact that the Balatonőszöd site and other settlements had not been permanently occupied. An intermittent occupation and the periodical return to these settlement sites according to some cycle not known to us led to the growth of these settlements and their "chaotic" conditions in terms of their excavation, with many features cutting each other already during their occupation because the community that periodically returned to the site no longer remembered or was no longer familiar with the layout of the abandoned settlement. It seems likely that only a few more significant features had been marked such as the wells and the repeatedly renewed areas of the major community rituals, and possibly the locations of the houses designed for portability that could be easily dismantled and re-assembled again.

A look at the distribution of the sites reveals that settlement chains or networks were established along watercourses and that the settlements were spaced three to five km apart. The sites within a drainage network may represent links in a chain of settlements used by a community of smaller families that was continuously on

the move along the watercourse with their large stock of animals, rather than separate, individual communities (Horváth, 2014, Chapter 4). Thus, the seemingly high number of Baden sites compared to the preceding Middle Copper Age and the ensuing Early Bronze Age is grossly misleading because the number of Baden sites cannot be correlated with the number of Baden communities occupying them. The high number of sites does not reflect a population growth, but rather a specific lifestyle.

For a broader model of this phenomenon, the other Late Copper Age sites in the Balaton region should by all means be incorporated into the model, which should then be extended to the entire territory of Hungary to discern patterns, if any, on the cultural level. What was the nature of this cyclical movement pursued by the Baden communities along the watercourses flowing into the lake along the southern shore of Lake Balaton? How mobile were the communities of the Baden complex compared to the genuinely mobile and migrant Pit-grave population, whose settlements are not known from the Great Hungarian Plain, only their burial places? Based on the Russian and Hungarian archaeological record, the Pit-grave population is assumed to have had a migratory range of some 50 km and a seasonal movement conforming to a transhumance model. Are there archaeological or other approaches with which this issue can be explored in the case of the Baden complex?

In his monograph on the Baden culture published in 1956, János Banner outlined a regional Baden group which he labelled the Fonyód-Úny group after a smaller cemetery section with nineteen cremation and two inhumation burials uncovered in modern Fonyód in 1935. Unfortunately, it remains unclear from what is known about the excavation whether the site represents part of a formal cemetery, whether it lay on the fringes or immediately adjacent to a settlement, or whether the burials were settlement burials. The Late Copper Age sites uncovered along the planned track of the M7 Motorway using modern field techniques yielded finds of both Boleráz and Baden and all sites were occupied over considerably more phases than Baden IIa. In this sense, the concept of the Fonyód group as defined by János Banner can be discarded (Horváth, 2014, Section 4.2; the re-assessment of the Úny group: Bondár, 2015b, Horváth *et al.*, 2020). The newly identified sites outline the shoreline zone of Lake Balaton during the Late Copper Age, although there are a few sites farther inland along the smaller watercourses flowing into the lake.

Returning to Balatonőszöd, the sites along the watercourse beside which the settlement is located outline a closed settlement network. Much more detailed studies and a meticulous assessment of all excavated sites would be necessary to confirm that these were established by the same community as the one settling at Balatonőszöd and to determine whether there was any hierarchy between them. Some of the sites in the settlement network could have been formal cemeteries or animal pens without any settlement features, while others could have functioned as seasonal, intermittent or permanent settlements.

A targeted search strategy possibly would yield refitting artefacts from different sites within the network, probably not among the utilitarian objects of daily life, but among the more remarkable, and therefore more easily identifiable ritual devices or unique objects such as the Balatonőszöd mask, one of the culture's and the period's unique finds, of which only one half was found. Where can its other half be? If it came to light, it would provide conclusive evidence for the incontestable interaction and maintenance of relations between the two communities. Is there any chance of it ever being found, or is it an illusion to hope for its discovery (Horváth, 2002, 2004, 2010, 2015)?

Unlike in the earlier Neolithic cultures, the mask was not a frequently used ritual device – at least, there is no evidence whatsoever for the use of masks in the currently known voluminous Baden find material. The modelling of the Balatonőszöd mask differs from the other prehistoric masks in that is unusually detailed, to the extent that even the anthropological type depicted by it could be identified. Curiously enough, the mask does not portray the average gracile Mediterranean Baden type, but a robust Cro Magnon type, which during that period was frequent among the burials of the Pit-grave population (Horváth, 2014, Section 3.2.5).

How did an individual of the Pit-grave population from their settlement territory in the trans-Tisza area come to be portrayed in a Baden village in Transdanubia? The realistic, almost portrait-like details suggest that its creation was inspired by a personal encounter because its creator could hardly have rendered the face so accurately based on someone's description. It remains unknown whether this personal encounter took place in the Baden village or a Pit-grave settlement. The mask was carefully broken in two, suggesting, on the strength of various analogies, that its other half was intentionally kept by someone. Similar examples can be cited from better documented prehistoric periods such as the Minoan Palatial period on Crete, where various artefacts were used as tokens for personal identification. An individual identified himself or herself by presenting the other half of a particular, usually special artefact and thereby gained access to some important thing such as information, some special right, or admittance to a prominent individual. The identity of the Kurgan-type man portrayed on the mask in the distant Baden society living by Lake Balaton is not known: his status could have a conqueror, an overlord, a high-status religious leader or an individual on par with the Baden people (a merchant or a military strategic thinker, perhaps a craftsman), or, conversely, a subjugated person, a slave or even a prisoner. The cultural contacts in the background of the mask nevertheless suggest that the mask's other half should not be sought in another Baden settlement but in the Pit-grave distribution of the trans-Tisza region.

4. Southern shore of lake Balaton

For roughly fifty years after János Banner's publications of the urn cemeteries and a few sporadic settlement traces in the Fonyód area, the so-called Fonyód horizon or Fonyód group (Fonyód/Tekovský Hrádok IIa after Němejcová-Pavúková) distributed in the Fonyód-berek (marshland) along the lake's southern shoreline was assigned to the Baden IIa transitional period based on the finds from these sites (Banner, 1956, pp. 28–33, Sites 37–41; and Table 1 in Horváth, 2014, Chapter 4). There was an ongoing debate on whether the sites represent a transitional phase or whether they should be assigned to Boleráz or Baden, with most Hungarian scholars adopting István Torma's view that the Fonyód horizon represented the final phase of the Boleráz sequence (Torma, 1977, p. 55).

Four other sites of the southern Balaton region must be highlighted which can provide information by Balatonőszöd for modelling the Late Copper Age settlement network.

One of these is the site on the outskirts of Balatonlelle, extending along the opposite banks of a former watercourse, the Forró-árok (Nagy, 2006, 2010; Sófalvi & Nagy, 2007; Sófalvi *et al.*, 2007). The excavated area with 36,554 m^2 on one side was a Boleráz–Baden settlement with cultural layer, settlement burials and sacrifices as at Balatonőszöd, while the site on the other side of the watercourse was a separate formal cemetery with 22 Boleráz and Baden graves, obviously associated with the settlement. Unfortunately, only the report on the cemetery has been published to date (Nagy, 2010), but even so, the preliminary

data shed some light on a recurring pattern: some settlements had a separate community cemetery, usually located on the bank of a watercourse opposite the settlement. A similar situation was documented at the sites of Vámosgyörk (Farkas, 2004; see later). The implication for future research is that formal Baden cemeteries can perhaps be more successfully searched for in the light of this pattern, and a rise in their number can be expected.

The other interesting region is represented by the sites in the Balatonszemes (at Balatonszemes–Szemesi-berek a large classical Baden settlement was excavated on 42,000 m^2) and Balatonlelle–Balatonboglár area (e.g., Honti, 1981; Bondár *et al.*, 2007; Fábián, 2014, pp. 408–415), which were perhaps part of a huge conglomerate of sites. In this case, we are faced with the problem that in the lack of an association between the excavated areas, we are not always capable of determining whether the investigated site portions lying strikingly close to each other were part of the same huge continuous site, or whether they were the independent, nearby links of a network along a watercourse. The sites at Szemesi-berek and Egyenes-dűlő in the Balatonszemes area were quite certainly the continuations of the same site (Fábián, 2014, pp. 408–414), and the continuity between the sites at Balatonlelle-Rádi út mellett, Rádi-domb and Rádpuszta-Temetői-dűlő too seems quite probable (Fábián, 2014, pp. 415–431).

The third highly promising site is Balatonkeresztúr-Réti-dűlő, which lies slightly farther from Lake Balaton, in the wetland along the River Zala. Unfortunately, the assessment of the site is incomplete. The occupation pattern of this settlement differed from the Balatonőszöd settlement since the Baden and the Boleráz features lay among each other across the settlement's entire territory, while the radiocarbon dates confirmed a relative chronology in which the successive phases followed each other fairly rapidly. There was no indication of a post-Copper Age survival. If the preliminary report can be believed, the significance of the site lies in that it indicates an entirely different occupation pattern than at Balatonőszöd, with a full spatial mixing between Boleráz and Baden, while its chronological range has an entirely different dynamism than that of the Boleráz and Baden communities at Balatonőszöd, where the two co-resided for a long time, but in isolation from each other (Fábián, 2013, 2014, pp. 103–397).

A long chain of sites was discovered in the Fonyód-berek during the investigations preceding the construction of the M7 Motorway (Horváth, 2014, Chapter 4, Fig. 5). The sites were occupied for varying lengths of time, but overall, they span the period from Balaton–Lasinja/*Furchenstich* through Boleráz to Late Baden (up to the appearance of Kostolác), indicating that these sites do not represent a separate chronological phase or a regional group. At the same time, they share numerous similarities with the settlements found elsewhere along the lake's southern shoreline such as Fonyód-Vasúti-dűlő Sites 1, 2 and 3, Fonyód-Bézseny-puszta, Fonyód-Fehér-bézseny and Fonyód-Tüskés, excavated by Krisztina Somogyi and Zsolt Gallina (Honti *et al.*, 2004; Honti *et al.*, 2007, pp. 23–26, 35–42).

The Fonyód-Ordacsehi region differs slightly from the region between Balatonszemes and Balatonőszöd. A glance at the region's historical maps shows that aside from the zone of the few meters high sandbars and bluffs along the lake's shoreline in the Keszthely, Fonyód, Boglárlelle, Balatonföldvár, Zamárdi and Siófok area, in the area between Balatonvilágos and Balatonkenese, as well as in the Balatonfüred and Tihany area, a high water level resulted in a single constantly or intermittently water-covered huge area and that only the basalt cap of Mount Fonyód rose above the water. In other words, hardly any settlements can be expected in the shoreline zone in this area

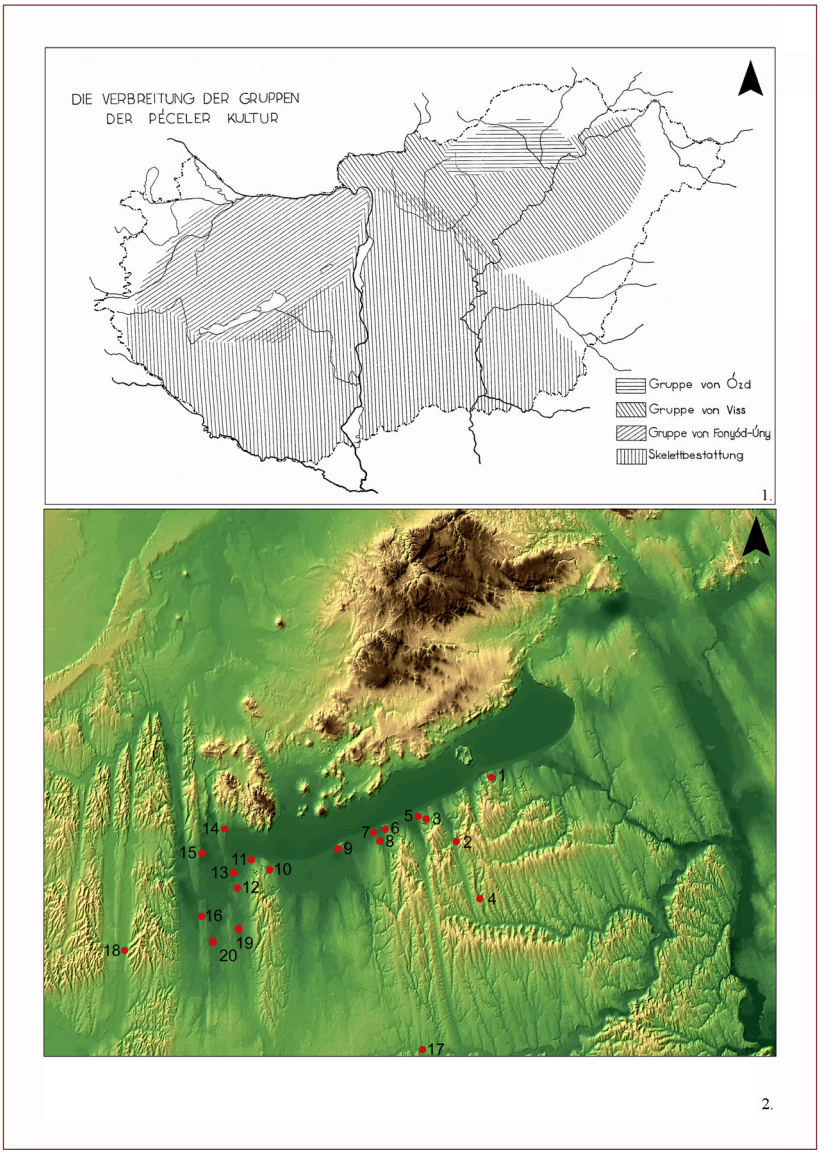


Figure 2. 1 (top): The Baden pottery styles after Banner (1956, Abb. 35). 2 (bottom): The southern Balaton region with the Late Copper Age sites. The sites are: 1 – Zamárdi, 2 – Szólád, 3 – Balatonőszöd, 4 – Andocs, 5 – Balatonszemes, 6 – Balatonlelle, 7 – Balatonboglár, 8 – Ordacsehi, 9 – Fonyód, 10 – Balatonkeresztúr, 11 – Balatonberény, 12 – Tikos, 13 – Vörs, 14 – Keszthely, 15 – Sármellék, 16 – Balatonmagyaród, 17 – Kaposújlak, 18 – Nagykanizsa, 19 – Sávoly, 20 – Szőkedencs. Prepared by the author.

or considerably less than east of Balatonboglár and Balatonlelle.

It follows from the above, that the Fonyód/Tekovský Hrádok horizon cannot be treated as an independent regional or chronological group in southern Transdanubia or as a separate chronological phase representing the IIa transitional period between Boleráz and Baden.

The geographic boundaries of the southern Balaton region are also slightly blurred (See: Horváth, 2014, Chapter 4, Fig. 1): it is uncertain whether there was a meaningful connection between the northern Balaton shoreline to the northern or southern Transdanubian region, the Pécs area and the Danubian region (Cp. Horváth, 2014, Chapter 4, Fig. 2). A similar pattern of sites

located on the ridges running parallel to the watercourses can be noted in the Rábaköz region, in the Marcal Basin, in the Kemenesalja region and the Göcsej (Kerka Valley region).

The southern Balaton region is characterised by the north-west to south-east meridional valleys extending the southern shore of Lake Balaton, the Sió/Sárvíz rivers in the east, the Zala river in the west and the closed drainage system of the Völgység, Hidas and Kapos rivers in the south (in the Dombóvár–Kaposvár–Nagykanizsa line). There is a break in the distribution of Baden sites in County Zala: a single site (Hahót-Szartori I) is known in the Kerka Valley, while none have been identified in the adjacent south-eastern Styrian region of Austria and the Prekmurje region of Slovenia, indicating that the western boundary of the Baden distribution lay in this region.

A settlement pattern resembling the one in the southern Balaton region can be discerned along the River Rába and its tributaries in the Little Hungarian Plain down to the River Zala and in the Mezőföld region along the Sárvíz/Móri-víz and the Váli-víz/Benta streams.

The Baden occupation in the Pécs area and the Mecsek Mountains differed: in this region, we find hilltop and tell-like settlements, for example at Pécs-Nagyárpád and Zók-Várhegy, often together or successively with the Vučedol culture. The relation between the Baden and the Somogyvár-Vinkovci culture, often documented on the same sites (Cp. Horváth, 2014, Chapter 4, Fig 2, Chapter 5, Fig. 10) is not known. Although vessels with a similar decoration pattern to Baden's are known from several sites in the South Balaton region (e.g. Vörs-Batthyányi disznólegelő, Pécs-Nagyárpád: Horváth, 2014, Chapter 5, Fig. 6.2–3; Ordacsehi-Kécsi-mező: Kulcsár, 2013, Fig. 4). For the time being, the geographic sub-regions cannot be correlated with the currently known typological and chronological groups of the Baden complex.

Similarly, to the Fonyód group, the other assumed chronological horizons and regional groups identified by János Banner in 1956, Viera Němejcová-Pavúková in 1981 and József Korek in 1983 can probably also be rejected because their separation as distinct units within the Baden complex is not borne out by the current evidence.

The main conclusions – and caveats – that can be drawn from the data are that the regional Baden groups as defined by János Banner, which have been strictly adhered to in prehistoric studies, have practically lost their relevance and that very different cultural and occupational patterns can be discerned even within the same geographic region such as the southern Balaton, meaning that the period was characterised by a mosaic-like cultural patterning. However, this does not mean that we will not encounter recurring patterns, one good illustration of which is the combination of settlements and their associated cemeteries. It is also quite evident that the settlement layouts and settlement networks of the Baden complex can hardly be described with a single model.

However, a single site such as Balatonőszöd, or even an entire region such as the southern Balaton region is insufficient for constructing models on the country or on the culture level, for which a much larger sample is necessary. This can be achieved by the re-assessment of older assemblages and the assessment of the new excavations to broaden our overall picture as much as the evidence permits.

Following the details above the suggested label for this territory is the Southern-Balaton group of classical Baden, but it is cannot extended to the whole territory of Transdanubia. The chronological position of the Southern-Balaton group extended to the classical Baden II–III–IV Phases (Fig. 2: 2).



Figure 3. 1: The examined sites in the environment of Szombathely. 2: Mug decorated with incised labrys motif on its base (Úny-type). 3: Fragments of a bowl decorated with a seated human figure, large mammals and an Ózd-type handle from Bükkábrány (Photos: L. Fekete). Made by T. Horváth.

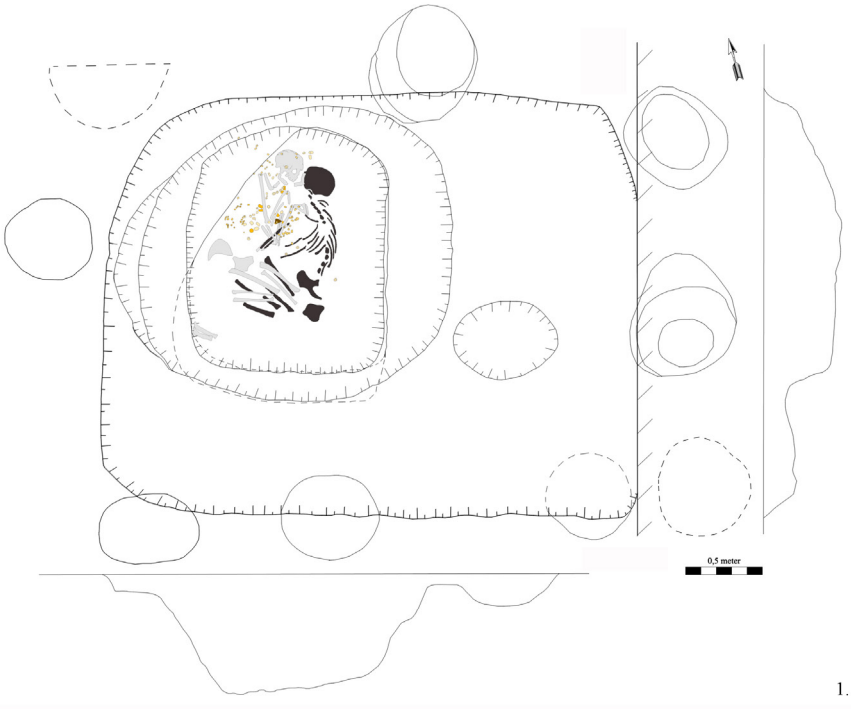
5. Regional pottery styles in Hungary not after János Banner

There are indeed regional variations in the classical Baden pottery assemblage in Hungary, as János Banner was the first to publish. This can often be seen in the decoration of the ceramic forms, sometimes in the different shaping methods of the same types. A similar phenomenon has not been reported for a long time from other countries in the area of classical Baden, although it may exist (*cf*. Furholt, 2009).

To what can this divergence in ceramic styles be attributed? Does it have any other characteristics than territoriality (e.g. chronological, settlement aspects, possibly a cultural background from the end of the Middle Copper Age)?

Research on settlement history over the last twenty years has convinced me that regional variations in ceramic style are linked to geographically and topographically determined settlement history.

In other cases, they show the influence of the cultures of the preceding, terminal Middle Copper Age period. The paradox is that this influence is not on the Boleráz culture that immediately followed the Middle Copper Age, but on Baden after a time gap (or, the terminal Middle Cooper Age cultures survived and lived in the Boleráz-period, at the beginning of the Late Copper Age). In these



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Figure 4. 1. The double human burials from Tatabánya-Delphi. 2. The distribution of Boleráz and Baden sites in the Komárom-Esztergom and Pest Counties. Prepared by the author.

areas, there is either no or a noticeably sparser network of Boleráz settlements compared to the total area of distribution. This process is particularly marked in areas where the cultures of the terminal Middle Copper Age were stronger and more homogeneous, and where the geographical conditions made deposition more difficult (e.g. mountainous regions with limited places of settlements at NE-Hungary, Pest County, Transdanubia; or regions with extensive water network e.g. Southern-Balaton region).

In the next, I shall briefly discuss my preliminary findings regarding the sites analysed as part of my Lise Meitner scholarship. I made every effort to cover the entire territory of Hungary, bearing in mind that I only had two years at my disposal (Fig. 1). I therefore had to make a few compromises. I did not find any evaluable material in southern Transdanubia (Decs-Dög-kút and Tamási-Csikó-legelő are two Boleráz–Baden settlement parts, the excavations of Géza Szabó, which I am processing) or in the country's central region, in the Danube-Tisza interfluve and the central part of the Great Hungarian Plain. As an alternative, I undertook a critical review of the monographs on Budakalász-Luppacsárda, the one cemetery lying in this region (Horváth, 2017a).

I assessed three new sites in the Szombathely area, in north-western Hungary bordering on the Burgenland (Au), one site in Tatabánya-Delphi in north-western Transdanubia, one site on the outskirts of Hódmezővásárhely-Gorzsa-Sandpit V in the southern Hungarian Plain, one site on the outskirts of Vámosgyörk-Motorhajtóanyag-tároló in the piedmont area in the northern Hungarian Plain, and I also undertook the critical re-assessment of several already published sites in the Salgótarján (Pécs-kő) and Ózd (Center, Kőalj-tető, Szentsimon) areas as well as the assessment of a newly excavated sites at Szurdokpüspöki-Hosszúdűlő, Csécse-Nagyréti oldal and Salgótarján-Baglyas-kő in the country's north-eastern region (Nógrád and Borsod-Abaúj-Zemplén Counties). These sites are either well-known iconic sites of the Baden complex, which largely determined our perception of the culture, or are the key sites of a regional Baden group as defined by János Banner, and thus play a prominent role in the study of a region's site network or the critical review of a Baden group.

5.1. Environment of Szombathely (NW-Hungary, Transdanubia)

I undertook the assessment of three sites in Szombathely (Fig. 3), which can be regarded as the region's first Late Copper Age sites found since the 1900s, after a long research gap.

A Boleráz pit was found during the construction of Road 89 bypassing the town (Site 2: Kőszeridűlő: Horváth, 2017b); two other pits and part of a Kostolác settlement came to light slightly north of the Boleráz pit (Site 5: Reiszig-erdő alatti dűlő: Horváth & Wild, 2017). The water washed out an assemblage of Baden vessels in a former gravel pit inside the city (Újperint: Horváth, 2017c, 2018c).

The three sites along the Gyöngyös-Perint drainage represent three different cultures and periods of the Late Copper Age, although, unfortunately, not on the same site that would have enabled a study of the transition between them.

The vessel types of the Boleráz sites and their ornamentation have much in common with the Boleráz material from Austria, and the site's very early date, falling between 3700/3600 BC, similarly compares well.

The assemblage of Baden vessels washed out by the water in the Újperint gravel pit included a highly remarkable vessel: a mug bearing an incised labrys on its base. This motif represents the double axe, a formerly unencountered artefact type, which is a reflection of the culture's far-ranging contacts.

The Kostolác site is rather unusual in Hungary because it lacks Baden material; instead, this site

yielded genuine Pivnica-type late Kostolác material without any Baden. Its radiocarbon date assigns this Kostolác settlement part to after the Late Copper Age, to the Copper Age/Bronze Age transition between 2800 and 2600 BC.

The classical Baden pottery types and decoration (Úny group) show similarities with the adjacent territory toward Burgenland (Austria).

5.2. Tatabánya-Delphi (Transdanubia)

A small portion of a Baden settlement was uncovered in the inner city area of Tatabánya on the bank of the Szent-György stream, where only the lower sections of the various features could be observed owing to later disturbances and natural erosion. Only a more deeply dug settlement burial containing two skeletons survived undisturbed (Fig. 4: 1). One unusual feature of this double burial containing a man and a woman embracing each other was that the woman was interred in a funerary garment covered with *Dentalium* beads. An arrowhead was found in her abdomen, suggesting a violent death. According to the field observations, there were no similar traces or finds suggesting an unnatural death in the case of the man, who had been interred at a much earlier date (Horváth *et al.*, 2020). The slight difference in the radiocarbon dates confirms that the two bodies had not been interred at the same time, confirming the observations made at Balatonőszöd regarding the diversity of burial rites, violent death and the post-mortem manipulation of the bodies.

This double burial offers an opportunity for a critical look at Banner's Úny group and for the reconstruction of how *Dentalium* adornments were worn.

The vessel hoard that is now treated as a stray find was found at Úny-Diós-Bozzay ráta in 1936 (Bondár, 2015a). This depot of 12 posts is the eponymous site of the northern Transdanubian regional group of Úny.

The Fonyód and Úny groups were first identified and described as separate units by Banner in his monograph, but with partly overlapped distribution (Banner, 1956, 40–42, Abb. 35, Taf. XV/1–2, 5–16, Taf. XVI/1–10, Taf. XVII/14, 18–21; 186; Fig. 1.3). In later scholarship, the two groups were conflated and the Fonyód-Úny group was used to denote a regional distribution as well as a chronological period, although opinions varied as to whether this should be equated with the early Baden Phase IIa, the transition from Boleráz in the light of the Fonyód burials, or Phases IIb, III or IV of the classical Baden period on the testimony of the vessel assemblage from Úny.

Of the group's diagnostic traits, only the applied plastic ornamentation on the neck of large amphorae is acceptable today, which is attested in the Vienna Basin too (Vienna, District 22, Seestadt Aspern, cf. Penz, 2014, Abb. 13). If the Úny group does exist, it spanned the entire classical Baden sequence in time, and in the Northern Transdanubia toward Austria/Burgenland in space.

The Ludanice and the Balaton-Lasinja cultures can both be found in northern Transdanubia. It is possible that this duality persisted during the Late Copper Age and was reflected in small regional variations in ceramic style and/or ornamentation in the classical Baden culture. In areas lacking an occupation during the terminal Middle Copper Age, there is a cultural hiatus during Boleráz, i.e. during the initial period of the Late Copper Age.

The radiocarbon dates for the Boleráz cemetery at Pilismarót-Basaharc indicated that the cemetery's use began between 3645 and 3500 BC, during the average classical Boleráz Ib–Ic phases. However, the cemetery has a later section extending into the classical Baden II–III Phases between 3370–2930 BC, and perhaps a third phase of use during the post-Late Copper Age Baden IV Phase, suggested by two dates falling between 3100–2920 and 2860–2490 cal BC (Hamilton, 2015). Unfortunately, this radically new chronology was

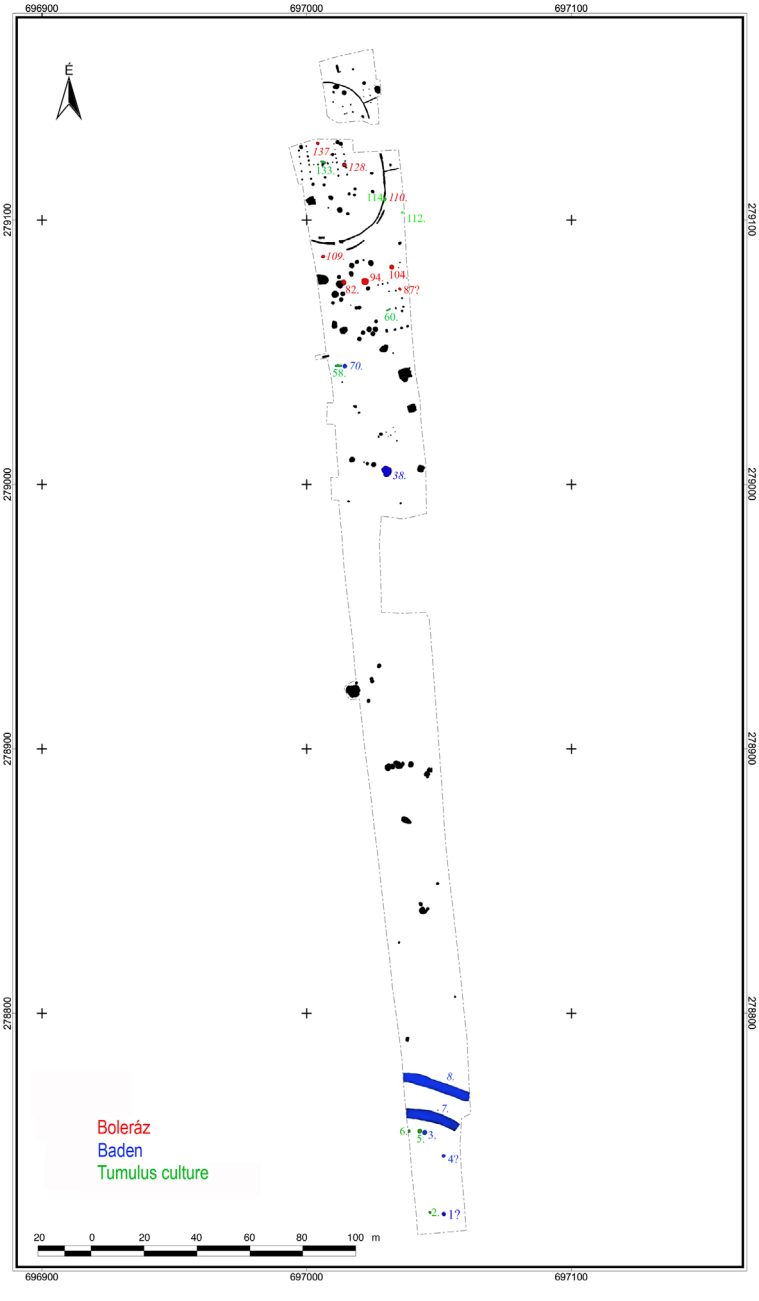


Figure 5. The ground plan of the excavations at Szurdokpüspöki-Hosszú-dűlő. Prepared by the author, after the groundplan of the excavation, made by N. Larsson.

not explained at all in the section evaluating the site by M. Bondár, sticking to the conventional chronology of Boleráz before 3350 BC (Bondár, 2015a).

This would imply that although the Boleráz culture appeared in the county between 3700 and 3500 BC, its presence spanned a longer period than previously assumed. This implies an entirely different status quo than what we have hitherto conceptualised of the Boleráz–Baden sequence. A comparison of the new radiocarbon dates for the double Baden burial at Tatabánya with the dates for the Boleráz cemetery at Pilismarót indicates that Boleráz and Baden overlapped in time during the entire duration of the Late Copper Age from 3350 BC until 2800 BC, and perhaps toward in the transitional period between Copper and Bronze Age (Fig. 4: 2).

5.3. Szurdokpüspöki–Hosszú-dűlő (NE-Hungary, Great Hungarian Plain, foreleg of the Northern Mountain Range/Cserhát–Mátra)

The excavation reports by two teams described a Boleráz–Baden–Kostolác settlement part with peculiar features, namely two enclosures near each other and post-framed structures inside the ditches at Szurdokpüspöki, an enormous multicultural site lying on the bank of the River Zagyva in the piedmont between the Mátra and Cserhát Mountains (the excavated part is 35,000 m^2).

The assessment of the find material indicated that the smaller enclosure at the northern part of the excavation can be dated to the Lengyel culture, while the larger one at the south is unknown (Baden or Middle/Late Bronze Age periods). The so-called Kostolác finds can be assigned to the Late Bronze Age Tumulus culture (Fig. 5).

Settlement parts of both the Boleráz and the classical Baden culture were uncovered at the site, which can play a key role in the research of the Late Copper Age in this region: No Boleráz, or Boleráz–Baden sites have so far been found in the Northern Mountain Range. The so-called Ózd-Piliny and Salgótarján groups were previously described as representing the latest Baden groups in this region (although without hard archaeological evidence or radiocarbon dates to substantiate this claim).

Despite its small size, the occupation patterns of Boleráz and Baden observed at the Szurdokpüspöki site, their find material (and especially their separation from the Tumulus culture finds) and their relationship to each other in the Late Copper Age yielded important new insights. Amongst the pottery we can not find Ózd-Piliny or Salgótarján forms, they belong to the classical Boleráz Ib–c and Baden II–III phases (Viss type after Banner), the radiocarbon data support this (Horváth *et al.*, 2018). The archaeologists of the Dornyay Béla Museum (Salgótarján) carried out further salvage excavations in 2021–2022, which covered the southern enclosure. After processing, its cultural classification and function will finally be known.

5.4. Vámosgyörk-Motorhajtóanyag tároló telep (NE-Hungary, Great Hungarian Plain, foreleg of the Northern Mountain Range/Mátra)

Several excavations have been conducted on the outskirts of Vámosgyörk lying in the area where the Hungarian plain grades into the piedmont. Some 50,000 m^2 of the site has been investigated since 1997 by Csilla Farkas: one part is made up of a settlement of which fifty features have been uncovered, while the other is the settlement's burial ground, where fifteen burials have been unearthed, lying on the opposite bank of the Gyöngyös Stream (Fig. 6). We have inventoried some 4,000 artefacts from this site to date (Ongoing project with Csilla Farkas since 2016).

One intriguing aspect of the site is that an Early Bronze Age Makó occupation could also be documented, meaning that the cultural trajectory of a longer period can be studied here,

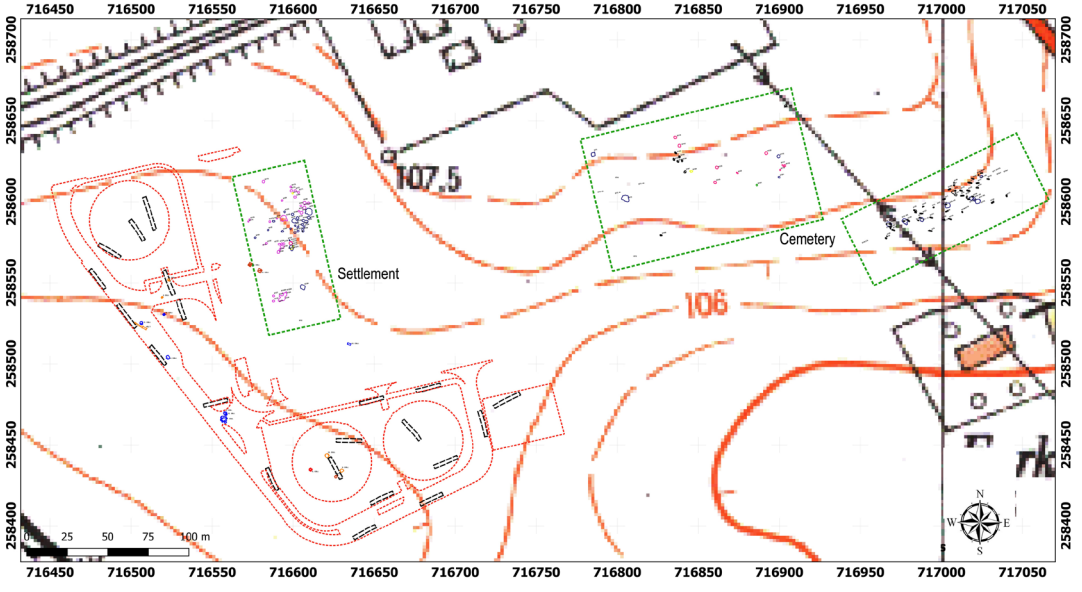


Figure 6. The ground plan of the excavations at Vámosgyörk-Motorhajtóanyag-tároló. Prepared by the author.

while the burial ground also contained five mixed Bodrogkeresztúr–Ludanice graves of the terminal Middle Copper Age.

The site can be assigned to János Banner's Viss group, whose most distinctive features are the grooved strap so-called Viss-type handle and the ornamentation of vessel surfaces with stabbed patterns. A Boleráz presence has not been documented either at the site or in its broader region.

5.5. Csécse–Nagyréti oldal (NE-Hungary, Great Hungarian Plain, foreleg of the Northern Mountain Range/Cserhát)

At the foot of the Cserhát, at the confluence of the Csécsei and Szuha streams, we excavated an area of 300 m^2 with a wall plane consisting of post-framed construction (house or fence?) and a few pits from a Baden (Viss) settlement. In two pits there were cattle sacrifices, and in one pit there was a pottery depot that could be valued as kitchen equipment of a nuclear family that fell into the wall plane of the house. We were the first to realistically make household archaeological observations at this site. Unfortunately, the excavation area was so small that we could not estimate parameters for the full extent of the site in space and time (Fig. 7) (Horváth *et al.*, 2022).

I have to note here how much I disagree with the use of so-called household archaeology in some of the work of my Hungarian colleagues dealing with late Copper Age sites. The fundamental flaw in the approach is that no houses were found at these sites. Assuming the location of houses on empty excavation surfaces is not scientific, especially not about reconstructing a household (Cp. Bondár, 2010; Fábián *et al.*, 2013; Fábián *et al.*, 2018; Fábián & Rajna, 2021). The application of theoretical archaeology in a basically „homeless" archaeological culture like the Baden, forced by the faculty of the Department of Archaeology at the Eötvös Loránd University, takes the research in an unrealistic direction,

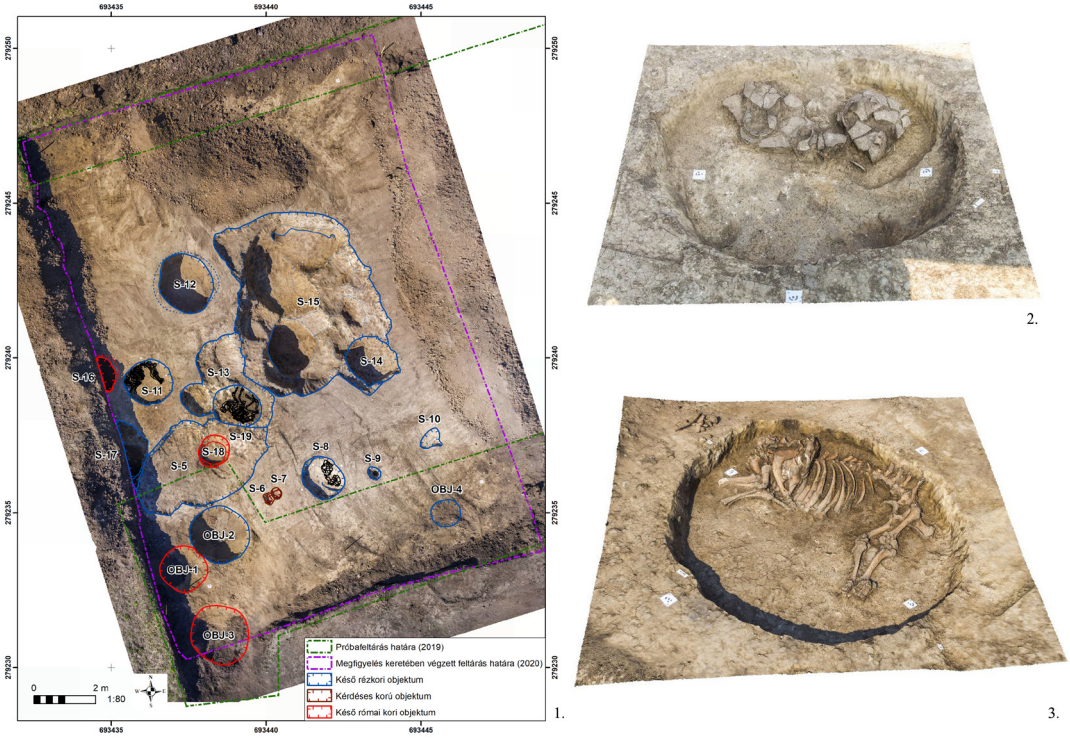


Figure 7. 1: The ground plan of the excavation in 3D at Csécse-Nagyréti oldal. 2: Vessel depot in Pit 8 in 3D. 3: Cattle depot in Pit 11 in 3D. Prepared by the author after the excavation groundplan and the 3D photogrammetry of Pits 8 and 11, by K. Tóth.

whereby reconstructing the excavation data falsifies the reality. We should focus more on finding the houses at the sites, because if they are at one site (Balatonőszöd), they should be at more sites, too. The application of excavation techniques, the urgency and unenforceability of the deadlines set, and last but not least the inadequacy of those who carry out the excavations, lead us primarily to a little knowledge of the Baden buildings.

5.6. Environment of Ózd and Salgótarján (NE-Hungary, mountain region)

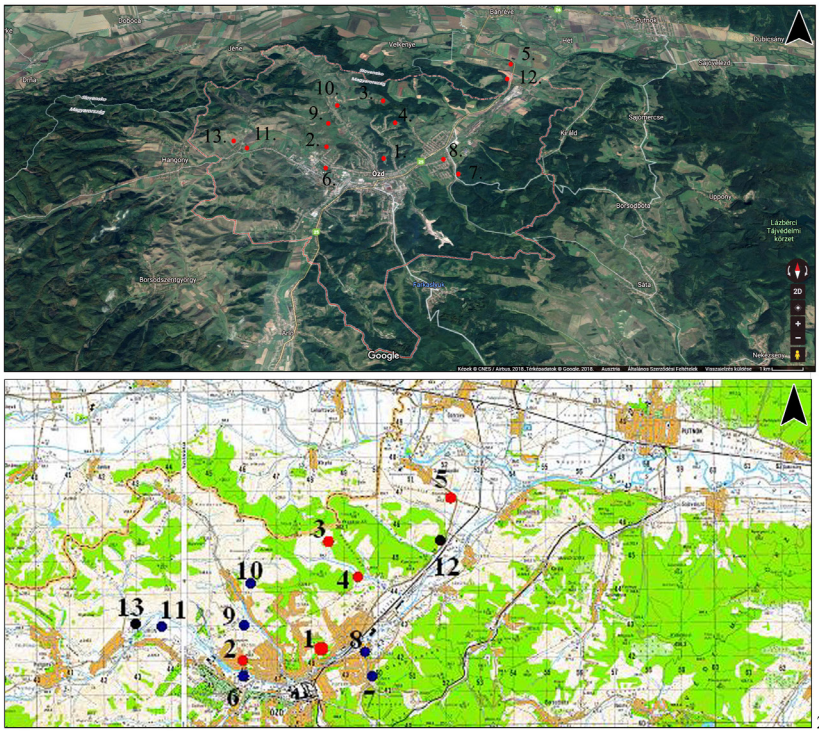
The sites hallmarking Phase IV, the latest phase of the Baden culture, lying in the Ózd area and at Salgótarján-Pécs-kő, have all been known for a long time from their publications. Following the discovery of the anthropomorphic funerary urns containing cremation burials deposited under funerary mounds at Ózd-Center, Nándor Kalicz argued in 1963 that these Baden finds can be associated with the face urns from Troy level II–V and that the Baden culture emerged under the influence of groups who had migrated to the Carpathian Basin from Troy.

The sites in the Ózd area were recently revisited in a doctoral thesis written in 2014, which confirmed the previous scholarly consensus (György, 2014).

However, my research yielded radically different conclusions. The change was effectuated by a modern excavation on the outskirts of Szurdokpüspöki–Hosszú-dűlő, where, in addition



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Figure 8. 1: Late Copper Age sites in Borsod-Abaúj-Zemplén County (after György, 2014, Vol. 1, Fig. 11). 2: Late Copper Age settlement network in the environment of Ózd, along the drainage of Hangony stream (after György 2014, Vol. 1, Fig. 46, base maps: Google, Topographic map of Hungary). Prepared by the author.

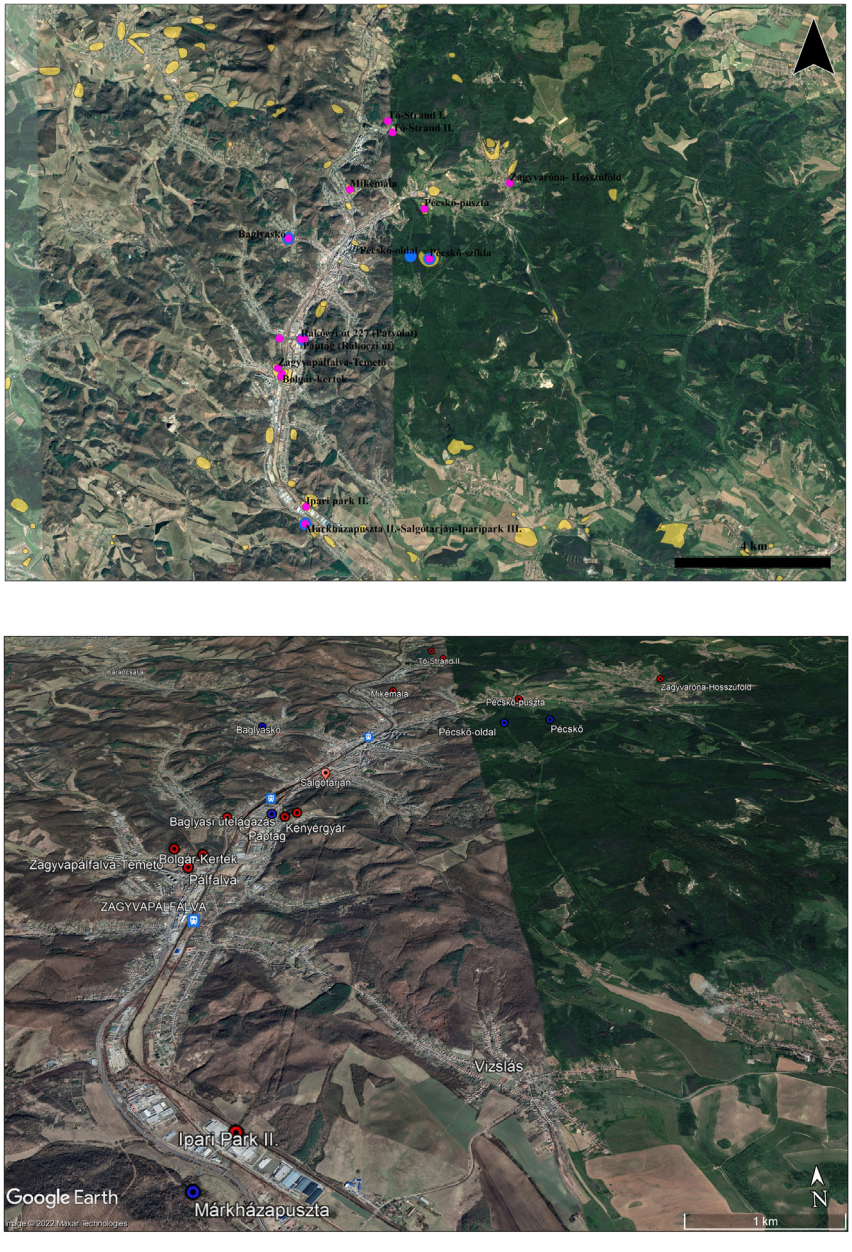
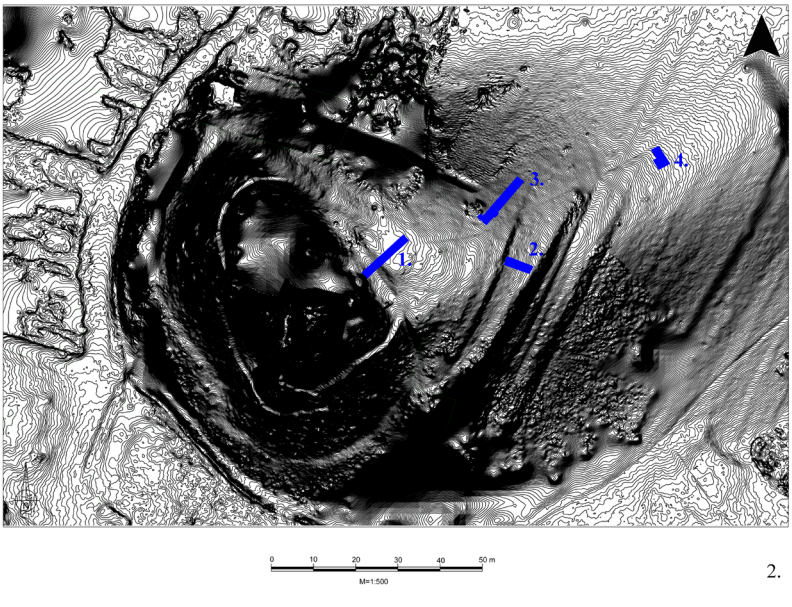


Figure 9. Late Copper and Bronze Age network system in the environment of Salgótarján (Base maps: Google, Google Earth 3D). Key: yellow: archaeological sites, blue: Baden, red/purple: Bronze Age. Prepared by the author.



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Figure 10. 1. The Salgótarján-Baglyas-kő site (orthophoto). 2. Contour map of Baglyas-kő showing the excavation trenches. Prepared by the author.

to the portion of a jointly occupied Late Copper Age Boleráz and Baden settlement, part of a Late Bronze Age settlement was also uncovered. This enabled the separation of the finds described as reflecting Kostolác, Bosáca and Coţofeni influence designated as Baden IV from the genuine Baden finds in the assemblages from the sites in the Ózd and Salgótarján area. As it turned out, the finds previously described as late Baden or as reflecting the impact of other cultures (Kostolác, etc.) could be assigned to the Late Bronze Age Tumulus culture (Horváth *et al.,* 2018).

The genuine Baden finds do not have any traits typical for Phase IV – although it must be borne in mind that the salient features of Phase IV have not been determined yet owing to the lack of sites and finds. The Baden sequence has only been elaborated up to Phase IVa, and thus we do not know what the Baden IVb Phase actually looks like. It yet remains to be determined whether Baden IVb is "missing" because the culture does not have this typological phase or whether it is lacking because only its onset was defined, and now that the finds previously attributed to this phase have been assigned to other periods, we are at a loss as to how to fill up Baden IV, what types should be ordered here. Since we are unable to fill the period with types, we cannot single them out either.

The finds remaining in the Late Copper Age are Baden II and III Phases types, which are mixed with genuine Kostolác and Kostolác-type finds. However, the old excavations do not provide sufficient information to enable an assessment on a settlement level. As we have seen, relative typo-chronology is of no use in this case, while an absolute chronology could only be confidently employed in the case of securely identified Baden cemeteries – it seemed senseless to even attempt to select samples from settlement material mixed up with the finds of other periods.

The first radiocarbon measurements for the cremation burials in the anthropomorphic urns from Ózd-Center and the formal cemetery at Szentsimon–Kender-földek gave dates between 3100 and 2800 BC, confirming that they fall into younger Baden, the later classical Baden period (Phase IV), which is still well within the Late Copper Age, meaning that, for the time being, a post-Copper Age Baden survival cannot be demonstrated in this region (Horváth, 2018a, Chapter 1).

Following the critical review of the material from the stratified, fortified, tell-like hilltop Baden settlement at Salgótarján–Pécs-kő, I found that no more than 16 of the roughly 600 finds previously assigned to Baden could be assigned to the Late Copper Age, while the other finds dated from other periods. As a consequence, the site can hardly be regarded as a fortified hilltop or even a stratified tell-like Baden settlement since it was predominantly occupied by the Hatvan, Tumulus and Piliny Bronze Age cultures and most of the occupation levels can be associated with Bronze Age cultures and not with Baden. Moreover, there is no evidence that the site had been fortified (Horváth, 2017d, 2018a, Chapter 2).

There are no significant regional, typological or chronological differences between the find assemblages from the Nógrád region and the Borsod region; moreover, its sites and distribution are part of the so-called Ózd-Piliny and Salgótarján groups. At the same time, the use of the label Ózd-Piliny variant instead of Ózd-Piliny group seems more appropriate.

The classical Baden group of the Baden complex north-east of the Danube is the Viss group after Banner (A deposit of pots and some stone tools found at the Viss-Szőlő-homok in 1938 is the eponymous site of Viss group, among the pots, a breast pot and a saucer represent the special shapes: György, 2014, vol. 2, pp. 270–272), while Ózd-Piliny is a regional variant of Viss because it has typical elements of the Viss group alongside Ózd-Viss combinations. Its distribution can be located in the Northern Mountain Range, making it

a kind of mountain region variant – in contrast to the Viss group distributed on the northern plains across a much larger territory.

Its slight divergence from Viss and Ózd-Piliny can probably be explained by the lingering influence of the terminal Middle Copper Age cultures (Ludanice, Hunyadihalom, Lažňany, Bodrogkeresztúr cultures) on its territory during the Late Copper Age. At the same time, there are no visible traces of similar, separate groups during the Boleráz period. The only logical explanation for this apparent paradox would be the survival of Middle Copper Age cultures at the beginning of the Late Copper Age, Boleráz-timespan.

The Ózd-Piliny variant of the classical Baden culture flourished in the basins and hill country of the Northern Mountain Range during the Late Copper Age between 3350 and 2800 BC, while a Boleráz presence can be demonstrated in addition to Baden in the piedmont region before 3350 BC (e.g., Szurdokpüspöki-Hosszú-dűlő) and in the mountain caves lying above 400 m. The Boleráz settlement network in the mountain region of the Northern Mountain Range between 3700 and 3350 BC is not known.

In addition, classical Baden built microregional settlement networks in the Ózd (Fig. 8) and Salgótarján area (Fig. 9), where we were able to investigate in detail, similar to the Southern Balaton region. The sites around Ózd follow a main valley of Hangony stream and its tributary valleys in an approximate NW-SE direction, with two cemeteries at the end points (Ózd-Center and Szensimon-Kender-földek). The sites at Salgótarján follow the main valley running roughly north-south, dominated by two hilltop settlements at approximately the same latitude in the north: the Pécs-kő in the east and the Baglyas-kő in the west.

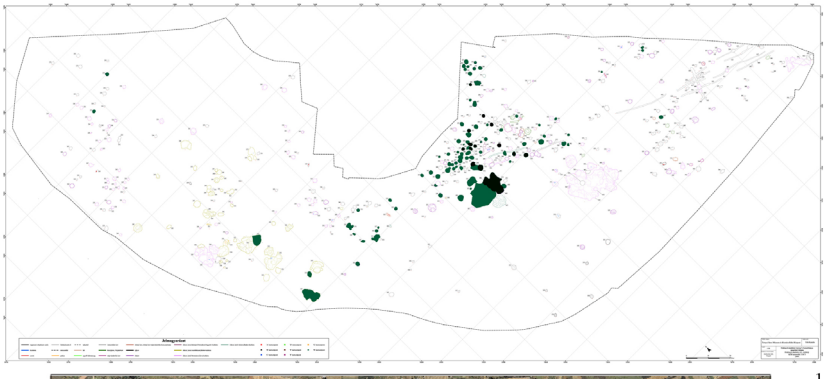
The critical review of the settlement excavated at Salgótarján-Pécs-kő, whose material was formerly described as a separate group of the late Baden culture (the Salgótarján group) indicated that the find assemblage from the site contained several finds other than those of the Baden culture (mostly from Late Bronze Age Tumulus culture). There is nothing to justify the continued use of the label Salgótarján group since the critical review of the finds revealed that the majority of the decorative traits regarded as distinctive to the group can be assigned to other cultures.

In addition, however, the site contains some Kostolác, Vučedol and Neusiedl-type finds that can be dated to the Transitional period between the Copper Age and the Bronze Age. Given that the site represents an unbroken continuity, I would suggest the use of the label *Salgótarján facies* for the post-2800 BC period following the Late Copper Age until the appearance of the independent Early Bronze Age Makó culture, probably sometime around 2600/2550 BC, although this can only be confirmed with future radiocarbon dates.

Even though it was not possible to sample finds from the settlements for radiocarbon measurements, the data from the settlements in the Ózd area (e.g. Kőalj-tető) and from Szurdokpüspöki indicate that neither the Ózd-Piliny group regarded as embodying late Baden since 1956, nor the Salgótarján group assigned to this period in 1986, actually represent surviving Baden after 2800 BC; instead, both fall into the classical Baden period spanning the Late Copper Age between 3350 and 2800 BC (Phases II–III–IV).

5.7. Salgótarján-Baglyas-kő

The Baglyas-kő is a smaller, dyke-like pass among the small basalt cones of the Karancs Hills at the NW outskirts of the city of Salgótarján, which, unlike the volcanic cones of the Nógrád region, lies not on a mountain, but on one of the low hills on the eastern margin of the hill range. The core of the stronghold dates from the Árpádian Age, the irregularly shaped basalt outcrop with steep sides (except on the northern side). The medieval stronghold's north-eastern, terraced fore-

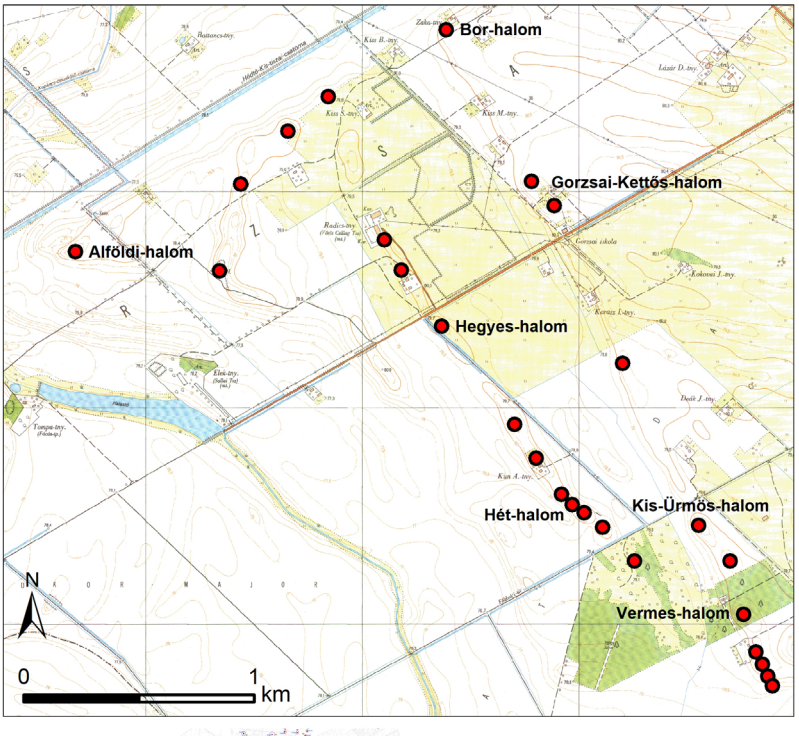


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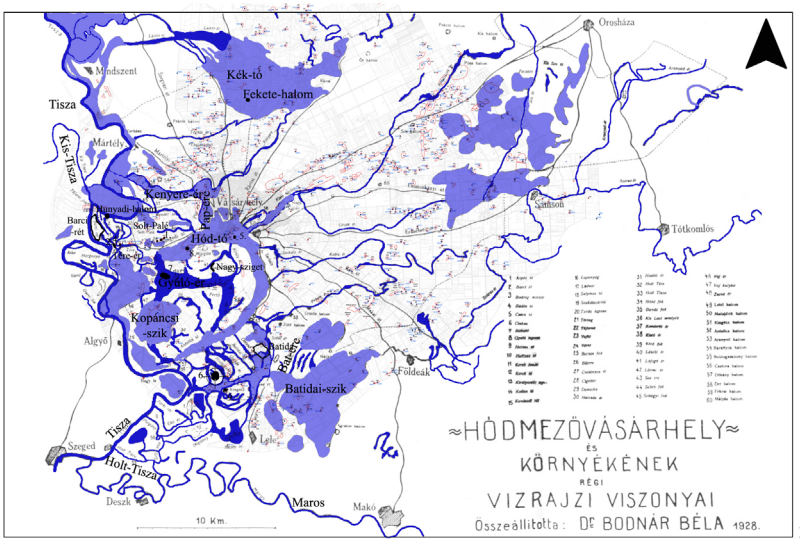


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Figure 11. 1: The ground plan of the excavation at Hódmezővásárhely-Gorzsa-Sandpit V. 2: The Baden sites in the environment of Hódmezővásárhely (Base map: Orthophoto). The sites are: 1 – Bodzás-part, 2 – Szakál-hát, 3 – Nagy-sziget, 4 – Solt-Palé, 5 – Laktanya, 6 – Gorzsa-Sandpit V, 7 – Kopáncs-Sandpit IX, 8 – Kis-Homok, 9 – Kingéc-Site V. Prepared by the author.



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Figure 12. 1. Pit-Grave kurgans in the environment of the Gorzsa–Sandpit V Baden settlement (The Baden settlement is on the same hill as the Alföldi-halom kurgan) 2: The water system of the environment of Hódmezővásárhely in 1928. (The numbers of the Baden sites are the same as Figure 11.2. Gorzsa-Sandpit V is no. 6). Prepared by the author.

ground, currently covered with grass, was suitable for excavation. We opened trenches in these areas across an 80 m^2-large area (Fig. 10).

The prehistoric features uncovered in Trenches 3 and 4 attested to the presence of an extensive settlement occupied during both the Baden and the Hatvan periods. The finds and the features indicate that the hillside was artificially terraced during the Late Copper Age and that the storage pits and other features were established in this area. These terraces were levelled during the Early and Middle Bronze Age – although natural erosion probably also played a role – and the community settling here then cut its installations, such as the ovens, into this layer. The occupation layers of possibly different cultures accumulated to a thickness of almost 2 meters in Trench 3. The fill layers dating from different periods and the outlines of the superimposed features of different cultures could not always be clearly distinguished, not least because of later disturbances, which poses difficulties in dating.

Pál Patay made similar observations on several sites in the region, for example at Ózd-Kőaljtető, Salgótarján-Pécs-kő, Piliny-Vár-hegy and Sőreg-Vár-hegy (Patay, 1999, p. 50). Unfortunately, these are all old excavations that lack proper field documentation or none was made and were excavated according to spade spits. This type of hilltop settlement with its tell-like occupation layers – differing markedly from the average scattered Late Copper Age Baden settlements – and the barely visible natural humus levels separating the occupation layers led to a general scholarly consensus according to which the Ózd-Piliny group, one of the late groups of the Baden complex, had retreated to the mountain region of north-eastern Hungary where it survived as a relict and lived to see the arrival of the Bronze Age tell cultures (specifically of the Early and Middle Bronze Age Hatvan culture in this region) – moreover, this group acted as a substrate of the Bronze Age cultures or its population blended with latter (Kalicz, 1968, pp. 133, 166–167, 172, 174; for a discussion of the purported Baden–Hatvan continuity, see Horváth, 2019, Chapter 4.7).

The assumed survival of the Baden culture into the Bronze Age and the cultural impulses from its early cultures would have explained a settlement strategy and occupation pattern that has much in common with the Bronze Age tell cultures. In addition to the uncommon settlement features, the abundance of Baden pottery with an entirely differing ornamentation would have again bespoken the late date of the Ózd-Piliny group and its survival into the Bronze Age.

The lack of clearly distinguishable occupation layers separated by naturally deposited soil layers dating from different periods, specifically from the Baden and Hatvan periods at Baglyas-kő, can be explained by that the space suitable for settlement was limited and the nature of the site – not being a level area – invariably led to spatial re-organisations during later periods before a new community's settlement and any building activity, whereby the natural soil layer(s) accumulating over previous occupation layers was destroyed or disturbed together with the underlying layers and their features, rather than by the site's continuous occupation.

Although the excavation and the associated non-invasive surveys were completed in spring 2019 alongside the conservation and inventorying of the finds as stipulated by the grant conditions, our understanding of the site remains tentative until the full assessment of the excavation and the finds (The investigation of the site was undertaken as part of the INTERREG V project (within the framework of the Slovakian-Hungarian Collaborative Project, Grant SKHU/1601/1.1/267, Living Heritage-Presentation of the cultural heritage transcending borders and ages in historic County Nógrád).

We considered the publication of the preliminary results important because the gap and discontinuity between the Copper Age and the Bronze Age that was previously conjectured and convincingly demonstrated on other sites (critical re-assessment of find assemblages, radiocarbon chronology: Horváth, 2018a) now could be proven through an excavation (Horváth & Szilasi, 2020) and, even more importantly, specifically in the mountain region of north-eastern Hungary, on a site lying a few kilometres away from the iconic Ózd-Kőalja-tető and Salgótarján-Pécs-kő sites.

The first radiocarbon dates and the ceramics place the settlement between 3350 and 2800 BC (classical Baden II–III–IV). There is a surviving between 2800 and 2600 BC with new cultural elements of this microregion (with a new label: *Salgótarján facies*, Transitional period between Copper and Bronze Age).

5.8. Hódmezővásárhely-Gorzsa-Sandpit V (SE-Hungary, Great Hungarian Plain)

A 58,000 m^2 large area on a hill overlooking a former Tisza meander was investigated on the southern outskirts of Hódmezővásárhely in 2009. Of the 700 features uncovered at this site, 100 can be assigned to the Late Copper Age Baden and Kostolác cultures. The features of the classical Baden culture uncovered in the four adjacent trenches showed a concentration in the site's central area, with scarcer scatter in a 50-meter-wide zone, followed by a 100-meter-wide zone lacking any features, after which various features were again documented. The separate cluster of features and the zone reflecting a scarcer occupation can perhaps be interpreted as indicating a dispersed settlement layout or perhaps as independent links within a settlement chain (Fig. 11–12).

Most of the uncovered features were pits, alongside two wells and several animal and human deposits. One peculiar trait of the site is that the neighbouring sites yielding similar material were described as representing Baden IV Phase, so-called "*Skelettbestattung*" by János Banner (Banner, 1956, p. 184.) and Bodzáspart group after József Korek (Korek, 1983, pp. 26–27). However, the assessment of the finds revealed that the material can be assigned to the classical Baden II–III phases, while the vessels earlier identified as representing Phase IV are Kostolác or Kostolác-type ceramics. This relative chronology is confirmed by the radiocarbon dates, none of which fall beyond 3000 BC. The meticulous field observations allow the conclusion that the three archaeologically distinguishable pottery styles, namely classical Baden, genuine Kostolác and Kostolác-type, are contemporaneous because they occurred jointly in closed, undisturbed features.

There was no trace of Boleráz at the site and thus a Boleráz–Baden sequence can be rejected in this region too. One reason for this may be the strong network of sites from the Middle Copper Age (Hunyadihalom, Bodrogkeresztúr, Cernavodă III?). However, a dense network of classical Baden sites can be reconstructed in the marsh-wetland region, interspersed with the burials of the Pit Grave kurgans of a similar age.

This site, lying in the country's south-eastern corner, confirms the conclusion drawn from the critical review of the north-eastern region that the finds hitherto ordered into the Baden IV Phase can be typologically assigned to Kostolác, and that they do not succeed the classical Baden II–III Phases, but are contemporaneous (Horváth, 2018b).

The skeleton burial group (*Skelettbestattung*) was named after Banner in the southern parts of Hungary, so this group was not named after a style of pottery but after a burial method. Skeletal burials are found throughout the Baden area. The question now is whether they are within the settlement (sacrifices, burials in settlements, post-mortem manipulations) or outside, in graves excavated in cemeteries. In the southern lowland region,

József Korek used the name Bodzáspart but did not develop the group characteristics. What is certain is that the typical Viss group handles are not found here, so another name will have to be chosen for the region southeast of the Danube. However, it is still questionable whether this area can be merged with the southern Transdanubian region, so the choice of name would be put on hold until suitable sites are found to provide a meaningful answer to the question.

6. Conclusion

No matter how much we would like to, we cannot describe a period characterised by intense population movements and communities with diverse material cultures such as the Late Copper Age and the Baden complex with a single model. Unlike Einstein's concise and elegant general world model condensed into a simple equation, any attempt to do so for the Late Copper Age is beyond our current knowledge.

Nevertheless, we have made significant advances in several respects, for example by discarding Baden IV Phase, described as reflecting Kostolác, Bosáca and Coţofeni impacts, which turned out to date from the Bronze Age or imported Funnel Beaker (Cp. Horváth, 2018a, pp. 145–146; Horváth *et al.*, 2019–2020).

1) By eliminating the Baden IV Phase as a surviving Baden after 2800 BC, we have simplified the classical part of the existing typological sequence into an earlier IIb between 3350 and 3000 BC, and a later III Phase until 2800 BC. Together with my earlier conflation of the classical Boleráz Ib and Ic Phases, this makes the existing, extremely complicated Němejcová-Pavúková typological system much more manageable.

2) Regarding the Banner-ceramic style groups, the new name of the Fonyód IIa group is the Southern-Balaton group, and its chronology covers the whole of the classical Baden.

3) We do not yet have sufficient data for analysis of the South Transdanubian region and the Danube-Tisza Interfluve with the central part of the Great Hungarian Plain.

4) The Úny group of North Transdanubia may be similar to Southern-Balaton, only the settlement patterns differ. In style, it spreads further west towards Austria.

5) In the northeastern area from the Danube, the Viss group is present throughout the classical Baden period, toward Slovakia, in the northern and central part of the lowland and piedmont region.

6) Its northeastern, mountainous sub-group is the Ózd-Piliny variant, toward NE-Slovakia and Little Poland.

7) In the southern part of Hungary (Southern Transdanubia and southern Great Hungarian Plain) was the Skeleton burial group after Banner. This label does not cover the reality of today's research, nor do we know whether the areas west and east of the Danube can be linked, so the name Korek's Bodzáspart cannot be applied to the southern lowlands. For the time being, we must leave this question open pending the evaluation of further Baden sites in South Transdanubia. What is certain is that the Viss handles are not found in the Southern Great Hungarian Plain, and therefore cannot be included in that regional group either.

Although the boundaries of the regional groups of the Baden pottery styles in Hungary are not yet clearly defined everywhere, certainly, the stylistic differences do not have a chronological aspect. All of the groups shown here cover all known phases of classical Baden.

I attribute the formation of the different spatial groups to the determinacy of geographical differences and the strong influence of the preceding Middle-Copper Age cultures.

In a small area around Salgótarján, we found strong evidence of the existence of multicul-

tural communities surviving the Late Copper Age in the Transitional period between the Copper Age and the Bronze Age (2800–2600 BC). A similar Transitional period settlement trace was found near Szombathely, but here we uncovered a Late Kostolác settlement fragment. Kostolác were found in the Ózd, Salgótarján and Hódmezővásárhely areas too, but without radiocarbon dates their age is questionable: they can be within the frame of the Late Copper Age until 2800 BC, or beyond it, in the transitional period between the Copper and Bronze Age.

We have also managed to identify recurrent patterns in the site chains along former watercourses and the spatial organisation of sites combining a settlement and a cemetery.

Currently, we can distinguish four basic, but fundamentally different settlement and occupation patterns in the Boleráz–Baden domain, as a result of the large-scale excavations over extensive areas.

The first one lacks Boleráz sites as in the Hódmezővásárhely, Salgótarján, Ózd area, the greater part of County Pest and Komárom-Esztergom and the overwhelming part of the Northern Mountain Range. It seems quite certain that in these regions Baden was not preceded by Boleráz and neither can it be regarded as the antecedent of Baden in any sense because it is not documented here during the Late Copper Age. Thus, we witness a cultural hiatus between 3700 and 3350 BC, excluding any contact between the two cultures. In these regions, there was a strong Middle-Copper Age site network.

In some regions, Boleráz and Baden both occur, but always separately, on separate sites, none of which reflect any signs of co-residence between the two. Their chronological position relative to each other shows some overlap between 3350 and 3000 BC. These regions include large tracts of Counties Komárom-Esztergom, Pest and Southern-Balaton region. In these cases, there is no archaeologically visible interaction between Boleráz and Baden. Their sites sometimes lie quite close to each other, no more than one km apart, and thus despite the separateness, contact between them cannot be wholly excluded, but there are no jointly occupied sites (e.g., Pilismarót-Basaharc Boleráz cemetery and Pilismarót-Szobirét Baden settlement).

Yet a third one indicates the same long overlap as in the previous case, but with a radically different occupation pattern as could be observed at Balatonőszöd-Temetői-dűlő, where Boleráz and Baden occupied the same site. A closer interaction can be noted, which is visible to us too, but despite the co-residence, a spatial separation persists. A similar settlement and occupation pattern could be noted in the north-eastern piedmont region too, where no jointly occupied Boleráz–Baden sites were previously known. The settlement layout at Szurdokpüspöki-Hosszú-dűlő again shows a clear separation between the areas occupied by Boleráz and Baden, although the two radiocarbon dates reflect a closer overlap and linearity compared to Balatonőszöd. However, I have only assessed a small part of the settlement and we currently only have two radiocarbon dates, and thus any conclusions are tentative at best, while at Balatonőszöd, the available data was considerably larger.

The fourth pattern represents a spatial and chronological variant of the joint Boleráz and Baden occurrence, which could be observed at Balatonkeresztúr-Réti-dűlő and perhaps Balatonlelle, where Boleráz and Baden were mixed, and the Boleráz I and Baden II–III Phases followed each other linearly and in rapid succession. This pattern involves the highest degree of interaction between Boleráz and Baden.

In light of these observations, we can perhaps predict that Boleráz will eventually be divorced from Baden and will be treated as an independent culture, similar to Kostolác and Vučedol. It will no

longer remain the organic initial Baden phase, although Boleráz will be retained in the Baden complex owing to its interaction with Baden and their shared contacts. It will continue to represent the early phase of the complex, similarly to Cernavodă III, viewed as a related culture, but Baden will not be regarded as having evolved from Boleráz. In other words, it seems likely that while Boleráz will "survive" within Baden, it will not be regarded as the par excellence substrate to the emergence of the Baden culture either in terms of its material culture or in terms of its chronology and the distribution of its sites.

Another important issue regarding occupation patterns and the chronology of settlements is their assumed periodic/intermittent/seasonal occupation, the genuine spatial extent of settlements, their internal periodisation, the rhythm of their occupation and their layout.

In the case of the Pit-Grave communities, their subsistence patterns and their burials enabled the reconstruction of the direction of their migration, its duration and the distances covered, while regarding the Boleráz/Baden culture, neither the features nor the finds or the currently used analytical procedures have proved sufficient for reconstructing occupation patterns on the so-called periodic settlements, i.e., the rhythm of their occupation, their abandonment and intermittent re-occupation. It remains to be proven that the apparent lack of a coherent layout, the apparent chaos, and the presence or lack of houses and house rows do in fact indicate an intermittent occupation. Perhaps the lack of houseplans from earlier excavations in Hungary can be simply explained by the existence of previously unencountered buildings that were not known from publications and most archaeologists were unprepared for structures of this type. The structure and type of the houses uncovered at Balatonőszöd conform to a type which was specific to Late Copper Age cultures (lakeside settlements) and they formed rows on the highest point of the settlement.

A more sedentary lifestyle and the immense number of finds would suggest that the Boleráz/Baden communities did not pursue a nomadic cycle resembling that of the Pit-Grave population, despite being similarly engaged in stockbreeding. It seems more likely that after the exhaustion of the resources available to a settlement, the community moved to the next settlement, lying some 1–3 km away, leading to the emergence of a network of settlement chains along watercourses (however, we cannot even make an educated guess as to the duration of a cycle along the entire length of a particular watercourse, or as to when at what intervals a site in the chain was re-occupied).

What seems certain is that the emergence of intermittently occupied settlements typical for the Late Copper Age can be explained by a climate change and conditions unsuited to permanent settlements, to which every culture responded diversely. Small mobile communities engaged in stockbreeding are reconstructed across the greater part of Europe from the close of the Middle Copper Age onward, and there is evidence for open animal pens from several sites, as well as for the increased use of cave sites (for a comprehensive overview of Hungary, see György, 2009), interpreted as indications for transhumant pastoralism. Vertical pastoralism between lower-lying plains and uplands is assumed during the summer months for the Polish, German, French and Greek Copper Age sites mentioned above (e.g., Arnold & Greenfield, 2006; Walsh & Mocci, 2011), only involving a part of each community moving from one place to another with the livestock, while the other part of the community remained in the villages. This may be the reason that despite their long use-life, Late Copper Age settlements are never as "orderly" or have as intensively occupied buildings as settlements inhabited permanently by one community (such as tells). Cultural

anthropological studies suggest that poorer communities paid for the temporary use of pastures if the summer pastures were controlled by other communities (Milisauskas *et al.,* 2012, p. 140). A similar transhumant pastoralism can be conceptualised between the lower-lying plains along the Balaton shoreline and the higher lying, more forested and more diverse landform of the Somogy Hills, or, the environment of Ózd and Salgótarján.

Studies on the movement patterns of animals have shown that in the case of restricted or shared resources, the best strategy is the so-called Lévy flight or Lévy random walk, characterised by a random combination of many small steps and an occasional big leap. This is a special variant of random movement which differs from a random walk owing to the power-law degree distributions. However, this universal movement pattern, followed by most animals during foraging, cannot be applied to human cultures. In Lévy-flights, there is little chance that the individual will return to an earlier location, meaning that the movement of human communities cannot be described using the Lévy-flight pattern because they would rarely or never return to their homes (Barabási, 2010, pp. 173–180).

One of the greatest problems in the application of the model is that the movement of human communities is usually conceptualised as a unidirectional or back-and-forth movement between two points. An alternative model would be one in which only the period's formal cemeteries are regarded as permanent community places, and the smaller, seemingly haphazard, intermittently occupied settlement points without a regular internal layout inhabited during a certain period that forms smaller closed networks along watercourses as permanent, organised, but less intensively occupied habitations on which there was a continuous interchange of occupants and their livestock. In this model, herders and their herds move from one settlement point to the next, without returning to the previous one. This movement implies a forward motion along a circular path in space. A mobility pattern along a watercourse system seems logical in the case of a smaller community of mobile stockbreeders linked by blood ties (such as an extended family made up of a handful of nuclear families) engaged in pasturing their herds on meadows and in forests with little arable farming, the type of economy usually posited for the Boleráz/Baden culture. However, until we have conclusive evidence that can be evaluated, this system can only be described with a large-scale entropy, i.e., one with multiple interpretations.

In sum, we may say that Late Copper Age studies still lack meaningful economic and settlement data because the excavations on most settlements were small-scale affairs and most of the evidence comes from burials ("scanty economic and settlement data … almost pure burial archaeology" Milisauskas & Kruk, 2011, pp. 294–295, quoting Ian Hodder).

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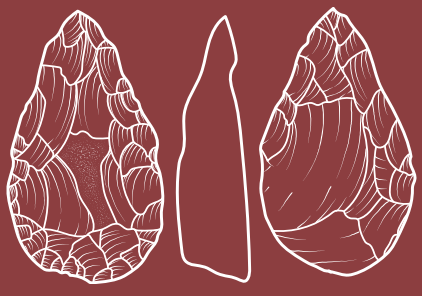
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April 10, 2019, "MOMOΣ – XIth Gathering of Researchers in Prehistory – Environment and People" conference. Zsolt Mester, as section president, helps one of the speakers with time management.
Photo: Nóra Szilágyi, BTM; drawing: after Kozłowski et al., 2009.



10

Complex study of the Acsa-Rovnya endscrapers

SURFACE COLLECTIONS IN THE RECONSTRUCTION OF UPPER PALAEOLITHIC LAND USE

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Abstract. The majority of Upper Palaeolithic sites in Hungary consist of surface artefact scatters with poor chronostratigraphic control. However, the technological, morphometric and taphonomic characteristics of the finds, as well as their geographical location constitute valuable data for regional-scale land use models. The Acsa-Rovnya Early Upper Palaeolithic site is considered an aggregation site or base camp due to its numerous finds, the dominance of endscrapers, and its strategic location. The duration of its occupation and the archaeological-taxonomic identity of its users are yet to be known. I investigated the dominant tool type of the site, endscrapers, to explain their variability by chronological, taxonomic or functional reasons. Based on morphometry and production methods, I classified these tools with the help of hierarchical clustering on principal components (HCPC). The results show that the typologically diverse set can be the result of similar tool production methods and usage. This result confirms the view about the similar function of the site in the landscape through the ages, whether it was used by groups classified into one or more culture-taxonomical units.

Keywords: Upper Palaeolithic, Acsa-Rovnya, Endscrapers, Cluster analysis, Land use

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I expected to think carefully about what Zsolt could have said about the paper's topic. There was no need for this since we had already talked about everything in the two decades of our acquaintance, in the classroom, at conferences, and in the field up the mountain (rarely down). Zsolt listens to you in every situation, considers, talks, teaches and gives advice. Thank you for what you have done so far and I look forward to the rest, God bless you!

1. Introduction

In Hungary, the vast majority of archaeological sites considered to be of Palaeolithic age are open-air and surface occurrences, that is, knapped lithics outside rock cavities or subsurface sediments.[1] As a consequence of several factors, these sites were pushed to the periphery of domestic archaeological research, among which weak chronological control and the possibility of mixing are relevant for this study. The knapped stones lying on the surface surely left their original contexts of deposition under the geomorphological conditions of Hungary. In the absence of material suitable for absolute dating and the spatial conditions that facilitate relative dating, we cannot place such finds within the desired timeframe. Weak chronological control is a frequently mentioned problem in Palaeolithic research, where accuracy would be required often on a millennium scale (Barton & Clark, 2021; Discamps *et al.,* 2015; Douka & Higham, 2017). The so-called palimpsest phenomenon is also a topic often touched upon, that is, the accumulation of material remains deposited at different times at a special point in space and time, in this case in the act of discovering a surface deposit (Bailey, 2007; Clark *et al.,* 2019; Mallol & Hernández, 2016). In such a collection, artefacts whose use is separated by up to tens of thousands of years can be mixed – not to mention the special case of recycling, which further complicates the relationships between co-occurring finds.

Unfortunately, the majority of Hungarian "non-surface" Palaeolithic sites are also characterized by poor chronological control and the possibility of mixing, as many researchers have highlighted in recent years. To list a few examples: the relationship between Upper Palaeolithic radiocarbon dates and the archaeological phenomena to be dated by those has become doubtful in several cases (Lengyel, 2009; Lengyel & Mester, 2012). Revisions of widely known Hungarian cave sites usually contest clichés previously treated as evidence regarding the integrity of their archaeological record (Lengyel *et al.,* 2016; Markó, 2015, 2019; Mester, 2018). Nevertheless, the vast majority of data on the Palaeolithic in Hungary are still provided by surface material, so their detailed study is justified and necessary despite all the difficulties. One obvious way to solve the problems presented here is to take them into account and adapt our questions to the data that surface artefacts can offer (Chu *et al.,* 2018; Fitzsimmons *et al.,* 2020; Holdaway & Davies, 2020; Škrdla *et al.,* 2016). My doctoral research concerns these possibilities, and as part of it, in this study, I examine a specific group of knapped lithic tools: endscrapers.

2. Background: land use, artefact use and endscrapers

In recent years, several studies have dealt with the topography of Upper Palaeolithic settlements in the Carpathian Basin (Péntek & Zandler, 2016; T. Dobosi & Holl, 2013) and their land use (Chu, 2018; Gutay *et al.,* 2019; Hauck *et al.,* 2018; Vörös, 2000), and the issue of site function regularly arise in domestic research as well (Markó, 2017; Péntek, 2016; Simán, 1988). In this study, I attempt a so-

1 The Hungarian version of this paper has been published in 2021. See: Király, 2021.

cio-ecological study of the surface deposits and the surrounding landscape on a regional scale, following studies that examine the interactions of human communities and the natural environment, considering that before food production, these interactions were organized into specific mobile land use strategies (Banks, 2017; Barton *et al.,* 2011; Clark *et al.,* 2019; Fitzhugh *et al.,* 2019; Kuhn & Miller, 2015; Nettle *et al.,* 2013; Robinson & Sellet, 2018). During the Late Pleistocene, resources useful to humans were distributed in space and time in a way that has not been experienced since then (Gamble, 1999). Palaeolithic communities partially offset resource fluctuations through mobility and migration (Bettinger *et al.,* 2015; Binford, 1980; Clark *et al.,* 2019; Kelly, 1995; Picin & Cascalheira, 2020). As a result, one archaeological site only represents a fraction of the land use strategies of these communities, a small slice of the former prey area, while examination on a regional scale reveals a more comprehensive view of the hunter-gatherer landscape (Barton *et al.,* 2011; Kuhn & Miller, 2015; Maher & Conkey, 2019). The partial results collected at individual sites can thus reinforce each other and reveal new relationships on a regional scale.

The primary sources of regional land use strategies in the Palaeolithic are knapped stones, the production, use, maintenance and disposal of which were embedded in the everyday life of the community and distributed over time and space. In contrast to, for example, pottery or metalwork, knapping transforms the (lithic) raw material to a small extent, and it is also a reductive process involving material loss. These two characteristics of the technology make it possible to reconstruct past lithic technological systems by assigning the lithic finds to each other. In this way, we can manage the artefacts of several sites in one system, and in rare cases, we even discover a concrete, physical fit between knapped stones found far from each other. Exploiting the particularities of this

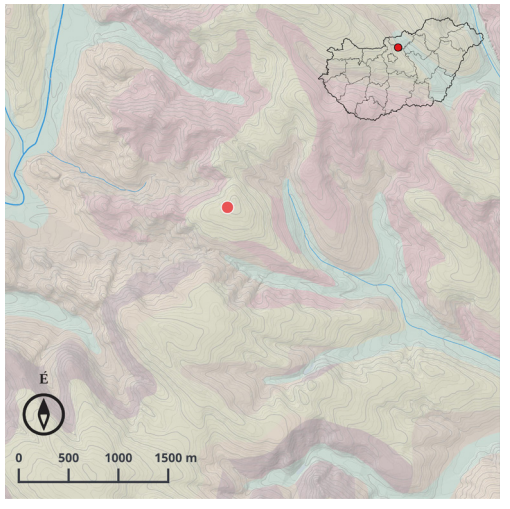


Figure 1. Geographical position and topography of the Acsa-Rovnya site. Data: EOTR 1:10,000. Prepared by the author.

find type, primarily research in the United States outlined connections between the lithics found at the sites and the former functions of those places, in other words: between the tool technology and land use systems of the former communities (Andrefsky, 2009; Bamforth & Bleed, 1997; Barton & Clark, 2021; Brantingham, 2006; Collard *et al.,* 2005; Fitzsimmons *et al.,* 2020; Holdaway & Douglass, 2012; Holdaway & Davies, 2020; Kuhn, 1992; Nelson, 1991; Robinson & Sellet, 2018; M. Shott, 1986; Torrence, 1983).

Endscrapers, as tools with a relatively fixed design, represent a characteristic segment of the exploitation of natural resources (de Sonneville-Bordes & Perrot, 1954). Based on traceological and ethnoarchaeological research, these tools retouched on their distal end, were generally used for processing skin, bone and plant parts (Beyries & Rots, 2008; Domingo *et al.,* 2012; Shott & Weedman, 2007; Weedman & Arthur, 2008).

In the various land use models, they are therefore classified as processing tools, the prominent presence of which indicates the nature of the ac-

Table 1. Acsa-Rovnya. The composition of the knapped lithic find material used for the study by type (rows) and raw material (coloumn). Data: Attila Király.

	Limnosilicite		Flint & chert		Radiolarite		Quartz porphyry		Other		Total	
	pcs	%	pcs	%	pcs	%	pcs	%	pcs	%	pcs	%
Debitage total	2193	78.5	20	0.7	7	0.3	14	0.5	54	1.9	2288	81.9
Chunk	1047	37.5	5	0.2					33	1.2	1085	38.8
Chunklike flake	364	13.0	7	0.3	2	0.1					373	13.3
Flake	649	23.2	5	0.2	4	0.1	13	0.5	19	0.7	690	24.7
Blade	89	3.2	3	0.1	1	0.0	1	0.0	2	0.1	96	3.4
Bladelet	15	0.5									15	0.5
Preparation element	29	1.0									29	1.0
Core	88	3.1	2	0.1					2	0.1	92	3.3
Endscraper	166	5.9	5	0.2	2	0.1			1	0.0	174	6.2
Perforator & combined	15	0.5	1	0.0							16	0.6
Burin	24	0.9									24	0.9
Backed & truncated	33	1.2	1	0.0	1	0.0					35	1.3
Retouched & notched	98	3.5	6	0.2	1	0.0	2	0.1	2	0.1	109	3.9
Bifacial tool	19	0.7					6	0.2			25	0.9
Scaled "retouch"	31	1.1	1	0.0							32	1.1
Total	2667	95.4	36	1.3	11	0.4	22	0.8	59	2.1	2795	100.0

tivities carried out on the site, hence the duration of the occupation and the frequency, or intensity of its visits (Clark *et al.,* 2019). The endscrapers are also suitable for detecting many other features of land use. The retouch intensity, the degree of renewal reveals the curated or opportunistic approach of their users, their mobility, and the duration of site use (Blades, 2003; Morrow, 1997; Shott & Seeman, 2015; Shott & Weedman, 2007). In addition to the endscraper front, other modifications often appear on the supports, which further enriches the evaluation of these tools. Overall, the frequency and formal variability of Upper Palaeolithic endscrapers make the type a promising land use marker even in palimpsest situations.

The location of the find and the function of the artefacts are related to each other even in open archaeological contexts encompassing a long period, which provides information about the way a given landscape was used, regardless of cultural-taxonomic issues. I use these advantages when examining the endscrapers of the Acsa-Rovnya site. My questions are whether 1) the technological-morphological variation of the endscrapers found here can be traced back to functional, cultural-chronological, or mixed reasons, and 2) what does the presence of the endscrapers tell us about land use for the period covered by the find material.

3. Material and methods

The Acsa-Rovnya (Fig. 1) site has been known since the late 1990s thanks to the surface collections of Attila Péntek, Sándor Béres and István Homola. Viola T. Dobosi conducted verification excavations here in 2002 and 2004 (T. Dobosi, 2008, 2010, 2013). The material of about 12,000 surface and about 350 excavated artefacts is considered one of the largest Palaeolithic collections in the country. In the absence of adequate absolute dating results, the excavator dated the soil layer containing the finds to the Arcy interstadial period (DO 6–7, 31,500–30,000 BP) based on tool typology and stratigraphic considerations. T. Dobosi interpreted the findings from the surface collections and excavations as a coherent sample and determined it to be younger Aurignacian based on typology. At the same time, she notes that several of the typical Aurignacian tool types are missing, as well as evidence of the Gravettian taxon; in addition, bifacial elements and side-scrapers characteristic of transitional industries are present. T. Dobosi considers these "transitional" elements to be part of the Aurignacian material (T. Dobosi, 2013).

In this study, I included unworked blanks and worked pieces, i.e. tools (1,566 pieces), with the 174 endscrapers that make up the sample (Table 1), from among the Acsa-Rovnya lithics processed so far within the framework of my doctoral research (2,795 pieces).

I separated six groups according to the production technologies of the pieces and the morphology of the supports. For the technological investigation, I used Inizan's work (Inizan *et al.*, 1999) and Mester et al.'s Hungarian-language articles based on it (Holló *et al.*, 2001, Holló *et al.* 2002, 2004). To further investigate the support preferences, I examined the dimensional data of the endscrapers. I assumed, that if size was a prominent aspect in the selection of the endscrapers' supports, then the distribution of their given size characteristics differs significantly from the similar characteristics of other groups in the collection. In the study, I used only the thickness, width and weight data, not the length. Due to the distal formation of the endscrapers and the taphonomic effects and fractures, the latter dimension does not necessarily represent the original length of the supports. The shape change resulting from the processing, use and abandonment of stone tools affects the thickness to the smallest extent (Blades, 2003). In the case of endscrapers, thinning at the point of attachment to a handle may occur, but this action usually affects the proximal and mesial portions of the pieces, so maximum thickness is rarely compromised (Shott, 1995). The metric tests performed on endscrapers usually consider the width value constant. However, most of these tests concerned endscrapers made on regular blades, the width of which changes slightly between support detachment and tool discard (Blades, 2003; Morrow, 1997; Shott & Seeman, 2015). During the production of the "robust" Acsa-Rovnya scrapers (see below), the original width may have decreased, so I treat width-related conclusions with due caution.

In addition to descriptive statistics, non-parametric Mann-Whitney U tests were used to compare the size data of different artefact groups. Based on the Kolmogorov-Smirnov normality test, the length, width, thickness and weight data all show a non-normal distribution in the entire sample ($n = 1566$, in each case $df = 1566$, $p < 0.001$; Table 2). The size distribution of the different groups formed from the sample also followed a non-normal distribution (all flakes and blades: $n = 1158$; all intact flakes and blades: $n = 700$; all endscrapers: $n = 174$; all intact endscrapers: $n = 90$; all other tools: $n = 234$), the phenomena following a normal distribution are located at the lower limit of the significance level (endscraper length $df = 174$, $p < 0.2$; intact endscraper length $df = 90$, $p < 0.2$, width of other tools $df = 234$, $p < 0.07$). Except for

Table 2. Acsa-Rovnya, descriptive statistics of the knapped lithic sample and its groups. Data: Attila Király.

Sample	Variable	Mean	Median	Standard deviation	Minimum	Maximum	Skewness	Curtosis	K-S	K-S df	K-S significance
Total sample (n=1566)	Length (unbroken)	31.05	30.00	10.49	7.00	73.10	0.65	0.43	0.04	1566.0	0.00
	Width	26.80	25.10	9.27	0.70	69.00	0.95	1.27	0.08	1566.0	0.00
	Thickness	9.62	9.00	4.02	1.60	26.40	0.74	0.42	0.07	1566.0	0.00
	Mass	9.33	6.40	9.31	0.30	73.30	2.30	7.01	0.17	1566.0	0.00
Flakes (n=1158, unbroken n=700)	Length (unbroken)	31.25	30.00	11.03	10.20	73.10	0.81	0.77	0.05	700.0	0.00
	Width	26.92	25.20	9.67	0.70	67.40	0.86	0.88	0.08	1158.0	0.00
	Thickness	9.41	8.80	4.08	1.60	26.40	0.77	0.52	0.07	1158.0	0.00
	Mass	8.84	5.40	9.50	0.30	73.30	2.44	7.70	0.18	1158.0	0.00
Endscrapers (n=174, unbroken n=90)	Length (unbroken)	29.97	31.00	8.97	12.80	52.00	0.11	-0.50	0.07	90.0	0.20
	Length (all)	34.37	34.65	9.74	11.10	59.00	0.06	-0.03	0.04	174.0	0.20
	Width	24.76	24.10	5.89	8.00	49.60	0.74	1.92	0.08	174.0	0.01
	Thickness	10.48	9.75	3.69	4.00	20.10	0.80	0.09	0.09	174.0	0.00
	Mass	10.10	8.30	7.13	0.90	44.10	1.68	3.84	0.13	174.0	0.00
Other tools (n=234)	Length	29.43	28.90	7.72	10.30	53.50	0.38	-0.11	0.07	234.0	0.01
	Width	26.04	25.40	7.00	11.00	51.40	0.65	0.57	0.06	234.0	0.07
	Thickness	9.79	9.75	3.17	3.00	20.10	0.38	0.02	0.07	234.0	0.00
	Mass	7.43	5.95	4.80	1.30	24.80	1.20	1.24	0.13	234.0	0.00

two groups, the number of cases is over 40, which can justify the use of parametric tests based on the central limit distribution theorem, although most of the variables do not follow a normal distribution. However, the groups did not meet the robustness conditions and variance homogeneity beneficial for parametric paired tests.

I explored the trend-like co-occurrences of the morphological diversity with principal component analysis (PCA) and then grouped the cases along the resulting latent variables with hierarchical clustering on principal components (HCPC). Finally, I compared the clusters with the grouping according to production methods. In the study, I included variables that could be measured in all cases, the data were not distorted by the fragmentary nature of the pieces, met the PCA prerequisites, and are of course relevant to the research.

The use of different HCPC protocols is known in archaeological lithic analysis (Jennings *et al.,* 2015; Seeman *et al.,* 2013), but it is a more common procedure in other scientific fields (Abdulhafedh, 2021; Maugeri *et al.,* 2021). Out of the 174 endscrapers in the collection so far, 150 met all the conditions of the PCHC test. Twelve items could not be included in the study due to data collection deficiencies, and eleven additional items were excluded to increase the coherence of the sample. The latter tools were found a little further away from the main find concentration, in a lower-lying area. Finally, an additional piece differed both in its raw material (andesite) and in its proportions

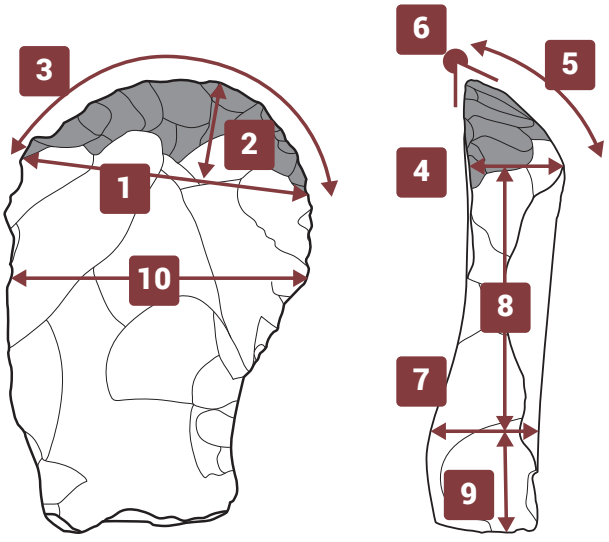


Figure 2. Acsa-Rovnya endscrapers; initial variables used for PCHC analysis on the supports. 1: endscraper front width, 2: endscraper front depth, 3: endscraper front length, 4: retouch height, 5: retouch length, 6: retouch angle, 7: maximum thickness, 8: the distance between the maximum thickness and retouch height, 9: the distance between the maximum thickness and the proximal end, 10: maximum width. Prepared by the author.

from the other endscrapers known so far at the site, perhaps it was used as a bladelet core. Since one of the conditions for the reliability of the PCA is the presence of at least 150 cases, I did not eliminate any additional pieces. Accordingly, many tools with broken edges remained in the sample, and because of these, I could not use the variables affecting the length. During the PCA, I focused primarily on the form and taphonomic properties of the endscraper front, and secondly on the morphological features that can be measured even on the fragmentary pieces, which proved to be significant in the case of support preferences. I established the following ten variables (Fig. 2).

The endscraper front width (1) is the distance between the two endpoints of the retouch in the plane of the dorsal surface, given in millimetres. The endscraper front depth (2) is the length of the section perpendicular to the endscraper front width, expressed in millimetres, which leads to the farthest point of the endscraper front. The endscraper front length (3) is the distance between the two endpoints of the width along the distal edge of the piece, expressed in millimetres. The retouch height (4) is the distance between the ventral and dorsal surfaces at the point of the morphological axis of the piece where the retouch reaches its greatest extent in the direction of the proximal end of the piece. The retouch length (5) is the greatest distance between the proximal and distal ends of the retouch on the dorsal surface, given in millimetres. I gave the retouch angle (6) in degrees by averaging the meeting angles of the dorsal and ventral surfaces measured in three places on the endscraper front. The maximum thickness (7) is the maximum distance between the ventral and dorsal surfaces of the support, expressed in millimetres. The distance between the maximum thickness and retouch height (8) is measured along the morphological axis in millimetres and shows whether the thickest point of the piece is located at the beginning of the endscraper front or not. The distance between the maximum thickness and the proximal end (9) is also measured in millimetres. The maximum width (10) is also measured in millimetres, which can be compared with the width of the endscraper front to give an approximate idea of whether the

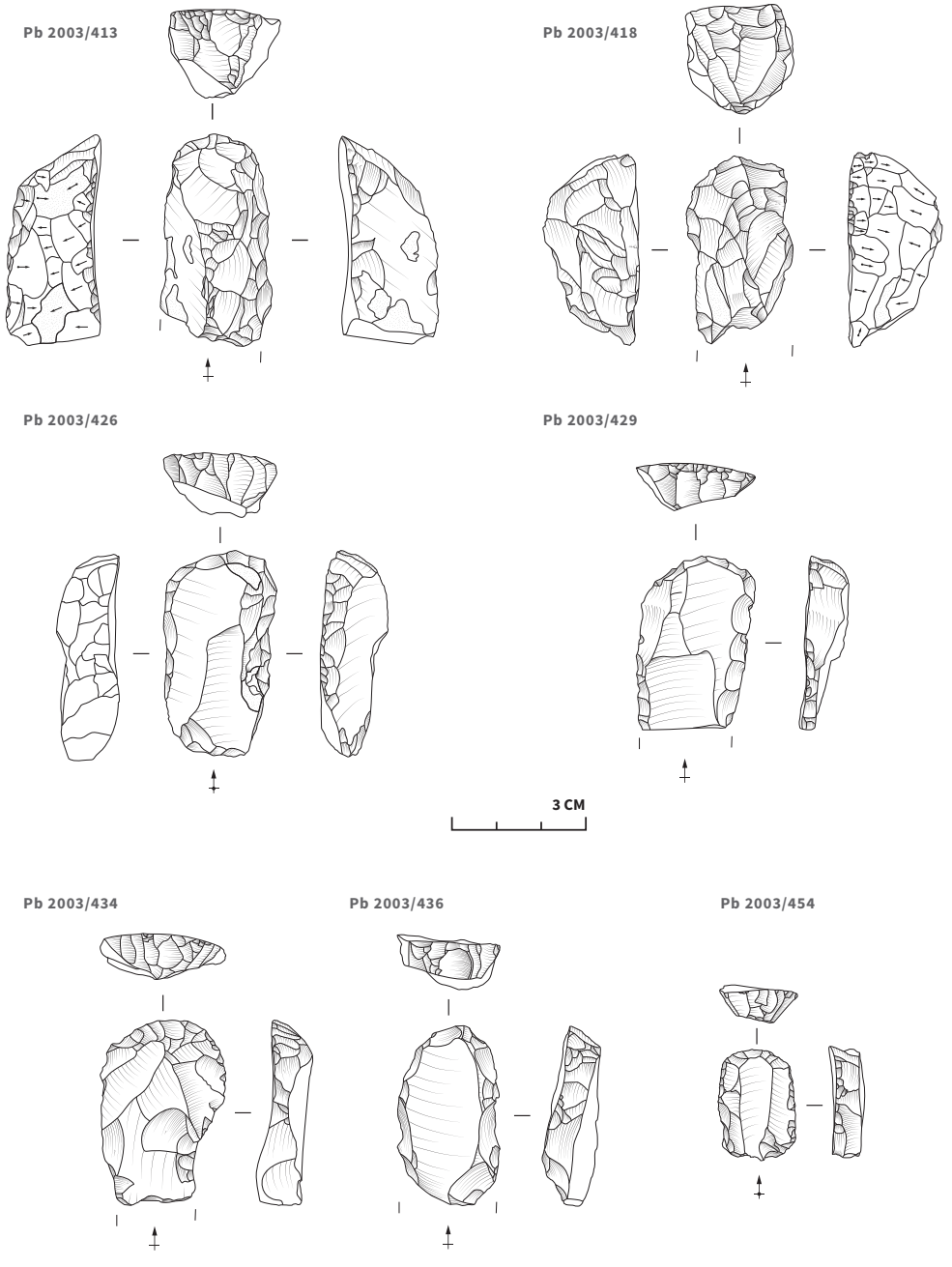


Figure 3. Acsa-Rovnya, endscrapers, and examples of the technical groups discussed in the text. Pb 2003/413 – robust 1 group, Pb 2003/418 – robust 2 group, Pb 2003/426, Pb 2003/429 – thinned group, Pb 2003/434 – other group, Pb 2003/436 – plain group, Pb 2003/454 – parallel group. Prepared by the author, based on pieces stored in the Hungarian National Museum.

shape of the piece widens or narrows in the direction of the endscraper front.

The principal component analysis serves to simplify the multidimensional space designated by the ten initial variables and to discover the relationships between the variables (Hair *et al.,* 2010; Ho, 2013; Jolliffe, 2002; Nguyen & Holmes, 2019; VanPool & Leonard, 2011). The method determines background variables that cannot be directly observed, i.e. factors based on correlations between variables. Among the factor analyses, PCA takes into account the entire variety present in the sample and is not predictive but exploratory. These properties make it suitable for the examination of the Acsa-Rovnya scrapers. On the one hand, I wanted to use the full variability represented by the variables to classify the open-context find material. On the other hand, I do not aim at a general characterization of endscrapers of a given era or culture, but only at a better understanding of the find material. The conditions for using PCA include the appropriate number of cases, the variables measured on an interval or ratio scale, between which there is a correlation of appropriate strength and geometry, and the smallest possible number of outliers in the sample. According to the Kaiser-Meyer-Olkin test, the Acsa-Rovnya sample is suitable for testing, and the obtained factors are reliable (KMO = 0.724). The Bartlett test also indicates that the correlation between the elements is sufficiently strong ($\chi 2$ ($df = 45$) = 1085.089, $p < 0.000$). There are some excessively strong loadings in the correlation table, but there is no strong multicollinearity based on the value of the determinant ($D = 0.001$).

Based on the Kolmogorov–Smirnov tests performed on the sample, the distribution of the investigated variables did not meet the prerequisite of normality. However, PCA is a robust enough test to be used in such cases, especially if the purpose of the test is to reduce variables (Jolliffe, 2002, p. 339; Zygmont & Smith, 2014). This was confirmed by the HCPC protocol performed on normalized data, which led to almost identical partial results and final results. In the study, I use standardized data to ensure that the values of all variables included in the study are on the same scale, not in degrees and millimetres. Each of the main components obtained by mathematical transformation has an eigenvalue, which shows how much of the total variability present in the data set is represented by a given factor. For the sake of simplification, I only took into account in the study those factors that carry the largest part of the variation, that is, they have a high eigenvalue. I determined the number of relevant factors based on the Kaiser criterion, the elbow rule, the variance ratio and Horn's parallelism test (Josse & Husson, 2012; Patil *et al.,* 2008). For the sake of easier interpretation, I rotated the factors using the Promax method ($\kappa = 4$), assuming a correlation between the factor axes. Finally, each endscraper received unique values along the factors kept as variables.

I then grouped the sample according to the values obtained for the factors, using hierarchical cluster analysis (Abdulhafedh, 2021; Hair *et al.,* 2010; Husson *et al.,* 2010). This type of study is ideal for samples with a small number of cases, where we do not have prior knowledge of discrete sets. The method treats each case as a separate group and gradually arranges them into higher and higher order sets according to the distance and difference of their given properties from each other. There are several methods for determining the distance. In the case of the Acsa-Rovnya endscrapers, I used the Ward method, which is based on measuring the variance of the resulting cluster, so it is optimal for handling the multidimensional spaces represented by the principal components. I determined the number of clusters used (4) based on the resulting dendrogram. I checked the quality of the clusters with an analysis of variance (ANOVA), supplemented by a Tukey post-hoc test. With these, the degree of separation of the sets

was determined along the individual variables, which I formed from the factors.

As the last step of the investigation, I plotted the cases along the axes of the main components, grouped according to the way they belong to the cluster and the way they were formed. I no longer interpreted these complex dot charts using statistical methods, but qualitatively. The data was recorded with a manual calliper and jewellery scale, and with the help of the Fiji morphometric software (Schindelin *et al.,* 2012), for statistics I used the SPSS 25.0 and JASP 0.14.1 software, and in the case of Horn's parallelism test, an R-based web application (Ho, 2013; IBM Corp, 2017; JASP Team, 2021; Patil *et al.,* 2017).

4. Results

4.1. Technological-morphological groups

Almost all of the 174 endscrapers in the sample were made of limnosilicite of local, possibly Mátra origin. I separated them into six groups according to the morphology of their support and their methods of production. The design of the thinned group (group 1, 23 pieces) is characterized by a big detachment negative on the dorsal surface parallel to the morphological axis, initiated from the proximal direction, which thins the body of the tool in a side view (Fig. 3, example Pb 2003/429). The parallel group (group 2, 70 pieces) includes supports with a unidirectional dorsal detachment negative pattern, lacking any other special design, usually with parallel lateral edges (Fig. 3, example Pb 2003/454). A high ridge runs along the morphological axis on the dorsal surface of the stout supports in the "robust 1" group (group 3, 15 pieces). Shaping negatives perpendicular to this ridge starts in the direction of the lateral edges; these negatives are usually deep, and wide, with padded terminations, indicating the application of great force. Similar detachments often start from the direction of the lateral edges towards the central ridges on these pieces (Fig. 3, item Pb 2003/413). The result of this design is similar to the morphology of the maintenance flakes used to remove spent core edges, where the central ridge is the core edge, i.e. the meeting of the detachment and debitage surfaces. An important difference is that on the vast majority of endscrapers belonging to the robust 1 group, the shaping negatives perpendicular to the ridge are complete, that is, they are not necessarily partial negatives of supports detached from the debitage surface of a core. The negatives starting from the spine were created either after the endscraper's support was detached, or before it was detached, but for shaping the blank, and are not traces of core reduction. In the latter case, we cannot rule out that the supports were originally fragments of crested blades or flakes; traces of core reduction, which assumes these products, can be detected in the material of the site (Demidenko & Usik, 1993).

The appearance of the "robust 2" group (group 4, 9 pieces) is similar to the previous group, but in these cases, the shaping negatives from the lateral edges towards the spine dominate the morphology of the pieces (Fig. 3, item Pb 2003/418). If the pieces of the robust 1 group are interpreted as crested flakes or blades, then this fourth group differs from a technological point of view, since the purpose here could have been specifically to shape the support, not the core. On the specimens of the plain group (group 5, 22 pieces), the dorsal surface is defined by one detachment negative, it is plain except for the retouch (Fig. 3, item Pb 2003/436). Finally, the *varia* group (group 6, 35 pieces) includes pieces with a multi-directional dorsal negative pattern and other endscrapers that cannot be included in the above categories (Fig. 3, item Pb 2003/434).

The groups can be divided into two sets, which is also reflected in the width and thickness values of the supports (Fig. 4). The specimens of the first, second, and fifth groups are generally thinner,

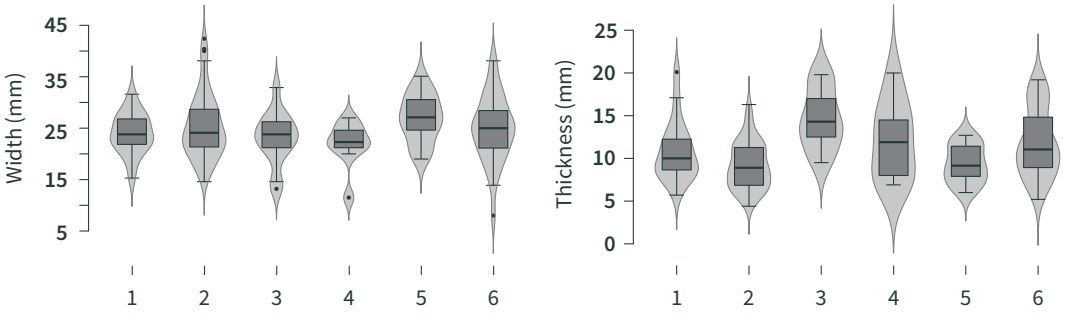


Figure 4. Acsa-Rovnya, violin and box diagrams of the width and thickness data of the knapped stones. Boxplots show median, second quartile, fourth quartile, and outliers (points). Left: width data of the endscraper technical groups. 1: thinned group (23 pcs); 2: parallel group (70 units); 3: robust 1 group (15 pcs); 4: robust 2 group (9 pcs); 5: plain group (22 pieces); 6: other group (35 pcs). Right: thickness data of the endscraper technical groups, in the same breakdown as the previous figure segment. Prepared by the author.

concerning the pattern of their dorsal negatives, they were produced in more advanced phases of debitage, and the debitage mostly occurred from one direction and resulted in flakes with parallel edges ("gracile set"). The set comprising the third and fourth groups consists of more robust scrapers ("robust set"). Compared to the first set, the width data in these cases are slightly more narrowly defined, although they hardly differ from the values of the first set. The thickness values, on the other hand, are scattered within larger limits and are generally larger than those of the first set. Specimens of groups 3–4 usually bear strong traces of the shaping of the support, short and wide, scaled, often stepped negatives, fissures and cracks. The blank morphology also affects the endscraper fronts, which are usually higher, and further retouching occurs less often on these pieces.

4.2. Principal component and cluster analyses

PCA identified three principal components that explain more than three-quarters of the variation present in the sample (n = 150). The three components were loaded with variables of a distinctly different nature, so the components are well separated from each other, which was also supported by post hoc analysis of variance (for all three components, $p < 0.000$) (Table 3 and Fig. 5).

The length (0.967), width (0.914), and depth (0.885) of the endscraper front, and width of the piece (0.801) accounted for the first component to a large extent, these variables played almost no role in the variance represented by the other components (their value < 0.0). The correlation between width-related variables is not surprising, but the depth of the endscraper front does not necessarily change together with the other parameters. If the length and width of the endscraper front are large, but the depth is small, then the shape of the endscraper front is almost straight in dorsal view, and the retouch is probably abrupt. If the depth is large, the endscraper front is strongly curved or pointed. The close correlation of the parameters suggests that the producers paid special attention to the shape of the endscraper front, even during possible resharpening. The correlation between the maximum width of the scratch-

Table 3. Acsa-Rovnya endscrapers, loadings of the principal components on the initial variables. Data: Attila Király.

Variable	PC1	PC2	PC3
Endscraper front length (bl)	**0.967**	-0.054	0.006
Endscraper front width (bw)	**0.914**	0.028	0.027
Endscraper front depth (bd)	**0.885**	-0.096	-0.089
Maximum width (w)	**0.801**	0.033	0.009
Maximum thickness (t)	0.042	**0.916**	-0.161
Retouch height (rh)	0.030	**0.914**	0.115
Retouch length (rl)	0.093	**0.855**	0.118
Retouch angle (ra)	-0.234	**0.555**	-0.134
(t) - (rh) distance	0.014	0.267	**-0.909**
(t) - proxi end distance	-0.037	0.224	**0.803**

PCA factor exctraction, Promax rotation with Kaiser normalization, the function converges in 4 iterations.

ing front and the support allows us to conclude that the silhouette of the tools is fixed.

The second component combines properties related to the thickness of the endscrapers, such as the thickness of the support (0.916), the length of the retouch (0.855), its height (0.914) and, to a lesser extent, the retouch angle (0.555). There is a clear correlation between the height of the retouch and the thickness, but the retouch length varies depending on the retouch angle: an abrupt retouch tends to be shorter, and a less steep one tends to be longer.

The third component contains the variables referring to the length since thickness was measured along the morphological axis. These variables are intended to show where the thickest part of the tools is located: it supports the working edge or rather it participates in the fixation (hafting or prehension) of the proximal part. Although the sample includes pieces that are broken along their width, i.e. shortened, the variables are still capable of characterizing the location of the thickest part, since the supports thicken either at the endscraper front or necessarily in the proximal direction from the working edge. Finally, the component revealed a strong inverse relationship: if the distance between the maximum thickness of the support and retouch height (-0.909) is small, then the place of the maximum thickness is relatively far from the proximal end of the artefact (0.803). If the thickness of the supports were relatively constant throughout their length, such a relationship would not be observed. The Acsa-Rovnya scrapers are thicker toward their distal or proximal end, which undoubtedly plays a role in the proximal thinning observed in many cases.

The cluster analysis resulted in the establishment of four significantly different sets (Fig. 6). The cases of the cluster marked in blue are typically pieces made on a thicker support, the shape and extent of the endscraper front, and other dimensions of the support are less important parameters. The cluster marked in red encompasses the opposite trends, it contains the thinner supports, where the endscraper front is relatively long and deep, and usually falls further from the thickest part of the support. Along the first principal component, the yellow cluster forms a third distinct group in contrast to the blue and red elements: it includes less thick, less wide pieces with a shorter endscraper front, which is located closer to the thickest section of the support. The elements of the fourth, green cluster are distributed relatively evenly along the first and second main components, but in the case of the third main component they are located in a negative direction, that is, the thickness of the pieces can be relatively uniform along their entire length. A particularly interesting result is that the instances of the technological groups are not strongly separated even according to the clusters. Weak trends are that the pieces of the robust group are more likely to be in the blue and green sets, and the

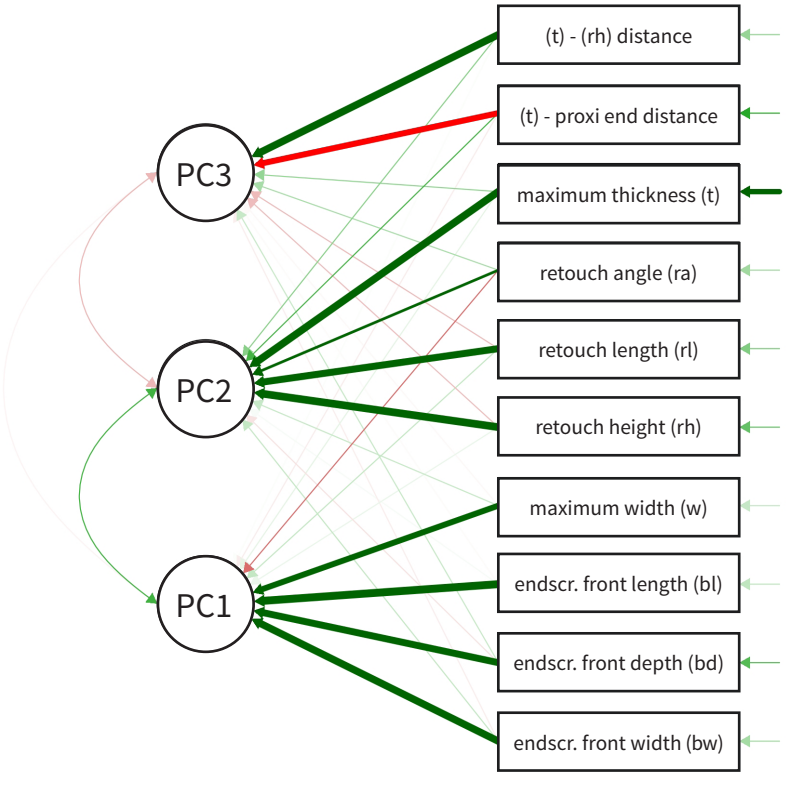


Figure 5. Path diagram depicting the results of the principal component analysis. Green lines indicate positive correlation, red lines indicate negative correlation, and the thickness of the lines indicates the strength of the correlation. Prepared by the author.

thinned, parallel and plain pieces are more likely to belong to the yellow or red sets.

4.3. Support preferences based on size data

I compared the dimensional data of the endscrapers, other tools and other unworked flakes of the collection to infer preferences within the site regarding the design of the tools (Table 4 and Fig. 7). A comparison of endscrapers and unworked flakes reveals that narrower and thicker supports are preferred for scrapers. The width of the scrapers (24.76 mm) is significantly less than that of the unworked flakes (26.92 mm), U = 91,726, Z = -1.907, p = 0.028 (one-sided), and the thickness of the endscrapers (10.48 mm) is significantly greater than the unworked flake data (9.41 mm), U = 83,373, Z = -3.675, p < 0.000 (one-tailed). The width of endscrapers (24.76 mm) is significantly smaller than that of other processing tools (28.31 mm), U = 14,956, Z = -3.598, p < 0.000 (one-tailed); however, there is no significant difference between their thicknesses (10.48 and 10.16 mm, U = 17,995, Z = -0.871, p = 0.185 (one-sided)).

The size differences between the endscrapers and the armatures are clearly visible. The width of the scrapers is significantly greater than that of the armatures (20.1 mm), U = 781, Z = -2.903, p = 0.001 (one-sided), their thickness is also significantly greater (armatures: 7.82 mm, U = 798, Z = -2.822, p = 0.002 (one-tailed)). The size relationships between all the tools and the unworked flakes are gentler, which is partly caused by the significantly smaller average size of the armatures. There is no significant difference between unworked flake and tool widths (26.92 vs. 26.47 mm), U = 235,351, Z = -0.112, p = 0.455 (one-tailed).

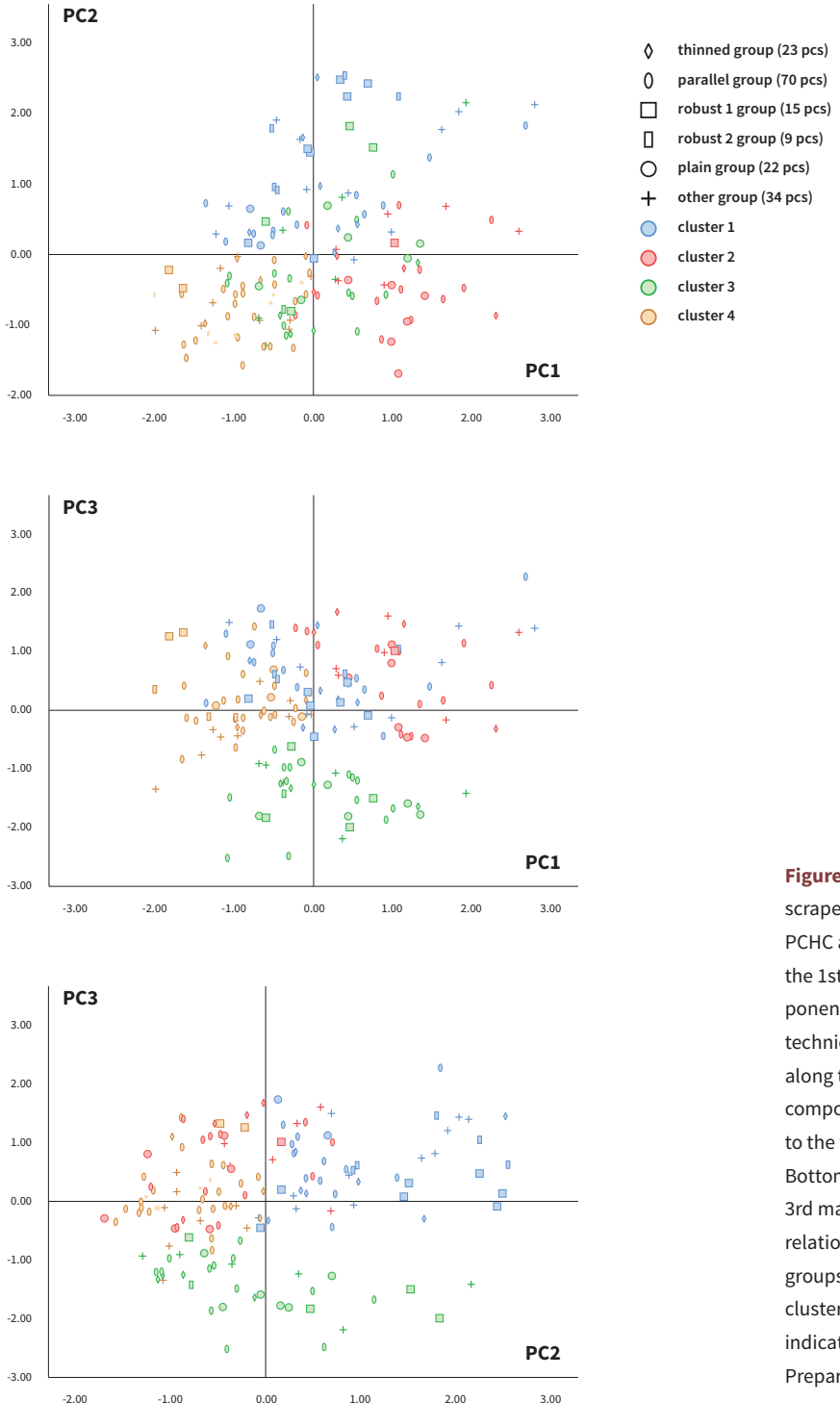


Figure 6. Acsa-Rovnya endscrapers, the result of the PCHC analysis. Top: along the 1st and 2nd main components, in relation to the technical groups. Middle: along the 1st and 3rd main components, in relation to the technical groups. Bottom: along the 2nd and 3rd main components, in relation to the technical groups. Colours indicate clusters and shapes indicate technical groups. Prepared by the author.

However, the thickness of the unworked flakes is still significantly lower than that of the tools (9.41 mm and 10.21 mm), U = 206,382, Z = -3.800, p < 0.000 (one-sided). Concerning dimension data, the group of endscrapers is distinguished by their well-defined width of 20–35 mm from other processing tools, armatures, and other blanks optimal for tool making. In terms of thickness, the gracile armatures differ from the average, the other artefact categories are similar in this respect. I did not evaluate the length data because of the fragmentation.

5. Discussion

The supports and design of the endscrapers classified into the "robust" and "gracile" technology sets differ from each other, but their blanks may be the products of a single core reduction method (see e.g., Bataille & Conard, 2018). The chunky flakes bearing traces of shaping correspond to the initial processing phase of the cores, while the thinner pieces with a regular silhouette, and unipolar dorsal pattern are the products of the debitage phase of core reduction. This connection is also indicated by the use of raw materials. The lower-quality outer sections of the limnosilicite blocks with voids, inclusions and cortex are more the raw material for robust scrapers, the more finely worked pieces usually have better quality raw material with fewer inhomogeneities. Other features of debitage do not differ greatly between groups: when it is observable, the vast majority of butts are plain, and the angle of detachment is right-angled or slightly obtuse.

The width and thickness data support the robust-gracile dichotomy and also show small differences. Although the length data were excluded from the statistical analysis, it is worth mentioning that the average length of the intact endscrapers (n = 76) is 40.3 mm, the intentionally snapped pieces (n = 23) 28.7 mm, the broken ones (n = 61) 28.9 mm, while that of the double scrapers worked on both the distal and proximal ends (n = 14) is 35.4 mm. The average length of processing tools (n = 218) is 34.5 mm, that of intact unworked flakes (n = 700) is 31.2 mm, and that of all flakes (n = 1,158) is 29.9 mm. From this we can draw the preliminary conclusion that longer-than-average supports were chosen to form endscrapers, but shorter fragments were also used, as shown by the double endscrapers worked on both the proximal and distal sections. Double endscrapers occurred more often in the gracile technological groups, similarly to another retouch (e.g. retouched lateral edge), which may indicate a longer period of use of these pieces. Subsequent research should deal with the issue of recycling and resharpening the Acsa-Rovnya endscrapers.

The principal component analysis confirmed the expected correlations between the metric variables. The first main component connected the extension and course of the endscraper front with the width of the support. Based on the second principal component, the steepness and depth of the endscraper front are mostly a function of the thickness of the support. The third principal component established an inverse relationship between the proximal and distal end (endscraper front) regarding the location of the thickest section of the support. Although it is not a rule for these two parameters to change together, the endscraper front occupies often the thickest part of the support and is therefore located far from the proximal end. That is why the green group of the cluster analysis is interesting, where this relation did not have a very strong charge, based on which the thickness of these supports can be said to be relatively uniform.

The cluster analysis showed that there is no special association between a technology group and a cluster, the instances of the technology groups are almost equally scattered in the four established clusters. This phenomenon can be evaluated in several ways, the first of which is that I in-

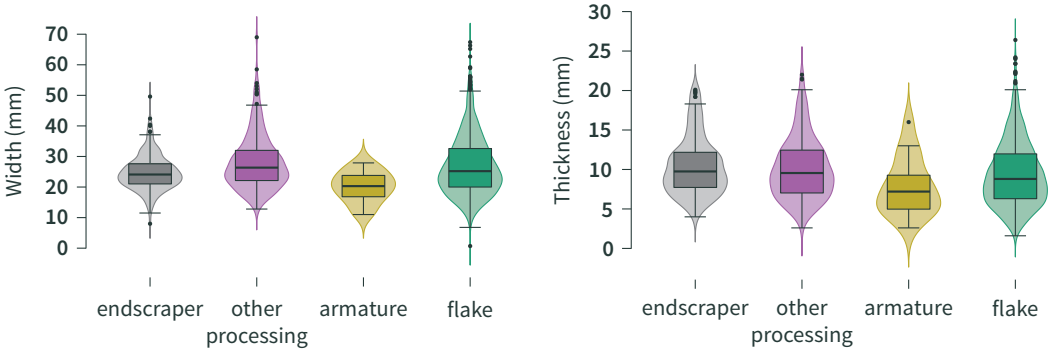


Figure 7. Acsa-Rovnya, violin and box diagrams of the width and thickness data of the knapped stones. Boxplots show median, second quartile, fourth quartile, and outliers (points). Left: width data of the examined sample (n = 1,566): endscrapers (n = 174), other processing tools (n = 218), armature (n = 16), unworked flakes (n = 1,158). Right: thickness data of the examined sample, in the same breakdown as the previous figure segment. Prepared by the author.

correctly established the grouping variables when planning the technological and statistical study. A further possible interpretation is that the combinations of morphological characteristics taken into account during the HCPC analysis are equally valid for the scrapers of the gracile and robust technology groups. Constraints arising from the lithic raw material and the dimensions of the supports are the cause of the homogeneous scattering, for example, the thickness of a flake determines the steepness or depth of the endscraper retouch. In addition to these constraints, the morphological similarities and the narrow size spectrum of the endscrapers suggest that the endscrapers belonging to different technological groups may be products of similar core reduction processes, obeyed similar support preferences, and the spectrum of their use overlapped. Without an analysis of use-wear, we can only assume the functional differences of the various endscraper forms, i.e., technological groups. Pieces with thinned bases may have been included in handles, and intentionally broken and double scrapers may have been recycled specimens.

Based on the results, it cannot be decided with certainty whether the differences in the production methods of the endscrapers can be traced back to temporal, archaeological taxonomic ("cultural") or functional reasons. In any case, scrapers belonging to different technological groups cannot be said to be tools of different industries, since they could have been products of the same core reduction process, their dimensions are similar, and their function is the same according to our current knowledge. In the case of high endscrapers, the possibility may arise that the artefact served as a microblade core. There is no evidence of the detachment of lamellae of adequate length and regular shape on any tool defined as an endscraper, I have classified such specimens as cores. The function of the scrapers can thus be the scraping mentioned in the name.

From the comparison of the endscrapers and other elements of the examined Acsa-Rovnya collection, we can draw several conclusions indicating the function of the site. The amount of finds is exceptionally high by Hungarian standards, which indicates the important role of the site in land use, whether it is the result of longer or several shorter

Table 4. Acsa-Rovnya, pairwise comparison of different segments and variables of the sample using the Mann-Whitney U test. Data: Attila Király.

Group 1	n	Group 2	n	Variable	Mann-Whitney U	Asymp. sig. (2-tailed)	MC sig. (2-tailed)	MC sig. (1-tailed)	r (effect size)
Endscrapers, all	174	Flakes, all	1158	Width	91726.000	0.057	0.057	0.028	-0.052
Endscrapers, all	174	Flakes, all	1158	Thickness	83373.500	**0.000**	0.000	0.000	-0.101
Endscrapers, all	174	Armatures	16	Width	781.000	**0.004**	0.004	0.001	-0.211
Endscrapers, all	174	Armatures	16	Thickness	798.000	**0.005**	0.004	0.002	-0.205
Endscrapers, all	174	Processing tools	218	Width	14956.000	**0.000**	0.000	0.000	-0.182
Endscrapers, all	174	Processing tools	218	Thickness	17995.500	0.384	0.379	0.185	-0.044
Flakes, all	1158	Tools, all	408	Width	235351.500	0.911	0.915	0.455	-0.003
Flakes, all	1158	Tools, all	408	Thickness	206382.000	**0.000**	0.000	0.000	-0.096

Monte Carlo simulation is based on 10000 sampled tables.

occupations (Barton *et al.,* 2011; Clark *et al.,* 2019). The proportion of retouched tools within the collection is low, according to T. Dobosi (T. Dobosi, 2013), 537 (7.3%) out of 7,390 examined pieces. The few tools are a function of the large amount of blocks and pieces from the local raw material source. Areas rich in raw materials are usually characterized by a lack of curated technologies involving several retouched tools since the acquisition of newer and newer supports does not involve a significant energy investment (Kuhn & Miller, 2015). However, the presence of double scrapers and combined tools indicates a kind of economical approach, which can be traced back to the poor quality of the local raw material. Pieces with a homogeneous texture, free of inclusions, and therefore easier to knap, were subjected to intensive processing. According to all calculations, the proportion of endscrapers among tools is high in Acsa: 327 pieces (60.9%) in T. Dobosi's sample (T. Dobosi, 2013), 174 pieces (42.6% of the 408 tools) in the sample examined here. Taking other processing tools into account, armatures are in the absolute minority in the collection. This distribution indicates the nature of the activities carried out at the site. According to our current knowledge, it may be a base camp, where the processing and consumption of resources took place (e.g., Domingo *et al.,* 2012).

Based on technological and typological arguments, the excavator determined the presence of an archaeological taxon, the Aurignacian, at the Acsa-Rovnya site (T. Dobosi, 2013). According to the current status of the revision of the site, Gravettian elements do not occur in the Acsa-Rovnya material, but traces of several early Upper Palaeolithic taxa may be present. Whether the collection represents groups belonging to one or more archaeological cultures, the material residue of their activities remained similar on Acsa-Rovnya, which indicates a similar land use during the Early Upper Palaeolithic, and a similar status of abandonment in the later stages of the Upper Palaeolithic. The site is located on a hilltop at 260–270 meters above sea level, at a relative height of 106 meters. Considering the taxon defined by Dobosi, during the Arcy interstadial, the settlement fell on the Galga valley with mixed

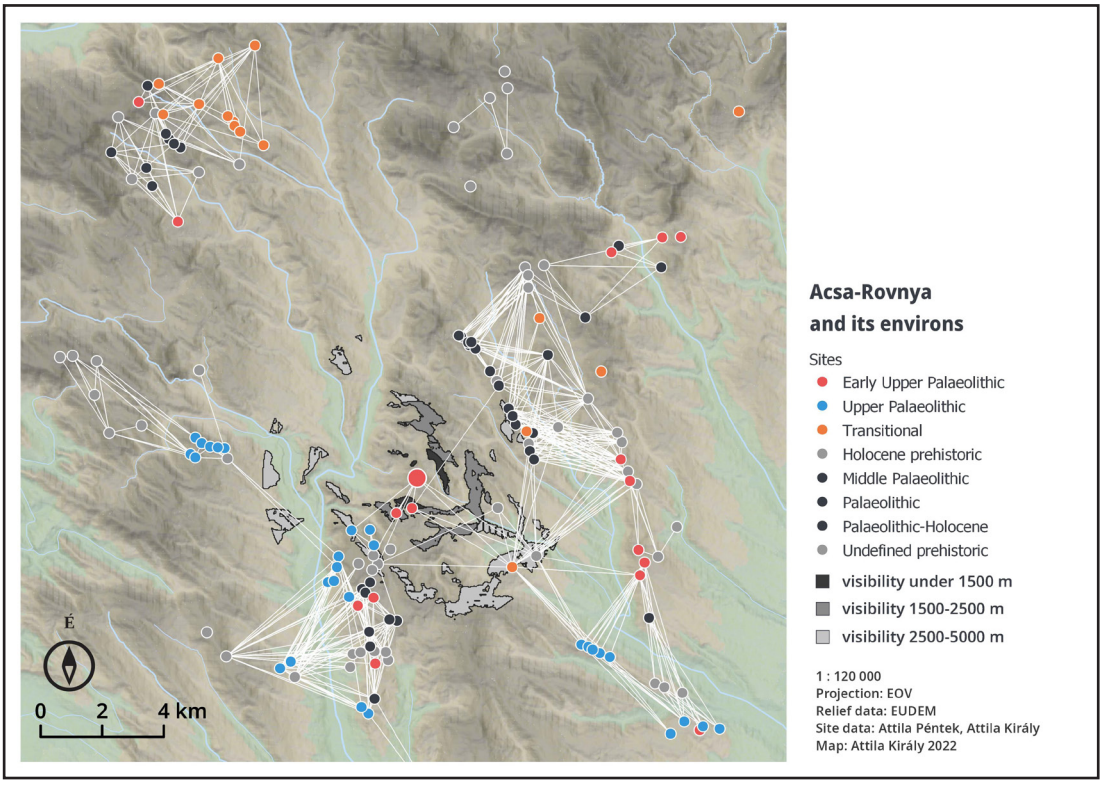


Figure 8. Acsa-Rovnya and its surroundings. The white lines express the visual connection between the studied sites. Acsa-Rovnya, marked with a large red dot, is surrounded by the visibility areas marked with grey: the identity of a person can be recognized in the dark grey area; it is possible to recognize that it is a person in the middle-shaded area; movement can be detected in the light grey area, this is the limit of visibility. Prepared by the author.

taiga forests and the Rovnya hill with spruce-steppe vegetation, based on paleoecological research conducted on similar landscape units (e.g., Feurdean *et al.,* 2014; Sümegi, 2014; Sümegi *et al.,* 2019).

Its localization corresponds to the typical Aurignacian settlement pattern, a foothill environment between 150 and 300 meters, from which several biomes are easily accessible (Hauck *et al.,* 2018). In the form of the Galga, the permanent water source was also nearby (2,090 m distance), and the raw materials needed for knapping were also available locally. The visibility tests show an interesting position for the site (Fig. 8). The visibility of Acsa-Rovnya is particularly poor from the sites of different ages in the investigated area. Compared to other areas of the region, especially the areas along the streams, the hill itself is less visible. Acsa-Rovnya can only be seen from a few sites, and vice versa, these are: Püspökhatvan-Takács-hegy, Acsa-Provosznya, Erdőkürt-Cigány-part, Erdőkürt-Szedmina. The latter is a Holocene site, the rest are all considered Early Upper Palaeolithic, but currently unpublished finds (Péntek & Zandler, 2016). Taking these data into account, the Rovnya hilltop was less suitable for hunting during the Early Upper Palaeolithic, because it was located further from the river valley

that allowed the migration of presumed prey animals. It was less suitable for collecting limnosilicite raw material, since the outcrops were available about two kilometres to the southwest, also on the hillsides located on the edge of the Galga Valley. Its position could have been optimal from a strategic point of view, within arm's reach of the mentioned resources, yet in a protected place, presumably with a view of camps of the same age, and directly above an erosion valley in a NW-SE direction, which cut through the Ecskendi Ridge and provided a connection between the Galga and Zagyva river valleys. The size and composition of the find material and the function suggested by the endscrapers harmonize with this paleoecological and settlement scenario.

Compared to other find materials in Hungary determined to be Aurignacian, the proportion of endscrapers compared to the other elements of the toolkit is high at Acsa-Rovnya, but the group of armatures is strongly underrepresented at all such sites except for the upper culture layer of Istállóskői cave (Table 5). The relative proportions of processing tools and armatures require further explanation. In the case of the Aurignacian *sensu lato* industries, the research considers various lamellae as elements of hunting weapons (Teyssandier *et al.,* 2010). The Hungarian sites also include various retouched points, possibly truncated pieces, which could have been parts of hand-held hunting weapons (Shea & Sisk, 2010). The underrepresentation of armatures does not necessarily reflect the roles of former occupations in regional land use strategies. Microblades are less likely to be found during surface collection, and the large-scale methods of the early excavations. We cannot rule out the possibility of misinterpretation either, since in the absence of use-wear analyses, pieces with a pointed morphology are classified as armatures, and a simple flake is usually classified as debitage. In addition, the experiment of Gravel-Miguel and his colleagues convincingly demonstrates that the armatures are usually discarded in places that have a negligible chance of being discovered by archaeological research (Gravel-Miguel *et al.,* 2021).

The interpretation is further nuanced by artefacts made of organic material since one of the hallmark finds of the Early Aurignacian is the antler tips, which are usually interpreted as parts of hunting weapons (Doyon, 2020; Tartar, 2015). In addition, other tools, such as scrapers, were surely made of bone and other organic materials (Tartar, 2012). Due to taphonomic reasons, the vast majority of our open-air Early Upper Palaeolithic sites have no remains of organic material at all, including potential hunting weapons (e.g., Chu *et al.,* 2018). On the other hand, a large number of antler artefacts are known at the Istállós-kői cave, among them at least 23 points with split bases and 9 points with other bases from the lower find layer (Markó, 2017; T. Dobosi, 2002). Markó described the cavity as a temporary hunting site based on its isolated topographical position, its periodic visits, the small amount of knapped lithic finds, including the small amount of waste indicating tool making, and the presence of points (Markó, 2017). In terms of land use, this definition forms an excellent counterpoint to the Acsa-Rovnya site, treating with reservations the lack of armature in the compared sites.

6. Conclusions

In this study, the principal component and cluster analyses considered the morphological and typological features of the Acsa-Rovnya endscrapers, which are usually used to characterize this type of tool. The components of the factors established during the principal component analysis are morphometric variables that are largely allometrically related to each other. The cluster analysis thus separated sets primarily based on the thickness of the endscrapers and the location of the thickest section of the support, as well as

the resulting properties of the retouch. The technical groups established based on support preferences and tool-making methods did not align with these clusters. The difference between the more robust, more roughly made and the more carefully formed, gracile tools is caused more by the different raw material quality of the supports and the different roles of these blanks in core reduction. The former may have been created in the preparatory or initial phases of reduction, and their material is usually of lower quality and contains inclusions. The latter are usually made from the more homogeneous raw material products of the debitage phase of the reduction, so their design is also more regular, with fewer knapping errors. According to the metric data, these technological groups consist of similar-sized tools, which, according to the HCPC study, were affected in a relatively uniform manner by the morphological changes associated with use, such as fractures or changes in the shape of the retouch. Compared with the rest of the find material, it can also be seen that the supports of the endscrapers are generally narrower and thicker than the other processing tools and the unworked flakes. However, their size range is narrow, and there are no outstanding differences, except for the armatures.

The study did not provide a straight answer to the first question of the paper, the reasons for the variation in the endscrapers in Acsa-Rovnya, but according to the most economical explanation, the reasons are more functional than cultural or historical. Endscrapers appear in large quantities from the Upper Palaeolithic onwards in the European archaeological record, so we can rightly assume this maximum age here as well. Due to the complete absence of tools and knapping methods typical of the Gravettian, the lower age limit of the Acsa-Rovnya find can be placed at the end of the Early Upper Palaeolithic. Within this period, we currently know the Aurignacian (Chu *et al.,* 2020), an unidentified Early Upper Palaeolithic industry (Budek *et al.,* 2013), and the Szeleta transitional industry (Mester, 2018) in our country, their exact chronological relationship however, is still controversial. Endscrapers made on stout blades and flakes are known in the collections of all three mentioned taxa, which show great typological diversity even from one site to another. The Acsa-Rovnya find material can even be classified into several taxa - this is currently the subject of a revision – but the uniform raw material, dimensions and technological groups that complement each other in terms of core reduction do not justify the division of the sample along supposed cultural or aesthetic arguments, they simply do not contradict such a division. The functional-taphonomic evaluation of different endscraper designs is the subject of subsequent research.

Consistency can also be observed in the land use characteristics of the Acsa-Rovnya site. The large amount of knapped stones indicates intensive use of the site in the Early Upper Palaeolithic, which means frequent visits, longer stays, or both. Only a small part of the collection is a formal tool (currently 7.3%), which can be caused by both the abundance of local raw materials and their poor quality for knapping. In the case of abundant raw material supply, opportunistic tool management is often observed instead of careful preparation and retouching, and more waste is more likely to be generated from raw material pieces that are difficult to process (Király, 2020). In any case, the large amount of waste and debitage points to the fact that the tools were made locally. The vast majority of stone tools are endscrapers (currently 60.9%), usually used for processing organic materials; armatures account for only 2.4% of stone tools.

The amount and composition of the find material indicate the consumption and transformation of resources, and the geographical position of the site is also a little far from the assumed sources of procurement. The limnosilicite outcrops

are situated about two kilometres away, and the Gravettian settlements can already be found here; the biome suitable for prey animals, the Galga Valley, is also further away. On the other hand, the Rovnya hilltop could have been a great strategic point, with a view of the camps of the same age in the area, as well as the erosional trench connecting the Galga and Zagyva river valleys at the foot of the hill.

Based on all these features, communities belonging either to one or more archaeological cultures settled on the hill, they left us traces of a very similar repertoire of land use: that of a frequently visited base camp, where primarily stone and organic material tools were made, skins were prepared and resources were consumed.

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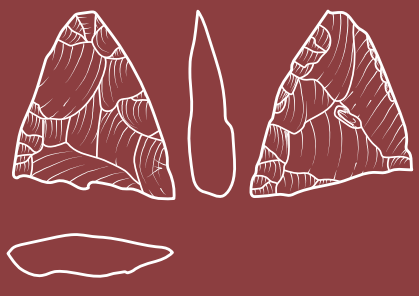
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June 1, 2021, Zsolt Mester's greeting in the library of the Institute of Archaeological Sciences, Faculty of Humanities, ELTE Eötvös Loránd University, Budapest, Hungary. Zsolt is posing in a shirt made as a gift by his son. Facing him are the audience (l–r): Tivadar Vida, Pál Raczky in the back, Alexandra Anders, György Lengyel, István Kristóf Szegedi, Gábor Kalla, Dávid Bartus. *Photo: Attila Király; drawing: after Kozłowski* et al., *2009*.



11

Mesolithic and Neolithic finds from Zbehy-Dolné lúky site, sectors A0–M10

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Abstract. Rescue excavations in the Nitra industrial park at the Zbehy-Dolné lúky site in 2017 revealed occupations from the Mesolithic, Neolithic, Eneolithic, Early Bronze, early medieval and modern periods. The Mesolithic remains are remarkable, as no settlement has been recorded previously from that period in Nitra and its vicinity. In the eastern part of the site, in sectors A0–M10, a cultural layer contained assemblages of mostly lithic artefacts from the Mesolithic and Neolithic periods, confirmed by ^{14}C dates on animal bones from the lower part of the cultural layer, 5910 ± 40 uncal. BP and 7790 ± 60 uncal. BP.

Keywords: Mesolithic, Neolithic, Slovakia, Nitra, Rescue excavation, Lithic industry, ^{14}C dating

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1. Introduction

The Institute of Archaeology of the Slovak Academy of Sciences carried out extensive rescue excavations as part of a road infrastructure construction in the Nitra industrial park in 2017 (Vojteček *et al.,* in press). A multi-period settlement was discovered at the interface of the Lužianky and Zbehy cadastral areas (Fig. 1). The site itself was located outside the urban area, in a field used for farming. The site today looks almost flat, but in the past, small elevated areas scattered over the floodplain of nearby water streams. These elevations were later transformed, probably as a result of agricultural activity. North of the site, the terrain becomes hilly. The settled area is located between two water streams, the Nitra river in the southwest, just next to the site, and the Dobrotka stream in the northeast. The Nitra river had meandered in the wide floodplain, evidenced by still visible meanders which were artificially filled in the course of the river's regulation in the 1930s and 1960s.

2. Archaeological excavation

Machinery removed the topsoil down to the underlying loess in the western part of the area. Pits were identified there (Fig. 2). The eastern part of the area was only partially removed, as a dark cultural layer with pits was identified just below the humus topsoil. Therefore, a different excavation method was applied using sector-based deepening in 3 × 3 m squares (Fig. 2). The manual deepening in the cultural layer by subsequent individual levels allowed us to obtain finds which did not come exclusively from the pit features. The concentration of lithic artefacts in sectors F5–7, G6 (Fig. 3; 4), where finer sediment removal was carried out, proved to be the most interesting feature. Unfortunately, due to the character of the rescue excavation and lack of time, the sediment from the sectors was not sieved. However, a rather

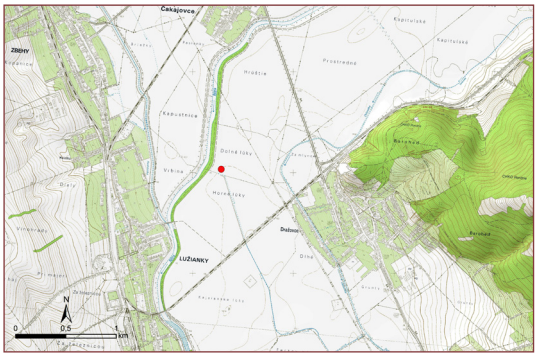


Figure 1. Location of the Zbehy-Dolné lúky site. Prepared by the authors.

numerous lithic assemblage was obtained; the *in situ* find location of the pieces has been recorded by geodetic means (Fig. 4; 5). A soil profile sample had also been taken from sector F7 (Fig. 6), which was macroscopically evaluated in detail in the State Geological Institute of Dionýz Štúr in Bratislava.

3. Find context

3.1. The site

The occupation of the investigated area was concentrated on elevated loess sites. 328 pits from the Neolithic (Linear Pottery culture), Eneolithic (Lengyel and Baden cultures), Early Bronze Age (Únětice culture), early Middle Ages, and the modern era were investigated within the site. Apart from the pit features of the settlements, the skeletal remains of seven individuals have been discovered. Three of them were burials in settlement features and four skeletons were found in grave pits. Based on the accompanying finds, the burials were dated to the Eneolithic and the Early Bronze Age. Despite the existence of settlements from several periods, only one residential feature from the early Middle Ages was identified (Daňová & Cheben, 2021).

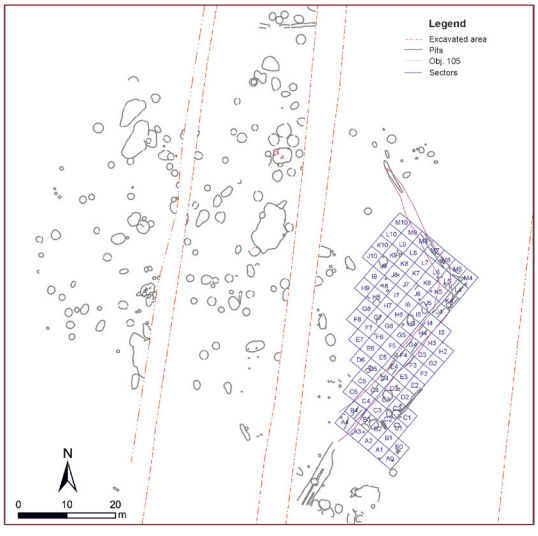


Figure 2. Plan of the Zbehy-Dolné lúky site. Prepared by the authors.

3.2. Sectors A0–M10

The cultural layer in the eastern part of the site was up to 30–50 cm thick. It was detected over approx. 20 × 40 m area (Fig. 2). Several pits dated from the Early Bronze Age (feature 134) to the modern era were sunken in its upper part. Thus, the cultural layer must have been deposited before the Bronze Age. It is also suggested by the find material which contained mostly pottery fragments, lithics and animal bones. The largest find concentration, lithics in particular, occupied sectors F5–F7, G6, G8 and I10 (Fig. 3). In other sectors, more than 5 lithics were found only occasionally. There were even no stone artefacts in some of them.

3.3. Sectors F5–7, G6

Most lithic finds, 56 items, have been recorded in sector F6. The neighbouring sectors F7 (27 items) and G6 (24 items) were also rich. In sector F5, only 7 examples were found. The exact location of 40 stone artefacts, three animal bone fragments and a pottery sherd were recorded in this concentration. The finds were detected in the lower level of the dark brown cultural layer which gradually changed to a transitional pale brown sediment and finally to an archaeologically sterile yellow loess layer. *In situ* finds were recovered in various depths (Fig. 5). Most of them were lying horizontally in the sediment, an inclined position was exceedingly rare. The restricted vertical distribution, the considerably dense concentration as well as the number of conjoining items suggest that if the finds were not in their original positions, they were only slightly moved. The difference in find distribution, e. g., their vertical dispersion, between sector F7 and sectors F5, F6 and G6 is remarkable. The finds in sector F7 were lying within the altitude interval 142.3–142.4 m a. s. l. in an approx. 10 cm-thick concentration. In sectors F5, F6 and G6 they were situated a bit lower, approx. between 142.15–142.3 m a. s. l. and within a slightly thicker arrangement, approx. 15–20 cm (Fig. 5). The differences might have been caused by a minor terrain depression leading from sector F6, through F5 and further southeastwards.

The soil sample from the profile of sector F7 (Fig. 6) contains recent soil, carbonate fluvisol, and anthrosol. The humus horizon is 0–32 cm thick with fine structure and loam texture (granularity), with 10YR4/2 colour. The transitional horizon (A/C) is 5 cm thick (32–37 cm), followed by carbonated alluvial soils with fine structure and loam to clay loam texture – soil-making substrate (C horizon), horizon colour 10YR6/3. The soil profile bears features of hydromorphic influence expressed by hydrous ferric oxide stains. Such macroscopic features indicate that the soil profile was not systematically flooded by inundations but the chemical composition of the soil was and is influenced by groundwater seeping up by capillary action. It follows from the morphology of the soil profile that the soil-making substrate (C horizon) was deposited by fluvial processes followed by pedogenesis with the development of a

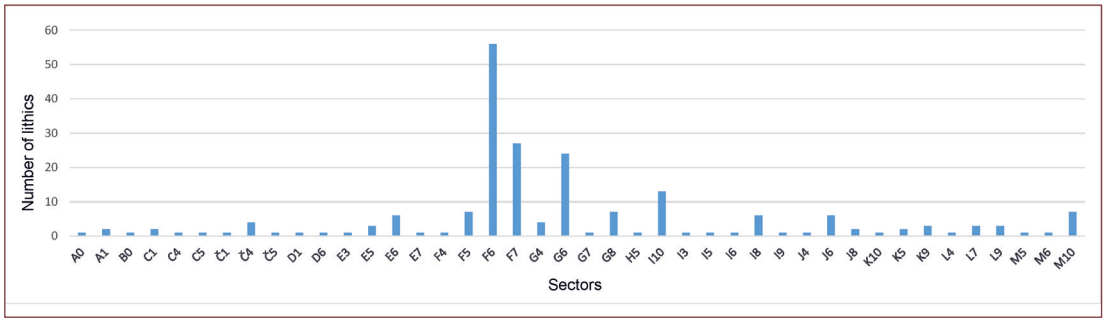


Figure 3. Zbehy-Dolné lúky. Frequency of lithic finds in sectors A0–M10. Prepared by the authors.

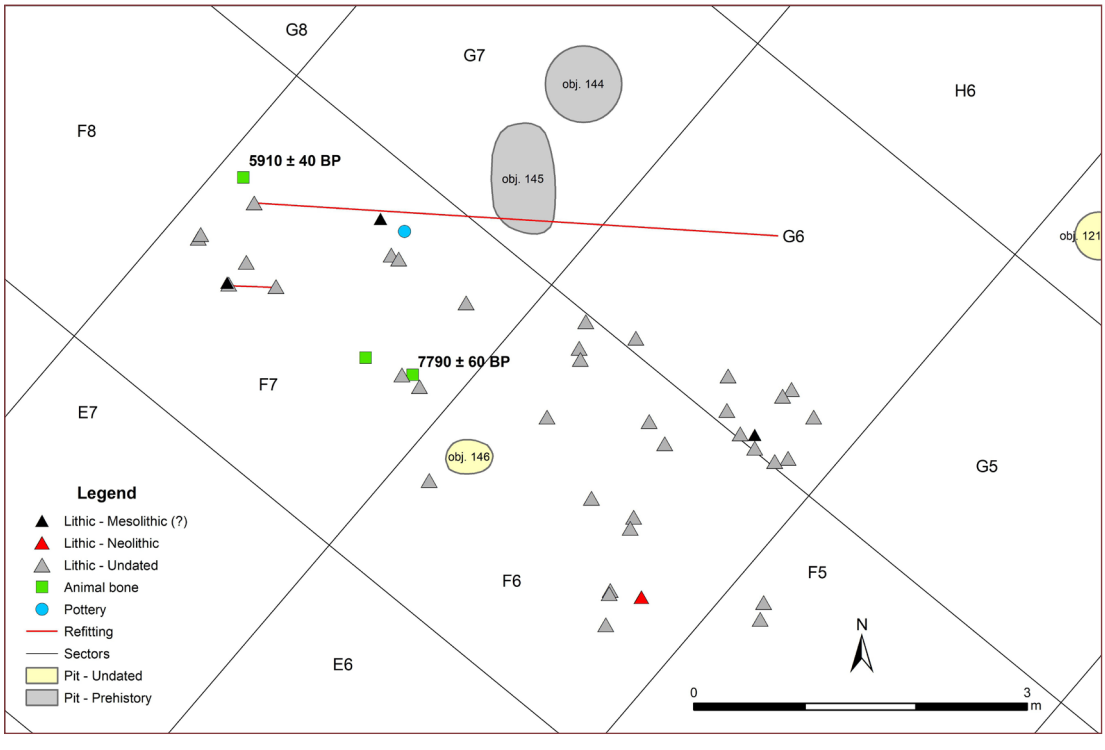


Figure 4. Zbehy-Dolné lúky. Plan of finds distribution in sectors F5–7, G6. Prepared by the authors.

humus horizon (A horizon). The humus horizon indicates that this area was not inundated and the river – water stream – was diverted to another part of the investigated area. The investigated profile can be chronologically divided into two development stages:

A – start of pedogenesis (bottom of the A horizon) to recent (surface part of the A horizon influenced by human activity)

B – end of sedimentation of the soil-making substrate (C horizon).

Table 1. Zbehy-Dolné lúky. Major lithic groups and raw materials.

		Radiolarite	Tevel flint	Limnosilicite	Jurasic flint*	Obsidian	Patinated silicite	Burnt silicite	Unknown	Total
Cores		12	-	3	-	-	-	-	-	15
Debitage	Blades, bladelets	21	-	2	1	3	-	-	3	30
	Flakes	32	-	5	-	1	-	1	1	40
	Chips, flake fragments	58	-	5	-	2	-	8	6	79
Retouched & used tools	Blades, bladelets	19	1	3	2	-	2	2	1	30
	Flakes	8	-	-	-	-	-	1	2	11
Total		150	1	18	3	6	2	12	13	205

* – Jurassic flint from the Cracow-Częstochowa Upland

4. The lithic industry from sectors A0–M10

The assemblage of 205 lithic artefacts comes from the cultural layer in the eastern part of the site (Table 1). Most of the artefacts were made from various types of radiolarites, mainly the Hungarian Szentgál type with typical dark red or brown colour and the so-called "porcelain cortex". Limnosilicite, obsidian, Jurassic flint from the Cracow-Częstochova Upland and Tevel flint were considerably less frequent. Some unspecified pieces were burnt or patinated.

Most of the 15 cores in the assemblage are fragmentary, we were able to restore some of them (Fig. 7: 13). As for the preserved examples, they are mostly pyramidal or flat cores (Fig. 7: 6, 13). They are exclusively unipolar cores usually with striking platforms created by one strike, from which blades and bladelets were knapped.

Unretouched blades, bladelets and their fragments are rather frequently represented both among debitage and tools (Table 1). Most of them are blades and bladelet fragments (23 examples); only 7 complete artefacts have been preserved. The length of the complete examples varies between 20.8 and 46.2 mm, they are 4.2–20.7 mm wide and 1.3–8.5 mm thick. Identification of techniques was difficult, direct percussion, probably with a soft organic hammer is present. Two cases can represent indirect percussion with a punch and one example shows remarkably regular edges (Fig. 7: 9), implying pressure technique or indirect percussion.

40 unretouched flakes were identified, but they were considerably less frequently used for the production of tools (Table 1). They are mostly products of raw material block and core decortication or rejuvenation. The length of the flakes varies between 56.5–9.6 mm, they are 33.3–4.4 mm wide and 22.5–2.8 mm thick. The smallest flakes, chips and flake fragments were included in a separate group, which was the most numerous of all, comprising 79 examples (Table 1).

Tools are the second most numerous group of lithics. Besides retouched tools, this group includes used pieces and artefacts with sickle gloss. Blades, bladelets and their fragments were used to make 30 of them, flakes were used 11 times. Retouched tools contain three endscrapers on radiolarite blades, an endscraper on a bilaterally retouched radiolarite blade, an atypical endscraper on a patinated silicite blade with lateral sickle gloss and an atypical endscraper on radiolarite

blade. The assemblage also contains two short endscrapers of radiolarite (Fig. 7: 3), one miniature (Fig. 7: 1), two endscrapers on flakes, one radiolarite, and one burnt silicite item (Fig. 7: 11). Two burins were also identified – a multiple dihedral burin of an unidentified raw material and a burin of a radiolarite blade or flake fragment. Retouched blades consist of a truncated radiolarite blade with partially ventral bilateral retouch (Fig. 7: 12), a truncated radiolarite blade fragment, possibly a trapeze fragment (Fig. 7: 4), two truncated blades with lateral sickle gloss, one of them is made of Jurassic flint from Cracow-Częstochova Upland (Fig. 7: 14) and the other, a fragment, is of radiolarite (Fig. 7: 15). Retouched blades are also included two truncated blades (of limnosilicite and an unidentified raw material) and two laterally retouched blades from radiolarite. Geometric microliths are represented by a limnosilicite scalene triangle retouched on all edges (Fig. 7: 16), a radiolarite isosceles triangle retouched on all edges with a burin facet (Fig. 7: 7), three trapezes, one limnosilicite (Fig. 7: 2), one radiolarite (Fig. 7: 8) and also a radiolarite item, but with sickle gloss and burin facets on its ends (Fig. 7: 10). A further microlith is a backed piece made on the cortex part of Szentgál radiolarite (Fig. 7: 5). Two retouched flakes are made on radiolarite and an unidentified raw material. As for used pieces, there was one laterally partially used radiolarite blade, four bilaterally partially used blades, three radiolarite and one patinated silicite, and three used radiolarite flakes. Sickle gloss has been identified on three blades and blade fragments, their raw material is radiolarite, Jurassic flint from Cracow-Częstochova Upland and Tevel flint.

5. Absolute dating

Three bone samples provided important data for the absolute dating of the cultural layer, the find context and finds themselves (Fig. 8). As we have already mentioned, several pits were dug in the cultural layer which were younger than the lithics from this layer. The pit thought to be the earliest is feature 134 (sector Č3–D3), which was dated to the Early Bronze Age based on the archaeological material. In its upper part, human skeletal remains were recovered in anatomical position; their identified age was 3515 ± 35 uncal. BP (Poz-143458). The absolute age of the upper – the youngest – part of the cultural layer is thus older than this date. Two other dates are also important, they were recovered from animal bones in sector F7, discovered in the lower – the oldest – part of the cultural layer. Their datation was aimed to earn a more secure chronology of the find context containing the lithic concentration. Based on technology and typology, the industry can be dated roughly from the Mesolithic to the final Neolithic. Unfortunately, they were not deposited in separate layers. The vertical distribution of the finds in sector F7 partly corresponds with their *in situ* deposition within the horizontal stratigraphy. Chronologically, a single Neolithic pottery fragment was found at the highest point, above the concentration of the lithic assemblage (Fig. 5). This applies also to the deposition of dated animal bones. Traces of processing by humans, e. g. hunting, portioning, cooking, etc., were not found on any of them. The sample deposited higher is a mandible fragment, probably belonging to *Sus scrofa* and it is dated to 5910 ± 40 uncal. BP (Poz-97083). The lower and older Mesolithic sample consisted of antler fragments probably belonging to *Cervus elaphus* and it is dated to 7790 ± 60 uncal. BP (Poz-97056). The third fragment, currently undated, may belong to *Bos* sp. or *Cervus* sp. Unfortunately, the recovered microliths were not found in their original positions and their exact geodetic measuring was not carried out. Only a few stone artefacts with questionable Mesolithic classification (Fig. 4; 5) were found in sectors F6 and F7. In sector F6, a fragment of a sickle-blade from Tevel flint has been identified; it was locat-

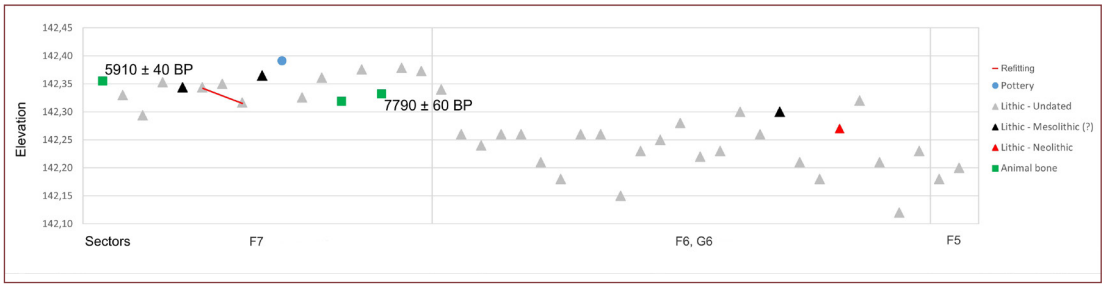


Figure 5. Zbehy-Dolné lúky. Elevation a.s.l. of finds in sectors F5–7, G6. Prepared by the authors.



Figure 6. Zbehy-Dolné lúky. Photo profile of sector F7 with the location of the geological sample. Prepared by the authors.

ed lower than the miniature endscraper probably classified in the Mesolithic (Fig. 7: 1). It is most probably associated with post-depositional processes of sediments mixing with finds.

6. Discussion

The discovery of Mesolithic finds in the course of archaeological excavation at the site of Zbehy-Dolné lúky is rather rare in the larger region. The Mesolithic occupation from this period in Nitra and its vicinity is currently not known.

The nearest Mesolithic site was discovered and investigated by J. Bárta in 1953–1955 (Bárta, 1957) in Sereď-Mačianske vŕšky. The extensive assemblage of retouched tools (Bárta, 1957, tab. XV–XXI) is dominated by endscrapers, micro-endscrapers, retouched bladelets, retouched flakes, backed bladelets, scalene and isosceles triangles usually

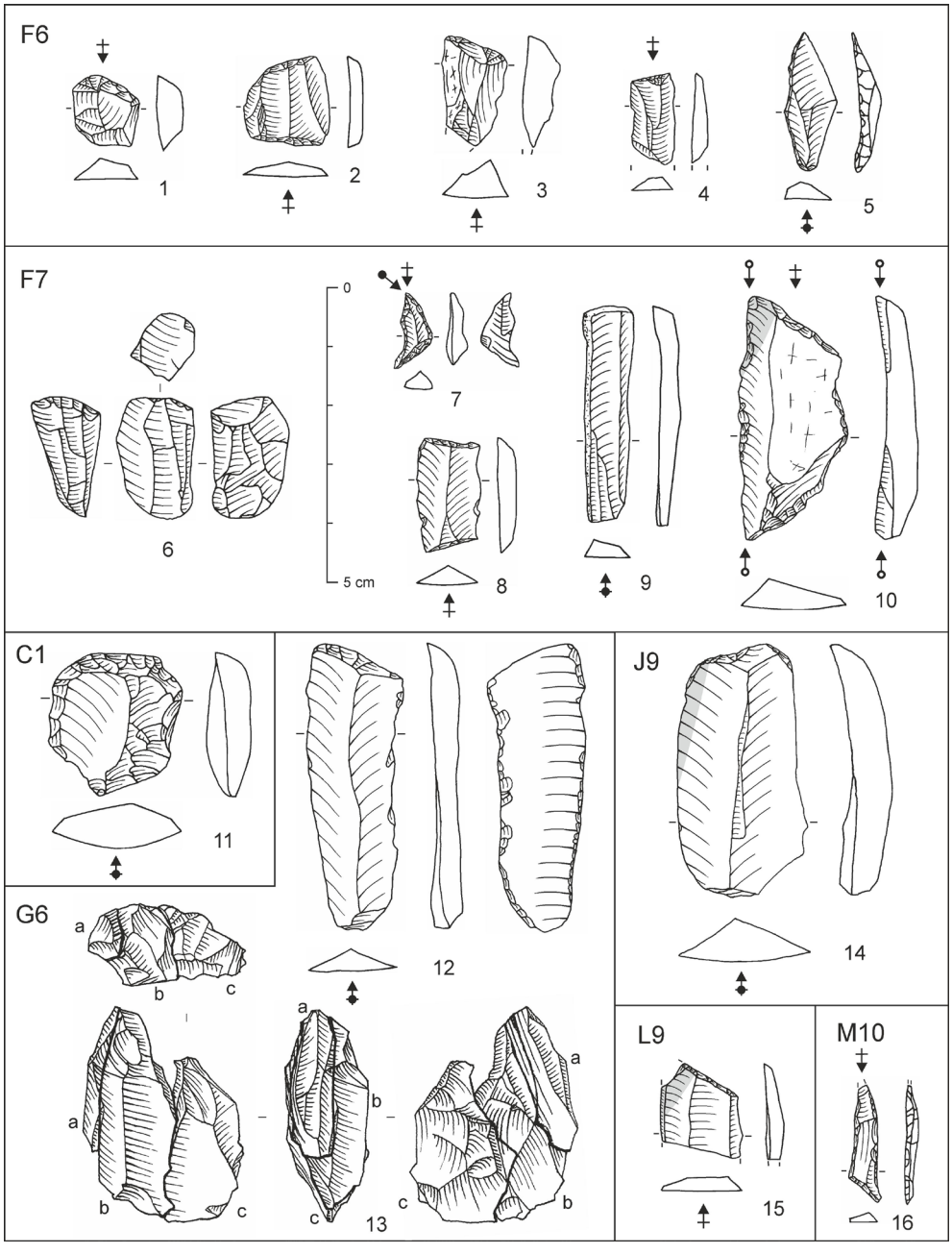


Figure 7. Zbehy-Dolné lúky. Selected lithic industry by sectors. 1, 3–10, 12, 13, 15 – radiolarite; 2, 16 – limnosilicite; 11 – burnt silicite; 14 – Jurassic flint from the Cracow-Częstochowa Upland. Prepared by the authors.

retouched on two edges, segments and few trapezes. In the context of results from the analysis of flora and fauna, J. Bárta classified the assemblage to the end of the Boreal and the beginning of the Atlantic (Bárta, 1957, p. 36). The latest results of 14C dating of animal bones from the site place the age of the occupation to the Boreal period. Other assemblages from the region of Sereď are from Dolná Streda (Bárta, 1959), Mostová (Bárta, 1960) and Tomášikovo (Bárta, 1955) most probably belonging to the same period.

The frequent occurrence of the Szentgál-type radiolarite in Zbehy suggests remote contacts with western Hungary, the Transdanubian Mountains. The Páli-Dombok site was investigated in the NW part of Hungary in 2014. The assemblage from this site was preliminarily dated to the turn of the Epipalaeolithic-Early Mesolithic (Mester *et al.,* 2014, p. 353). The lithic industry consists of radiolarite from the Bakony Mountains, the source of the Szentgál type as well. Retouched tools include several endscrapers, bifacially formed pieces, triangles, backed points, truncated blades and burins.

Vác-Sződliget II is another site in northern Hungary. In 1967, M. Gábori recorded there an area paved with pebbles of 9 m^2 and two hearths which were probably used simultaneously (Gábori, 1968). The paved area can be interpreted as a base for a dwelling with light construction (Kertész & Király, 2021, p. 169). Based on the find typology (especially the presence of trapezes), stratigraphy, and taphonomy of the site, the settlement can be most probably dated to the Late Mesolithic, the final Boreal or early Atlantic period. Key information regarding the Mesolithic occupation of the northern part of the Carpathian Basin comes from the Jászság region. In the 1990s, the sites of Jászberény I and Jásztelek I were investigated there (Kertész *et al.,* 1994). Chronologically older finds were identified at Jászberény I. Three radiocarbon dates are known from this site (Fig. 8): 8030 ± 80 uncal. BP was obtained from *Cepaea vindobonensis* mussels, 7350 ± 80 uncal. BP and 7154 ± 62 uncal. BP come from the "sediment carbonate of the matrix of the Mesolithic culture-bearing layer" (Kertész, 2002, p. 290; Kertész *et al.,* 1994, p. 28). A more recent settlement was discovered at the site of Jásztelek I, where a dwelling with a circular ground plan was found. It was "built around a framework of posts" (Kertész, 2002, p. 288). Assemblages in this region are dominated by microliths including backed points, and together with the occasional straight and oblique backed types, arched pieces were the most frequent. Backed pieces, obliquely truncated backed bladelets and retouched truncations are represented as well. The Microburin technique was recognized there. Geometric microliths are represented by crescents, isosceles and scalene triangles as well as trapezes (Kertész *et al.,* 1994, pp. 21, 29). They were divided into two groups. The early phase is characterized by smaller types, while larger pieces belong to the later phase (Kertész, 2002, p. 288).

Last but not least, there is the site of Barca I in eastern Slovakia. The lithic assemblage is made of obsidian and it is typologically dominated by short scalene and isosceles triangles, backed bladelets, atypical trapeze and microburins (Prošek, 1959, pp. 146, 147). The finds were deposited in a layer together with charcoals. Below, there was a pit from the Palaeolithic (Prošek 1959, p. 145). The latest ^{14}C on birch (*Betula* sp.) charcoal is 7820 ± 50 uncal. BP (Fig. 8). Another similar date was obtained from the site by other colleagues (W. Chu, Ľ. Kaminská, pers.comm.). The date is almost identical to the one from Zbehy and it is similar to the absolute age of Jászberény I (Fig. 8). The typological picture of Barca I and Jászberény I, together with Jásztelek I, is remarkable, which has been pointed out before (Kertész, 2002, pp. 289, 294, 296; Kozłowski, 2001, pp. 268, 269).

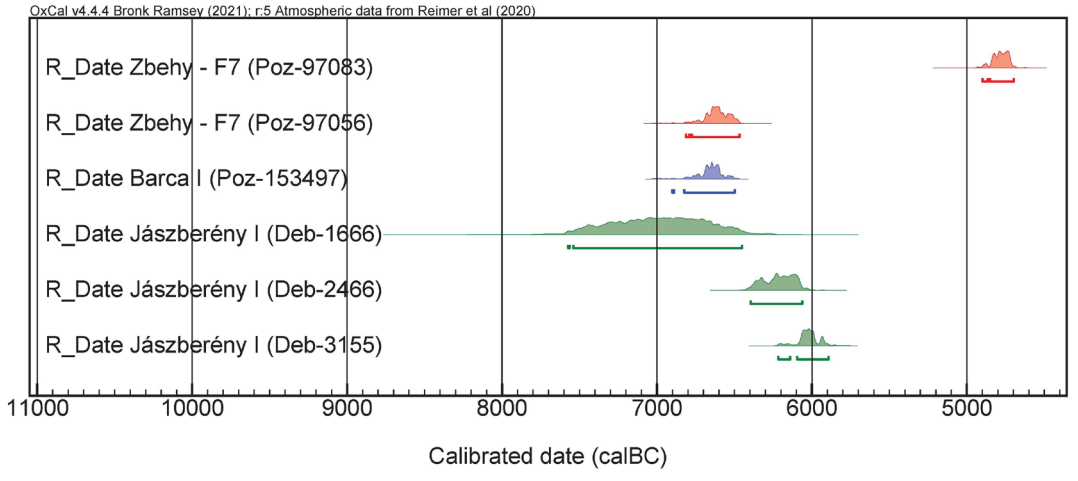


Figure 8. Calibrated radiocarbon dates from the sites Zbehy-Dolné lúky (red), Barca I (blue) and Jászberény I (green) using the atmospheric calibration curve Intcal20 (Reimer et al. 2020). Prepared by the authors.

7. Conclusion

The analysis of the lithic industry from sectors A0–M10 in Zbehy as well as the results of radiocarbon dating of animal bones from sector F7 suggests that the assemblage of finds from the bottom of the cultural layer was not homogeneous and it does not come from one chronological stage of the settlement. The finds are stone artefacts from the Mesolithic and Neolithic, possibly Eneolithic. According to the absolute dates from animal bones, the chronological difference between these components is approx. 2,000 years. We are aware that the selected samples for 14C dating were not ideal and animal bones do not necessarily reflect human agency, as they probably come from wild species, without any traces of processing by humans. On the other hand, their age confirms the classification of the lithic industry. However, the two assemblages dated to different periods were not deposited in different layers, well distinguishable in the sediments. As for post-depositional processes, sector F7 displays the minimum vertical distribution in find deposition (max. 10 cm), a considerably dense concentration, and some pieces that could be refitted or conjoined. These factors suggest that if the finds were not in their original position, they were only slightly moved, which is also corroborated by the frequent horizontal position of longer finds with minimal inclination. The situation was different from sector F7 in sectors F5, F6 and G6, where the finds were deposited a little lower, and more dispersed (15–20 cm). This position is probably associated with post-depositional displacement within the sediments along a depression leading from sector F6 through sector F5 and further in the SE direction. In the rather small lithic collection, Mesolithic microliths can be clearly distinguished; they are represented by a backed piece (Fig. 7: 5) and two small atypical triangles retouched on all edges (Fig. 7: 7, 16), which sometimes occur in other European assemblages. A micro-endscraper could also be dated to the Mesolithic (Fig. 7: 1). The microburin technique was not identified in the assemblage. Occurrence of trapezes without sickle gloss (Fig. 7: 2, 8) or truncated pieces

(Fig. 7: 4) might be associated with the Mesolithic as well as the Neolithic periods. Tools with sickle gloss (Fig. 7: 10, 14, 15) or other larger lithic artefacts, such as endscrapers on blades, etc., were most probably also associated with the Neolithic.

Despite the difficult and probably mixed context, the above-mentioned finds are interesting and they are associated with the last Mesolithic hunter-gatherers and Early Neolithic farmers. In the western part of the site, several pits from the Neolithic and Eneolithic were investigated. They will be analysed in near future and they bring a more complex picture of the settlement. The frequent occurrence of Szentgál radiolarite and Tevel flint point to intense contact with the territory of today's Hungary. Regarding the uniqueness of the finds, more attention should be paid to elevations near water streams in further field activities in the studied region and the methodology of investigation should be adapted appropriately.

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Zsolt Mester and zooarchaeology in the French National Museum of Natural History

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Abstract. This paper describes the history of the collaboration between Zsolt Mester and zooarchaeologists from the *Muséum National Histoire Naturelle* (MNHN, France), which has been lasting for almost 25 years! It has enabled the development of common research projects about Neanderthal and early *Homo sapiens* subsistence behaviours in Central and Eastern Europe. Through an interdisciplinary approach, our collaboration focuses on the valorisation of the Hungarian and French archaeological cultural heritage. The results of this collaborative research have been disseminated in conference papers and publications. Zsolt has also contributed significantly to animate and strengthen our network through common courses and workshops, the training and supervision of students and PhD candidates and, finally, by joining our MNHN research unit as an associate researcher.

Keywords: Zsolt Mester, France, MNHN, Zooarchaeology, Collaboration, Bilateral project, Hungary

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Until recently, the use of the French language was a widespread tradition among most Hungarian palaeontologists and prehistorians. This attests to the influence of French prehistoric research on Hungarian prehistoric research as early as the 19th century (Mester, 2007), but also to the dissemination of scientific results in French/in France by perfectly bilingual researchers such as our colleague Zsolt Mester.

Zsolt is a francophone and francophile, and describes himself as a "*francomane*". This attachment to French culture is expressed through his personal, professional and friendly relationships, past and present. His thorough knowledge of the French language has facilitated exchanges with the scientific community of different institutions and, in particular, with prehistorians and zooarchaeologists of the *Muséum national d'histoire naturelle* (MNHN). This collaboration has lasted for almost 25 years! Zsolt has (co-)led or participated in several interdisciplinary research projects, Franco-Hungarian, Hungarian and French, with several members of our research unit (*Histoire Naturelle de l'Homme Préhistorique*). His interest in zooarchaeology and his revisions of lithic material from early excavations in Hungary (Mester, 1994) allowed the elaboration of these joint research projects on the subsistence behaviours of Neanderthals and early Homo sapiens in Central and Eastern Europe. Thus, our collaboration gives pride of place to the valorisation and conservation of the Hungarian and French archaeological cultural heritage.

The zooarchaeological and taphonomic analyses provided new information on archaeological sites, which complemented the palaeontological work previously carried out by our Hungarian colleagues. Combined with the re-examination of lithic materials, these results allowed us a novel interpretation of the technical and subsistence behaviours in the territory of present-day Hungary during the Middle and Upper Palaeolithic. The contribution of this Franco-Hungarian scientific cooperation and the results obtained were the subjects of a lecture presented by Zsolt in 2018 at the *Musée de l'Homme* in Paris.

In December 1997, having learned that osseous tools (i.e. made of hard animal material) attributed to the Middle Palaeolithic had been reported from the Lovas site (Transdanubia), we (Marylène Patou-Mathis – MPM) undertook to study them as well as the associated large mammal bones. In this context, a close and long collaboration with Zsolt began. He helped with the publication of the zooarchaeological results from this site (Patou-Mathis, 2002) and then, a year later, with the presentation of the Tata site (Transdanubia) material at the International Conference in Tata. The heterogeneity of faunal remains including bone tools from Lovas, which come from two different pits, probably is the result of a mixture of occupations, from the end of the Middle Palaeolithic (perhaps) to the Neolithic or even the Metal Ages (Patou-Mathis, 2002). The Tata site corresponds, in agreement with the observations concerning lithic material, to a temporary camp with recurrent occupations, perhaps seasonal (summer), where the main activities would have been the debitage of lithic raw material and the provisioning of meat and skin quarters, in preparation for the cold season (Patou-Mathis, 2004).

At the same time, we (MPM) proposed to Zsolt to co-supervise the PhD thesis of Éva J. Daschek (ÉJD) on the Érd site (Transdanubia), which he enthusiastically accepted. After completing her 5th-year university diploma (*Diplôme d'études approfondies*) in 2004, ÉJD successfully defended her PhD in 2008, with her dissertation on the zooarchaeological study of large herbivores from the upper levels of the same site, i.e., on all the faunal material then available (Daschek, 2014). Regular discussions and exchanges about this site have resulted in 12 presentations in French, English and Hungarian, and 4 other publications



Figure 1. Zsolt Mester and Marylène Patou-Mathis in the Bükk Moutains in 2002 (Photo: S. Péan).

(Daschek, 2011, 2021; Daschek & Mester, 2020). This research not only attests to the Neanderthal exploitation of cave bears but also to their importance surpassing that of ungulates. In addition to Neanderthal groups, who were using the site recurrently (seasonally), carnivores also participated in the accumulation and modification of the site assemblages at various times as evidenced by the numerous hyena marks and some coprolites. In addition, a new hypothesis on the formation of the site was proposed: a cavity comprising two sectors, which would have gradually collapsed until it became an open-air site on at least one part (Daschek & Mester, 2020). Several works are underway to understand the exact modalities of the Érd site formation. This major Middle Palaeolithic deposit in Hungary is the subject of displays in the permanent exhibitions of the Hungarian Geographical Museum, the Aquincum Museum, and the Budapest History Museum (presentation: Mester & Daschek, 2018, see the Appendix). A zooarchaeological analysis was conducted on another Middle Palaeolithic site, Kiskevély cave (Transdanubia), in 2009. The role of humans in the bone accumulation of the Mousterian levels is presumed anecdotal (2 presentations: Daschek 2010, 2014 in Appendix).

In parallel with this work on Middle Palaeolithic sites, Zsolt proposed the study of new faunal material from Gravettian and early Epigravettian deposits, from two open-air sites, Bodrogkeresztúr and Ságvár, and two caves, Jankovich and Peskő, analysed in 1999 as part of a thesis (Péan, 2001). Ságvár exhibits a specialization in reindeer hunting. In addition to a similar orientation to this cervid, the Jankovich and Peskő caves are characterised by the specialised acquisition of hares for meat and fur, and also the surprising collection of their scapulae. More unusually, Bodrogkeresztúr shows evidence of elk hunting and the processing of quarters from at least two mammoths (scavenged or hunted animals?) for meat consumption. The assemblages attest to the frequent acquisition of carnivore fur, especially common fox, and, in Jankovich and Peskő, cave bears presumably carrion. The open-air sites were used as long-term or recurrently occupied camps, while the caves served as transitory habitats (hunting stations). The seasonality of occupation in the autumn of the Carpathian Basin during the Gravettian and Early Epigravettian periods differs from that of other regions of Central Europe: summer in southern Poland and Moravia, and winter in north-eastern Austria.



Figure 2. Zsolt Mester and Éva J. Daschek after she defended her PhD dissertation, in the library of the Institut de Paléontologie humaine, in 2008 (© Photo: Éva's family).

In 2005, to continue zooarchaeological studies at other sites, Zsolt and we (MPM) decided to set up, in co-direction, a bilateral exchange project, within the framework of the Balaton *Programme d'Actions Intégrées* (PAI) of the French Ministry of Europe and Foreign Affairs (MEAE), entitled "Comparison of technical and subsistence behaviours of Neanderthals and *Homo sapiens* in Hungary and in France" (2006–2008). The zooarchaeological study of the Subalyuk (as well as the taphonomic study of the human remains) and Istállóskő sites (as well as the osseous tools, in collaboration with Carole Vercoutère, assistant professor at the MNHN) began within this framework. They resulted in two publications. New studies of the bone and lithic materials from Subalyuk have allowed the interpretation of the history of occupations, both animal and human, throughout the stratigraphic sequence (Mester & Patou-Mathis, 2016). Subalyuk cave was repeatedly occupied by Neanderthals. The inhabitants, bearing typical Mousterian tools, practised diversified but targeted hunting of small mixed ibex herds. These occupations probably attest to a seasonal camp. Bearers of the Quina-type Mousterian killed mainly ibex but also horses, so the cave would have served as a hunting station, mainly in the summer. According to the taphonomic study, the child's body was probably buried during the adult's decomposition on the surface (Mester & Patou-Mathis, 2016). In Istállóskő cave, the bone industry is linked essentially with hunting activities and confirms the cultural attribution of the lower layer to the Early Aurignacian (split-based points). Bone artefacts from the upper layer are too few to be diagnostic but two end-scrapers from the lithic assemblage suggest an Aurignacian attribution. This zooarchaeological study supports that the archaeological assemblages of Istállóskő cave were formed during successive hunting campaigns (Patou-Mathis *et al.,* 2016).

The research on the nature of human occupations in these two caves, located in the Bükk mountain, shows the archaeological potential of the country's northern regions to answer the problem of the ancient settlement of Hungary. Our scientific collaboration has therefore continued in the framework of a project of the MNHN Department *Homme et Environment* entitled "Modalities of occupation of cave habitats by Neanderthals and *Homo sapiens* in northern Hungary", obtained in 2018 (led by Stéphane Péan – SP), then a bilateral project PHC Balaton (*Programme Hubert Curien*) of the MEAE, entitled "Interdisciplinary study of subsistence behaviours during Middle and Upper Palaeolithic in the Carpathian Basin" (PALEO 2019–2021, co-direction Zsolt Mester & SP). This latter collaborative project aimed to characterize different occupation modalities in the Carpathian Basin, by combining

zooarchaeological, typo-technological, traceological and geochronological analyses (presentation: Péan & Mester, 2019, see the Appendix). Within the framework of these projects, zooarchaeological analyses of several Middle and Upper Palaeolithic sites have been undertaken by several of us (MPM, Marie Seguedy – MS, SP): Büdöspest (Middle Palaeolithic), Jankovich (Middle and Upper Palaeolithic), Remete Felső (Middle/Upper Palaeolithic), Szeleta (Middle and Upper Palaeolithic), Peskő (Upper Palaeolithic) caves and the Pilisszántó I rock-shelter (Upper Palaeolithic). The large mammals from the 1915's excavations at the latter site were studied as part of a Master 2 thesis at the MNHN (Seguedy, 2018). It was during an international course module in experimental archaeology, co-organized by Zsolt, David Pleurdeau (DP), and one of us (Antony Borel – AB) at Százhalombatta in 2017, that the topic of this thesis was complemented with a traceological approach. This study highlighted the exploitation of several taxa for food (reindeer, chamois, bison, horse) and symbolic purposes (arctic hare), and provided a better understanding of how this site was alternately occupied by carnivores and humans (3 presentations: Seguedy *et al.,* 2019; Seguedy, 2021; Seguedy *et al.,* 2021, see the Appendix). As an extension of our scientific collaborations, a PhD project in co-supervision (MNHN-ELTE) has been set up with Zsolt (MPM and SP). Led by MS, this dissertation aims to study the "Invariants and innovations in subsistence behaviours among Neanderthals and *Homo sapiens* in the Carpathian Basin: taphonomic analyses of faunal remains and bone/lithic interface" through the zooarchaeological and taphonomic study of the mammalian fauna of the Büdöspest and Szeleta caves and the Pilisszántó I rock-shelter. Another part of this dissertation focuses on the identification of the lithic raw materials used in the processing of animal carcasses through the microscopic observation of the cutting marks produced by lithic tools on bone. At the intersection of different fields such as zooarchaeology, traceology, and lithic typo-technology, this approach is made possible in particular by the large raw material reference collection that Zsolt and his collaborators have built up at the ELTE Institute of Archaeological Sciences (e.g., Mester, 2013) and by the recent creation of a reference collection for traceology at the MNHN and the ELTE by Zsolt and AB (who has been partially delegated at the ELTE since 2017). This new collection includes more than a hundred pieces so far, of eight different raw materials from the Carpathian Basin. These specimens are associated with several hundred surface measurements (by laser-scanning confocal microscopy), allowing the application of quantitative methods to characterize use traces (Borel *et al.,* 2021a, 2021b).



Figure 3. Éva J. Daschek and Zsolt Mester at the lecture "Érd, 775th birthday" in Érd at the Hungarian Geographical Museum in 2018 (© Photo: Földrajzi Múzeum/ Hungarian Geographical Museum).

The dynamism of our research with Zsolt has resulted in the joint production of 14 conference presentations (see Appendix) and 9 publications (see References). Our colleague Zsolt contributes to animate our collaborations and to valorise the results of our work, not only in terms of re-



Figure 4. Zsolt Mester and Antony Borel in 2018 in Budapest during the pre-launch of the Franco-Hungarian mission of the French Ministère de l'Europe et des Affaires Étrangères to be led by Agnès Lamotte (University of Lille) and Zsolt (© Photo: Agnès Lamotte).

search but also of teaching, in particular within the framework of the MNHN Masters programme. He has been teaching in two educational units of the "Quaternary, Prehistory, Bioarchaeology" course, on experimental archaeology (QPB 7, coordinated by AB and DP; see Borel *et al.*, 2018, 2019, forthcoming) and on technical behaviour in the Middle and Upper Palaeolithic in Hungary (QPB 8, coordinated by SP and MPM). As illustrated above, he has been involved in the training of doctoral students and the supervision of post-doctoral students. During his stays in Paris, Zsolt gave several lectures at the *Musée de l'Homme* and the *Institut de Paléontologie humaine* (Paris research and education institutes of the MNHN in prehistory), on recent Hungarian research and questions currently debated in Palaeolithic archaeology about the validity of the Szeletian, Bábonyian and Jankovichian as techno-cultural complexes. He also took part in the scientific life of our research unit, in several of its meetings. This collaboration was administered by his invitation as a guest professor of the MNHN in 2019 and his attachment to the NOMADE team as an associate researcher in 2021.

Our longstanding scientific collaboration (crossing zooarchaeology, lithic and bone typo-technology and, more recently, traceology) has allowed, through an interdisciplinary approach (lithic tool/animal bone interface in particular), a better understanding of the prehistoric settlement dynamics of present-day Hungary as well as Neanderthal and early *Homo sapiens* behaviour, in terms of natural resource exploitation strategies and resilience to climatic variation. The updated interpretation of activities and behaviours at these major archaeological sites, with the help of novel lithic and zooarchaeological studies, including taphonomy, and even geological analyses, contributes to our understanding of the Middle and Upper Palaeolithic in Central and Eastern Europe and affects scientific discourse beyond the borders of Hungary.

The dynamism of this research has been made possible by the personality of our colleague Zsolt Mester. We are grateful to him and look forward to continuing our scientific and friendly exchanges through new projects.

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Appendix 1: Oral and poster presentations at scientific meetings or lectures, jointly or concerning the mentioned Hungarian sites (25)

Borel, A., Lengyel, Gy., Deltombe, R., Moreau, Ph., Marteau, J., Bigerelle, M., & Mester, Zs. (2019). Qualitative and quantitative analyses of surface alterations of stone tools: manufacture and use traces on stone raw materials from Hungary. *2nd Franco-Hungarian Forum for Scientific Research "Horizon Europe"* [poster]. September 27, 2019, Institut français de Budapest, Budapest

Borel, A., Lengyel, Gy., & Mester, Zs. (2021). Stone tools surface analysis: method and application on experimental artifacts made of raw materials from the Carpathian basin. *Lithic Research Roundtable 11*. December 3, 2021, Institute of Archaeological Sciences, Eötvös Loránd University, Budapest

Borel, A., Marteau, J., Deltombe, R., Moreau, Ph., Lengyel, Gy., & Mester, Zs. (2021). *WEAR* 2.0_ Hungary. Qualitative and quantitative analyses of surface alterations of stone tools: digital and physical reference collection for the characterization of manufacture, use and natural/accidental traces on stone raw materials from

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Daschek, É. J. (2010). The Kiskevély cave: new zooarchaeological analysis of a Mousterian site of Hungary. *11th International Council for Archaeozoology (ICAZ), Session 7-3 Archaeozoology in Central and Eastern Europe* [poster]. August 23–28, 2010, Paris

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13

If these stones could talk – An attempt to enlighten a four-variable archaeological problem

TWO MACRO-BLADES FROM PARABURDOO (PILBARA REGION, WESTERN AUSTRALIA)

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Abstract. The following article presents two chipped stone blades held by the author. The blades, in the company of other chipped lithic artefacts, were sold at the International Mineral Exchange in Hamburg in the mid-1990s. There was an accompanying notice to the blades, with additional information in incorrect German language: "*Aboriginals Artefakten Jung Paläolithikum 15.000 bis 9.500 v, Chr. Steingeräte mit typische Levallois technique (abschläge) - F.O. UA. DINGO POOL bei PARABURDOO in Nord West Australien nach A. Wouters 1989.*" However, there are several vague questions about both the supposed archaeological site and the reference to a person named A. Wouters and the so-called Levallois technique cited. Below we will try to take a closer look at these details.

Keywords: Western Australia, "Leilira" macro-blade, Basalt

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"What matters is the work, not the author who happened to write it; I would say rather that it writes itself through him. The individual person is no more than the means of transmission and survives in the work only as a residue."
Claude Lévi-Strauss (1908-2009)

1. Who was the person A. Wouters?

Due to the archaeological aspect of the subject, practically only one person can be considered as a candidate.

Adrianus Maria (Ad) Wouters (Tilburg, January 16, 1917 - 's-Hertogenbosch, June 17, 2001) was one of the best-known and well-respected amateur archaeologists from the Netherlands. At a young age, Wouters entered as 'brother Aquilas' into the Brothers of Charity in Eindhoven. Before World War II, Wouters and the Reverend A. P. van der Vlugt from Drunen searched for flint tools in the Drunense Duinen. After the war, from 1949 on Wouters became involved in archaeology again; searched for flint tools in Limburg and discovered various archaeological sites. This brought him into contact with the Dutch archaeologist Assien Bohmers (born as Johan Christiaan Böhmers, first name also: Azzien, last name also Bommers, Böhmers or Bëmmers; 1912, Zutphen – 1988, Göteborg). In 1954, Wouters assisted Bohmers with excavations and collected more flint tools in Brabant. He published some papers under his name (see, for example, Wouters, 1955, 1957) and several important papers with Bohmers (e.g., Bohmers & Wouters, 1954, 1956, 1962). The ultimate goal, together with Bohmers, was to produce a survey of sites from the Paleolithic and Mesolithic periods for the Netherlands and Flanders. Because of Bohmers' suspension and dismissal in 1962, this has never appeared. After Bohmers had resigned, Wouters withdrew from the archaeological world. In 1975 the Drenthe amateur archaeologist Tjerk Vermaning (1929, Staphorst, Overijssel – 1986, Assen) was charged with forgeries. The accusations were made by the province of Drenthe, based on the findings of the archaeologist professor Tjalling Waterbolk and his associate Dick Stapert of the University of Groningen (see, for example, Stapert, 1975a, 1975b, 1982, 1986, 1992; Stapert *et al.*, 1998). When the lawsuit against Vermaning was appealed, Wouters returned to archaeology and was part of the defence; he provided evidence for the authenticity of the finds. In 1977 Wouters founded the magazine *Archeologisch Berichten* with Caspar Franssen, in which many articles about Vermaning and his findings were published (see, for example, Wouters, 1980, 1982a, 1982b, 1983, 1984, 1990a, 1990b, 1991). In the magazine, he also published archaeological discoveries from the moraines and many sites that he originally wanted to publish with Bohmers. There is considerable doubt regarding numerous finds and sites published by Wouters (see, for example, Maas, 2009; Deeben & Schreurs, 2012; Boomsma, 2018; Niekus *et al.,* 2019). However, the assessment of some of the archaeological finds published by Wouters is controversial. Among these artefacts, a decorated, broken bone retoucher (the so-called 'Venus of Geldrop') should be mentioned, which was discovered at the Late Upper Palaeolithic (Ahrensburgian) site of Geldrop (province of Noord Brabant) (Bohmers & Wouters, 1962). The authenticity of this anthropomorphic engraving has been the subject of intense controversy. In a study, Leo Verhart and Francesco d'Errico (2012, p. 365) concluded that there are no indications to suggest a forgery. On the contrary, results strongly suggest that the Geldrop pebble is an authentic prehistoric retoucher.

A possible connection of Wouters to archaeological objects of Australian origin – if such existed at all - can be traced back to years after World War II. Then artists became increasingly interested in ethnographic objects, especially from Africa and New Guinea. Wouters was living in the

mission house in Roermond, where a lot of ethnographic objects were stored in the attic, having been brought here by different missionaries over the years. Wouters started to transfer part of this collection to Joep Thissen (Joseph Alphons Maria Thissen, 1919, Roermond – 2010, Roermond) an amateur archaeologist and artist. However, after a few years, he asked for the objects to be returned because the congregation had discovered that some of them were missing.

There are at least three possible explanations for the origin of the lithic artefacts offered for sale in Hamburg at the Mineral Exchange. The lithic finds may have come from the private collection of Wouters, – if he had any – acquired by him from the mission house. They may have been from artefacts passed by Wouters to Joep Thissen, who wanted to get rid of them before his death. Ultimately, however, it is not ruled out that Wouters only provided a professional opinion on the lithic finds offered for sale by a merchant without archaeological expertise. The German term "*nach A. Wouters 1989*" may refer to a publication of Wouters from 1989, about which, however, we do not know. It can also refer to a personal statement made by Wouters. The latter explanation is more likely. On the whole, the part of the story about the origin of the lithic finds is unclear and cannot be explained.

Although the origin of the finds is unclear, based on "Occam's razor principle of simplicity", in the following we start from the assumption that the finds come from the Paraburdoo area of Western Australia.

2. The description of the artefacts

In Fig. 1, in the lithic illustration, the so-called French system was applied (see, for example, Inizan *et al.,* 1999, p. 108, Fig. 42). Below is the proximal part of the artefact. The views in turn are the right edge, upper (dorsal) face, left edge, and lower (ventral) face. Both artefacts are blades, in a simplified sense that the length of the artefact is at least equal to twice its width. For the measurement, the so-called "box method" was used (Debénath & Dibble, 1994, p. 19), by taking the maximum length and width measurements (Dogandžić *et al.,* 2015, p. 7, Fig 3b). The maximum length represents the distance from the point of percussion to the distal end, following the axis of percussion (the debitage axis *sensu* Inizan *et al.,* 1999, p. 138) (perpendicular to the striking platform width). Maximum width is taken at the widest point perpendicular to the length axis, and maximum thickness is recorded at the thickest point along the third dimension.

The blade in Fig. 1: 1 (B1) is asymmetric to its longitudinal axis; the lateral edges are not parallel. The proximal end of the left lateral edge is almost straight; the right lateral edge is rather curved. On the upper face, two arrises are visible, so the blade has a sub-trapezoid cross-section. The side profile is slightly S-shaped and curved. The straight-lined right arris runs up to the right part of the tipped distal end of the blade, which is covered by the cortex, the weathered natural surface of the core. The left arris is leftward curved; it is the right margin of a large-sized previous removal. The striking platform is unprepared, and there are no traces of either dorsal reduction (small flake removals) or abrasion. The butt is flat and has an amorphous, trapezoid-like shape. Its measures are 20.5 × 10.4 mm. The bulb is flat and imperceptible. The dimensions are 81.4 × 32.6 × 12.7 mm.

The blade in Fig. 1: 2 (B2) is strongly bent towards the right. The rightward curved lateral edges are not parallel. On the upper face, a Y-shaped arris is visible; the legs are the margins of a previous small flake removal. On the whole, the blade has a sub-triangular cross-section. The blade is somewhat twisted and has an almost straight side profile. The arris runs up to the oblique distal end of the blade, which is covered by the cortex. The striking platform was unprepared, and



Figure 1. The discussed macro-blades. Prepared by the authors.

there are only minimal traces of dorsal reduction. The butt is flat and has an approximately "*en chapeau de gendarme*" shape. Its measures are 26.4 × 7.8 mm. The bulb is diffuse. The dimensions are 96.6 × 31.1 × 11.2 mm.

From a technological point of view, the blades suggest the possible use of the "direct percussion with a hard hammer" technique. However, it should be noted that when the "direct percussion with soft hammer" technique is applied, the detached artefact may happen to remove a larger amount of material in the butt area. As a possible result, the proximal part shows a very broad butt (blade/flake platform). Platform thickness, which is measured from the interior to the exterior surface of the platform at the point of percussion, is an independent variable in flake formation because it is controlled by the knapper. It is highly correlated with maximum flake thickness (Speth, 1981, p. 17). The exterior platform angle (*angle de chasse*), the angle between the butt and the upper (dorsal) face is acute. Its values are 82° and 69°, for the blades B1 and B2 respectively. The interior platform angle (flaking angle, *angle d'éclatement*), the angle between the butt and the lower (ventral) face is obtuse. The corresponding values are 105° and 118°, for the blades B1 and B2 respectively.

The edges of the blades are not worn or rolled, but along the edges, there are traces of some kind of observable damage. These edge damages have a "cryoturbation retouch" impression, which can strongly resemble an artificial retouch. Dick Stapert mentioned several distinctive characteristics: '*…in the case of natural "retouch" small "teeth" often develop along the "retouched" sides. Alternating retouch is also often present*' (Stapert, 1976, p. 29). Both blades have smooth, glossy surfaces. Gloss patina is a natural post-depositional surface alteration. The gloss is a shiny surface condition, which can have natural origin such as water, wind, friction due to vibration, etc. Both blades have a cortex near the tip; it is likely these are core reduction blades removed in the process of creating a more serviceable blade (point), not as projectile (spear) points but would have been used as cutting tools.

For long macro-blades, the most common term in Australia is "*leilira*" (see, for example, Akerman, 1976a, 1976b, 2007; Hook, 2009; Moore, 2003a, 2003b; Tibbett, 2006). The term "*leilira*" derives from the Arrernte (sometimes referred to as Aranda, Arunta or Arranta; a group of Aboriginal peoples who live in the Arrernte Lands in Central Australia) name for resin-hafted knives. There is a frequently cited definition of the term by Frederick D. McCarthy (1976, p. 35): "*The leilira is either a long pointed blade triangular in section, or an elongate rectangular blade trapezoid in section. The striking platform is plain and high angled. The lateral margins may be trimmed, frequently at the butt end only and often up to the point. This trimming may extend to a central or lateral ridge and have some flat outer surface with a ridge on each side. The distal end is trimmed or plain point but it may be an oblique thin edge. They range in size up to 8 inches long [20cm] … The leilira is used for cutting up animals, cutting cicatrice scars, circumcision and subincision on men and introcision on women.*" There is a dispute regarding the function of these blades, although, according to some scholars, this term should be restricted to those blades hafted as knives (see, for example, Casey *et al.,* 1968). Based on the first use of the term for macro-blade (Spencer & Gillen, 1968 [1899], p. 652), Kim Akerman (1976b, 2007) suggested that the name should only be used to refer to blades made of quartzite or silcrete and their length exceeds 120 mm.

In Fiona Hook's paper, in Table 1. (2009, p. 25), there are measurements for Paraburdoo macro-blades. As regards the 66 measured dolerite blades, the mean values of length, width, and thickness are 71.1 mm, 26.6 mm and 9.2 mm respectively. The mean platform width and thickness are 15.8 mm and 3.8 mm. Among the metric

data, only the length has a relatively high standard deviation of 24.7. Based on these data, the studied Paraburdoo blades are somewhat shorter, narrower and thinner than the two discussed blades.

In Fig. 2, the geographical distribution of macro-blades is represented after the relevant literature available.

The list of the sites is the following: 1) Oodnadatta (Horne & Aisken, 1924), 2) Quondong Point (Akerman, 1976a), 3) MacDonald Downs (Binford & O'Connell, 1989), 4) Camooweal (Moore, 2003a), 5) Burke River, 6) Lawn Hill, 7) Moondarra, 8) Selwyn Range, 9) Toko Range (5–9 after Roth, 1904, see also, Tibbett, 2006), 10) Chichester Range, 11) Dampier Land, 12) Devil's Lair, 13) Hall's Creek, 14) Ingaladdi, 15) Lake Argyle, 16) Millstream Station, 17) Puntutjarpa rock shelter, 18) Koonalda Cave (10–18 after Dortch & Bordes, 1977).

3. The raw material

The Hamersley Range is a mountainous region to the north of the mining town of Paraburdoo (WGS 84: -23.201 S, 117.671 E; UTM: 50K 568664 7434071) of the Pilbara region of Western Australia, which consists of a series of ranges, ridges, hills and plateau. The Hamersley Range extends east-southeast for 260 km south of the Fortescue River. Part of an ancient (Archaean–Proterozoic, 3,600–545 mya) tableland broken by faults and gorges. The range includes the highest peak in Western Australia, Mount Meharry (1,253 m) and terminates in rocky headlands and coral islets in the Indian Ocean. The immense quantities of modified iron and silica-rich precipitates make up the present iron formation. In the banded formation, veins of quartzite, dolerite, shale, chert, quartz, basalt, granite and silicified tuffs are found (Morris & Horwitz, 1983; Morris, 1993; Tyler, 1991; van Vreeswyk *et al.,* 2004; McKenzie *et al.,* 2009; Semeniuk & Brocx, 2019).

Unfortunately enough, because of the patinated surface, not even the original colour of the raw material of the discussed macro-blades can be determined with certainty. It has a fine-grained homogeneous structure. Based on a macroscopical examination made with the naked eye, the most likely raw material of the two discussed blades is some kind of volcanic rock.

Based on several archaeological field surveys at the southern edge of the Hamersley Plateau, Fiona Hook (2009) gave a detailed description of the manufacture and distribution of macro-blades in the Paraburdoo area of south-central Pilbara. Although in the region of the Hamersley Plateau, there are various volcanic, sedimentary and metamorphic rocks as potential lithic raw materials with good to excellent flaking qualities, because of their high numbers, Hook focused on dolerite and banded iron formation (BIF) blades.

According to Hook (2009, p. 25, Fig. 6), northeast to Paraburdoo, in the Bellary/Considerable Creek, dozens of archaeological sites were localized. At most of the sites were dolerite macro-blades found.

Le Maitre and colleagues (2002, p. 74) defined dolerite as a rock, which is intermediate in grain size between basalt and gabbro and composed essentially of plagioclase, pyroxene and opaque minerals; often with ophitic texture (where pyroxene or occasionally olivine forms larger crystals and typically contains numerous crystals of plagioclase). In Figure 3 of Hook's paper (2009, p. 24), the raw material of the illustrated macro-blade of graphite colour seems to be also rather medium-grained. In the Ph.D. dissertation of Wendy Reynen, there is a photo of local dolerite from the Pilbara Uplands (2019, p. 275). It is described as a medium-grained subvolcanic rock with a conchoidal fracture. The illustrated raw material chunk has a greenish-grey colour and a rost-brown cortex.

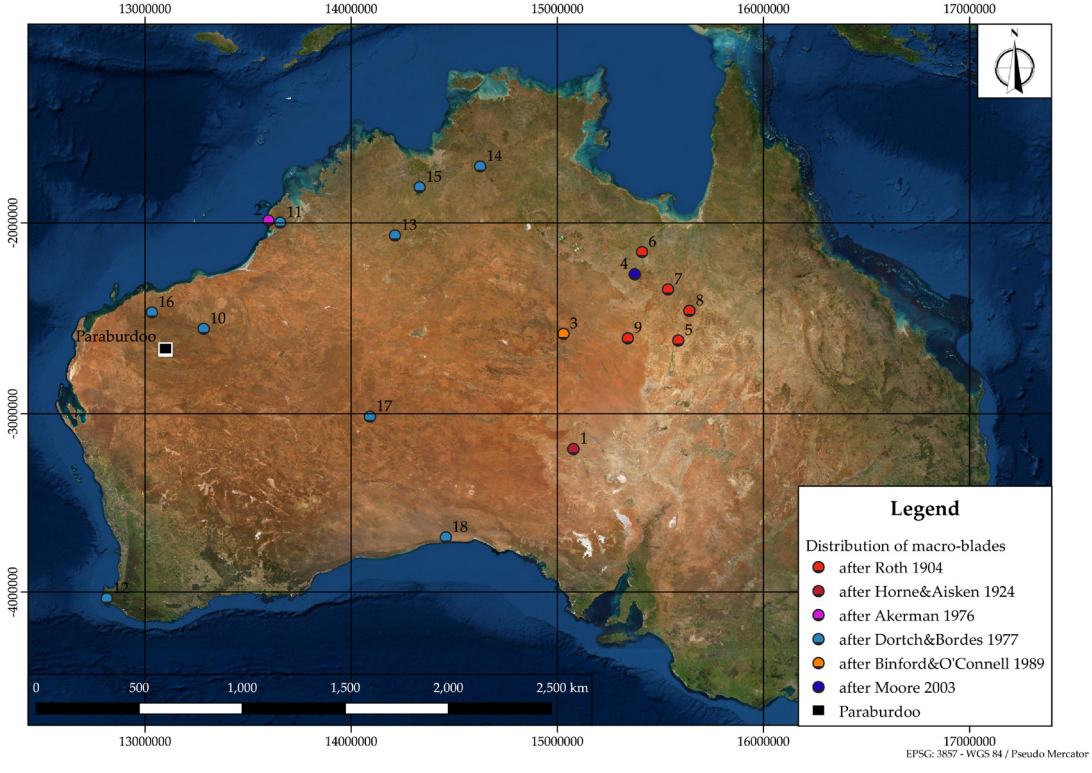


Figure 2. Geographical distribution of macro-blades in Australia. Prepared by the authors.

Among the above-mentioned broad range of lithic raw materials, by process of elimination, fine-grained basalt seems to be the most probable. Basalt is a dark-coloured, fine-grained, igneous rock composed mainly of plagioclase and pyroxene minerals. It most commonly forms as an extrusive rock, such as a lava flow, but can also form in small intrusive bodies, such as an igneous dike or a thin sill. It has a composition similar to gabbro. The difference between basalt and gabbro is that basalt is a fine-grained rock while gabbro is a coarse-grained rock.

4. The site

The designation of the location where the artefacts came from is F. O UA. DINGO POOL at Paraburdoo in Northwestern Australia ("... *bei Paraburdoo in Nord West Australien*", in German). For the time being, there is no possible way to interpret the somewhat enigmatic abbreviation F. O UA. before the assumed archaeological site name of DINGO POOL. Theoretically, F. O can be the abbreviation of the German word "Fundort" (meaning "find site") but is rather a vague hypothesis. The exact locations of archaeological sites are protected information in Australia as well. Of course, it is doubtful whether "Dingo Pool" is an archaeological site at all. In a dry, partially semi-desert area like the Pilbara region, a geographic name with the ending "pool" may seem quite common. There are several such geographical names on the 1:50,000 scales topographic survey map of Bellary

Creek. According to the legend, "pools" indicate a tank or small dam or waterhole.

According to the accompanying paper with the macro-blades, the assumed age is 11–12,000 years. If the discussed macro-blades indeed came from the environment of Paraburdoo then this assumed age is more than questionable. In the paper of Bruce Veitch and colleagues, there are radiocarbon dates from the Paraburdoo, Mount Brockman and Yandicoogina areas of the Hamersley Plateau (2005, p. 60, Tab. 1). No surface sites have even an approximate radiocarbon date. A large rock-shelter (Yirra, CME-A-31, Channar Ranges, south-east from Paraburdoo) has the oldest dates, which vary between 16,950 ± 90 BP and 19,270 ± 140 BP from a depth range of 38.63 and 55.80 cm below surface respectively. Fiona Hook (2009, p. 28, Tab. 2) published some radiocarbon dates for blades in the Pilbara region. The oldest date is connected to the Newman Orebody XXIX geological unit (9,870 ± 80 cal BP) and the Newman rock shelter (3,740 ± 100 cal BP to 6,270 ± 210 cal BP) (see also, Slack *et al.,* 2018, p. 5, Tab. 2). Based on the archaeological evidence of the other much more recent dates, the macro-blade production occurred after 3,000 years ago with a dramatic increase after 1,300 years ago.

5. The technology

François Bordes (1967, p. 28) was the first in the archaeological literature who dealt briefly with the issue of macro-blades of Australian origin. He referred to the classic ethnographic work of Baldwin Spencer and Francis J. Gillen (1966 [1927]) and in connection with the illustrations Fig. 192–200 and 202–209, stated that the shown pointed blades are long Levallois points or pointed blades ("*pointes Levallois allongées ou des lames pointues*"). Charles E. Dortch (1972) described the lithic material of rich archaeological sites in Western Australia on the southern slopes of the Chichester Range on the north side of the Fortescue River. Among the collection of artefacts, the large, finely manufactured "leilira" type pointed blades were dominant.

The used lithic raw material was an extremely fine-grained cherty siltstone, a clastic sedimentary rock (Haldar, 2020, p. 220). According to Dortch, the pointed blades or points have been manufactured by the same form of prepared core technique which has been described in the ethnographic literature by Walter E. Roth (1904, pp. 16–18) and Spencer and F. J. Gillen (1904, pp. 641–648). The essence of the technique is briefly that two or more preparatory blades or flakes from a properly prepared core stone are removed in such a way as to cause the projected target blade to have more or less convergent lateral edges and a pointed distal end. As regards the flakes in the assemblage, most of them are thick, broad specimens with broad butts. The interior platform angle (flaking angle), the angle between the plane of the butt and the lower (ventral) face is generally wide. There are also some flakes with centripetal faceting on the upper faces. Regarding the assemblage, Dortch stressed that there are only some cores that substantiate the similarities to the Levallois technique and therefore it is necessary to examine a larger collection of cores.

The Western Australian stone industrial sequence has been separated into an earlier and a later phase (Dortch & Bordes, 1977). While there is no certain evidence for blade technology in the earlier phase, during the later phase, blade techniques were applied where suitable lithic raw material was available. In parts of the Kimberley and the Pilbara regions, the Levallois techniques appear to be confined to the later phase. To substantiate the importance of the Levallois techniques, the authors gathered the available information and discussed many significant lithic assemblages. Based on the examination of the lithic material, they suggested two techniques to make points and blades of the "leilira" type. The prismatic

blade technique is based on the preparation of the core flaking face for successive blade production. The preparation consists of the following steps, 1) the removal of a natural ridge from the edge of an angular block of stone, 2) the creation or improvement of a natural crest or ridge by unilateral or bilateral flaking, and the removal of a crested blade, 3) removal of adjacent flakes (or blades) to form a central ridge as in the Levallois point technique.

The Levallois point technique was used often on cores that were re-prepared after the removal of the first point or points. The application of the two techniques seems to be dependent upon the available raw material. In general, typical prismatic blade cores were made on angular quartzite raw material blocks, whereas typical Levallois point cores were often made on chert (flint) and fine-grained quartzite or basalt. Given the fact that angular lithic raw materials blocks often have natural longitudinal ridges, which may after slight modification guide the first blade (Bordes & Crabtree, 1969, p. 3), the raw material dependency of the used technique is self-explanatory. In the discussion of their paper, the authors referred to personal communication with Kim Akerman. According to Akerman, in Dampier Land (Western Australia), symmetrical points were sometimes made by the true Levallois technique. Three preparatory flakes (or blades) were removed to produce a "second-order Levallois point" *sensu* Bordes (1961, pp. 18–19).

Kim Akerman (1975) published a description of the archaeological remains of aboriginal sites on the Dampier Land Peninsula, Western Australia. The lithic industry used local silcrete, "*a silica-rich duricrust, an indurated, or hardened layer in or on a soil*" (Taylor & Eggleton, 2017, p. 1). As Akerman noted, the most striking feature of the lithic industry is the refined production technology that has produced long blade points with some marginal trimming. Akerman referred to a similar industry in the Chichester Range, described by Dortch (1972, pp. 65–72). In his conclusion, Akerman stated that during the three major cultural phases in the prehistory of Dampier Land, the bifacially worked spear points were never important implements. The relatively short (3 to 12 cm long) blade points of the cultural Phase 2 were used possibly as knives. Among the lithic artefacts from the site Quondong Point on the Dampier Land, Akerman (1976a) carried out the morphometric analysis of a small collection of blades manufactured from silcrete. The mean dimensions (length, width and thickness) of the 24 examined blades are 95.71, 39.3 and 12.66 mm respectively. The butt of the blades was usually cortical or plain, suggesting that the blades were struck likely from unprepared cores. Interestingly enough, except for one blade, all others were backed blades having either a cortical or a natural back, which made the blades very suitable to use as knives. Akerman noted that the tools made of the very brittle silcrete used in the Dampier Land would have been highly unsuitable for working activities with resistant materials such as wood or bone. However, they were excellent tools for the butchering of prey games such as wallaby, dugong or turtle.

After gathering the data on ethnographically recorded uses of long blades and points and examining the available lithic artefacts, Akerman made experiments for blade production and described the suggested experimental manufacture (1976b). During the reconstruction of the manufacturing process, despite the lack of accurate technological details, which are important to the production of the blades, Akerman took into consideration several descriptions from the ethnographic literature (Roth, 1904; Spencer & Gillen, 1904; Spencer, 1928). Since most of the ethnographic specimens were manufactured from orthoquartzites of varying degrees of grain site, for his experiments, Akerman used fine to medium-grained orthoquartzite.

While blades made from orthoquartzite have a straight almost flat lower (ventral) face, fine-grained and cryptocrystalline materials tend to produce blades considerably more curved longitudinally. From the applicability point of view, an important feature of the orthoquartzite blades is the micro-serrated nature of the edge, which is well suited for butchering works or hunting activities. Spear wounds made with such blades cause serious internal damage and result in massive internal haemorrhage. The micro-serrated edge is caused by the fracturing nature of orthoquartzites, which have not undergone a metamorphosis. The quartz grains are interlocked and hardened by a cementing process. The fracture happens along the internal cement interstices between individual quartz grains and in the case of fine-grained orthoquartzites without internal flaws, a more or less conchoidal fracture can be achieved (Whittaker, 1994, p. 72; Andrefsky, 1998, pp. 54–55; Seong, 2004, p. 77). In the paper written by Roth, apart from the description of the manufacturing (Roth, 1904, pp. 16–18), his diagrams and especially his two figures (Roth, 1904, Plate III, 23–24) are important. These figures show the used hammerstone and how the raw material block to be worked was held in the hand and on the whole suggest the application of the "direct percussion with a hard hammer" technique. Since successful flaking depends on the weight of the hammerstone rather than the applied force of the blow, for the technique developed, Akerman used basalt or dolerite cobbles of weight varying between 0.5 and 1.0 kg. The preparation of the block has been described diagrammatically by Spencer (1928, p. 504, Fig. 351). Two large primary blades were struck from one end of the block so that their resulting flake scars intersect to form a median ridge. Though Spencer has not explained, through the removal of these blades the correct angle between the flaking face and the striking platform can be established. Akerman stated that the technique which is from a technological point of view similar to the Levallois point technique produces a potential flaking surface that is properly angled to a pre-existing unprepared platform area. As a consequence of a correctly performed removal of the two primary blades, the line of the two intersecting flake scars forms a correct acute angle to the striking platform. This line will be the median ridge on the upper face of the intended blade.

In the paper of Akerman (1976b, pp. 125–126, Fig. 1–11), blades made by him have been represented. The length varies between 10 and 17 cm, and the width of some chunky blades is about 5 cm. Morphometric measurements were carried out on 24 blades. The exterior platform angle ranged between 64° and 84° with a mean value of 72.7°. The interior platform angle ranged between 98° and 110° having a mean value of 106°. According to Akerman, the use of cores with angles outside the given range reduces the likelihood of regular blade production by the applied technique. Most of the represented blades show traces of the removal of the projections (overhangs, see, for example, Inizan *et al.,* 1999, p. 147), which can be done by rough abrading with the hammerstone or by fine flaking about the negative bulbs of percussion. The removal of the projections defines the butt of the intended product. Akerman emphasized the essential importance of the force with which the intended blade will be struck. If the blow is too forceful, the blade will carry right across the core to the base and possess parallel to sub-parallel lateral edges. If the blow is not heavy enough, the blade will hinge out when the force has been expended. Such hinges or step flaking may spoil the core. A satisfactory blade, which is suitable to be used as a spear-point, should have converging edges terminating on the median ridge forming a point. The attributes of the point will be controlled by the thickness of the blade and the angle of intersection of the primary blades removed. Very obtuse angles result in flat

blades with fine, sharp lateral edges; on the other hand, if the angles are acute or at right angles, the blades will have a more equilateral section. Akerman concluded that the experimental blades are similar in shape to the ethnographic blades and bear the same morphometric characteristics. This fact would suggest that the same manufacturing technique has been employed.

During his ethnoarchaeological fieldwork near the cattle station MacDonald Downs, Central Australia, Lewis R. Binford studied and described in detail the stone blade manufacturing process of the Alyawara aboriginals (Binford & O'Connell, 1984, pp. 425–427). Binford noted that his observations are consistent with Spencer and Gillen's previous observations taken in the Central Desert between the Warramunga aboriginals (Spencer & Gillen, 1912, p. 374). Based on these, the cores from which the "leilira" blades were struck, had the form of a large keel or a "nosed" block of raw material, that is they were non-Levallois-shaped cores. Other ethnographic accounts also state that aboriginal blade production focused on striking pointed blades directly from the core (e.g., Roth, 1904, p. 17; Spencer & Gillen, 1904, pp. 641–643). In connection with the Levallois technique, Binford referred to and criticized previous publications of Dortch and Bordes (Bordes, 1967, 1980; Dortch & Bordes, 1977). In his view, the identification of the Levallois technique was not based on the formal properties of the cores. In contrast, "leilira" blades were identified as Levallois points and then inferred a type of Levallois preparation during the blade production. Levallois technique should not be inferred from the typological characteristics of an assemblage because artefacts meeting the typological criteria of Levallois products (Levallois flakes and Levallois points) could be produced through non-Levallois techniques (Boëda, 1995, pp. 43–45).

Mark W. Moore (2003b), attempted to compare the archaeological reconstruction of blade production methods on the Georgina River (Camooweal, Queensland), to ethnological accounts across northern Australia. Archaeological analysis of the lithic material recovered from the study area revealed two reduction trajectories. The first trajectory, the Camooweal "Standard" Method for producing pointed blades dominates the archaeological assemblages. Based on the detailed description and the cited ethnographic records, this method corresponds to the experimental reconstruction of Akerman reviewed above. The second common trajectory, the Camooweal "Shark's Tooth" Method, named for the distinctive shape of the target blade, involved the serial production of small, non-pointed blades. Concerning the geographical distribution of blade-making, Moore stated that the Camooweal method appears to be similar to the Levallois-like "prismatic blade" technology identified at the Ord River Valley in east Kimberley (Western Australia) (Dortch, 1972; Dortch & Bordes, 1977). At the same time, Moore mentioned the fact that although Camooweal and the Ord River Valley in east Kimberley are located some 1,000 km apart, the Levallois trajectory has not been described in the intervening region. For the time being, this fact is unexplainable and according to Moore, this may have resulted from a lack of technological analysis rather than the real absence of the technology.

As regards the presence of the Levallois technique in lithic production in Australia, it is necessary to refer to the publication of Grant. W. G Cochrane (2014). Cochrane analysed a surface-collected lithic assemblage of a total of 5,095 artefacts from the Arcadia Valley (South Central Queensland). The assemblage contained 401 cores, among them very distinctive Levallois and discoidal cores. The debitage reflected a substantial amount of centripetal flaking, which is an unusual characteristic in Australian stone tool assemblages. The Levallois cores display great variability; both the preferential and recurrent

Levallois techniques are present. In the assemblage, the artefacts classified as likely Levallois products contained type 1 and 2 Levallois flakes (distal and lateral removals), recurrent Levallois flakes, Levallois points, shark's tooth flakes and *éclats débordants* but no blades. Although faceted platforms are common in most Levallois assemblage, in the Arcadia Valley only 15.9% of the flakes exhibited a clear faceted platform. The low frequency of platform faceting can be interpreted as an example of the technological variation within the framework of Boëda's volumetric concept of Levallois technology. According to Cochrane, "*reasonable to hypothesise that the formal reduction methods that are most prevalent in the Arcadia Valley core reduction sequence model, the Levallois and discoidal methods, are an unrecognised defining feature of the Recent Industry that replaced the Small Tool Industry about 2000 years ago*". Cochrane (2014, p. 17).

In Central Queensland Highlands, the stone artefacts recovered from rock shelter sites were usually made from basalt (Webb *et al.,* 2013). One of the possible reasons Levallois and discoidal methods were applied in the Arcadia Valley could have been that these methods are well-suited to lithic raw material in cobble form. In the analysed assemblage, the overwhelming majority of the flaked stone artefacts were manufactured from silcrete (see, for example, Taylor & Eggleton, 2017) cobbles with smooth water-worn cortex.

6. Conclusion

Taking the above facts into account, we have good reason to assume that the two stone blades in the author's possession are of true Australian origin. This fact is not altered by the uncertainty about the archaeological site and the raw material. The similarity in the technology of making the blades is much more significant than this. However, in particular, the irregular shape of the blade Fig. 1: 2 (B2) and the presence of cortex at the distal end of both blades make it probable that these are not "target blades" but by-products of the blade-making process. Both Akerman (1976a, p. 121) and Moore (2003b, p. 46) emphasized the importance of "termination control" that the angularity of the arris (ridge) created by the removal of the primary blades, particularly when the intended target blade should be pointed with centred arris, is critical for successful blade production. Ethnographic evidence and even the experiments of Akerman suggest that the success rate may have been very low.

Unsuccessful blades were not suitable as spear points but could be used as domestic tools such as knives or scrapers. However, there was likely a large number of such failed blades in the area of some lithic workshops. Although we have no data on the activities of Dutch missionaries in Western Australia, it can be assumed that an ethnographic and/or archaeological collection was also carried out. The blades described above may have come into the possession of the missionaries, courtesy of the natives. The further fate of the blades, how they ended up at the Mineral Exhibition in Hamburg, can only be assumed, but not reproduced with certainty.

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14

The provenance of a forgotten Copper Age spectacle spiral pendant

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Abstract. A spectacle spiral pendant, which has been known since the 1950s is kept in the Ferenc Kubinyi Museum in Szécsény. It was partially forgotten in the archaeological literature, or in other cases, it was duplicated. We discuss the possible provenance of its raw material and the place of its manufacturing based on the examination of the lead isotope ratios and chemical composition of the artefact.
According to the results, both could have been in the northwestern Carpathians, which falls within the distribution area of this pendant type. The exploitation of raw materials, the steps of manufacturing and the meaning of these artefacts represent local traditions and innovations, thus a completely independent metallurgical centre.

Keywords: Copper Age, Ludanice culture, Spectacle spiral pendant, Copper provenancing, Lead isotope analysis, Chemical compositional analysis

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1. Introduction

Large spectacle spiral pendants have been linked with the concept of the Copper Age since the 19th century. Ferenc Pulszky argued for the Copper Age to be an independent period based on the Stollhof hoard, which contained six spectacle spiral pendants alongside other artefacts (Pulszky, 1883; von Sacken, 1865). Although several similar pendants have been kept in museums since then (Fig. 1), and Irenäus Matuschik prepared their typological analysis (Matuschik, 1996), the available information about their former role, the manufacturing of these artefacts, and their provenance is scarce. A hoard was found at a Balaton-Lasinja settlement (at the site of Magyaregres-Varga-Bonyi-ároktól keletre) at the end of 2016, which was the first hoard containing such type of a pendant discovered during an archaeological excavation (Hornok & Kiss, 2017). As a consequence, the context of the deposition of the objects could also be studied.

Nándor Kalicz assumed an independent metallurgical centre within the area of the Ludanice-Jordanów/Jordansmühl-Balaton-Lasinja complex based on the distribution area of Stollhof-Csáford-type discs and spectacle spiral pendants (Kalicz, 1982, p. 13).

Although the context of the deposition of these objects and their former use were unknown, previous research has already linked them to a new metallurgical centre emerging in the northwestern Carpathians in present-day Slovakia (Dobeš, 1992; Krause, 2003; Matuschik, 1996, p. 29; Schreiner, 2007; Šikulova & Zápotocký, 2010). Although chemical compositional analyses were also carried out on several large spectacle spiral pendants (in addition to Balassagyarmat, also: Domahida/Domanești, Moravské Lieskové, Pohořelice, Rašovice, Stollhof, Štramberk-Kotouč (Dobeš *et al.*, 2019; Junghans *et al.*, 1968, pp. 31, 54; Šikulova & Zápotocký, 2010), the Magyaregres hoard was the first on which lead isotope measurements were also performed. According to the results, the provenance of the hoard's raw material is located in the northwestern Carpathians, and it could probably have been made in a workshop in this region (Siklósi *et al.*, 2022).

In 1950, Pál Patay inventoried the only other specimen from present-day Hungary into the Balassagyarmat museum collection (Fig. 2). Although P. Patay mentioned this object in his study about Copper Age metallurgy in 1958, he did not provide an illustration of it (Patay, 1958). Perhaps this is also the reason why the object appears incorrectly in later publications discussing spiral pendants. It is mentioned twice in I. Matuschik's catalogue of sites, first with no. 4. Balassagyarmat as a stray find, and then no. 5. from an unknown site in Hungary (Matuschik, 1996, pp. 31–32). In the case of the latter, I. Matuschik refers to Siegfried Junghans (Junghans *et al.*, 1974) and Konrad Spindler (Spindler, 1971, Fig. 5). However, the two objects are identical. This artefact was measured in the *Studien zu den Anfängen der Metallurgie* (SAM) project (lab. no. 6563, Junghans *et al.*, 1968, p. 182). The origin of the confusion might be the fact that P. Patay did not publish an illustration in 1958 and I. Matuschik probably did not find the object in the museum collection, so he could not identify that the two are the same.

Nothing is known about the circumstances of the discovery of another Malé Leváre type specimen from the Gbelce site (Furmánek, 1980; Matuschik, 1996; Récsey, 1892). We have not even found any evidence that the pendant was placed in a museum collection.

Large spectacle spiral pendants are known only from within the distribution area of the Ludanice-Jordanów/Jordansmühl-Balaton-Lasinja complex (Fig. 1). The only exception is the piece from the Domanești site, which, according to 19th-century description, was found as part of a Bronze Age hoard (Pulszky, 1883). Therefore, it is

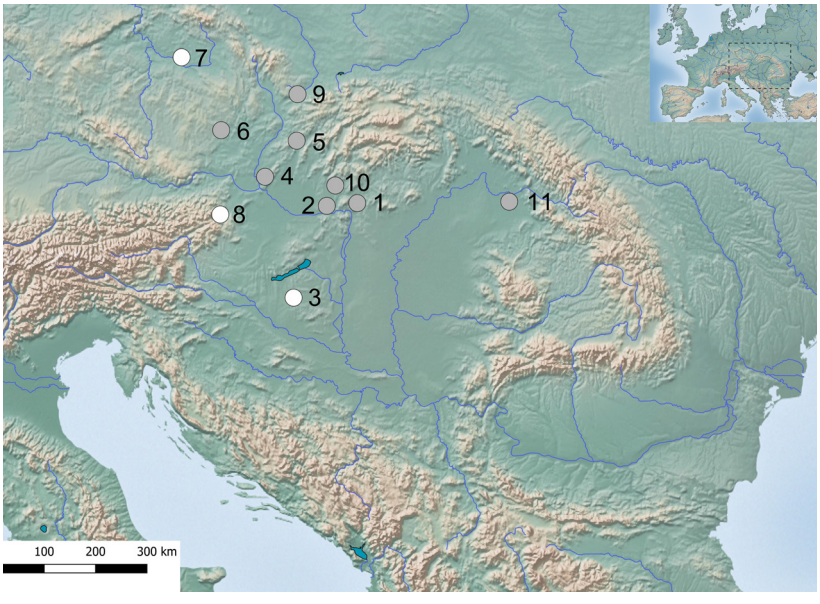


Figure 1. Sites of large spectacle spiral pendants. Marked in grey are the sites of the Malé Leváre type, made with a folded connecting section: 1. Balassagyarmat, 2. Gbelce, 3. Magyaregres-Varga-Bonyi ároktól keletre, 4. Malé Leváre, 5. Moravské Lieskové, 6. Pohořelice, 7. Rašovice, 8. Stollhof, 9. Štramberk-Kotouč, 10. Velky Pesek, 11. Domanești. Prepared by the authors.

uncertain whether this specimen could have originated in the region of present-day northwestern Romania and this area can also be considered the area of Copper Age use, or it is only the site of a much later deposition. Probably the latter is more likely. In the collection of the Hungarian National Museum, there are several objects from the Bronze Age hoard collected in Domaneşti in the Péchy collection, but none of them fit Pulszky's description. Identifying this pendant is difficult because according to Pulszky's description, one disc is broken into two pieces, the other wire is bent, and the drawing shows the reconstructed artefact (Pulszky, 1883, Fig. 5). Among Bronze Age and Early Iron Age metal artefacts from unknown sites, there is a large, fragmented spectacle spiral pendant, inv. no. 52.29.443, which is highly probably identical to the Domaneşti pendant. This was measured in the SAM project, lab.no. 12864-66 (Junghans *et al.*, 1968, p. 96).

Although the exact site and the circumstances of the discovery are unknown, we decided to carry out lead isotope and chemical compositional analyses on the Balassagyarmat pendant to compare it with the results of the Magyaregres hoard. Were they made of similar raw materials, of raw materials from the same or nearby mines?

2. Description of the find

The artefact is a spectacle spiral pendant (Fig. 2), broken into two pieces, which was wound from a copper wire of rounded cross-section. Its surface is heavily corroded, and covered with indentations caused by corrosion. During its restoration, it was vigorously cleaned, so it is now only covered by a thin, dark, matte oxide layer. A drilled hole can be seen on the larger piece. This is probably the location of the sampling done in the SAM project. The spirals have five threads. The end of the wire narrows gradually in the middle of the spiral and is pointed. The section between the two spirals is bent like a hook. The wire leading to the spiral on the right has thinned out in one place – probably due to corrosion – and broke. The pendant as a whole is slightly deformed, the spirals were probably forced to bend slightly out of their original position. Length: 19.5 cm and 9.3 cm, Width: 9.5 cm and 7.5 cm, diameter of spirals:



Figure 2. The large spectacle spiral pendant from Balassagyarmat. Photo by the authors.

7.7 cm. Inventory number: 50.633. Place of preservation: Hungarian National Museum, Ferenc Kubinyi Museum, Szécsény.

3. Methods

A 75 mg sample was taken with a 3 mm diameter stainless steel drill next to the previous sampling site. Prior to sampling, the sample site was first cleaned thoroughly removing all traces of corrosion. The sample was then extracted, documented and measured. A sample of 75 mg was acquired and sent to the laboratories for further investigation. After sampling, the object was restored.

3.1. Chemical compositional analysis

The concentrations of eighteen elements (Cr, Mn, Fe, Co, Ni, Zn, As, Se, Ag, Sn, Sb, Te, Au, Hg, Pb, Bi, Th, U) were measured by mean Inductively Coupled Plasma Mass Spectrometer (ICP-MS) model 7850 manufactured by Agilent Technologies (Santa Clara, California, USA) at the Laboratori Nazionali Gran Sasso, Assergi, Italy (Giuntini *et al.*, 2021).

The sample was weighed and dissolved in a sonic bath at 60 ℃, using 10 ml of 10% solution of ultra-pure nitric acid purified with a sub-boiling system (DuoPur, Milestone, Bergamo Italy). After dilution, the sample was measured in quantitative mode introducing 4.0 ml min^{-1} of He in the collision cell of the spectrometer to minimise the potential risk of isobaric interferences due to polyatomic species generated by the plasma torch. All the operations related to the sample handling and the instrumental measurements were performed in an ISO6 clean room to avoid the risk of environmental contamination.

Table 1. Lead isotope abundance ratios of copper artefacts from Balassagyarmat and the hoard of Magyaregres.

Site, Inventory number Artefact type	$^{206}Pb/^{204}Pb$	2 SE	$^{207}Pb/^{204}Pb$	2 SE	$^{208}Pb/^{204}Pb$	2 SE	$^{207}Pb/^{206}Pb$	2 SE	$^{208}Pb/^{206}Pb$	2 SE	Reference
Balassagyarmat, 50.633. Spectacle spiral pendant	18.4918	0.0177	15.6318	0.0143	38.3005	0.0426	0.84511	0.00011	2.07116	0.00022	-
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.22. Tubular spiral coil	18.4355	0.0038	15.6325	0.0031	38.5270	0.0076	0.84796	0.00004	2.08982	0.00007	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.33. Cylindrical bead	18.5476	0.0008	15.6162	0.0008	38.4973	0.0022	0.84195	0.00002	2.07560	0.00006	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.67. Tubular spiral coil	18.5379	0.0020	15.6198	0.0009	38.4954	0.0026	0.84259	0.00006	2.07652	0.00024	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.95. Tubular spiral coil	18.5383	0.0014	15.6200	0.0011	38.4989	0.0041	0.84261	0.00004	2.07679	0.00017	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.145. Spiral bracelet	18.4429	0.0026	15.6373	0.0022	38.5232	0.0054	0.84787	0.00002	2.08879	0.00005	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.182. Spectacle spiral pendant	18.4544	0.0011	15.6428	0.0010	38.5489	0.0026	0.84765	0.00001	2.08888	0.00005	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.183. Spectacle spiral pendant	18.4521	0.0035	15.6427	0.0030	38.5420	0.0127	0.84775	0.00004	2.08918	0.00008	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.243. Spiral bracelet	18.4496	0.0008	15.6363	0.0007	38.5315	0.0028	0.84752	0.00002	2.08844	0.00008	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.244. Spiral bracelet	18.4596	0.0016	15.6438	0.0012	38.5553	0.0032	0.84744	0.00003	2.08858	0.00009	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.253. Cylindrical bead	18.5274	0.0020	15.6387	0.0017	38.5131	0.0045	0.84406	0.00002	2.07866	0.00006	1

Reference: 1 = Siklósi *et al.*, 2022, table 2

Table 2. Trace element concentrations (in ppm) of copper objects from Balassagyarmat and the Magyaregres hoard.The concentrations were determined by ICP-MS with a relative measurement uncertainty of 5% for concentrations >1 ppm, rising to 20% for lower concentrations.

Site, Inventory number Artefact type	Co	Ni	Ag	Au	Sb	As	Bi	Pb	Ni/Co	Ag/Au	Bi/Sb	As/Sb	Ag/Sb	Reference
Balassagyarmat, 50.633. Spectacle spiral pendant	0.12	6	686	1.15	2628	0.51	160	0.60	51	598	0.06	0.0002	0.26	-
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.22. Tubular spiral coil	0.23	11	90	0.22	23	1.9	8.4	3.2	47.8	409	0.37	0.08	3.9	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.33. Cylindrical bead	0.72	22	23	0.23	1.7	0.26	2.7	23	30.6	100	1.59	0.16	13.5	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.67. Tubular spiral coil	0.14	23	541	0.14	3.3	2.4	1	16	164.3	3864	0.3	0.73	163.9	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.95. Tubular spiral coil	0.15	24	400	0.18	3.8	1.9	1.1	20	160	2222	0.29	0.5	105.3	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.145. Spiral bracelet	0.33	16	14	0.04	0.76	2.6	0.26	5.3	48.5	350	0.34	3.42	18.4	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.182. Spectacle spiral pendant	0.15	17	44	0.18	5.1	1.6	1.4	4.8	113.3	244	0.27	0.31	8.6	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.183. Spectacle spiral pendant	0.65	18	242	0.17	5.9	0.65	1.6	5.8	27.7	1424	0.27	0.11	41	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.243. Spiral bracelet	0.24	13	10	0.14	0.32	0.31	0.24	16	54.2	71	0.75	0.97	31.3	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.244. Spiral bracelet	0.35	16	14	0.02	0.74	0.31	0.26	4.9	45.7	700	0.35	0.42	18.9	1
Magyaregres-Varga-Bonyi ároktól keletre, Ő.2019.8.1.253. Cylindrical bead	0.27	22	163	0.12	0.62	0.36	0.16	7.7	81.5	1358	0.26	0.58	262.9	1

Reference: 1 = Siklósi *et al.*, 2022, table 2

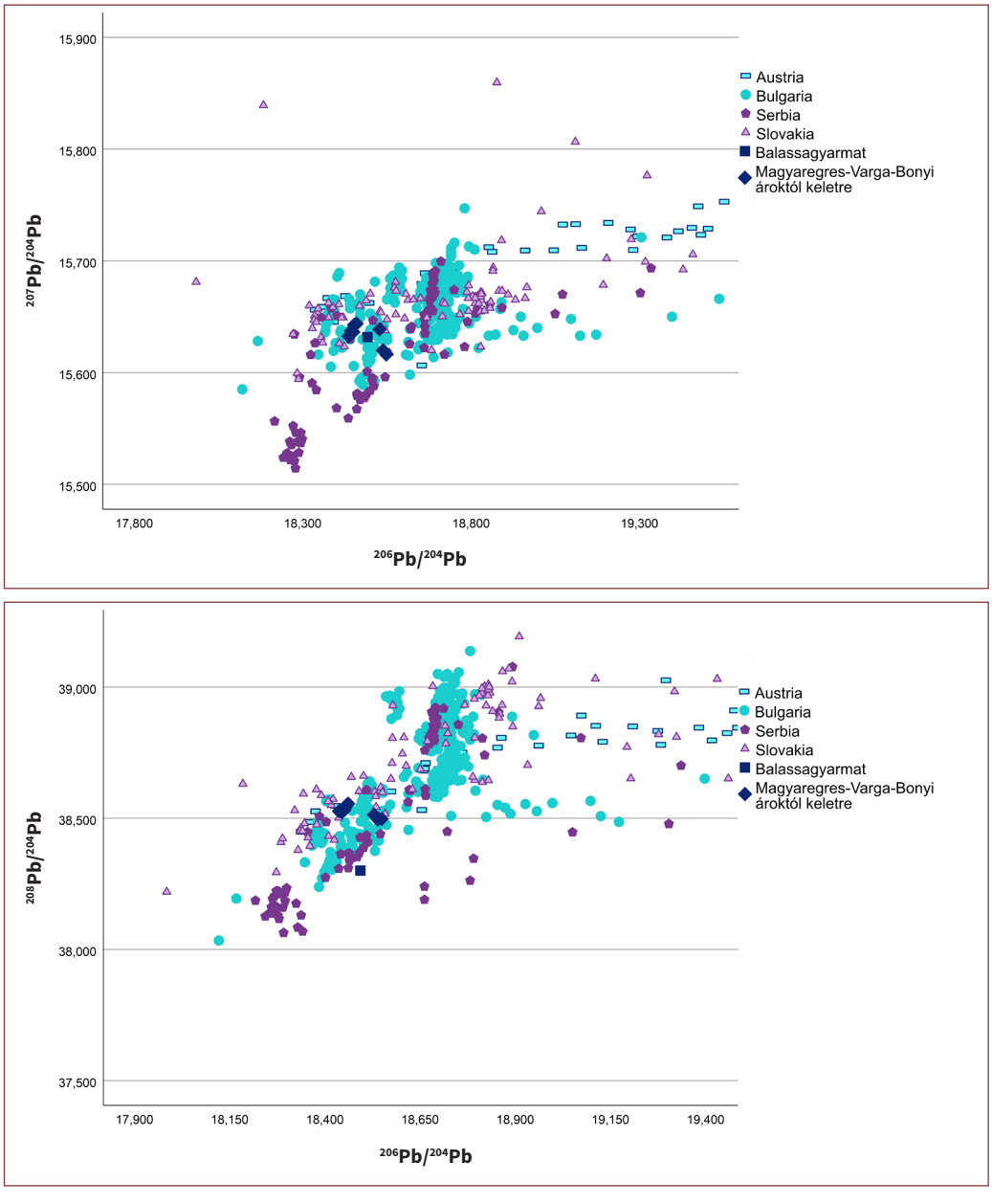


Figure 3. Potential sources of the copper raw material of copper finds from the Balassagyarmat pendant and the hoard Magyaregres based on lead isotope analysis. Bivariate plots are shown the measured lead isotope ratios, compared with the potential sources (Artioli *et al.*, 2016; Bugaj *et al.*, 2019; Gale *et al.*, 1991, 2000, 2003; Höppner *et al.*, 2005; Krauss *et al.*, 2020; Pernicka *et al.*, 1997; Pernicka *et al.*, 1993; Schreiner, 2007; Stos-Gale *et al.*, 1998) according to (top) $^{206}Pb/^{204}Pb$ vs $^{207}Pb/^{204}Pb$ and (bottom) $^{206}Pb/^{204}Pb$ vs $^{208}Pb/^{204}Pb$. Prepared by the authors.

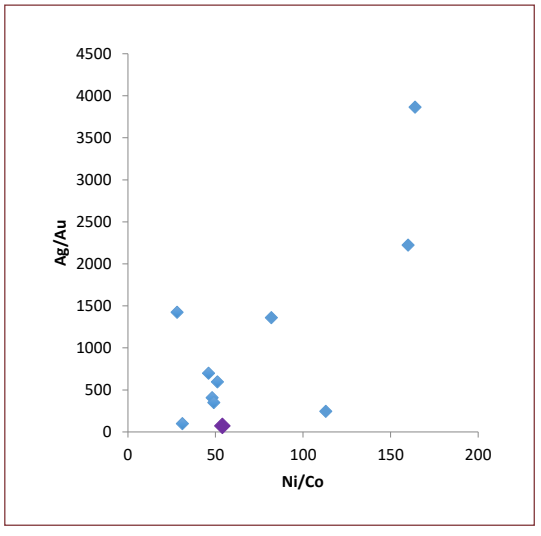


Figure 4. The silver/gold (Ag/Au) ratio versus the nickel/cobalt (Ni/Co) ratio. The Balassagyarmat pendant is marked by the purple diamond. Prepared by the authors.

The calibration of the instrument was performed by measuring five levels of concentration of reference solution containing certified amounts of the analysed elements.

3.2. Lead isotope analysis

To investigate the lead isotope ratios the drilled burrs (0.5–10.0 mg) were dissolved in hot triply distilled concentrated nitric acid in sealed PTFE vessels. As described in (Villa, 2009), the dissolved lead was purified using the SrSpec™ resin (EIChroM Industries) (Horwitz *et al.*, 1992). About 100 µl of resin is filled in a 3 mm diameter handmade PTFE column. The height-to-width ratio is approximately four. The sample solution is loaded in 0.5 ml 1M HNO_3, 1.5 ml of which is also used to wash out the matrix metals, while Pb is very strongly retained on the resin. Pb is then eluted with 1 ml 0.01 M HCl and is ready for analysis.

The measurements of lead isotope ratios were performed using a Thermo Scientific Neptune Multi-collector Inductively Coupled Plasma Mass Spectrometer (MC-ICP-MS) instrument at the Institute of Geology, University of Bern, Switzerland. This instrument is a dedicated tool for highly precise determination of lead isotope ratios, equipped with a double-focusing mass spectrometer of Nier-Johnson geometry. The Faraday collector array allows the simultaneous acquisition of masses 202 to 209. The sample introduction system consisted of an auto-aspirating low-flow (50 µl min^{-1}) Apex dissolving nebulizer (ESI Scientific, Omaha, NE, USA) mounted onto a combined cyclonic/double-pass spray chamber made of quartz glass. Potential isobaric interference of ^{204}Hg on ^{204}Pb was controlled and, if necessary, corrected by monitoring the ^{202}Hg signal. Hydride formation (PbH) was monitored on mass 209 and not detected. Mass fractionation was monitored by adding a small quantity of Tl, which has a known $^{203}Tl/^{205}Tl$ ratio, is fractionated by the same mechanism as Pb and does not interfere with Pb isotope measurements (White *et al.*, 2000). Typical in-run relative uncertainties (2 SE of the mean) on $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ isotope ratios ranged between 0.004 and 0.020%. The measurement accuracy was controlled with frequent measurements of the NIST SRM 981 standard reference material interspersed with the sample measurements. The measured isotopic composition for SRM 981 was indistinguishable from the certified value and the recent, more precise literature measurements (Rehkämper & Mezger, 2000) so no adjustment of the measured ratios was necessary. The external reproducibility on the SRM 981 reference material over the measuring period of several days amounted to ±0.01% (2σ), very similar to the individual in-run precision on unknown samples.

4. Results

In the case of the ratio pairs $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$, as well as the ratio pairs $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$, we examined the agreement with the

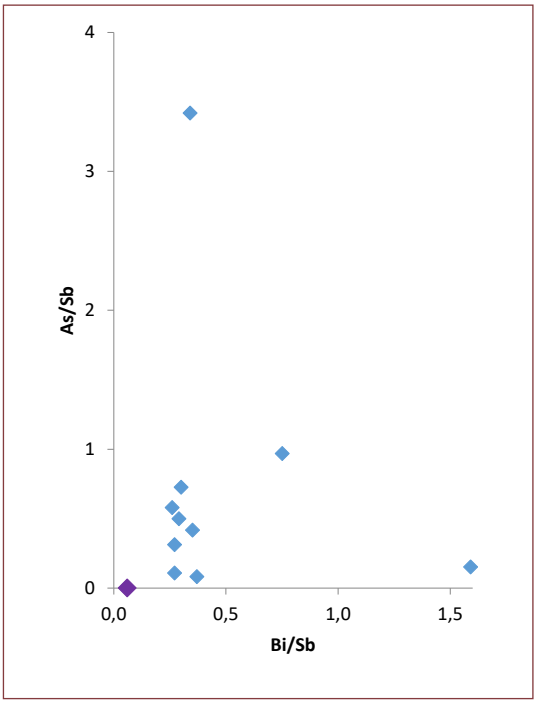


Figure 5. The bismuth/antimony (Bi/Sb) ratio versus the arsenic/antimony (As/Sb) ratio. The Balassagyarmat pendant is marked by the purple diamond. Prepared by the authors.

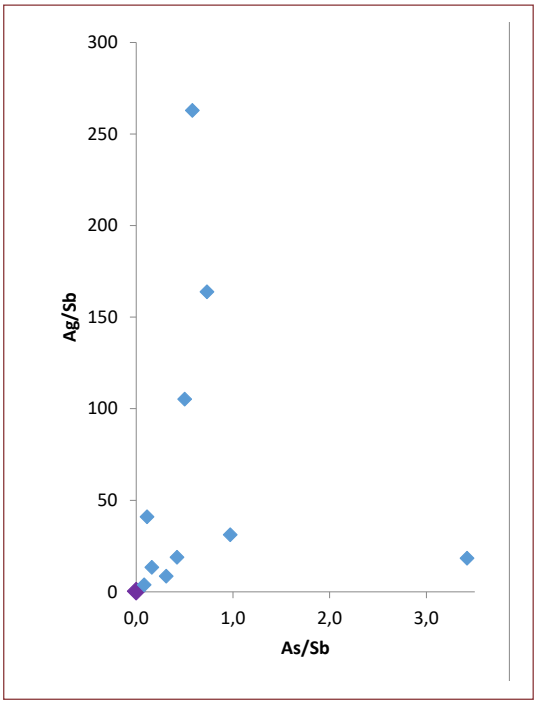


Figure 6. The silver/antimony (Ag/Sb) ratio versus the arsenic/antimony (As/Sb) ratio. The Balassagyarmat pendant is marked by the purple diamond. Prepared by the authors.

surrounding, published, geological sources to localize the source of the raw material (Artioli *et al.*, 2016; Bugaj *et al.*, 2019; Gale *et al.*, 1991, 2000, 2003; Höppner *et al.*, 2005; Krauss *et al.*, 2020; Pernicka *et al.*, 1997; Pernicka *et al.*, 1993; Schreiner, 2007; Stos-Gale *et al.*, 1998). In the case of the ratio pairs $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$, the raw material of the Balassagyarmat pendant corresponds to several possible, very broad fields of copper ore sources, including Bulgaria and northwestern Carpathians (Table 1; Fig. 3); the $^{208}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ ratio pair does not match any presently known and analysed copper ore source.

Based on the chemical element and trace element composition measurement, mainly Sb, Ag and Bi are found in smaller quantities in the Balassagyarmat pendant (Table 2). To reveal the geochemical regularities, we used the ratios of chemically related elements that could not be modified in prehistoric conditions and followed regularities derived from their chemical properties. We plotted silver/gold (Ag/Au) ratio versus nickel/cobalt (Ni/Co) ratio as they are refractory elements and remain unmodified during the *chaîne opératoire* (Fig. 4). The bismuth/antimony (Bi/Sb) ratio versus the arsenic/antimony (As/Sb) ratio plot shows the pnictogen elements that belong to a continuous series of highly variable As/Sb ratios (Fig. 5). The third plot shows the silver/antimony (Ag/Sb) ratio versus the arsenic/antimony (As/Sb) ratio (Fig. 6). As silver is refractory, arsenic is volatile and antimony is between them, their ratio provides information about the original chemical signature and the temperature on

the object was worked (Bray & Pollard, 2012; Gross *et al.*, 2021; Siklósi *et al.*, 2022).

5. Discussion

The chemical composition of the spectacle spiral pendant from Balassagyarmat was already measured within the SAM project, and together with the Domaneşti pendant, it was classified in the C1B material group, which was considered to be common in the case of East-Central European Copper Age objects (Junghans *et al.*, 1968, pp. 31, 54). Since the SAM project, geochemistry has been applied also to metals deriving from ores, and the classification scheme based on absolute concentration thresholds has been superseded by actual geochemical systematics (Gross *et al.*, 2021; Villa, 2016).

The lead isotope ratios alone (Fig. 3) cannot localize the provenance of the raw material of the Balassagyarmat pendant with absolute certainty, so we tried to confirm the source area based on the chemical trace element composition.

By examining the ratios of the chemically related elements and comparing them with the Magyaregres hoard, we noticed a variability of the used raw materials. An important constraint is given by the Ag/Au and Ni/Co ratios, as Ni and Co could not be separated using pre-industrial know-how, and Au and Ag, if present in traces, were extremely unlikely to be intentionally modified during the *chaîne opératoire* and therefore reflect the original compositional signatures of the sources of raw materials. In a silver/gold (Ag/Au) versus nickel/cobalt (Ni/Co) plot (Fig. 4), the Balassagyarmat pendant forms a narrow group with some of the items from the Magyaregres hoard. This compositional similarity supported one of the interpretations of the Pb isotopic identification: the one which has shown that the Balassagyarmat pendant's raw material might derive from the northwestern Carpathians, as that of the Magyaregres hoard (Siklósi *et al.*, 2022).

Both the bismuth/antimony (Bi/Sb) ratio versus the arsenic/antimony (As/Sb) ratio plot (Fig. 5) and the silver/antimony (Ag/Sb) ratio versus the arsenic/antimony (As/Sb) ratio plot (Fig. 6) confirm the compositional proximity of the Balassagyarmat pendant to the Magyaregres hoard. The main difference lies in the extremely low As/Sb ratio of the pendant, which is a clear sign of the use of an As-poor, Sb-rich fahlore, which is very close to the pure tetrahedrite end-member. Other objects from the Magyaregres hoard derive from tetrahedrite with a higher tennantite component whereby each object has a slightly different As/Sb ratio (Figs. 5–6).

Based on the present data, it is likely that the raw material of the Balassagyarmat pendant comes from the area of the northwestern Carpathians. This is congruent with the archaeological data since similar, large spectacle spiral pendants are known only from the area of the Ludanice-Jordanów / Jordansmühl-Balaton-Lasinja complex (Fig. 1).

The next important question regarding the *chaîne opératoire* is where this pendant could have been manufactured. A distinctive feature of the design of the large spectacle spiral pendants is the shape of the element that connects the two discs. Specimens of the Malé Leváre-type pendants with a folded connecting section were found in an even narrower area of roughly 300 km in diameter, in the vicinity of the northwestern Carpathians. The research into the beginnings of copper mining in this region is not as intense as the research into the early copper mines in the Balkans, but the number of data that dates the exploitation of these resources from the Early Copper Age is increasing (Modarressi-Tehrani & Garner, 2014; Modarressi-Tehrani *et al.*, 2016; Schreiner, 2007). A recent study has already revealed traces of local copper metallurgy, e.g., in the Horná Mičiná site (Zachar *et al.*, in press). Thus, we can rightly assume that the workshop(s) where these pendants were

made probably operated somewhere in the vicinity of this mining region, in present-day Western Slovakia. Although we still have little information about their location, the Transdanubia area still lacks traces of local metallurgy, even in those deposits where copper objects with a large demand for raw materials were found, such as Zalavár-Basasziget or Magyaregres-Varga-Bonyi-ároktól keletre. In the case of these Transdanubian sites, we concluded that these objects had already arrived here as finished products (M. Virág, 1986; Siklósi *et al.*, 2022).

In contrast to the Balassagyarmat pendant with a highly corroded surface, the artefacts from Magyaregres were preserved in such a good condition that we were able to reconstruct the individual steps of their manufacturing by examining them under a microscope. According to it, the pendants were wound up from thin copper sheets placed on top of each other, and the ends of the wire were thinned by hammering (Siklósi *et al.*, 2022). This production technology is not typical for Balkan objects, as the investigation of the production technology of the armbands found in the Durankulak cemetery showed that they were made by casting (Dimitrov, 2002). Thus, the procurement of raw materials, the steps of manufacture and the finished form can be linked to the local metallurgical centre.

Large spectacle spiral pendants are only known as part of hoard finds or stray finds from a narrower geographical area in present-day Hungary, Slovakia, Austria and the Czech Republic (Dohnal, 1973; Furmánek, 1980; Matuschik, 1996; Patay, 1958), no examples are known from burials. We hardly know anything about the circumstances of the discovery of these assemblages, they were mostly found scattered, by chance, in the 19th century or at the beginning of the 20th century (e.g., Stollhof, Štramberk-Kotouč, Malé Leváre, Rašovice) (Dobeš, 2013; Jisl, 1967; Matuschik, 1996; Novotná, 1955; Novotná & Novotný, 1974; Patay, 1958; Šikulova & Zápotocký, 2010), so it is very difficult to reconstruct who and how wore and used these objects.

In the burials in the area of the Ludanice-Jordanów / Jordansmühl-Balaton-Lasinja complex, only small copper items that require a small amount of raw material – beads, rings, small bracelets – are found. Only the stone stele found at the Sion site in Switzerland can provide a clue to the way how the large spectacle spiral pendants could have been worn. On this anthropomorphic stele, there is a depiction of a spectacle spiral pendant that is hanging from the neck accompanied by a dagger under the belt. Due to the latter and the lack of representation of female gender characteristics, it is interpreted as a male figure (Gallay, 1995). Because there are significant differences in space and time between the site of the stone stele and the distribution area of the large spectacle spiral pendants, we must be careful when applying this wearing representation directly to the East-Central European areas at the end of the 5th millennium cal BCE.

The large spectacle spiral pendants, as well as the large spiral bracelets, discs and pectorals that can be connected to them, represented exceptionally great value and wealth. The use of large spectacle spiral pendants was highly limited in space and time. It seems that they had meaning only within a narrow socio-cultural environment. As a consequence, we can consider them more a status good, a symbol of a social position, than a prestige good within this circle (Siklósi, 2004).

6. Summary

Every element of the large spectacle spiral pendant reflects the innovations of local metallurgy. In terms of culture, the Ludanice communities are the descendants of the earlier Late Neolithic Lengyel communities, who lived here for a long time and gradually acquainted and adapted to their environment. These communities laid the

foundation for the development of local metallurgy by searching for local sources of raw materials. They recognized the characteristics of processing these raw materials and created their own object types. These objects were used only in a narrow circle, within the cultural complex where they were made. This is significantly different from several other types of objects of the same age, e.g., from the Jászladány axe-adzes, which were circulated in an extremely large area throughout Europe (Heeb, 2014). Consequently, these objects could have had a meaning that could only be interpreted within this circle, and access to them could have been severely limited.

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Data availability statement. The authors confirm that the data supporting the findings of this study are available within the article.

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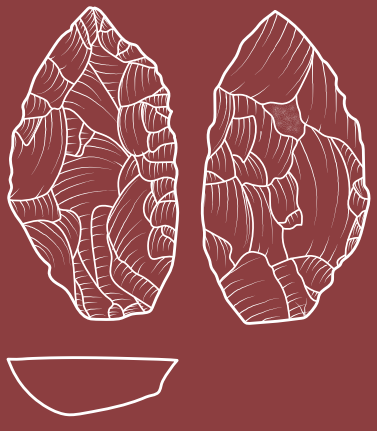
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Perhaps this is how most of his peers and students know Zsolt, among lithics and colleagues at the Institute of Archeological Sciences, Faculty of Humanities, ELTE Eötvös Loránd University, Budapest, Hungary. To the left stands Ukrainian archaeologist Yuri E. Demidenko, who provided us with the picture taken in 2019, an internationally recognized expert on the Early Upper Paleolithic. To the right, Sándor "Szása" Béres in a striped shirt, a tireless field researcher who we unfortunately lost recently. Throughout his career, Zsolt devoted selfless attention to the promotion of relationships between researchers. *Photo: Yuri E. Demidenko, drawing: after Kozłowski* et al.*, 2009.*



15

Bringing social process into lithic studies

IMPLEMENTING THE *CHAÎNE OPÉRATOIRE* CONCEPT INTO THE ANALYSIS OF NEOLITHIC STONE MATERIAL

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Abstract. Lithic technological analysis, experimental studies, and ethnoarchaeology, together with cultural and social anthropological approaches all provide excellent tools for the interpretation of knapped stone artefacts – not only from the Palaeolithic era but the Neolithic as well. The fundamental concept of *chaîne opératoire* was developed by French scholars studying Palaeolithic materials, providing a consistent framework for the recognition of the technological system of a community. This approach can take into account not only the technological knowledge, skills and abilities of the individual but also the traditions of the community and the surrounding environment that influence the qualities of the community (potential knappable raw materials, characteristic toolkits, etc.). By contrast, the conventional archaeological approach to lithics too often narrowly focuses on the spatial distribution of raw materials, and the occurrence of specialised tools, to reconstruct, for example, the communication networks between communities. However, the technological approach can explore a broader range of activities in more detail – stone tool production, usage and deposition. Observed technological traits of lithic implements enable us to recognise these activities at different levels on spatial and social scales. Thus, we can identify technical choices and gestures, as well as recurring activities, i.e. practices, even with a ritual character, inside and outside the settlements, within the scopes of individuals, households or an entire community. This paper presents a Late Neolithic case study on how the technological approach facilitates the study of stone tool production on different levels, scales, their use and their deposition, and integrates them into the Neolithic narrative.

Keywords: Technological approach, Stone tool production, The tradition of “the French technological school”, Neolithic, Scale

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"*...because the answer is never the most important thing, but the way to it!*"

(Mester Zsolt, Hungarian National Museum, 2009)

1. Introduction

The technological approach to stone tool research and interpretation is often referred to as the "French school" or the "French technological approach" (Audouze *et al.,* 2017; Delage, 2017; Shott, 2003, pp. 95–96; Soressi & Geneste, 2011, pp. 334–337). Not without reason, since the detailed and systematic research on Palaeolithic stone assemblages was fundamentally influenced by the work of French archaeologists: André Leroi-Gourhan (1911–1986), François Bordes (1919–1981), Jacques Tixier (1925–2018) and Jacques Pelegrin (Le Brun-Ricalens & Potin, 2018). The quantity and quality of Palaeolithic sites and their finds, and nevertheless, the research questions are entirely different from the younger periods. The question is: how far the methodology used in processing Palaeolithic assemblages proves appropriate for Neolithic finds, and how can the approach be applied to settled communities? The highly mobile lifestyles of the Palaeolithic and Mesolithic communities had specific dietary habits, settlement patterns and social structures, all of which were completely different from Neolithic communities of the 7th–5th millennium BC in Southeastern and Central Europe. These details are not strictly within the scope of this paper, so see the relevant data in the cited literature (Gamble, 2001; Mellars, 2001; Mithen, 2001; Whittle, 1996, 2001). These divergent features represent markedly different material cultures, technological systems, toolkits, traditions, and individual and communal activities. The environment, people and objects are linked in different relations, so the object and questions of cognition itself are different.

In addition to approaches based on human-thing entanglement (Hodder, 2016) and the back-and-forth interaction between the local environment and the community (landscape archaeology, Anschuetz *et al.,* 2001; Müller, 2018; Shennan, 2009), social archaeology is the dominant trend in the Neolithic research. The latter is a rather diversified approach, which can be summarized as a synergistic study of the trinity of environment-community-material culture. In many cases, the household itself is at the centre or even the starting point of Neolithic social archaeological research (Bender, 1967; Foster & Parker, 2012, pp. 1–3). People belonging to a household are considered the smallest unit of analysis for a community. A household is a social unit whose (co-)functioning is influenced by the social, economic and ideological processes specific to the community and its environment (Ames, 2006; Allison, 1999; Blanton, 1994; Parker & Foster, 2012; Souvatzi, 2008). Basic activities such as production, distribution, use/consumption, transmission/exchange and deposition are particularly well studied in stone tools, representing the best-preserved material of Neolithic settlements (Inizan *et al.,* 1999; Odell, 2006). Stone assemblages provide a 'window' into the activities of everyday life, identifying the activities of individuals/micro-communities within and outside the settlement that constitute households.

Basically, there are two ways of looking at a household, so there are two possible starting points for the research (Souvatzi, 2008; Wilk & Rathje, 1982). One starting point is the physical building, which in fact, includes archaeological features, these are the buildings or the post-holes, that indicate their location, or the majority of the settlement features are the pits. The other root of the research is the community of people living together in the building, which can only be identified as an imprint, as they are often intangible phenomena. An approach based on archaeological phenomena most often defines the unit(s) belonging to the household together with the archae-

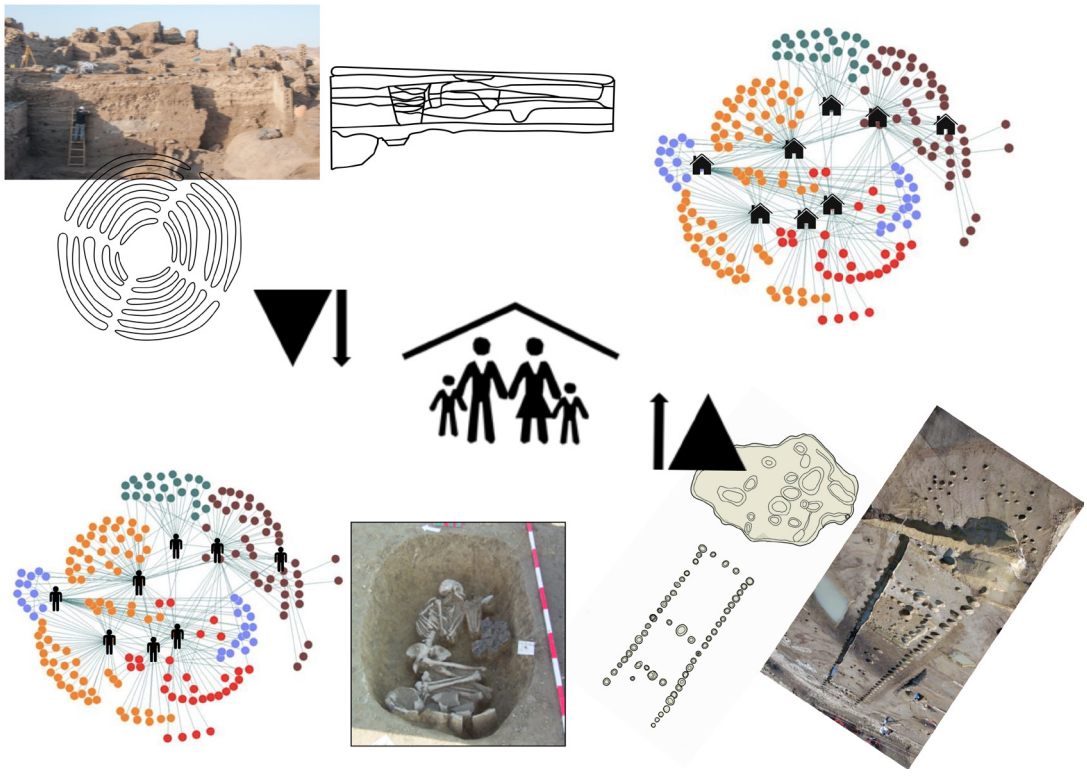


Figure 1. A schematic diagram of different perspectives (top-down – bottom-up) of a household approach resulting from the archaeological contexts of tell and horizontal settlements (prepared by the author).

ological finds themselves based on their physical location and stratigraphic context. The tell settlements are the perfect basis for this, where the complex stratigraphy is accompanied by the internal and absolute chronology of the settlement, which is particularly important in the study of the Central European Neolithic (top-down, deductive approach) (e.g., Drașovean & Schier, 2010; Müller *et al.,* 2011; Müller *et al.,* 2013; Müller-Scheeßel *et al.,* 2010; Raczky & Anders, 2006; Rosenstock, 2009). In contrast to the tell communities (Vinča, Tisza), the communities defined as Linear Pottery cultures (LPC, LBK) left traces of horizontal settlements, which suggest a very different spatial perspective. The buildings and pits (*Längsgrube*) beside their longitudinal walls and the models of the LBK settlement patterns display the main focus of the research – particularly in the German-speaking area – (Bickle, 2020, Fig. 3; Lenneis, 2013; Lüning, 2005; Rück, 2007; Whittle *et al.,* 2013). For horizontal settlements, the community that creates archaeological features and artefacts, i.e. human activity and its arenas, is one of the main research directions, which requires a more activity-centred technological approach (bottom-up, inductive approach) (Fig. 1). A technological approach is useful in the study of households, which can identify human activity, such as stone tool production, both within and outside the settlement, and perhaps in some cases "fingerprints of the craftsman". In addition, it is important to note that top-down and bottom-up approaches

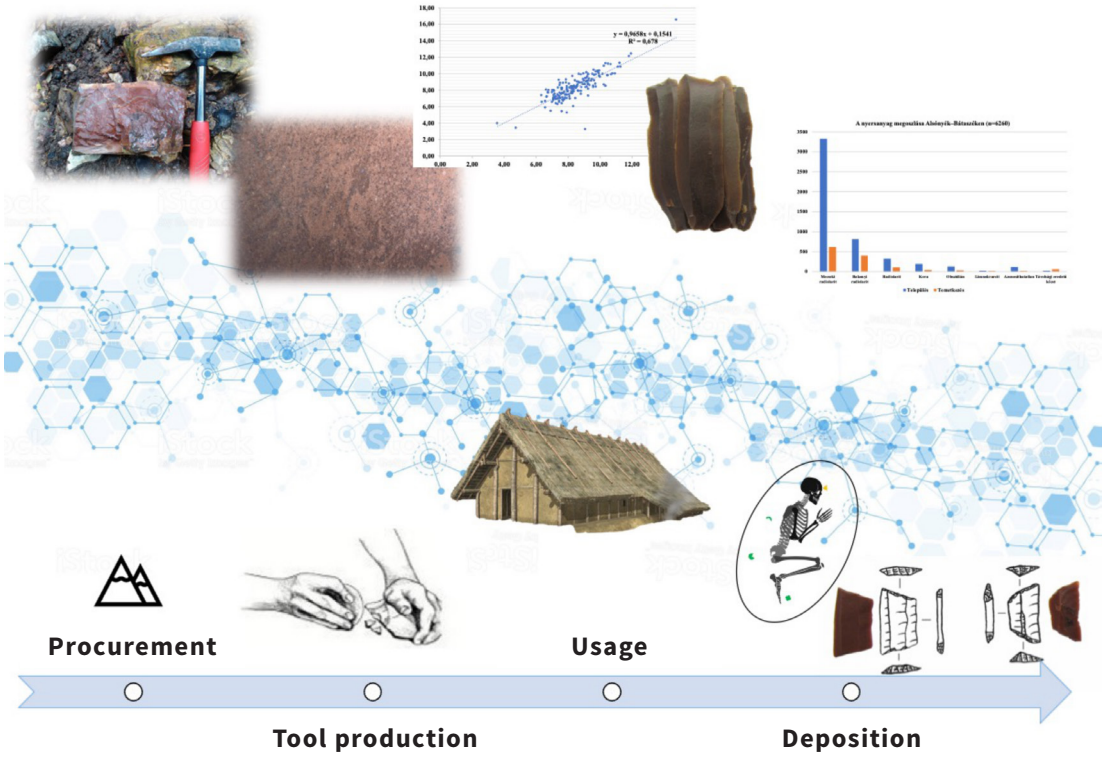


Figure 2. Schematic flow chart of mental refitting/remontage with the technological processes of stone tool production (prepared by the author).

are not mutually exclusive, and both approaches are effective and can lead to useful conclusions (Lucas, 2015). The correct method to be applied can be chosen depending on the research questions, which are strongly influenced by the nature of the sites and finds.

2. The "source of the problem" or the origin of the question

In the last decades, not only the technological approach has spread worldwide, but also the study of the tool production process as a sequence/chain of operations, in the case of artefacts younger than the Palaeolithic and not exclusively made of stone (Roux, 2016; Spataro, 2018; Spataro & Furholt, 2020; Vieugue, 2014; Vukovic, 2010). As far as the younger prehistoric artefacts of the Carpathian Basin are concerned, following the research on bone and antler tools (Bartosiewicz, 2006, pp. 35, 51–52; Csippán, 2012, 2013; Tóth, 2014), the technological approach to the study of pottery production has also become more widespread in the last few years (Füzesi, 2019; Gomart *et al.,* 2020; Marton *et al.,* 2020). Basically, it does not consider only tools but all artificially created objects as finished products from a static point of view, but, on the contrary, it examines the process of production in the causal context of the object's creation. We can find many papers and methods that try to analyse and explain different process-

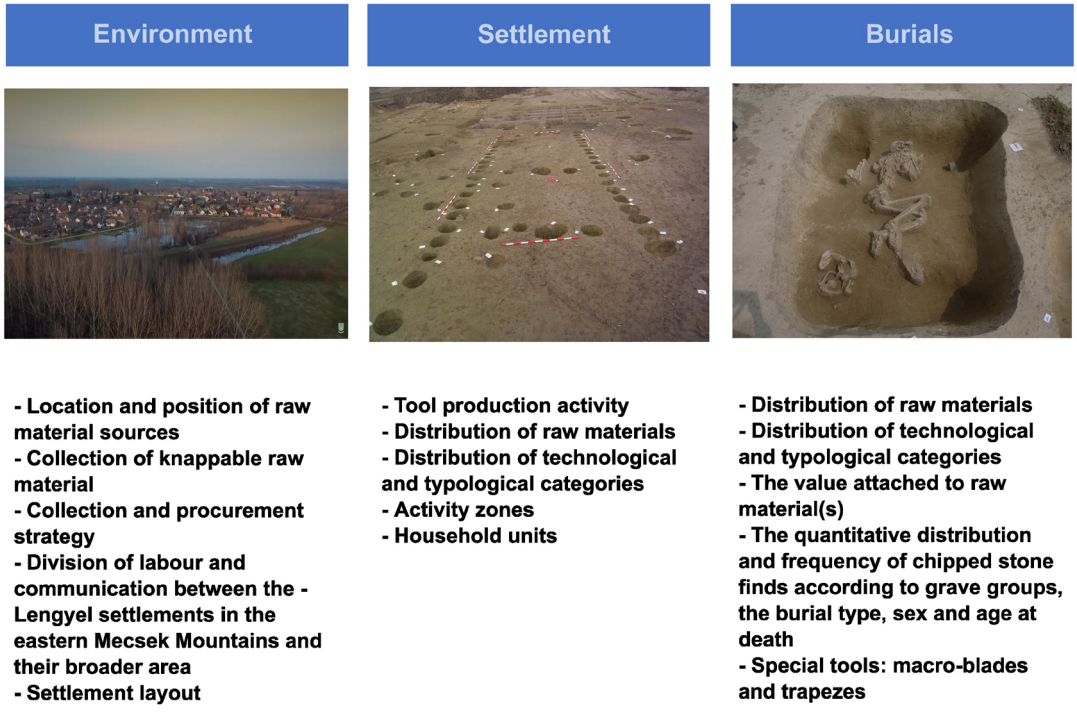


Figure 3. Schematic structure of the research topics and analytical units of the dissertation (Szilágyi, 2019, p. 39).

es from the 1960s in processual, post-processual and cognitive-processual archaeology. The richly diverse research themes, methods and their justification and critique have been the subject of much discussion, filling the pages of conferences and other edited volumes (Hodder, 1991, 1992, 2013; Hodder & Hutson, 2003; Meskell & Preucel, 2004; Preucel & Mrozowki, 2010; Renfrew, 1973, 1994; Renfrew & Bahn, 1996). Replacing the traditional ceramic-based relative chronological approach with the unquestionably ceramic-centred processing method has an increasing impact on the prehistoric research of the Carpathian Basin. Thus, the analytical method with a technological approach and, in parallel, the bottom-up, i.e., inductive logical procedure, are tested almost simultaneously in processing materials from several sites (Faragó, 2016; Siklósi & Szilágyi, 2016). This process happened more easily, perhaps faster and more smoothly in the western and northern half of Europe, which can be traced back to several phenomena, but the most important of all is that the quantity and quality of the remaining finds are much more modest than in the eastern half of Europe (Bánffy, 2019; Vandkilde, 2007, pp. 11–23). The situation is particularly complicated due to the finds and complex stratigraphic relationships of the tell settlements accumulated over many decades, which often appear as an almost impenetrable wall in front of the researchers working on them. It is no different with the finds of thousands of pieces of horizontal settlements, where instead

of stratigraphic problems, the question is the establishment of relationships between contemporaneous phenomena (Domboróczki, 2009, p. 83, Fig. 5).

Here the logic of thought connects back to the French technological school's approach to the concept of *chaîne opératoire* – or in English, the line of operations or operational sequence –, but the original French term became widely used. Given that the *chaîne opératoire* is a well-known and well-published topic, I will refrain from going into more detail in this article (cf. Audouze & Karlin, 2017; Delage, 2017; Holló *et al.,* 2001; Holló *et al.,* 2002; Holló *et al.,* 2004; Inizan *et al.,* 1999; Leroi-Gourhan, 1964; Le Brun-Ricalens & Potin, 2018; Sellet, 1993; Tixier, 2012). The reconstruction of the stone tool production process can be done physically and mentally. The physical process can be done by (re)fitting together pieces of a removal series, which is an extremely time-, labour- and patience-consuming task. It is possible for the vast majority of Palaeolithic or Mesolithic finds from small-sized excavations – mostly related to scientific projects –, which have been meticulously excavated. An excellent example of the complex analysis is the blade depot of Boldogkőváralja, which is associated with the Middle Neolithic Bükk community (ALPC) (5300–5000 BCE) (Csengeri, 2013; Mester & Tixier, 2013; Király *et al.,* 2020, pp. 24–29). Matched pieces can be used to determine the location of the stone tool production activity and technological signs can even be used to determine the skill and unique handles of the person or persons who made them. However, the process called refitting is practically infeasible in the case of large-scale – e.g. Neolithic – excavations, where not nearly as meticulous – not stratigraphic – methods were used excavation technique. In this case, the vast majority of small-sized debitage production and debris of the lithic assemblages are completely missing. Another way of reconstructing the stone tool production activity is mental refitting or mental remontage, which does not require the physical matching of products that have been separated during the knapping process. The stone tool production activity can be reconstructible based on the technological categories of an assemblage (the technological and typological groups are often mixed in the literature), the signs of the knapping process, together with the typical debitage of the period. In practice, this means that, without matching, a single stone item can be mentally placed in the correct 'place' of the reconstructed sequence of operations based on the technological signs. As an illustrative example, I want to use the technique of professional chess players because, in their case, it is not necessary to physically move the figures on the chessboard, it is enough to describe the sequence of figures' moves by field codes, so that the physical presence of the chessboard and the figures, i.e. their "matching", is not necessary. The reconstruction is a unique and specific pattern of changes in the move combinations of the chess pieces, strung together in a logical and temporal chain, which only makes sense within the framework of the board (Fig. 2).

3. A case study from Alsónyék

The Alsónyék-Bátaszék site can be seen as an interesting case study where the set of information provided by the chipped stones and its conclusion became known even before the processing of the ceramic finds in the part of the site belonging to the Late Neolithic Lengyel community. This is an unusual case since the previously mentioned primary ceramic processing, and the internal chronological interpretation almost always have priority, and the lithics are used as network markers, especially as exact evidence of intercultural exchange systems, in the narrative of the entire site. In contrast, the traditional ceramic-based archaeological interpretation does not apply at Alsónyék, instead, nearly 200 data of ^{14}C dating,

Table 1. Raw material distribution of the entire chipped stone assemblage recovered from the settlement features and burials of the Alsónyék-Bátaszék site.

Raw material	Settlement (number)	Proportion (%)	Burial (number)	Proportion (%)
Mecsek radiolarite	3324	67.19	616	46.92
Bakony radiolarite	812	16.41	405	30.85
Unsourced radiolarite	328	6.63	113	8.61
Chert	194	3.92	46	3.50
Obsidian	131	2.65	36	2.74
Limnic silicite	22	0.44	18	1.37
Unidentifiable	114	2.30	19	1.45
Supraregional raw material	22	0.44	60	4.57
Total	4947	100.00	1313	100.00

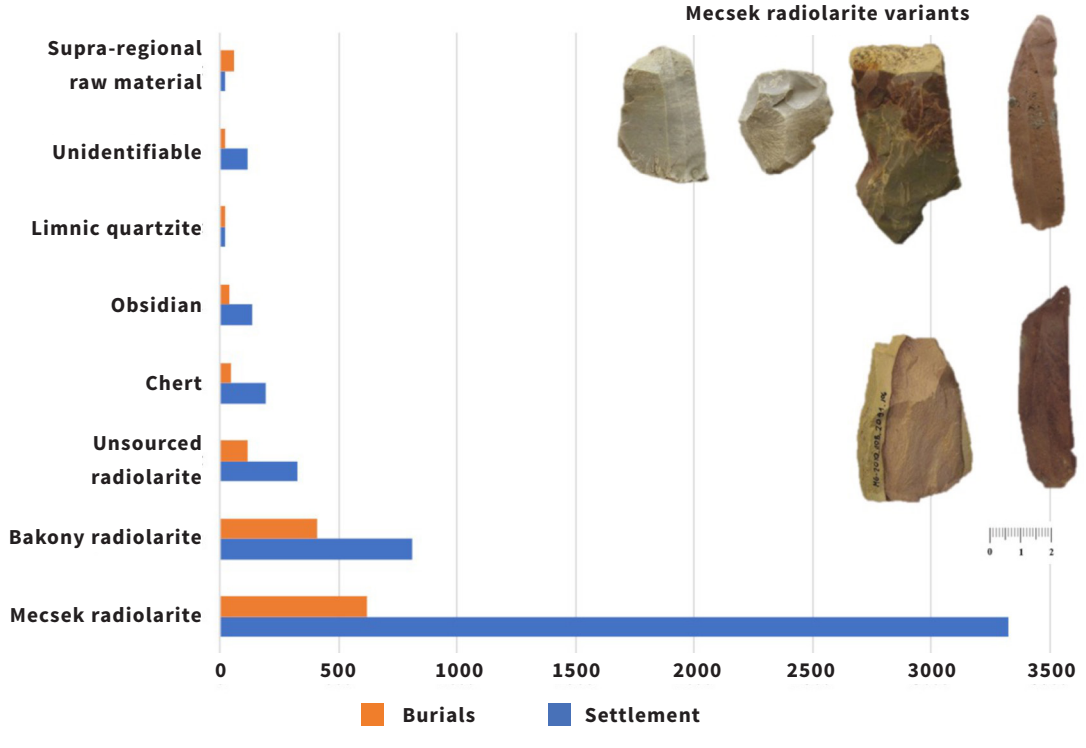


Figure 4. The raw material distribution of the stone materials from settlement features and burials in Alsónyék and local radiolarite variants (prepared by the author).

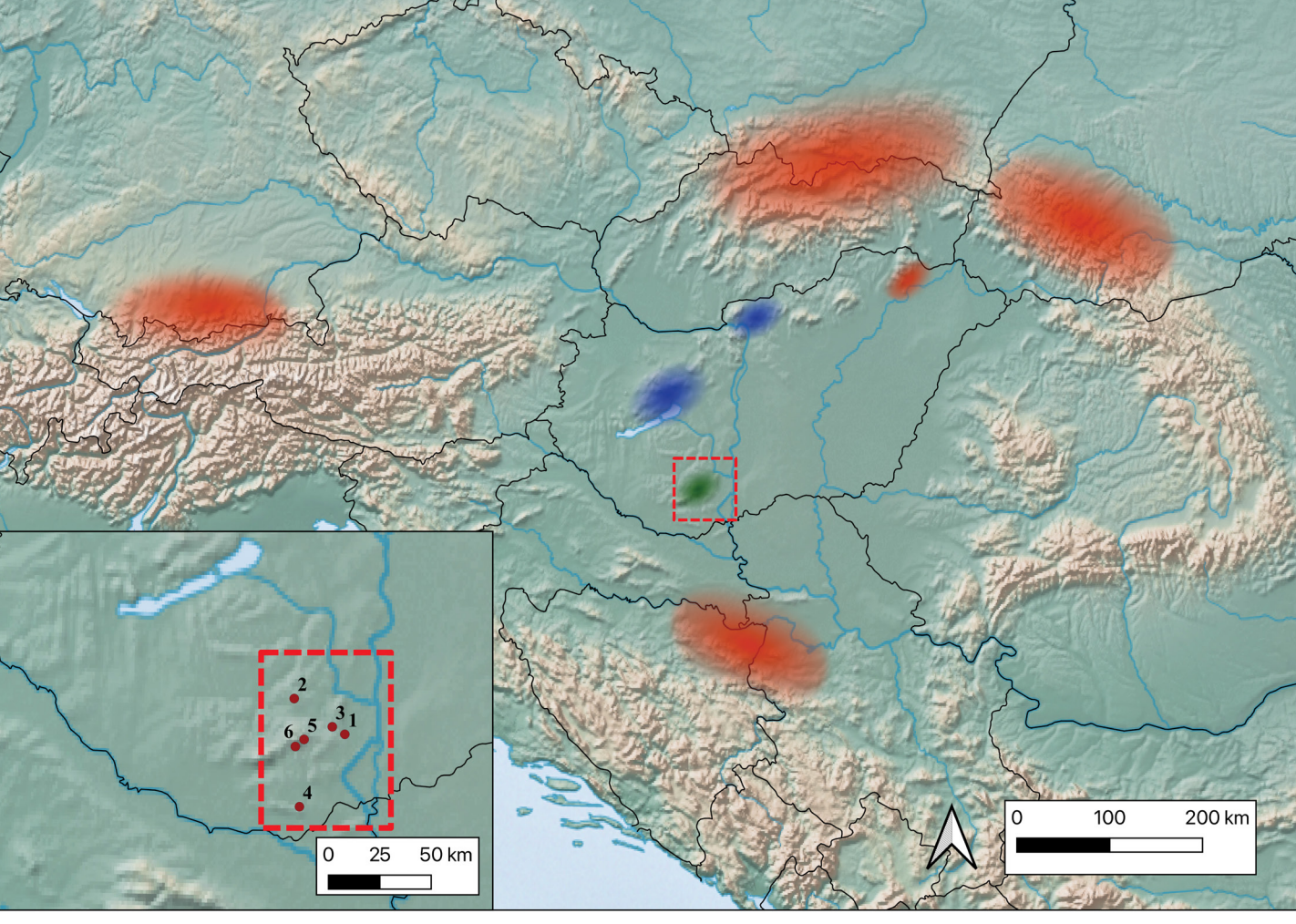


Figure 5. The study area (marked by a dashed line) and the presumed procurement zones are based on the stone material. Legend: red: long distance; blue: regional; green: local procurement zone area. 1: Alsónyék-Bátaszék, 2: Lengyel-Sánc, 3: Mórágy-Tűzkődomb, 4: Villánykövesd, 5: Zengővárkony-Igaz-dűlő, 6: Pécsvárad-Aranyhegy (prepared by the author).

isotope and aDNA data series are available in addition to the analysis of the entire chipped stone material (Bánffy *et al.,* 2016). There is no outline, based on the pottery typochronology, of the patterns that, together with the pre-existing system of thought, inherently delineate and determine the archaeological interpretation itself in the Late Neolithic material that represents almost 90% of the Alsónyék site. Of course, the earlier cultural, chronological and ceramic-based archaeological knowledge is also an important point of reference and a common coordinate system, which should neither be forgotten nor ignored. At the same time, the unusual situation of Alsónyék provides possibilities in that the activities reconstructed based on the chipped stones and their locations are only subsequently verified by the other types of finds.

My doctoral thesis, defended in 2019, was based exclusively on the Late Neolithic settlement features and burials of Alsónyék, which consisted of a 6,260 pieces assemblage of chipped stones. The work was carried out under the supervision of Zsolt Mester, and thus the technological approach played a crucial role (Holló *et al.,* 2001; Holló *et al.,* 2002; Holló *et al.,* 2004), one of the aims was to reconstruct the knapping activities of the Late Neolithic communities of Alsónyék and

southeastern Transdanubia (Fig. 3). In this study, the stages of raw material procurement, preparation, production and use can be distinguished, followed by the discard/disposal/taphonomic processes of object´s life biography. I skipped the re-usage from the stages, which is also important but not typical in the material of Alsónyék. This approach is reflected in the basic structure of this dissertation (Szilágyi, 2019, Szilágyi, in press a), and I would like to present it as a case study, as a possible use of the *chaîne opératoire* concept in the study of Neolithic material, which is the subject of this article.

4. Materials and methods

The most important numerical data of the Alsónyék material are only described tangentially since the methodological part, and the logical reasoning at the centre of this paper is to demonstrate the use of the *chaîne opératoire* concept in the study of Neolithic lithics. A total of 4,947 pieces of chipped stones were recovered from the settlement features, representing 79.03% of the total 6,260 pieces of lithic material from the entire site (Szilágyi, 2019, p. 82), and 1,313 pieces of chipped stones were appeared from the burials, representing almost a quarter (20.97%) of the total lithic material (Szilágyi, 2019, p. 84). The vast majority of the lithics of the settlement and the burials were made of radiolarite, more precisely of Mecsek radiolarite from a source of raw material located 30–50 km away from the site. In addition to the homogeneous raw material, the predominance of blades and blade-based tools (blade scraper, borer, trapeze) is a characteristic of the entire find (Tab. 1; Fig. 4).

One of the main pillars of the research was to clarify the location and position of the raw material sources, which was achieved through field geoarchaeological research. The primary aim of this was to map and document the spectrum of raw materials suitable for knapping in the eastern Mecsek area, and by collecting samples to create a reference rock library or collection suitable for comparing archaeological finds and geological samples. The fieldwork was conducted to investigate the issue of raw material procurement, which was aimed at understanding the selection, collection and/or extraction strategies of Late Neolithic communities for knapping rocks (Szilágyi, 2018a).

The stages of preparation and production of the stone tools, i.e. the practical stone tool production itself – and its techniques – can be identified by analysing the entire chipped stone material from one consistent point of view. The stone assemblages recovered from the settlement phenomena and the burials form the basic units of analysis and comparison. A complex picture can be built by comparing the primary characteristics such as raw material, technological category, type of tool, and their quantitative distribution. This approach provides a general overview of the stone tool production activity in the settlement, which can be used to prove that intensive stone tool production may have taken place in the Late Neolithic settlement. As a more detailed unit of analysis, further analysis of the settlement and the burial stone assemblages requires a different methodological approach, and thus research is needed on the occurrence phenomena, quantitative distribution and relationship with the timber-framed buildings in the settlement.

The chipped stone artefacts recovered from the burials represent an assemblage that had been selected according to certain criteria and therefore their assessment called for a wholly different interpretative framework than the one employed for the settlement finds. The majority of the 2,236 graves uncovered at the Alsónyék site formed distinct clusters, which, knowing that the burials of the preceding period were scattered between the building in different parts of the settlement without any apparent pattern, reflects the profound social and cognitive changes occurring

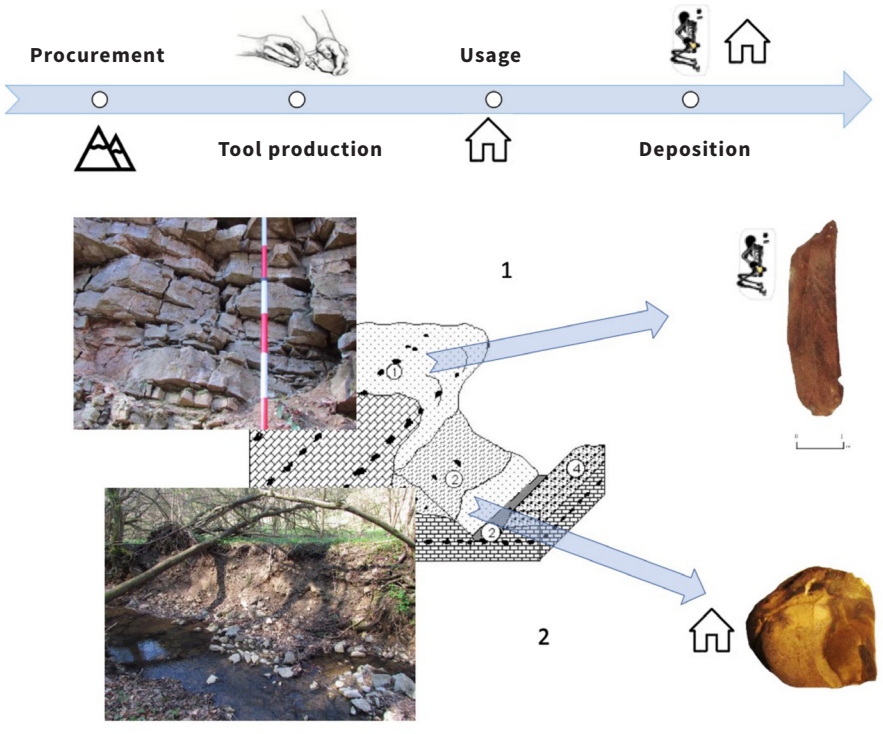


Figure 6. Two possible strategies for raw material procurement: 1 - primary autochthonous source - outcrop – macro blades from burials; 2 - secondary autochthonous source - stream load - medium-sized cores from the settlement (prepared by the author).

in the Late Neolithic (Szilágyi, in press b; Whittle *et al.,* 2013). The grave clusters at Alsónyék can be interpreted as the imprints of a converging mortuary rite, with consistent patterns in orientation, the body placement of the deceased and the choice of grave goods. Accordingly, the main question when studying the chipped stone finds was the meaning ascribed to them in the context of burials (Szilágyi, in press b). The raw material, the type and the position within the grave were all important indexical signs that pointed beyond the simple materiality of the artefacts and were vested with a symbolic value (Bell, 2009, pp. 69–93; Devlin & Graham, 2015; Short, 2007, pp. 165, 207–208, 214–215, 219–220). My main goal was to offer one possible and feasible interpretation, also based on a collation with the available anthropological data to identify possible correlations with biological sex and age at death. Finally, to gain a broader perspective, I compared the chipped stone assemblage from Alsónyék with the already published lithic assemblages from the sites of the Southeastern Transdanubian group of the Lengyel communities (Zengővárkony-Igaz dűlő, Mórágy-Tűzkődomb, Pécsvárad-Aranyhegy, Lengyel-Sánc and Villánykövesd) (Bácskay, 1989, 1990; Biró T., 1989, 1990, 1998; Zalai-Gaál, 2010, pp. 114–122). The chipped stone assemblages from these sites share countless similarities in terms of their raw material and technological categories, offering insights into the technological system of the group's tool production, the value and meaning attached

to locally available rocks, and any transformations that occurred during this period (Fig. 5).

5. Results

The procurement mode of local raw materials suitable for knapping sheds light on how Lengyel communities exploited their environment. Major research questions were how raw material was procured and how intense was the cooperation and division of labour in tool production, if any, between different communities. The fieldwork and the assessment of the various chipped stone assemblages would suggest that while the actual acquisition of locally available rocks did not call for special extraction activities, it did require a good working knowledge of the raw materials, and it seems likely that the communities in question were familiar with the raw material sources in the eastern Mecsek Mountains. The field survey indicated that larger valleys and stream beds were potential sources of raw materials, where good-quality, easily knappable rocks could be found and collected, just as in the case of the Hódmezővásárhely-Gorzsa lithic assemblage (Starnini *et al.,* 2015, pp. 118–124). It seems likely that the larger raw material fragments needed for the manufacture of the macro-blades made from Mecsek radiolarite deposited in the burials at Alsónyék were not collected from stream beds but from outcrops in the valleys. These outcrops were suitable sources, with radiolarite intercalations in the thin-bedded structure. Thus, the dislodged blocks of raw material could be acquired without the need for special extraction tools and activities, which, judging from the field observations, contained larger chunks of radiolarite suitable for creating the cores needed for larger blades. It seems likely that raw material procurement was undertaken by individuals who were adept at making tools, had the necessary knowledge of rocks, were familiar with the area, and knew exactly which stream beds and outcrops were likely to yield suitable raw materials (Manolakakis, 2008, pp. 119–120; Saville, 2008, pp. 6–9; Szilágyi, 2018a) (Fig. 6).

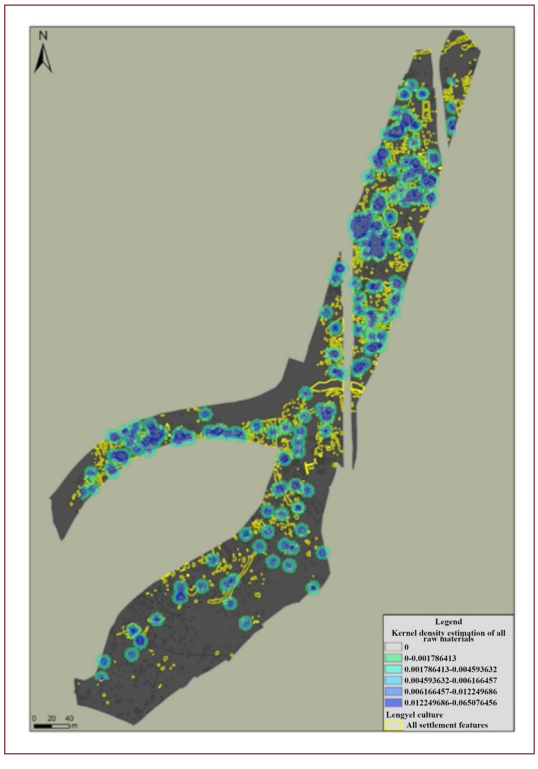


Figure 7. Kernel density estimation of the chipped stone finds from the settlement features of the Alsónyék-Kanizsa-dűlő sub-site (map prepared by Péter Czukor).

The chipped stone assemblage from Alsónyék does not contain substantial numbers of decortication flakes indicating the preparation of cores on the settlement, which would suggest that local raw materials arrived at the settlement as cores or as already decorticated raw material fragments. Two explanations offer themselves or seem plausible. Firstly, several tools were made from less homogeneous "pure" radiolarite and wholly silicified parts, and thus decortication was not always necessary. Second, the field observations would suggest that larger pebbles or nodules of raw material had to be broken to determine whether or not

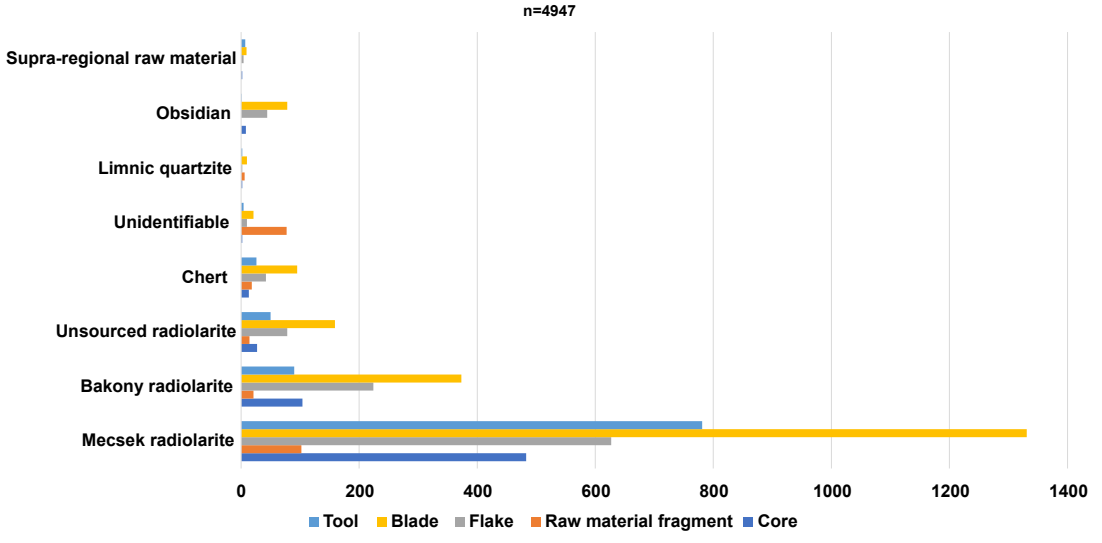


Figure 8. Distribution of raw materials and technological categories in the settlement assemblage from Alsónyék (prepared by the author).

they were suitable for knapping, resulting in sharp breaks and fracture surfaces, which would have caused some difficulties for the persons engaged in collecting raw material and could easily tear any bags used for storage and transportation. This posed a practical problem in the Late Neolithic, too, since raw material was either transported on pack animals or carried back to the settlement on foot. The transportation of knappable raw material over a distance of 20–30 km was no easy task across the terrain of the Mecsek Mountains, and carrying rocks whose greater portion was useless for tool production simply meant an unnecessary expenditure of energy. This would again suggest, as well as explain, why pre-cores and cores were fashioned near the place of collection or extraction (Mateiciucová, 2008, pp. 144–145; Starnini *et al.,* 2015, pp. 118–124; Szilágyi, 2018b, 2020, pp. 292–294) (Fig. 7–8).

The comparison of the frequencies of the technological categories, reflecting the cultural traditions of the Lengyel communities as shown by its chipped stones, also provides important insights for the reconstruction of tool production. Given the dominant technological traits, the southeastern Transdanubian group of the Lengyel communities can be characterised as a "blade culture" since the currently known chipped stone assemblages are dominated by blades and tools made on blades. The high proportion of blades varies depending on how large a part of the assemblage was recovered from burials. The chipped stone finds recovered from settlement features are characterised by a high proportion of blades and flakes (Zengővárkony, Pécsvárad, Villánykövesd, Alsónyék), followed by cores and tools. The burial assemblages have high frequencies of blades and tools, with blades representing the most important category.

Similarly intense mortuary activity and a comparably large chipped stone assemblage like Alsónyék have not yet been encountered in the Southeastern Transdanubian group of the Lengyel communities, which in itself sheds entirely new

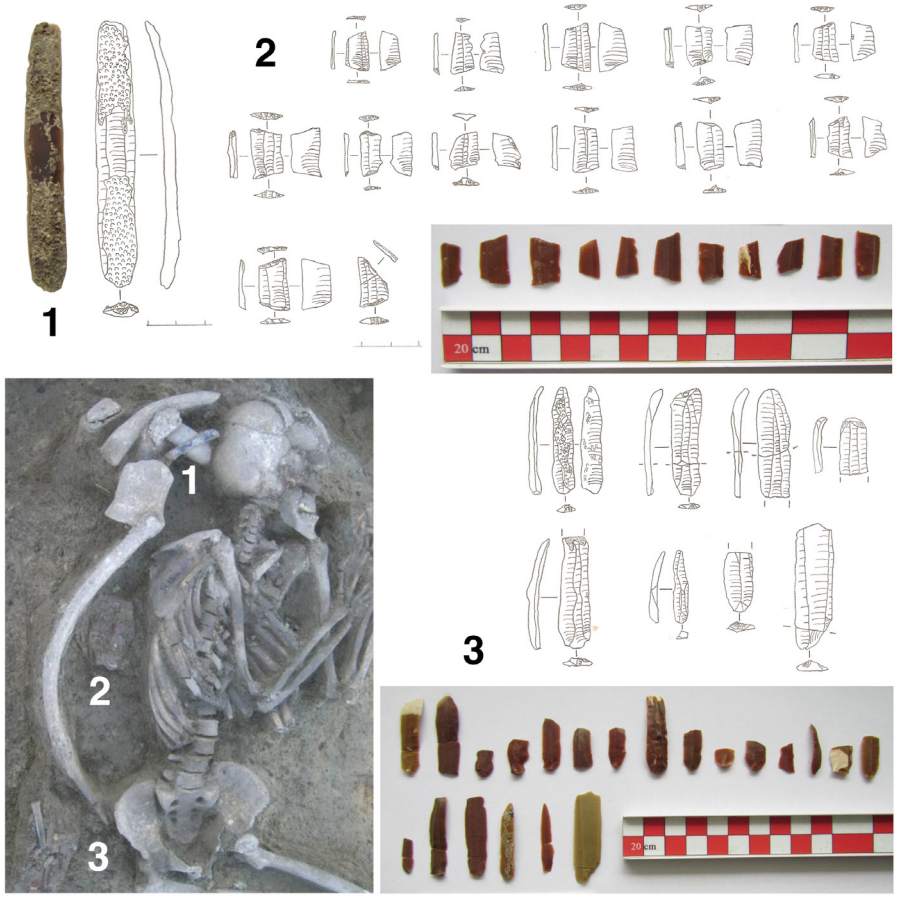


Figure 9. Distribution of lithic raw materials and technology categories of the burial material from Alsónyék (prepared by the author).

light on the group as well as on its cultural expressions. The overwhelming majority of the 2,236 burials uncovered at Alsónyék were deposited in customary oval grave pits, alongside which 130 post-framed grave pits were also uncovered during the site's investigation. There are major differences in the distribution of the burials across the site. There was no apparent correlation between the number of burials in a particular grave group and the frequencies of the chipped stone implements since about one-half of the burial assemblage was recovered from isolated single graves, and thus there is nothing to suggest that chipped stones had been deposited more frequently in burials that were part of a grave cluster. There are major differences between the grave groups regarding the number of burials, their spatial arrangement, the form and type of the grave pits and the frequency of the deposition of chipped stones. While definite regularities, or patterns, can be noted in the placement and orientation of the deceased, several "irregularities" can be

Table 2. Characteristics of individual and communal stone tool production activities in archaeological context.

Individual	Communal
1) Activities outside the settlement were strongly influenced by the nature of the raw material available for processing in the environment and the type of activity required to obtain it. Where lithics could be collected by locating the source of the raw material, the procurement could be more independent and highly individualised. While those lithics require a specific extraction activity may need a collective investment of energy by the community to some extent.	
• individual raw material collection	• communal raw material extraction
• no division of labour required	• possible division of labour
• possibility of individual "expeditions" for raw material procurement, less cooperation	• higher personnel requirements, even organised energy investment
• no or very little control over raw material source	• the possibility to control the raw material source (centralised or very limited extraction depending on lithic type)
• individual preferences, specific selection strategy	• the lithic dominance depends on the raw material source
• bigger diversity of the selected raw materials (several low-quality lithics may be brought into the settlement, which might be the source of further knapping accidents)	• targeted procurement of raw materials, smaller-scale lithics diversity
• adequate knowledge of raw materials is required, but knowledge of the local environment is a greater advantage	• specific expertise to obtain the lithics
2) Intramural activities	
• the evidence of tool production activity is concentrated in certain parts of the settlement	• the evidence of tool production activity can be found throughout the settlement
• the dispersion of raw materials and technological categories shows a specific pattern (a knapping specialist can be assumed)	• the dispersion of raw materials and technology categories shows an almost identical, uniform pattern
• specific expertise (only certain knapping accidents occur)	• various knapping accidents, which can be observed in many parts of the settlement
• a concentration of debris and debitage waste production	• even distribution of debris and debitage waste production
3) The deposition of stone tools in the burials	
• few (extraordinary) burials had chipped stones as grave goods	• the habit of chipped stones deposition is common
• random grave positions, no deliberate preferred deposition place inside the grave	• the position of chipped stones within the grave has a regular, recurring pattern
• unusual, special burials (an outstanding number of chipped stones or matching pieces)	• raw materials and technology categories show a pattern (special selection)
• Supra regional (exotic) raw materials	• homogeneous raw material (usually local or regional lithics)
• completely different from the raw material and technological categories of the settlement	• the same or very similar nature to the raw materials and technology categories of the settlement

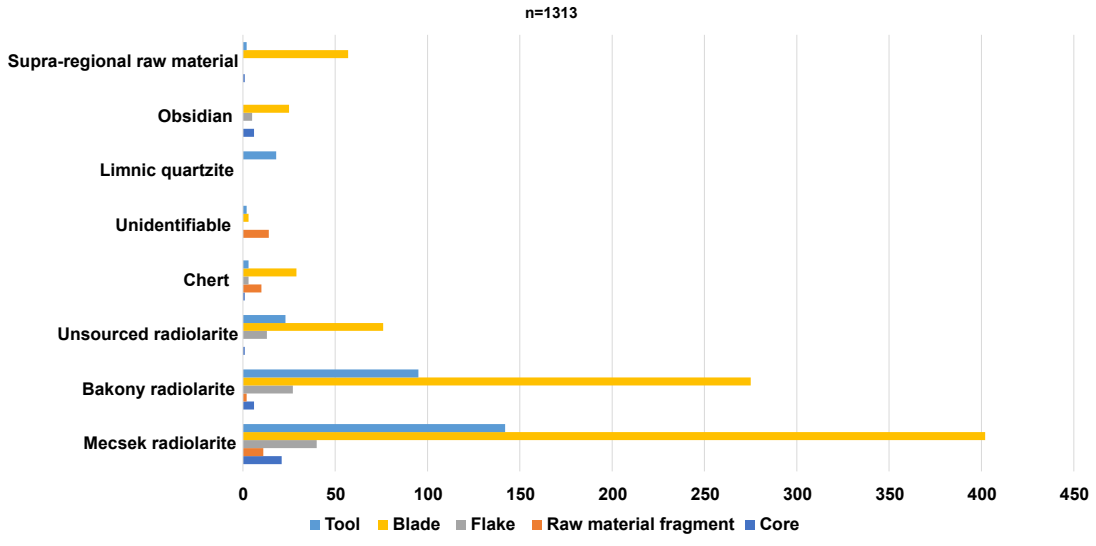


Figure 10. The most frequent grave positions of chipped stone grave goods with the example of No. 927 grave (prepared by the author).

seen on the group level, both in terms of quantity (number of burials, differences between the form of the grave pits, number of chipped stone grave goods, etc.) and quality (presence or absence of grave goods, types and number of grave goods placed in the burial, etc.) (Fig. 9–10).

6. Conclusion

In the case of Alsónyék lithic material, the technological approach proved to be effective in identifying activities related to stone tools inside and outside the settlement. The deductive and inductive reasoning methods mentioned earlier, i.e. the top-down and bottom-up approaches, which are the two most commonly used in the archaeological literature, are excellent methods for linking technological data. These data can be combined using different 'data linkages', strongly determined by the social unit to which the activity under study is linked and the process it represents. It is possible to reconstruct a stone tool production activity for a single individual, a whole household community or even a bigger social unit based on technological characteristics. This is the essence of the technological processing of stone tools in social archaeological interpretation. In fact, stone tools can be used to scale activities from the individual knapper to the technological system of community "workshops". By scale, I mean the social scale, on the axis of which are the individual-community and the community-cultural unit "society" of a settlement, which are the smallest (individual) and the largest (society) units of the scale.

To summarise, I provide an overview table detailing the characteristics of individual and communal stone tool production activities that depend on the archaeological context. I have separated the three distinct archaeological contexts based on the location of the activities and their types, which are (1) extramural activities, i.e. the collection of stone tools and possible preparation for processing; (2) intramural activities, stone tool production activities; and (3) the deposition of

chipped stones in burial sites. It did not occur at Alsónyék, but for the sake of completeness (4) it is necessary to mention also the deposits within the settlement as a possible archaeological context, which is not yet known from sites belonging to the Lengyel communities, but several have been published from the Neolithic period (Endrőd 39, Boldogkőváralja, Kašov (Kasó)-Čepegov I, Kosd-Kéméndvég, Szegvár-Tűzköves, Nyírlugos) (Bánesz, 1991; Biagi & Starnini, 2013; Biró T., 2009; Mester & Tixier, 2013; Szilágyi, 2018c, p. 10).

With the overview tables, I have highlighted those aspects that can form units of analysis for a Neolithic site, and from their data, technological characteristics and statistical patterns, and inductively, it is possible to reconstruct the stone tool production activity of the community. With this mental refitting, the extra- and intramural activity of the community can be scaled, i.e. expressed in terms of exact data. In addition to answers to the chronological questions emphasised in Neolithic research, expressed in absolute data, it is possible to model subtle social processes at the technological scale supported by lithics that can in fact provide both individual and community narratives through activity-based reconstruction. The relative nature of 'physical time' is that different types of processes take place at different scales so that the scale represented by the lithics can identify different types of social processes, community and individual level activity sequences and events.

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16

The detachable barbed bronze harpoon heads with a loop

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Abstract. The paper presents two variants of detachable harpoon heads with a loop (Variant 1: with a spur, Variant 2: without a spur) made of bronze, called by the author Mikulovice-type. Based on the finds from Špičák Mountain in Mikulovice and Gór-Kápolnadomb, these tools can be dated to the Ha B1 period. They are essentially West-Central European forms, appearing in the Czech Republic, Germany, and Austria. Based on casting moulds, of which the Celldömölk-Ság-hegy is presented here again after Jenő Lázár, these objects were also made in the territory of the Transdanubian Urnfield culture. The advantage of the Mikulovice type is that it can be associated with several casting moulds, which helps us see more clearly the details of its casting techniques, particularly the design of the negatives. These objects were cast with two-piece casing moulds with two negatives and one casting core. The surviving finds show similarities, but mostly unique and varied solutions were used by metalworkers in different areas. The placement of the pouring cup, the gating system, the multiple casting, and the placement of the risers are all examples of unique solutions.

Keywords: Late Bronze Age (Ha B1), Detachable bronze harpoon heads with loop, Casting moulds, Production technology

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1. Introduction

It is a cliché, but the Palaeolithic – an era of which the celebrated Zsolt Mester is a recognised scholar – was one of the most formative prehistoric periods. The techniques and tools that emerged during this period lived on for an unimaginable amount of time, sometimes even forming part of our lives to this day. Although the shape of the objects has changed and their technology is different, their message remains the same. In this paper, we will look at an object whose origins can be traced back to this period and which is fundamentally linked to the hunting and fishing lifestyle. This is the detachable barbed harpoon head, also known as a toggle harpoon head, which is a later, specialised Copper Age/Bronze Age version of the various types of harpoons that appeared in the Palaeolithic. A detachable barbed harpoon head with a loop is a variant of this object type made of bronze during the Late Bronze Age, basically from the end of the so-called Ha B1–Ha B2 periods (traditional absolute dates: 1000–850 BC, LB IIc–LB IIIa2: 1080–900 BC) (Sperber, 2017, pp. 299–300). This study is also the completion of a recently published work (Tarbay, 2022). It discusses a bronze metal harpoon type, which represents a different line of development from the specimens with line holes. The paper also elaborates on the technology of these bronze harpoons, with particular attention to their moulds. Unlike in the case of the harpoon heads with line holes, the research is in a fortunate position because stone casting moulds have been preserved on the studied type, which allows us to formulate a more sophisticated opinion on the question of their production technology.

2. The Mikulovice type: bronze barbed harpoon heads with a spur and a loop

At the centre of the work is a long-known casting mould (Lázár, 1943, p. 282, Pl. 4.24; Ilon, 2022, Tab. 3.22), which originated from the Late Urnfield settlement at Celldömölk-Ság-hegy, Vas County, Hungary (Patek, 1968, pp. 135–148; Mozsolics, 1974, pp. 81–82; Kőszegi, 1988, p. 130) (Fig. 1: 1). This object is one preserved part of a two-piece casting mould with two negatives and one casting core. Its negative depicts a barbed head with one spur and a loop. The material of the casting mould is probably sandstone (Lázár, 1943, p. 280) similar to other moulds from Celldömölk-Ság-hegy. Sandstone is the most common material used for casting moulds during the Urnfield period in the West Carpathian Basin, particularly in Transdanubia (Péterdi, 2004, pp. 488, 495–496). There are obvious blackish burn marks (T. Biró, 1995, p. 53) on the backside and half of the front side of the mould, suggesting that it was used for casting. A functional mould must have a completely smooth surface to ensure the best possible contact with the other half. But the surface of this artefact is heavily worn and, in some places, slightly uneven; the origin of this is not clear to me (Fig. 1: 1). The mould from Celldömölk-Ság-hegy spent a long time in a private collection and later became part of the Prehistoric Collection of the Hungarian National Museum. The surface may have been altered either because of peri- or post-depositional taphonomy processes or inappropriate restoration and cleaning techniques. It is certain that during the modern use-life phase of the object, at least two plaster positives were cast in this mould. The first one is shown in Jenő Lázár's publication (Lázár, 1943, Pl. 4.24); the second one was probably made by Tibor Kovács and is still in the collection. The creation of the plaster positives could erode the surface of the artefact.

As I mentioned above, a large, barbed harpoon head with a spur and a loop was carved into this mould (Fig. 1: 4). Analogues of this mould are known owing to the works of Monika zu Erbach and Jiří Říhovský who listed numerous similar heads with or without spurs from the Late Bronze Age (zu Erbach, 1989, p. 92; Říhovský, 1996, p. 128).

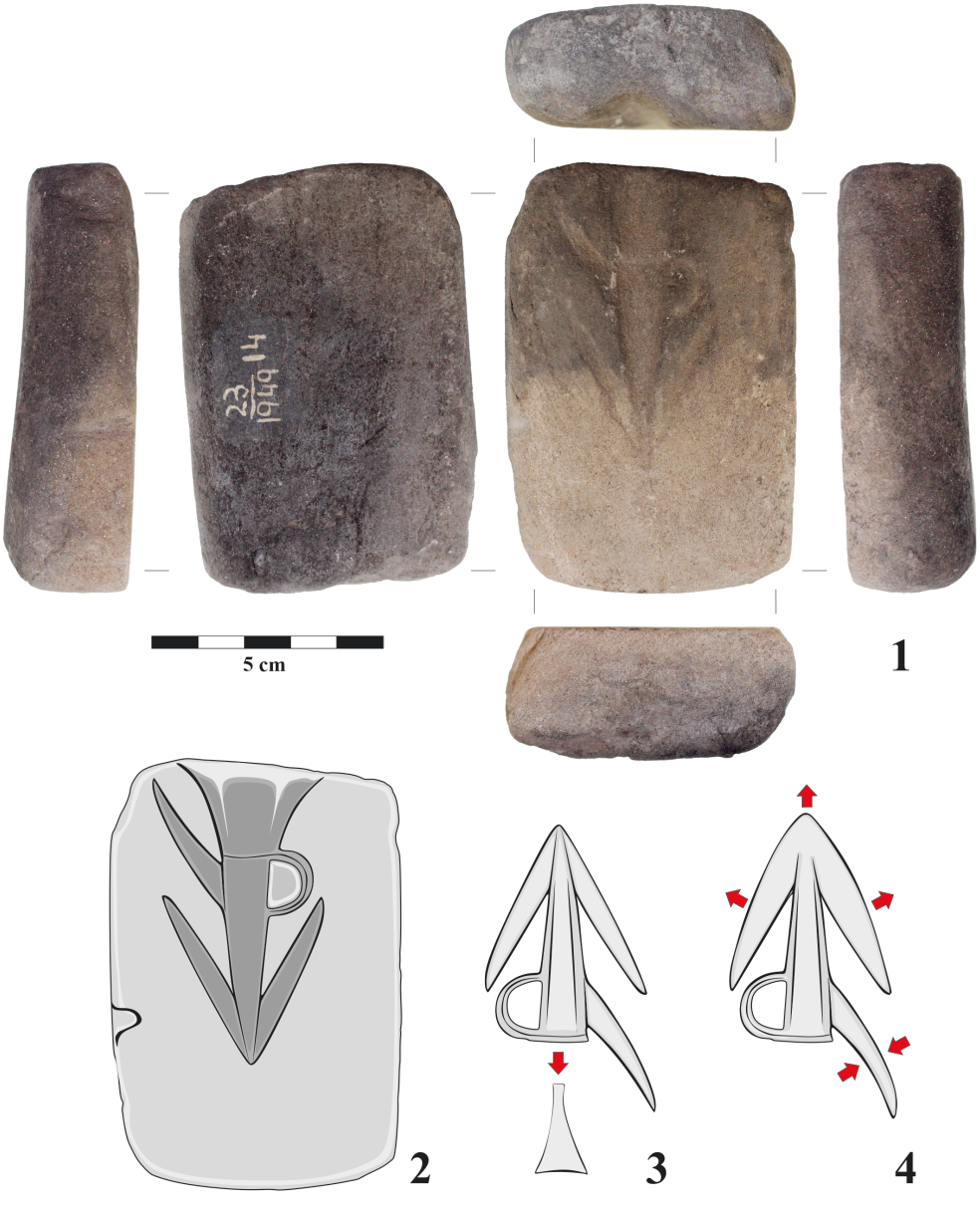


Figure 1. 1–2. Sandstone casting mould of a harpoon from Celldömölk-Ság-hegy (Vas County, Hungary), 3. Reconstruction of the as-cast that could have been made in the mould and the removal of the casting jet, 4. The formal changes that occur when the blade and the spur are hammered during the post-casting treatment phase (Hungarian National Museum; Prepared by the author)..

The best parallel to the barbed harpoon head that could be made in this mould is known from *Zlín-Malenovice* (Zlín Region, Czech Republic). In this Late Bronze Age settlement, a similar sandstone casting mould was found as a stray find (Říhovský, 1996, p. 128, Pl. 27.433). Another one was found in the 3/72 pit of a Knovíz culture settlement at the Špičák Mountain in *Mikulovice*. Jiří Říhovský dated this find to the Ha A/Ha B1 phase of the site while Jan Blažek, Michal Ernée and Lubor Smejtek dated the 3/37 pit to the Ha B1 (Phase Knovíz VI-Štítary I) based on the ceramic fragments from the same context (Smrž & Mladý, 1979, pp. 32, 53, Fig. 4.1; Říhovský, 1996, p. 128; Blažek *et al.*, 1998, pp. 54–55, 145, Pl. 16A.31). A stray find head was found in *Werfen* (Austria) during railway construction at the station house (Kyrle, 1918, pp. 44, 55, Fig. 4.10) another one is known from *Rannariedl* (zu Erbach, 1985, Pl. 84.4, 1986, pp. 173–174, nr 719, 1989, p. 92). There is also an unpublished casting mould from *Heidenstadt bei Limberg* cited by Jiří Říhovský and Monika zu Erbach (Říhovský, 1996, p. 128, fn. 5; zu Erbach, 1986, p. 92, fn. 35). In addition to the Celldömölk-Ság-hegy mould, there is one unprovenanced head that may originate from Hungary. It was purchased by the Hungarian National Museum from János Schiefner along with several other finds around 1871 (Inventory Book of the Hungarian National Museum 1871.5.18) (Fig. 3: 1). Michael Overbeck also included two stone casting moulds with the negatives of looped arrowheads from Germany. One was found at the foothills of the *Höglberg in Landshut*. Although, this object is a stray find, objects dated to the Ha B1 were reported from that area (von Braunmühl, 1826, p. 4, Pl. 2.11; Behrens, 1916, p. 27, No. 90; Overbeck, 2018, pp. 127–129, Pl. 24.40). The other stray find mould was found in the *Goldberg* at *Riesbürg* (Overbeck, 2018, p. 128, Pl. 24.42).

In summary, we suggest the use of the Mikulovice type name for the barbed harpoon heads with a loop. This type can be divided into two variants based on the presence (Variant 1) and absence (Variant 2) of the spur. This is not only a stylistic difference but also a very functional one considering the embedding mechanisms of harpoon heads (Park & Stenton, 1998). After the works of Gábor Ilon, a variant without a spur is known from Gór-Kápolnadomb. This specimen was excavated in a settlement context from K-6 Quadrant, pit "a" which was dated 1032–928 Cal. BC (Ilon, 1992, p. 244, Fig. 6.3, 1996, p. 177, Pl. 2.9, 2022, Tab. 3.38). These dates correlate with Ha B1 according to the absolute chronology of Lothar Sperber (Sperber, 2017, pp. 299–300). The mould from the *Velem-Szent Vid* settlement may also belong to this type. This classification depends on whether the canals of the pouring cups were removed or transformed into a spur (see Tompa, 1927, p. 46, Fig. 5a–b; Miske, 1929, p. 85, Fig. 7.2a–b; Ilon, 2022, Fig. 5.3, Tab. 3.100). Our conclusion holds for the casting mould of the *Prague-Vokovice* settlement (Richlý, 1894, pp. 168–169, Pl. 40.2a; Blažek *et al.*, 1998, pp. 55, 173, Pl. 27.119).

The first variant of the Mikulovice type is known from present-day Austria, Hungary, and the Czech Republic. The second variant was discovered in Transdanubia and Bohemia. The first variant can be dated to the Ha B1 based on the Mikulovice find, but its later presence (Ha B2) should not be excluded based on Late Urnfield sites like Celldömölk-Ság-hegy. Absolute dates from the Gór-Kápolnadomb site allow the 2nd variant to be dated to Ha B1. Again, later depositions should not be excluded. It seems that the harpoon heads with a loop are much younger than the Karaburma-type, which imitate antler harpoons with a line hole, which were earlier: Br D/Ha A1 (Vasić, 2015, pp. 75–76; Tarbay, 2022, p. 338). The Karaburma type may have been preceded by or coexisted with a barbless version that fully imitated the detachable antler harpoon heads. An example of such bronze harpoon heads from the Carpathian Basin is known from the

Koszider Period (MBA, Br B1) hoard from Satu Mare, Romania, near the Maros/Mureş River. This specimen has double spurs and double line holes (Kacsó, 1998, p. 10, Pl. 3.4, 2006, p. 79, fn. 19, Pl. 2.3). We are aware of a similar barbless harpoon sold on eBay a couple of years ago by an illegal metal detectorist, together with other artefacts of Eastern European origin (Fig. 2). Another barbless metal harpoon head with one line hole and one spur of uncertain periodization was found in the Ljubljanica River (Gaspari *et al.*, 2009, pp. 222–223, No. 6).

In the literature, these metal heads are generally interpreted as barbed arrowheads (Kyrle, 1918, p. 55; Lázár, 1943, p. 282; Smrž & Mladý, 1979, pp. 32, 53; zu Erbach, 1986, pp. 173–174; Blažek *et al.*, 1998, pp. 145, 173; Overbeck, 2018, p. 128). The typological characteristics of the studied harpoon heads with a loop (and a spur) indicate that they were rather intended to be 'detachable barbed points' (Ickerodt, 2011, pp. 128–130). The socket cavity is short, like the barbed or barbless variants with line holes. In the case of the unprovenanced harpoon head presented in this paper, the cavity ends roughly at the upper line of the loop (Fig. 3: 1). The small cavity was designed for easy detachment from the so-called foreshaft, which either detaches from the shaft (throwing harpoon) or is permanently fixed to it (thrusting harpoon). In the ethnographic literature, harpoon arrows are also known, which have a similar construction to the above. In my opinion, hafting these heads onto arrows is a possibility, especially for small bronze points like the examples without spurs. The larger variants were probably hafted on throwing harpoons (Mason, 1900, pp. 212, 217–218, Fig. 11, Pl. 3; Gábori, 1950; Banner & Bóna, 1974, p. 148; Jost, 1994, pp. 134–136; Park & Stenton, 1998, pp. 2–4; Ickerodt, 2011, p. 127; Tarbay, 2022, pp. 342–346).

Essentially, the studied harpoons with loops were hafted similarly to the previously introduced types (Tarbay, 2022, pp. 342–346). The difference is in what the harpoon line is attached to. In contrast to the variants with line holes, these bronze harpoon heads are equipped with a cast loop. Socketed axes have loops in the regions where this type of harpoon appears (Mozsolics, 1985, pp. 32–38; Říhovský, 1992, pp. 179–246; Mayer, 1977, pp. 185–201), which aids in the fastening of wooden handles (Kuśnierz, 1998, p. 6, Fig. 5). The idea of adding the loops may have come from the design of socketed axes, but in the case of the harpoons, the loops served a different purpose. It replaced the line holes, but its aim remained the same: to hold the harpoon line.

Based on ethnographic analogues for harpoons, these weapons are generally associated



Figure 2. Looted Bronze Age barbless metal harpoon head with double lines holes and double spurs. The object was sold on eBay around 2013 by a user called "virus 1981". Length: 75 mm, Weight: 25 g. The provenance of the object is 'Noricum' which is probably a falsified one considering the high number of Carpathian objects sold by the user (http://www.ebay.com/itm/261272530706; last accessed: 13:57:42, 1.09.2013, the link is no longer available).

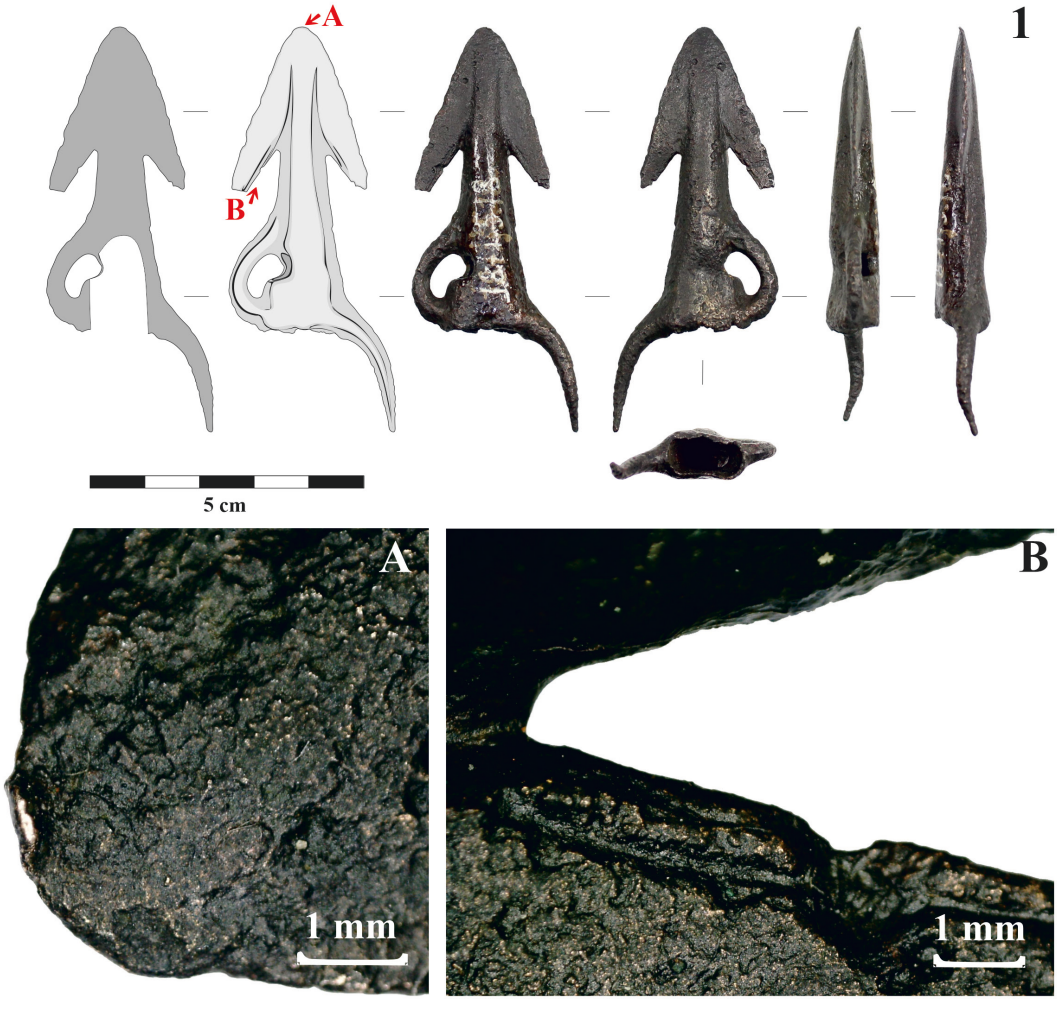


Figure 3. 1. The unprovenanced bronze barbed harpoon head with a spur and a loop from the Prehistoric Collection of the HNM, A. Damage on the tip (origin unknown), B. an impact on the blade (Hungarian National Museum; Prepared by the author).

with the hunting of aquatic mammals, fishes, and terrestrial mammals and birds. Examples of their use as combat weapons are known (Hallam *et al.*, 1973; Hartz *et al.*, 2007, pp. 584–585; Ickerodt, 2011, pp. 114–115, 130–131; Hansen, 2015, pp. 286–287; Maydana, 2020, p. 145). For the version with a line hole, I argued that these bronze tips were mainly used for harpoon fishing in Southeast Europe (Tarbay, 2022). The basis of my argument was the topographical location of the harpoon sites, which were almost always located in the immediate vicinity of large rivers (e.g., Danube, Tisza). In one case, two specimens were also found in such a river: Belgrade-Zemun (Vasić,

2015, p. 76, Pl. 18.376–377). Some of the barbed tips with loops and a spur also show a similar distribution: Werfen – River Salzach, Prag-Vokovice – River Vlatava, and Rannarield – River Danube (Richlý, 1894, pp. 168–169; Kyrle, 1918, pp. 44, 55; zu Erbach, 1986, pp. 173–174, 1989, p. 92; Blažek *et al.,* 1998, pp. 55, 173). As in the case of the harpoon heads with line holes, the topographical position of the objects may reveal some data on these finds. The Rannariedl find was found near the "*Fischerhäusl*" 80 cm from the bank of the Danube (zu Erbach, 1986, p. 173). However, most of the artefacts, which consist mainly of moulds, were not found in wetland areas or near larger rivers. Settlements are the context of these objects: e.g., Zlín-Malenovice (Czech Republic), Celldömölk-Ság-hegy, Velem-Szent Vid, Gór-Kápolnadomb (Hungary). In these cases, it is obvious that the location of the finds probably reflects the place of making and not the place of use. During the Late Bronze Age, at least in the territory of the Transdanubian Urnfield culture, intensive metalworking activity could be observed within or in the close vicinity of settlements. This is particularly well known and recorded in the case of central sites like Celldömölk-Ság-hegy or Velem-Szent Vid (Miske, 1907; Tompa, 1927; Lázár, 1943; Ilon, 2022, p. 145). In light of the above, I consider it probable, not excluding other possibilities, that the bronze heads in question were used as harpoons in a wetland environment. Their production in Transdanubia was done in central sites where other tools, weapons, and ornaments were produced.

3. Negatives

No petrological analysis of harpoon moulds can be found in the literature. Most studies describe the raw material as sandstone, which is relatively easy to identify macroscopically: Gór-Kápolnadomb, Celldömölk-Ság-hegy, Zlín-Malenovice (see Lázár, 1943, p. 280; T. Biró, 1995, p. 53, Fig. 6; Říhovský, 1996, p. 128). It is also possible that the moulds for these fishing-hunting tools could have been made in other materials (soapstone, slate, ceramic) or using different casting techniques (sand casting, lost-wax casting). Below, we will focus on the archaeologically tangible version: two-piece stone casting moulds with two negatives and a casting core. The moulds are made from blocks of stone roughly shaped into a square. The way they are worked is determined by the type of material. Sandstones are difficult to work with metal tools (saws, chisels) because they deform easily. The stone is typically best shaped by itself or by a more resistant stone like basalt, etc. During the grinding process, surface irregularities can be smoothed away, and then completely smooth mould surfaces can be formed, into which the gating system and the negative of the objects to be cast can be carved. The negatives can be formed by using tools or by placing small blocks of sandstone. The design of the negatives of the harpoon moulds what we can now most meaningfully comment on as parallels, which can be studied mainly based on the literature.

The preserved casting moulds suggest that metalworkers followed different schemes to make the negatives of the harpoons and their gating system. The bronze artefact, made in the casting mould from Celldömölk-Ság-hegy, was cast in an "upside-down" position. The wide, conical-shaped pouring cup was placed on the rim of the harpoon negative. The casting core was fitted into it. The mould from Zlín-Malenovice is a special case. Based on the published illustration, our opinion is relatively limited. This object could be cast from the direction of the tip, where one can observe a conical-shaped pouring cup, from the rim part where the casting core is inserted, or perhaps even from the riser, which terminates right below the negative of the spur. In all three cases, a third, smooth-surfaced mould part is required, which is placed under the narrow side of

the mould to seal the opening(s) during the casting process (Říhovský, 1996, Pl. 27.433). Another example is the casting mould from the Špičák Mountain in Mikulovice. In this case, the bronze artefact is cast "upside down" in the same way as the piece from Celldömölk-Ság-hegy, but the gating system is completely different. This is a casting mould with a fixed closed core inside the two mould halves. The pouring cup was placed on one of the extended barbs and the spur. The craftsman also placed a riser right below the tip (Smrž & Mladý 1979, pp. 32, 53, Fig. 4.1). The casting moulds from Velem-Szent Vid, Gór-Kápolnadomb and Prague-Vokovice are evidence for another gating system. The Velem-Szent Vid mould had the negatives of two harpoons carved on it and could be cast simultaneously through a simpler casting tree with branches ending in barbs and spurs. This solution reminds me of the mould from Špičák Mountain in Mikulovice (Tompa, 1927, Fig. 5a–b; Miske, 1929, Fig. 7.2a–b; Smrž & Mladý, 1979, Fig. 4.1). Prague-Vokovice has a simplified version of this solution. The pouring cup ends in two canals leading to the two head negatives. During the post-casting treatment phase, these may have been removed or formed into spurs by hammering (Richlý, 1894, pp. 168–169, Pl. 40.2a). The construction of the Reisbürg mould is somewhat similar. There is a difference between the two in that one barb of the harpoon negatives is connected to the canals (Overbeck, 2018, Pl. 24.42). In the Gór-Kápolnadomb casting mould, three weapons could be cast. The pouring cup was placed on the tip of the negatives. It is very likely that a third, smooth-surface mould was placed under the narrow side of the mould, sealing the casting cores inside the mould (Ilon, 1992, Fig. 6.3, 1996, Pl. 2.9). The mould from Landshut followed a similar concept. In this mould, two harpoons could be cast simultaneously through a pouring cup placed on their tips (Overbeck, 2018, Pl. 24.40).

As previously stated, the moulds were supplemented with a casting core. Some hypotheses were raised about the way casting cores are inserted into harpoon moulds. At the same time, the exact shape and construction of the casting cores in the case of harpoons are not known at all, neither from Hungary nor from west-central Europe. The casting cores that have been found at the Celldömölk-Ság-hegy site were probably used to make larger objects such as socketed axes (Lázár, 1943, Pl. 7.69–74). These are relatively simple versions, with a thickened head and a channel on the side of the core through which the metal could flow into the mould. Further grooves could also be added to the pouring cup part of the mould (Wanzek, 1989, Fig. 5.8). A smaller version of these casting cores could be a fine choice to make harpoons as well.

The production of the metal heads after casting is not very different from that of harpoons, arrowheads, and spearheads of similar construction. The metalworker removes the casting jet, which is probably broken off while still hot or cut off with an edged tool like a chisel or an axe. Risers on the casting are treated similarly. If the casting jet is the same as the spur, then this process is done more carefully, and further hammering is done on the spur part. They may remove the casting seams on the sides of the objects to make these parts smooth. The final stages of post-casting treatment involve hammering out the edges and sharpening them. These hammering marks can be observed on the harpoon head of unknown provenance from the Prehistoric Collection of the Hungarian National Museum (Fig. 3: A). If necessary, the spur can also be shaped by further hammering. The casting surface is ground using various stones, for which process even sandstone may be suitable in principle. The finished product can be used and mounted on a throwing or thrusting harpoon. Smaller versions can be attached as harpoon arrowheads. The maintenance of this

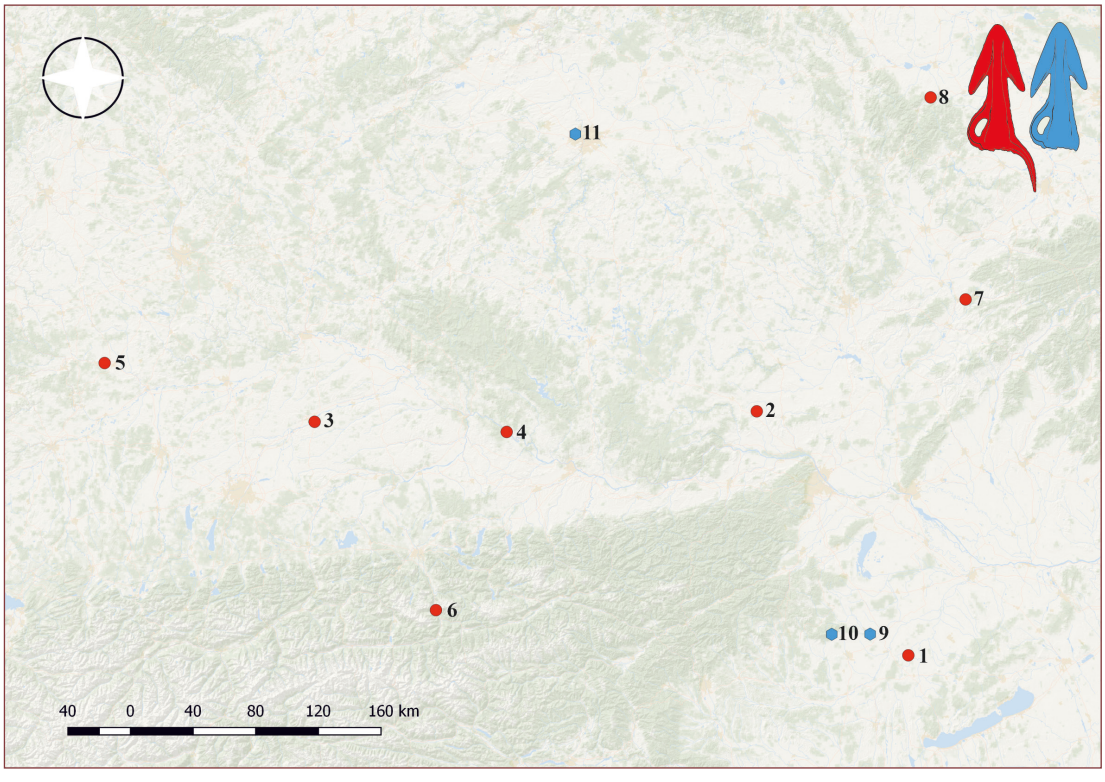


Figure 4. Distribution of barbed, detachable harpoon heads with loops. Red circle: harpoon heads with a spur, Blue hexagon without spur: 1. Celldömölk-Ság-hegy, 2. Heidenstadt bei Limberg (Maissau), 3. Höglberg in Landshut, 4. Rannarield, 5. Goldberg at Riesbürg, 6. Werfen, 7. Zlín-Malenovice, 8. Špičák Mountain in Mikulovice, 9. Gór-Kápolnadomb, 10. Velem-Szent Vid, 11. Prague-Vokovice. Prepared by the author.

fishing and hunting weapon does not require any special care. Cyclic hammering and resharpening of the cutting edges are sufficient. Even in the event of major damage, the cutting edges can be reshaped by these techniques.

4. Conclusions

In contrast to the Karaburma-type dated to Br D/Ha A1, the two variants (Variant 1: with spur, Variant 2: without spur) of the Mikulovice type (detachable harpoon heads with a loop) presented in this study seem to be mainly characteristic of the second half of the Late Bronze Age. This dating is supported by the Ha B1 dating of the Špičák Mountain in Mikulovice as proposed by Jan Blažek, Michal Ernée and Lubor Smejtek (Blažek *et al.*, 1998, pp. 54–55, 145, Pl. 16A.31). For the second variant, the radiocarbon dates correlated with Ha B1 from the Gór-Kápolnadomb are decisive: 1032–928 Cal. BC (Ilon, 1992, p. 244, Fig. 6.3, 1996, p. 177, Pl. 2.9; Sperber, 2017, pp. 299–300).

On the other hand, the fact that these artefacts, including the Celldömölk-Ság-hegy mould discussed in the paper, come from a Late Urnfield settlement suggests that some specimens can be younger than the Ha B1. In the latter case, several of the metal finds and hoards dated to Ha B2 by Amália Mozsolics are well known to research

(Mozsolics, 1974, 2000, pp. 37–39). Therefore, it cannot be excluded that these fishing-hunting tools were still present in Ha B2. This possibility should also be left open since a significant number of the Mikulovice-type representatives do not come from archaeological contexts of dating value. The type in question could have been primarily a Central-Western European fishing-hunting tool that appears to have also been made in Transdanubia based on mould finds. We know of such objects outside the Transdanubian region (Celldömölk-Ság-hegy, Gór-Kápolnadomb, Velem-Szent Vid) in Austria (Heidenstadt bei Limberg, Rannariedl, Werfen), in the Czech Republic (Prague-Vokovice, Špičák Mountain in Mikulovice, Zlín-Malenovice) and Germany (Goldberg at Riesbürg, Höglberg in Landshut) (Fig. 4). The distribution of similar finds points primarily towards the Urnfield culture and more closely related regions and cultural groups.

The Mikulovice-type harpoons are essentially like the earlier-described Karaburma-type. The main difference between them is that the Mikulovice type has a loop instead of a line hole, an idea probably borrowed from the local socketed axes by the Bronze Age metalworkers. The importance of this type is that, unlike the Karaburma-type from the eastern Carpathian Basin and the Lower Danube, many moulds of this type are known, which provides a more solid background for the reconstruction of the casting technology. Specifically, gating systems, pouring cups, and multiple casting. They were made in two-piece moulds with two negatives and a casting core. These moulds were designed differently by local metalworkers. The casting technology of the Mikulovice-type harpoon heads is not standard, although there are similarities. Some mould designs follow the same logic, but each metalworker strives for uniqueness. These individual solutions reflect a personal experiential way of thinking about how to cast the desired shape of the object most efficiently and successfully and then finish it in a relatively convenient way during the post-casting treatment phase. These individual solutions can be understood by examining the negatives of moulds that give information on the direction of casting, the design of the gating system, the use of risers, or the connection of the spurs to the pouring cups.

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Appendix – Description of objects

1) Harpoon casting mould from Celldömölk-Ság-hegy (HNM, Inv. No. 1949.23.14): Casting mould of a large, barbed arrowhead with a loop and spike. The mould is rectangular, and it has a slightly conical pouring coup. Dimensions of the mould: 63.59×93.10 mm. Width (narrow sides): 26.15×91.88 mm, 24.89×89.60 mm, weight: 247.2 g. Harpoon head negative, total length: 63.56 mm, length (without spur): 45.32 mm, width (b): 30.20 mm. Observations: burnt surface, possible traces of invasive sampling, scratches (Fig. 1).

2) Unprovenanced harpoon (HNM, Inv. No. 1871.5.18): Large barbed arrowhead with a loop and a spike. Its blade is hammered and sharpened; the tip and one of its barbs are damaged. Length: 75.25 mm, length (without spur): 55.89 mm, width (rim): 9.40×23.18 mm, width (blade/mid-rib): 24.56×7.84 mm, thickness (blade): 2.67 mm, weight: 22.4 g. Observations: incomplete defect (socket), casting seams, hammered cutting edge, bent tip, tip damage, crushed socket (Fig. 3).

3) Looted barbless harpoon (Looted, eBay) Looted Late Bronze Age barbless metal harpoon head with double lines holes and double spurs. The object was sold on eBay around 2013 by a user called “virus 1981”. Length: 75 mm, weight: 25 g. The provenance of the object is ‘Noricum’ which is probably a falsified one considering the high number of Carpathian objects sold by the user (http://www.ebay.com/itm/261272530706; last accessed: 13:57:42, 1.09.2013, the link is no longer available) (Fig. 2).



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