Investigations at the Epigravettian site of Barmaky in Volhynia, north-west Ukraine: analyses and taxonomic reflections

Untersuchungen am Epigravettien-Fundplatz Barmaky in Volhynia, Nordwest-Ukraine: Analysen und taxonomische Überlegungen

Victor Chabai[1]*, Diana Dudnyk[1]*, Kerstin Pasda[2]*, Michael Brandl[3] & Andreas Maier[4]*

[1] Institute of Archaeology, National Ukrainian Academy of Sciences, Volodymyr Ivasiuk ave., 12, Kyiv, 04210, Ukraine; ORCID: 0000-0002-1066-3137 [Chabai]; email: v.p.chabai@gmail.com; ORCID: 0000-0003-0855-3219 [Dudnyk] email: di.dudn.k@gmail.com;

[2] Institute of Prehistoric Archaeology, Friedrich-Alexander-Universität Erlangen-Nürnberg, Kochstraße 4/18, 91540 Erlangen, Germany; ORCID: 0000-0003-3016-3815; email: k.pasda@mail.de

[3] Austrian Archaeological Institute, Austrian Academy of Sciences, Archaeological Sciences (coordinator), Hollandstrasse 11-13, 1020 Vienna, Austria

[4] Institute of Prehistoric Archaeology, University of Cologne, Bernhard-Feilchenfeld-Straße 11, 50969 Cologne, Germany; ORCID: 0000-0002-5021-3341; email: a.maier@uni-koeln.de

Abstract - Known since 1981 and investigated in several campaigns between 1982 and 2007, the site of Barmaky in north-west Ukraine has recently been the subject of renewed investigations from 2018 to 2020. The assemblage is strikingly similar to the one reported from the famous site of Mizyn, located at a distance of about 490 km to the east, except for the absence of a mammoth bone structure. With a weighted average of radiocarbon dates of 19,004 ± 60 calBP, Barmaky is the so far oldest site in north-west Ukraine after the hiatus of the Last Glacial Maximum. The early chronological and – compared to other Epigravettian sites – rather remote spatial position of the site raise several questions, for instance regarding the taxonomic attribution or the role in the resettlement process of the mid-northern latitudes after the Last Glacial Maximum. In this paper, we address these questions in light of the current state of knowledge on the stratigraphy, spatial organisation, faunal assemblage as well as lithic typology and technology. Due to the circumstances since 2020 (pandemic and war), not all analysis could be completed, and some results must still be considered preliminary.

Zusammenfassung - *Die Fundstelle Barmaky in der Nordwest-Ukraine wurde 1981 entdeckt und zwischen 1982 und 2007 in mehreren Kampagnen untersucht. Zwischen 2018 und 2020 fanden erneut Untersuchungen statt. Das Inventar ist dem der berühmten Fundstelle Mizyn, etwa 490 km östlich gelegen, sehr ähnlich, abgesehen von dem Fehlen von Mammutknochenstrukturen. Mit einem gewichteten Mittel der Radiokarbondatierungen von 19.004 ± 60 calBP ist Barmaky bisher die älteste Fundstelle der Nordwest-Ukraine nach dem Hiatus des Letzten Glazialen Maximums. Die frühe chronologische und – verglichen mit anderen Fundstellen des Epigravettien – abgelegene räumliche Position der Fundstelle wirft einige Fragen auf, wie beispielsweise nach der taxonomischen Zuweisung oder der Rolle im Wiederbesiedlungsprozess nach dem Letzten Glazialen Maximum. Dieser Aufsatz widmet sich den angesprochenen Fragen im Lichte des aktuellen Wissensstands zu Stratigraphie, räumlicher Organisation, Fauneninventar sowie lithischer Typologie und Technologie. Wegen der Gegebenheiten seit 2020 (Pandemie und Krieg) konnten nicht alle Analysen abgeschlossen werden und manche Ergebnisse müssen daher noch als vorläufig angesehen werden.*

Keywords - Epigravettian, technology, typology, taxonomy, Eastern Europe
Epigravettien, Technologie, Typologie, Taxonomie, Osteuropa

Introduction

The site of Barmaky (50°37.700'N; 26 17.579'E) is situated in the eastern suburb of Rivne, on the western slope of a small hill, whose top is about 10 m above the valley of Barmatsky creek (Fig. 1).

This creek is a right tributary of the Ustia River, which belongs to the drainage system of the Middle Dnieper basin. In a broader geographical context, Barmaky is situated within the loess plateau of the Volhynian-Lublin upland (Piasetsky 2009). In 1981, Barmaky (also sometimes referred to as Rivne) has been found

*corresponding author

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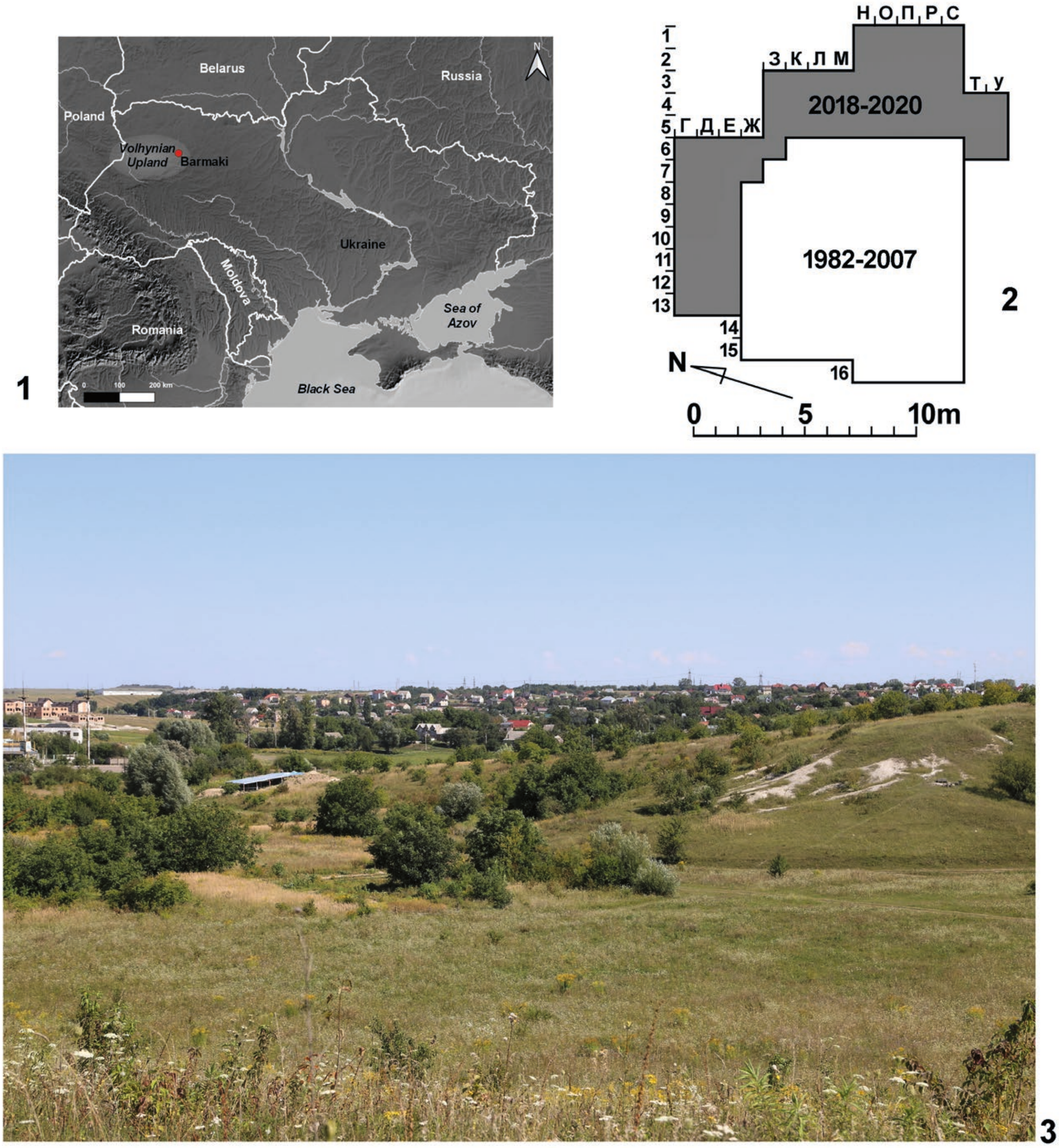

Fig. 1. The site of Barmaky. 1: Geographic location in the Volhynian uplands; 2: excavation plan of the 2nd archaeological level by field campaigns; 3: view from the south: the blue roof covers the site; the whitish slope is a flint outcrop.

Abb. 1. *Die Fundstelle Barmaky. 1: Geographische Position im Volhynischen Hochland; 2: Fundstellenplan des zweiten archäologischen Horizonts nach Feldkampagnen; 3: Blick von Süden: das blaue Dach schützt die Fundstelle; die weißlichen Stellen am Hang sind Feuersteinaufschlüsse.*

by the local geologist Valery Piasetsky. During 1982, 1990, 2002-2005, and 2007, the site was excavated by Ye. Lupenko, V. Piasetsky and D. Nuzhnyi. These investigations could document two cultural layers with an AMS date for the 2nd (lower) layer of about 17.5 ka calBP (SI Tab. 7). The 1st (upper) cultural layer was excavated in the area of 117 m^2, the 2nd cultural layer on 99 m^2, and the faunal assemblage comprised mammoth, rein deer, red deer, horse, bear, wolf, wolverine, fox, arctic fox, and hare. The artefact assemblage of the lower layer is strikingly similar to the one from the famous site of Mizyn, located at a distance of about 490 km to the east, both in terms of the techno-typological features of the stone industry and the personal ornaments. However, despite the presence of mammoth remains, a mammoth bone structure as reported from Mizyn could not be documented. Instead, a kind of pit-dwelling has been proposed (Lupenko 1983; Piasetsky & Samoliuk 1990; Nuzhnyi et al. 2004, 2005, 2006; Piasetsky 1997; Nuzhnyi & Piasetsky 2003; Piasetsky 2009; Nuzhnyi 2015). Between 2018 and 2020, work at the site has been resumed in the framework of a DFG project. The old trenches have been located, reopened, and enlarged.

Taxonomically, Barmaky is attributed to the East European Epigravettian. In Ukraine, this techno-complex follows the latest manifestations of local Gravettian industries roughly around 25-24 ka calBP. While Epigravettian assemblages are reported as early as 23-22 ka calBP in the river basins of Dniester and Prut, the Northern Black Sea steppe region, and the eastern part of Central Europe (Noiret 2009; Krotova 2013; Połtowicz-Bobak 2013), the presence of comparable assemblages in Ukraine north of 50°N has not been reported before 19-18 ka calBP and thus shows a hiatus of five to six thousand years during the Last Glacial Maximum (Chabai & Vasyliev 2021).

The Epigravettian in Ukraine is subdivided in several taxonomic sub-units, based on the typological particularities of lithic projectile implements from 22 stratified assemblages in the periglacial zone of the mid-Dnieper basin. Most important for the subdivision are small straight-backed ('microgravette') points, small lanceolate backed points as well as 'rectangles' (double-truncated backed bladelets) and 'atypical rectangles' (backed bladelets with one truncation only), made on bladelets (width ≥ 7 mm and < 12 mm) and micro-blades (width < 7 mm). Relevant for our study are the Ovruchian, Yudinovian, Mizynian, and Mezhyrichian sub-units, referred to as 'industries' by Nuzhnyi (2008; 2015; Tab. 1). Other units, such as the Dnistrovian or single sites with an idiosyncratic tool kit, such as Zhurivka, Velyka Bugaivka, Yeliseevychi and Suponevo (ibid.), will not be considered in the following.

In assemblages attributed to the Mizynian, straight-backed (and few lanceolate) micro-points with fine abrupt dorsal retouch on bladelets and micro-blades are common, which often show an obliquely retouched/truncated base. In addition, few narrow rectangles with one or two oblique truncations occur but are rather uncommon. The characteristic features of the Yudinovian are lanceolate points on flakes, blades, and bladelets with abrupt/semi-abrupt retouch and typical/atypical rectangles on blades and bladelets. For the Mezhyrichian, the characteristic insets are narrow lanceolate with fine dorsal and ventral abrupt and semi abrupt retouch and numerous rectangles made on bladelets and micro-blades, sometimes by inverse and alternate retouch. The Semenivka 1, 2, and 3 assemblages contain the evidence of micro-burin technic application. The Ovruchian is characterised by lanceolate and straight-backed points made on blades and bladelets. Often, the bases of these points are obliquely retouched. Rectangles are not common. The chronological data (158 radiocarbon dates from 16 sites) suggests that these taxonomic units date roughly between 19 to 14 ka calBP (Chabai et al. 2020), while the temporal relation between them remains questionable.

Compared to other Epigravettian sites in Ukraine, Barmaky is located rather remotely in the north-western part, while its artefact assemblage indicates a comparatively early chronological position. This raises several questions as to its taxonomic attribution or role in the resettlement process of the mid-northern latitudes after the Last Glacial Maximum. In this paper, we address these questions in light of the latest results on the site formation process and stratigraphy, chronology, spatial organisation, faunal assemblage

Taxonomic sub-units	Mizynian	Mezhyrichian	Yudinovian	Ovruchian
Main sites	Barmaky, Mizyn,	Mezhyrich, Gintsy, Dobranichivka, Fastiv, Semenivka 1-3, Buzhanka 2	Yudinovo, Timonovka 1 & 2, Pushkari IX, 1, Chulativ 2	Sholomki 1, Zbran'ki, Dovginichi
Backed points	straight-backed points on bladelets/micro-blades with fine abrupt dorsal retouch, often with obliquely retouched/truncated base	lanceolate points on bladelets/micro-blades with fine dorsal abrupt/semi-abrupt retouch; ventrally retouched base	lanceolate points on flakes, blades, and bladelets with abrupt/semi-abrupt retouch	lanceolate and straight-backed points on blades and bladelets with abrupt/ semi-abrupt dorsal and bipolar retouch with oblique or transversal truncation
Rectangles	few rectangles on bladelets/microblades with one or two oblique truncations in Mizyn assemblage; uncommon in Barmaky	numerous narrow rectangles on bladelets/micro-blades with one but usually two straight or convex truncations; often with ventral retouch/truncation	rectangles on flakes, blades, and bladelets with one and two truncations; atypical rectangles – rounded angle between lateral and distal/proximal sides	uncommon
Organic artefacts	spindle-shaped and sometimes slotted points; batons percées	spindle-shaped and sometimes slotted points; batons percées	cylindrical points	not reported
Mammoth dwellings	yes	yes	yes	no
Dating	19-17.5 ka calBP	18.5-16 ka calBP	18-14 ka calBP	undated

Tab. 1. Taxonomic sub-units of the Epigravettian techno-complex in mid Dnieper basin.

Tab. 1. *Taxonomische Untereinheiten des Epigravettien-Technokomplexes im mittleren Dnieper-Becken.*

as well as lithic typology and technology. Due to the circumstances since 2020, not all investigations could be completed. Already the last campaign in 2020 was affected by the covid19 pandemic and several analyses became delayed. With the Russian invasion, the circumstances for scientific work became even more complicated. Therefore, some results must still be considered preliminary.

Material and Method

In the following, we present the results of the 2018-2020 field campaigns. At the end of the 2020 excavation, the total studied area of the upper and lower cultural layers comprises 190 and 171 m^2, respectively. A total of 152,617 lithic artefacts from the lower layer has been uncovered and analysed technologically and typologically by two of us (VC and DD).

The osteological material was recorded during fieldwork in 2018 and 2019 (KP). So far, 55 objects from the excavations in 2018 and 2019 and the entire material from the excavation campaign in 2020 have not yet been determined, but are currently under study. The recorded parameters include location, species, skeletal element, bone part, side, sex, age class, age criterion, pathology, cut marks and traces of butchering, burn traces, weight, and dimensions. In addition to the recently excavated material, the faunal remains from the 1990 excavation, stored at the museum in Rivne, has also been recorded as detailed as possible, although some finds in show cases could not be removed. In total of 1,462 bone specimens could be analysed.

Measurements were taken with a digital calliper up to 0.1 mm accuracy according to von den Driesch (1976) and a fine scale (> 200 g with a luggage scale). For the taxonomic analysis, an osteological comparative collection of smaller species was used, while for the larger species 3D offline (developed by the University of Leipzig) tools were used. Selected skeletal elements of mammoth could be compared with the collection at the Austrian Academy of Sciences. On site, objects were photographed with a digital camera (Nikon D5100). Details were recorded in the laboratory with a Nikon D7500 using a microscope lens (Nikon DX AF-S Micro NIKKOR 40 mm 1:2.8 G) and additional magnification rings. Selected objects were documented in detail with a strong light microscope at the University of Hildesheim. The age determination was carried out according to Habermehl (1961), Haynes (1991), Laws (1966), Pasda (2009), Raubenheimer et al. (1995), and Rountrey et al. (2012).

Results

Stratigraphy

The stratigraphic sequence comprises 2.5 m of sediments, which are sub-divided in 12 lithological layers (Figs. 2-4). All layers show an inclination of about 3° in east-west direction, thus matching the gradient and direction of the modern slope. The Pleistocene deposits are heavily affected by cryoturbation processes, resulting in permafrost depression channels and solifluction. The studied depression channels are part of a bigger polygonal permafrost system.

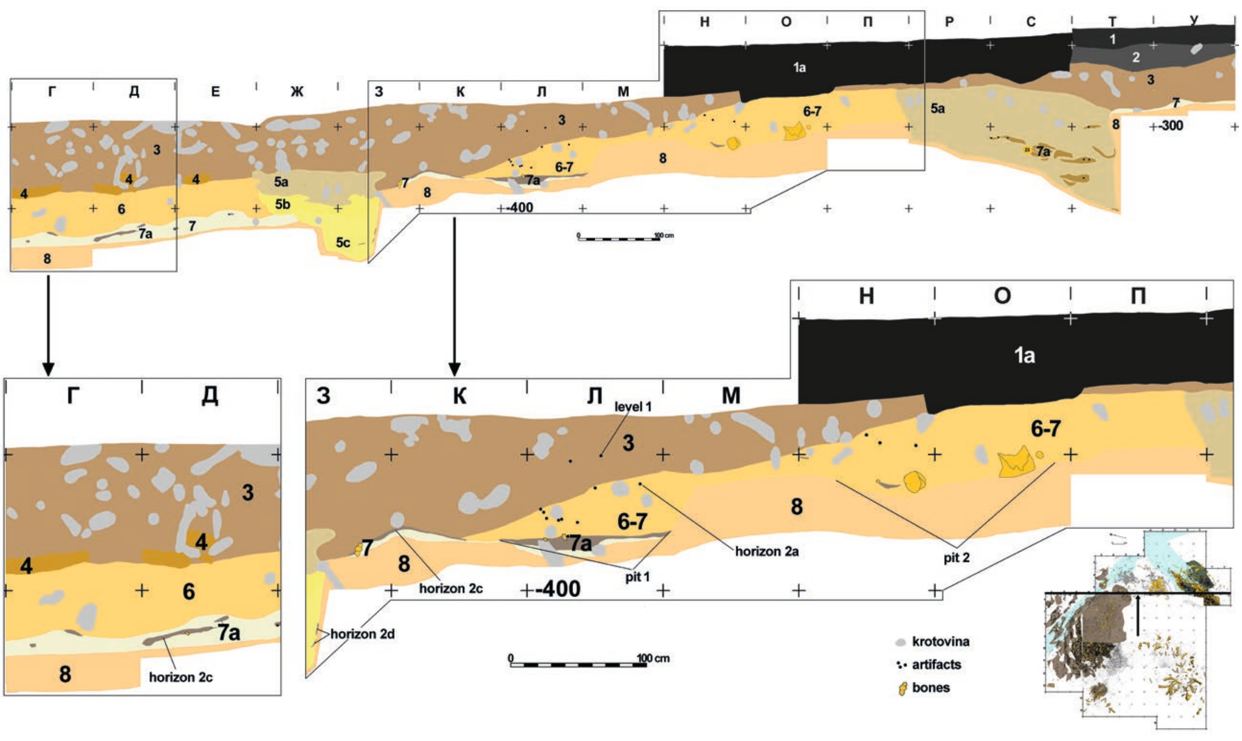

Fig. 2. Barmaky: north-south profile, facing west, along the square lines 5/6. Numbers indicate lithological layers. For a larger site plan see figure 6.

Abb. 2. *Barmaky: Nord-Süd-Profil, Blick nach Western, entlang der Quadratmeter-Reihe 5/6. Für einen größeren Fundstellenplan siehe Abbildung 6.*

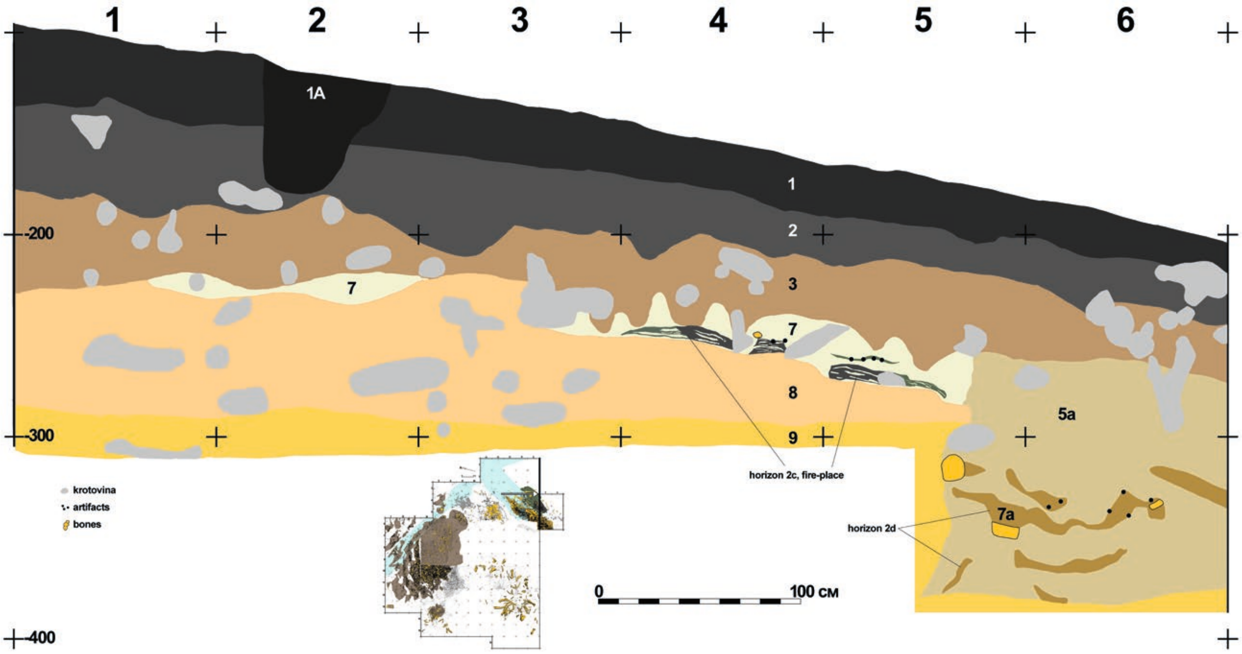

Fig. 3. Barmaky: east-west profile, facing north, along the square lines c/т. Numbers indicate lithological layers. For a larger site plan see figure 6.

Abb. 3. *Barmaky: Ost-West-Profil, Blick nach Norden, entlang der Quadratmeter-Reihe c/m. Für einen größeren Fundstellenplan siehe Abbildung 6.*

Lithological layers

This section provides an overview of the lithological layers documented at the site. Colour descriptions are complemented by Munsel soil colour charts (2000), recorded on dry sediment.

Layers 1 and 1a – "*chernozem*" black colour soil (10B, 2.5/1); with pronounced traces of modern agriculture activity and bioturbation processes; the thickness is up to 0.4 m.

Layer 2 –grey colour Holocene soil (N, 4/); with pronounced traces of bioturbation processes; loose sediment structure; the upper boundary is clear; the thickness is up to 0.6 m.

Layer 3 – greyish brown loose silty-loess (7.5YR, 5/2); spread over the entire excavated area; contains carbonate concretions – "*beloglazka*" and animal burrows – "*krotovinas*"; in the western part of the excavated area, the sediments of layer 3 fill a permafrost depression, the upper boundary is gradual; the thickness of lithological layer 3 varies from 0.1 up to 0.9 m.

Layer 4 – the light brown compact silty-loess (7.5YR, 6/4); found in the western part of the excavated area as separated lenses; both upper and lower boundaries are clear; in the western part of the excavated area, the lenses of layer 4 are truncated by permafrost depression fillings; the maximum thickness of each lens is up to 0.25 m.

Layers 5a, 5b, 5c – light, greyish, yellowish silty-loess sediments (2.5Y, 7/2; 2.5Y, 7/4; 2.5Y, 6/4); represent the filling of permafrost depression channels; the upper boundaries are gradual; the lower boundary is clear; the maximum thickness found in the eastern part of the excavated area in the section along the line of squares c/т is up to 1.4 m.

Layer 6 – dark yellow silty-loess (10YR, 6/6); compact; spread over the entire excavated area, except the westernmost square lines; contains carbonate concretions – "*beloglazka*"; the upper boundaries in a contact with lithological layers 3 and 4 are gradual and clear, respectively; lithological layer 6 is truncated by the fillings of erosional depression channels (layers 3, 5a, 5b, 5c); the maximum thickness is up to 0.57 m.

Layer 6-7 – yellow silty-loess sediments (10YR, 8/6); loose; found in the eastern part of the excavated area, above and around pits 1 and 2; contains bone fragments, flint artefacts, and lenses of brownish sediments; the upper boundaries in a contact with lithological layers 1 and 3 are clear and gradual, respectively; the northern part of lithological layer 6-7 is truncated by the filling of permafrost depression; the maximum thickness is about 0.6 m.

Layer 7 – whitish silty-loess sediment (7.5YR, 7/1); spread nearly all over the excavated area; compact; truncated by fillings of permafrost depressions; the upper and lower boundaries are wavy and clear; the maximum thickness is about 0.25 m.

Layer 7a – the dark brown silty loess (7.5YR, 3/3 in western area and greyish brown in eastern area 10YR, 5/2); compact; found inside the whitish sediments of lithological layer 7 and in the filling of permafrost depression channels; in depressions, the sediments of 7a accumulated as small, thin, often vertically disposed lenses of brown silty loess; contains flint artefacts, faunal remains, burnt material, ochre pieces and powder, as well as thin whitish / yellowish lenses of solifluction origin (Fig. 5); the upper and lower boundaries are both wavy and clear; truncated by fillings of permafrost depressions; the maximum

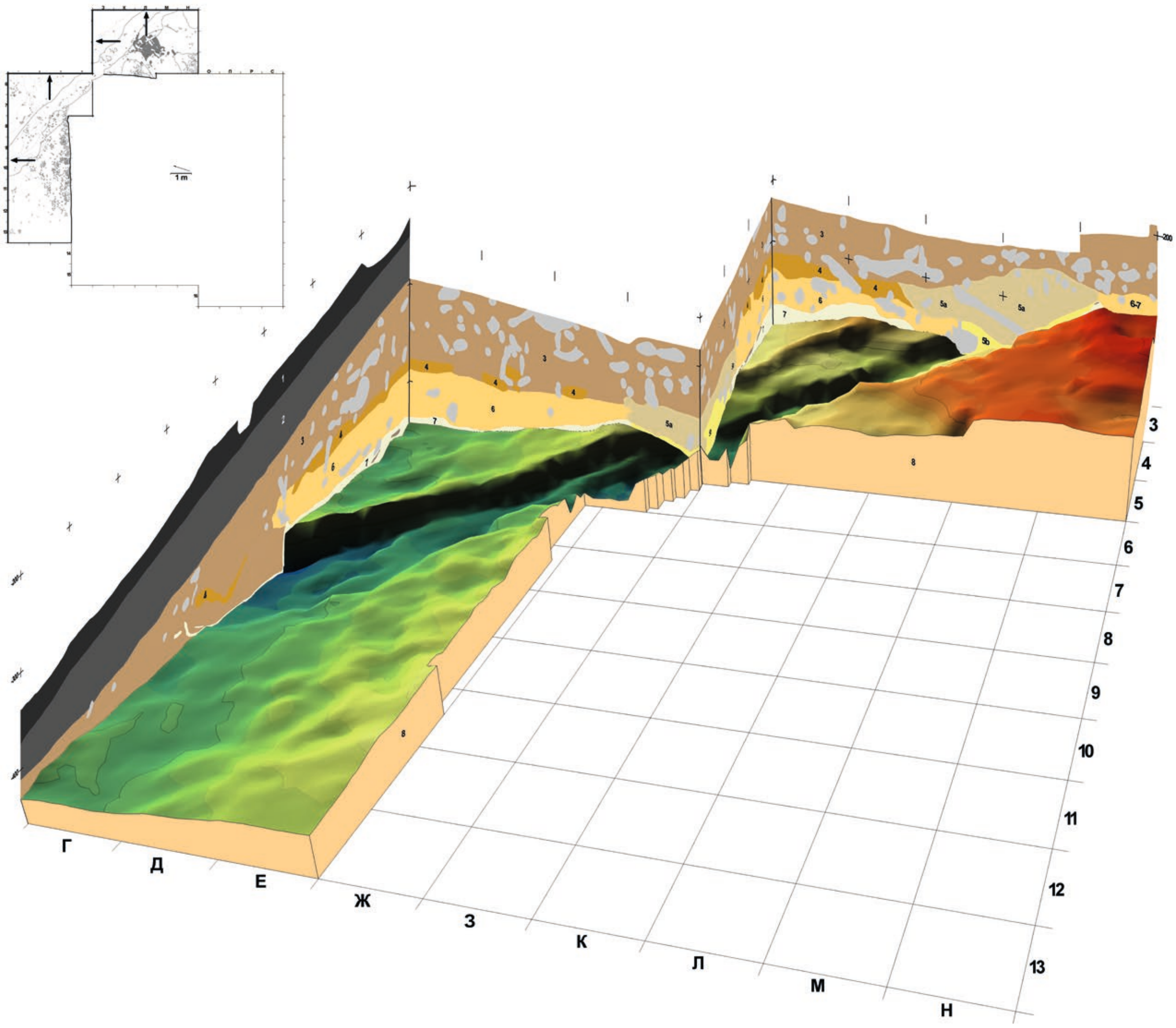

Fig. 4. Barmaky: profiles and 3D reconstruction of the floor surface (base) of archaeological horizons 2c and 2d (details in the text).
Abb. 4. *Barmaky: Profile und 3D Rekonstruktion der Oberfläche (Unterkante) der archäologischen Horizonte 2c und 2d (Details im Text).*

thickness is about 0.15 m; the deposits of the 7a layer were covered by the horizon of chalk / marl crust in the squares 4к, 4л, 4м, 5л, 5м, 5у, 6у.

Layer 8 – pale-yellow silty-loess (2.5Y, 8/3); spread all over the excavated area; compact; striated; the upper boundary is clear; the maximum thickness is about 0.7 m.

Layer 9 – pale-yellow silty-loess (2.5Y, 8/3); spread all over the excavated area; compact; intensively striated; the upper boundary is unclear; the studied thickness is more than 1.8 m.

The wavy boundaries and surfaces of lithological layers and their discontinuous character seem to be the result of post-depositional cryoturbation processes, which also created the channels of permafrost depressions and solifluction lenses (Fig. 4). These cryoturbation processes were caused by permafrost degradation. The available stratigraphic sequence suggests the beginning of permafrost degradation during / after the accumulation of lithological layer 4. Such permafrost depressions were observed at a number of Eastern European sites, such as Zaraisk, Yeliseevichi I, Timonovka I, Yudinovo (Velichko et al. 1997: 51-66; Amirkhanov 2000: 88, 94; Sergin 2007: 14-15; Gribchenko & Kurenkova 2014: 107). The presence of permafrost deposits suggests a relative stability of the living floor during the accumulation of the cultural deposits, a necessary requirement for settlement activities under periglacial conditions (Sergin 2007; Grigorieva 2008: 53-54).

The archaeological sequence

The artefacts of the 1st archaeological level are associated with the 3rd lithological layer. The archaeological level 2 is subdivided in several horizons depending on their depositional context: 2a, 2a1, 2b, 2c, and 2d. Horizon 2a was found in the deposits of lithological layer 6-7. The finds from the marl crust were defined as archaeological horizon 2b. The finds from lithological layer 7a compose the material of archaeological horizon 2c. The material from permafrost depression channels was labelled as archaeological horizon 2d.

Fig. 5. Barmaky, horizon 2c: section along the squares 10e/11e, showing the yellowish solifluction lenses in the brownish sediments of lithological layer 7a.

Abb. 5. *Barmaky, Horizont 2c: Schnitt entlang der Quadratmeter 10e/11e mit gelblichen Solifluktionslinsen im bräunlichen Sediment der lithologischen Schicht 7a.*

The archaeological level 1 contains a small number of flint artefacts and a few bone fragments. The bones and artefacts do not form clear vertical and / or horizontal concentrations and are more or less equally distributed all over the excavated area. Therefore, level 1 is constituted most probably by redeposited artefacts and faunal remains.

The archaeological horizon 2a as well as the sediments of lithological layer 6-7 are only found on a limited area above and around pits 1 and 2, that is at about 17 m^2 in squares 3м, 3н, 4л, 4м, 4н, 4о, 5к, 5л, 5м, 5н, 5о, 5п, 6к, 6л, 6н, 6о, 6п. The main concentrations of bones and artefacts from horizon 2a are situated strictly above pits 1 and 2 (Fig. 6). Conspicuously, layer 6-7 shows a dome-like depositional structure (Fig. 2). Together with its position above pits 1 and 2, this might point towards modifications of the site's topography by constructions covering the deepened pit-features. If correct, the presence of artefacts, bone fragments, and brownish lenses within layer 6-7 suggests that cultural deposits were already present before the pits have been dug.

The archaeological horizon 2a1 takes the form of a 1.5 m^2 wide, vertically and horizontally compact lens of flint artefacts directly above pit 1 in squares 5к, 5л, 6к, 6л. This lens is separated by 0.1-0.15 m thick sterile sediments from both the above and below deposited finds of horizons 2a and 2c, respectively.

The archaeological horizon 2b is represented by two concentrations of chalk/marl crust of probably anthropogenic origin (see chapter 'The chalk/marl crusts'). In both cases, the brownish sediments of lithological layer 7a directly underlie the crusts. The largest concentration was found in squares 4к, 4л, 4м, 5л, 5м (Fig. 6). It directly underlies the deposits of lithological layer 6-7 and overlies the deposits of lithological layer 7a. In squares 4к and 4л, due to the post-depositional permafrost degradation process, the chalk/marl crust was partly affected by vertical dislocation (Fig. 7). The second chalk/marl crust is found in squares 5у, 6у in the deposits of lithological layer 7 (Fig. 6).

The archaeological horizon 2c accumulated in lithological layer 7a and has been documented in two spatially distinct areas in the western (35 m^2) and eastern (34 m^2) parts of the site. The colour of the 7a lithological layer in the western area is more brownish (7.5YR, 3/3), while in the eastern area, it is more greyish (10YR, 5/2). The border between these two areas roughly runs through the squares 3м, 4м, and 5м (Fig. 6). Unfortunately, due to the post-depositional cryoturbation processes, the direct stratigraphic contact between the two areas was not found. These areas are characterised by both continuous and patchy spread of brownish/

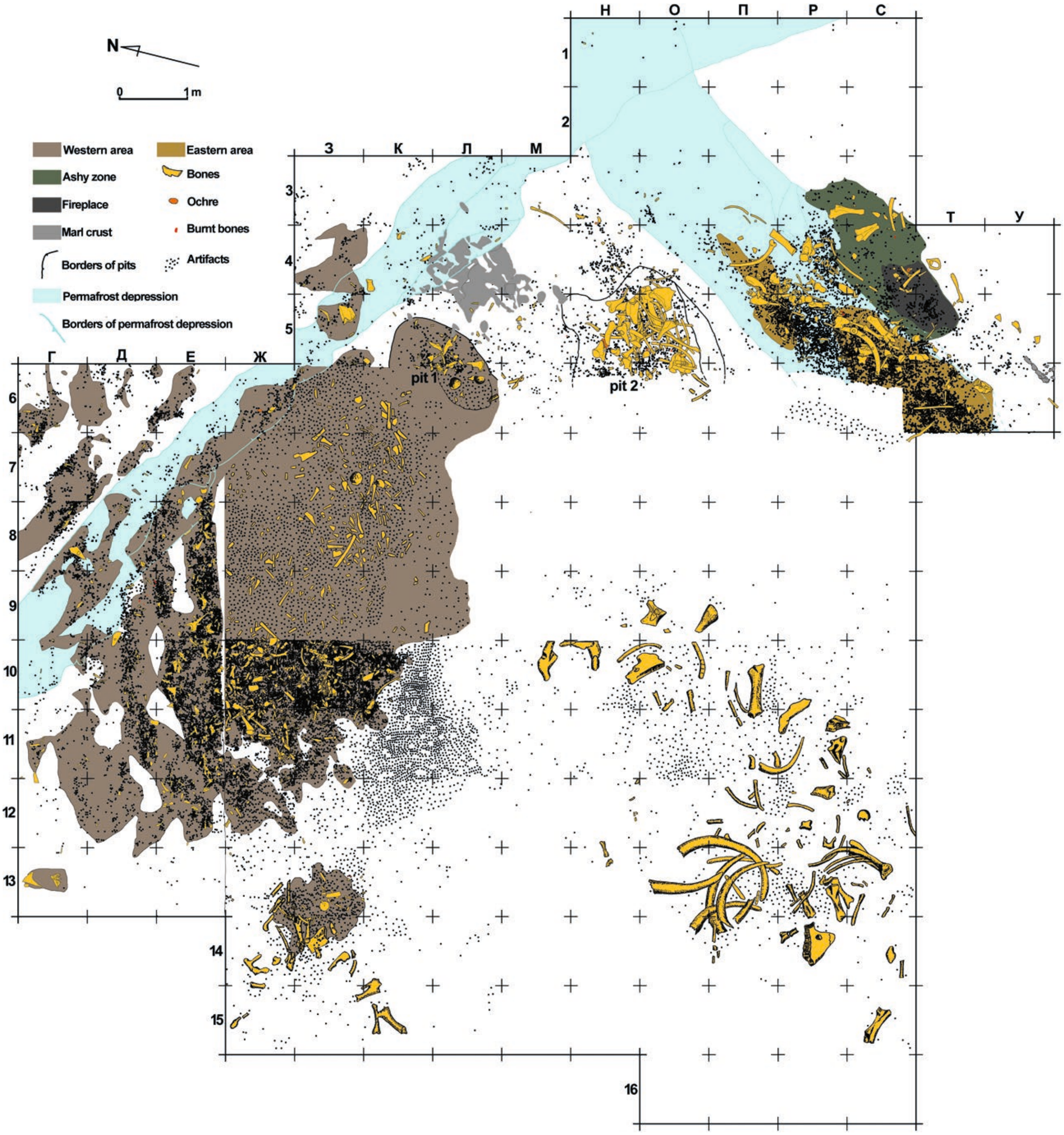

Fig. 6. Barmaky, archaeological level 2: site plan showing the distribution of bones, artefacts, structures, coloured sediments, and permafrost depressions.

Abb. 6. *Barmaky, archäologischer Level 2: Plan der Fundstelle mit Verteilungen der Knochen, Artefakte, Strukturen, gefärbten Sedimenten und Permafrost-Depressionen.*

yellow-greyish sediments of layer 7a and whitish sediments of layer 7. The same is true for the depositional characteristics of archaeological horizon 2c. The number of artefacts in the most densely packed squares in the western (sq. 9e) and eastern area (sq. 5p) is quite similar with 13,997 and 12,419 items, respectively. It needs to be stressed that despite the cryogenic processes, the net movement of objects both in terms of distance and quantity was quite low. This is demonstrated by several cases of ochre powder concentrations and still articulated bones, indicating rather a plastic deformation of the find horizon than stronger erosional events (Fig. 8).

The archaeological horizon 2d found in the permafrost depression channels (lithological layers 5a, 5b, 5c); contains numerous flint artefacts, faunal remains, parts of chalk/marl crust of horizon 2b, and brownish/yellow-greyish lenses of horizon 2c. There are two channels, one in the eastern and another in the western section, conjoining in squares 1н, 1о, 2н, 2о. The eastern channel was opened on a length of 7.2 m and had a maximum width of 1.95 m and maximum depth of 1.2 m. The western channel has been studied on a length of 13.5 m, a width of 1.1 m, and a depth of 0.2-0.6 m. The numbers of both artefacts and bones

Fig. 7. Barmaky, horizon 2b, squares 4к, 4л, 4м, 5л, 5м: chalk/marl crust of probably anthropogenic origin, partly dislocated by permafrost processes.

Abb. 7. *Barmaky, Horizont 2b, Quadratmeter 4к, 4л, 4м, 5л, 5м: Kalk/Mergel-Kruste wahrscheinlich anthropogenen Ursprungs, teilweise verlagert durch Permafrost-Prozesse.*

Fig. 8. Barmaky, horizon 2c, square 10e: articulated bones of polar fox.

Abb. 8. *Barmaky, Horizont 2c, Quadratmeter 10e: Knochen vom Eisfuchs im anatomischen Verband.*

in the depression and neighbouring areas of horizon 2c are comparable. Numerous bones in anatomical order were found in the depressions (Fig. 9).

Given that the occupation at Barmaky post-dates the period of maximum cold, it seems reasonable to assume that during the accumulation of archaeological level 2, at least two permafrost ice wedges were situated beneath the inhabited area at a depth of 0.2-1.2 m. During the subsequent climatic warming, the melting permafrost led to a vertical translocation of both sediments and archaeological material. The net horizontal movement of both sediments and artefacts was probably not very pronounced.

Structures

The chalk/marl crusts

Two thin crusts of chalk or marl deposits (Fig. 7), probably of anthropogenic origin, could be documented during excavation. The material can still be extracted from natural outcrops in close proximity to the site and was spread on the loess. The shape of the first crust from squares 4к, 4л, 4м, 5л, 5м is amorphous. It covers an area of about 1.5 m^2 and has a thickness of between 0.03 and 0.05 m. It consists of densely packed chalk/marl fragments of different sizes (Figs. 6-7). The maximum size of the fragments is 0.2×0.15×0.05 m. The relatively small artefact sample associated with the crust – archaeological horizon 2b – amounts to 276 pieces. The second crust from squares 5у and 6у consists of a line of fragments with a total length of 0.5 m, width of 0.2 m, and thickness of 0.1 m. It might be a part of larger, not yet excavated structure. So far, no artefacts are associated with it. Another chalk/marl concentration is known from the site of Samotoevka, where it was apparently used as the "floor" around a fireplace (Bessudnov & Bessudnov 2012).

Pit 1

Pit 1 has already been documented by V. Piasetsky and V. Samoliuk (1990), who excavated it in large parts (Fig. 6). Pit 1 has an ovoid shape with a maximum diameter of 0.72 m, sloping walls, and a wavy floor with a maximum depth of 0.17 m. The filling is represented by sediments of lithological layers 7 and 7a. The undisturbed stratigraphic sequence at the bottom of pit 1 might be evidence of a natural origin of this depression. The finds of archaeological horizon 2c amount to 3,258 flint artefacts and 48 pieces of faunal remains. Among the later, two mandibles of young mammoths were identified. The density of faunal remains in pit 1 also sets it apart from the surrounding areas, speaking against an accumulation by erosion. Taking into account the probable natural origin of pit 1, the faunal concentration it contains might be defined as a cache in a natural depression.

Pit 2

Like pit 1, pit 2 has also been excavated partly by V. Piasetsky (Figs. 6 & 10). Unfortunately, he has not

Fig. 9. Barmaky, horizon 2d, squares 4п, 4р, 5п, 5р: articulated mammoth vertebrae at the bottom of the permafrost depression.

Abb. 9. *Barmaky, Horizont 2d, Quadratmeter 4п, 4р, 5п, 5р: Mammutwirbel im anatomischen Verband am Grund der Permafrost-Depression.*

documented it as such. Pit 2 has an irregular to ovoid shape with a maximum length of 2.14 m and a maximum width of 1.71 m. The walls are sloping, and the floor is concave with a maximum depth of 0.35 m. The filling consists of sediments of lithological layer 6-7. The lenses of brownish/greyish sediments and chalk/marl pieces in the filling of pit 2 suggest the presence of cultural deposits of horizons 2b and 2c. The archaeological material is represented by 5,290 pieces of flint artefacts, 1 fragment of amber, 5 perforated fossil shells, and 89 faunal remains. The later are mainly represented by mammoth ribs; also, the fragment of a skull of a young mammoth has been recovered.

Dwelling structure

A complex of three settlement objects in the eastern part of the site, namely a fireplace (squares 4с, 4т, 5с, 5т), a patch of ashy sediments (squares 3р, 3с, 4р, 4с, 4т, 5с, 5т), and a line of seven big fragments of long bones (squares 3с, 4т, 5у) might be the remnants of a former dwelling structure (Fig. 10).

In the south-eastern part of the site, there is a cluster of intensively grey ashy/sooty sediments showing a clear eastern and partly norther border without gradual transitions, while its western and southern limits were truncated by the permafrost depression channel. The ashy cluster has a NE-SW extension and an irregular ovoid shape. The preserved length is 2.86 m, the preserved width is 1.25 m, and the preserved thickness is 0.07 m. The archaeological finds from the ashy cluster consist of 1,643 flint artefacts, 19 of which are burnt, and 21 bone fragments, two of which are burnt, although not intensively as indicated by their brown colour. The clear northern and eastern limits of the distribution of ash and artefacts might be evidence of the former presence of some kind of barrier or wall.

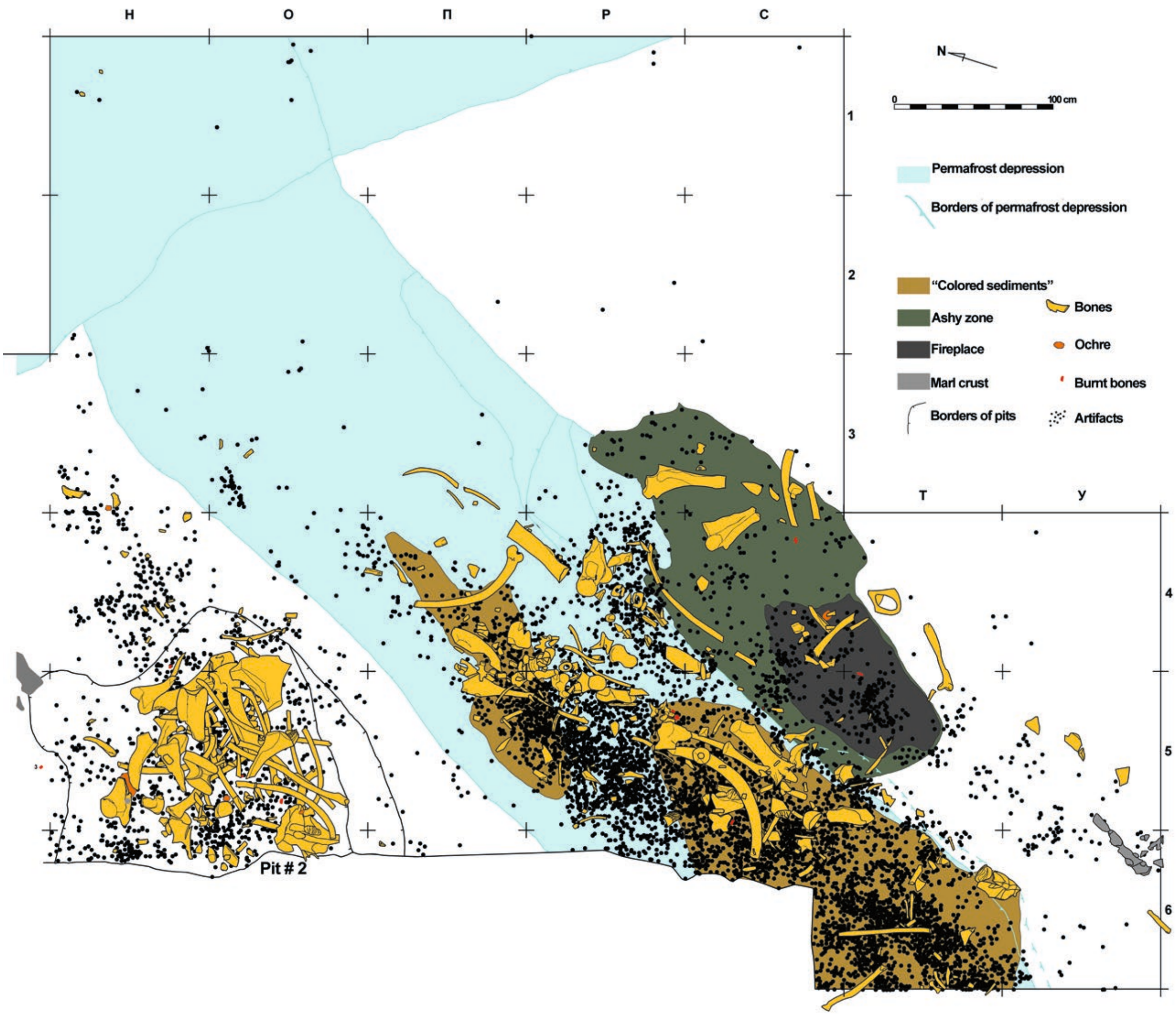

Fig. 10. Barmaky, horizons 2c and 2d: enlarged map section of the eastern area, showing bones, artefacts, structures, and permafrost depressions.

Abb. 10. *Barmaky, Horizont 2c und 2d: vergrößerter Ausschnitt des östlichen Teils des Fundstellenplans mit Knochen, Artefakten, Strukturen und Permafrost-Depressionen.*

Located in the southwest of the ashy cluster – and probably its source – is a fireplace. It belongs to the simple type, i.e., not deepened and without additional constructions (Figs. 10 & 11). It has an ovoid shape of 1.36 x 0.71 m extending in the NE-SW direction and a preserved thickness of 0.08 m. The black colour sediments of the fireplace consist of ashy/sooty components, which clearly contrast with both the ashy cluster and whitish silty-loess deposits of lithological layer 7. Solifluction lenses (max. thickness 0.02 m) of whitish, silty loess were found in the ashy/sooty deposits of the fireplace. 1,374 flint artefacts (30 burnt), 18 fragments of bones (1 burnt), and a concentration of burnt ochre powder (diameter ≈ 0.1 m) were found in the deposits of the fireplace. There is an alignment of seven large fragments of tube bones in squares 3c, 4т, 5у which show the same NE-SW orientation as the fireplace and the ashy cluster. Also, three of them are preserved in a vertical position, reaching about 5-7 cm below the level of other finds of this horizon (Figs. 10 & 12). However, the relation of this bone line to both features remains unclear. The same is true for the small chalk/marl concentration with the same orientation in squares 5у, 6у. When considered together, the fireplace, the ashy cluster with its clear limits, and the alignment of seven large bone fragments might be the remnants of a light dwelling structure, such as a tent. However, since the feature's alignments run parallel with the permafrost depression, i.e., strung-out in north-south direction, taphonomic processes as agents in the formation of these features cannot be excluded.

Eventually, we propose the following sequence of processes affecting the formation of archaeological level 2:

1. The accumulation of the materials of horizon 2c, including the dwelling structure and pit 1. The dwelling structure in the eastern part of the site and pit 1 in its western part were both used during the accumulation of horizon 2c, because its brownish sediments were found as continuous deposits in the walls and floor of pit 1, while its yellow-greyish sediments are associated with the dwelling structure (see figure 2, squares к and л).
2. The formation of the chalk/marl crusts – i.e., the horizon 2b in the western area.
3. The digging of pit 2 and its partial filling by the greyish/brownish sediments and chalk/marl fragments of horizons 2c and 2b, respectively. The brownish sediments of layer 2c were presented in the shape of numerous small lenses in the filling of pit 2, suggesting a later construction of this pit after the accumulation of the cultural deposits of horizon 2c in the western area had taken place.
4. The accumulation of horizon 2a1 above pit 1 – i.e., the process of covering the pit by surrounding sediments, forming the cache in natural depression.

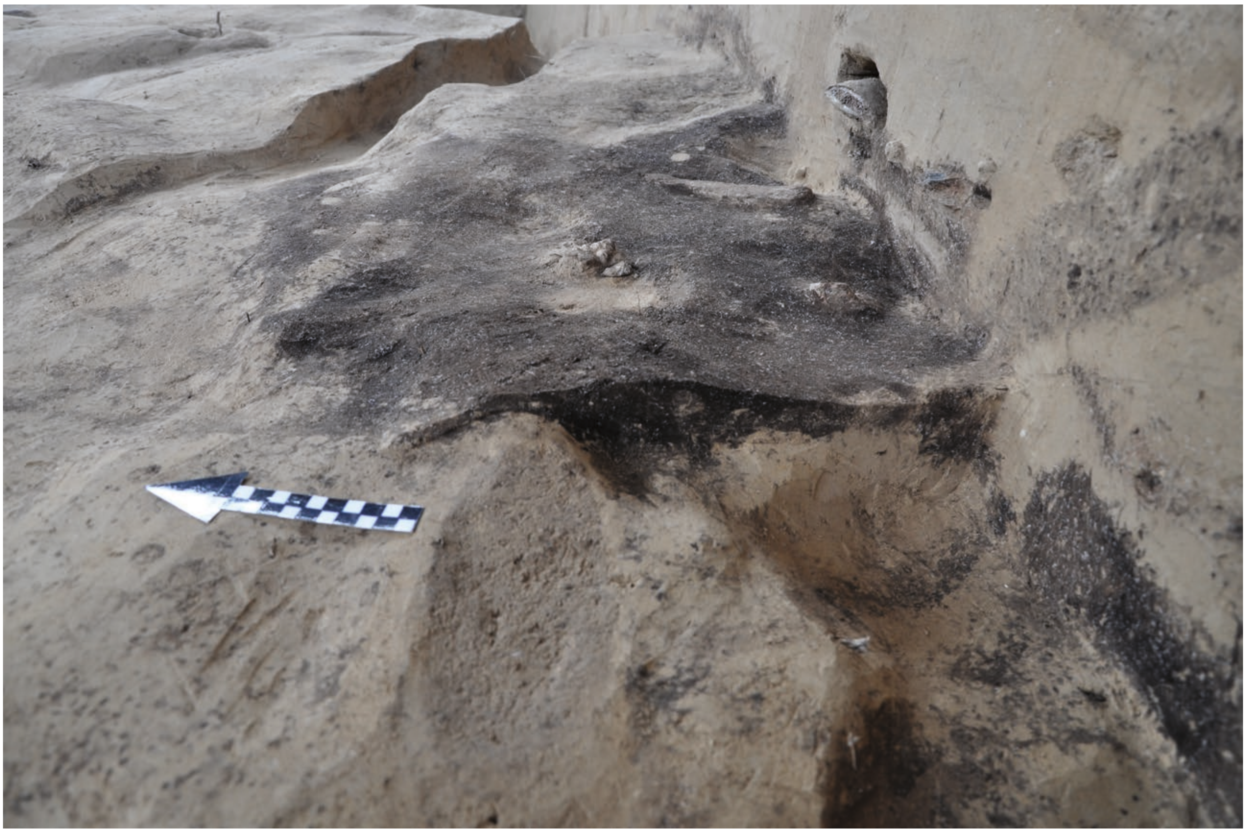

Fig. 11. Barmaky, horizon 2c, fireplace. Sections along the squares 4c / 5c and 5c /5т.

Abb. 11. *Barmaky, Horizont 2c, Feuerstelle. Schnitt entlang der Quadratmeter 4c / 5c und 5c /5т.*

Fig. 12. Barmaky, horizon 2c, square 5y. Line of vertically positioned tube bone fragments.
Abb. 12. *Barmaky, Horizont 2c, Quadratmeter 5y. Reihe vertikal positionierter Langknochenfragmente.*

5. The accumulation of horizon 2a above the pits 1 and 2 and partly above the chalk/marl crust – i.e., the covering of pits by surrounding sediments.
6. The degradation of permafrost leading to the appearance of the depressions – i.e., the formation of horizon 2d.

The absence of a direct stratigraphic contact of the deposits of horizon 2c in the western and eastern areas prevents a determination of their temporal correlation. In other words, the western and eastern areas might be two habitation zones of a single settlement event or two temporally different settlement events. The process of digging pit 2 happened after the accumulation of bones and artefacts of horizons 2c and 2b both in the eastern and in the western area. Thus, pit 2 is supposed to be the latest archaeological structure in the history of Barmaky, level 2 settlement(s). The separate covering of pit 1 by horizon 2a1 deposits suggests that pit 1 was covered before the covering of both pits by sediments of 2a horizon.

Chronology

For Barmaky, there are currently five AMS dates on bones (SI Tab. 7). All samples are taken from relatively thick fragments of tube bones. According to D. Nuzhnyi, the sample Ki-11087 originates from an unclear stratigraphic context. The samples of tube bone fragments OxA-38249, OxA-38250, and OxA-X-2804-40 belong to the horizon 2c, squares 12e and 10e. The sample MAMS-49912 was found in the fillings of permafrost depression: horizon 2d, square 6ж.

The radiocarbon dates place the Barmaky, level 2 occupations towards the very end of the Last Glacial Maximum. A weighted average result in an age estimate of between 19,050 and 18,950 cal BP. The dates are thus in a good agreement with the observed cryogenic features characteristic for that time and make Barmaky the so far oldest Epigravettian site in Ukraine north of 50° northern latitude.

Lithic raw material studies – preliminary results

The lithic artefacts found in Barmaky are all made on high-quality Turonian flint. This raw material can be found in the entire area of the Volhynian Uplands in nodular or flat shapes and is macroscopically very similar. The closest outcrop is located only 300 m to the south within the chalk/marl deposits at an eroded slope of the hill. So far, the import of non-local flint could not be attested. Analyses on the provenance of the raw material used at Barmaky are currently underway. Here we report the results from a first background sampling from lithic outcrops at the site and in the region.

In order to test possibilities for a differentiation of specific varieties of locally available high quality Upper Cretaceous (Cenomanian and mainly Turonian) flint raw materials within the study area, several geological spots were sampled in the vicinity of Rivne and Barmaky. The best suitable samples for a geological reference so far come from a quarry at Ostriv, some 30 km to the southwest of Barmaky, in which three distinct flint layers were examined according to the Multi Layered Chert Sourcing Approach (MLA: Brandl 2016; Brandl et al. 2018). Taking Ostriv as a reference, the samples from the location Rivne 1 and Barmaky (spots 326 – 329) in the vicinity of the site were tested, including residual and transported material collected from all sampled spots. Stereomicroscopic examination revealed a much larger range of micro-facies within the materials collected from Rivne and Barmaky than attested for the primary sequence at Ostriv (Fig. 13).

Additional to initial microfacies analyses, geochemistry using Laser Ablation – Inductively Coupled Plasma – Mass Spectrometry (LA-ICP-MS) was performed on representative samples from the three locals at the NAWI Geocenter of the University of Graz, Austria. An extended report is in preparation. Preliminary geochemical results indicate that it is possible to define a narrow chemofacies of the Ostriv sequence using chemical elements strontium (Sr) and magnesium (Mg), amongst others (Fig. 14). Especially strontium appears to be a significant marker, most likely related to bioproductivity within certain depositional environments. It may also be possible to differentiate between individual layers within the primary outcrop, however, the number of samples tested for this study is too low to allow secure conclusions. Including the test samples from Rivne and Barmaky into the geochemical study, it was possible to assign some to the narrower chemofacies characterised for the primary Ostriv sequence, while others point to an origin from the wider chemofacies within the Upper Cretaceous depositional regime of the Volhynian region (Fig. 14). Although these preliminary results reveal the potential for targeted future studies in this direction, it will be necessary to conduct more systematic geological surveys and populate the micro-facial and geochemical database to place all analysed geological samples into the larger picture. Once this is achieved, it will be possible to include archaeological materials for sound provenance analyses useful for research in the wider Volhynian region.

Lithic Artefacts

The assemblage of lithic artefacts consists of more than 150,000 pieces (Tab. 2). Chips (≤ 15 mm) dominate in each horizon and feature with more than 80 %. Chunks and unmodified raw pieces are present in small numbers in nearly all horizons and features. About 20 % are big enough to be a reserve of raw material, including nodules. Without chips and chunks, flakes make up about half of the artefacts. The sum of bladelets (width ≥ 7 mm and < 12 mm) and micro-blades (width < 7 mm) exceeds the number of blades. In general, the assemblages are characterised by a relatively small number of pre-cores, cores, and formal tools.

Hammer-stones

There are two relatively complete hammer-stones: one is the fragment of sandstone pebble, the other is a flint pebble. In addition, small fragments and flakes of sandstone and quartzite (692 pieces) occur in nearly all horizons and features. Such pieces might be spalls from used hammer-stones. It is likely that some of the flint chunks also originated from hammer stones, given that pebbles are absent in the local rivers and flaking instruments therefore rare.

Cores and pre-cores

The pre-core assemblage is characterised by the predominance of narrow flaking surface items (Fig. 15: 3), made on flakes, natural flakes, and flint plates with crested ridges as preparation for the flaking surfaces. Most pre-cores show unidirectional negatives on the flaking surface (Fig. 15: 2). The width of these negatives suggests that two thirds of all pre-cores were intended for blade or bladelet production (Fig. 15: 1). On average, the pre-cores are 67.1 mm long, 30.7 mm wide and 57.7 mm thick.

About 70 % of the cores are unidirectional sub-cylindrical and/or narrow flaking surface cores

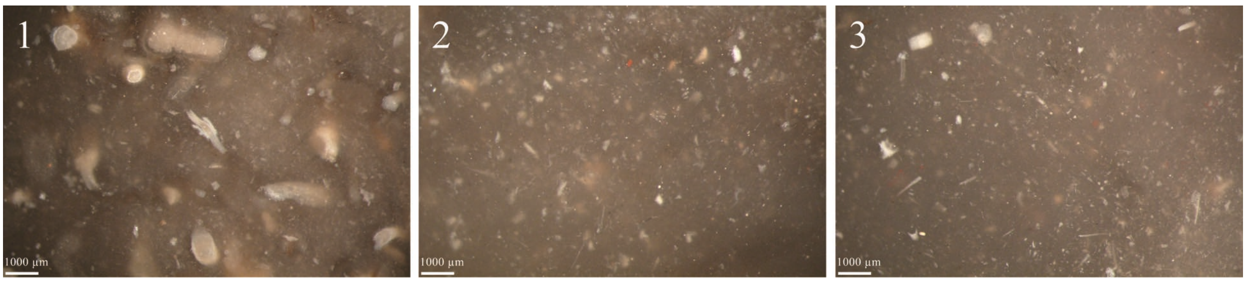

Fig. 13. Microfacies of the three examined layers at Ostriv. 1 – layer 1; 2 – layer 2; 3 – layer 3. Layer 1 displays larger bioclastic remains (sponge remains, bryozoa and echinoderms), while layers 2 and 3 are dominated by demosponge microscleres. Layer 3 is also rich in echinoderm remains (predominantly trochites from crinoids).

Abb. 13. *Microfazies der drei untersuchten Schichten in Ostriv. 1: Schicht 1; 2: Schicht 2; 3: Schicht 3. Schicht 1 zeigt größere bioklasitische Reste (Schwammreste, Bryozoen und Stachelhäuter), während die Schichte 2 und 3 durch Mikroskleren von Hornkieselschwämmen dominiert werden. Schicht 3 ist zudem reich an Resten von Echinodermen (vorwiegend Trochiten von Crinoiden).*

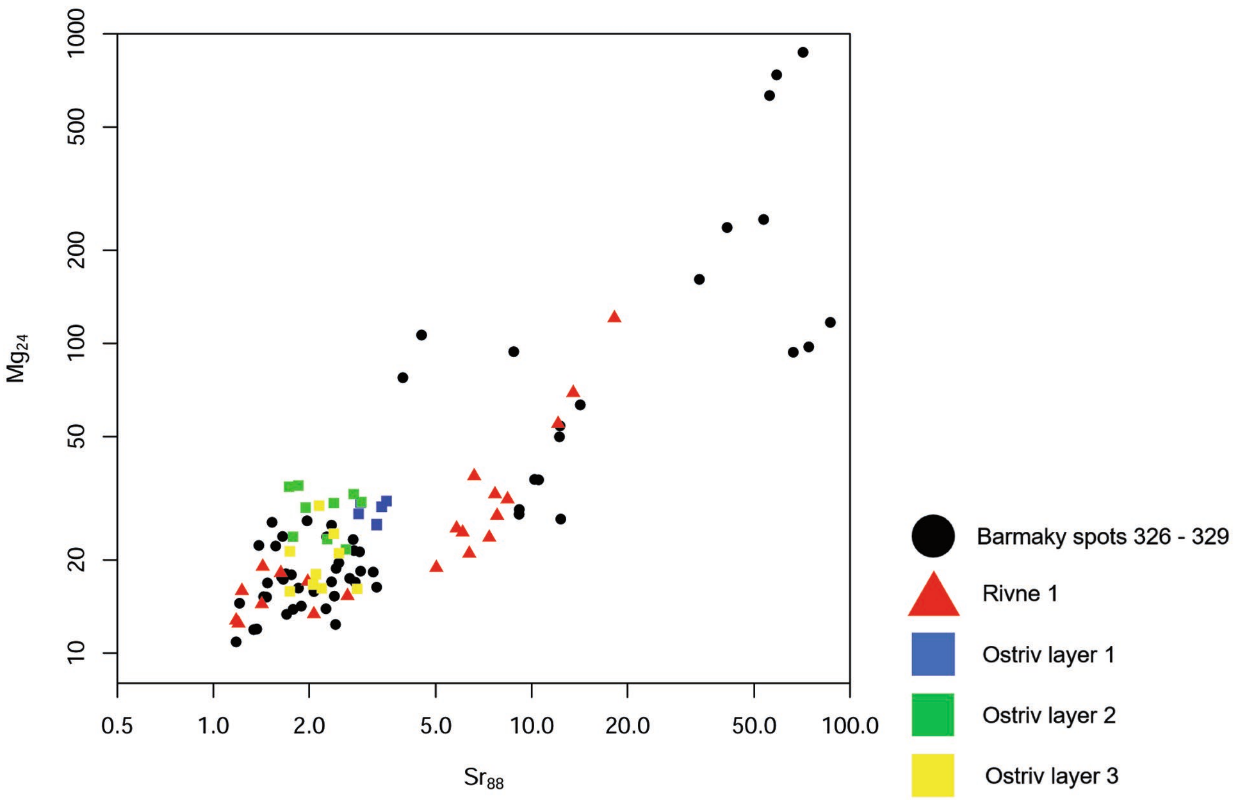

Fig. 14. Strontium (Sr) versus magnesium (Mg) concentration plot indicating the chemofacies of the tested geological samples. Graph: Michael Brandl.

Abb. 14. *Plot der Konzentration von Strontium (Sr) gegen Magnesium (Mg), welche die Chemofazies der getesteten geologischen Proben anzeigen. Graph: Michael Brandl.*

Artefact types	Western area							Eastern area				Pit 2	Total	%	esse, %
	2a	2a1	2ab	2b	2c, pit 1	2c	2d	2c	2c, ash	2c, hearth	2d				
Pre-cores	1	–	–	–	–	18	6	1	–	1	9	6	42	0.03	0.26
Cores	3	–	–	1	4	44	13	5	1	2	53	6	132	0.09	0.83
Tools	46	2	–	5	21	483	150	3	2	6	79	14	811	0.53	5.07
Flakes	386	17	–	22	147	2,649	954	131	169	134	2,830	278	7,717	5.06	48.27
Blades	122	9	–	6	41	1,031	337	54	42	67	890	99	2,698	1.77	16.88
Bladelets	121	4	1	6	40	871	304	36	52	54	916	83	2,488	1.63	15.56
Micro-blades	73	3	–	3	20	538	128	23	30	19	480	42	1,359	0.89	8.50
Burin spalls	18	1	–	1	13	472	83	4	6	3	58	8	667	0.44	4.17
Trunca-tion spalls	1	–	–	–	–	54	4	–	2	–	12	–	73	0.05	0.46
Chips	5,563	184	123	217	2,885	60,612	19,261	980	1,262	1,043	35,832	4,591	132,553	86.85	–
Uniden-tifiable debitage	290	9	4	15	87	1,259	699	62	76	44	1,298	159	4,002	2.62	–
Chunks	13	–	–	–	–	35	7	1	1	1	13	4	75	0.05	–
Total	6,637	229	128	276	3,258	68,066	21,946	1,300	1,643	1,374	42,470	5,290	152,617	100.00	100.00

Tab. 2. Barmaky, level 2, artefact counts by horizons and structures.

Tab. 2. *Barmaky, Level 2, Artefaktanzahl nach Horizonten und Strukturen.*

for blade and bladelet production (Figs. 15-17). The blade negatives on the flaking surfaces are more characteristic of sub-cylindrical cores, while the bladelet and micro-blade negatives prevail among the narrow flaking surface cores (Figs. 16: 1-3 & 17: 2-3). The sub-cylindrical cores demonstrate both blade and bladelet negatives on the flaking surface (Fig. 17: 1-4). Bidirectional reduction is represented by bidirectional, bidirectional-adjacent, and bidirectional-alternative cores (Fig. 17: 2-4). Bidirectional cores in the strict sense – i.e., with negatives alternating in opposite directions on one flaking surface – are rare. Usually, the opposite striking platform was made on a very acute angle and served the restoration of the flaking surface (Fig. 17: 2-4). Such supplementary platforms with acute angles opposite of the striking platform are also found on some unidirectional cores (Fig. 17: 1). Trimming of overhangs is common for all types of cores. The main reasons for core discard are hinge fractures on the flaking surface, crushed/smashed striking platforms, and fragmentation. Differences in core typology between horizons, features, or areas were not identified. Exhausted cores, however, are more characteristic for the western area. The cores' average metrics are 58.1 mm in length, 34.3 mm in width, and 40.5 mm in thickness. The average width to thickness ratios for both cores (0.85) and pre-cores (0.53) reflects the narrowness of the flaking surfaces.

Débitage

The technological and typological characteristics of flakes, blades, bladelets, and micro-blades from all horizons and features are very similar. Differences result from different amounts of flakes on the one hand and blades, bladelets, and micro-blades on the other.

The flakes are characterised by the predominance of trapezoidal and irregular off-axis shapes (≈ 45 %), differently incurved lateral profiles (≈ 60 %), feathering distal ends (≈ 60 %), triangular and trapezoidal cross-sections (55-60 %), unidirectional dorsal scar patterns (≈ 55 %), and cortex on the distal and lateral parts of the dorsal surfaces (≈ 25 %). The flakes' striking platforms are mainly plain (≈ 50 %), un-lipped (≈ 90 %), and right-angled butts (≈65 %). Overhang trimming (≈ 20 %) and butt abrasion (< 1 %) traces are rare. Pronounced bulbs are dominant (≈ 75 %).

The blade/bladelet/micro-blade assemblages are characterised by the relatively high amount of on-axis rectangular shapes (20-23 %), straight lateral profiles (40-50 %), feathering distal extremities (50-65 %), triangular (30-50 %), trapezoidal (20-35 %), and lateral steep (≈ 25 %) cross-sections, and cortex on the distal and lateral parts of the dorsal surfaces (up to 40 %). Along with the plain butts (35-50 %), the linear type (21-42 %) of striking platforms is common. Overhang trimming (37-46 %) and mainly un-lipped (≈ 90 %), right-angled butts (74-83 %) are common. The pieces with pronounced bulbs (70-80 %) are

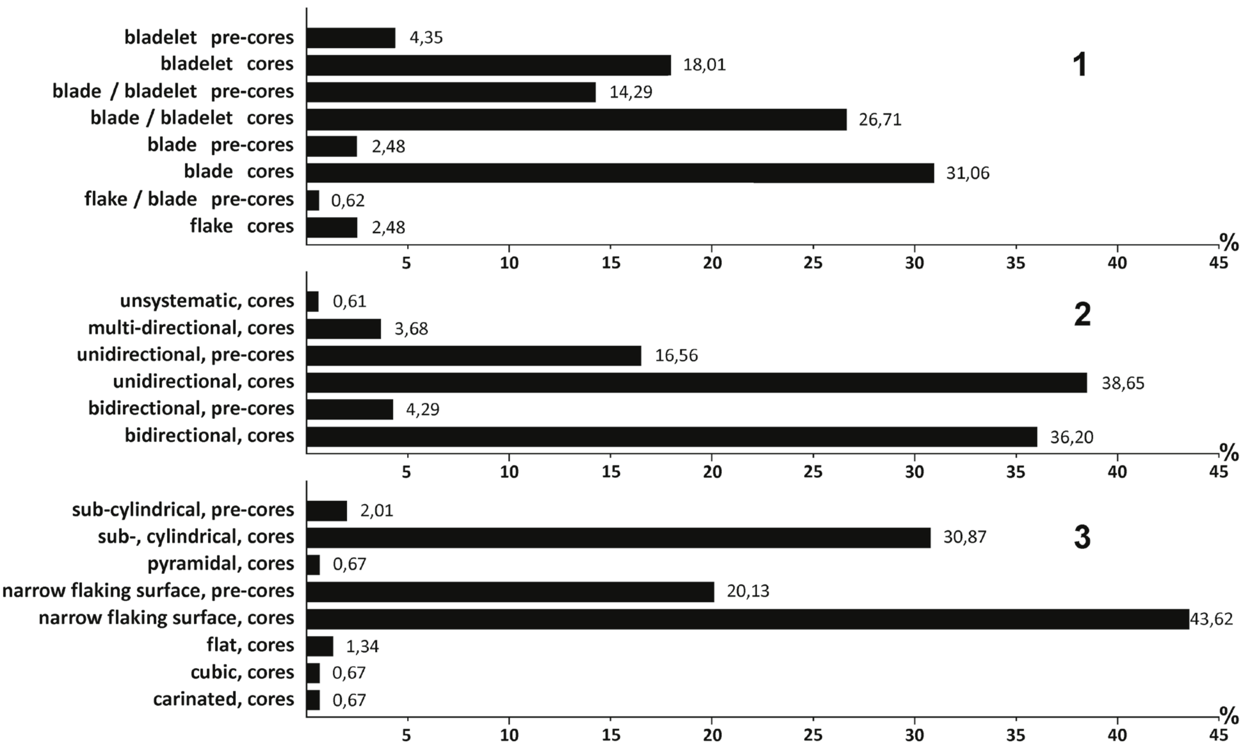

Fig. 15. Barmaky, level 2, pre-cores (N = 42) and cores (N = 132). 1: produced blanks; 2: direction of negatives on the flaking surface; 3: shape of flaking surfaces.

Abb. 15. *Barmaky, Level 2. Vorformen (N = 42) und Kerne (N = 132). 1: produzierte Grundformen; 2: Richtung der Negative auf der Abbaufläche; 3: Form der Abbaufläche.*

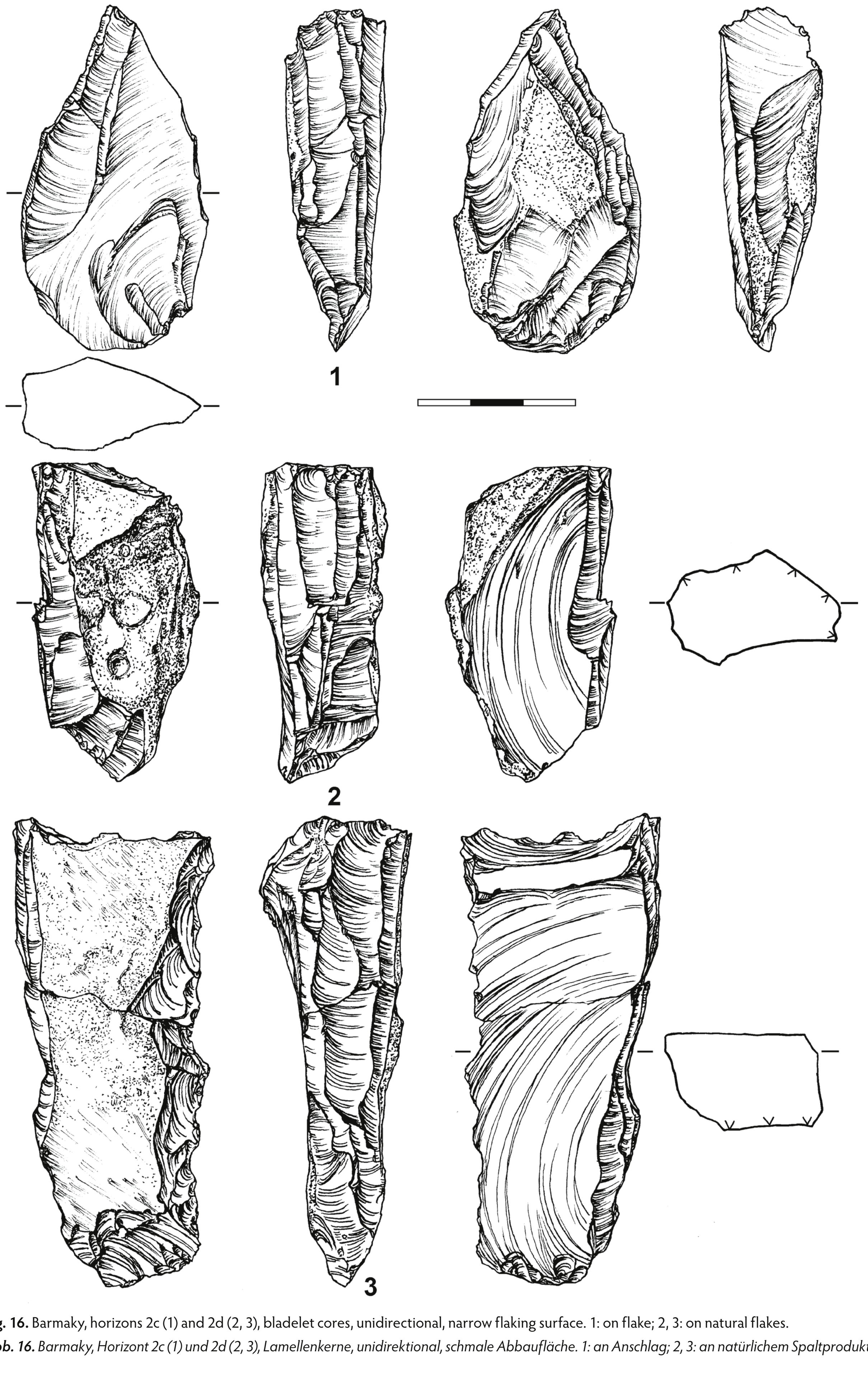

Fig. 16. Barmaky, horizons 2c (1) and 2d (2, 3), bladelet cores, unidirectional, narrow flaking surface. 1: on flake; 2, 3: on natural flakes.

Abb. 16. *Barmaky, Horizont 2c (1) und 2d (2, 3), Lamellenkerne, unidirektional, schmale Abbaufläche. 1: an Anschlag; 2, 3: an natürlichem Spaltprodukt.*

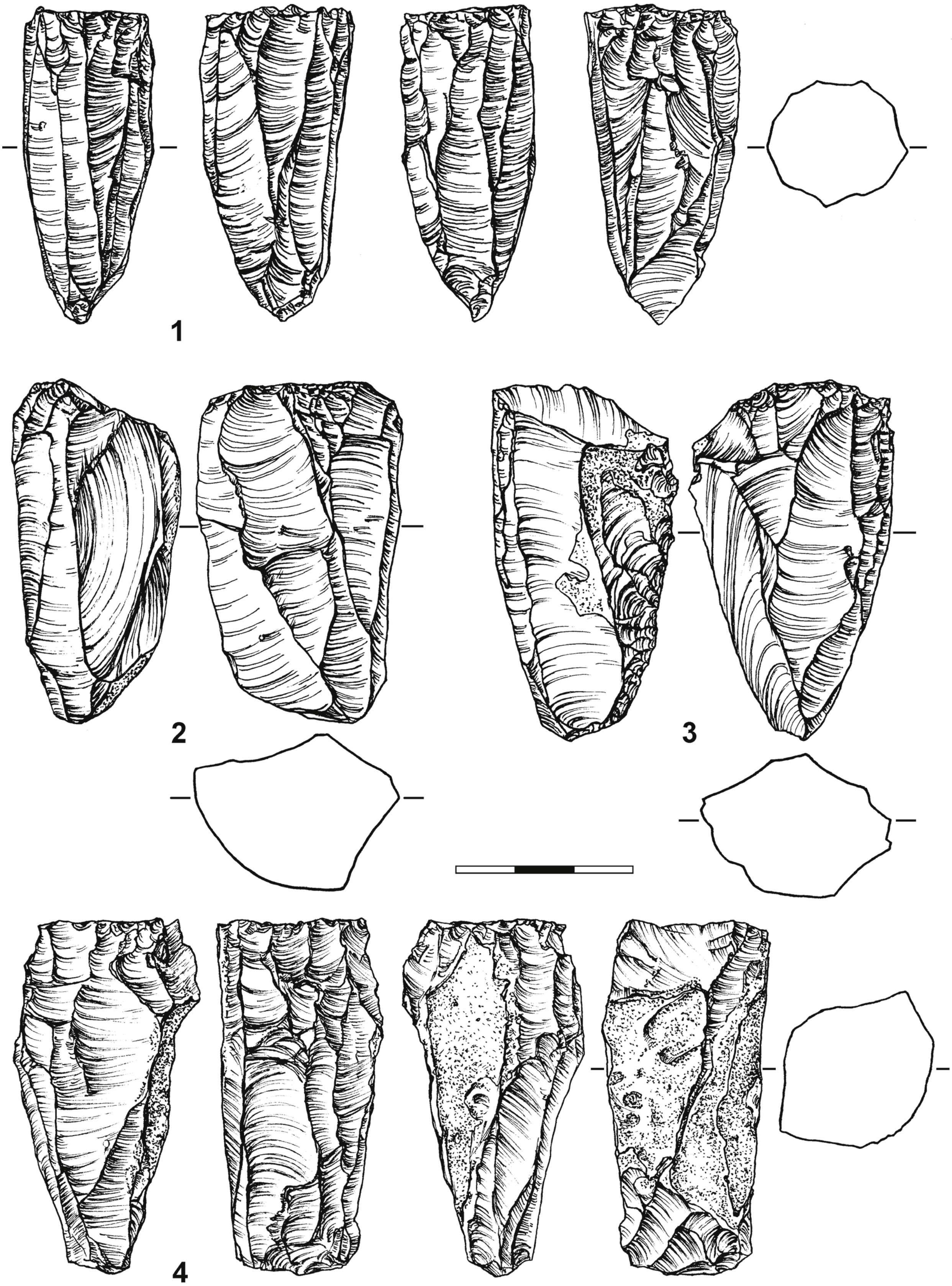

Fig. 17. Barmaky, horizons 2c (1, 4) and 2d (2, 3), cores. 1: for bladelets, unidirectional, cylindrical; 2, 3: for blades, bidirectional-adjacent, sub-cylindrical; 4: for bladelets, bidirectional, sub-cylindrical.

Abb. 17. *Barmaky, Horizont 2c (1, 4) und 2d (2, 3), Kerne. 1: für Lamellen, unidirektional, zylindrisch; 2, 3: für Klingen, bidirektional-angrenzend, sub-zylindrisch: 4: für Lamellen, bidirektional, sub-zylindrisch.*

dominant. The relatively high amount of crushed striking platforms (16-20 % for all types of *débitage*) along with pronounced bulbs and un-lipped butts are characteristic of hard hammer-stone percussion.

The most characteristic feature of *débitage* assemblage is the high percentages of technological blanks: crested blanks, different types of *débordant* blanks, core-tablets, trimming flakes, and primary pieces. In sum, the technological pieces comprise 25-35 % for the different types of blanks. The trimming flakes, by definition, and primary pieces are more characteristic for flakes, while crested pieces and different types of *débordant* blanks are common for blades, bladelets, and micro-blades. Primary blanks are represented by about 5 % of all *débitage* types. Blanks with cortex on the dorsal surfaces constitute about 42 %, and about 24 % of the *débitage* are made up by *débordant*, crested, and core tablet blanks. The average dimensions of the *débitage* products are represented in Tab. 3. More than half (56.68 %) of the *débitage* with laminar proportions shows widths in the range between 5.00 and 12.99 mm (Fig. 18: 1).

Burin and truncation spalls

The burin spalls are subdivided into three main groups: primary, secondary (with one negative from previous spall), and multiple (with two or more negatives from previous spalls). The sum of secondary and multiple burin spalls is slightly higher than the one of primary items. One third of all burin spalls were retouched before detachment. There are no significant differences between the eastern and western areas in the representations of burin spall types, and the ratio of burins to burin spalls between these areas is likewise insignificant: western area – 2.65, eastern area – 2.63. Truncation spalls are generally rare in all assemblages of Barmaky, archaeological level 2 (Tab. 2).

Tools

The largest assemblage of tools originates from the western area, horizons 2c and 2d (Tab. 4). Significant differences in the typological composition of the documented horizons and features have not been observed. The only exception might be end-scrapers, which are more abundant in the western area, but are generally not numerous. In essential counts (without retouched pieces and unidentifiable tools), nearly half of the tools are burins, about a quarter are microliths, and about 20 % are truncated pieces, while other types only occur in low numbers (Tab. 4). Most tools are made on blades (49.7 %), followed by flakes (18.1 %), micro-blades (12.6 %), bladelets (9.1 %), and burin spalls (0.1 %). For 10.4 % of the tools, the initial blanks could not be identified because of fragmentation.

End-scrapers are made on blades and flakes. Simple end-scrapers with a convexly retouched distal part prevail (Fig. 19: 6 & 8). Several end-scrapers show lateral retouches (Fig. 19: 7), and a few pieces have a truncated base (Fig. 19: 3 & 4). The latter was recognised by D. Nuzhnyi as a characteristic type of the Mizyn industry (Nuzhnyi 2015: 195).

About 80 % of burins (Fig. 20) are made on blades, about 9 % on flakes, and about 2 % on bladelets. For nearly 8 % the blank is unidentifiable. The typological spectrum comprises burins on truncations (60.7 %), dihedral (15.5 %), angled (15.1 %), transversal (1.6 %), and combined (4.8 %) types, while for 2.4 % a further specification is not possible. Multiple burin terminations (edges) are found on 17.1 % of all burins. The dominant type is the burin on obliquely proximally and/or distally truncated blades (Figs. 20 & 21: 1-10). This type comprises one third of all burins and two thirds of burins on truncations. In fact, the oblique truncation is the main method of burin production in this assemblage (52 %). In addition, straight, concave, and convex truncations on both the distal and proximal ends of blades were used for burin production. In sum, burins with two or three opposed or alternating burin terminations (edges) were identified in 14.5 % (Fig. 21: 8 & 9). Many burins show edges rejuvenated by truncations (Fig. 21: 6, 8 & 9). Dihedral symmetrical and asymmetrical burins occur in nearly equal numbers (Fig. 22: 1-4, 6 & 9); only few belong to the type of double dihedral burins (Fig. 22: 5). Angled burins were made on blades and, as a rule, exhibit one burin termination (edge); double angled burins are rare (Fig. 22: 7 & 8). Combined burins are mainly represented by combinations of angled burins and those with dihedral terminations and truncations. Of the latter, two thirds are made on oblique truncation. Thus, the most numerous burins are those on obliquely truncated blades with a single burin termination. Given the mentioned ratio of burins to spalls, as well as the relatively small number of burins with multiple terminations (edges), it seems that the reduction of burins in the studied areas is moderate.

Débitage	Blank length	Blank width	Blank thickness	Platform width	Platform thickness
Flakes	24.9 (1.4-100.2)	21.4 (0.9-110.1)	4.2 (0.5-43.7)	10.7 (0.5-90.6)	3.2 (0.2-36.7)
Blades	48.9 (25.0-118.7)	17.7 (12.0-47.9)	5.4 (0.9-29.3)	7.7 (0.4-40.7)	2.8 (0.2-20.5)
Bladelets	26.8 (15.5-83.1)	9.3 (7.0-11.9)	2.8 (0.6-15.7)	4.6 (0.6-15.6)	1.6 (0.2-8.3)
Micro-blades	19.6 (15.0-53.2)	5.5 (2.2-6.99)	1.9 (0.6-6.8)	2.9 (0.4-6.6)	1.2 (0.2-5.2)

Tab. 3. Barmaky, level 2: average and range of dimensions of débitage (in mm).

Tab. 3. *Barmaky, Level 2: durchschnittliche Maße und Spanne der Grundformen (in mm).*

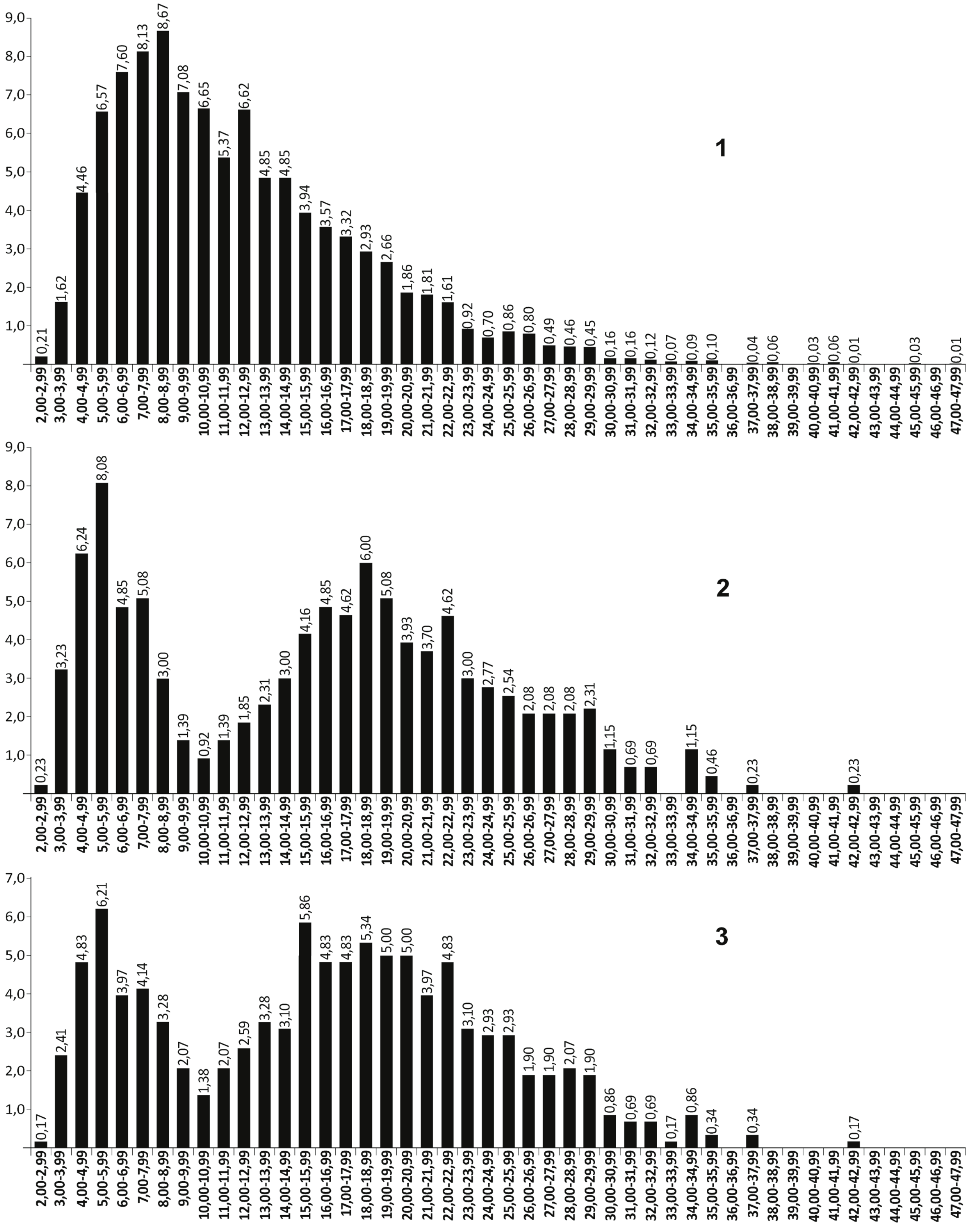

Fig. 18. Barmaky, level 2, width of artefacts on blades, bladelets, micro-blades. 1: blanks (N = 6,726); 2: burins, truncated pieces and microliths (N = 433); 3: tools (N = 580).

Abb. 18. *Barmaky, Level 2, Breiten von Artefakten an Klingen, Lamellen, Mikrolamellen. 1: Grundformen (N = 6.726); 2: Stichel, Endretuschen, Mikrolithen (N = 433); 3: Werkzeuge (N = 580).*

The only combined tools are end-scrapers – burins. They occur in combinations of simple end-scrapers and burins on oblique and concave truncated blades (Fig. 19: 5).

About 80 % of the truncated pieces are made on blades. Obliquely truncated blades comprise about 60 % of all truncated pieces (Figs. 20 & 23: 2-4, 6 & 7). Concave and straight truncations are not numerous

Tool types	Western area						Eastern area				Pit 2	Total	%	esse, %
	2a	2a1	2b	2c, pit 1	2c	2d	2c	2c, ash	2c, hearth	2d				
End-scrapers	–	–	–	–	13	4	–	–	–	1	–	18	2.22	3.21
Burins	10	1	2	8	165	39	1	1	–	21	4	252	31.07	45.00
Truncated pieces	4	–	2	1	62	27	1	–	3	13	3	116	14.30	20.71
Denticulates	1	–	–	–	–	–	–	–	1	1	–	3	0.37	0.54
Notches	1	–	–	1	11	3	–	–	–	–	–	16	1.97	2.86
Borers/ perforators	–	–	–	–	7	2	–	–	–	1	–	10	1.23	1.79
Points	1	–	–	–	2	1	–	–	–	3	–	7	0.86	1.25
Raclette	–	–	–	–	2	–	–	–	–	1	–	3	0.37	0.54
Combined tools	–	–	–	–	2	–	–	–	–	1	–	3	0.37	0.54
Microliths	11	–	–	5	80	22	–	–	–	14	–	132	16.28	23.57
Retouched pieces	16	1	1	2	113	41	1	1	2	20	5	203	25.03	–
Thinned pieces	–	–	–	–	2	–	–	–	–	–	–	2	0.25	–
Unidentifiable	2	–	–	4	24	11	–	–	–	3	2	46	5.67	–
Total	46	2	5	21	483	150	3	2	6	79	14	811	100.00	100.00

Tab. 4. Barmaky, level 2: tool types by horizons and structures.

Tab. 4. *Barmaky, Level 2: Werkzeugtypen nach Horizonten und Strukturen.*

(Fig. 23: 1 & 8). Few pieces show a bi-terminal truncation (Fig. 23: 5 & 9-12). The abundance of obliquely truncated blades corresponds well with the numerous burins on obliquely truncated blades (Fig. 20). Some obliquely truncated pieces show traces of burin facets on their lateral sides partly cut by truncation, indicating burin rejuvenation.

Pointed blades occur as into laterally and distally retouched specimens. The laterally retouched pointed blades were made by scalar, sub-parallel semi-abrupt or abrupt obverse retouch on one lateral convex side of a blade (Fig. 19: 2). The distal points show the same types of retouch.

Perforators-borers are all made on blades. Three are spike-like, with a short, alternating retouched tip (Fig. 19: 1). The others do not have further typologically distinguishable features.

Microliths are the second largest tool class and made on bladelets (24.2 %) and micro-blades (75.8 %). They occur complete (8.3 %) and as fragments (distal 15.9 %, medial 41.7 %, lateral 0.8 %, proximal 33.3 %). The microliths were produced by continuous scalar and micro-scalar obverse abrupt retouch. These retouches are intensive and reduced the width of the blanks up to 2-3 mm. Alternating retouches have been recognised on a few pieces. These modifications resulted in straight and rarely wavy backed lateral side.

All complete pieces have points with a straight back and obliquely truncated or retouched base (Fig. 24: 4-6, 8, 20 & 22-23). These were defined by D. Nuzhnyi (2015) as *type fossil* of the Mizyn industry. Rarely, these points exhibit micro-scalar inverse or obverse semi-abrupt/flat retouch on a lateral edge opposite to the backed side (Fig. 24: 22-23). All distal fragments of microliths, except two pieces, are pointed enough to belong to the described type (Fig. 24: 1-3 & 9-10). Most proximal fragments show traces of oblique truncation or retouching (Fig. 24: 11-12, 14-15, 18 & 21), probably also belonging to the Mizyn type of micro-points. It is difficult to determine the typological status of mesial and proximal fragments without oblique retouch and truncations (Fig. 24: 13 & 16-19). The only complete piece without proximal retouch or truncation might be identified as a point (Fig. 24: 7). Numerous microliths show clear impact fractures related to the use as projectiles (Fig. 24: 4, 18 & 19).

Laterally retouched pieces are made on flakes (29.5 %), blades (43.2 %), bladelets (8.6 %), and unidentifiable blanks (18.7 %) by partial irregular and marginal retouch. Mostly, the obverse retouch was used. Most denticulate and notched pieces are made on flakes by obverse and/or alternating scalar abrupt and semi-abrupt retouch. And small fragments with different types of retouches are typologically unidentifiable. Special mentioning deserves the presence of three raclettes (Fig. 19: 8) made on flakes by distal/lateral obverse, sub-parallel abrupt retouch.

Artefacts on organic materials and fossil shells

Artefacts on organic materials are subdivided in two groups: tools (N = 7) and adornments on bone/tusk (N = 17) or fossil shells (N = 321). The fragments of two tusk/bone needles were found in horizon 2a and

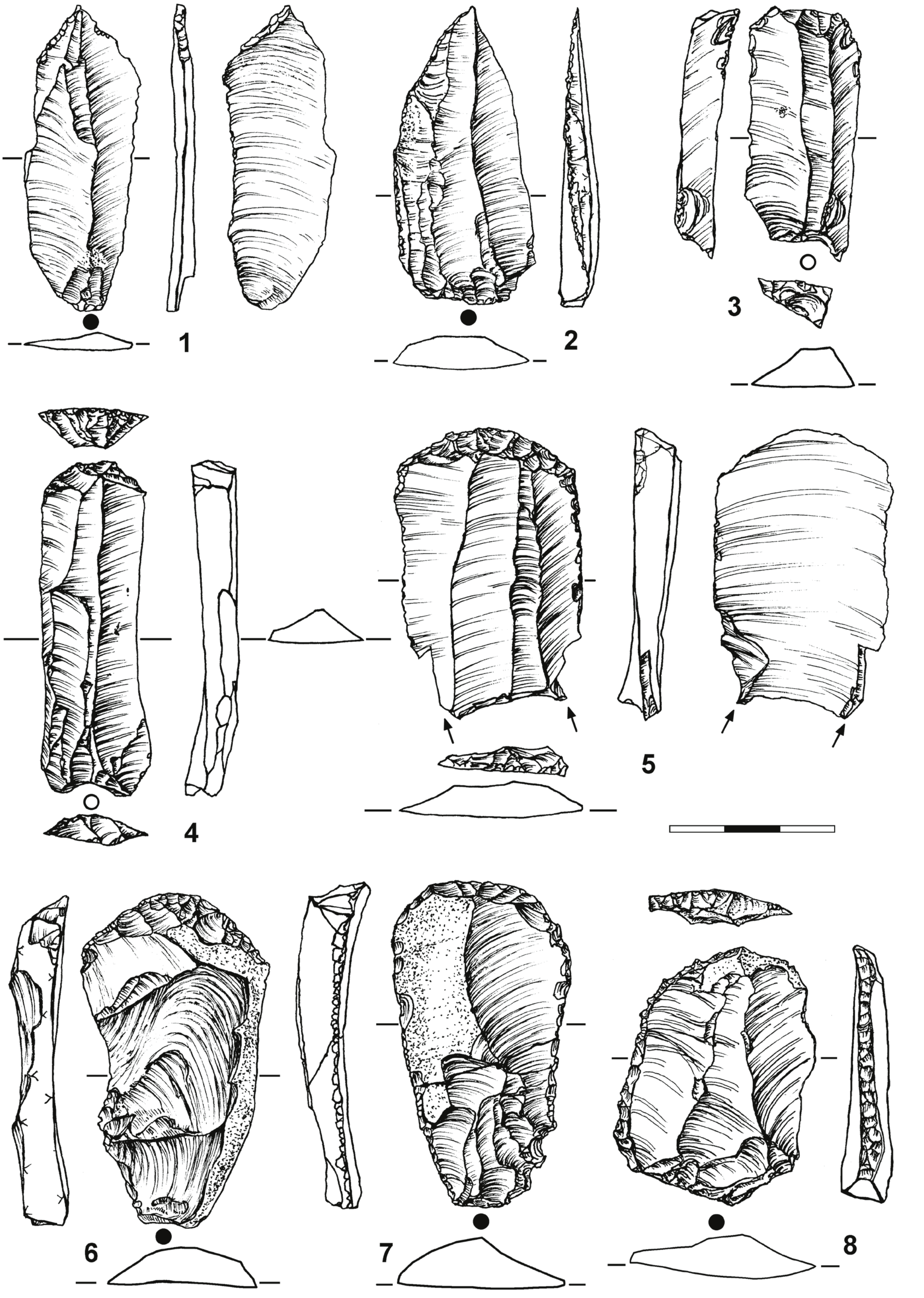

Fig. 19. Tools from Barmaky, horizons 2c (1-3, 5-7) and 2d (4, 8). 1: borer-perforator, distal, alternate; 2: point on blade, lateral, dorsal; 3, 4: end-scrapers on proximally concave truncated blades; 5: combined tool on bilaterally dorsally retouched flake, end-scraper/bilateral burin on proximal concave truncation; 6: simple end-scraper on flake; 7: simple end-scraper on bilaterally dorsally retouched blade; 8: raclette.

Abb. 19. *Werkzeuge aus Barmaky, Horizont 2c (1-3, 5-7) und 2d (4, 8). 1: Bohrer, distal, alternierend; 2: Spitze an Kling, lateral, dorsal; 3, 4: Kratzer an proximal konkav retuschierter Klinge; 5: Kombinationsgerät bilateral retuschierter Kratzer/bilateraler Stichel an konkaver Endretusche; 6: Kratzer an Abschlag; 7: bilateral retuschierter Kratzer an Klinge, 8: Raclette.*

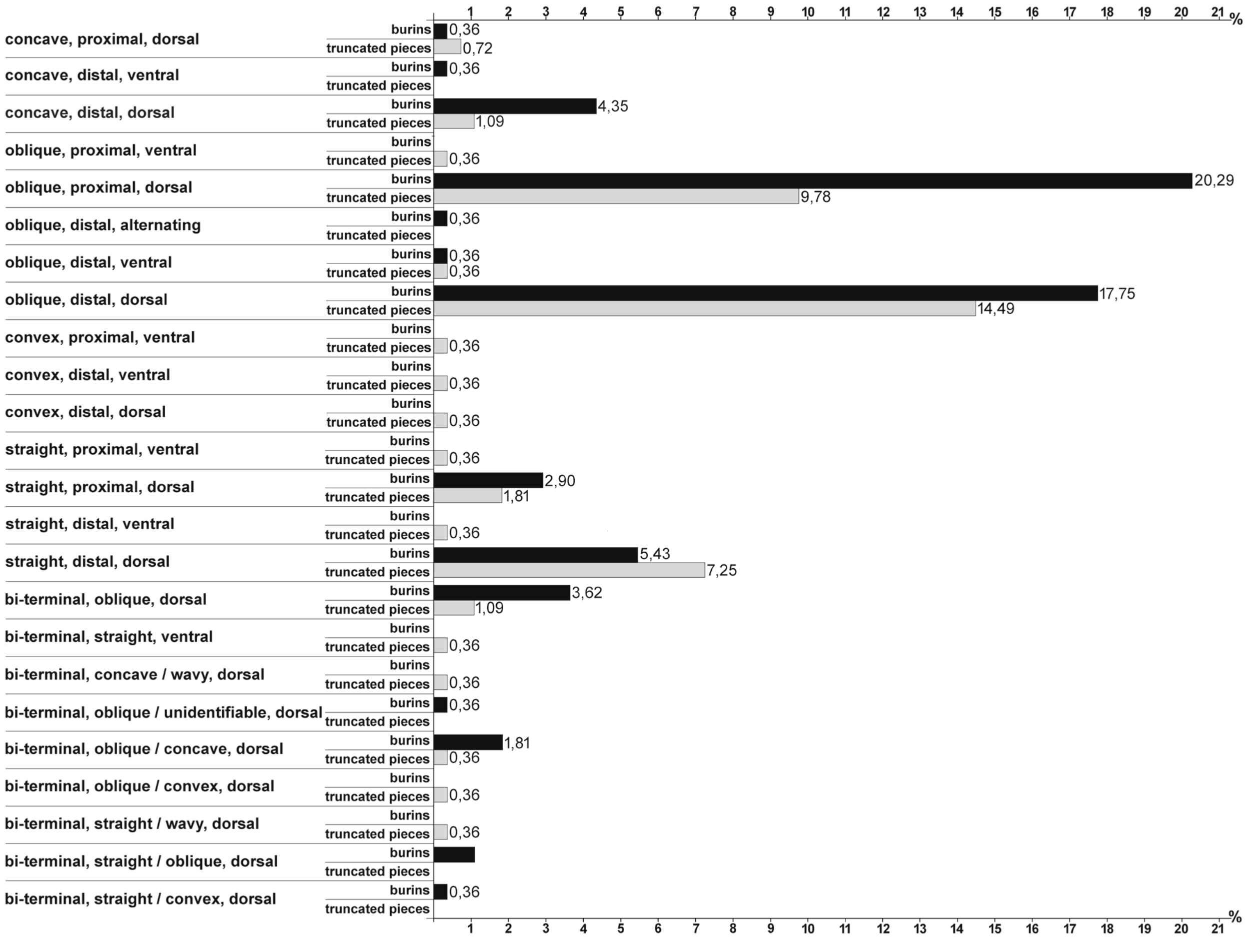

Fig. 20. Barmaky, level 2: shapes of burin truncations (N = 164) and truncated pieces (N = 112).

Abb. 20. *Barmaky, Level 2: Form der Endretuschen bei Sticheln (N = 164) und Endretuschen (N = 112).*

in horizon 2c, the hearth in the eastern area. It is the only organic tool in the eastern area.

The organic artefacts from the western area are more variable: 3 fragments of needles, 2 tip fragments of arrow- or spearheads, 16 complete and fragmented bi-conical pendants, and one bracelet fragment (Fig. 25: 1-3). The bracelet is made on a Mammoth tusk lamella and decorated with an incised herring-like ornament. The same type of bracelet and ornamentation is known from previous investigations at Barmaky and Mizyn (Nuzhnyi 2015: 207, Fig. 109, 14-17; Shovkoplias 1965: 237-241). Also, bi-conical pendants (L<10 mm; Th<4 mm) on ivory are known from previous investigations of Barmaky site (Nuzhnyi 2015: 207, Fig. 109, 18). All pendants and bracelet originate from the horizon 2c, squares 9e, and 10e in the western area. In crotovina deposits, the fragment of a probably grooved, spindle-shaped ivory point has been found at a depth of horizon 2c in square 8e.

According to Dr. Grytsenko's analyses, the fossil snail assemblage (N = 343) consists of shells of *Dorsanum* sp. (83.3 %) and *Trochus* sp. (16.7 %; Fig. 25: 4). These shells originated from Miocene deposits of the Volhynian and Podolian uplands and were widely used by Epigravettian populations in Eastern Europe (Nuzhnyi 2015: 208, Fig. 111; Iakovleva 2013: 131-146). About 80 % of the fossil shells exhibit artificial holes. The fossil shells concentrate in those squares that also show the highest density of flint artefacts and the density of shells in the western area is about nine times higher than in the eastern area. In squares 9e, 10e, and 11e alone, 38.9 % of all shells of the 2018-2020 campaign (72 m^2 in total) have been found.

Faunal remains

In general, bone preservation of the excavations in 1990 and 2018-2019 was quite good. Regarding taphonomic processes, it can be stated that the surface of most specimens shows signs of dissolution due to root corrosion and sometimes, the bones were perforated and permeated by roots. Some bones were poorly preserved, only allowing for a classification at species size and few long bones and teeth were in an advanced process of decay. Tusk fragments were often chipped off in layers (Fig. 26) or only isolated lamellae were found. Overall, however, the substance was so well preserved that manipulations such as cutting or impacting and, in some cases, use wear on the surface of fragments were easy to recognise (Fig. 27).

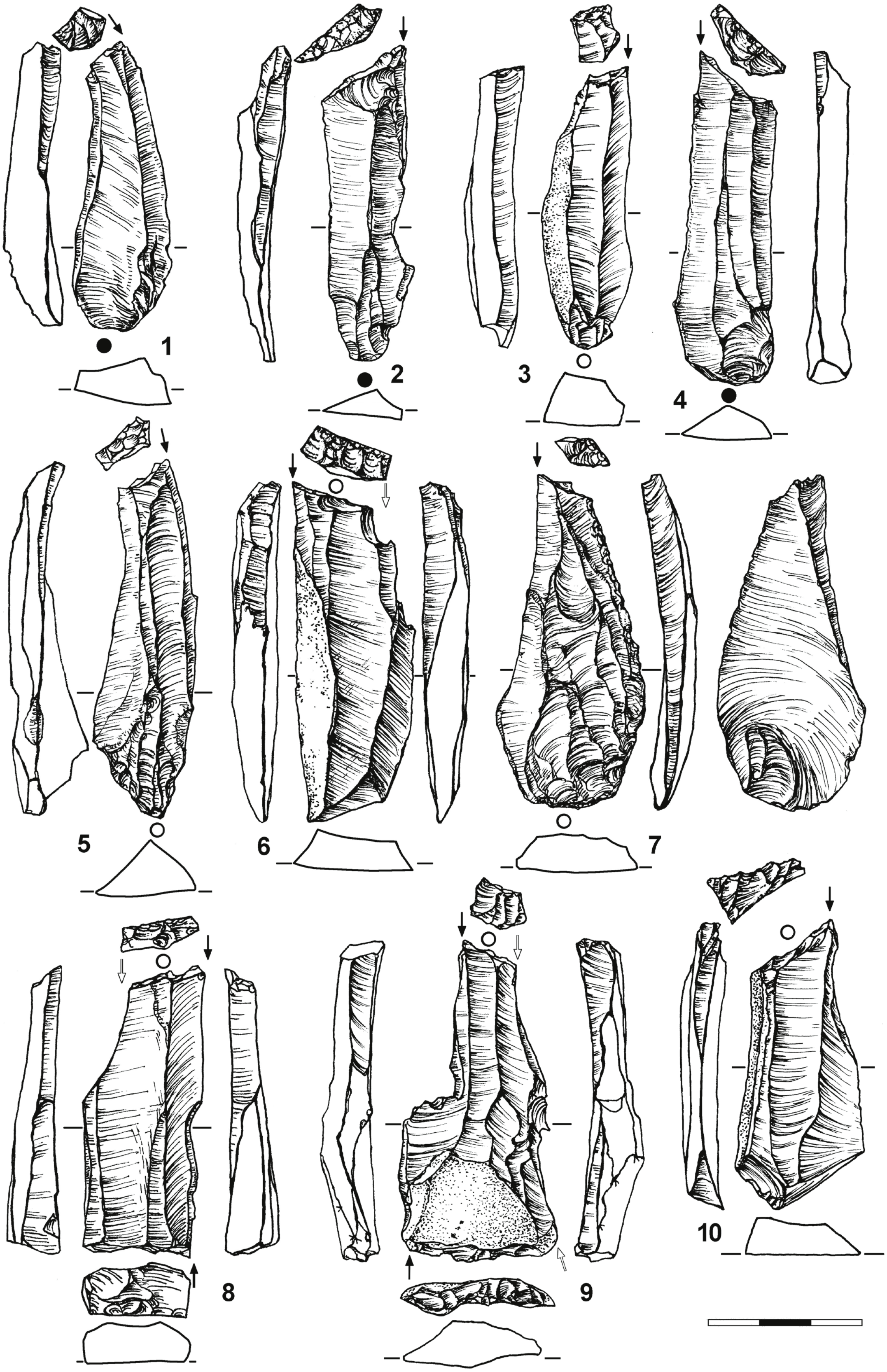

Fig. 21. Barmaky, horizon 2c, burins on truncated blades. Black arrows: last burin spall; white arrows: partly truncated negatives of burin spalls.

***Abb. 21.** Barmaky, Horizont 2c, Stichel an endretuschierten Klingen. Schwarzer Pfeil: letztes Stichelnegativ. Weißer Pfeil: teilweise gekapptes Stichelnegativ.*

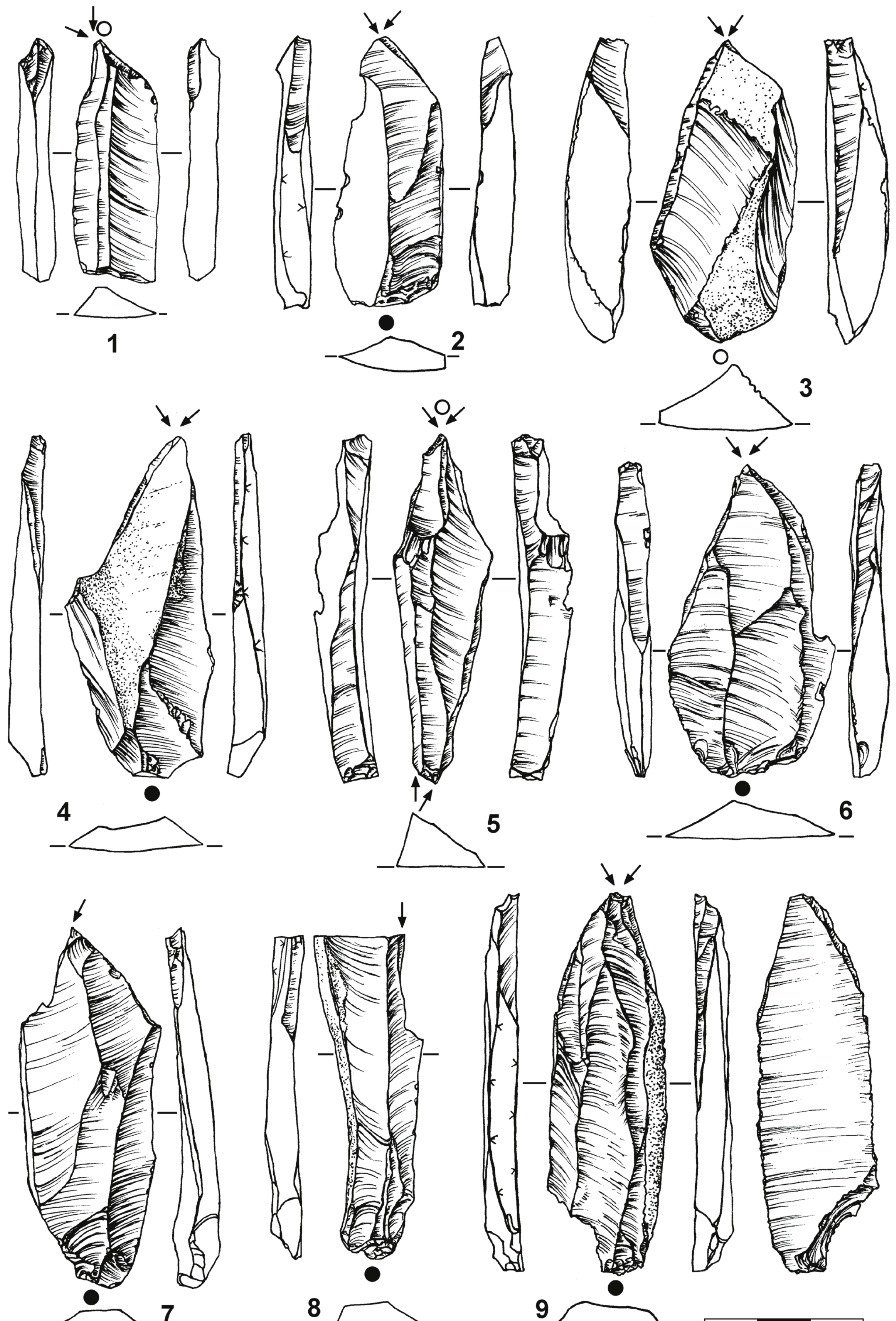

Fig. 22. Barmaky, horizons 2c (1, 9), 2c, pit 1 (2, 4) and 2d (3, 5, 6, 7, 8): burins on blades. 1-6, 9: dihedral burins; 7, 8: angle burins.
Abb. 22. *Barmaky, Horizont 2c (1, 9), 2c, Grube 1 (2, 4) und 2d (3, 5, 6, 7, 8): Stichel an Klingen. 1-6, 9: Mehrschlagstichel; 7, 8: Eckstichel.*

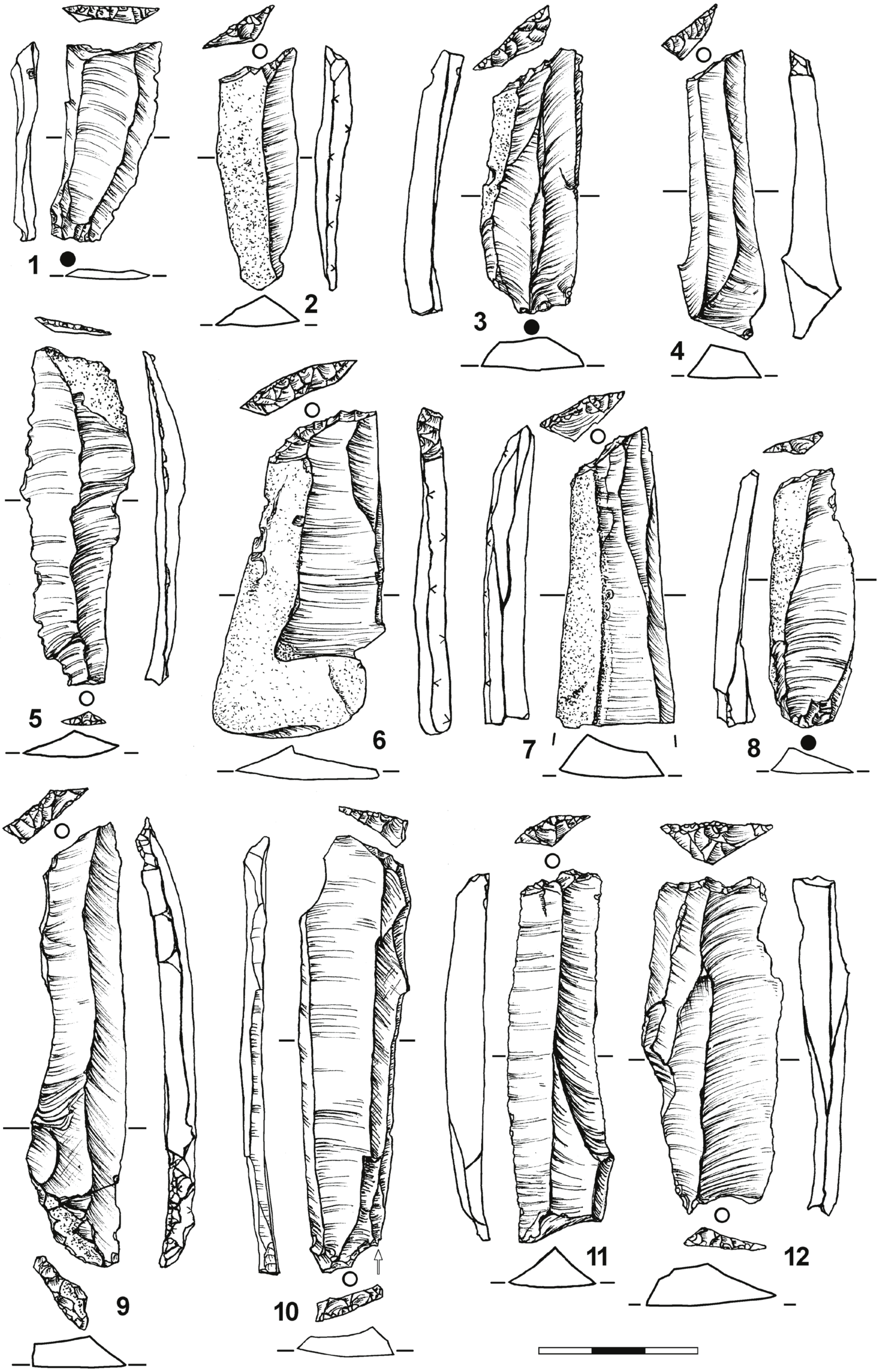

Fig. 23. Barmaky, horizons 2c, fireplace (1, 6), 2c (2-4, 7, 9, 12), 2d (5, 8, 11) and pit 2 (10): truncated blades.

***Abb. 23.** Barmaky, Horizont 2c, Feuerstelle (1, 6), 2c (2-4, 7, 9, 12), 2d (5, 8, 11) und Grube 2 (10): endretuschierte Klingen.*

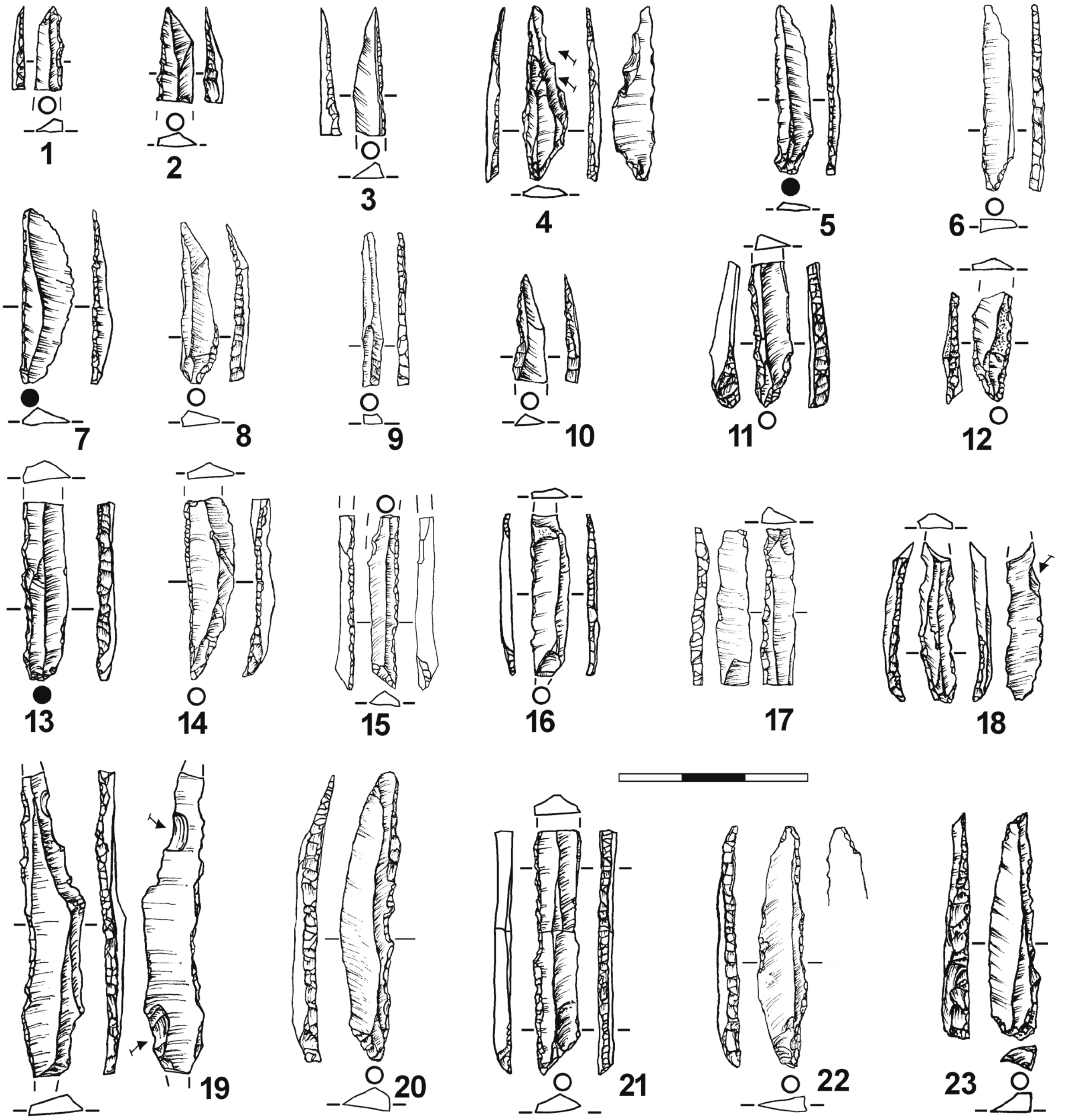

Fig. 24. Barmaky, horizons 2a (23), 2c (5-9, 12-14, 17, 20, 22), 2c, pit 1 (15) and 2d (1-4, 10-11, 16, 18, 19, 21): microliths on bladelets (4, 7, 13, 14, 19-23) and micro-blades (1-3, 5, 6, 8-12, 15-18); curved arrows point to impact fractures.

***Abb. 24.** Barmaky, Horizont 2a (23), 2c (5-9, 12-14, 17, 20, 22), 2c, Grube 1 (15) und 2d (1-4, 10-11, 16, 18, 19, 21): Mikrolithen an Lamellen (4, 7, 13, 14, 19-23) und Mikro-Klingen (1-3, 5, 6, 8-12, 15-18); gebogene Pfeile bezeichnen Impakt-Beschädigungen.*

Carnivore gnawing was in no single case clearly identifiable. Since decomposition of organic material in an arctic environment takes a long time (Pasda 2001, 2005: 5-7, 2009: 8), remaining organic material can attract carnivores even after years. Cervids are also known to eat skeletal substance in times of need to compensate a lack of proteins and minerals, especially in the winter season (Herre 1986: 210; Kahlke 2001; Kierdorf 1993). The absence of gnawing marks and the fact that numerous skeletal elements were still in anatomical connection suggest that the site was not accessible to carnivores and other bone eating animals for long after the people had left. It can therefore be assumed that the site was sealed by sediment relatively quickly.

Because of differences in the available information, the materials from the 1990 and 2018-2019 campaigns are discussed separately. In the material of the excavation 2018-2019, 1,102 fragments (NISP) with a weight of about 17 kg could be documented (Tab. 5). Seven species were identified with certainty and the undeterminable fragments were divided into two size classes: bison and reindeer. Numerous fragments of mammoth are readily identifiable as such

Fig. 25. Barmaky, level 2, horizons 2c (1, 3, 4), pit 1 (2), organic artefacts and mollusc shells. 1-2: distal part of projectile points made on mammoth ivory; 3: refitted fragments of an ivory bracelet of Mizyn type; 4: perforated fossil shells, 4a-4l – *Dorsanum duplicatum*, 4m-4p – *Trochus* sp.

Abb. 25. *Barmaky, Level 2, Horizont 2c (1, 3, 4), Grube 1 (2), organische Artefakte und Molluskenschalen. 1-2: Distalfragmente von Elfenbeinspitzen; 3: zusammengesetzte Fragmente eines Elfenbein-Armbands vom Typ Mizyn; 4: durchbohrte fossile Molluskenschalen, 4a-4l – Dorsanum duplicatum, 4m-4p – Trochus sp.*

due to the thickness of the compacta, which influences the results on the proportion of the species. For comparability, the fragments of reindeer and bison size classes are included in the calculation and discussed separately. Among the 2018-2019 faunal remains, mammoth makes up by far the largest part of the ungulates, both in terms of the numbers (Fig. 28: a) and weight (Fig. 28: c). Bison and reindeer were represented in about equal proportions (Fig. 28: a), while horse and saiga are only represented with a few finds. In terms of weight (Fig. 28: c), the values for bison are twice as high as those of reindeer. If the fragments of the bison and reindeer size classes are added to the respective species (Fig. 28: b & d), the proportion of reindeer shifts significantly from 7 % to 46 %, while mammoth drops to 30 %. Regarding bone weight, bison is particularly affected and amounts to 16 %. Since weight reflects the relevance in human diet better than numbers, the latter is probably more significant. In this scenario, mammoth contributed 2/3 of the carnal food, followed by bison with 16 % and reindeer with only 9 %. Horse and saiga were apparently quite insignificant.

Looking again at the number of finds, carnivores are often represented (Fig. 28: a), among which arctic fox could be identified, with the former occurring in much higher numbers. The weight of less than 1 % (Fig. 28: c), however, shows that resources supplied by the carnivores was insignificant. Only few undeterminable fragments fall into the size class of carnivores. Because of remaining uncertainties, these fragments are not considered in figure 28, but would not change the results anyway. 85 items from the 2018-2019 excavation (SI Tab. 4) come

Fig. 26. Example of a tusk fragment in decay.

Abb. 26. *Beispiel eines sich zersetzenden Stoßzahnfragments.*

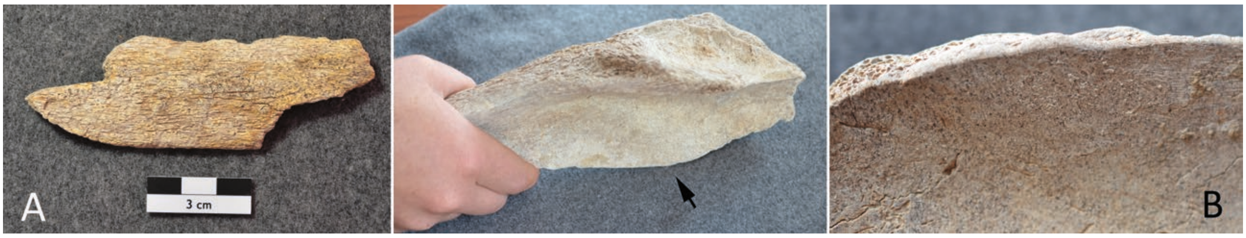

Fig. 27. Examples of bones with edge rounding. A: smaller bone fragment; B mammoth bone.

Abb. 27. *Beispiele von Knochen mit Kantenrundungen. A: kleineres Knochenfragment; B: Mammutknochen.*

from sondages L-32 and L-33, including wolf and 24 undeterminable bones in the size of wolf. However, the relation to level 2 is unclear and therefore these objects are not included in this study.

From the 1990 excavation, 219 remains have been documented (Tab. 5). Again, seven species could be identified, corresponding to those from 2018-2019. The only difference is that bear is present instead of saiga. The proportions of the individual species (Fig. 29) also roughly correspond to the proportions of the 2018-2019 excavation. The observation that mammoth is less frequently represented in favour of the other species may result from the fact that only skeletal elements with clear morphological features were present in the museum while undeterminable fragments were absent.

MNI of animal species

To calculate the minimum number of individuals (MNI), the most common skeletal element (bone part) was considered (SI: Tabs. 1 & 2) and differentiated according to the body side and age (shown in brackets below).

Mammoth

2018-2019: Skeletal elements from all areas of the skeleton were present, 1 adult (without specific age characteristics, therefore size and structure of bones was assessed, indicating an adult age), 1 juvenile/subadult (humerus, sin., prox. and dist. unfused; humerus prox. unfused), 1 juvenile (fibula dist. unfused; including size and structure), 1 infantile (tibia prox., unfused; size and structure, mandibula dex., mandibular deciduous molar (dI3) appearing - MNI 3.

Species	2018-2019			1990	
	NISP	MNI	weight in g	NISP	MNI
Ungulata	-	-	-	-	-
Mammuthus primigenius	342	3	12,563.6	118	4
Bison priscus	33	1	1,449.1	24	3
Bison priscus/Rangifer tarandus	-	-	-	4	-
Equus ferus	1	1	32.6	2	1
Equus ferus/Bison priscus	2	-	65.1	-	-
Rangifer tarandus	36	3	417.4	22	2
Saiga tatarica	1	1	78	-	-
Carnivora	-	-	-	-	-
Canis lupus	-	-	-	2	1
Vulpes lagopus	88	2	52.6	45	3
Ursus arctos	-	-	-	2	1
Carnivora indet. medium size	5	-	1.2	-	-
Mammalia indet.	-	-	-	-	-
Size of reindeer	450	-	914.9	-	-
Size of bison	144	-	1,252.6	-	-
Total	1,102	11	16,950.1	219	15

Tab. 5. List of species from the 2018-2019 and 1990 excavations at Barmaky. NISP: Number of Identified Specimens. MNI: Minimum Number of Individuals.

Tab. 5. *Artenliste der Ausgrabungen 2018-2019 und 1990 in Barmaky. NISP: Anzahl bestimmter Elemente. MNI: Mindestindividuenzahl.*

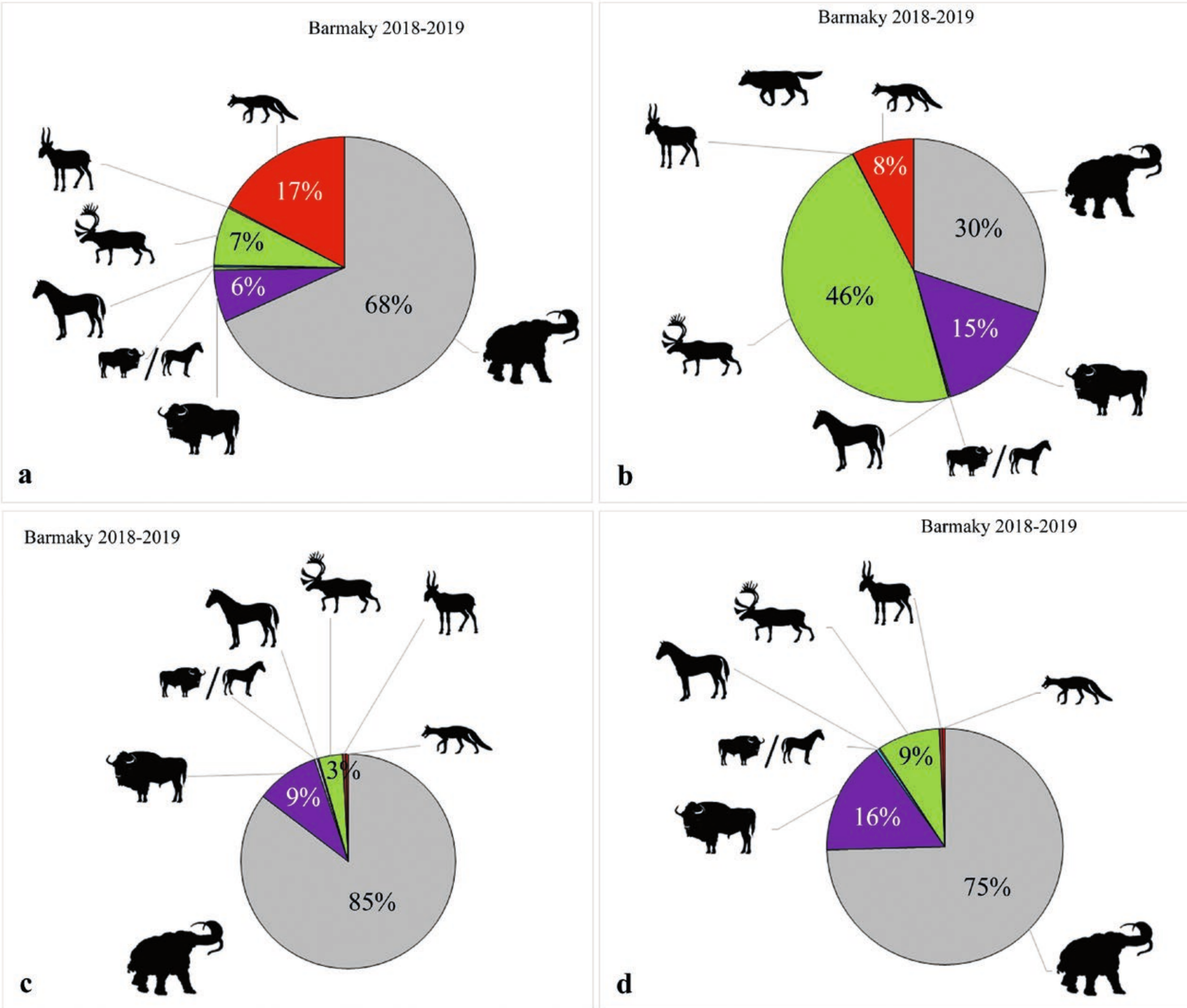

Fig. 28. Faunal elements from the 2018-2019 excavation. a: NISP of identifiable species; b: including undeterminable fragments of size classes of reindeer and bison; c: weight of identifiable skeletal elements; d: including undeterminable fragments of size classes of reindeer and bison.

Abb. 28. *Faunenelement der Grabung 2018-2019. a: NISP der identifizierbaren Arten; b: inklusive unbestimmbarer Fragmente der Größenklassen von Rentier und Bison; c: Gewicht der identifizierbaren Skelettelemente; d: inklusive unbestimmbarer Fragmente der Größenklassen von Rentier und Bison.*

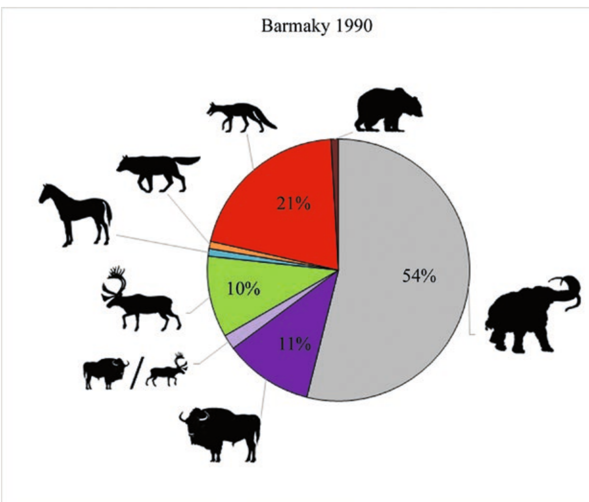

Fig. 29. NISP from the excavations of 1990.

Abb. 29. *NISP der Grabung 1990.*

1990: Skeletal elements from all areas of the skeleton present, 1 adult (costa, humerus prox., phalanx 2, all fused), 1 subadult (humerus prox. in fusion), 2 juvenile (/subadult) (costa, femur prox., humerus prox., ulna prox./dist., radius prox. (3 individuals), radius dist., tibia prox./dist., all unfused) - MNI 4.

Mammoth in total: MNI 5 – 1 infantile, 2 juvenile/subadult, 1 subadult, 1 adult.

Bison

2018-2019: Skeletal elements from all areas of the skeleton present but no cranium/mandibula, many ribs, 1 adult (size and structure) - MNI 1.

1990: Skeletal elements from all areas of the skeleton present but no cranium/mandibula, but horn piece present, 2 adult (3 patella, size and structure), 1 juvenile/subadult (costa unfused, tibia dist. unfused) - MNI 2.

Bison in total: MNI 3 - 1 juvenile/subadult, 2 adult.

Horse
2018-2019: Single tooth, adult - MNI 1.
Horse in total: MNI 1 - adult.

Reindeer
2018-2019: Postcranial elements, almost exclusively posterior limb, antler, cranium, ribs, no toes, males; 1 adult (no epiphyseal areas, size and structure), 1 juvenile/subadult (tibia dist. unfused), 1 infantile (femur, prox. epi. unfused) - MNI 3.

1990: Postcranial elements, costa, anterior and posterior limb, no cranium/mandibula; 1 adult (ulna prox. fused), 1 juvenile/subadult (multiple skeletal elements, among others ulna prox. unfused) - MNI 2.

Reindeer in total: MNI 3 - 1 infantile, 1 juvenile/subadult, 1 adult.

Saiga
2018-2019: 1 femur dex., prox. unfused, MNI 1 – 1 juvenile/subadult.

Wolf
1990: Costa and vertebra cervicalis (fused), 1 adult (size, structure) - MNI 1.
Wolf in total: MNI 1 - adult.

Fox
2018-2019: Skeletal elements from all areas of the skeleton present, 1 adult (all fused) – MNI 1.
1990: Skeletal elements from all areas of the skeleton present (all fused), 3 adult (3 mandibula dex., 3 mandibula sin.) – MNI 3.
Fox in total: MNI 3 - adult.

Bear
1990: 2 femur, one diaphysis and a distal end with fused epiphysis, possibly of the same animal. One right femur owned remarkable arthritic destruction of the knee joint. Previously, this bone was labelled as bison.

Bear: MNI 1 - adult.

Seasonality
Only a right mandibula fragment of a mammoth from pit 1 could be used to determine the season. The dl3 (deciduous molar) was in appearance, the foremost area of the dental crown was already in use and showed little wear (Fig. 30). The left second deciduous molar (dl2) had erupted, but was not preserved. The empty alveolus of the dl2 shows that this tooth must have been present but was not found during excavation.

Tooth erupting (Haynes 1991; Law 1966) and aging systems derived from elephant data are used to estimate the age of mammoths (Rountrey et al. 2012: 188). It should be stressed, however, that these systems have not been calibrated for mammoths, and Haynes (1991) has noted differences in apparent wear rates for mammoths compared to African elephants. Concerning the birth time of mammoth, Rountrey et al. (2012: 188) assume that – with regard to elephants and other Arctic ungulates – mammoths probably gave birth just before the start of the growing season, sometime in May. Concerning Rountrey et al. (2012: 198-199) and Kosintsev et al. (2010), a mammoth calf carcass, discovered in 2007 on a bank of the Yuribei River, Yamal Peninsula, Russian Federation, may be useful to determine the age of death of young individuals. This female mammoth calf has been dated (AMS, on bone collagen) to 41,910 + 550/- 450 radiocarbon years before present. The left deciduous molar (dl2) was completely formed, the dl3 was slightly in wear at the foremost area, the rest of the tooth was not erupted completely. Using the African elephant tooth eruption and wear aging system of Laws (1966), Rountrey et al.

Fig. 30. Right mandibula fragment of a mammoth from pit 1. The deciduous molar dl3 was in appearance, the foremost area of the dental crown was already in use and shows little wear.

Abb. 30. *Rechtes Unterkieferfragment eines Mammuts aus Grube 1. Der Milchmolar dl3 ist im Durchbruch, der vordere Kronenteil ist bereits in Gebrauch und zeigt geringe Abnutzung.*

(2012: 198) supposes that the calf appears to have died at an age of between 0 and 0.5 years. According to Raubenheimer et al. (1995), crown formation in the dI2 is completed after 16 months of gestation in African elephants and root formation is completed in the first three months of postnatal development. Haynes (1991: 321) notes that the dI2 drops out with one year of age. If the birth of the animal in Barmaky took place in May, the development of the tooth should have been completed in August. The dI3 of this jaw was in the breakthrough with incipient wear and tear at the foremost tip. Accordingly, the animal was no longer neonatal. With reference to the Yuribei River mammoth calf, it was approximately 0.5 years old. If one assumes that the birth took place around May, the time of death may have been early to mid winter (October to December).

Spatial distribution

Due to differences in the spatial resolution of the finds recorded in 1990 and 2018-2019, the number of bones is given per square meter (Fig. 31), while mapping according to species displays the exact position for the 2018-2019 finds and lists the 1990 finds per square meters (Fig. 32). 38 items of the 1990 excavation could not be spatially assigned and one find came from a sondage (SI Tab. 3).

Looking at the frequency of all objects, concentrations appear to be in the area of 13г, 8-11е, 9-8ж, 10д, 10е, 3-7з, and 6-7к (Figs. 31 & 32). Mammoth remains occur in the entire area, but concentrations are located in square 13г, 9ж, 7-8з, 6-7к, and 5-6кл (pit 1). Bison and reindeer, in contrast, are scattered without visible concentration. Horse was located in square 4з and saiga in 10е. The remains of the carnivores are widely distributed but show concentrations in certain areas: 9-11е, 6ж, 8-9ж, 7-9з, and 7-8к (Fig. 33).

Pit 1 contained 58 finds (Fig. 34 & SI Tab. 5), three of which could not yet be studied and thus are not included. The remains consist of mammoth and of bison with an MNI of 4-5 animals: 1 adult bison (scapula blade, costa corpus, metacarpus III+IV diaphysis), 3-4 mammoth individuals including the calf: 1 adult (lamellae of a tusk and of a molar, scapula blade, several ribs, a pelvis), possibly of 1 subadult (humerus sin., prox. unfused; vertebra caudalis, prox. unfused), 1 juvenile (fibula dist. Epi., unfused), and of the very young (infantile) animal (tibia prox. diaphysis, unfused (not in the plan); right mandibula, dI3 (3rd milk molar) erupting).

Taphonomy and game exploitation

Bones of the medium sized or large ungulates (reindeer and bison), are strongly fractured. Many postcranial elements of mammoths also show traces of blows and fracturation in fresh condition. However, several skeletal elements, especially those from the 1990 excavation, were also quite large and not fractured. The average weight of ungulate bone fragments (determined species and undeterminable fragments in size classes) is 6 g while those of mammoth are 37 g. This might indicate that marrow and bone fat extraction was more important for the former. Whether mammoth bones were used for construction purposes and therefore left relatively large cannot be decided on the basis of the recorded material. The presence of a minimum of five individual mammoths from different age classes could indicate that a smaller family with offspring from several years was killed.

Among the carnivores, three species could reliably be determined, arctic fox, wolf, and brown bear. All remains came from adult animals and most are located in this central area with an east-west scattering (Fig. 33). Wolf and brown bear were represented by only a few individual finds of possibly only one individual each (Tab. 5 & SI Tabs. 1-3). Arctic fox was the most common carnivore with 133 finds of at least 3 individuals. In contrast to the ungulates remains, those of arctic fox show no systematic fracturing, speaking against their use as a source for nutrition, but rather suggesting that fur was of prime interest. Also 45 items – all from lower limbs and paws – were found in anatomical connection (SI Tab. 6). It seems that they all are right skeletal elements, mainly concentrate in squares 9-10е (Fig. 8: 33), and thus potentially belong to one animal only that might have been skinned there. The fact that three species of carnivores are represented might indicate that in addition to the nutritional aspect, other animal products were of interest. The significance of carnivores for Palaeolithic hunter-gatherer has also been pointed out in other contexts (Wojtal et al. 2020).

Discussion

Before discussing the characteristics of the Barmaky, level 2 occupation comparing the assemblage to other Epigravettian sites of Ukraine, we will recapitulate briefly the most important results of the technological, typological and spatial analyses:

1. on-site reduction of flint nodules and plates probably transported from the adjacent outcrop under the condition of a lack of locally available flaking instruments (pebble hammer-stones);
2. core reduction followed two strategies: bladelet/micro-blade production from narrow flaking surfaces and blade production from sub-cylindrical cores;
3. both core reduction strategies involve hard hammer percussion of mainly unipolar cores with the application of overhang trimming;
4. this results in the prevalence of bladelets and micro-blades of rectangular, trapezoidal, and triangular on-axis shapes, mainly with straight profiles, feathering distal ends, and triangular and trapezoidal cross-sections;
5. the on-site production of lithic and organic artefacts is characterised by the dominance of burins on obliquely truncated blades and microlithic points of Mizyn type with a straight back and an obliquely

	Г	Д	Е	Ж	З	К	Л	М	Н	О
2										
3								1		
4					5	6	2			
5					25	8	32			
6	20	3	4	14/5	7/4	7/15		2	1	1
7	13	11	18	6	33	459				
8	20	30	75	7	20	9			2	2
9	8	29	117	26	7					
10	7	111	230							
11	19	20	86		1					
12	5	5	71							
13	85									

Fig. 31. Number of skeletal elements of the excavations 2018-2019 and 1990.
Abb. 31. *Anzahl der Skelettelemente in den Ausgrabungen 2018-2019 und 1990.*

truncated base, the presence of ivory bracelets of Mizyn type, and abundant perforated fossil shells;

6. the western part of the site shows a higher tool to core ratio, a higher degree of bone fragmentation, and a higher abundance of organic artefacts and adornments, while in the eastern part the remains of a potential dwelling structure could be recorded;
7. Because of the pronounced permafrost-depression, the exact relation between the western and eastern part remains – for the moment – unknown.

The nature of occupation and site function of Barmaky, level 2

The spatial analyses show clear differences between the western and eastern part of Barmaky, level 2. This allows for two potential readings. The first sees the excavated features as the remains of single, longer-term occupation during spring or early summer. In this scenario, we are dealing with a functionally differentiated occupation surface. While the eastern part would harbour a domestic area with a fireplace, pit-features and maybe a light dwelling structure, the western part would have been used for dismembering and skinning hunted prey. However, some observations are not in accord with such an interpretation. First, there is the higher degree of bone fragmentation in the western part, usually related to fat and marrow extraction and thus rather related to domestic activities than to dismembering and skinning prey. Second, there is the higher abundance of adornments in the western part, also unusual for a zone functionally dedicated to animal processing, but usually rather

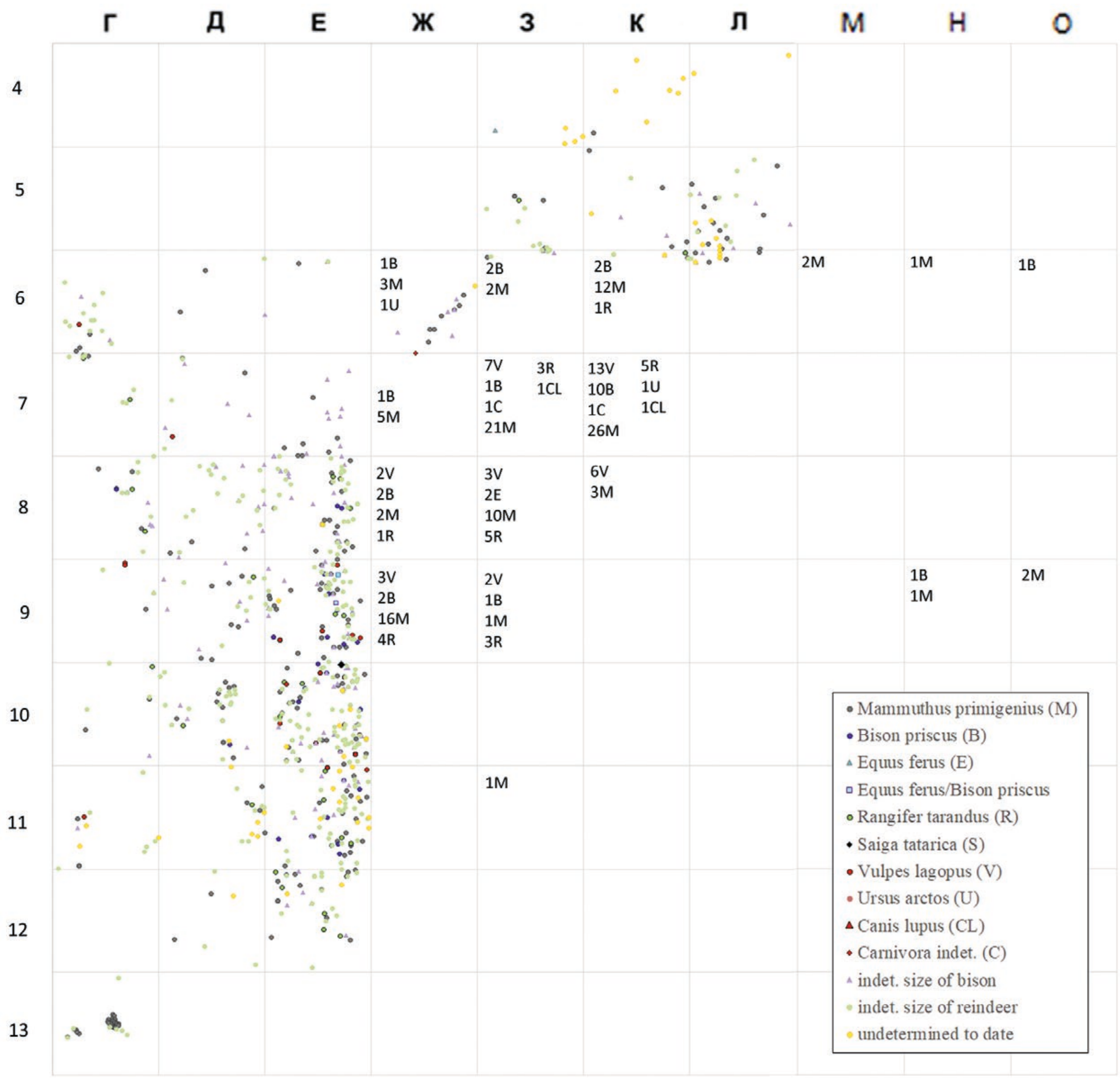

Fig. 32. Distribution of skeletal elements by species of the excavations 2018-2019 (coloured dots) and 1990 (numbers and letters).

Abb. 32. *Verteilung der Skelettelemente nach Arten der Grabungen 2018-2019 (farbige Punkte) und 1990 (Zahlen und Buchstaben).*

found in dwelling areas. Third, there is the low tool to core ratio in the eastern area and pit 2 (1.2) in comparison to the western area and level 2a (7.9), which rather has the character of a lithic workshop, but in the case of the eastern area is related to clear domestic features. This workshop character has already been pointed out by Nuzhnyi (2015: 424) and is also found in other sites, such as Piekary IIa, sector XXII layer 5 or B+B1 (Wilczyński. 2006). Together, these observations point to the second potential reading.

In this view, Barmaky, level 2 represents a palimpsest of at least two (but probably more) subsequent settlement events at the site. In this scenario, the western area likely reflects a higher intensity of settlement activities with food consumption and fur processing, either in the form of repeated short-term visits or a single intensive stay. An argument for the former might be the presence of adornments, organic tools and ochre. The eastern area, in contrast, might be the remains of another single stay related to the hunt for mammoth early in the cold season. All settlement events are characterised by the exploitation of the nearby flint outcrop and have characteristics of a workshop, although to varying degree.

So how do these observations compare to the organisation of other habitation areas of the Mid-Dnieper Epigravettian? Here, three main types of sites can be identified. The first type comprises the dwelling structures made from mammoth bones and tusks with pit-caches containing mainly mammoth bones and tusks and external fireplaces, such as Mizyn, Mezhyrich, Dobranichivka, Yudinovo, Gintsy, or Suponevo (Shovkoplias 1965, 1972; Abramova & Grigoreva 1997; Sergin 2003; Nuzhnyi 2015) subdivided into a number of variants (Sergin 2011). To date, there is no convincing evidence of such dwellings in

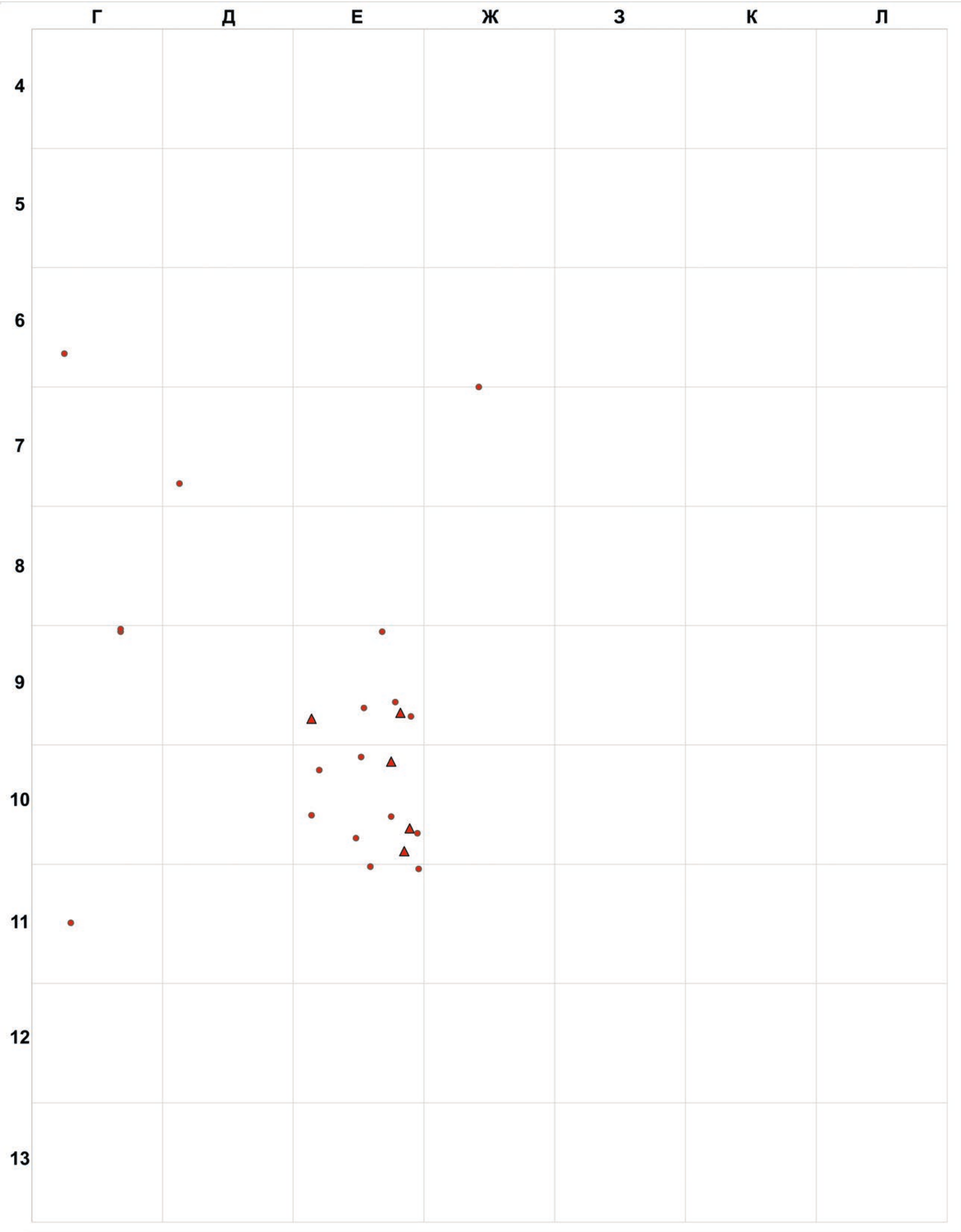

Fig. 33. Distribution of carnivore cones. Dots: objects of the excavation 2018-2019; numbers: objects of the excavation 1990; triangles: skeletal elements in anatomical connection.

Abb. 33. *Verteilung der Karnivorenknochen. Punkte: Objekte aus der Grabung 2018-2019; Zahlen: Objekte aus der Grabung 1990; Dreiecke: Skelettelemente im anatomischen Verband.*

Central Europe, where habitation structures were of more ephemeral architectural character. The second type comprises sites with clear concentrations of lithic artefacts and faunal remains, pit-caches containing both find categories, and fireplaces. An example is Yeliseevychi I (Velichko et al. 1997). The third type

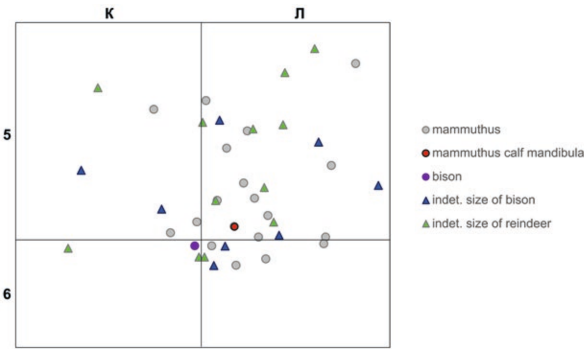

Fig. 34. Pit 1, spatial distribution of the species.
Abb. 34. *Grube 1, räumliche Verteilung der Arten.*

comprises sites with more or less clear concentrations of archaeological material, but without clear fireplaces and pit-caches, such as Semenivka 1, 2, and 3 (Nuzhnyi et al. 2017). Due to post-depositional processes, it is difficult to identify the presence or absence of structures at Timonovka 1 and Timonovka 2 (Velichko et al. 1997). At other sites, the excavated area might be too small to identify the presence or absence of artificial structures, for instance Pushkari IX, layers 1, 2, Buzhanka 2, upper layer, or Chulativ (Khlopachev 2014; Stupak 2014). D. Nuzhnyi proposed a seasonal-functional approach for the interpretation of the differences in the organisation of the settlement areas. He argues that Semenivka 1, 2, and 3 are short term spring-summer occupations, while Mezhyrich and Dobranichivka are base camps of longer use (Nuzhnyi & Stupak 2001). However, this idea was not supported by the fauna analyses.

With regard to its spatial structure, Barmaky, level 2, belongs to type 2. The probably repeated use of the same location is in accord with a pioneering use of the landscape, where already known locations are used for recurrent but short-term stays. The indication of only light dwelling features and absence of more substantial structures also speaks in favour of short-term stays. A seasonal indication of the beginning of the cold season is also in line with groups expanding northwards into previously unfamiliar areas, potentially following migrating animals which, in turn, follow the greening of the landscape (Merkle et al. 2016). Barmaky thus would mark a late stay in the north, before returning to more familiar areas in the south for winter.

Chorological reflections on the Barmaky, level 2 assemblage

Assemblage variability constitutes the main argument in the discussion about the origin of Epigravettian hunter-gatherers north of 50° latitude in the Mid-Dnieper basin (Fig. 35). In light of currently available evidence, it seems that there are no cultural links between Gravettian and Epigravettian industries in this region, given the at least five thousand years hiatus separating assemblages of both units (Chabai et al. 2020). Probable source-regions for the re-population of the Eastern European northern latitudes might be found in the Prut-Dniester area, the Black Sea steppe zone, and the eastern part of Central Europe, where Epigravettian assemblages are reported to show continuous evolution from 23/22 until 16/14 ka cal BP (Noiret 2009; Krotova 2013; Połtowicz-Bobak 2013).

To date, extensive technological studies of Mid Dnieper Epigravettian assemblages are lacking. Nonetheless, there are similarities and differences of Barmaky, level 2 core reduction strategies and primary flaking technologies when compared to the rest of the Mid Dnieper Epigravettian assemblages. Based on the metric dimensions of the blade assemblages, a continuous reduction strategy for blades and bladelets has been proposed for all Epigravettian occupations, and for Semenivka 3 in particular. Here large raw volumes were continuously exploited, producing blades with a width of around 17 mm in an early stage down to bladelets of around 7 mm width in the final stages. In addition, medium to small raw volume were also continuously reduced (Gavrilov 2016: 55; Nuzhnyi et al. 2017: 21). At Barmaky, level 2, in contrast, primary flaking was based on two distinct core reduction strategies without butt abrasion. The dissociation of blade and bladelet production, however, has been reported as a characteristic feature for the Early Middle Magdalenian between 19 and 17.5 ka calBP (Langlais et al. 2016). Regarding lithic typology, the absence of asymmetrical perforators on flakes, including double or triple pointed pieces, stands out. These perforators are also not numerous in Mizyn but are common in the Badegoulian and at the LGM site of Grubgraben, for instance, and have been the base for reflections on possible Epigravettian-Magdalenian relations (Grigoriev 2008; Demidenko 2020). In this regard, the presence of *raclettes* at Barmaky – although in low numbers

Taxonomic sub-units	Mizynian	Mezhyrichian	Yudinovian	Ovruchian
Spatial scale level	supra-regional	regional	regional	regional
Taxonomic scale level	facies	facies	facies	facies
Dating	19-17.5 ka cal BP	18.5-16 ka cal BP	18-14 ka cal BP	undated
Dating cor.	19-17.7 ka cal BP	18-16.3 ka cal BP	15.5-14.2 ka cal BP	undated

Tab. 6. Taxonomic sub-units of the Epigravettian technocomplex in the Mid Dnieper region with regard to their chronological boundaries, and spatial as well as taxonomic scale levels (cf. Maier et al. 2022).

Tab. 6. *Taxonomische Untereinheiten des Epigravettien-Technokomplexes in der Mittel-Dnieper-Region hinsichtlich ihrer chronologischen Begrenzung sowie räumlichen und taxonomischen Skalenniveaus (vgl. Maier et al. 2022).*

– deserves mentioning, since they are also characteristic of Badegoulian assemblages and the inventory from Grubgraben. Also, the occupation at Maszycka Cave holds some interesting parallels. Although dated a little younger, probably between 18.5 and 18 ka calBP, and clearly attributed to the Magdalenian *à navettes*, the lithic collection includes Vohynian flint and blade production is done on unipolar cores with narrow flaking surfaces (Kozłowski et al. 2016). Notable is the presence of a straight-backed point on a bladelet with an obliquely retouched base, otherwise uncommon in the Magdalenian, as well as few rectangles (Ibid.: Fig. 12).

Apart from that, the typological attributes of lithic and organic artefacts of Barmaky, level 2 are in close agreement with characteristics described for Mizyn at the Desna River (Nuzhnyi 2015). This is also underlined by the perforated shells found at both sites, which are highly similar in species composition, come from outcrops in Volhynia and are a characteristic feature of the Mid Desna Epigravettian (Nuzhnyi 2015: 208, Fig. 111; Iakovleva 2013: 131-146). A close proximity to the Desna area and Mizyn in particular is also given by the decorated ivory bracelets (Nuzhnyi 2015). However, it is necessary to stress the 'weakened'

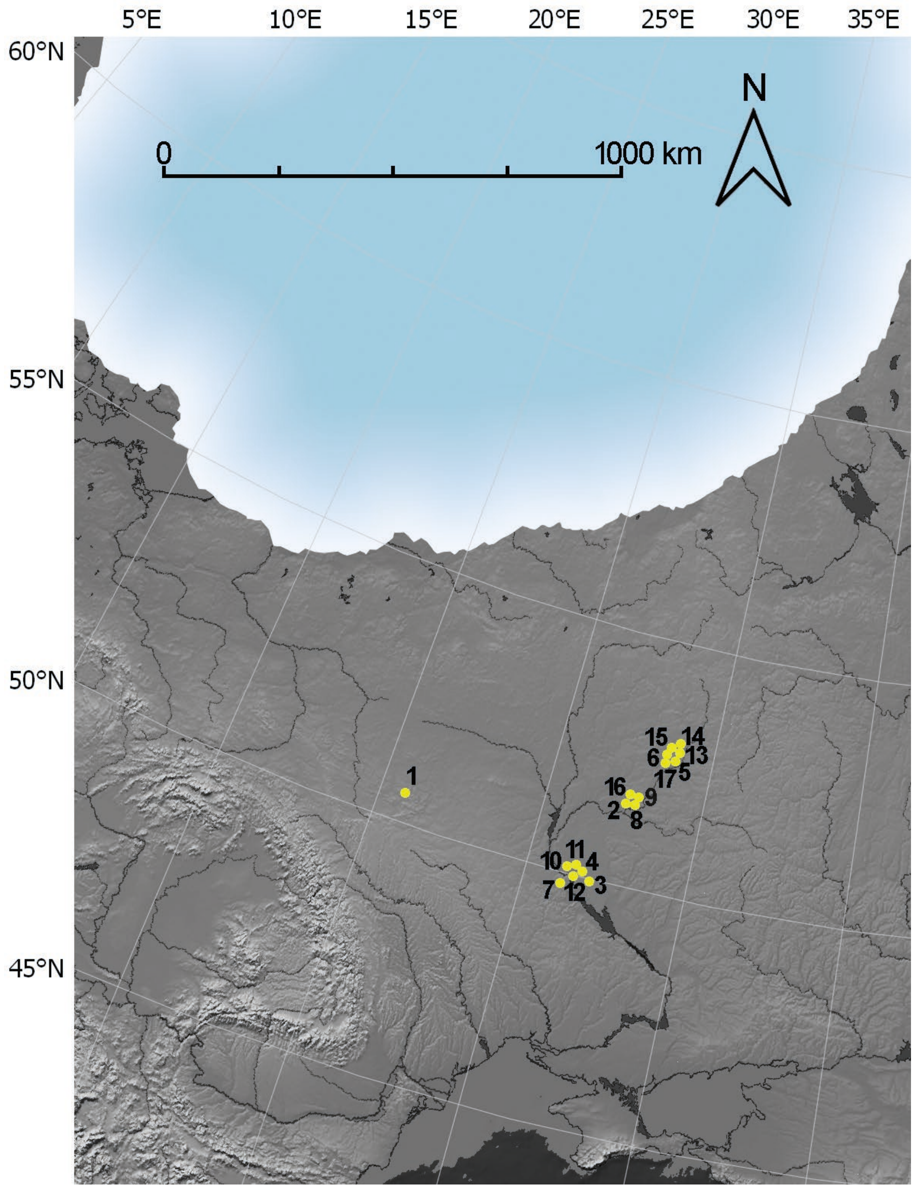

Fig. 35. Map of the Eastern European Epigravettian sites in the periglacial zone mentioned in the text. 1: Barmaky; 2: Buzhanka 2, upper layer; 3: Gintsy, 4: Dobranichivka; 5: Yeliseevychi I; 6: Yeliseevychi II; 7: Mezhyrich; 8: Mizyn; 9: Pushkari IX, cultural layers 1 and 2; 10: Semenivka 1; 11: Semenivka 2; 12: Semenivka 3; 13: Suponevo; 14: Timonovka I; 15: Timonovka II; 16: Chulativ 1; 17: Yudinovo.

Abb. 35. *Karte mit den im Text erwähnten Fundstellen des osteuropäischen Epigravettien im Periglazialraum. 1: Barmaky; 2: Buzhanka 2, upper layer; 3: Gintsy, 4: Dobranichivka; 5: Yeliseevychi I; 6: Yeliseevychi II; 7: Mezhyrich; 8: Mizyn; 9: Pushkari IX, cultural layers 1 and 2; 10: Semenivka 1; 11: Semenivka 2; 12: Semenivka 3; 13: Suponevo; 14: Timonovka I; 15: Timonovka II; 16: Chulativ 1; 17: Yudinovo.*

character of the Barmaky assemblage in comparison to the one from Mizyn. Even when all collections are taken together, the absence or extreme rarity of items such as anthropomorphic and animal figurines or decorated/painted pieces of ivory and bone is salient.

Eventually, the closest proximities can be observed between Barmaky and other sites of the Mid Desna Epigravettian, particularly Mizyn, while weak similarities also seem to exist with late LGM/early post/LGM assemblages in Western and Central Europe.

Chronological development of the Mid Dnieper Epigravettian

The question of the chronological relation between the assemblages of the Mid Dnieper Epigravettian and their taxonomic units is still debated. Technologically, Barmaky, level 2 differs from the assemblage at Mezhyrich in the high amount of overhang trimming and butt abrasion of core platforms for the latter (Lozovski & Lozovskaya 2014). The morphology of the microlithic insets at Barmaky and Mizyn also differ from those of the Mezhyrichian, Yudinovian, and Ovruchian (see Introduction), while the typology of the rest of the tool-kit does not differ much. Considering the early dates for Barmaky, level 2 (19,004 ± 60 calBP) in the framework of the Mid-Dnieper Epigravettian, a development of straight-backed microliths into lanceolate microliths, as well as an appearance of rectangular microliths in the chronologically younger Mizhyrichian and Yudinovian, might be hypothesised.

However, the available radiocarbon dates from Mizyn (weighted averages at 18.5 and 17.5 ka calBP) are close to those reported for the Yudinovian known from Timonovka 1 (weighted average at 18 ka calBP) Pushkari IX, 2 (weighted average at 18 ka calBP), and Mezhyrichian, known from the occupations at the eponymous site with weighted averages between 18.5 and 17.5 ka calBP (Haesaerts et al. 2015; Chabai & Vasyliev 2021; SI Tab. 7). Given that these industries appear to be virtually contemporaneous, a chronological approach for the interpretation of Epigravettian variability in the territory of the Mid Dnieper basin seems unwarranted. However, many of the available dates – though from stratigraphically reliable context – must be considered with caution, since they have been done on mammoth remains, including teeth. These items might have been gathered in the landscape and thus be much older than the occupation in question. If only repeatedly confirmed measurements in the form of weighted averages are accepted, and in case of mammoth-only date clusters only the youngest are selected (since the others might be biased by gathered materials), a rather clear chronological succession emerges from the Mizynian over the Mezhyrichian to the Yudinovian (Fig. 36 & SI Tab. 7). Only exception is the assemblage of Pushkari IX, 2. Two dates on teeth (one of mammoth, the other of musk ox) result in a weighted average of roughly 18.1 ka calBP. Given the nature of the samples, it cannot be excluded that gathered material has been dated.

In light of these reflections, it seems possible to hypothesised that the Mizynian is currently the oldest manifestation of the Epigravettian in the Mid Dnieper region roughly dated to between 19 and 18 ka calBP. With the inclusion of Barmaky, level 2, the Mizynian also shows the largest extent of the discussed taxonomic units, being the only one of supra-regional spatial scale (Tab. 6; cf. Maier et al. in press). Chronologically, it is followed by the Mezhyrichian from around 18 to about 16 ka calBP, a facies of regional spatial scale which, in turn, is followed by the Yudinovoan between 16 and 14 ka calBP, again a facies of regional scale. The Ovruchian is currently undated.

Judging from the available radiocarbon dates, the highest number of Epigravettian occupations occur during a period between 18.5-17.0 ka calBP in an environmental setting with a predominance of herbaceous plants, where river valleys and other local favourable places serve as the natural refugia for forest elements (Sapelko 2014; Komar 2015). However, this impression might indeed be misleading and rather reflect oscillations of the mammoth population in the East European Plain, which peaked exactly around the same time between 18 and 17.5 ka calBP (Nadachowski et al. 2018). Given the subsequent decrease, it is exactly from this period that most mammoth remains could probably be gathered in the landscape. For the dynamics of the human population, this signal is therefore likely to be fallacious and should not be taken as a proxy.

Conclusion

To date, Barmaky, level 2 is the oldest assemblage related to the Epigravettian in the territory of the mid Dnieper basin and also the oldest occupation north of 50° latitudes after the LGM. The site probably represents a palimpsest of repeated stays. Although further investigations are needed for confirmation, it seems that these stays reflect seasonal pioneering trips into the north during summer until the beginning of winter. Interestingly, already during this early phase of the Epigravettian technocomplex, mammoth played an important role in the subsistence of hunter-gatherer groups. With regard to lithic and organic technology, typology, personal ornaments, and artisan craftwork, the strongest similarities can be seen to sites located further to the east, particularly Mizyn in the Desna region, although some aspects in the lithic assemblage might indicate contacts to people further west. Still pending analyses of faunal remains as well as raw material and micromorphological samples will help to clarify some of the open questions in the future.

Acknowledgements: We are thankful to Dr. Carsten Witzel, Prof. Dr. Horst Kierdorf and Prof. Dr. Uwe Kierdorf, Institute of Biology and Chemistry, Department of Biology of the University of Hildesheim for the use of the light microscope and Robin John and Marcel Schemmel from the University of Cologne for graphic support. We are also tankful for the helpful review

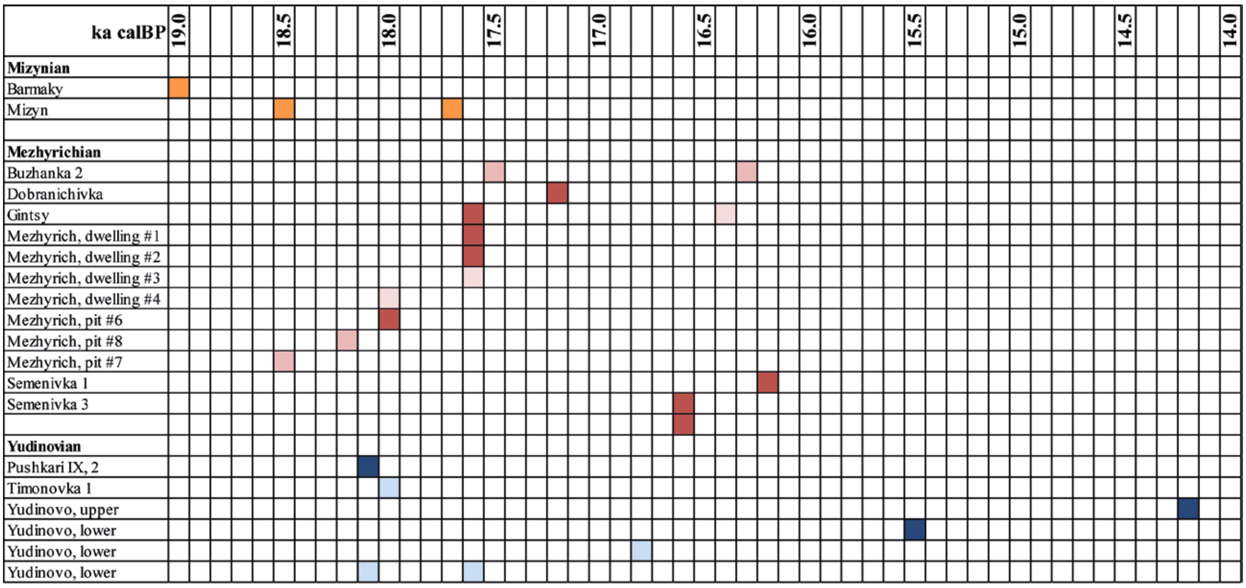

Fig. 36. Chronological position of dated assemblages from the Mizynian, Mezhyrichian, and Yudinovian. Light colours: single dates and weighted averages including mammoth-only and conventional-only date clusters; dark colours: only weighted averages, no conventional-only date clusters, and only the youngest mammoth-only date clusters.

Abb. 36. *Chronologische Position datierter Inventare des Mizynian, Mezhyrichian, and Yudinovian. Helle Farben: Einzeldaten und gewichtete Mittel inklusive Datierungscluster mit ausschließlich Mammutknochen und ausschließlich konventionellen Daten; dunkle Farben: nur gewichtete Mittel, keine Datierungscluster mit ausschließlich konventionellen Daten und nur die jeweils jüngsten Datierungscluster mit ausschließlich Mammutknochen.*

comments. This paper is part of the studies conducted in the framework of the DFG project "Between East and West. Social networks and environmental conditions before, during and after Last Glacial Maximum in Volhynia, Western Ukraine", project number 392605832.

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