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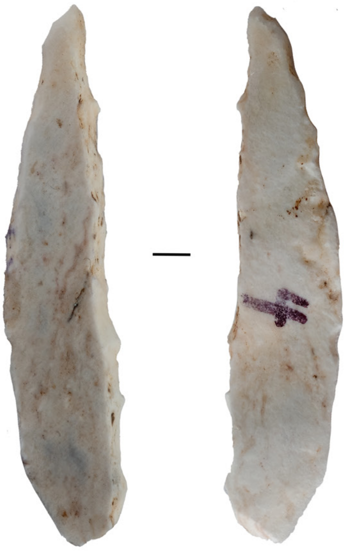

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RESEARCH ARTICLE

Stone assemblages from the surroundings of Tennant Creek (Northern Territory, Australia) Part II. Macrolithic and edge-ground tools

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Abstract

A large part of the Australian collection of the Hungarian Museum of Ethnography in Budapest, 766 stone artefacts altogether, was donated in November 1977 by László Pintér, a Hungarian citizen who had immigrated from his hometown Tata to Sydney. The stone artefacts have been processed by the author. The results of the processing are presented in two parts. This first part contains the description of the 731 flaked stone artefacts, while the planned second part will describe 15, partly macrolithic, partly edge-ground artefacts. Twenty artefacts will not be described. Most of these are grinding, polishing and smoothing stones with macroscopically undefined functions, for which only a formal description would be possible. In addition to the descriptions of the finds, the papers include detailed descriptions of specific Australian stone tools, based on the available archaeological and ethnographic literature. For the first part of the study, see Péntek (2021)

Keywords

Australia, Northern Territory, macrolithic and edge-ground tools, Warramunga and Walbiri tribes, Museum of Ethnography in Budapest

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"Sometimes you gotta run before you can walk."
~ Tony Stark (Iron Man)

1. Introduction

In the previous paper, the flaked stone assemblage of the Hungarian Museum of Ethnography from Pintér's collection has been reviewed. In this paper, the 15 grinding, polishing and smoothing stone tools from the same collection will be described. These tools have macroscopically undefined functions, for that very reason, only a formal description would be possible. The likely most complete ethnographic record of the northern tribes of Central Australia, especially the Warumungu people is in the works of Spencer & Gillen (1904; 1912, 364–439) can be found. There are relatively much comparative data on these types of tools.

2. Australian macrolithic tools

The study of Valoch (1979, 144–149) also contains a type list of 19 groups for macrolithic tools based on morphological and technological criteria. Large unifacial and bifacial coroid implements are well known in Australia. McCarthy and colleagues (1967[1946], 13) gave a general definition of the *uniface coroids*, which are "*irregular pebbles, nodules or lumps of stone trimmed or untrimmed all round the margin, and the lower face is usually of cortex.*" Norman B. Tindale (1937; 1957; McCarthy 1943b) named a stone industry on Kangaroo Island (South Australia) "Kartan", after the name given to the island by the Aboriginals. The Kartan industry consists almost exclusively of large core tools, unifacially flaked pebble tools and hammerstones (see, for example, Lampert 1980; 1981a; 1981b). The tools are heavy, averaging around 900 grams. Some of the heavy tools were described and represented earlier by Tindale and Brian G. Maegraith (1931) from the Hawk's Nest site on Kangaroo Island. Among them, there are large-sized trimmed flakes (see, for example, 1931, 280, Figs. 6-7) and core-like implements as well (1931, 282, Fig. 9). Concerning the trimmed flakes, it was uncertain in what manner these expedient tools were employed, however, it seemed likely that they were general cutting tools.

As an analogy, Tindale and Maegraith (1931, 286–287, Figs. 10–11), referred to a tool "*The árapia of the people of the Iliaura tribe* [or Alyawara; other synonyms are listed in Tindale 1974, 226 with numerous ethnographic references)]*, Central Australia, which is a similar implement, functions as a hand-chopper or cleaver, and is used without any handle, in the rough trimming of wood, and in the removal of bark from gum trees.*" McCarthy and colleagues (1967[1946], 13) considered that "*The uniface pebble implements form a specialized sub-group. These comprise the semi-uniface kinds which are trimmed either at one end, end and lateral margin, or end and both lateral margins, and the uniface or* Sumatra-*type. Their uses appear to have been chopping and scraping, although some bear signs of percussion on the edges and sometimes the surfaces. The Sumatra-type (Fig. 21) is trimmed all over its upper surface, which is generally convex, and the margins show signs of use at various points.*" (see also McCarthy 1941a) The uniface pebble implements occur chiefly in the eastern and coastal parts of south-eastern Australia, as far west as Kangaroo Island. On the other hand, in Queensland, at Point Cartwright, similar heavy tools appear to be present ("Sumatra implements", Jackson 1939, 290–293, Figs. 1–3) as well.

McCarthy and colleagues (1967[1946], 15) defined the *bifacial coroids* as follows:

"*Biface coroids are nodules, pebbles or lumps of stone either partly or wholly trimmed on both surfaces. The partly trimmed examples are conveniently termed semi-bifaces. The larger examples are apparently hand-axes and choppers, but there are scraping and cutting implements, or edges used for these purposes, on implements among the bifaces coroids of both small and large size. Cleavers may also occur, but have not yet been specifically determined. Many biface coroids are blanks and rejects prepared during the making of edge-ground axe-heads and adze-heads. In shape specimens in this subgroup vary from ovate to discoidal, cordiform to rectangular, and irregular forms common. An interesting series of flint biface coroids (Fig. 24) occurs in the Mt. Gambier district of South Australia (McCarthy, 1940, A, Mitchell, 1943) which have been termed Buandik bifaces by Campbell (1934), the name Buandik being that of a tribe in whose territory the implements are found. The term is appropriate and should be retained.*"

The well-stratified "Gambieran" assemblage at the Koongina Cave in Lower Southeast of South Australia confirmed that the Gambieran industry is Late Pleistocene/Early Holocene in age (Bird & Frankel 2001; Frankel 1986; 1989).

It was McCarthy (1941a; 1941b) who first drew attention to the possible Hoabinhian parallel concerning the South Australian macrolithic tools. Based on the paper of Madeleine Colani (1927), the Hoabinhian is divided into three sub-stages; the Hoabinhian I contains flaked implements only, rather large and crude (Matthews 1964, 1). According to the interpretation of McCarthy, Hoabinhian I consists of two hand axes: the *sumatra* (Sumatra-type, Sumatra implement, Sumatralith; see above) is a pebble chipped on one surface only, and the *karta* (the index fossil of the above-mentioned Kartan industry) is a split pebble chipped on the crust surface only. In Hoabinhian II the pebble hand axes are prepared on both surfaces, and the majority of them have a ground-edge blade. McCarthy suggested that sites in New South Wales, such as Yamba Head and Crescent Head contain Hoabinhian collections.

J. M. Matthews (1964; 1968) investigated the Hoabinhian affinities of some South Australian collections. Among the examined collections, there were two samples of Kartan collections, one from the Kangaroo Island, the other from the Wakefield River; pebble tools from Yamba Head and the Seelands rock shelter (in the Clarence Valley, west of Grafton; McBryde 1962). Additionally, a sample from the Sai Yok site in Thailand was taken. The samples were compared in terms of various parameters, such as maximum length, breadth, thickness, weight and length/breadth index. The most obtuse angle presented by the cutting edge was measured as well. An observation was made of the nature of the junction between the upper and lower faces of the artefacts, whether either or both were flaked or cortex covered. The comparison concluded that the Kangaroo Island sample is distinct from the others; the pebble tools of the north coast sites of Yamba Head and Seelands showed closer affinities to the distant Hoabinhian site of Sai Yok. Matthews also exposed the problems of Colani's typology. He aimed to determine if Colani's Hoabinhian types could be defined as clusters of constantly recurring morphometric attributes and cortex amount and distribution. The classification of Colani had been found unsatisfactory and Matthews found that Hoabinhian types did not exist; instead, Hoabinhian artefacts reflect a continuous range of shapes and sizes. Chester Gorman (1970) listed the main attributes used to link several sites from North Vietnam to Sumatra under the general term Hoabinhian. Among these attributes, Gorman mentioned core tools ("Sumatraliths") made by complete flaking on one side of a pebble. The radiocarbon dates, obtained by Gorman (1970, 99, Table 2) at Spirit Cave (Northwest Thailand) place Hoabinhian levels between 12,000 and 8,000 BP. However, since the excavation of Gorman, there are several more recently gained radiocarbon dates, indicating a much older age of the Hoabinhian (see, for example, Ji et al 2015; Moser 2012, 8–9; Yi et al. 2008).

Isabel McBryde (1976), working on Seelands (mid-north coast of New South Wales) industries, also found elements that seemed to be features of the Hoabinhian industries. These are the association of the unifacial pebble tools with edge-ground tools; the association with bifacially flaked pebble tools and the presence of truncated pebble tools. In Southeast Asia, there are references also to bifaces hand-axes (see, for example, Matthews 1964) and oval-shaped tools, which are similar to Valoch's macrolithic types *7* and *8*.

Although the Hoabinhian industry claimed firstly the attention of McCarthy (1941a) because in his opinion it was the earliest known link between Australia, Malaysia and Southeast Asia, in other parts of Australia, macrolithic tools, especially pebble tools seem to be discussed only rarely in connection with the Hoabinhian industry. In his paper, Valoch (1979, 155) stated that if the hypothesis of a direct Hoabinhian tradition in Australia will be rejected, it must be presumed that the Australian pebble tools developed independently and convergently from older roots of similar technology. Valoch mentioned also that concerning the spread of Hoabinhian in Indonesia, the transfer of a stimulus from this region seems fairly likely.

Sandra Bowdler (1994, 91), in her retrospective review on the Hoabinhian in Australia, alluded to the occurrence of "pebble edge tools" in New Guinea highlands, which had been excavated at least from three rock shelters in this region and dated to ca. 10,000 BP (Bulmer 1964, 256–258; Bulmer & Bulmer 1964, 59, 67; Bulmer 1975; White 1972). As regards Australia, she wrote: "*In Australia itself, it would appear that no pebble edge tools are known from the arid interior, the Northern Territory, North Queensland, or New South Wales west of the mountains, from either stratified or unstratified locations.*" Concerning the peculiar distribution of Hoabinhian artefacts in Australia (in the southeast, and possibly southwest) she wrote: "*It does not seem to be the case that they represent some sort of earlier 'stratum' of occupation later overlain other cultural manifestations, as they have not been found in any archaeological context of any age at all in northern Australia.*" Bowdler claimed that the morphometrical and technological similarities between Pleistocene artefacts from Australia and mainland Southeast Asia may indicate a diffusion of technology or activities requiring a certain kind of technology across Southeast Asia and Australia during the Pleistocene (Marwick 2008, 10).

3. Australian edge-ground implements

According to the classification of McCarthy and colleagues (1967 [1946], 44), the major sub-groups of edge-ground implements are the axe-heads, adze heads, scraper knives, chisels and alien forms. Most of these implements are coroids, which were made on pebbles, raw material nodules or lumps; others were made from knapped, flaked pieces. It is quite problematic to distinguish the sharp boundaries between the different types. Therefore, the classification included the edge-ground, semi-ground or polished, and the fully grounded or polished implements should any or all of them occur in any type. From a technological point of view, the axe heads show great diversity. Many of those "*show signs of battering and percussion on their lateral margins, on the butt, and on the upper and lower surfaces; the butt end especially exhibits frequent use as a hammerstone, and on the surfaces percussive pits due to anvil use are frequently observed on these implements.*"

Based on the numerous cited ethnographic literature, the axe heads (sometimes referred to as axes, tomahawks or hatchets) were widespread throughout the Australian continent. (see, for example, Basedow 1925, 362–363; Horne & Aiston 1924, 99–100, Fig. 75; Spencer 1922, 75–76, 83–86, Plate 15, Figs. 157–158; Spencer & Gillen 1899, 588–590; Tylor 1895).

Spencer and Gillen (1899, 588–590), among the native tribes of Central Australia, identified and described two different types of stone axes or hatchets. In the assemblage from Tennant Creek, there are three undamaged specimens, which are from a morphological point of view very similar to the first type, which "*has the form of a flattened, usually oval, pebble of diorite, one edge of which is rounded and ground down, the pebble is then fixed into a wooden handle. This form is known by the name of Illupa, and is, or was made by the Arunta, Kaitish, Warramunga* (emphasis by the authors of this paper)*, and other tribes living to the* *north.*" Spencer and Gillen described the method of fixing the axe into the handle and gave some measures as well. The dimensions of a hafted example are "*the total length of the stone is 12 cm, the width 9 cm, and the greatest thickness 2.2 cm.*" Two unmounted ground stones measure in greatest length 18 and 14 cm, in width 8.5 and 11.4 cm, and thickness 4 and 3.5 cm respectively.

Spencer and Gillen (1912, 368–370, Figs. 208–210) also described the manufacturing process of the ground stone axes among the Warramunga people. They referred to the fact that the ground axes were much less common than flaked implements. The cause was that suitable raw material for making ground axes is only found in relatively few spots in Central Australia. At the same time, quartzite - which can be easily flaked and chipped, but not grounded – is very widely distributed.

From the relevant archaeological papers on the different aspects of edge-ground implements, here is a non-exhaustive list. The papers of Tugby (1958), Dickson (1976; 1980), and Dibden (1996) deal with the technology, design and manufacturing of groundstone tools. Brzezicki (2015) devoted his unpublished thesis to the linkage between artefact morphology, hafting and tool function. Dubreuil *et al.* (2015) discussed the issue of the use-wear study of ground stone tools. Some authors deal with the spatial occurrences of groundstone tools (Davidson 1938; Corkill 2005; Ulm *et al.* 2005; Attenbrow *et al.* 2012). As regards the pattern of trade and exchange, Turpin (1983) dealt with the social and economic significance of the movement of stone edge-ground hatchets in Australia; Walker (2016) made also non-destructive X-ray Fluorescence (pXRF) analysis to determine the provenance of the used raw materials of 242 hatchets found in southeast South Australia. Geneste *et al.* (2010; 2012) reported the evidence of the earliest securely dated fragment ground edge to implement in the world from Nawarla Gabarnmang, Arnhem Land. Hiscock *et al.* (2016) reviewed the world's earliest ground-edge axe fragment from the Carpenter Gap in the Kimberley region of Western Australia.

Since groundstone tools are an ill-defined group of archaeological artefacts, reflecting a variety of functions, the paper of Rosenberg *et al.* (2016) deserves special attention, which dealt not only with the possible area of usage and function of these artefacts but with the perspectives of the future research.

4. Raw material utilisation

The used raw materials of the assemblage containing altogether nine macrolithic and six edge-ground implements can be classified as follows.

4.1. Raw material class 1 (RMC-1A and RMC-1B)

This class contains igneous rocks (volcanites).

A) Intrusive (or *plutonic*) igneous rocks are formed by slow and gradual cooling and crystallisation of minerals from magma inside the Earth, i.e. deeper below the surface. Among the most common intrusive igneous rocks, there are the *diorites* from the intermediate group and the *gabbro* from the mafic group (Haldar & Tišljar 2014, 94, 104–120, (Chapter 4 Igneous Rocks)).

B) Extrusive igneous rocks are formed at the crust's surface as a result of the partial melting of rocks within the mantle and crust. The molten rocks, with or without suspended crystals and gas bubbles, erupt outside the crust due to lower density and spread as lava. The rocks cool and solidify very quickly and are fine-grained in general. The most common extrusive igneous rocks are rhyolite and dacite (felsic; rocks, which are rich in elements that form feldspar and quartz), *andesite* and trachyte (intermediate), *basalt* and diabase (mafic; rocks, dominated by silicates rich in magnesium and ferric oxides, giving the rocks their characteristic dark colour) and spilite (plagioclase-rich rocks occur in changes and albitization of basalt) (Haldar & Tišljar 2014, 94, 116–120, (Chapter 4 Igneous Rocks)).

4.2. Raw material class 2 (RMC-2)

This class contains several clastic (detrital and mechanical) sediments and sedimentary rocks, which are composed of particles, grains and fragments that resulted from physical and chemical weathering. Macroscopically, without having a good deal of experience, the different types are hardly distinguishable. *Shales* are thinly laminated fine-grained pelite (clayey fine-grained clastic sediment or sedimentary rock) clastic rock composed predominantly of siliciclastic materials. Shales can be grouped as clay and mud shale based on the mutual shares of particles of (clay and powder). *Mudstones* (or poorly lithified *argillites*) are, unlike the shale, homogeneous, solid lithified rocks that contain a mixture of particles (clays and powder. *Sandstones* are divided into two main groups that are based on the relative content of grain sizes of sand and mud matrix. Pure sandstones or arenites are classified into various types according to the proportion of the major components of quartz, feldspar and rock fragments (Haldar & Tišljar 2014, 145–162 (Chapter 5 Sedimentary Rocks)).

As regards the raw material utilisation of the assemblage, among the nine macrolithic tools the raw materials of the RMC-1 raw material class have a clear dominance. Four specimens were made of fine-grained gabbro (RMC-1A); two specimens were made of gabbro (RMC-1A); one was made of diorite (RMC-1A) and one of each was made of andesite and porphyritic andesite (RMC-1B). And similarly, the RMC-1 raw material class dominates also among the six edge-ground implements. Each of the two specimens was made of fine-grained gabbro (RMC-1A) and fine-grained andesite (RMC-1A). A single specimen was made of fine-grained sandstone (RMC-2) and there is a single specimen, which was made of mudstone (RMC-2).

5. Description of the assemblage

5.1. The macrolithic tools

In Fig. 1, there is a large-sized tool, made on an approximately circular flake or a raw material piece with a bi-convex cross-section. It has a supposed "base" of 76 × 25 mm size, but no bulb is visible. On both faces, there are reddish iron oxide deposits. On the lower face, some thinning detachment along the perimeter can be seen. On the upper face, there are traces of several centripetal removals. Except for the "base", the entire rim of the instrument is rather roughly, bifacially elaborated. The raw material is fine-grained gabbro (RMC-1A). The dimensions are 124.6 × 126.4 × 43.8 mm. The weight is 902.0 g.

In Fig. 2, there is a large-sized tool, made on an approximately circular flake or a raw material piece with a plano-convex cross-section. On the upper face, a reddish iron oxide deposit is visible. On the lower face, there is a large thinning removal; no bulb is visible. The upper face is unworked. The entire rim is bifacially elaborated. The raw material is fine-grained gabbro (RMC-1A). The dimensions are 122.6 × 118.7 × 40.1 mm. The weight is 740.0 g.

In Fig. 3, there is a large-sized tool, made on an approximately circular flake or a raw material piece with an asymmetric bi-convex cross-section. On the upper face, a reddish iron oxide deposit is visible. On the lower face, along the perimeter, there are sporadic thinning removals; no bulb is visible. On the upper face, there are some centripetal removals. The entire rim is roughly, bifacially elaborated. The raw material is coarse-grained diorite (RMC-1A). The dimensions are 126.3 × 112.9 × 48.1 mm. The weight is 904.0 g.

In Fig. 4, there is a large-sized tool, made on an elongated ellipsoid flake with a plano-convex/ bi-convex cross-section. On the greater part of the eroded upper face and the lower face, reddish iron oxide deposits are visible. The left side of the tool has an irregular form. The lower face is unworked and no bulb is visible. Except for one removal on the left side, the upper face is also unworked. The entire rim is roughly made, with short removals directly, and unifacially elaborated. The raw material is fine-grained gabbro (RMC-1A). The dimensions are 130.5 × 113.9 × 47.2 mm. The weight is 978.0 g.

In Fig. 5, there is a large-sized tool, made on an approximately circular pebble with a bi-convex cross-section. On the upper face, a reddish iron oxide deposit is visible. Both faces are unworked. The entire rim is roughly, bifacially elaborated. The raw material is fine-grained gabbro (RMC-1A). The dimensions are 96.8 × 90.2 × 31.7 mm. The weight is 416.0 g.

In Fig. 6, there is a large-sized tool, made on a flake of irregular form and plano-convex cross-section. On the upper face, along the edge, a reddish iron oxide deposit is visible. The lower face is unworked; the bulb is flat and diffuse. The butt of the flake is 80 × 16.6 mm. The upper face is partly the eroded outer surface and there are some rather fresh, unpatinated removals.

The distal end is unifacially elaborated with steeped retouch creating an approximately 50 mm long working edge. The raw material is porphyritic andesite (RMC-2). The dimensions are 96.2 × 97.3 × 38.7 mm. The weight is 457.0 g.

In Fig. 7, there is a large-sized tool, made on a pebble of ovaloid form and plano-convex/asymmetrical bi-convex cross-section. On both faces are reddish iron oxide deposits visible. On one end, there is a straight-lined unifacially elaborated 57.5 mm long working edge.

The heavily eroded faces are unworked. The lateral edges are roughly, bifacially elaborated with short removals. The raw material is very fine-grained andesite (RMC-2). The dimensions are 112.5 × 89.1 × 43.6 mm. The weight is 627.0 g.

In Fig. 11: 2, there is a large-sized unworked tabular raw material piece of irregular form and asymmetrical plano-convex cross-section. On the convex face, a reddish iron oxide deposit is visible. The

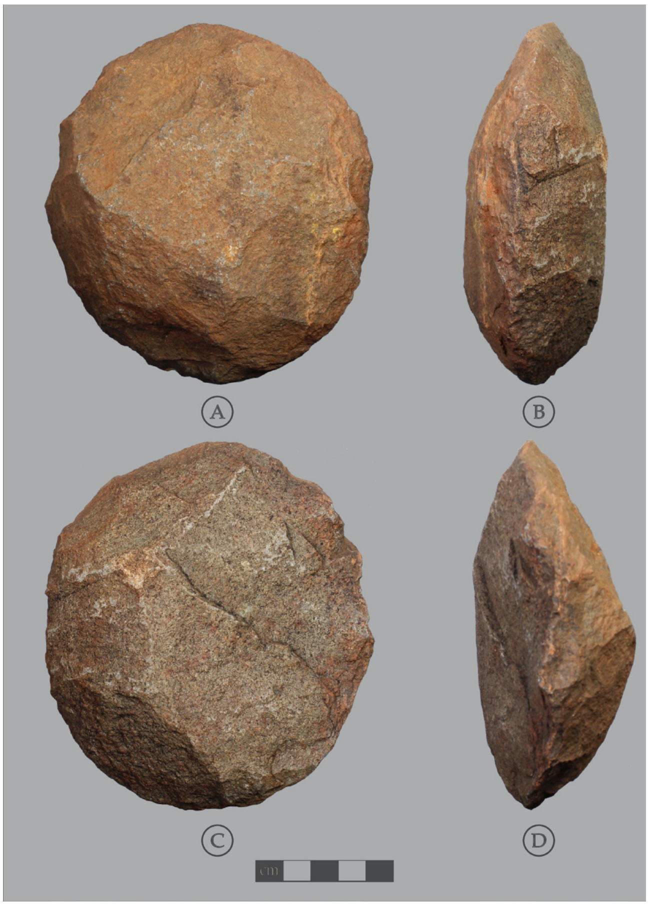

Figure 1 (upper left)**.** Macrolithic tool. **Figure 2** (upper right). Macrolithic tool. **Figure 3** (lower left) Macrolithic tool. **Figure 4** (lower right) Macrolithic tool. Figures: Attila Péntek, by courtesy of the Ethnographic Museum in Budapest, Hungary.

raw material is gabbro (RMC-1A). The dimensions are 106.7 × 71.6 × 44.3 mm. The weight is 435.0 g.

There is a large-sized ovaloid raw material piece with an asymmetrical plano-convex cross-section. On both faces reddish iron oxide deposits are visible. The heavily eroded faces are unworked. Along the rim, there are some rough, indefinite, uncertain removals. The raw material is gabbro (RMC-1A). The dimensions are 124.0 × 91.8 × 38.5 mm. The weight is 618.0 g.

5.2. The edge-ground implements

In Fig. 8, there is a single bevelled axe made on a large-sized pebble of ovaloid form with an elliptical (lenticular) cross-section. The 62.6 mm long working edge (cutting and/or splitting edge) is slightly curved and in side-view, it is aligned with the longitudinal axis. The extension of the polished surface is asymmetrical; its width on the upper face is 28.0-35.0 mm, and on the lower face it is about 23.0 mm. On the working edge, no traces of working activity (chips or pittings) are observable. On the heavily worn butt of the axe, on an area of about 37.5 × 19.0 mm, there are traces of intensive battering/hammering activity. On the entire surface of the tool, there are several signs of weather-beaten mechanical damage (mostly small breakages). The raw material is fine-grained gabbro (RMC-1A). The dimensions are 108.5 × 86.9 × 37.4 mm. The weight is 560.0 g.

In Fig. 9, there is a single bevelled axe made on a large-sized pebble of irregular form and wedge-like cross-section. The 60.7 mm long working edge (cutting and/or splitting edge) is straight-lined and in side-view, it is asymmetrical to the longitudinal axis. Its lower corner and the lower edge of the axe are damaged. The width of the working edge on the upper face is about 25.0 mm and on the lower face between 19.0 and 39.0 mm. On the working edge, no traces of working activity (chips or pittings) are observable. On the butt of the axe, on a circular sector area of about 41.5 × 26.5 mm, there are traces of intensive battering/hammering activity. On the entire surface of the tool, there are several signs of weathered mechanical damage (mostly small breakages). The raw material is fine-grained andesite (RMC-1B). The dimensions are 90.8 × 76.0 × 43.8 mm. The weight is 414.0 g.

In Fig. 10: 1, there is the supposed working edge of an axe made on a large-sized pebble of likely sub-circular form and bi-convex cross-section. The butt of the axe was broken long ago, the breakage surface is patinated. On the edge, there are some rough, indefinite removals. Due to intensive working activity, the edge is broken. The heavily weather-beaten faces of the tool are unworked and bear the signs of weathered mechanical damages (mostly small breakages). The raw material is mudstone (RMC-2). The dimensions are 92.7 × 49.2 × 31.8 mm. The weight is 209.0 g.

In Fig. 10: 2, there is the working edge of an axe made on a large-sized pebble with a bi-convex cross-section. The butt of the axe was broken long ago, the breakage surface is patinated. The 59.0 mm long working edge (cutting and/or splitting edge) is straight-lined and in side-view, it is slightly asymmetrical to the longitudinal axis. On the upper face, the lower part of the working edge is damaged. The width of the working edge on the upper face is between 20.0 and 26.0 mm, and on the lower face between 30.0 and 32.0 mm. On the working edge, there are no signs of working activity (chips or pittings). On the surface of the tool, there are several signs of weathered mechanical damage (mostly small breakages). The raw material is fine-grained andesite (RMC-1B). The dimensions are 85.9 × 69.3 × 39.6 mm. The weight is 340.0 g.

In Fig. 11: 1, there is a scraping tool made on a flat flake of irregular form. The upper face of the tool is the patinated outer surface of the raw material; it is covered with a reddish iron oxide deposit. Along the entire edge, rough-and-ready abrupt elaboration is observable. The raw material is fine-grained sandstone (RMC-2). The dimensions are 73.6 × 113.7 × 18.5 mm. The weight is 201.0 g.

And lastly, there is a 57 mm long, curved edge fragment of a cutting and/or splitting tool. The edge fragment has no signs of working activity. The raw material is fine-grained gabbro (RMC-1A). The dimensions are 58.3 × 28.8 × 16.7 mm. The weight is 28.2 g.

6. Discussion and conclusions

In connection with the archaeological evaluation of the assemblage, we can refer primarily to the doctoral thesis of Kenneth J. Mulvaney (1997). The thesis concerned the nature of the production and distribution of prehistoric sandstone artefacts, primarily with those implements used in the milling of seed, produced at the Helen Springs sandstone quarry site named *Kurutiti.* The quarry is situated within the Ashburton Range, on the edge of the Barkly Tablelands, within the Northern Territory, at a distance of 150 km (*ca.* 93.2 mi) from Tennant Creek. Besides a very rich, varied flaked stone assemblage, many bifaces and edge-ground axes, hammerstones and other pebble artefacts were found as well. The

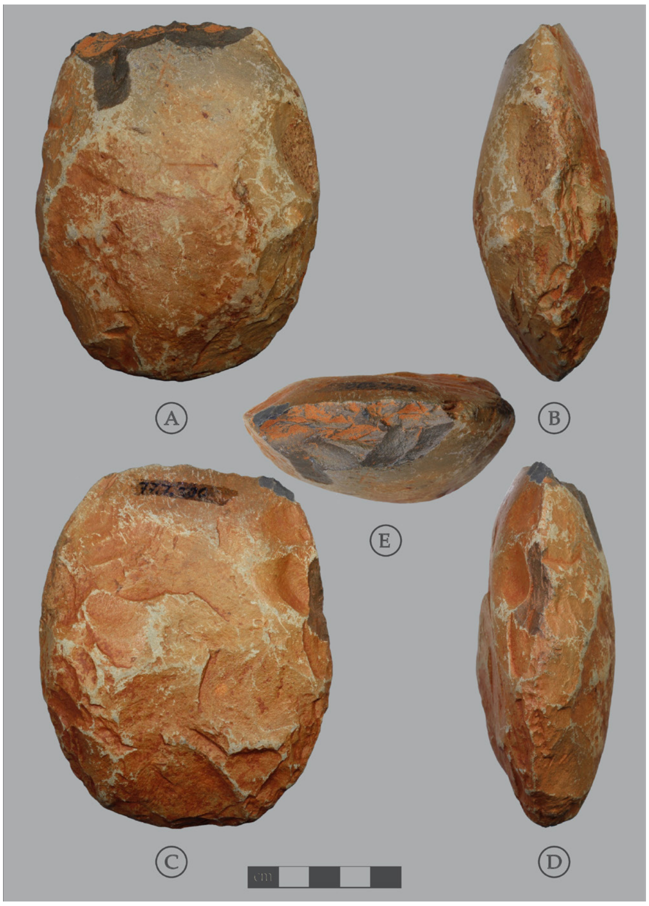

Figure 5 (upper left)**.** Macrolithic tool. **Figure 6** (upper right). Macrolithic tool. **Figure 7** (lower left) Macrolithic tool. **Figure 8** (lower right) Edge-ground tool. Figures: Attila Péntek, by courtesy of the Ethnographic Museum in Budapest, Hungary.

Figure 9 (left)**.** Edge-ground tool. **Figure 10** (right). Edge-ground tool. Figures: Attila Péntek, by courtesy of the Ethnographic Museum in Budapest, Hungary.

15 axes, recorded at *Kurutiti*, were made either of a basaltic rock or dolerite, which are likely to be locally derived and associated with the Lower Cambrian Volcanics that outcrop within the Ashburton Range (Randal & Brown 1969, 11). [Concerning the Pintér's collection, especially as regards the raw material class RMC-1B, it is necessary to be mentioned that the Helen Springs Volcanics have been mapped on the Tennant Creek Sheet area to the south (Ivanac 1954).] In the production of the bifaces and edge-ground axes at *Kurutiti*, large flakes and naturally fractured pieces of stone were utilised. Mulvaney (1997, 101) underlined the fact that "*There is no evidence of hammer-dressing of their flaked surface prior to grinding, as described for the manufacturing process employed by the Warumungu (Spencer and Gillen 1904: 656-659)*." He also noted that the use of relatively unmodified artefacts is in contrast to axes recorded on sites in adjacent areas (see, for example, Smith 1986). Those referenced implements exhibited better symmetry and a greater extent of grinding surface.

Tibbett (2003), dealt with the hammer-dressed stone hatchets in the Lake Eyre Basin. He stated that in the northern regions of the Lake Eyre Basin, there are lower percentages of hammer-dressed stone hatchets compared with the southern regions. In the south of the Lake Eyre Basin, the hammer dressing technique appears to effectively reduce the thickness of the stone hatchet, allowing the resharpening without a marked increase to the edge angles. When working with medium and fine-grained rock (*e.g.* sandstone, basalt or dolerite), the hammer-dressing technique is relatively common as a method of preparing the surface of artefacts to eliminate irregularities.

Spencer & Gillen (1904, 657–658) described the application of this method related to the production of ground edge axes, used by the Warumungu, camped near the Tennant Creek Telegraph Station:

" …*there follows the tedious operation of levelling the surface. For this purpose the operator takes a small rounded pebble of quartzite, and hour after hour, for a day or two in succession, he will patiently hammer away or rather tap at the rough surface, each stroke removing a fragment of the stone, until the whole surface is covered over with minute dents and all of the irregularities are smoothed down. In a well-made axe this operation is performed so thoroughly that all traces of the first made, rough flaking are removed.*
…

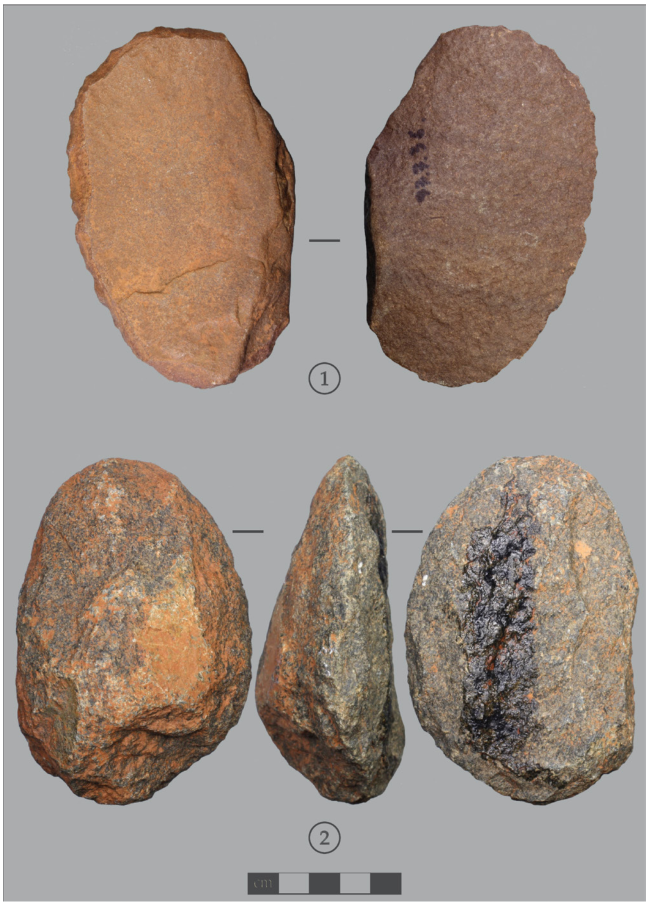

Figure 11. Top: scraping tool, bottom: unworked tabular raw material (gabbro)..Figures: Attila Péntek, by courtesy of the Ethnographic Museum in Budapest, Hungary.

When the hammering operation is completed to the satisfaction of the maker there follows the grinding-down process. For this purpose one of the ordinary flat blocks of sandstone used for grinding ochre or grass seed is used."

Spencer & Gillen (1904, 656) mentioned also the fact that ground axes were much less common than flaked implements because the raw material suitable for making them is only found in relatively few spots in the central area of Australia. Without a more precise indication, the authors mentioned the existence of a special diorite supplying quarry in the Macdonnell Ranges, where the making of ground axes was practically ceased. The range is a 644 km (400 mi) long series of mountains in Central Australia (in south-central Northern Territory), a series of bare quartzite and sandstone parallel ridges running to the east and west of Alice Springs. In any case, the quarry referred to was situated at a distance of a couple of hundred kilometres from Tennant Creek, so the raw material probably got there through exchange and barter. On the other hand, Ivanac (1954, 25) mentioned that to the southeast of Tennant Creek, in the Rising Sun gold mining area, granodiorite was mapped. This is a coarse-grained intrusive rock, in composition, it is an intermediate between diorite and granite.

In summary, concerning the above-described assemblage consisting of macrolithic tools and edge-ground implements, the following can be said. There is sufficient ethnographic and archaeological evidence of their occurrence in the area. However, no specific assessment can be made without raw material analyses for possible provenance, use-wear and geochemical analyses for utilisation function. Given that these tools have been produced for many thousands of years using the same or similar manufacturing techniques and used for a wide variety of tasks, it is not possible to determine the age of the examined tools either.

Statements

Data availability statement. The author confirms that the data supporting the findings of this study are available within the article and its supplementary materials.

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RESEARCH ARTICLE

Lithic typological analysis of new surface finds from the Megyaszó–Szelestető site, Hungary

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Abstract

This paper aims to provide new archaeological data for the Upper Palaeolithic in Eastern Central Europe (ECE) based on the typological analysis of surface finds from the Megyaszó–Szelestető site (MSZT). The discussed site is located in the Szerencs Hills, in the southern part of the Western Carpathians. The lithic assemblage of MSZT was considered previously a Pavlovian industry with Aurignacian features. The result of the comparative lithic typological investigation presented in this article contradicts the earlier view and suggests that the lithics can be associated with multiple occupations of the site by hunter-gatherers. Presumably, the site must be heavily eroded, the archaeological assemblage is mixed and some part of it could be dated to the Early, Middle and Late Upper Palaeolithic periods as well.

Keywords

Upper Palaeolithic, Late Gravettian, Late Epigravettian, Western Carpathians, lithic typology

Cite as

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Article history

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1. Introduction

MSZT is located in the vicinity of the village Megyaszó, in the northeastern part of Hungary, in the North Hungarian Mountains, which is a part of the Western Carpathians. It is found on the top and slopes of a 230-meter-high cultivated hill (Fig. 1). Geologically, the site is situated on the 'Kishuta Rhyolite Division', dated to the Miocene (Gyalog 2005, 125). Silicified pumiceous rhyolite tuff pieces are found on the surface as well (Fig. 2). Soil erosion and colluvium on the slopes were reported here (Dobosi & Simán 1996, 9).

K. Simán recognized the first lithics during field surveys in 1986 (Hellebrandt & Lovász 1988). She suggested an 'Upper Palaeolithic or Early Gravettian' age for the finds. The site was excavated by V. T. Dobosi and K. Simán in 1993 and 1994 (Dobosi & Simán 1996). Viola T. Dobosi reported 8263 artefacts in sum. Two archaeological layers were observed, both of which yield sparse lithics and no bones and hearths at all. Nonetheless, lithics were found in various stratigraphic positions and 94% of the finds were collected from the ploughed humus level and the surface. Of the whole assemblage only 1% derived from the upper archaeological layer, and 5% from the lower one. V. T. Dobosi and K. Simán classified the assemblage culturally as an older phase of the Gravettian with Aurignacian elements and claimed a relationship with the 'Pavlovian' site Bodrogkeresztúr–Henye (Dobosi–Holl 2013; Dobosi–Simán 1996, 18) and Hont-Parassa III/Orgonás (Dobosi & Simán 2003). Their cultural classification was based on carinated endscrapers (n=6 from the surface, n=1 from the upper archaeological layer), nosed endscrapers (n=1 from the humus level, n=1 from the upper archaeological layer), Gravette points (n=4 from the surface), and Aurignacian blades (n=2 from the surface). The cultural attribution of the site was supported by a radiocarbon date, 27,070±680 (Deb-5372) (Dobosi 2000, 80), calibrated with OxCal

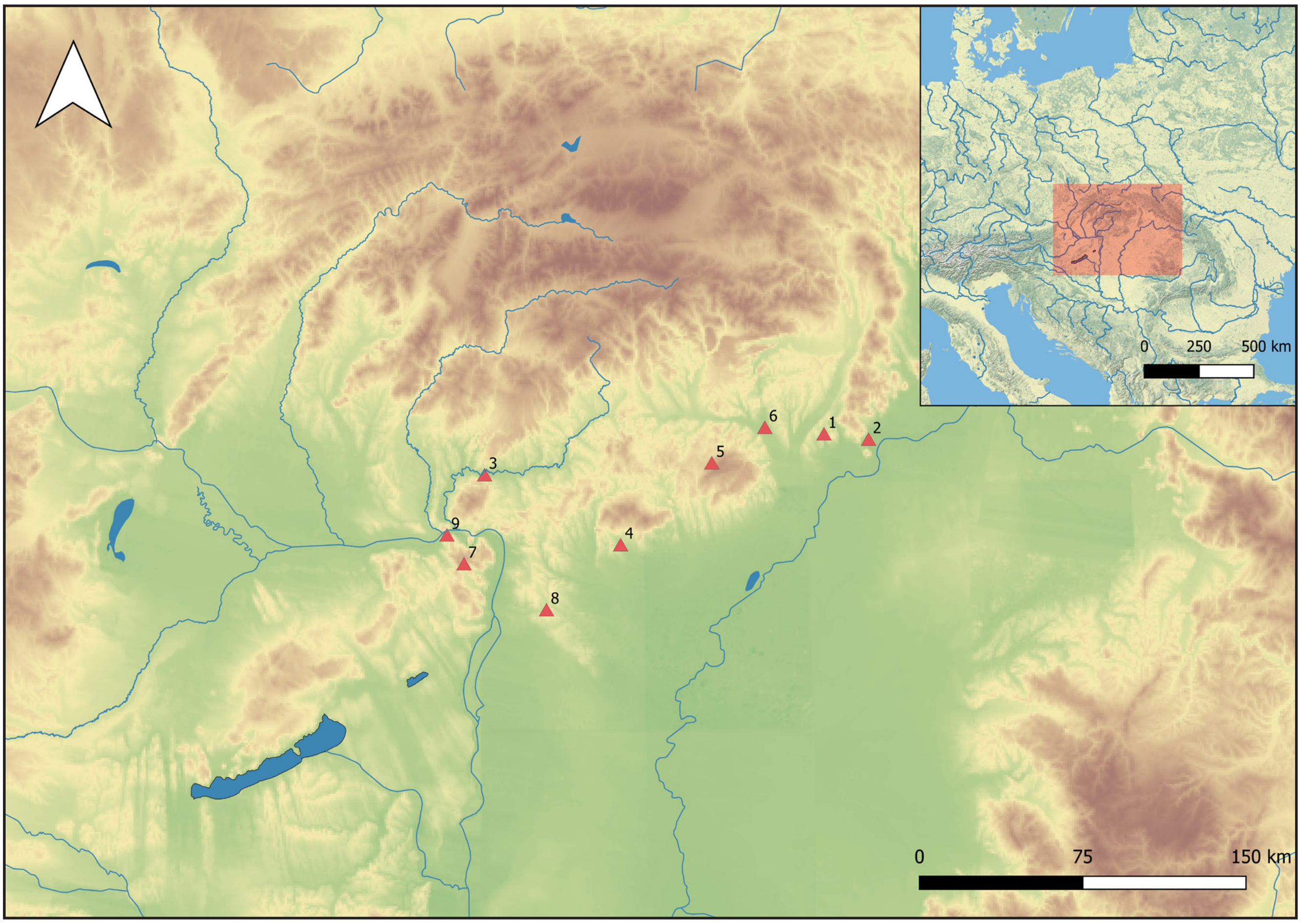


Figure 1 Sites mentioned in the text: 1. Megyaszó–Szeletestető; 2. Bodrogkeresztúr–Henye-hill; 3. Hont–Parassa III; 4. Nagyréde; 5. Istállóskő-cave; 6. Sajószentpéter; 7. Pilisszántó-rock-shelter; 8. Pécel; 9. Esztergom–Gyurgyalag. Edited by László Pokorni.

4.4. to 33,000–30, 000 cal BP (Reimer *et al.* 2020). The location or the material of the sample is not published.

Due to stratigraphic and chronological issues the site's archaeological reliability was questioned (Lengyel 2008–2009) as well as the typological integrity of the lithic material (Lengyel 2018, 9).

The paper aims to resolve the controversy about the chronology and cultural attribution of the site.

2. Materials and methods

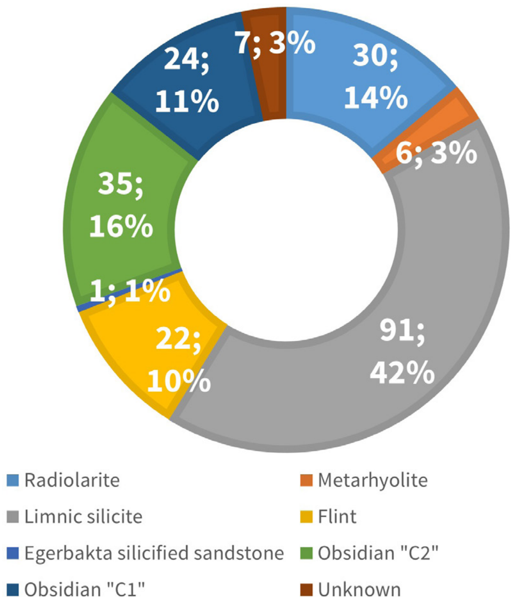
As the most important culturally diagnostic lithic tools were found on the surface, the earlier published results are re-evaluated based on the evaluation of lithic tools acquired during recent field surveys.

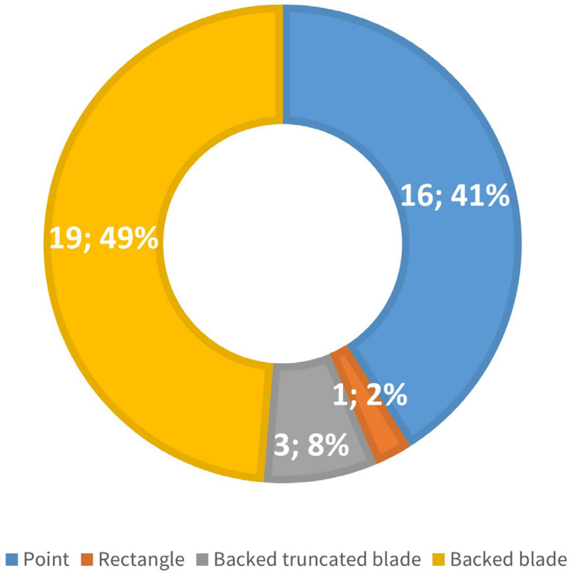
The here newly presented archaeological material (n=6373) was collected during field surveys of D. Hajdú and Gy. Lengyel. A small part of the collection was subject to a BA thesis at the University of Miskolc (Bartus 2019).

As the lithics were collected from the surface, only retouched knapped stone tools were investigated (n=216), which is 3.4% of the total collection. Lithic raw materials were identified macroscopically following A. Přichystal (2010), so the various silicites formed in a freshwater limnic environment were grouped as 'limnic silicites'. According to their origin, lithic raw materials were divided into three categories (Lengyel 2018). The provenance of local raw materials is defined in a 10-kilometre radius. Regional ones are found 10 to 100 kilometres from the site. Distant ones are from more than 100 kilometres from the site. I do not make further statements regarding the composition of the raw material or the lithic technology of the assemblage, since the artefacts are collected from the top of an Ap soil horizon that has been disturbed by modern, agricultural human activity and must be mixed.

Due to heavy ploughing of the site, in some cases, lithics found on the surface were damaged and refractured. Therefore 'tools' with fresh, unpatinated scars were not considered authentic tools.

Tooltypes were divided into two groups, domestic tools and armatures (Lengyel 2016). Domestic tools consist of end-scrapers, burins, edge-retouched tools, splintered tools, borers, truncations and combined





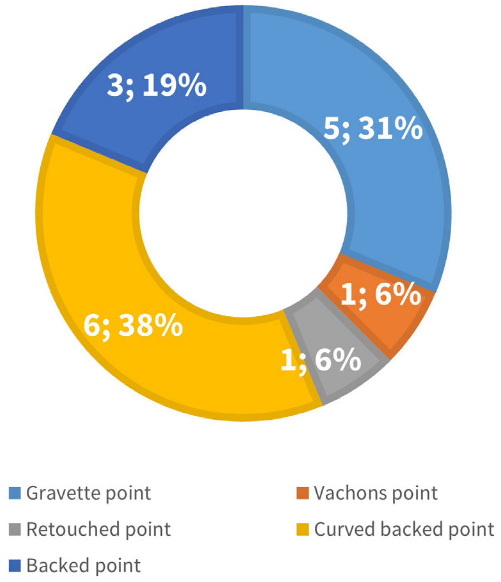


Figure 2 Silicified pumiceous rhyolite tuff pieces from the surface of the site. Photos by Eszter Duong-Li. **Figure 3** (top right). Raw material compostion of the tools. **Figure 4** (middle right). Categories within the armature group. **Figure 5** (bottom right) Categories within the group of points.

tools. The armature category was further subdivided into retouched points, backed points, backed blades, rectangles curved-backed points, arched backed points, Gravette/microgravette, fléchette, Vachons points, and shouldered points. Blades and bladelets were not differentiated, since the surface material must be mixed and the production modes or size ranges cannot be accurately determined. Typological categories were based on the work of P. Demars and P. Laurent (1989). I paid special attention to the armatures and especially, to the points, as these tools are used to emphasize cultural differences in the recently revised Middle and Late Upper Palaeolithic of ECE since domestic tools in most cases seem to be part of the daily life of hunter-gatherers and they are used for general tasks (Lengyel 2016; 2018).

3. Results

Dominant raw materials (Fig. 3) are the limnic silictes in the tool assemblage (n=91, 42%), which is not surprising since outcrops of Tertiary siliceous sediments from limnic basins of the Tokaj Mountains

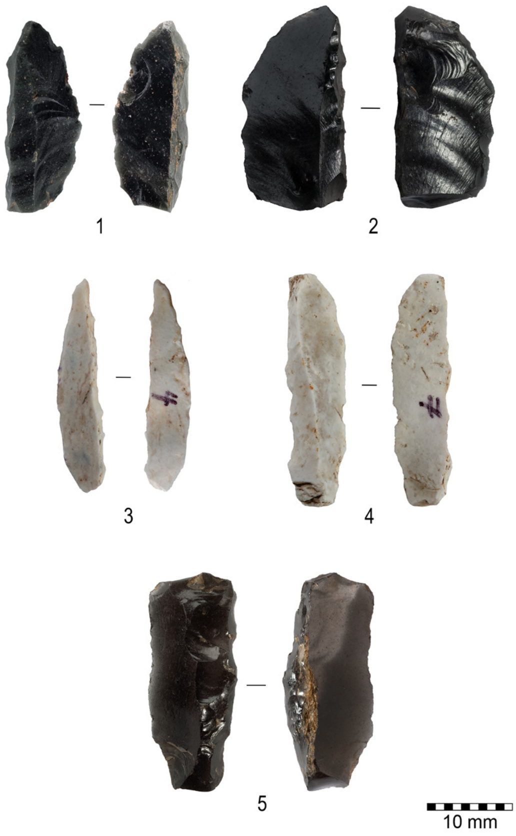


Figure 6 (upper left)**.** Megyaszó–Szelestető surface finds: 1. nosed carinated endscraper; 2–3. carinated endscrapers; 5–7. blades with Aurignacian retouch. **Figure 7** (upper right). Megyaszó–Szelestető surface finds: Gravette-points. **Figure 8** (lower left) Megyaszó–Szelestető surface finds: 1. Vachons-point; 2. retouched point; 3. rectangle. **Figure 9** (lower right) Megyaszó–Szelestető surface finds: 1–3. backed points; 4–9. curved backed points. Photos by Eszter Duong-Li.

are found within a radius of 35 kilometres (Szekszárdi *et al*. 2010). This raw material is often highly patinated, inclusions are observable on the surfaces of the lithics and it has great variability in colour.

The second most abundant raw material is obsidian which was also formed as a result of Neogene volcanic activity. Two varieties were found in the assemblage. "C1" type (n=24, 11%) is more transparent and has a glassy texture. "C2" type (n=35, 16%) is not transparent and has a blacker and greyish colour. Sources of obsidian are in the Eperjes–Tokaj-Mountains, close to the site (Biró 2004). A total of 14% (n=31) of the tools are made from radiolarite, probably originating in the White Carpathians (Slovakia), where it could be collected from primary autochthonous and allochthonous sources (Nemergut *et al*. 2012). It appears in grey, green, brown and yellowish colours as well. A portion of the radiolarites could be related to the Transdanubian sources of the Bakony Mountains.

Flint is also present in the material (n=22, 10%). These tools are heavily white, white-blueish and white-brownish patinated, so their exact origin is not definable. The most we can say is that they are of northern erratic origin. The number of tools made from metarhyolite (n=6, 3%) is low. Its source lies approximately 45 kilometres away in the vicinity of Bükkszentkereszt (Vértes & Tóth 1963) and Bükkszentlászló (Tóth 2011). A single backed blade made from silicified sandstone from Egerbakta is also noteworthy.

Raw material sources can be categorized by their distance from the MSZT site. Limnic silictes can be considered both local and regional raw materials since these are found less than 10 kilometres and also between 10–100 kilometres from the site. Obsidian and metarhyolite can be counted as regional raw materials. Since the two assumed radiolarite sources are equally around 250 kilometres far from the site, they are counted as distant raw materials.

The material is dominated by blades as the main blank type (n=161, 74,5%), and flakes are represented in smaller numbers (n=55, 25.5%). Domestic tools are the most numerous (n=177, 82%). Within the previous category, endscrapers, edge-retouched tools, burins and truncations are abundant. Three splintered pieces were also found.

In the category of armatures (n=39, 18%), backed blades make up almost 50% of the assemblage (Fig. 4). Backed-truncated blades, a single rectangle and points were found as well. The group of points consist of curved backed points (n=6), Gravette points (n=5), backed points (n=3), a Vachons point and a retouched point (Fig. 5).

Despite their small number, the three thick blades could be recognized as Aurignacian blades and four carenoid endscrapers. It is worth mentioning that one of the blades (Fig. 6: 5) is strangled and one particular endscraper made on a flake blank is a nosed endscraper (Fig. 6: 1).

One of the five slender Gravette points is broken on the distal part, although the inverse retouch opposed to the backed edge is visible on the proximal part (Fig. 7.5). The remaining four Gravette points are having inverse retouch at their distal part (Fig. 7: 1–4). The earlier mentioned rectangle is made on an unusual, thick limnic silicite blade blank and backed ventrally, although this piece is not typical (Fig. 8: 3).

One Vachons point was identified (Fig. 8: 1). The point has a lanceolate, narrow shape, it was made on a broken blade and has inverse retouch at the base and the distal end. A retouched point (Fig. 8: 2), similar in shape is also part of the assemblage, but it has no inverse retouch, just an abrupt one on both edges. Out of the six curved backed points (Fig. 9), two are broken distal parts, although judging from the curvature of the backing, they were diagnosed as curved backed points. Four curved backed points are made from limnic silicite, one is from obsidian and one is from radiolarite.

4. Discussion

The typological composition of the discussed assemblage indicates that the MSZT site was visited by hunter-gatherers several times during the Upper Palaeolithic. Some tools might be associated with the Early Upper Palaeolithic Aurignacian industry, like the thick blades with Aurignacian retouch, carenoid and nosed endscrapers. Such lithic tool types were recognized on open-air Aurignacian sites in the vicinity of Nagyréde (Lengyel *et al*. 2006), Istállós-kő-cave (Vértes 1965, XLV 4.) and throughout ECE as well (Demidenko et al. 2021). Blades with Aurignacian retouch are reported in the earlier publication (Dobosi–Simán 1996, Fig. 14).

The above-mentioned types are often considered fossile directeurs of the European Aurignacian (Demars & Laurent 1989). Carenoid endscrapers are distinctive features of Early Upper Palaeolithic industries, although in some cases these are also characteristic of other Upper Palaeolithic industries as well, for example on Early Epigravettian (EE) sites in ECE (Béres & Demidenko 2021, Fig. 8; Neugebauer-

Maresch *et al*. 2016, Tafel 11). That is to say, a human occupation at the site, dated to the Last Glacial Maximum, cannot be ruled out, since EE armature is characterized solely by backed blades and retouched points (Lengyel *et al*. 2021, Table 5–6), thus it cannot be securely isolated.

Despite their small number, some lithics certainly can be dated to the Late Gravettian, (LG) as these are fossiles directeurs of these industries. The most evident is the presence of the five Gravette points, as this tool type is mostly missing from the archaeological record of ECE in Epigravettian (Lengyel 2016). The Vachons point and the rectangle also have close links to the LG site's lithic tool composition in Hungary, like Bodrogkeresztúr, Sajószentpéter and Pilisszántó-rock-shelter (Dobosi & Vörös 2000; Lengyel 2016). LG occupation of the site is further supported by the presence of possible shouldered points, published earlier (Dobosi & Simán 1996, Fig. 12.). Szeleta-cave's layer 5 and 6 also seems to be analogous, as those included Gravette points, two shouldered points and two retouched points (Lengyel *et al*. 2016, Fig. 4). Apparently, typical LG armature is present on the site, except Kostienki knives, which are not yet recognized on Hungarian LG sites. The latter seems to strengthen the argumentation of V. T. Dobosi about the Gravettian cultural identification of the site. Although, the 'older phase of Gravettian with Aurignacien elements' cannot be proved. First, typical Early Gravettian or Pavlovian tool types are missing from the site. Secondly, the LG is dated between 30 and 26 ka calBP in the ECE (Wilczyński *et al*. 2020) and the latest absolute dates for Aurignacian in Hungary are falling between 35 and 33 ka calBP (Davies & Hedges 2008–2009). Therefore, there is a 3000-year chronological hiatus between the two cultures. In light of the new absolute dates of the Late Gravettian in the ECE, the earlier published 33,000–30, 000 cal BP age of the site still looks inconsistent.

It is conceivable that curved backed points and backed points point to a Late Epigravettian (LE) occupation of the site, considering these are characteristic armatures of it (Béres *et al*. 2021; Lengyel *et al*. 2021). Contemporary research proved that the LE can be reliable absolute dated between 20 and 14.7 ka cal BP and it occupied southern Poland, Moravia and the Carpathian Basin. Archaeological record implies that the Carpathian Basin was inhabited by LE hunter-gatherers in the post-LGM period, although most of the sites are found in the Transdanubia except the yet undated site Pécel (Markó & Gasparik 2018), which is located in the Great Hungarian Plain, approximately 30 kilometres from the closest Transdanubian LE site. If LE settlement indeed can be proved, that makes the MSZT site the easternmost and first LE assemblage from the Hungarian part of the Western Carpathians. Besides, LE assemblages are described by a high frequency of armatures like backed blades, which makes up almost 50% of the discussed lithic material. In such a manner, the abundance of backed blades could also point to a LE presence at the site. Presumably, a part of earlier published lithics can be regarded as curved backed and backed points (Dobosi & Simán 1996, Fig. 12) and a trapeze-rectangle can be assumed as well (Dobosi & Simán 1996, Fig. 13). Analogous geometric trapeze-rectangles are recognized in the LE assemblage of Esztergom–Gyurgyalag (Lengyel 2018) and a curved backed point, retouched at the proximal part of the blade, similar to the one found at MSZT (Fig. 9.6). Nevertheless, the limnic silicite, obsidian and radiolarite raw materials of the discussed curved backed points differ from the earlier published one's, as those are entirely made from Transcarpathian flints (Lengyel 2018).

5. Conclusion

The lithic typological assessment of surface finds from the MSZT site demonstrated that the assemblage should not be considered uniform, rather multiple occupations can be identified. Evidence shows that distinctive tool types of Aurignacian – conditionally EE – LG and LE can be identified. Hunter-gatherer communities must have been attracted by the proximity of local raw materials, which are still collectable from eroded Tertiary deposits. More precise relative and absolute dating of the site is necessary for future interpretations.

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RESEARCH ARTICLE

Convergence in the Design of Final Palaeolithic, Mesolithic and Ethnographic Projectile Points

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Abstract

In traditional hunting and gathering societies, it is a common practice to fashion projectiles for different purposes. The spectrum of the available morphologies for projectiles and their tips is dictated by several kinds of constraints such as aerodynamic and mechanical properties, different hunting strategies, the available game or the range of the shot. This article focuses on a particular aspect of duality in primitive projectile technology interpreted with a fitness landscape model. Using geometric morphometric analysis, the author argues that the duality in projectile morphology and performance characteristics observed in the studied projectile weapon systems is the result of technological and physical constraints placed upon primitive projectile technology. For a more comprehensive explanation of this phenomenon, an optimality model explaining the development of flexible projectile weapon systems is proposed.

Keywords

Projectile Technology, Convergence, Geometric-Morphometrics, Fitness landscape, Projectile Points, Ethnographic Analogies, Final Palaeolithic, Mesolithic

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1. Introduction

In convergence, functional or developmental constraints result in similar forms being developed in independent lineages (O'Brien *et al.* 2018). In the case of archaeological and ethnographic projectile technology, we are often dealing with morphological and functional similarities of points deriving from different spatial and temporal contexts (i.e., Charlin & Gonzalez-Jose 2018; O'Brien *et al.* 2014; Smallwood *et al.* 2018). In the cultural-historical paradigm, such similarities in the form and function of artefactswere often treated as an outcome of contact between toolmakers using information exchange between human populations (Groucutt 2020). At the root of these processes, diffusionists saw mechanisms such as cultural transmission and enculturation (Lymann *et al.* 1997). Recently it is becoming clear that at least some of the cases of morphological and functional similarity in artefacts design are an outcome of convergent evolution in human technology (Groucutt 2020; O'Brien, Buchanan & Eren 2018).

Given that humans tend to come up with similar solutions to common problems it seems reasonable to search for examples of convergence in areas of technology, which are affected by natural constraints more than others. In this regard projectile technology of hunters and gatherers remains a potentially prolific field of research.

Similar designs appear more often in hunting weapons and this is due to invariant laws of physics and mechanics, such as the force of gravity or drag of the air, which remain a strong selective factor influencing the form and performance of primitive arrows, spears and darts (Christenson 1986; Hughes 1998). These natural restrictions act as constraints on projectile technology causing hunters to come up with similar solutions despite different ecological conditions and spatio-temporal contexts.

In this paper, I use the concepts of convergence and fitness landscapes model as a framework for the interpretation of morphological and functional similarities between projectile points deriving from Final Palaeolithic, Mesolithic and ethnographic contexts.

2. Convergence and design constraints of projectile technology

Convergence as a biological phenomenon is based on the fact, that organisms originating from different lineages may develop analogous structures or organs as a response to similar environmental constraints (McGhee 2018). In living organisms, analogous organs or structures occur by means of relatively complicated processes, such as genetic mutation, drift and selection (McGhee 2011). When it comes to man-made tools the case is more down to earth, as convergence in the form and function of strictly utilitarian artefacts, such as projectile points, appears usually as an outcome of the selection of appropriate traits to perform similar tasks. In the case of ancient projectile weapon systems, these traits can be for example penetration depth, velocity or aerodynamic characteristics (Charlin & Cardillo 2018, 110; Hughes 1998).

To properly identify cases of convergence in primitive projectile technology we ought to look at projectiles and their elements from an evolutionary perspective. This approach implies that the archaeological record can be viewed similarly to the way paleobiologists see a fossil bed and that is as populations of "things", that represent hard parts (shells, for example) of past phenotypes (Dunnell 1980; Jones *et al.* 1995; Leonard & Jones 1987; Lyman & O'Brien 1998; O'Brien, Buchanan & Eren 2018). This particular example fits very well with what archaeologists have to cope with when reconstructing prehistoric projectile systems, as most often the "soft" parts of weapons, (i.e., their organic elements) are not preserved and usually the only things that remain are stone points.

Biologists see a bird's nest, a beaver's dam or a twig tool made by a chimpanzee as strictly phenotypic traits (e.g., Dawkins 1990; Turner 2000). Archaeological projectile points were also parts of past phenotypes because they played a significant role in gaining food and other resources and for this reason, their characteristics were shaped by the same evolutionary processes as those which influence their makers and users (Leonard & Jones 1987). Consequentially, in this approach, artefacts are viewed as an extension of human biological phenotype. It should be emphasized, that this notion of "extended phenotype" is nothing new and it was first introduced to archaeology by O'Brien and Holland (1995) and by Lyman and O'Brien (1998) nearly three decades ago.

Table 1. Basic characteristics of bimodal projectile weapon systems

Distance	Characteristics	Purpose
Short range projectiles	- Broad lanceolate/oblanceolate points	Induce shock and damageto kill off quickly at close range
	- Heavy	
	- Simple construction	
Long range projectiles	- Narrow points with sharp tip	Enhance penetration to keep the arrow inside prey's body
	- Light	
	- Complex arrows with barbs	

In the realm of projectile technology, convergence occurs under certain restrictions, which force humans to come up with similar solutions due to the limited range of possibilities (McGhee 2018, 28). In some cases, this produces substantial diversity in the construction and morphology of hunting weapons (Serwatka 2018). This phenomenon is often characterized by the occurrence of certain duality in projectiles ranging from heavy, high-power ones to light and fast. Heavy projectiles are usually tipped with wide projectile points to enhance the impact force and killing power at short range, while lighter projectiles are tipped with narrow points with sharp tips to facilitate penetration and ensure a precise shot (see Serwatka 2018 and Table 1). A weapon system's arrows or darts can be designed to maximize distance or energy based on what is known as the mass/velocity relationship. (Hughes 1998, 370).

The concept of this specific duality in projectile form and function appears earlier in the studies on prehistoric projectile technology and there are several examples of such bimodal projectiles among

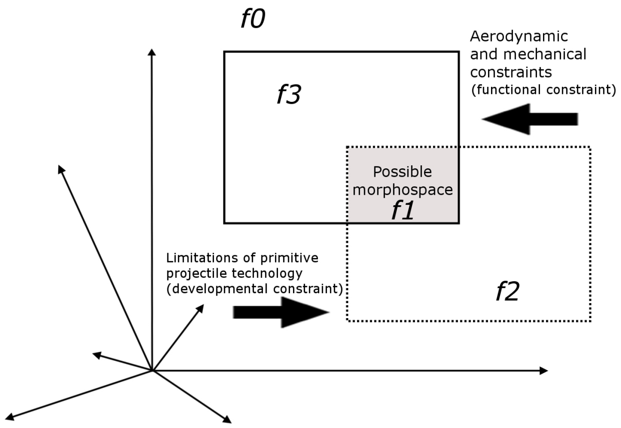

Figure 1. A spatial representation of basic constraints in a theoretical morphospace of projectile points. The solid line represents the invariant aerodynamic and mechanical limitations (functional constraints). Points within that boundary will be functional under physical and aerodynamic conditions. The dotted line represents developmental constraints. Points within that boundary are possible to create under the limitations of primitive projectile technology. Forms f0 are impossible both in terms of aerodynamic and mechanical requirements and primitive projectile technology; forms f1 are functional and developmentally possible; forms f2 are possible to manufacture with primitive projectile technology, but they would be nonfunctional under aerodynamic and mechanical constraints; forms f3 are functional, but impossible to develop due to technological limitations (after McGhee 2011).

traditional hunting societies. For instance, Cundy (1989) in his study on Australian spearthrowers observed that Aboriginal Australians used either small and light darts, which increased the distance of the shot or large and heavy darts, which produced higher energy upon impact and had more killing power.

A similar case, this time in bow and arrow technology, was reported by A.M. and P. Petrequin (1990) among the Danis people living in Western New Guinea. For hunting purposes, the Danis use simple arrows tipped with wide bamboo blades. Such construction causes large wounds and shock upon impact, which ensures a quick kill (Petrequin & Petrequin 1990, 492). Conversely, for warfare, the Danis prefer more complex and accurate arrows, which can be shot from a considerable distance. The points of these arrows are thin and barbed, which helps with deep penetration and causes complex internal injuries by keeping the point inside the wound (Petrequin & Petrequin 1990, 492).

Another interesting ethnographic example of such duality in the construction of arrows is provided by Griffin (1997), who studied the bow and arrow technology of Agta hunters from Northwestern Luzon. In a dense forest environment characterized by seasonal variation, the Agta hunt with self-bow and arrows. Hunters use a variety of projectile tips, which generally range from large, heavy single-bladetips to light, thincompoundtips. (Griffin 1997, 282; see Fig. 4 in this paper.) The selection of the right arrow and projectile point is determined by the size of the prey and the shot's distance. At close range, single-bladed points are utilized. The impact force at close range combined with large and wide points cause shock and sometimes instant death of the prey. The Agta use more precise, multicomponent arrows at fleeing game when a more accurate shot from a distance is needed. Points of these multicomponent arrows are connected to the shaft with a piece of string. Additionally, barbs attached to the narrow, sharp points ensure keeping the distal part of the arrow in the wound, which prevents the animal from escaping as the foreshaft and the string becomes entangled in bushes and scrubs when the animal is escaping. (Griffin 1997, 282).

There seem to be several archaeological examples of this duality in the construction of projectiles. Gurina (1956) reports finding different types of arrows in two graves at the Mesolithic cemetery at Deer Island situated on Lake Onega. The foreshafts deposited in burials were made of bone and still had lithic points attached to them. In each of these burials, the foreshafts and lithic points were different: 100 grave foreshafts had large, lanceolate points and were straight and smooth (see Fig. 4 in this paper). The foreshafts of grave 118a were shorter and possessed three to four short side barbs. These foreshafts had small, elongated tanged points attached at their distal ends (Gurina 1956).

According to the author's previous study, Final Palaeolithic Swiderian points were also parts of such a bimodal projectile weapon system (Serwatka 2018). Analogously to the mesolithic points from Oleni Ostrov, in the Swiderian Culture, we are also dealing with wide lanceolate points and considerably lighter and thinner tanged points. These points differ statistically in terms of weight, shape and the character of impact fractures, which strongly suggests that they were parts of such a bimodal weapon system (Serwatka 2018).

According to Susan Hughes, when weapons can be manufactured with options for increased distance and high energy, hunting flexibility increases (Hughes 1998, 370). The examples listed above show, that such flexibility in the design of primitive projectiles has the potential of appearing independently in different contexts as an analogous trait. For a better understanding of this phenomenon, it is necessary to look at the problem from the perspective of limitations imposed on primitive projectile technology.

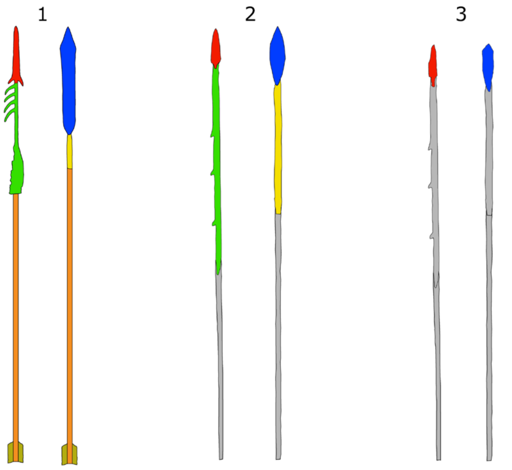

Figure 2. A scheme showing analogous design features in projectiles from three different spatiotemporal contexts: 1: Ethnographic Agta arrows; 2: Mesolithic foreshafts with lithic points; 3: Final Palaeolithic Swiderian points.

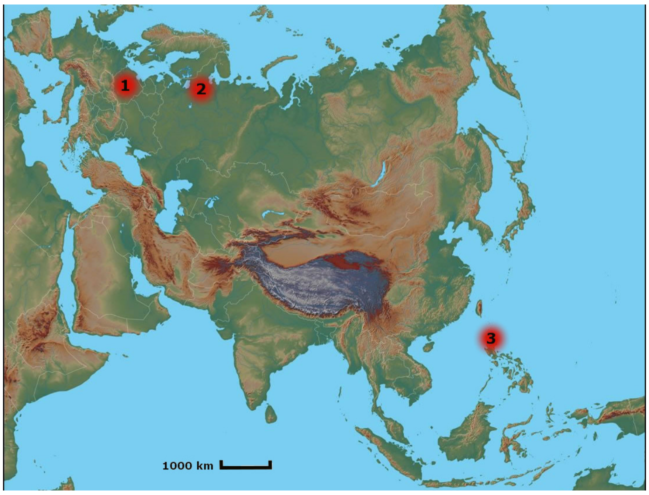

Figure 3. Map showing the location of projectile point contexts discussed in the text: 1: Final palaeolithic Swiderian points from Poland; 2: Mesolithic points from Oleni Ostrov cemetery; 3: Ethnographic Agta points from North-Western Luzon.

First, there are the functional constraints deriving from invariant laws of physics, which are globally universal and independent of ecological conditions, cultural context or time. These include forces such as gravity and the drag of the air. All prehistoric hunting societies must have conformed to these restrictions to make their projectiles functional, which means designing them according to basic rules of mechanics and aerodynamics (Cotterell & Kamminga 1992).

Every primitive projectile weapon system is characterized by an insufficient transfer of energy onto a projectile. This particular problem is caused by the construction of simple propulsion mechanisms, such as self-bows, which are unable to produce much energy, compared to modern bows (Cotterell & Camminga 1992; Hamilton 1982; Hughes 1998; Klopsteg 1943). These constraints are strictly technological as they mainly derive from the ignorance of certain methods for making more powerful propulsion devices (e.g., Bartram 1997). In a more general sense, these restrictions can be viewed as developmental constraints.

Drag increased as a result of the low velocity of prehistoric projectiles, limiting their range and making their trajectory more curved (Burke 1954; Cotterell & Kamminga 1992; Hughes 1998). Since the primary purpose of all hunting weapons is to inflict injuries that would result in the immediate death or immobilization of the prey, this remains a significant limitation of the functionality of primitive projectile weapons. With these restrictions in mind, and following McGhee's scheme of boundaries (McGhee 2018) we can take a spatial approach to visualize basic constraints governing the emergence of such bimodal projectile weapon systems in the area of human technology. Figure 1 shows a spatial representation of two types of constraints imposed on primitive projectile weapons in a theoretical morphospace.

One important conclusion, which derives from the limitations listed above is that primitive hunting weapons were only good enough at a relatively short distance, with the effective range for a self-bow reaching approximately 25 meters (Churchill & Rhodes 2009). Hunters often tried to overcome this difficulty by using strategies to approach the game with concealment and disguise or by bringing the game within the effective range (Hitchcock & Bleed 1994; O'Connell & Hawkes 1988; Verbicky-Todd 1984).

A different way of making low-velocity weaponry more effective is by manipulating the design characteristics of projectiles themselves to improve their key features, such as penetration, killing power and range (Christenson 1986; Hughes 1998). This seems to be the case in the ethnological and archaeological examples given above, where projectiles ranging from high power/short range to low power/long range are developed to be better prepared for different hunting situations.

The examples listed above also raise an important taphonomic issue regarding projectile technology in general. As we gradually move on to more ancient examples of bimodal projectile weapon systems we are facing a gradual depletion of data. The Agta or the Danis example provides full insight into the projectile weapon systems' function and performance, the Mesolithic example provides only partial information deriving from grave goods (projectile points and foreshafts), and Swiderian points can be interpreted as parts of a projectile weapon system only based on their functional and morphometric features. What links these cases is the appearance of specific bimodal projectiles and points with analogous technological, functional and morphological features (Fig. 2).

3. Geometric morphometric analysis and projectile points morphospace

Projectile points morphology reflects functional restrictions such as cutting capacity, penetration depth, aerodynamic characteristics and the trade-off between these features (Hughes 1998). In a taphonomic sense projectile points are "the hard parts" of past projectile weapon systems, which reflect the functional and performance characteristics of past weapons. For these reasons point morphologies and their technological features remain important traits for investigating cases of convergence in past and present projectile weapon systems (Buchanan & Collard 2010; Charlin & Cardillo 2018; O'Brien *et al.* 2014; Smallwood *et al.* 2018). Given the above a detailed analysis of projectile points morphology seems a proper method for investigating cases of convergence in projectile technology.

One way of addressing this issue is through the analysis of morphospaces. The idea of theoretical morphospaces was developed in evolutionary biology as a method for visualizing the spectrum of possible and impossible morphologies in the development of living organisms (McGhee 1999). Morphospaces are continuous and multidimensional spectrums of shapes and it is common to generate them using multivariate statistical methods, such as geometric morphometrics (Mitteroecker & Huttegger 2009). Convergence occurs when forms from different lineages occupy the same spatial region within the morphospace or follow a similar pattern of shape development (McGhee 2018). In the case of this study, generating a spectrum of projectile points forms will help in mapping out if and in which areas of an empirical morphospace convergence in the overall morphology occurs.

Geometric morphometric analysis is currently one of the basic methods for studying the morphological variation of archaeological and ethnographic projectile points (i.e., Azevedo *et al.* 2014; Borrell & Stefanisko 2016; Charlin & Cardillo 2018; O'Brien *et al.* 2014; Serwatka & Riede 2016). A valuable advantage of geometric morphometric methods is the ability to superimpose and compare shapes of many objects in the course of Procrustes analysis (Rohlf & Slice 1990). Further multivariate statistical ordination methods allow for diverging between different point types taking even slight morphological differences into account. These aims would be hard to achieve using traditional approaches, such as linear measurements.

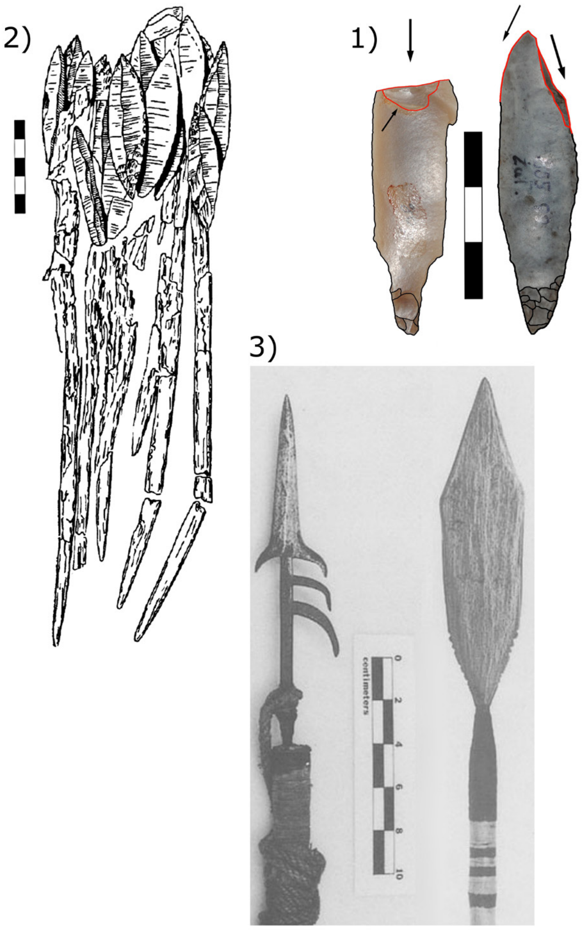

Figure 4. Examples of similar dual point types from three different spatiotemporal contexts: 1) Final Palaeolithic Swiderian points with visible impact fractures; 2) Mesolithic points from Oleni Ostrov still attached to bone foreshafts; 3) Single blade and composite points of the Agta hunters (After Griffin 1997; Gurina 1956; Serwatka 2018 (modified)).

In this study, an empirical morphospace of point shapes will be generated basedon the result of Canonical Variate Analysis. In contrast to theoretical morphospace, an empirical morphospace is based on a set of real observations, which in this case are outline shapes of actual projectile points deriving from Final Palaeolithic, Mesolithic and ethnographic contexts. The amplitude of such space will be a function of the morphological variation in the dataset.

In Palaeontological Statistics PC software created by Hammer *et al.* (2001), CVA is a discriminant option that produces a scatter plot of specimens along the first two canonical axes (those producing maximal and second to maximal separation between all groups

– see Hammer & Harper 2006) and offers a conjoined module that uses MANOVA to test for the equality of multivariate means between groups. The ability of a CVA to correctly allocate specimens by measuring their distance from the group means is used to evaluate its performance (Sheets *et al.* 2006). The axes with the greatest variance will be used to generate the morphospace.

4. The dataset

The sample comprised digitized photographs and scanned drawings of projectile points from three different contexts: ethnographic (Agta points), Mesolithic (Oleni Ostrov site) and Final Palaeolithic (Swiderian culture) (see Fig. 3–4 and Table 2). The whole sample comprised 284 points. The assemblage of Final Palaeolithic Swiderian points consists of 250 specimens from twelve Polish archaeological sites (see Serwatka 2018) and the assemblage of Mesolithic points from Oleni Ostrov consists of 14 points. The ethnographic sample consists of 12 Agta arrowheads taken from Griffin (1997). All images were processed and digitized for geometric morphometric analysis. These operations included a standardized orientation of all specimens and placement of semi-landmarks.

Table 2. Dataset of projectile points used in the study

Context	n=	Total	Reference
Ethnographic	n=12	n=276	Griffin 1997
Mesolithic	n=14		Gurina 1956
Final Palaeolithic	n=250		Serwatka 2018

There is a specific protocol involved in the orientation method. Using the grid gauge in the GIMP image editing program, all points were oriented along their longitudinal axis of symmetry following this protocol (https://www.gimp.org/). After being oriented, the images were sent to TpsDig (Hammer & Harper 2006), where an outline of each point was drawn around its perimeter, starting at the base's farthest point (Fig. 5). The basal region was picked as the outline beginning point since it is the piece of an artefact which is straightforwardly associated with the shaft or foreshaft and thusly it stays a steady, simple to recognize component in projectile points. Using the TpsDigprogram, the outlines were transformed into a set of forty equidistant semilandmarks.

For Canonical Variate Analysis the dataset was divided into three groups: Swiderian points (n=250), ethnographic points (n=12) and Mesolithic points (n=14)

A Procrustes superimposition (Rohlf & Slice 1990) was carried out using the PAST software following the completion of the artefacts' orientation and digitization (Hammer *et al.* 2001). All of the outlines were superimposed around a centroid during this operation, which corresponds to the 0.0 XY coordinates. To further track deformations concerning that consensus shape, the Procrustes superimposition also computes the mean from all coordinate values (Jungers *et al.* 1995).

5. Results of the Canonical Variate Analysis (CVA)

There was a statistically significant difference between the designated groups' means using MANOVA (Wilk's lambda=0.02615; F=12.38; p<0.005; Pillai trace=1.632; F=10.63; p<0.005).

The CVA plot reveals, that there is a clear separation between the three assemblages of projectile points. All three groups occupy slightly different areas of the plot and there is no overlap between the designated assemblages (Fig. 6). Swiderian points, which are the largest group, are located near the 0.0 value of the CVA plot, where they form a rather tight cluster. Mesolithic points are located farther along axis 1. This group forms a wedge-like distribution, following the positive values of the axis. Ethnographic points stand out the most, as this group is distributed mainly according to axis 2, where it forms two smaller and well-defined clusters.

Following the shape deformations along the axes it was possible to define the overall trajectories of shape change in the generated morphospace. Axis 1 describes a transition from elongated specimens with a pronounced tang and sharp tip to points with elliptical outlines and expanded midsection. Shapes distributed according to axis 2 range from very narrow, needle-shaped points with short tang to broad, lanceolate specimens (Fig. 7). A pattern emerges when the expansion factors are visualized: The expansion of the midsection and gradual atrophy of the tang and shoulders of projectile points account for the majority of the shape changes that progress with increasing values of axis 1 and 2. Based on shape variables obtained in the course of CVA an empirical morphospace was projected (Fig. 8). Total set of two dimensions holding the most variance is used to construct a two-dimensional morphospace of possible form coordinates. Dimensions of the morphospace

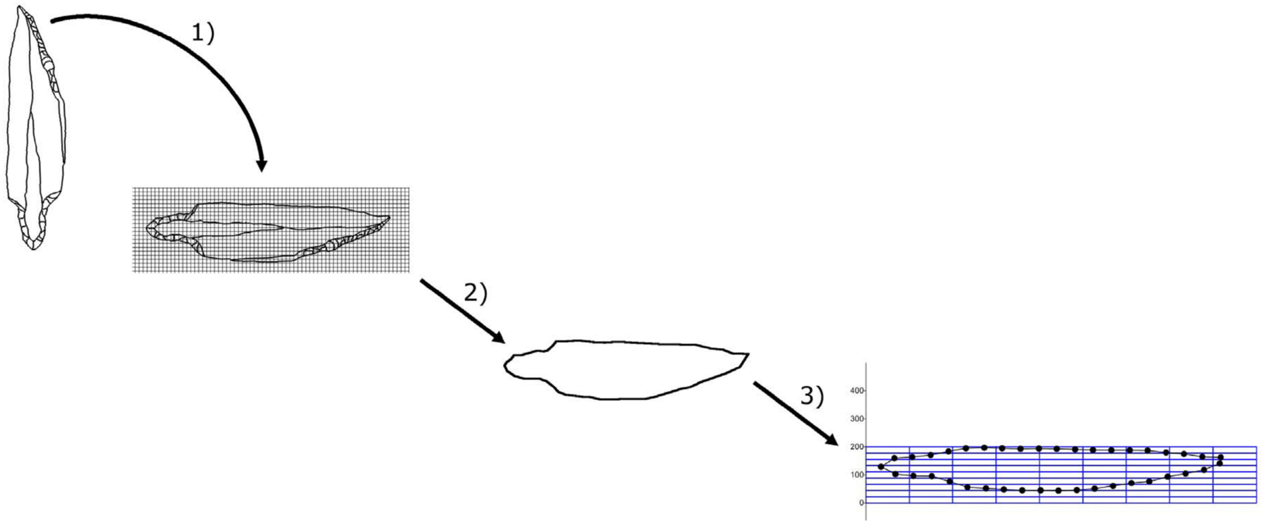

Figure 5. A simplified diagram showing the method of orientation of points outlines for geometric-morphometric analysis.

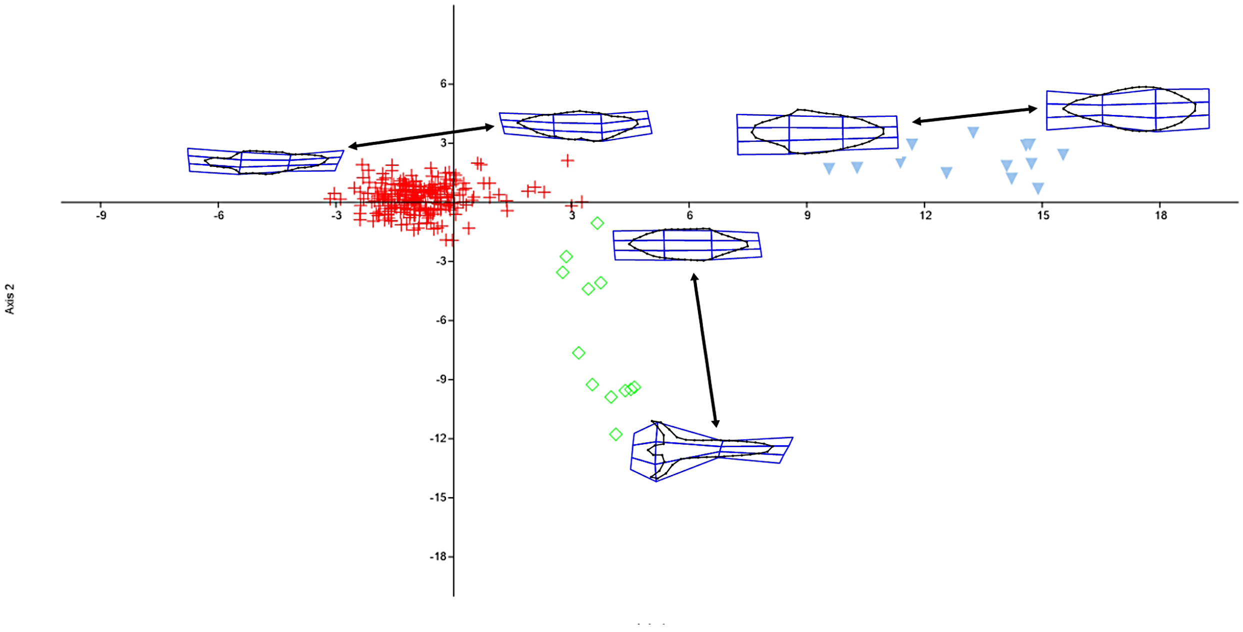

Figure 6. Scatter showing the result of Canonical Variate Analysis.

correspond with CVA axes 1 and 2, which derive from principal components 1 (47.116% of the overall variance) and 2 (15.096% of the overall variance) (see Table 3). Outlines with their expansion factors every 0.5 tick mark were included. The dimensions of the morphospace are geometric parameters, which correspond to the overall point expansion rate according to CVA axes.

The generated morphospace serves as a visual amplification of morphological variability obtained in the course of Canonical Variate Analysis. When looking closer at the position of subsequent shapes it becomes clear, that the morphospace is divided into two sections: one contains outlines of points with a more or less pronounced tang, contracted tip area and expanded midsection and the second part includes lanceolate and oblanceolate points with an expanded tip area. (see Fig. 8). This of course reflects the distribution of shapes on the CVA plot. The separation between these two parts of the morphospace is delimitated by a default shape corresponding to the 0.0 value (Fig. 7).

6. Points design space and fitness landscapes

Proving that convergence in the design of projectiles occurs is a relatively simple task. A more difficult objective would be to clarify why such convergence appears and how it develops. In the author's opinion,

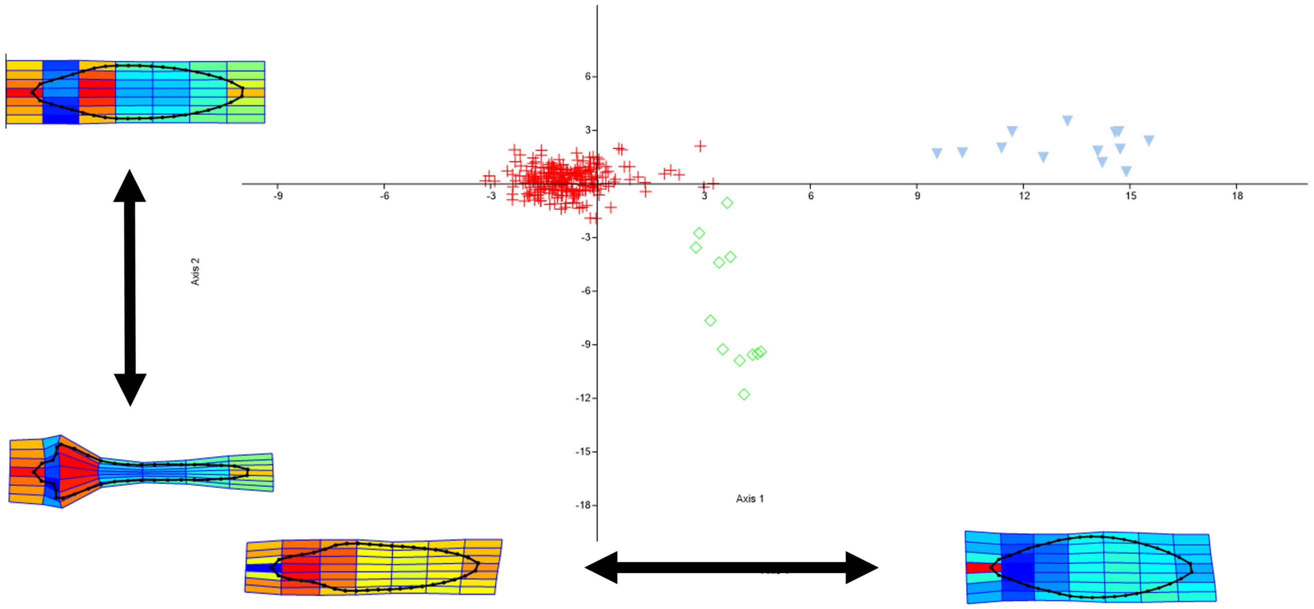

Figure 7. Shape transition according to axes generated with Canonical Variate Analysis. It represents the two main axes of shape change among the studied population of projectile points.

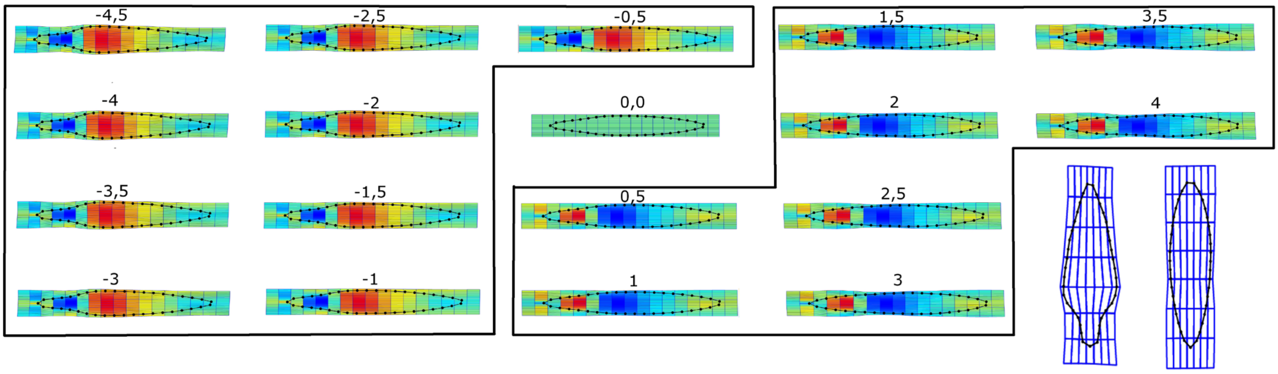

Figure 8. Empirical morphospace generated according to axis 1 of Canonical Variate Analysis. The thin black line separates lanceolate points from tanged points.

this phenomenon can be explained by using a fitness landscape model.

The fitness landscape is a concept in theoretical biology introduced by Sewall Wright almost a hundred years ago (Wright 1932). Since then it has become one of the most fundamental and influential models in evolutionary biology and beyond (i.e., Adami 2012; Laue & Wright 2019; McCanlish 2011; McGhee 2006). Initially, Wright used this concept as a graphical representation of the reproduction success of genotypes in the environment by depicting them as populations moving across a projected geographical landscape full of peaks and valleys (Fig. 9). The fitness assessed to each variant genotype represented the landscape's height on the Z axis, while the combination of all possible genetic variants represented genotype space in these fitness landscapes. The fitness landscape model predicts, that organisms will "climb" these peaks by developing traits, such as specific genes or organs, to maximize fitness.

However interesting and universal this model may seem, we need to keep in mind, that it was developed primarily to describe population dynamics in a strictly deterministic way. In fitness landscape theory, biological fitness refers to an organism's ability to adapt to its environment and thus survive and reproduce. In cultural evolutionary research, fitness can be used to determine the extent to which cultural or technological factors affect human reproduction and survival (Laue & Wright 2019). In the case of utilitarian artefacts, such an approach was introduced by Kuhn and Miller (2015). Their approach views stone tools as patches of utility, which do not provide a direct energy gain, but are being utilized as a mechanical advantage in achieving certain subsistence tasks, such as hunting or butchering. This is reasonable, because tools, similar to environmental patches, are commonly being utilized to the point of failure when they cannot be reutilized or repaired and must be replaced by a new artefact. This process seems analogous to patch exploitation in the natural environment.

The "Artifacts as patches" approach works even better in contexts, where tools are used briefly but intensively. The short use life of such artifacts would play out during a single episode and they have to be designed to perform the intended task most efficiently. A perfect example of such a situation includes projectile hunting weapons and specifically projectile points.

Following this approach, the specific duality in the design of Swiderian, mesolithic and ethnographic projectile points observed in the studied cases as a phenotypic trait, which ensures better fitness and reproductive success in specific hunting conditions. Usually, hunters would make a trade-off by enhancing the most desirable traits at the expense of others (see Witthoft 1968). However, as the ethnographic and archaeological examples indicate, high power-low range and high velocity-long distance projectiles can coexist within the same projectile weapon system to increase hunting flexibility. This selective pressure produces substantial variability in projectile point morphologies ranging from oval shapes to needle-like points coexisting within the same projectile weapon system (Fig. 10).

7. Results and conclusion

The obtained results raise a few interesting issues, both from an evolutionary as well as strictly archaeological perspective.

Geometric-morphometric analysis confirms that points deriving from three different spatiotemporal contexts occupy the same region in the generated morphospace. Along with ethnographic examples, this strongly suggests, that in this case, we are dealing with morphological convergence in points design shape.

In the case of the studied projectile points, we are dealing with two particular types, which evolved independently in different cultures under mechanical, aerodynamical and developmental constraints. The ethnographic examples reveal a simple pattern in projectile design, which seems to occur in the archaeological data as well. In this pattern, we are

Table 3. Factors of the CVA analysis

PC	Eigenvalue	% variance
1	0.00346152	47.116
2	0.00110911	15.096
3	0.000881493	11.998
4	0.000420216	5.7197
5	0.000388703	5.2907
6	0.000216756	2.9503
7	0.000169335	2.3049
8	0.000131097	1.7844
9	8.67552E-05	1.1808
10	7.91117E-05	1.0768

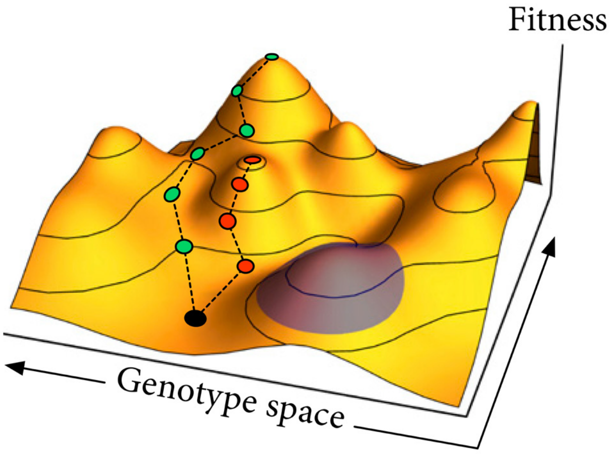

Figure 9. Fitness landscape. The horizontal axes represent the space of different combinations of genotypes, and the vertical axis is individual fitness as a function of genotype (after Van Cleve& Weissman 2015)

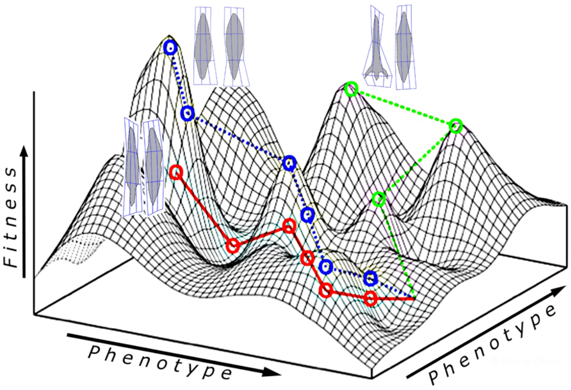

Figure 10. Visualisation of the development of bimodal projectile points as a convergent trait emerging in a rugged fitness landscape. The coloured dots and lines represent pathways of selection of appropriate techno-morphological traits (phenotypes), leading populations to achieve fitness through the application of dual projectiles.

dealing with two types of arrows with different applications: heavier arrows with wide tips are used at close range, while light arrows with slender points are shot at a considerable distance. This mainly results in the formal and functional similarity of projectile points from different contexts.

Certain advantages are coming from the implementation of such bimodal projectiles that make up the overall fitness. First of all, it is a very effective way of dealing with the insufficient transfer of energy of primitive propulsion devices. This improves the performance of projectiles and helps in overcoming the technological constraints of primitive weapons. Secondly, flexible projectile weapon systems allow the hunting of more terrestrial species in changing seasonal conditions and different hunting situations. In this manner, implementing such flexibility to the design of hunting weapons appears as a strictly adaptive trait, which allows for gaining more resources and thus ensures higher reproducibility.

Viewing projectile technology as a fitness landscape we can interpret the convergence in projectile points morphology as striving for evolutionary success. Populations will tend to diversify their projectile points to reach an adaptive peak, which in this particular case means crafting bimodal projectiles (Fig. 10). This conclusion corresponds with the outcomes of geometric morphometric analysis performed in this study. We can interpret the obtained CVA clusters as adaptive peaks (see Fig. 4 and 10). In each of these clusters, we encounter an analogous pattern of points shape change representing the duality in points design and function. Given the chronology and geographical setting of each of these cases, we can assume that this duality emerged independently under certain restrictions as a parallel fitness trait. Therefore, the co-occurrence of points with similar shapes and functions in these contexts can be viewed as an effect of the cultural selection of point morphologies for enhancing biological fitness.

The above conclusions raise an important issue in the taxonomy of projectile points. Natural selective factors, such as the described functional and developmental constraints, seem to play an important role in shaping the techno-morphological features of the described projectile points. This means that the selection of artefacts of the appropriate design under natural restrictions has the potential of creating and shaping artefact variability in the archaeological assemblages. In my opinion, this questions the validity of Swiderian and mesolithic points as “type fossils”, given, that their overall design was an outcome of adapting stone points to a specific type of projectile technology. In this manner, these points appear more as a byproduct of technological adaptation, than an actual artefact, especially given their simplistic techno-morphological traits.

Statements

Data availability statement. The author confirms that the data supporting the findings of this study are available within the article and its supplementary materials.

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REVIEW ARTICLE

Lithic Research Roundtable 12, 2022

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Abstract The twelfth annual meeting of Hungarian lithic specialists was held on December 9, 2022, from 9:00 a.m. to 5:00 p.m. at the Central Library of the Hungarian National Museum, Budapest, organized by Katalin T. Biró and András Markó. The abstracts of the presentations and posters are as follows.

Keywords *Lithic Research Roundtable, Litikum, Hungarian National Museum*

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Mogyorósbánya, final report for 2022

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In the presentation, we will outline the results of the analysis of the material from the three settlement patches of the most important Upper Paleolithic site in Hungary, Mogyorósbánya - Újfalusi dombok. We will discuss the poorly preserved large mammal fauna, the exotic Northern flints, local quartzite and the poor quality nummulitic chert, phyllite artefacts of non-practical use, as well as the distribution of finds belonging to several technological and typological categories.

Field investigation at Acsa-Rovnya in 2021–2022

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The Acsa-Rovnya site is located in the southwestern part of the Ecskend hills, in the territory of Acsa village, where the MNM database registers 53 archaeological sites. The vast majority of these are found in the Galga Valley, consisting of mixed surface pottery material from the Bronze Age, Iron Age and Middle Ages. The Paleolithic site has been known since 1999. Viola T Dobosi conducted verification excavations here in 2002 and 2004, and independent researchers Sándor Béres and Attila Pének collected knapped lithics on several occasions. In our presentation, we present the most recent field research conducted here. This time, the fieldwork was carried out with the help of the Ferenczy Museum Center, with the members and volunteers of the Community Archaeological Association, which might be of interest from a methodological point of view. On two occasions we examined an area of approximately 60,000 square meters and recorded 641 finds, almost exclusively knapped lithics from Early Upper Palaeolithic times. Together, the two visits enable more accurate archaeological mapping of the area and the preparation of a control excavation.

Recent results of research on the Aurignacian in Hungary

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The Istállós-kői Cave is the best-known Aurignacian site in Hungary. Its research dates back more than 100 years. It became famous with the excavations of László Vértes in 1947-1951. Based on his work, the Aurignacian culture in Hungary was divided into two phases. Several attempts were made to clarify the chronological position of the finds with the help of artefacts or stratigraphic samples. In 2020, we re-sampled the entire layer sequence of László Vértes, which allowed us to obtain chronological and archaeological data.

We excavated a new Aurignacian site, Alsódobsza-Kerekdomb in the Hernád valley, in 2021. We uncovered numerous animal remains and knapped lithics, making this the first open-air Aurignacian site in Hungary where animal bones have survived. Their study significantly contributes to the absolute and relative chronology and paleo-ecology of the Aurignacian open-air sites. Bodrogkeresztúr-Henye is primarily known for the settlement of the Late Gravettian culture. Based on the results of the 2019 excavation, the remains of an Aurignacian occupation are assumed based on relative and absolute chronological data. We present the results of the fieldwork mentioned above.

The role of mollusc fossils in the Hungarian Upper Paleolithic

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Tertiary molluscs, called jewels, in the Hungarian Upper Paleolithic record, raise many questions. In the case of sites with a large number of molluscs, a preference for certain species is evident, which suggests conscious selection. The concentration of such sites around the Danube Bend can be linked to the proximity of the primary sources of fossil mollusc skeletons. However, there may be other factors behind their frequent occurrence there, such as the presence of groups with distinct identities based on the classical interpretation of the objects as jewellery. The presentation focuses on these problems, as well as whether the classical interpretation of the objects as personal adornment is valid.

Traces of the Middle Paleolithic in the Mátraalja region

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A large number of Middle Paleolithic surface finds, rich in quartz porphyry raw material, are known from the Cserhát Mountains area, and in the case of three sites, excavation results, including OSL dating, have also confirmed their Middle Paleolithic age. The occurrence of leaf points in itself cannot be considered a watershed between the Middle Paleolithic and Upper Paleolithic, therefore the evaluation of the mixed collections in the vicinity of Eger, close to the geological source of the quartz porphyry, is problematic. Middle Paleolithic hunting groups came to the Cserhát Mountains through the Mátra foothills, the Mátraalja area. However, until Mónika Gutay's thesis was written in 2007, we had virtually no data on the Middle Paleolithic of the Mátraalja. One of the motivations for the fieldwork carried out by the speaker in the area was the systematic research of the Mátraalja sites, where Middle Paleolithic finds and/or quartz porphyry raw material were known to occur, following Gutay's thesis.

We present some partial results of the fieldwork and site documentation carried out in the Mátraalja area between 2017-2021, including middle palaeolithic finds of two site complexes (Gyöngyöspata-Gereg and Ecséd-Gárdony/Mogyorós-hegy).

Hont-Csitár: a leaf-tool site in the Ipoly Valley

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The Ipoly Valley is one of the best-researched areas of Hungary from a prehistoric point of view. The paleontological research of Ferenc Kubinyi dates back to the 19th century. The first prehistoric finds were found in Ipolyság by István Majer in 1920. In the 1950s and 1960s, Pál Patay conducted field walkings, and Miklós Gábori and Vera Gáboriné Csánk conducted test excavations. In the mid-1990s, Viola T. Dobosi and Katalin Simán authenticated the previously known deposits with surveys and test excavations. From 2011 until today, we have been conducting systematic field walks and stratigraphic test excavations in the area.

The Hont-Csitár site is located on a ridge above a small stream joining the Ipoly Valley at the junction of the Ipoly terraces and the foothills of the Börzsöny, in an ideal topographical location for a Middle Paleolithic hunting strategy. From Miklós Gábori's excavations at the end of the 1960s, 1,550 finds, some photos and brief descriptions have survived. The site was identified by the presenters in 2002, the material was published in 2010, and systematic collections have been taking place in the area since 2011. The stratigraphic sounding that began in 2021 could not be continued this year. Both the previous excavation material and the finds from surface collections show a double picture. The finds of a late Middle Paleolithic leaf-tool industry, as well as characteristic types of an Upper Paleolithic blade industry are both found. The raw material use is characterised by local Börzsöny, and regional Cserhát and Slovakian limnosilicites, radiolarite and quartzite pebbles. In the Middle Paleolithic material, distant metarhyolite (quartz porphyry) appears, while in the material of the Upper Paleolithic industry, also distant obsidian and northern flint appear. Similar mixed collections are known from the surface immediately north (Hont-Babat) and south (Hont-Csitár 2) of the site. The finds from Moravany nad Váhom-Dlhá and the Jankovich cave can be mentioned as parallels to the leaf-tool industry, while the Upper Palaeolithic types can be linked to a large number of Epigravettian materials known from the area.

Bátor (Csipkéstető) radiolarite: a possible prehistoric lithic raw material source

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In the summer of 2021, in the vicinity of Bátor, the source of a rare prehistoric lithic raw material, the blue version of Csipkéstető radiolarite, has been found. According to our current knowledge, this siliceous rock is so rare that until now it has only been found in large numbers among the Middle Paleolithic finds of the Suba-lyuk cave: the 108 Palaeolithic artefacts make up only a few per cent of all the finds we know of this raw material.

Both in terms of size and workability, the Bátor raw material stands out among the Csipkéstető formation radiolarites, which covers a relatively large area of the western edge of the Bükk. In the laboratory of the Institute of Mineralogy and Geology at the Miskolc University, the Bátor radiolarite was compared by X-ray diffraction (XRD) and destructive analysis with a blue radiolarite from the Suba-lyuk, provided by the Hungarian National Museum, and samples collected from a secondary deposit in the Bánya-hegy, at the western side of Noszvaj, Zsidó-szél-dűlő, and Felsőtárkány, as well as with a Bakony radiolarite sample collected from Szentgál. The measurement results of the samples from Suba-Lyuk and Bátor show a high degree of agreement, so it is assumed that a new location of Middle Paleolithic lithic extraction in the Bükk Mountains has been identified.

The so-called macro-laminar industry in the Bükkalja region

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In the framework of the collaboration between the Eötvös Loránd University in Budapest and the Jagiellonian University in Krakow, Janusz Kozłowski participated in three excavations in the Bükkalja region. His most important contribution is the discovery of a new culture based on the sites of Egerszalók-Kővágó-dűlő, Eger-Kőporos-tető and Andornaktálya-Gyilkos.

The newly identified industry is significantly different from the material of the previously known Aurignacian sites, and its roots are probably connected to the Bachokirian. Its main characteristics are the significantly high proportion of tools made on blade supports, the almost complete absence of carenoid pieces, and the extensive use of local raw materials. The three sites mentioned above have highly mixed collections, but at the Demjén-Szőlő-hegy site, Krisztián Zandler managed to identify a homogeneous assemblage that exactly meets the criteria established by J. K. Kozłowski. This latter material provides a good overview of the characteristics of the large blade industry from both a technological and a typological point of view, so it is suitable for a more comprehensive presentation of the industry.

Hont–Templomdomb and the Epipalaeolithic in Hungary

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Hont–Templomdomb is considered by Hungarian Palaeolithic research to be a Late Pleistocene, Epipaleolithic site. Since the first publication of its knapped lithic material in 1956, it has not been subjected to a more detailed examination, although the Epipaleolithic remains a white spot in Hungary. We present the results of the 2022 reassessment of the find material.

Diagnostic chronological phenomena from the research area of Neolithic stone tools in Hungary

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The research of the Hungarian Neolithic (6000 – 4600/4500 BC) began at the very beginning of the last century, and the framework of our cultural concepts, which we still use today, was formed relatively early. It is not surprising that the relevant units, such as the Körös culture, the Bükk culture or even the Tisza culture, were distinguished based on their ceramic styles and forms. In the last hundred years, Hungarian prehistoric research has done a lot to define the spatial and temporal boundaries of these cultures. By the 1980s, a chronological system that is still valid today crystallized, and the ceramics-centred approach has remained dominant to this day. Although the systematic research of Neolithic chipped stone tools does not have such a long history, its development in the last thirty years is sufficient to compare this artefact class with other elements of material culture and draw further conclusions by integrating them at a higher level.

It is generally accepted that the opportunistic Neolithic chipped stone tools do not allow for the development of sophisticated typologies characterizing the Paleolithic or Mesolithic. However, there are phenomena by which one region, period or archaeological culture can be distinguished from another. These phenomena can be lithic raw material selectivity, typological differences and technological change. For example, the abundance of scrapers and the presence of raw materials brought from regions far beyond the Carpathians can be linked to the Late Neolithic in the Great Hungarian Plain. However, almost all such characteristics have a common feature, namely that they are not exclusive, but rather can be considered a rule of thumb. In the presentation, I discuss these observations from the Carpathian Basin and interpret them in the context of our classic cultural units.

Kup – a Tevel flint processing workshop

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We noticed the Kup-Egyes site in the mid-1980s, during research related to the Sümeg-Mogyorósdomb flint mine. Together with Erzsébet Bácskay, we tried to find and map the distribution of the raw material of chipped stone tools from the Sümeg flint mine. The lithic material of the site excavated by Sándor Mithay in 1974 was outstanding among the prehistoric sites known at that time, both in terms of quality and quantity. Mithay found the material of the Transdanubian Linear Pottery and the Lengyel cultures at the site, published in 1989. Despite the relatively small distance and the dominance of "grey flint", the lithic material did not show significant connections with the Sümeg mine, but it was possible to identify it as the only processing site of Tevel flint in Hungary so far.

On a local initiative, and with the support of the village of Kup throughout, we carried out excavations at the site between 2000 and 2003 in cooperation with the Hungarian National Museum and the Laczkó Dezső Museum in Veszprém, largely using traditional ("manual") techniques, thanks to which we collected practically all lithic from the excavation area. As a result, we collected a significant number of stone tools, the largest set among the prehistoric sites known to me so far. The lithic raw materials are Cretaceous grey flints of Nagytevel, which is barely 10 km from the site as the crow flies, and colour variants of the Bakony radiolarites.

In the course of the new excavations, we discovered primarily the finds of the Lengyel culture, with a smaller number of finds of the Transdanubian Linear Pottery and the Copper-Age Protoboleráz cultures. Unfortunately, the intensive agricultural work significantly mixed the ceramic finds, so the dating of the stone tools is uncertain. According to the distribution of the ceramics, the Lengyel component is dominant, which is why the entire lithic material is treated uniformly. During the processing, we examined the characteristic stone tool types and „technological" pieces, and their size distribution regarding the two types of raw materials, as well as the relationship system designated by the lithic raw materials of the site.

Possible raw material sources of dolerite-metadolerite polished stone tools in Hungary

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Metadolerite is a rock type with basic composition, mostly of ophiolite origin, which, due to its dark grey-black, hard, dense, intergranular-subphytic-ophitic fabric, its fine- to medium-grained lithology, is suited well for the production of polished stone axes. The texture of closely connected new minerals formed as a result of the low-to-very low-grade metamorphic transformation further enhances the rock's physical toughness. The domestic and international archaeometry literature on polished stone tools describes metadolerite stone tools from many archaeological sites from the Neolithic to the Copper Age. Chunky chisels, chisel axes and shaft-hole axes, tools resistant to high mechanical impact, were mainly made from this rock type.

Metadolerite is a common and characteristic raw material in the Hungarian prehistoric polished stone tool record in the areas east of the Danube (e.g. Hódmezővásárhely-Gorzsa, Szakmány et al. 2009, 2011a, 2011b; Öcsöd-Kováshalom; Polgár-Csőszhalom, Szakmány et al. 2019; Aszód-Papi-földek, Judik et al. 2001). Without knowing the complete polished stone tool find material, we identified 1–6 specimens from the Middle Neolithic (Aggtelek-Baradla, Edelény-Borsod-Derékegyháza, Dévaványa-Sártó, Dévaványa-Simasziget, Dévaványa-Réhelyi dűlő), Late Neolithic (Kisköre-Gát, Tápé-Lebő Alsóhalom), in Early Copper Age (Szegvár-Tűzköves), Middle Copper Age (Tiszalúc-Sarkad) and Late Copper Age sites (Tarnabod). This raw material also occurs sporadically in North Transdanubia (see e.g. the Ebenhöch collection, Szakmány et al. 2011b), and among the finds of Neolithic sites in South Transdanubia (e.g. Alsónyék-Bátaszék, Szakmány et al. 2021; Lengyel).

Based on the results of the investigations so far, it can be assumed that the raw materials of Hungarian, mainly Neolithic metadolerite polished stone tools, do not form a uniform group. They can be divided into several types based on their state of preservation, their magnetic susceptibility values (MS), and their complete rock chemical and mineral chemical composition. A more precise definition of the types has not yet been made. Based on preliminary research, it can be assumed that the metadolerite stone axes found in northern Hungary can be linked to the Szarvaskő metadolerite raw material source, while the southern ones originate from the ophiolite belt along the Maros River (a Száva-Vardar zone origin is also not excluded).

In the framework of our research project, we examined 55 metadolerite stone tools to characterize the metadolerite raw material types appearing in the archaeological record. The dominant grain size ranges of the metadolerite types were characterized with the help of the macroscopic petrological examination. Magnetic susceptibility measurements were used to determine the magnetizable mineral content. Complete rock chemical data were obtained by non-destructive prompt gamma activation analysis (PGAA). We characterized the rock fabric by primarily non-destructive SEM-EDS of the original surface and, secondarily, by conventional destructive thin-ground petrographic description as well as SEM-EDS measurements. Based on these, we identified the rock-forming minerals, as well as determined their chemical composition. Our studies identified two main types of metadolerite among the polished stone tools.

By comparing the results with the lithological-geochemical properties of the metadolerite rock types of the potential raw material deposits (Szarvaskő, Maros Valley), we found that the metadolerites show a high degree of similarity in several respects (main element chemistry, modal composition). This is mainly due to the same rock development. The difference in the composition of the minerals (amphiboles) formed during late igneous or metamorphic processes and the secondary components (magnetizable opaque minerals) makes it possible to separate them. According to this, the use of the Szarvaskő raw material in the production of metadolerite polished stone tools can be justified, and the use of the Maros material is highly probable. The presence of metadolerite as a raw material in the areas east of the Danube thus simultaneously proves northern and eastern connections in the supply system of polished stone tools.

The tests were carried out with the support of the NKFIH, funded by the K 131814 tender program.

Complex petrographic examination of grey sandstones on the example of the Hódmezővásárhely-Gorzsa tell settlement

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From the Hódmezővásárhely-Gorzsa tell settlement, nearly four hundred sandstone toolstones are known, one quarter of which is red, while three quarters are yellow, gray and white sandstones. The previous studies focused primarily on red sandstones, therefore this work aims to present the complex lithological examination of “grey” sandstone tools.

Within the sandstones that appear grey to the naked eye, we have distinguished three groups, of which the largest number (about 40%) is the medium-dark grey, mica sandstones. In terms of their appearance, they are very diverse and in many cases, it is difficult to separate them macroscopically from sandstones with a medium grey, light grey, sometimes yellowish or slightly whitish grey colour. The grey sandstones may contain mica and show a strong reaction to dilute hydrochloric acid, which indicates a significant carbonate content. These are collectively called “young” carbonate sandstones, and within the non-red sandstones, they make up approximately 20%. The third type, the so-called white metasandstones represent nearly 30%, this group includes apparently white, greyish-white, sometimes purplish-grey, shiny rocks, often with a directed, deformed and even wrinkled texture.

In a polarizing microscope, the three groups can be separated from each other as well, and we were also able to distinguish subtypes. Among the three sandstone versions, the grey versions were the most varied. Based on experience so far, it is necessary to produce thin sections of these finds, even though this process involves a small degree of destruction, because this is the only way we can separate the different rock types from each other, and it also helps to classify the questionable types. In addition to the thin-section examination, we also performed heavy mineral tests using a larger amount of material. The essence of the process is that high-density microminerals, which are usually less than 1% in sandstones, are enriched with the help of a heavy liquid. These minerals are indicators of the rock exposure area, so by examining them we can get information about the raw material source of these artefacts. Our heavy mineral tests show that the three types of sandstone showed significant differences. Grey sandstones (grey-1) have significant heavy mineral content: garnet, brown-greenish-brown tourmaline, zoisite and rutile, less often zircon, green amphibole, apatite, epidote, titanite and chrome spinel. The other, rarer version (grey-2) contains a few heavy minerals: red-brown, almost black, and also greenish-brown tourmaline, zircon, rutile, and garnet. The white metasandstones are extremely poor in heavy minerals: brown or greenish-brown tourmaline, zircon, rutile, less often garnet, ortho- and clinopyroxene, epidote and zoisite. The carbonate sandstones contain a significant amount of heavy minerals with a characteristic composition: garnet, brown and green amphibole, oxyamphibole, orthopyroxene, epidote, zoisite, brown tourmaline, zircon, rutile, staurolite, kyanite, rarely tremolite-actinolite, chloritoid and andalusite. In the future, we plan to perform mineral chemistry tests on some types of heavy minerals (e.g. opaque minerals, garnet, amphiboles and pyroxenes, tourmaline, chrome spinel) with a scanning electron microscope (SEM-EDS). In doing so, we can separate the heavy minerals of different origins from different rocks based on the element content of each heavy mineral type, and this can help in determining the raw material deposits more precisely.

Together, the tests listed here can be suitable for distinguishing raw material types, and if we combine them with whole rock analyses (NAA and PGAA methods), our results can be further refined.

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Polished stone tools from the Late Neolithic Bátaszék-Alsónyék settlement with raw materials from the Mecsek mountains

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On the border of Bátaszék and Alsónyék, a part of a Neolithic settlement (ca. 5800–4500 cal BC) was excavated in connection with the construction of the M6 highway, which is one of the most important such sites in Hungary. From the settlement and its burials, 668 polished stone tools (shaft-hole axes, celts, adzes or flat chisels, shoe-last adzes and maces) were found. The finds are currently in the ELKH BTK Institute of Archeology and the Wosinsky Mór County Museum (Szekszárd). So far, a detailed description, definition and provenance studies of the high-pressure metaophiolites (eclogite, Na-pyroxenite) have been prepared (Bendő et al. 2014, 2019).

The detailed macroscopic geological processing of the artefacts was carried out in 2021–2022. In addition to the lithological determination of the material of the stone tools and their classification into rock groups, the archaeological typochronological features were also determined. Based on their lithological properties that can be examined macroscopically (texture, mineral composition, magnetic susceptibility), the assemblage contains a large number of deep igneous, volcanic, metamorphic and sedimentary rocks of extremely diverse material. Their presumed place of origin is mostly local: the Mecsek mountain and its vicinity. Most of the local raw materials are presumably the product of Cretaceous alkaline-base magmatism (alkaline basalt, alkaline gabbro, alkaline dolerite, phonolite), in addition, small amounts of mottled marl, bituminous limestone, and spiculite also occur. Based on preliminary tests, the long-distance raw materials came from the Carpathian-Pannonian region and its surroundings: e.g. the Balaton Highlands (basalt), the North Hungarian Range (andesite), Transylvania (hornfels), the Bohemian Massif, the Lesser Carpathians (contact metabasite – mainly the so-called Železný Brod type, and amphibolite), the Alps (Na-pyroxenite, eclogite), southern Poland (nephrite), and Serbia (serpentinite, whitestone).

In the present work, we focus on stone tools presumably made from igneous rocks. During the macroscopic rock determination, the following igneous groups were separated. 1) Mecsek-type alkaline basalt (dolerite): 1A) porphyry, vesicular/tonsular; 1B) rare porphyry, with trachytic fabric; 1C) porphyry-free, trachytic fabric; 1D) porphyry-free, vesicular; 2) microgabbro; 3) alkaline gabbro: 3A) inequigranular (porphyry); 3B) equigranular (porphyry-free); 4) phonolite; 5) andesite; 6) non-Mecsek alkaline basalt. A total of 43 stone axes were selected from these groups, from which we prepared lithological thin sections for precise petrographic description. After the polarization microscopic description, 14 samples were selected for scanning electron microscopic (SEM) petrographic and geochemical examination. Based on the polarization microscopy and SEM examinations, the source area of the stone tools belonging to group 4 (phonolite) can be identified with the greatest certainty (Mecsek: Szamár and Somlyó hills). Most of the gabbroid rocks (group 3) are related to the alkaline gabbro blocks found in the clastic sedimentary formations in the Mecsek. Alkaline vulcanites (group 1), based on literature data, are also related to basaltic rocks from the Mecsek (in the vicinity of Komló-Mecsekjánosi). Further tests are required to identify rocks belonging to groups 3, 5 and 6.

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A Buda hornstone lithic workshop in Solymár (poster presentation)

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Geologist István Szenthe collected knapped lithic artefacts on the ploughed surface during geological surveying in the outskirts of Solymár, on the hilltop south-southeast of the castle. The findings were transferred to the Hungarian National Museum. During the on-site inspection held in the spring of 2021, we collected additional finds, a trapeze, scrapers, unretouched blades and flakes among others, as well as cores and pieces of raw material, and recorded their location with a hand-held GPS. The ceramic material is represented by three tiny, weathered fragments. The common feature of the lithic finds is their raw material, the Buda hornstone, the nearest primary occurrences of which are known from a few kilometres away, on the steep northeastern slopes of Hármashatár-hegy and Viharhegy. According to our current interpretation, at the Solymár site, we managed to locate a special stone tool-making workshop from the Late Copper Age, less likely from the Bronze Age.

Lithic landscapes: The system of relationships of Neolithic and Copper Age communities in the Carpathian Basin based on stone tools (poster presentation)

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The wide range of workable lithic raw materials of the Carpathian Basin is well-known and well-researched at the European level. Of these, obsidian, Bakony radiolarite (Szentgál) and flint (Tevel) in particular, are distributed outside the Carpathian Basin and thus have international interest. The distribution of these rocks plays an important role in the long-distance exchange networks of Central-Southeastern Europe. The poster turns the attention from some prominent raw materials to the entire lithic raw material spectrum of the prehistoric communities and places them in the context of the geological potential of the local environment. Instead of an economy-oriented research perspective, it examines the presumed social and ritual values of the used rocks at the local and regional levels. The lithostratigraphic characteristics of the available rocks and the various cultural-technological traditions show significant diversity in the Carpathian Basin. I compare regions rich and poor in stones to take into account the parameters that could actively shape the relative value of each raw material in the life of a community. A more thorough knowledge of the different layers of economic, social and ritual values can help to better understand the role and values of rocks in Neolithic and Copper Age communities.

Archaeometric examination possibilities of sandstone archaeological finds in the case of young carbonate sandstones (poster)

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Since prehistoric times, mankind has used various rock types found in its environment, including sandstone. They were primarily used as tools for grinding, abrading, polishing and sharpening, as single-use moulds, and as building material. These rock types are very widespread in the Carpathian-Pannonian region, we know many different versions of them, so they play a prominent role in Hungarian archaeometry. In archaeology and its archaeometric aspect, the study of tool stones and sandstones is still less common. Our present work aims to show how and with what methods it is worth examining the finds made from this rock type using the example of a very characteristic “grey” type of carbonate sandstone.

The material examination of sandstone tools always begins with macroscopic, i.e. naked eye, observations, the purpose of which is the general characterization, as well as the separation of possible types. After that, we prepare a thin section of some representative samples, which is analyzed with a polarizing microscope. Using a microscope, we observe the main tissue marks characteristic of sandstones and also determine the composition and ratio of the four main components that make them up (grain, matrix, cement and pore). Within these, we pay particular attention to the grains, because we can specify the raw material source with them. The types separated during the macroscopic examination can be further refined if, during the thin-section examinations, quantitative determination is carried out by volume measurement, and heavy minerals that rarely appear between the grains are also observed, because these characterize the rocks that contain them, and are therefore vital in the clarification of raw material source areas. We can also perform mineral chemical analyses (SEM-EDS) on heavy minerals, and geochemical tests (NAA and PGAA methods) on the whole rock.

As a case study, we chose a “grey” type of sandstone with a characteristic heavy mineral content and a carbonate matrix of which we currently know 20 finds from four different sites:

Balatonszentgyörgy-Faluvégi-dűlő Site 2, from which 10 tool stones of the Late Copper Age (Baden culture), mostly grinding stones, were found. All of these are grave finds. Based on both macroscopic and microscopic examinations, they are of the same type, and based on measurements, they proved to be feldspathic greywacke. In this sandstone, minerals that are excellent for identifying the rock source, e.g. actinolite, orthopyroxene and sillimanite, were detected.

Sármellék-Száraz-eleje is a settlement, where four Late Bronze Age moulds (the beginning of the Urnfield culture) were found. These have a similar composition to the previous sandstones, and their heavy mineral content is also the same. In addition, they contained many skeletal remains of calcareous single-celled foraminifera of marine origin. With their micropaleontological examination, it would be possible to further narrow down their source area in the future.

At the Balatonendréd-Vaklápa Öreg-hegy Site 7, Neolithic (Lengyel culture) and Late Bronze Age (Urnfield culture) artefacts are known along with 88 graves. We examined 5 pieces of Late Bronze Age tool stones (grindstones, grinding slabs and their fragments), which were made of a similar rock type as the sandstones found at the previous two sites. Detailed chemical and heavy mineral tests are still in progress.

We know of one sandstone piece similar to the above from Perkáta-Homokkőbánya. Artefacts and features of several archaeological periods are known from the site (Middle Neolithic Želiezovce group, Late Bronze Age Tumulus and Urnfield cultures, native settlements from the Roman period, Avar and medieval settlements). From there, we examined a Late Bronze Age carbonate sandstone tool. Detailed investigations are underway.

Based on our investigations and observations so far, we have established that the examined tools representing several archaeological sites and ages were made of a uniform type of sandstone. Based on the petrographic thin-section methods, it seems that these sandstones are young, probably Upper Miocene, Pannonian in age. Their possible source is in the vicinity of Lake Balaton. In the future, we will try to delineate this raw material deposit more precisely with the help of heavy mineral, micropaleontological and geochemical tests.

We are grateful for the support of the NKFI projects K-128413 and K-131814. The test results of the Balatonszentgyörgy sandstones will be published in 2022 in the volume dealing with the cemetery.

Contact metabasite stone tools from two high-altitude sites near Vienna (preliminary results) (poster presentation)

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In the vicinity of Mödling, 16 km south of Vienna, two high-altitude sites are known from the Late Neolithic period: Jennyberg, where the Boleráz culture settled, and Hirschkogel, now located on the border of the neighbouring settlement of Maria Enzersdorf, which is the high-altitude site of the Jevišovice culture. The two sites lie at a distance of approximately 2 km and have settlement layers dating from 3400/3300 BC to 2900/2800 BC. This situation is considered unique even in Austria, which is characterized by a large number of high-altitude settlements belonging to the Jevišovice, Cham and Mondsee cultures. The high number of settlements is characteristic of the period because here two different cultures lived close to each other. However, the Boleráz culture has only two known settlements in Austria and one of them is one of these high-altitude settlements. Both sites have been researched for a long time, excavations took place at Jennyberg in 1970–1971, and at Hirschkogel in 1926. The examined material from both sites is mostly undocumented scattered excavation material from amateur excavation activities and less from the mentioned systematic excavations.

Among the stone tools at the Maria Enzersdorf-Hirschkogel site, we find the largest number of tools made of contact metabasite (29 of the 67 artefacts we examined), but they also occur among the stone tools at the Mödling-Jennyberg site (3 of the 59 artefacts we examined).

The raw material of the stone tools belonging to this group has a varied appearance, but all specimens are characterized by a fine or very fine grain size. Their colour is usually dark: black, and dark grey, but there are also light and light grey specimens, especially on their surfaces. Several of them are characterized by a directional fabric visible to the naked eye, foliation, which usually appears as an alternation of light grey and black bands. However, this can also be masked by the surface wear that occurs during the polishing of the surface or burial after use. The "spotted" appearance is also common: usually dark grey, greenish, bluish-green and/or light (light grey, pale pink, etc.) spots are visible on a black background. During ageing, the surface of some specimens became brownish. Due to the very fine grain size and surface changes, the classification into the macroscopic group is uncertain for some specimens.

To preserve the integrity of the artefacts, non-destructive OS-SEM-EDX examinations were performed on some selected specimens („original surface method", Bendő et al. 2013).

The specimens with contact metabasite raw material were classified into four versions. The raw material of version 1, which contains the most finds (12 finds), has a banded fabric, formed by bands rich in amphibole and plagioclase, and bands rich in quartz and ilmenite. The composition of the plagioclase is basic (labradorite-bytownite), among the amphiboles here are actinolite, ferroactinolite, magneziohornblende, ferrohornblende and in the core of some amphibole crystals, cummingtonite is present.

The main mass of the raw material of version 2 (5 finds) is composed of magneziohornblende-composed amphibole crystals (cummingtonite is also present in minor amounts). The rock contains muscovite and ilmenite in even greater quantities, but not quartz and feldspars.

The raw material of version 3 (2 finds) has a slightly directed texture (banded), and its main mass is composed of magneziohornblende and edenite-composed amphibole and muscovite. In addition to a larger amount of ilmenite, a small amount of basic feldspar (bytownite) and quartz can also be found in the rock.

Amphibole and plagioclase are also the main constituents of the raw material of version 4 (4 finds). The banding visible to the naked eye is caused by the alternation of bands rich and poor in ilmenite. The original rock before the metamorphosis was probably a gabbro which was coarser-grained than the other versions, which is why these specimens are also less fine-grained than the other 3 versions. The composition of amphiboles and feldspars is also varied: in addition to magneziohornblende, actinolite, edenite and cummongtonite, basic-neutral plagioclase (andesine, labradorite, bytownite) and alkali-feldspar (anorthoclase) also occur.

9 findings were not classified in any variant due to the uncertain macroscopic determination caused by surface changes.

Among the contact metabase variants we examined, variants 1 and 4, based on their texture and mineral composition (taking into account the limitations of the measurement method and the electron microscope used for measurement), can be identified with the contact metabasites occurring in the Krkonoše-Jizera Crystalline Massif in the NW part of the Czech Massif (Šída & Kachlík 2009).

The reason for the diverse composition of amphiboles and plagioclase can be traced back primarily to the original diversity of the rocks that underwent contact metamorphosis and the distance of the specific raw material source from the contact.

Based on the high muscovite content and the texture of the muscovite (it fills the space between the amphibole crystals), the 2nd and 3rd contact metabasite variants are similar to the raw material of some stone tools from NE Hungary (Kereskényi 2021), but in these latter, clinozoisite is also a characteristic component, which it is absent from the rocks we examined.

The delimitation of the source area of the above two metabasite variants requires further investigation.

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