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Exploitation of the natural environment by Neanderthals from Chagyrskaya Cave (Altai)

Nutzung der natürlichen Umwelt durch Neandertaler der Chagyrskaya-Höhle (Altai)

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Abstract - The article presents the first results of studies concerning the raw material procurement and fauna exploitation of the Easternmost Neanderthals from the Russian Altai. We investigated the Chagyrskaya Cave – a key-site of the Sibiryachikha Middle Paleolithic variant. The cave is known for a large number of Neanderthal remains associated with the Sibiryachikha techno-complex, which includes assemblages of both lithic artifacts and bone tools. According to our results, a Neanderthal population has used the cave over a few millennia. They hunted juvenile, semi-adult and female bisons in the direct vicinity of the site. Human impact on the paleontological remains provides additional evidence about the exploitation and consumption of at least part of the carcasses at the spot, which is characteristic for a consumption site. The first seasonal data available for the Altai Middle Paleolithic indicates that the death of the animals occurred at the end of the warm season, which corresponds to the annual migration of the *Bison priscus* from the plains to the Altai foothills.

The results of the attribute analysis of lithic artifacts suggest that raw pebbles from the nearby riverbed had been transported to the cave in one piece. The spatial data, the large amounts of lithic tools, the presence of bones with cut marks as well as the quantity of bone tools indicate a high intensity of the cave occupations. The composition of the artifact assemblage from Chagyrskaya Cave is characterized by a relatively high percentage of tools and débitage and a low percentage of cores and bifacial tools. The large number of cortical flakes, a significant number of partly cortical flakes (including different varieties of *débordant* core-trimming elements), as well as the presence of bifacial thinning flakes and chips are a clear indication of on-site core reduction and tool production. The metrical parameters of the cortical and non-cortical regular flakes testify to the complete reduction sequence on the site. In order to produce tools, the biggest blanks available have been chosen intentionally. The results obtained from the assemblage from Chagyrskaya Cave do not fit to the existing functional variability of the Altai Middle Paleolithic, which was dominated by "ephemeral" hunting camps and base camps with relatively low-intensive raw material utilization. The techno-typological characteristics of the Chagyrskaya Cave assemblage are completely consistent with the characteristics of the Crimean Micoquian techno-complex, which is an integral part of the European Micoquian. With regard to the settlement pattern, Chagyrskaya Cave is typical for a recurrently visited base camp with the exploitation and consumption of animal carcasses and an intensive lithic reduction as well as bone tool production. Such a site function demonstrates a considerable overlap with the Eastern and Central European Micoquian.

Zusammenfassung - *In dem vorliegenden Artikel werden erste Ergebnisse zu Strategien der Rohmaterialbeschaffung und Faunennutzung aus dem östlichsten Bereich des Verbreitungsgebietes der Neandertaler bekannt gegeben. Untersucht wurde die Chagyrskaya Cave im Russischen Altai, eine Schlüsselfundstelle der Sibiryachikha-Fazies des dortigen Mittelpaläolithikums mit Erhaltung nicht nur umfangreicher Steingeräte-Inventare und Überresten der Jagdbeute, sondern auch – zum ersten Mal in der Region – mit Knochenartfakten. Die Höhle erfuhr bereits große Popularität durch die Entdeckung zahlreicher fossiler Überreste des Neandertalers, die innerhalb der Abfolge in der Chagyrskaya Cave ausschließlich mit der Sibiryachikha-Fazies vergesellschaftet sind. Die vorläufigen Ergebnisse lassen bereits jetzt den Schluss zu, dass die Höhle über mehrere Jahrtausende hinweg von einer Neandertaler-Population genutzt wurde. Im Zuge der Begehungen wurden vor allem juvenile und semi-adulte weibliche Bisons in der unmittelbaren der Fundstelle Umgebung gejagt. Anthropogene Manipulationen an den Faunenresten deuten auf*

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eine Zerlegung und Aufbereitung der Jagdbeute für den Konsum vor Ort und damit auf eine Nutzung als Basislager. Erste Hinweise auf die Jahreszeit der Jagdereignisse bezeugen eine Tötung der Tiere am Ende der warmen Jahreszeit zu einem Zeitpunkt, an dem sich die jahreszeitlichen Wechsel von Bison priscus zwischen den Ausläufern des Altaigebirges und der Steppe rekonstruieren lassen. Die Ergebnisse einer Merkmalanalyse an den Steinartefakten deutet darauf hin, dass dem nahen Flussbett als Ganzes in die Höhle geschaffte Gerölle am Beginn der Zerlegungsketten standen. Die räumliche Verteilung der Funde, die hohe Anzahl an Steinartefakten, das Vorliegen von Faunenresten mit Zerlegungsspuren sowie die hohe Fundhäufigkeit von Knochenartefakten belegen eine intensive Nutzung der Höhle während der Begehungen. Die Zusammensetzung des Steinartefakt-Inventars zeichnet sich durch hohe Anteile an kantennah retuschierten Stücken und Abschlägen einerseits und geringen Anteilen an Kernen und bifaziellen Stücken andererseits aus. Aufgrund der hohen Anzahl an Kortexabschlägen und Abschlägen mit partieller Kortexbedeckung der Dorsalflächen, unter denen sich verschiedene Formen von Kernkantenabschlägen befinden, sowie angesichts des Vorliegens von Abschlägen der Flächenretusche und Absplissen bestehen keine Zweifel an einer Kernreduktion und Werkzeugherstellung vor Ort. Für die Erzeugung der modifizierten Stücke wurden nachweislich die größten Abschläge intentionell ausgewählt. Das sich aus den Analysen abzeichnende Muster der Begehungen der Chagyrskaya Cave passt nicht in die bekannte funktionale Variabilität des Altai-Mittelpaläolithikums, die bislang durch ephemere Jagdlager und Basislager mit einer wenig intensiven Rohmaterialverarbeitung gekennzeichnet war. Von den techno-typologischen Merkmalen her lassen sich für das Inventar aus der Chagyrskaya Cave die besten Entsprechungen im Micoquien der Krimhabinsel finden, das als integraler Bestandteil des Europäischen Micoquien angesehen werden kann. Diese Affinität gilt auch für das Siedlungsmuster: als mehrfach aufgesuchtes Basislager, an dem neben der Zerlegung und dem Verzehr der Jagdbeute auch eine intensive Grundform- und Werkzeugproduktion stattfand und darüber hinaus Knochenartefakte erzeugt wurden, sowie Rohmaterialverarbeitung, ist die Chagyrskaya Cave gut mit Fundstellen des östlichen und zentraleuropäischen Micoquien vergleichbar.

Keywords - Altai, Neanderthals, Middle Paleolithic, Micoquian, fauna and raw material exploitation
Altai, Neandertaler, Mittelpaläolithikum, Micoquien, Faunen- und Rohmaterialnutzung

Introduction

The Altai is a region widely known for interactions between Denisovans and Neanderthal populations established notably based on mtDNA analyses obtained from sediments and the discovery of the first generation offspring (Slon et al. 2017; Slon et al. 2018). Remains from the two human taxa were found associated with two regional Middle Paleolithic techno-complexes, e.g. the Denisova and Sibiriachikha variants, while until today no human remains were discovered within assemblages related to the third techno-complex present in Altai, the Kara-Bom variant (Fig. 1: a).

The Denisovan and Kara-Bom techno-complexes represent the local development of Levallois-based industries (MIS 8 – MIS 3) and are characterized by a combination of Levallois preferential, Levallois convergent and radial flaking methods as well as Kombewa cores at the earliest stages. Simple side-scrapers, notches and denticulate tools and Levallois points (Derevianko et al. 2013; Krivoshapkin et al. 2018) dominate the tool sets. These techno-complexes have been considered as technologically similar, but resulting from separate adaptive solutions to different constraints (such as raw material procurement, site function and chronological position within the Middle Paleolithic sequence: Rybin & Kolobova 2005).

To the contrary, the Sibiriachikha techno-complex, which has been identified on the base of two assemblages from Chagyrskaya and Okladnikova caves, is characterized by radial, orthogonal and parallel non-volumetric methods of core reduction strategies. The bifacial tool production is based on plano-convex and plano-convex-alternate methods. The low amounts of bifacial points and bifacial scrapers, the high frequencies of leaf-shaped points and leaf-shaped scrapers as well as trapezoidal points and trapezoidal scrapers characterize the Chagyrskaya Cave lithic industry (Kolobova et al. 2019). It has been assumed that the Sibiriachikha techno-complex is exclusively associated with Neanderthals (Derevianko et al. 2013; Derevianko et al. 2018; Kolobova et al. 2020a). Recently, based on a detailed attribute analysis of lithic artifacts and tool types in combination with new absolute dating and multivariate statistics, the assemblage from Chagyrskaya Cave has been interpreted as evidence for the intrusion into the Altai region of Neanderthals with Micoquian/*Keilmessergruppen (KMG)* tradition. However, while the site is well known for the numerous anthropological and bone tool collections (Derevianko et al. 2018; Baumann et al. 2020; Kolobova et al. 2020b), few data concerning the Neanderthal adaptive strategies are available.

Chagyrskaya Cave (51°26'34.6'' N; 83°09'18.0'' E) is situated on the left bank of the Charysh River in the mountain branches of the Tigirek Range in the Altai Mountains of Russia. The cave faces north and is situated at an elevation of 353 meters above sea level (Fig. 1: b) and 19 m above the river level. It consists of two chambers with a total area of approximately 130 m^2 (Fig. 1: c).

Known as a karstic cavity since 1859, Chagyrskaya Cave was referenced as a chiropterological site during the 20th century. The archaeological and paleontological deposits from Chagyrskaya Cave were discovered in 2007 by L. Kungurov and S. Markin (Vistingauzen 2016). From 2007 to 2015, a team led by S. Markin carried out excavations of 33 m^2. In 2016-2018, an international team led by K. Kolobova conducted new campaigns of fieldwork following modern excavation standards.

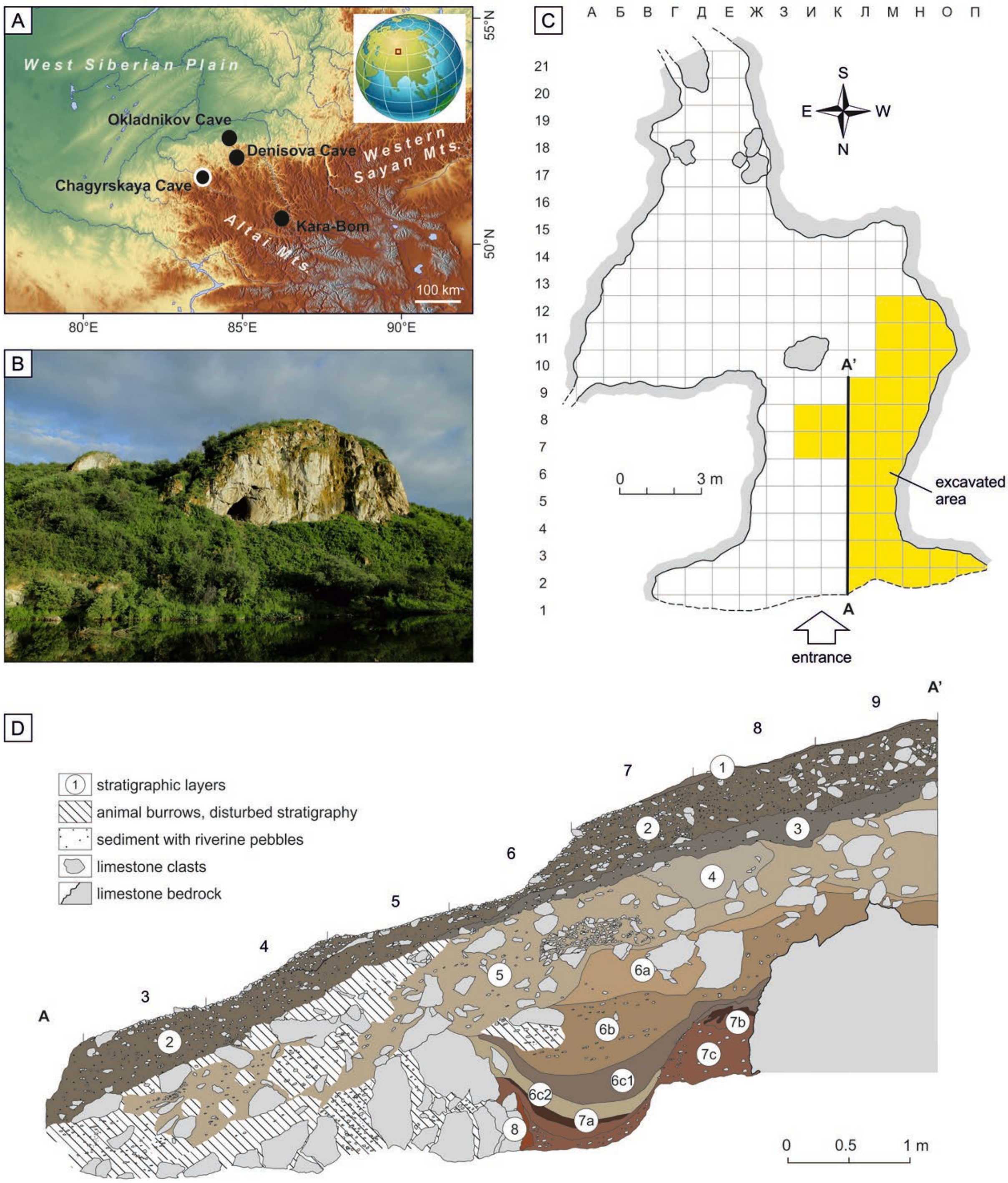

Fig. 1. Chagyrskaya Cave: A – localization of Chagyrskaya Cave and other Altai sites mentioned in the text; B – photograph of the cave entrance; C – plan of the cave with archaeological grid and excavated area; D – cross-section through the sediments along the A-A' line shown in the panel C.

Abb. 1. *Chagyrskaya Cave: A – Kartierung der Chagyrskaya Cave und weitere im Text erwähnte Fundstellen des Russischen Altai; B – Foto des Höhleneingangs; C –Höhlenplan mit Vermessungssystem und bisher ausgegrabenen Flächen; D – Profil entlang der Linie zwischen den Punkten A und A' in Abb. C.*

A series of absolute dates place the Neanderthal occupation chronologically to a relatively short period at the final part of MIS 4 and/or the beginning of MIS 3. The available paleoenvironmental data suggests that a steppic or semi-desert steppic environment had spread under a dry continental climate into the Charysh valley at this time (Derevianko et al. 2018).

Materials and method

Lithic analysis

A total of 89 539 artefacts have been recovered from layer 6. We selected a representative sample for the detail analysis, which was excavated during the 2008 season in sublayer 6c1 (3 021 lithic artifacts recovered from 12 m^2).

For the attribute analysis, we followed the method adopted for the Crimean Middle Paleolithic (Chabai & Demidenko 1998). The reconstruction of the raw material exploitation is based on the identification of technologically significant attributes. The analysis of techno-typological features aims at the identification of specific methods of primary flaking (using the typological variability and the metrical parameters of cores and *debitage*), the methods of tools production (based on the variety of retouch types and the manners of tool edges elaboration), as well as on characteristics of tool morphology (e.g. simple and complex shapes). It is therefore characteristic of the proposed methodology that each artifact is assessed as a set of technologically interrelated morphological and metric features in order to determine techno-typological peculiarities and its place in the reduction sequence.

Several definitions of core preparation blanks used here deserve a more detailed explanation. "Technical flakes"/"*Kantenabschläge*" result from the creation and modification of striking platforms of cores made on relatively thin pebbles or thick flakes (Richter 1997, p.186-187). "Radial core *debordant* flakes"/"core edge flakes" are characterized by an obtuse angle between the striking platform and the lateral part. The lateral part of the core edge flake was a part of the striking platform of radial cores. The flaking axis of radial core *debordant* flakes does not coincide with the maximum blank length (Debénath & Dibble 1994, p. 52).

Scar pattern analysis has been used to reconstruct the technological stages of bifacial production (Shalagina et al. 2015; Zotkina et al. 2018; Shalagina et al. 2019).

All the lithic artifacts characteristic have been collected using an E4-MS-Access database. Digital calipers have been used for measurements. The PAST software was used for non-parametric tests, non-metric multidimensional scaling (nmMDS) and principal component analysis (PCA) (Hammer et al. 2001).

Stratigraphy

The stratigraphy of the sedimentary sequence is based on the differences in color and grain size composition as well as the presence of specific sedimentary structures, such as disconformities. The sequence has been divided into lithostratigraphic units, called layers. Micromorphological analyses were also applied to discuss the site formation processes. All archaeological, anthropological and paleontological material was attributed to layers during the excavation.

Petrography

Petrographic identification of raw material was used for pieces of tools and cores larger than 2 cm. Both macroscopic observations and a non-destructive microscopic method were used for the observation of lithic surfaces in water immersion (Přichystal 2013). The same method was used for the analysis of pieces >4 cm from alluvial gravels that likely served as a source of the Paleolithic raw material. The analysis was repeated several times on samples from randomly chosen 2×2 m polygons on the riverbank.

Paleontology

The paleontological collection stems from nine excavation campaigns (2007–2015) and includes all layers. The samples were dried and then sorted. The reference collection of recent and Pleistocene large mammals of the Institute of Archaeology & Ethnography (Novosibirsk, Russia) was used for the taxonomic identification of the mammal remains. The season of the Neanderthal occupation of Chagyrskaya Cave is currently under examination using dental increments analysis of large ungulate teeth (Burke & Castanet 1995; Klevezal 1996; Pike-Tay & Cosgrove 2002; Rendu 2010; Naji et al. 2015). The teeth of adult individuals with well-preserved roots were sampled and used to prepare petrographic thin-sections. Teeth were embedded in epoxy resin, cut transversally just below the crown and polished to a thickness of around 100µm. Samples were analyzed with an optical microscope (Olympus SZX-ILLK200). Analyses were conducted under reflected and polarized transmitted light.

Zooarchaeology

Since faunal remains were only selectively excavated during the 2007-2015 field campaigns, the zooarchaeology analysis had to rely on the more limited, but unselected material yielded by the most recent excavation directed by K. Kolobova. For now, the totality of the material from the *in situ* sublayer 6c2, excavated in 2016, was investigated. Pieces were identified at the most precise level and, when it was not possible to propose a specific attribution, ungulate size classes were used (Brain 1981). With regard to the skeletal part profiles, all identifiable specimens (including shaft fragments) were taken into account and recorded following the "element, portion, segment" approach (Gifford & Crader 1977). Analyses of the bone surfaces were conducted on all the remains. Bone surfaces were observed under a low-angled light, using a hand lens (enlargement: 10x) for the taphonomic and zooarchaeological observations. Weathering, root etching, anthropogenic and carnivore modifications were systematically looked for (Behrensmeyer 1978; Olsen & Shipman 1988; Blumenschine et al. 1996; D'Errico & Villa 1997; Pickering & Egeland 2006). Oxide colorations of the bone cortical surfaces were also recorded. The proportion of the preserved cortical surface was estimated per quartile (Rendu 2010). When unclear modifications were detected, specimens were subjected to more thorough evaluation with a 20-80x microscope.

Stratigraphy

The stratigraphic sequence of Chagyrskaya Cave includes both Holocene and Pleistocene deposits (Derevianko et al. 2013). Up to 3.5 m thick, the sequence has yielded several layers identified on the basis of differences in color and grain size composition and the presence of sedimentary structures (Fig. 1: d, numbering ordered upward).

Layer 8 – red clay occurring locally in depressions in the bedrock. This sediment is preserved as small remnants that survived erosional events in pocket-like structures. The red clay is a typical weathered sediment (*terra rossa* type) that has accumulated as a residual material during karst dissolutions of the limestone, most probably during warm pre-Pleistocene climatic phases.

Layer 7 – red-brown clay or clayey loam, with quartz grains and fine, chemically weathered limestone clasts and riverine pebbles. Intercalations of greenish silt occur locally. This sediment lays on bedrock. The presence of pebbles and red clay indicates a complex origin of the layer. The pebbles probably originate from old alluvial terraces located above the cave, and were transported into the cave via chimneys, by colluvial processes. The red clay is a typical residual sediment (*terra rossa* type), accumulated as an effect of karst dissolution of the limestone.

Layer 6 is a grayish, brownish or orange loam. This layer has a complex structure and can be further subdivided into several sublayers, called 6a, 6b, 6c and 6d.

Sublayer 6d (Russian 6д) is a reddish-brown loam with fine weathered limestone clasts, sparse bones and fine riverine pebbles. It contains clasts and packets of layer 7 mixed with material of sublayer 6c, as a result of vertical re-deposition due to frost action.

Sublayer 6c (Russian 6в) is a gray carbonate silty loam with sparse fine riverine rounded pebbles, numerous bone fragments, lithic Middle Paleolithic artifacts and sparse limestone clasts. Locally, the sublayer has a complex structure and can be subdivided into two units. Sublayer 6c/2 (the lower one) is a loess-like sediment bearing traces of pedogenesis, possibly a sediment of sublayer 6c/2 mixed with paleosol by colluvial processes. The sediment is cryoturbated. The morphology of the convolutions in units 7, 6d and 6c is repeated in the cryogenic deformation of the overlying sediments, indicating that cryoturbation occurred after the deposition of sublayer 6a (i.e., long after Middle Paleolithic occupation). However, the sediments of sublayer 6c and below were not mixed with those of overlying layers. Sublayer 6c/2 is the primary depositional context of the Middle Paleolithic assemblage at Chagyrskaya Cave. This is indirectly proven by sharp edges of the lithics and directly by the presence of an intact fireplace.

Sublayers 6b and 6a (Russian 6б and 6a) are brown and orange carbonate silts with sparse angular limestone clasts, bone fragments, lithic artifacts and riverine pebbles. These sublayers were defined during the archaeological excavation in 2007-2015. However, these sediments form a complex colluvial series, built of more than two interbedded sedimentary units. Sublayers 6b and 6a should rather be considered as lithological types inside this series. Type 6a is more clayey and orange, similar to layer 7. Type 6b is more silty, slightly denser, less porous, grayish brown, and is similar to sublayer 6c/1. The lower boundary of the series is erosional.

Layer 5 is a yellowish carbonate silt. From a sedimentological point of view, this layer is a complex of strata, composed of two types of sediments dividing the layer in 5a and 5b. Type 5a is a cohesive colluvial fill deposited in erosional channels, built of loess-like silt with sparse, rounded pebbles and angular limestone clasts. Type 5b is limestone debris comprising angular clasts, with a silty matrix, but commonly without any fine material in intergranular spaces, indicating a very rapid accumulation. Sediments in type 5b consist of rock fall, most probably triggered by seismic events, but preceded by intensive mechanical weathering (frost action).

Layer 4 is a local variety of layer 5a and has a more grayish color.

Layer 3 is a grayish-brown loamy sand with abundant riverine rounded pebbles of variable lithology. The pebbles and sand most probably derive from ancient river terraces situated on the slope above the cave and were transported into the cave by colluvial processes via the karstic chimneys in the ceiling of the rear chamber. Fluvial activity can be excluded as a direct depositional agent, due to high elevation of the cave above the riverbed and the poor sorting of sediments by grain size. Numerous Bronze Age archaeological finds in this layer and its grayish color testify to the cultural character of the sediment.

Layer 2 is a yellowish brown loamy sand, similar to layer 3 except for the color. The imbrication of the pebbles is clearly visible in the longitudinal profiles, indicating the transport direction northward from the cave interior towards the entrance. Solifluction (sediment creep under cold conditions) was the main depositional process.

Layer 1 is a gray to dark gray non-carbonate loamy sand, slightly compacted, with many small fluvial pebbles. This layer represents the uppermost part of layer 2, altered by the input of organic matter and the effects of human trampling.

Paleontological and seasonal data

The paleontological complexes from the uppermost units 5-6b are characterized by a small number of bison (*Bison priscus*) remains, while in contrast, the lower layers (sublayers 6c1 and 6c2) have high numbers of bison remains with percentages of up to 47.2 % (Fig. 2). The assemblages from the upper sediment units (layers 5-6b) are not a direct result of human activity, but have formed as a consequence of colluvial processes. Some animal remains in these stratigraphic units could have been re-deposited from the lower strata. Layer 6c2, the lowermost in the sequence of the Upper Pleistocene, is preserved practically *in situ*. The high number of bison remains in this layer allows important insights into Neanderthal hunting behavior.

In Chagyrskaya Cave, almost all parts of the carcasses of bison are present, but isolated teeth and their fragments are prevalent (71.2 %). Among the bones of the bison postcranial skeleton, only single bones of the wrist, tarsus and phalanx were preserved in one piece. There are also rare fragments of hyoid bones, ribs and vertebrae (mostly tail vertebrae).

Among the isolated buccal teeth of bison, 67.3 % belong to juveniles and semi-adult individuals, 27.1 % to adults and 5.6 % to senile individuals. All of the postcranial bones suitable for measurements belonged to small individuals, most likely to female bison.

While the zooarchaeological analysis is at its first stage, some preliminary results give new insights into the origin of the faunal assemblage and the human behavior related to it. Carnivore impact on the material is extremely limited: only 8 % of the remains bare evidence of their activity on the site. Due to the scarcity of carnivores in the faunal spectrum and the absence of young carnivore individuals, it seems plausible to reject them as the agents of the constitution of the faunal assemblage. To the contrary, the human impact on the faunal assemblage from sublayer 6c2 is particularly impressive: 31 % of the remains exhibit evidence of cut marks, scrapping and notches, and in addition, bones were used as retouchers. This impact concerns all taxa and is approximately the same for both the medium and the large size ungulates (respectively 44 % and 36 % of the number of remains [NR]). The analysis of the distribution of cut marks attests that skinning, dismembering and processing of meat were conducted on the site. Bone breakages point to the recovery of grease and marrow, as attested by the frequency of notches and bone flakes (10 % of the NR). In the analyzed sample, no burnt bones have been identified for now. While the data is still limited, the abundance of cut marks, the processing of marrow at the site, the absence of anatomical connections and the absence of complete bones are coherent with the use of Chagyrskaya Cave as a consumption site.

The ongoing investigations of the cementochronology is focused on bison and horse teeth. Twelve specimens have been analyzed. Among these, data on seasonality were available only for two individuals of horse. Post-depositional processes to such extent that the deciphering of the increment record was impossible had damaged the other teeth. In both cases of satisfactory preserved horse teeth, the death of animals appears to have happened at the end of the warm season. Final increments show wide bands of nearly complete growth, with no signs of winter annuli formation, consistent with a death at the end of summer to early fall. This data provides a first information about the season of Neanderthal hunting activities in the region. Despite the undoubted benefits of dental cementum analyses as indication of the hunting season, at this stage of research additional results are needed for a conclusive picture of the seasonality of the occupation. If the results would be confirmed for the complete faunal assemblage, it would argue for a hunting of bison during the rut phase or the fall migration. The targeting of matriarchal groups (with juveniles, sub-adults and females) could be best explained by the fact that females have reached at this period of the year their maximum meat weight. On the opposite, males are highly aggressive during the rut and loose a great quantity of their body mass during it, being less suitable for a selection based on the meat acquisition. Such a pattern has already been identified in other Mousterian sites from Western Europe like sublayer 6c at La Quina (Rendu & Armand 2009) and Mauran (Farizy et al. 1994; Rendu et al. 2012).

We can assume that the seasonal hunting recorded in Chagyrskaya Cave could have happened in conjunction with the annual bison migrations across the Charysh river valley. Modern analogies are known among the North American Indians (Tanner 1956), who tried to hunt exclusively female bisons, which provided more tender and fatty meat. The meat of the male bisons, especially when heated, was rejected because of the specific flavor.

Lithic raw materials

Silicate rocks such as nodular chert or flint, a common raw material in the European Micoquian/*Keilmessergruppen (KMG)* sites, are not available in the vicinity of Chagyrskaya Cave. The list of raw materials identified in the lithic assemblage includes: clastic sedimentary rocks (shales, mudstones, sandstones, quartzites), bedded chalcedonites (radiolarites), jasperoids (jaspers and local jasperoids of "Zasur'ye" type), several variants of hornfels and effusive rocks (felsic porphyries, basalts), tephra (tuffs) and isolated quartz crystals. The most common types are mudstones, porphyries, jasperoids and radiolarites. The raw material is available in form of pebbles in gravelly alluvial deposits of the Charysh riverbed in the direct vicinity of the cave (in distances between 10 to 40 m).

Taxon	**Layer**										
	1	**2**	**3**	**4**	**5**	**6a**	**6b**	**6c**	**7**	**Spoil**	**Total**
Canis familiaris				2	1*		1*				**4**
Equus caballus		1	2	1						3*	**7**
Bos taurus		11	5	5	9*						**30**
Capra-Ovis (dom.)	4	64	88	36	12*	3*	5*			15	**227**
Asioscalops altaica	1	8	1	2	76	43	16	9		3	**159**
Chiropthera gen. indet.		29	4	3		4	1	1		1	**43**
Ochotona sp.		3	1		3	1	2				**10**
Lepus timidus	1	17	4	12						3	**34**
Lepus tanaiticus		6**	1**		64	18	11	1		3	**104**
Lepus tolai			3	1	47	11	6	6		2	**76**
Tamias sibiricus					1			1			**2**
Citellus sp.	2	24	13	9	283	111	45	32		11	**530**
Marmota baibacina	2	6	3		23	16	5	4			**59**
Castor fiber		2	1	1			1				**5**
Allactaga sp.		2**	1**		16	2					**21**
Cricetus sp.	2	117	20	13	8(2*)	7				5	**172**
M. myospalax	1	56	11	2	310	128	44	32		12	**596**
Arvicola terrestris		44	8	7	9	3	4	2		2	**79**
Rodentia gen. indet.	2	117	10	33	347	110	44	24		17	**704**
Canis lupus	1	2**	2		45	36	47	50	3	5	**191**
Vulpes vulpes	1	6	2(1**)	3	68	55	74	61	1	9	**280**
Vulpes corsak		1**		3	30	27	32	38	1	3	**135**
Cuon alpinus					35	8	10	9		2	**64**
Ursus arctos			2	1	7(1*)	1		3			**14**
Martes zibellina				1	3		1				**5**
Mustela nivalis		1			4		3				**8**
Mustela erminea		5			5			1*			**11**
Mustela altaica		2			5(1*)	2		2			**11**
Mustela eversmanni					2	2				1	**5**
C. crocuta spelaea			2**		33	25	12	11		6	**89**
Panthera spelaea					5	1		3			**9**
Lynx lynx		1						1			**2**
Mammuthus primigenius					49	13	24	9		4	**99**
Equus (E.) ferus					8	5	4(1*)	3		1	**21**
E. (Sussemionus) ovodovi		3**			30	32	37	38		4	**144**
E. ovodovi / ferus		2**		3**	61	65	31	26		3	**191**
Coelodonta antiquitatis					17	6	6	1			**30**
Cervus elaphus		14(1**)	19	13	18(6*)	19(3*)	13(1*)	12(1*)		12(6*)	**120**
Alces alces		1			1*	2*				1*	**4**
Caprolus pygargus	2	8	15	5	35*	3*		2*	1*	3*	**74**
Rangifer tarandus				1**	6	6	7	6		1	**27**
Bison priscus			1(3**)	3**	54	167	276	536	21	51	**1 109**
Gazella gutturosa					3						**3**
Saiga tatarica borealis					9	4		2			**15**
Saiga / Gazella					47	26	12	1		1	**87**
Capra sibirica		2(1**)	6**		210	140	74	85		10	**527**
Ovis ammon		5**	6**	1*	103	53	31	37	2	10	**248**
Capra / Ovis		5**			141	93	60	37		9	**345**
Pisces		28	16		19	3	1			2	**69**
Amphibia		3			2	1					**6**
Aves	2	223	34	31	176	58	39	24		13	**600**
Unidentifiable fragments	31	1 567	1 756	1 032	62 196	38 125	44 567	45 068	1 016	4 725	**200 083**
Total	**53**	**2 392**	**2 042**	**1 223**	**63 637**	**39 436**	**45 548**	**46 197**	**1 045**	**4 954**	**206 537**

Fig. 2. Composition of species and the number of bone remains from the sediments of Chagyrskaya Cave.

Abb. 2. *Zusammensetzung der Arten und Anzahl der Knochenfunde in Sedimenten der Chagyrskaya Cave.*

The rock types used as a raw material consist of about 25 to 30 % of the entire alluvial material (Fig. 3). The types ignored by Paleolithic collectors include conglomerates, crystalline igneous rocks (granites, diorites, and ultramafic rocks), amphibolites, granulites, gneisses, serpentinites and coarse-crystalline porphyries. According to this observation, the selection made by Neanderthals was oriented to homogenous and silica-rich rocks. Used for the biface manufacturing, radiolarites seem to have been considered as one of the best available raw material by Neanderthals and had been specifically looked for. Indeed, this raw material consists of less than 2 % of the alluvial material (Fig. 3) and occurs only in the smaller fraction (below 10 cm).

Archaeological assemblage

The assemblage of core-like artifacts (pre-cores, cores, pre-forms) constitutes 1.3 % of the total number of artifacts (2.7 % without chips and debris) (Fig. 4). The frequency of flakes, including tools on flakes, reaches 43.1 % (90.7 % without chips and debris). Retouched pieces were found in rather large numbers: tools constitute more than 14 % of the lithic collection.

The primary knapping was focused on flake production and based on two reduction strategies, e.g. radial and orthogonal. Radial cores have one striking platform arranged along the perimeter of an ovoid flaking surface (Fig. 5: 1). Orthogonal cores have one or two striking platforms located on the adjacent sides of a rectangular flaking surface (Fig. 5: 2). No Levallois convergent or Levallois preferential cores have been identified.

Blanks are classified into three major classes: flakes, blades and non-indefinable debitage. Core trimming blanks constitute 38.8 % of the total number of all definable flakes and blades. This category includes various lateral blanks, e.g. *debordant*, cortical (Fig. 6: 5), crested (Fig. 6: 1) and technical/*Kantenabschläge* (Fig. 6: 6) flakes, which resulted from radial (Fig. 6: 2, 7, 9-10), orthogonal (Fig. 6: 1, 8) and bifacial flaking (Fig. 6: 3-4) (Fig. 7).

More than half of all blanks (57 %) are non-cortical; those partially covered by cortex are also common (32.1 %), while blanks with almost full cortex coverage on the dorsal surface account for only 11.4 % (Fig. 8). Blanks with lateral cortex comprise 20.2 %, those with

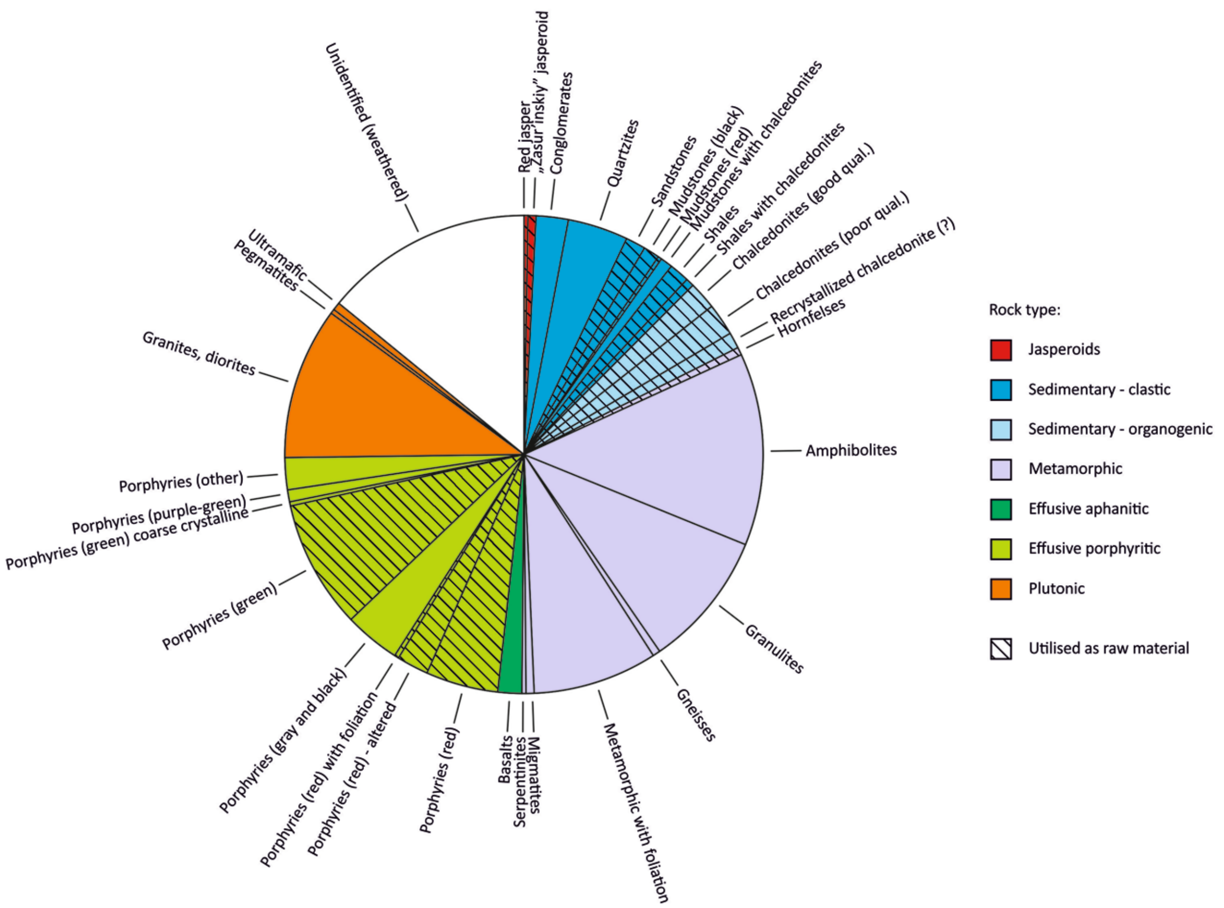

Fig. 3. Petrographic composition of pebbles (> 4 cm size fraction) in the Charysh riverbed below the Chagyrskaya Cave. Shading is used to mark the types utilized by Neanderthals as raw material.

Abb. 3. *Petrographische Zusammensetzung der Gerölle (Größenklasse > 4 cm) aus dem Charysh-Fluss unterhalb der Chagyrskaya Cave. Die hervorgehobenen Einheiten geben eine Nutzung durch Neandertaler an.*

	N	%	Total, esse %*
Pre-cores	3	*0.1*	*0.2*
Cores	27	*0.9*	*1.9*
Pre-formes	8	*0.3*	*0.6*
Tools	428	*14.2*	*29.8*
Flakes**	874	*28.9*	*60.9*
Blades	82	*2.7*	*5.7*
Unidentifiable debitage	13	*0.4*	*0.9*
Chips***	1 409	*46.6*	–
Chunks	177	*5.9*	–
Total:	**3 021**	***100.0***	***100.0***

Fig. 4. Overview of the lithic assemblage from Chagyrskaya Cave, sublayer 6c/1. *The portion of assemblage without waste products. **To define blank's parameters and definition we follow after Debenath and Dibble, 1994. ***Chips - flakes which do not exceed 30 mm in maximal dimension.

Abb. 4. *Überblick über das Steinartfaktinventar aus der Chagyrskaya Cave, Fundhorizont 6c/1. *Der Anteil der Sammlung ohne Abfallprodukte. **Die Parameter und Definition von Abschlägen entsprechen Debenath und Dibble, 1994. ***Absplisse - Abschläge, die in ihrer maximalen Abmessung 30 mm nicht überschreiten.*

distal cortex count for 7.5 %, whereas the percentage of blanks with cortex in the bilateral, proximal and central parts is negligible. Among the lateral *debordant* and core preparation blanks, cortical and partially cortical blanks are in the majority (55.9 %).

Over one-third of lateral *debordant* and core preparation blanks (36.3 %) retain lateral cortex. Distal cortical blanks and complete cortical blanks account for a rather high percentage of 11.5 % and 4 %, respectively. However, lateral *debordant* and technical blanks that show cortex in the bilateral, proximal and central parts were found in small numbers. The presence of numerous cortical and laterally cortical blanks may be attributed to the significant quantity of cortical *debordant* blades and cortical *debordant* flakes (Fig. 9). Radial core *debordant* flakes/core edge flakes and technical flakes demonstrate a radically different tendency in the distribution – distal cortex has been identified in 39 of the 59 specimens of cortical flakes. The differences in the position of cortex between all lateral flakes on the one hand, and radial core *debordant* flakes, technical flakes and radial core preparation *debordant* flakes on the other, can be explained by their association with different flaking methods: orthogonal and radial, respectively.

The metrical parameters of regular flakes and core trimming elements demonstrate the following:

1. In general, cortical flakes (with a cortical cover of 1 to 100 %) are bigger than non-cortical flakes (with a cortical cover of 0 %), including core trimming blanks (Fig. 10: 1-2); a Kruskal-Wallis test shows significant difference in length and width.
2. In general, core trimming blanks (cortical and non-cortical) are bigger than regular flakes (Fig. 10: 1-2).

The metrical parameters of the flakes indicate a continuous reduction processes that took place on the site. Unidirectional and orthogonal scars dominate all the blank types. The latter are blanks with dorsal surfaces covered by cortex or sub-cross and lateral negatives (Fig. 11). Blanks with combined scar patterns (convergent/lateral, unidirectional/lateral, bilongitudinal/lateral), which are usually associated with the Levallois technology (Usik & Chabai 2015), are represented by single specimens. No Levallois flake or Levallois point was found. All types of scar patterns correspond to radial and orthogonal flaking methods, inferred from the analysis of the cores.

Trapezoidal and rectangular shapes, including elongated flakes, are predominant among all blank types (67.1 %). More than one third (36 %) of these are trapezoidal. The flaking axis of most of the blanks does not coincide with the maximum blank length (Fig. 12). Almost one-half of the lateral profiles is straight (48.2 %), while one third is curved (34.7 %). More than two third of distal ends in all the blanks were recognized as feathered terminations (67.3 %); hinge and blunt distal types are represented in almost equal proportions (14 to 16 %). Overpassed blanks were found in small numbers. The typological structure of the blank cross-sections can be characterized by a prevalence of triangular (35 %) and trapezoidal (22.4 %) profiles. Lateral steep, convex and multiple cross-sections as well as flat and amorphous profiles are not numerous (2-18 %).

The striking platform faceting indices (Ifl = 44.79; Ifs = 22.99) in all the blanks show limited amounts of prepared core striking platforms, corresponding to the characteristics of the cores. Almost half of all the striking platforms of the blanks are plain (Fig. 13). Most of the blanks exhibit angles between the striking platforms and the ventral surfaces of 90 to 120 degrees, with the exception of bifacial thinning flakes (Fig. 14). The Kruskal-Wallis test for equal medians of angles demonstrates a significant difference between the angles, reflecting different technological actions between core and bifacial knapping (p value = $3{,}208E^{-14}$).

Almost half of the blanks lack a lip between the striking platform and the ventral surface. One-third of the blanks demonstrate the presence of a lip in characterized with a pronounced bulb or a diffused bulb of percussion that forms a semi-lip. Only the bifacial thinning flakes show a substantial prevalence of pieces with clear lips. This combination of the presence of a lip/semi-lip and a diffused/absent bulb of percussion suggests the use of a soft (organic/mineral) hammer. The presence of semi-lipped platforms associated with a pronounced/diffused bulb of percussion indicates that hard and possible relatively soft hammers were employed. Thus, we can conclude that at Chagyrskaya Cave soft and hard hammers were used for core and bifacial reduction (Fig. 15). Preliminary experimental data support these conclusions

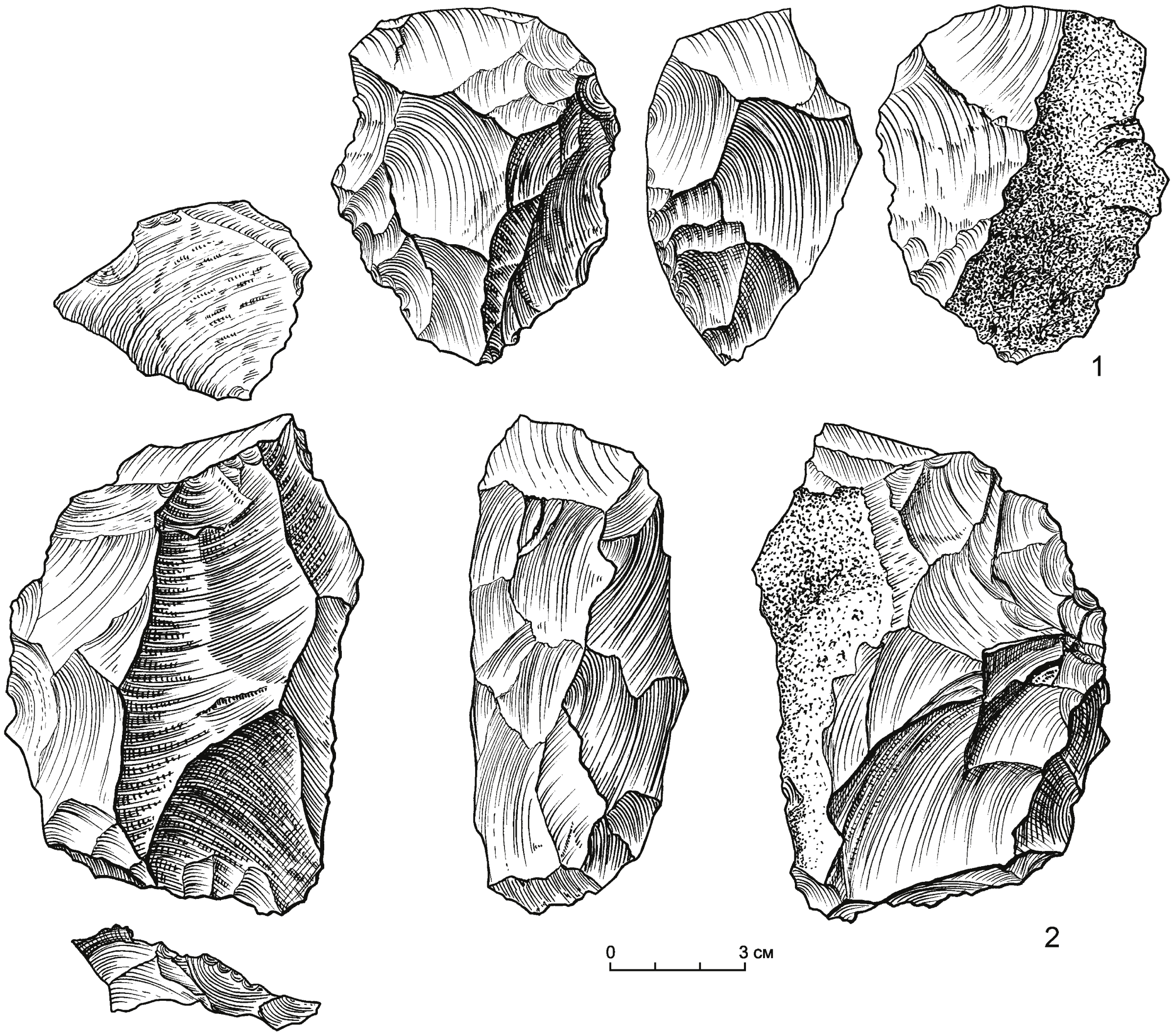

Fig. 5. Cores from Chagyrskaya Cave: 1 – radial core; 2 – orthogonal core.
Abb. 5. *Kerne aus der Chagyrskaya Cave: 1 – Radialer Kern; 2 – Orthogonaler Kern.*

and demonstrate the effectiveness of bone retouchers, which were found in great numbers in the Chagyrskaya Cave assemblages and most probably were used as soft organic hammer in the framework of bifacial production (Fedorchenko et al. 2017).

Almost 18 % of the chips with preserved striking platforms are related to the production and secondary treatment of bifacial tools (Fig. 16). They are characterized by the presence of a heavily obtuse striking platform, small removals in the area of the dorsal surface associated with the edge of the striking platform, an unpronounced bulb of percussion or its absence as well as the presence of a "lip" between the striking platform and the ventral surface of the blank. The relatively low quantity of chips might be influenced by the excavation methods, applied in 2008, before our new protocol.

The typological structure of the tool assemblage is defined by the prevalence of scrapers (70.9 %) (Fig. 17: 1-5, 9), points (14.4 %) (Fig. 17: 6-8), bifacial scrapers (4.6 %), truncated flakes (3.8 %) and bifacial points (2.1 %) (Fig. 18). Denticulated and notched tools, as well as end-scrapers, were found in small numbers. The total of bifacial points and scrapers constitutes 6.8 % of all tools. Neanderthals from Chagyrskaya Cave selected high-quality raw materials to produce highly modified tools, such as bifaces, convergent scrapers and retouched points (Derevianko et al. 2015).

We have compared the metrical characteristics of unmodified blanks and unifacial tools. The comparison of length (Fig. 19: 1), width (Fig. 19: 2) and thickness (Fig. 19: 3) shows evidence for the intentional selection of blanks to produce the tools. A Kruskal-Wallis test for equal medians of length and width demonstrated significant differences between the medians of samples from unmodified blanks and tools (length: p value = 1,208E-^{33}; width: p value = 2,287E-^{17}; thickness: p value = 1,338E-^{31}). Consequently, we can assume that the biggest flakes were intentionally chosen for the tool production. The same pattern can be found among the metrical parameters of striking platforms

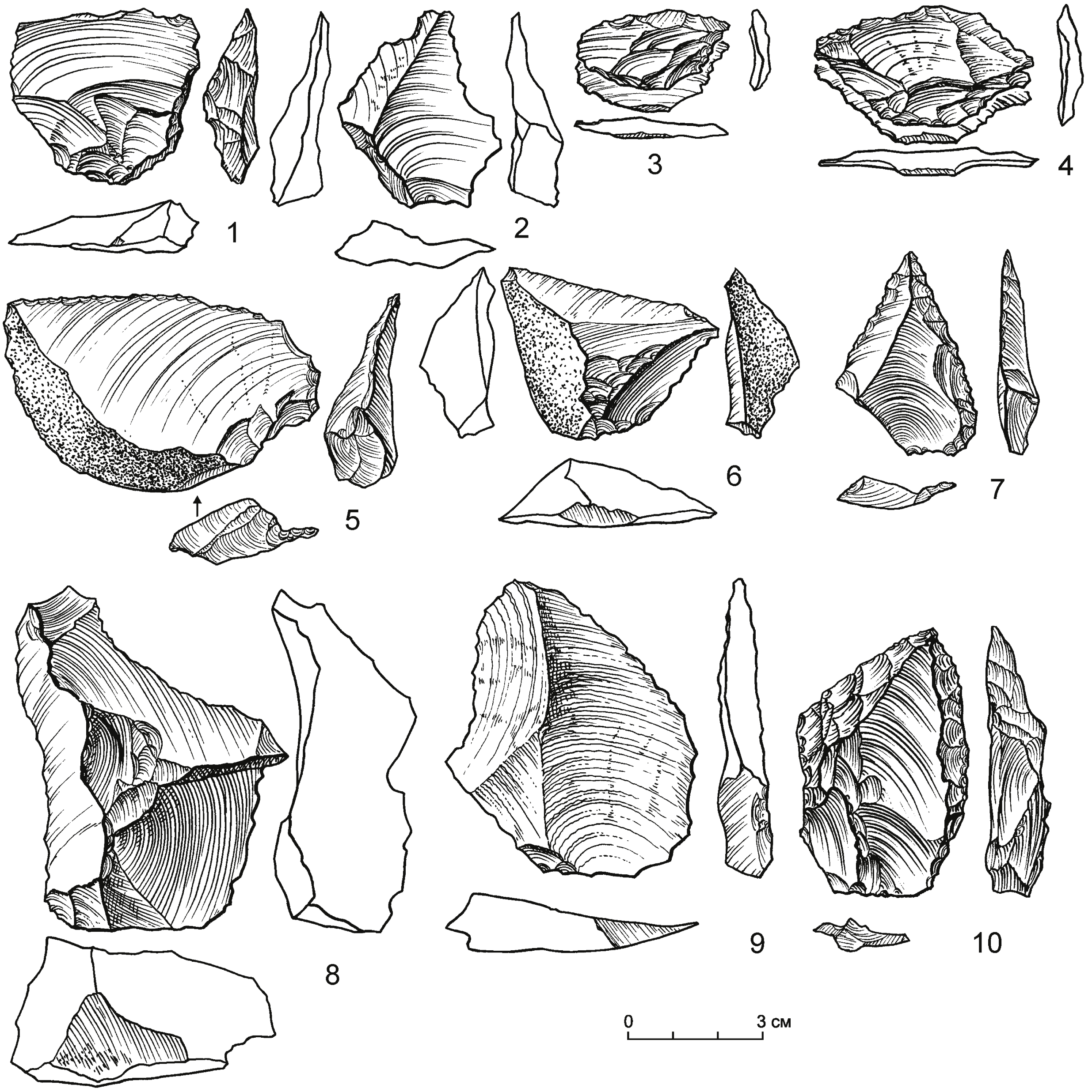

Fig. 6. Core preparation blanks from Chagyrskaya Cave: 1 - crested *debordant* flake, 2, 7, 10 - *debordant* flake from radial core, 3-4 - bifacial thinning flakes, 5 - cortical *debordant* flake, 6 - technical flake, 8 - lateral *debordant* flake, 9 - *debordant* flake from radial core/pseudo-Levallois point.

Abb. 6. *Grundformen der Kernpräparation aus der Chagyrskaya Cave: 1 – Abschlag mit Kernkante, 2, 7, 10 – Abschläge mit Kernkante des radialene Kernabbaus, 3-4 – Flächenretuschierung-Abschläge aus der Verdünnung bifazialer Geräte, 5 – Abschlag mit Kortexkante, 6 – Technischer Abschlag, 8 – Kernkantenabschlag, 9 – Abschlag mit Kernkante aus dem radialen Kernabbau/Pseudo-Levallois-Spitze.*

– the flakes with the biggest striking platforms were intentionally chosen for tool production (Fig. 20: 1-2). This is attested by the Kruskal-Wallis test p value = 9,669E-^{5} for striking platform width and the p value =1,17E-^{9} for striking platform thickness.

Unretouched blanks on the one hand, and blanks chosen for modification on the other, show great similarities in the relative frequencies of the following features: the typological structure of the blanks, the flaking axes, the lateral and distal profiles, cross-sections, dorsal scar patterns, the position and the size of cortex on the dorsal surfaces, the types and angles of the striking platforms, the types of dorsal overhang, the types of ventral lips, the types of the bulbs of percussion and, finally, the pattern of fragmentation. Therefore, blanks and unifacial tools constitute a single reduction sequence. It follows that unifacial tools were manufactured at the site from the biggest flakes, which appear to have resulted from *on-site* flaking of pre-forms, pre-cores and cores.

One of the most characteristic typological feature of the Chagyrskaya Cave assemblage is the presence of bifacial backed scrapers/bifacial knives, typical of the European Micoquian/*Keilmessergruppen (KMG)* techno-complex (Fig. 21-24).

	N	%	% esse*
Blades,regular**	74	5.4	5.5
Blades, cortical debordant	15	1.1	1.1
Blades, lateral debordant	9	0.7	0.7
Blades, crested debordant	7	0.5	0.5
Blades, radial core debordant	1	0.1	0.1
Blades, bifacial thinning	1	0.1	0.1
Blades, primary	6	0.4	0.5
Flakes***	750	54.6	55.7
Flakes, cortical debordant	94	6.9	7.0
Flakes, lateral debordant	70	5.1	5.2
Flakes, crested debordant	21	1.5	1.6
Flakes, crested	1	0.1	0.1
Flakes, radial core debordant	87	6.3	6.5
Flakes, technical/radial core debordant	1	0.1	0.1
Flakes, technical	42	3.1	3.1
Flakes, bifacial thinning	29	2.1	2.2
Flakes, bifacial thinning, over-passed	5	0.4	0.4
Flakes, primary	133	9.7	9.9
Unidentifiable debitage	27	2.0	–
Total	**1 373**	**100.0**	**100.0**

Fig. 7. Composition of the blank assemblage from Chagyrskaya Cave, sublayer 6c/1.* Percentage when unidentifiable debitage are omitted from the total. ** Blades - blanks with the maximum length that is twice as long as their maximum width. *** Flakes exceed 30 mm in minimal dimension.

Abb. 7. *Zusammensetzung der Grundformen aus der Chagyrskaya Cave, Fundhorizont 6c/1. * Prozentualer Anteil, wenn nicht identifizierbare Debitage aus der Gesamtzahl ausgelassen werden. ** Klingen - Grundformen mit der maximalen Länge, die doppelt so lang wie ihre maximale Breite ist. *** Abschläge mit einer minimalen Abmessung von mehr als 30 mm.*

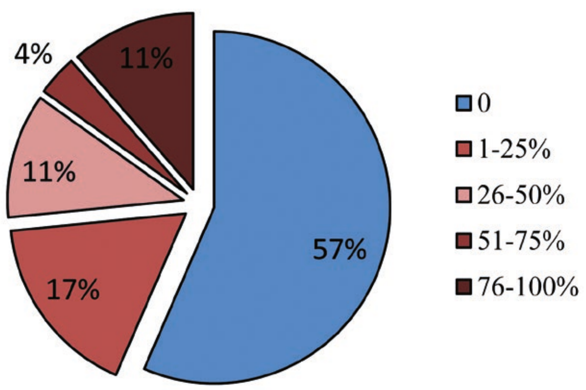

Fig. 8. Frequency of the proportion of cortex on the dorsal surface of blanks.

Abb. 8. *Häufigkeit der unterschiedenen Klassen für die Kortexanteile auf Dorsalflächen von Grundformen.*

Most of the *Keilmesser* were manufactured by using the plano-convex technique. The typical morphological elements of a *Keilmesser* are a back and an adjacent opposite working edge (Krukowski 1939-1948; Wetzel 1958; Bosinski 1967; Kowalski 1967; Chmielewski 1969; Bordes 1981). Typologically, the *Keilmesser* ought to be assigned to bifacial scrapers or knives (Chabai 2004), but, due to the acute retouched edge angle (<60°), they have often been associated with knives (Veil et al. 1994). The shape of *Keilmesser* resulted mostly from the initial shape of the raw material rather than from the utilization stage (Richter 1997; Pastoors and Schäfer 1999; Jöris 2001; 2006; Pastoors 2001). Most scholars agree that *Keilmesser* are long-term tools with the possibility of multiple rejuvenation (Pastoors 2001; Jöris 2006; Boroń 2006; Veselsky 2008).

In the assemblage of sublayer 6 c/1 from Chagyrskaya Cave, four bifaces are similar in shape to knives of the *Klausennische* and *Bockstein* types. The *Klausennische* knife is a bifacial tool with a retouched long edge and opposed back, which is modified into a retouched edge in the terminal part to form the pointed tip. The bifacial backed semi-triangular point (Fig. 23: a-b) could be described as *Bocksteinmesser*, which is a bifacial knife with one retouched edge and an opposed back (Bosinski 1967; Wetzel & Bosinski 1969).

All the *Keilmesser* from sublayer 6 c/1 assemblage were produced using a plano-convex technique. Sizes vary greatly (from 121 mm in length to 58 mm); retouched edges were formed by scaled retouch. Areas with pebble surface can be found on all the bifacial knifes. The backs of the mentioned *Keilmesser* were produced by breakage (Fig. 22) or are covered by pebble cortex (Fig. 21: 2; Fig. 23: b). According to the scar pattern, the backs from all four *Keilmesser* were important parts of the bifacial sequence and often used as a surface for the control of the shape and/or the splitting of the raw nodule.

One of the *Klausennischemesser* (Fig. 24: 1) is characterized by a short additional edge adjacent to the back (negative T), which was created at the final stage of bifacial shaping. After it, only the last set of facets (negatives U) were produced. Those negatives (T and U) could be defined as a rejuvenation of a *Bockstein*-type resulting in the manufacturing of a *Klausennischemesser*. At the final stage of biface shaping, numerous attempts of thinning are visible, mainly on the flat surface (negatives K and V), made from the back and the basal part. Probably, the objective was to remove the extra volume on the flat surface, which could further simplify the sharpening of the working edge.

The back of the second biface seems to have been used for the rejuvenation of the tool (Fig. 24: 2). Scar pattern analysis demonstrates the attempt to thin the tool from the back (Fig. 24: 2; negatives J) and from the base of the biface (Fig. 24: 2; negatives K, L) in order to rejuvenate the dull edge (Fig. 24: 2; negatives H) at the final stage of manufacturing. After this attempt failed, the rejuvenation was stopped.

	Cortex	Lateral	Bi-Lateral	Proximal	Central	Distal	None	Total
Blades, regular	–	27	–	–	1	4	42	**74**
Blades, cortical debordant	–	14	–	–	–	1	–	**15**
Blades, lateral debordant	–	2	–	1	–	–	6	**9**
Blades, crested debordant	–	2	–	–	–	–	5	**7**
Blades, radial core debordant	–	1	–	–	–	–	–	**1**
Blades, bifacial thinning	–	1	–	–	–	–	–	**1**
Blades, primary	6	–	–	–	–	–	–	**6**
Flakes	–	116	4	23	18	54	535	**750**
Flakes, cortical debordant	2	84	–	2	–	3	3	**94**
Flakes, lateral debordant	2	5	–	2	4	5	52	**70**
Flakes, crested debordant	1	2	–	–	1	1	16	**21**
Flakes, crested	–	–	–	–	–	–	1	**1**
Flakes, radial core debordant	4	10	–	1	–	11	61	**87**
Flakes, technical/radial core debordant	–	–	–	–	–	1	–	**1**
Flakes, technical	4	7	–	2	1	18	10	**42**
Flakes, bifacial thinning	2	1	–	–	–	5	21	**29**
Flakes, bifacial thinning, over-passed	1	2	–	–	–	–	2	**5**
Flakes, primary	133	–	–	–	–	–	–	**133**
Unidentifiable debitage	1	3	–	1	–	–	22	**27**
Total	**156**	**277**	**4**	**32**	**25**	**103**	**776**	**1 373**
%*	*11.4*	*20.2*	*0.3*	*2.3*	*1.8*	*7.5*	*56.5*	***100.0***

Fig. 9. Position of cortex differentiated by blank type from Chagyrskaya Cave, sublayer 6c/1. * Percentage when unidentifiable debitage are omitted from the total.

Abb. 9. *Position der Kortexbedeckung auf den Dorsalflächen der Grundformen aus der Chagyrskaya Cave, Fundhorizont 6c/1. * Prozentualer Anteil, wenn nicht identifizierbare Debitage aus der Gesamtzahl ausgelassen wird.*

Discussion and conclusion

Located in the Charysh valley, the Chagyrskaya Cave was used by Neanderthals for a few millennia. Paleontological data suggests that juvenile, semi-adult and female bisons were the main targets for hunting. The presence of all parts of the carcasses might indicate a transport over limited distances and, thus,

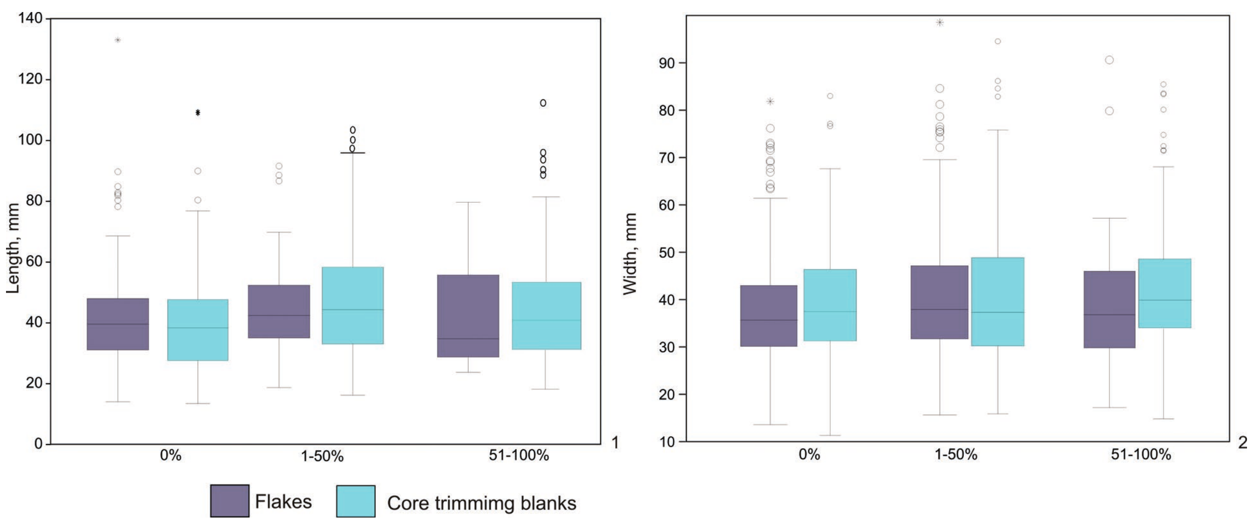

Fig. 10. Comparison between the frequencies of attributes in blank types differentiated by the proportion of cortex: 1 – Blank length and proportion of cortex; 2 – Blank width and proportion of cortex.

Abb. 10. *Vergleich zwischen den Häufigkeiten ausgesuchter Merkmale an Grundformtypen, unterschieden nach Kortexanteilen: 1 – Grundformlänge und Kortexanteil; 2 – Grundformbreite und Kortexanteil.*

	Cortex	Radial	Lateral	Bilateral	Convergent	Convergent / lateral	Unidirectional	Unidirectional / lateral	Bidirectional	Bidirectional / lateral	Orthogonal	Semi-crossed	Crossed	Crested	Unidentifiable	**Total**
Blades,regular	–	–	2	–	11	–	32	–	6	–	19	2	–	–	2	**74**
Blades, cortical debordant	–	–	–	–	1	–	10	–	1	–	2	–	–	–	1	**15**
Blades, lateral debordant	–	–	–	–	–	–	5	–	–	1	2	1	–	–	–	**9**
Blades, crested debordant	–	–	1	–	–	–	2	–	–	–	–	–	–	4	–	**7**
Blades, radial core debordant	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**1**
Blades, bifacial thinning	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	**1**
Blades, primary	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**6**
Flakes	–	33	65	12	62	2	221	2	22	–	185	86	1	–	59	**750**
Flakes, cortical debordant	2	3	15	2	4	–	28	–	4	–	26	7	–	–	3	**94**
Flakes, lateral debordant	2	1	14	2	2	–	14	–	1	–	18	14	–	–	2	**70**
Flakes, crested debordant	1	–	3	1	–	–	1	–	–	–	6	4	–	4	1	**21**
Flakes, crested	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**1**
Flakes, radial core debordant	5	2	4	–	9	1	26	–	2	1	22	12	1	–	2	**87**
Flakes, technical/radial core debordant	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**1**
Flakes, technical	4	–	2	–	1	–	23	–	–	–	9	2	–	–	1	**42**
Flakes, bifacial thinning	2	1	–	–	3	–	–	–	–	–	6	2	–	–	15	**29**
Flakes, bifacial thinning, overpassed	1	2	2	–	–	–	–	–	–	–	–	–	–	–	–	**5**
Flakes, primary	133	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**133**
Unidentifiable debitage	1	1	1	1	1	–	5	–	–	–	–	1	–	–	16	**27**
Total	**157**	**43**	**109**	**18**	**96**	**3**	**368**	**2**	**36**	**2**	**295**	**131**	**2**	**9**	**102**	**1 373**
*%**	*12.4*	*3.4*	*8.6*	*1.4*	*7.6*	*0.2*	*29.0*	*0.2*	*2.8*	*0.2*	*23.2*	*10.3*	*0.2*	*0.7*	–	***100.0***

Fig. 11. Dorsal scar patterns differentiated by blank type from Chagyrskaya Cave, sublayer 6c/1. * Percentage when unidentifiable debitage are omitted from the total.

Abb. 11. *Dorsale Gratmuster der Grundformen aus der Chagyrskaya Cave, Fundhorizont 6c/1. * Prozentualer Anteil, wenn nicht identifizierbare Debitage aus der Gesamtzahl ausgelassen wird.*

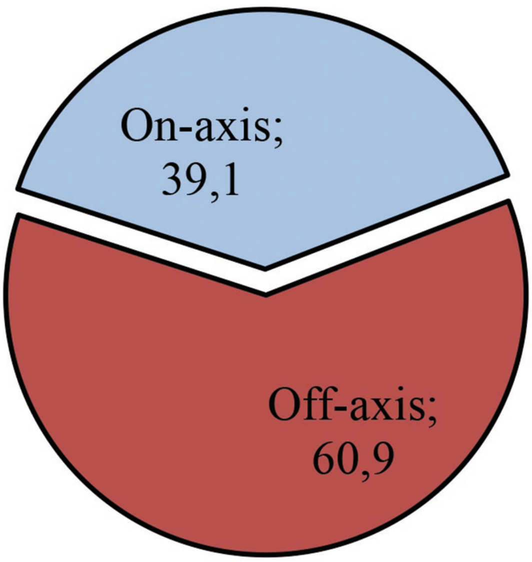

Fig. 12. Distribution of the frequencies of technological axes.

Abb. 12. *Verteilung der Häufigkeiten für verschiedene Richtungen der technologischen Achse.*

allow the conclusion that the killing-butchering activities happened in the direct vicinity of the site. Human impact on the faunal material indicates the exploitation and consumption of at least part of the carcasses at Chagyrskaya Cave, which in these cases would have had the function of a consumption site. Preliminary seasonal data indicates that the death of the animals occurred at the end of the warm season, which corresponds with the annual migration of the *Bison priscus* from the Northern plains to the Altai foothills along the Charysh River valley.

The Chagyrskaya Cave Neanderthals collected raw materials from the Charysh riverbed in immediate proximity to the cave. Lithic analysis data suggests that stone pebbles had been transported to the cave in one piece. The high density of lithics, the large amount of bones with cut marks as well as the quantity of bone tools indicate a high intensity of the cave occupations. The hominins that lived at Chagyrskaya Cave used orthogonal and radial core flaking methods. Cores were made of pebbles of rounded and rectangular forms. The striking platforms were produced along the perimeter of the pebble. Technical flakes resulted from the shaping of the striking platforms. That is to say, after shaping the striking platforms, lateral blanks

	Cortex	Plain	Dihedral	Polyhedral	Faceted straight	Faceted convex	Faceted chapeau	Faceted chapeau asymmetrical	Faceted concave	Faceted lateral	Crushed	Retouched	Missing	Unidentifiable	**Total**
Blades,regular	2	16	4	1	11	6	–	2	–	–	6	1	25	–	**74**
Blades, cortical debordante	1	8	–	–	2	3	–	–	–	–			1	–	**15**
Blades, lateral debordante	–	2	–	–	–	1	–	–	–	–	2	1	3	–	**9**
Blades, crested debordante	–	5	1	–	–	–	–	–	–	–	–	–	1	–	**7**
Blades, radial core debordante	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**
Blades, bifacial thinning	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Blades, primary	1	2	–	–	–	–	–	–	–	–	1	–	2	–	**6**
Flakes	44	188	59	44	67	44	1	1	4	4	72	14	207	1	**750**
Flakes, cortical debordante	3	30	6	2	6	6	–	–	–	–	13	3	25	–	**94**
Flakes, lateral debordante	7	21	4	2	6	4	–	–	–	–	6	2	18	–	**70**
Flakes, crested debordante	1	3	5	1	1	–	–	–	–	1	2	–	7	–	**21**
Flakes, crested	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**1**
Flakes, radial core debordante	3	38	21	5	10	4	–	–	–	1	5	–	–	–	**87**
Flakes, technical/radial core debordante	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**1**
Flakes, technical	4	17	5	3	1	–	–	–	–	–	8	1	3	–	**42**
Flakes, bifacial thinning	1	21	4	1	1	–	–	–	–	–	1	–	–	–	**29**
Flakes, bifacial thinning, overpassed	–	–	–	–	–	–	–	–	–	–	1	–	4	–	**5**
Flakes, primary	7	35	7	5	6	1	–	–	–	–	26	7	38	1	**133**
Unidentifiable debitage	1	3	2	–	–	–	–	–	–	–	–	–	20	1	**27**
Total	**75**	**391**	**120**	**64**	**111**	**69**	**1**	**3**	**4**	**6**	**143**	**29**	**354**	**3**	**1 373**
*%**	*8.9*	*46.3*	*14.2*	*7.6*	*13.2*	*8.2*	*0.1*	*0.4*	*0.5*	*0.7*	–	–	–	–	***100.0***

Fig. 13. Striking platforms differentiated by blank types (Chagyrskaya Cave, sublayer 6c/1). * Percentage when unidentifiable debitage are omitted from the total.

Abb. 13. *Art der Schlagflächenreste an Grundformen aus der Chagyrskaya Cave, Fundhorizont 6c/1. * Prozentualer Anteil, wenn nicht identifizierbare Debitage aus der Gesamtzahl ausgelassen wird.*

were used to create the required convexity of the working surface of the core, which was to be subsequently flaked.

A significant number of primary flakes and a high percentage of partially cortical flakes, including lateral and technical flakes, indicate that the initial stages of core flaking (decortication, the preparation of striking platforms and working surfaces) took place at the site. Furthermore, the presence of initial stages of primary flaking is characteristic of both major groups of cores, e.g. radial and orthogonal ones. The presence of non-cortical core trimming blanks illustrates that not only the initial, but also subsequent stages of radial and orthogonal flaking were employed on the site.

The available data on the metric characteristics of cores, lateral blanks and flakes does not imply an intensive utilization of cores – a single depleted radial core is present in the assemblage. The use of orthogonal and radial methods resulted in the production of rather large flakes consisting of mainly trapezoidal and rectangular asymmetric forms with straight and curved lateral profiles and feathered distal terminations. The metrical correlation between cortical and non-cortical flakes testifies to the complete reduction sequence on the site, because the first (cortical) flakes detached from the cores are in general bigger than the subsequent flakes.

The structure of the lithic collection can be defined as characteristic for workshops due to the following features: the presence of pre-cores, cores, bifacial pre-forms, raw material fragments, various flakes such as lateral, core trimming and primary flakes, as well as flakes resulting from bifacial manufacturing, and the occurrence of bone retouchers, all indicate a relatively high intensity of the processes of primary and secondary flaking at the site. The main part of the tool assemblage was apparently manufactured here. However, the substantial percentage of tools, along with a relatively high ratio of tools on flakes as compared to cores, imply that some portion of the tool-kit might have been imported from elsewhere.

The morphological structure of the tools on flakes shows a marginal domination of convergent forms over simple ones. Single-edge longitudinal scrapers dominate over transverse and diagonal scrapers; double scrapers have also been found in small numbers. Trapezoidal shapes and leaf shapes prevail in points and convergent scrapers; crescent and triangular-shaped tools are also present. In the case of bifacial tools, the morphological structure is

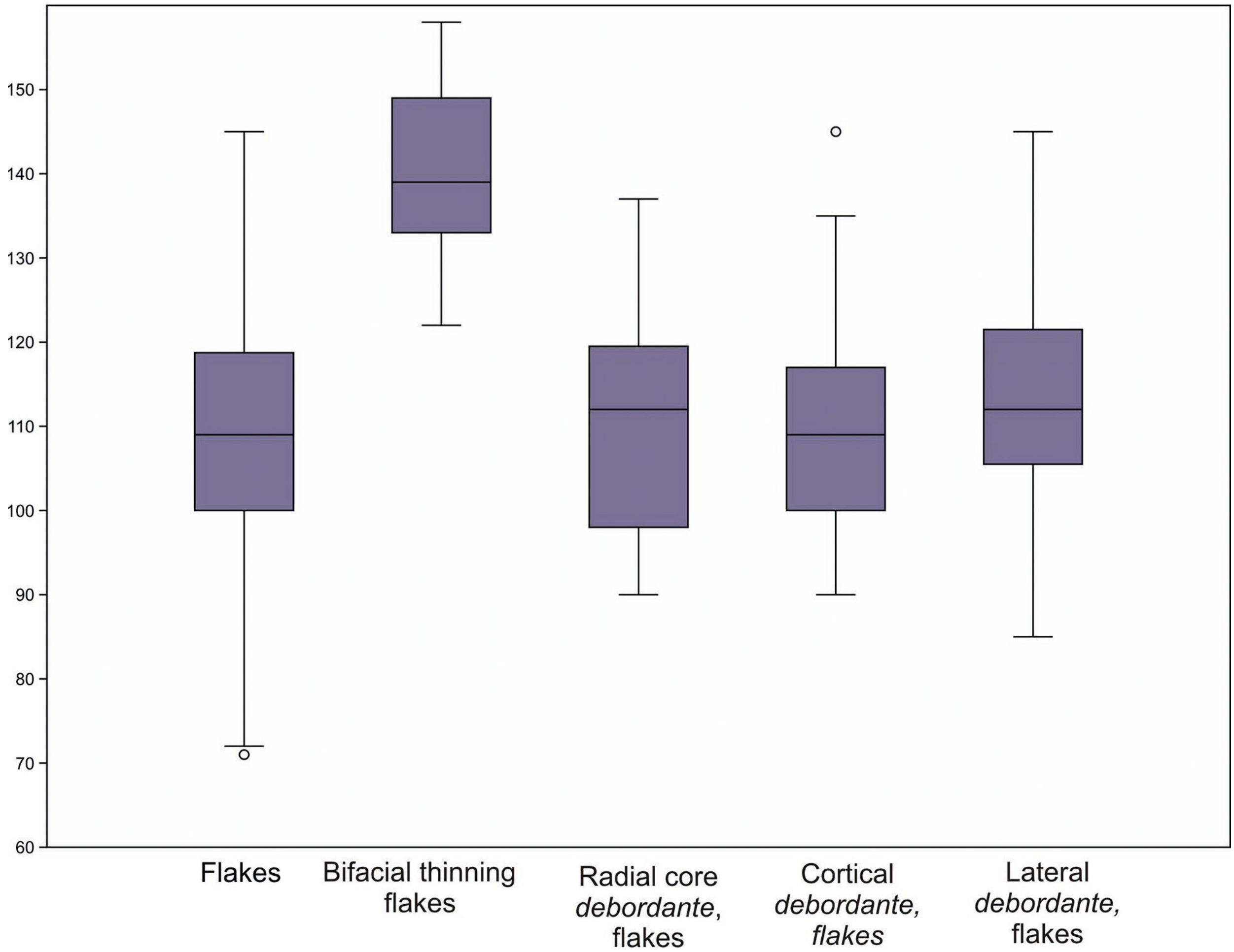

Fig. 14. Angle between striking platform and ventral surface according to blank type.
Abb. 14. *Winkel zwischen Schlagflächenrest und Ventralfläche, aufgeschlüsselt nach Grundformtypen.*

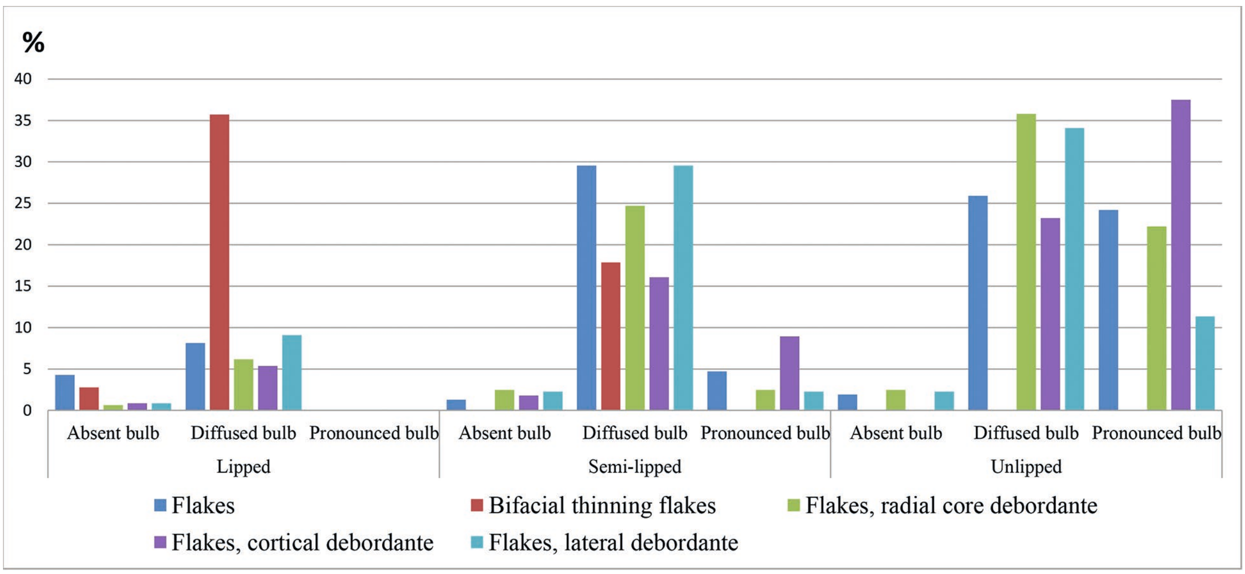

Fig. 15. Distribution of the frequencies of different types of bulb and lip in blanks types.
Abb. 15. *Häufigkeiten von unterschiedlichen Ausprägungen des Bulbus und der Schlaglippe, unterschieden nach Grundformtypen.*

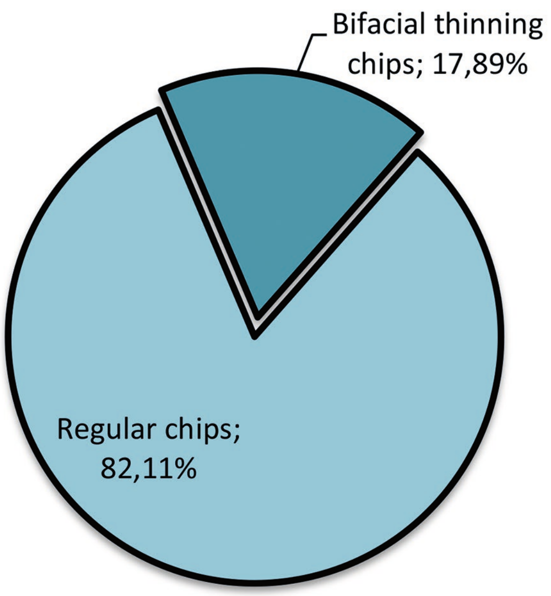

Fig. 16. Frequency of chip types.

Abb. 16. *Häufigkeiten der Absplisstypen.*

determined by the prevalence of leaf-shaped points; crescent, trapezoidal and triangular shapes are present. Bifacial tools include backed points and bifacial scrapers of the *Keilmesser* types.

A study of the functional variability among the Altai Middle and Upper Paleolithic sites (Rybin & Kolobova 2004) demonstrates the existence of short-term "ephemeral" hunting camps, short-term hunting camps with intensive raw material exploitation and carcasses treatment as well as base-camps with relatively less intensive occupations. Compared with the Altai site function variability observed so far, the Chagyrskaya Cave assemblage is an extraordinary phenomenon due to the fact that the portion of tools (formal tools in particular) by outnumbers that of all other Altai Paleolithic sites. However, excluding this parameter, the Chagyrskaya Cave assemblage shows similarities to some Upper Paleolithic short-term hunting camps type B with intensive raw material exploitation and carcasses treatment (Ust'-Karacol, layers 11-9, Denisova Cave, layer 11 in the Main chamber). However, within the Altai Middle Paleolithic record, which mostly

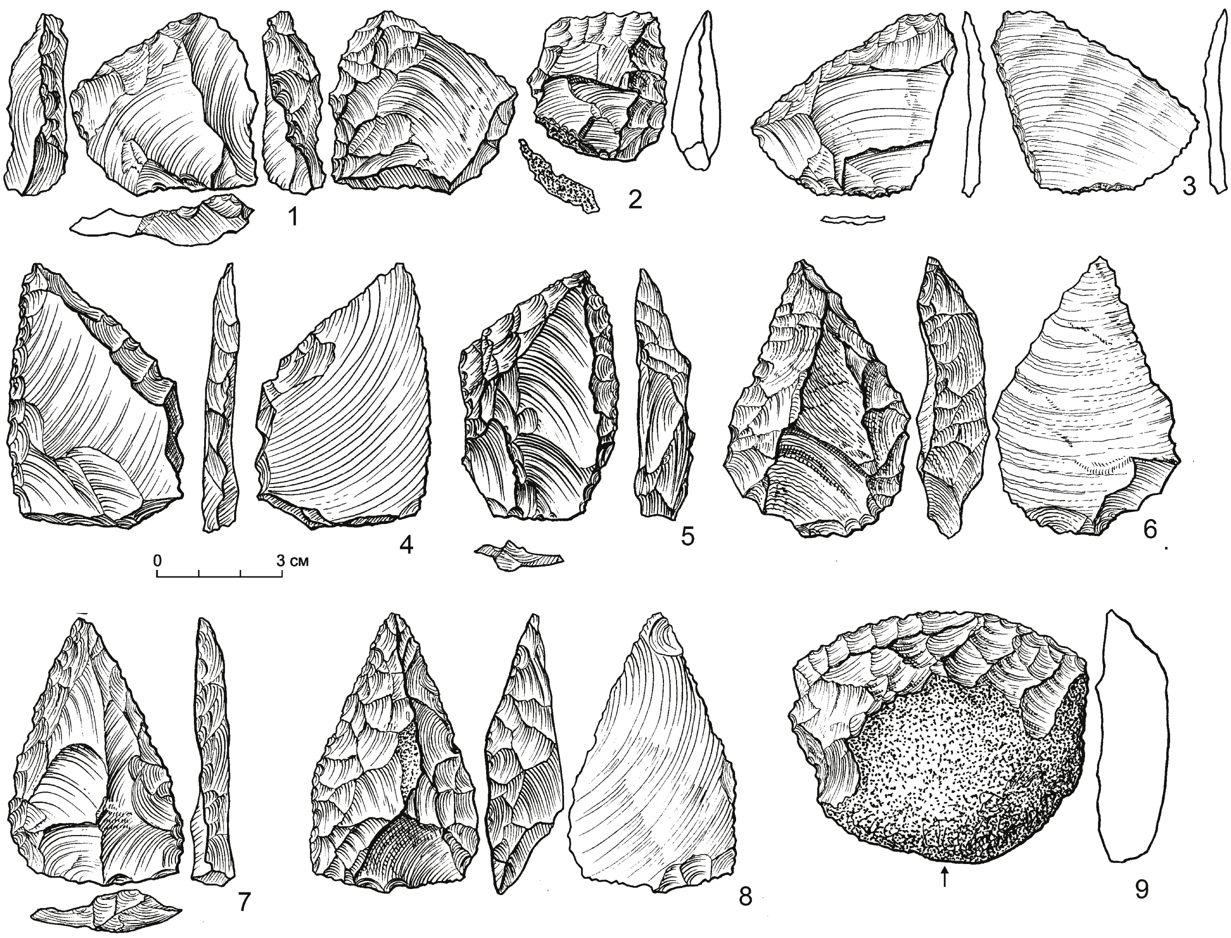

Fig. 17. Side-scrapers and points from Chagyrskaya Cave: 1-2 – semi-trapezoidal alternate scrapers; 3 – semi-trapezoidal alternate scraper; 4-5 – semi-trapezoidal dorsal points, backed; 6 – sub-leaf dorsal point, thinned base; 7 – sub-leaf dorsal point; 8 – semi-leaf dorsal point; 9 – transverse-convex dorsal scraper.

Abb. 17. *Schaber und Spitzen aus der Chagyrskaya Cave: 1-2 – Semi-trapezoide Wechselschaber; 3 – Semi-trapezoidaler Wechselschaber; 4-5 – Semi-trapezoidale dorsal retuschierte Spitzen mit Rücken; 6 – Sub-blattförmige, dorsal retuschierte Spitze mit verdünnter Basis; 7 – Sub-blattförmige, dorsal retuschierte Spitz; 8 – semi- blattförmige, dorsal retuschierte Spitze; 9 – transversal-konvexer, dorsal retuschierter Schaber.*

Tool types	N	%	%*
Bifacial points:	6	*1.4*	*2.5*
sub-triangular	1	*0.2*	*0.4*
semi-trapezoidal	1	*0.2*	*0.4*
leaf-shapped (semi/sub variants)	4	*0.9*	*1.7*
Bafacial scrapers:	10	*2.3*	*4.2*
straight	2	*0.5*	*0.8*
convex	1	*0.2*	*0.4*
straight-convex	1	*0.2*	*0.4*
leaf-shapped (semi/sub variants)	3	*0.7*	*1.3*
crescent (sub variant)	2	*0.5*	*0.8*
convergent	1	*0.2*	*0.4*
Scrapers:	169	*39.5*	*71.3*
transverse (straight/convex variants)	9	*2.1*	*3.8*
diagonal (straight/convex variants)	24	*5.6*	*10.1*
straight	22	*5.1*	*9.3*
convex	30	*7.0*	*12.7*
wavy	3	*0.7*	*1.3*
straight-convex	3	*0.7*	*1.3*
double (straight/convex)	3	*0.7*	*1.3*
triangular (sub- variant)	3	*0.7*	*1.3*
trapezoidal (semi/sub variants)	39	*9.1*	*16.5*
semi-recrangular	5	*1.2*	*2.1*
crescent (semi/sub variants)	11	*2.6*	*4.6*
leaf-shapped (semi/sub variants)	13	*3.0*	*5.5*
semi-ovoid	1	*0.2*	*0.4*
convergent	3	*0.7*	*1.3*
Points:	33	*7.7*	*13.9*
distal	4	*0.9*	*1.7*
sub-triangular	3	*0.7*	*1.3*
semi-trapezoidal	6	*1.4*	*2.5*
semi-crescent	3	*0.7*	*1.3*
leaf-shapped (semi/sub variants)	15	*3.5*	*6.3*
unidentifiable	2	*0.5*	*0.8*
Denticulates	4	*0.9*	*1.7*
Notches	4	*0.9*	*1.7*
Truncations	9	*2.1*	*3.8*
End-scrapers	2	*0.5*	*0.8*
Retouched pieces	104	*24.3*	–
Unidentifiable tools:	87	*20.3*	–
unifacial	79	*18.5*	–
bifacial	8	*1.9*	–
Total	**428**	***100.0***	***100.0***

Fig. 18. Overview of the frequencies of formal tools from Chagyrskaya Cave, sublayer 6c/1.* Percentage when unidentifiable tools and retouched pieces are omitted from the total.

Abb. 18. *Häufigkeiten der Werkzeuge aus der Chagyrskaya Cave, Fundhorizont 6c/1. * Prozentualer Anteil, wenn nicht identifizierbare Werkzeuge und retuschierte Stücke aus der Gesamtzahl ausgelassen werden.*

demonstrates "ephemeral" hunting camps and base camps (Rybin & Kolobova 2004), the settlement pattern observed at Chagyrskaya Cave is unique. The only other exception could be Okladnikov Cave, but no site occupation data have been published so far.

In the techno-typological context of the regional Middle Paleolithic, the assemblage of Chagyrskaya Cave differs significantly from the Levallois-Mousterian assemblages, suggesting an intrusion of late a Neanderthal population the Altai region associated with the *Keilmesser* tradition. The origin of this migration should be the territory of Eastern Europe, as the techno-typological characteristics of the lithic assemblage from sublayer 6c/1 of Chagyrskaya Cave is completely consistent with the characteristics of the Eastern European Micoquian techno-complex, which is an integral part of the European Micoquian (Derevianko et al. 2018 ; Kolobova et al. 2020a; Mafessoni et al. 2020).

The bifacial tools from the Chagyrskaya Cave assemblage, which were classified as *Keilmesser* and fit into the context of the European Micoquian/*Keilmesser-gruppen* typology, demonstrated not only morphological similarities, but are in full conformity with the technological concept. The *Keilmesser* from Chagyrskaya Cave were originally intended for repeated use and rejuvenation. The backs were originally used not only as accommodation elements, but were also for rejuvenation and re-sharpening.

The typological variability of the Micoquian industries from Eastern Europe is limited to differences between the proportions of simple, trapezoid, leaf, crescent and triangle shapes in points, scrapers and bifacial tools that predominantly show evidence of stepped scalar or scalar retouch in combination with a variety of ventral splitting. The characteristic types of the Eastern European Micoquian technocomplex that bear a stylistic significance include bifacial points and bifacial scrapers of leaf, trapezoidal and crescent shapes with natural or retouched backs – the *Klausennischemesser* type, which also occurs frequently in Central European Micoquian assemblages. Similar leaf-shaped, trapezoid and crescent-shaped scrapers and points constitute the stylistic basis for unifacial tools attributed to the Micoquian of Eastern and Central Europe (Kolobova et al. 2020a). A comparative analysis shows that techno-typological counterparts for the stone tool assemblages from sublayer 6c/1 of Chagyrskaya Cave can be found in Eastern European Micoquian assemblages with a medium to low quantity of bifacial points and bifacial scrapers, as well as almost equal proportions of convergent and simple tools. Comparable assemblages are Prolom II, layers II and IV, Starosele, level 1, Zaskalnaya VI, layer IV, Sukhaya Mechetka, Mezmaiskaya, layers 2-2A, 2B-4 and 3, Barakaevskaya and Gubsky Naves № 1 (Zamyatnin 1961; Kuznetsova 1985; Kolosov 1986; Lyubin 1994; Belyaeva 1999; Golovanova & Hoffecker 2000; Chabai et al. 2004). The intensity of the utilization of the toolkits in the Crimean Micoquian assemblages is determined by the ratio between the major morphological tool groups: the most intensively used toolkits include a smaller proportion of simple and bifacial implements, whereas convergent pieces constitute a greater share. We performed a PCA analysis based on the mentioned variables and the results demonstrate the proximity of Chagysrkaya Cave to the *Starosele facies*, which shows a medium degree of intensity of on-site raw material exploitation,

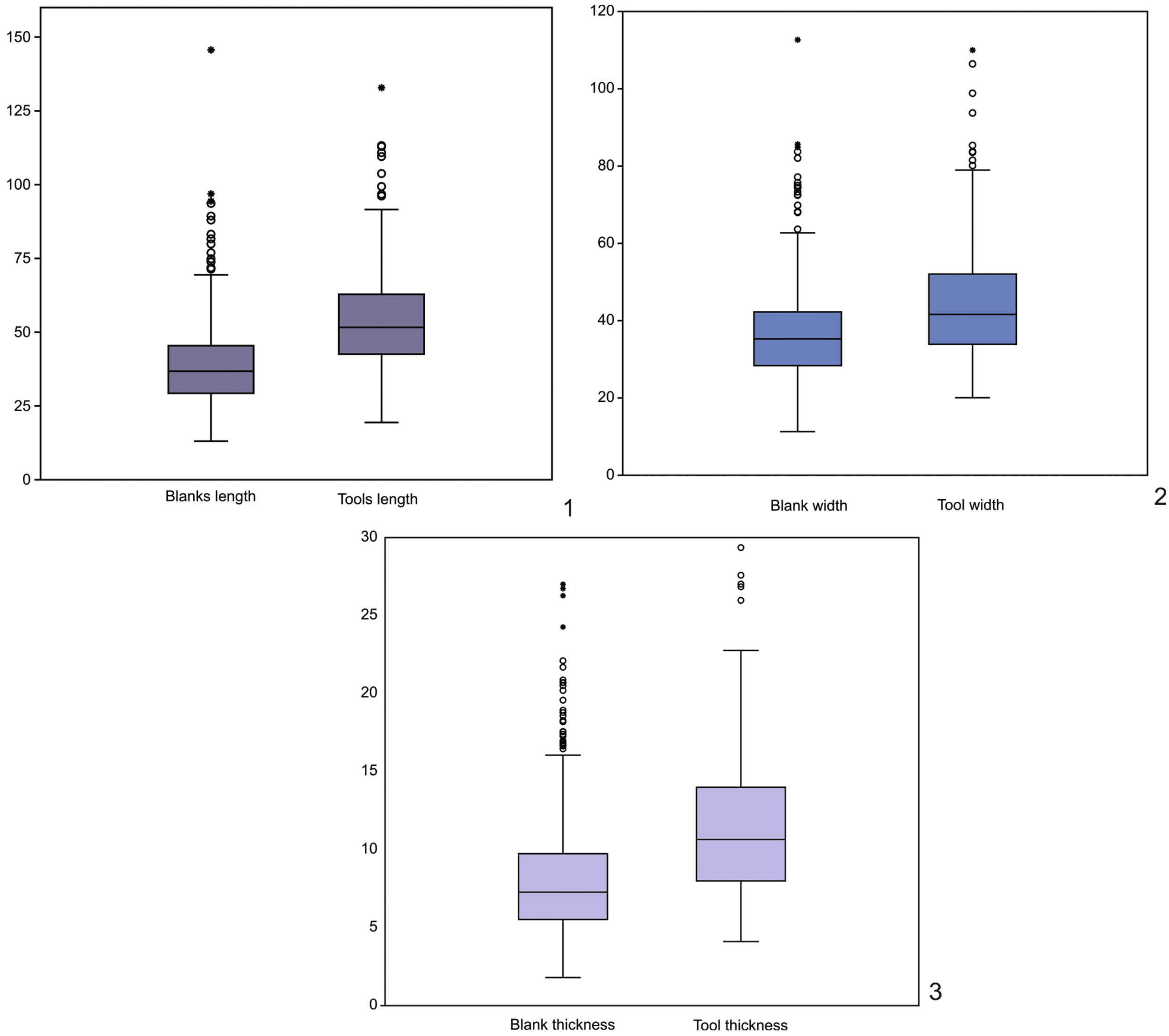

Fig. 19. Comparison of the metrical parameters of blanks and tools: 1 – Length; 2 – Width; 3 – Thickness.

Abb. 19. *Vergleich metrischer Parameter für unretuschierte Grundformen und Werkzeuge: 1 – Länge; 2 – Breite; 3 – Dicke.*

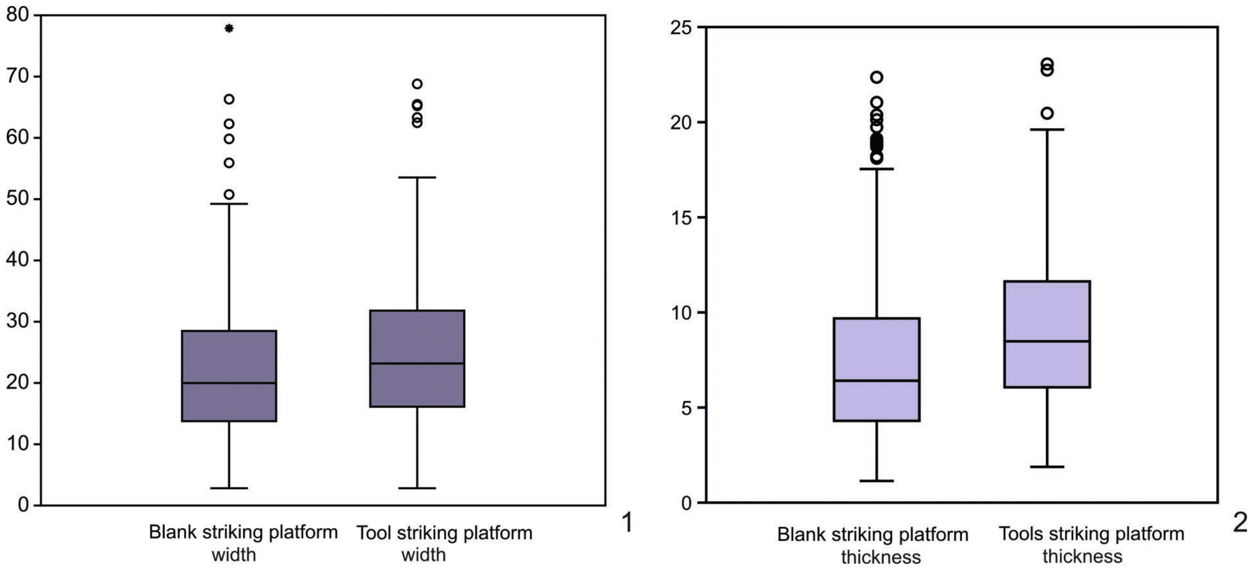

Fig. 20. Comparison of the metrical parameters of striking platforms of blanks and tools: 1 – Striking platforms width; 2 – Striking platforms thickness.

Abb. 20. *Vergleich metrischer Parameter der Schlagflächenreste für unretuschierte Grundformen und Werkzeuge: 1 – Breite des Schlagflächenrestes; 2 – Dicke des Schlagflächenrestes.*

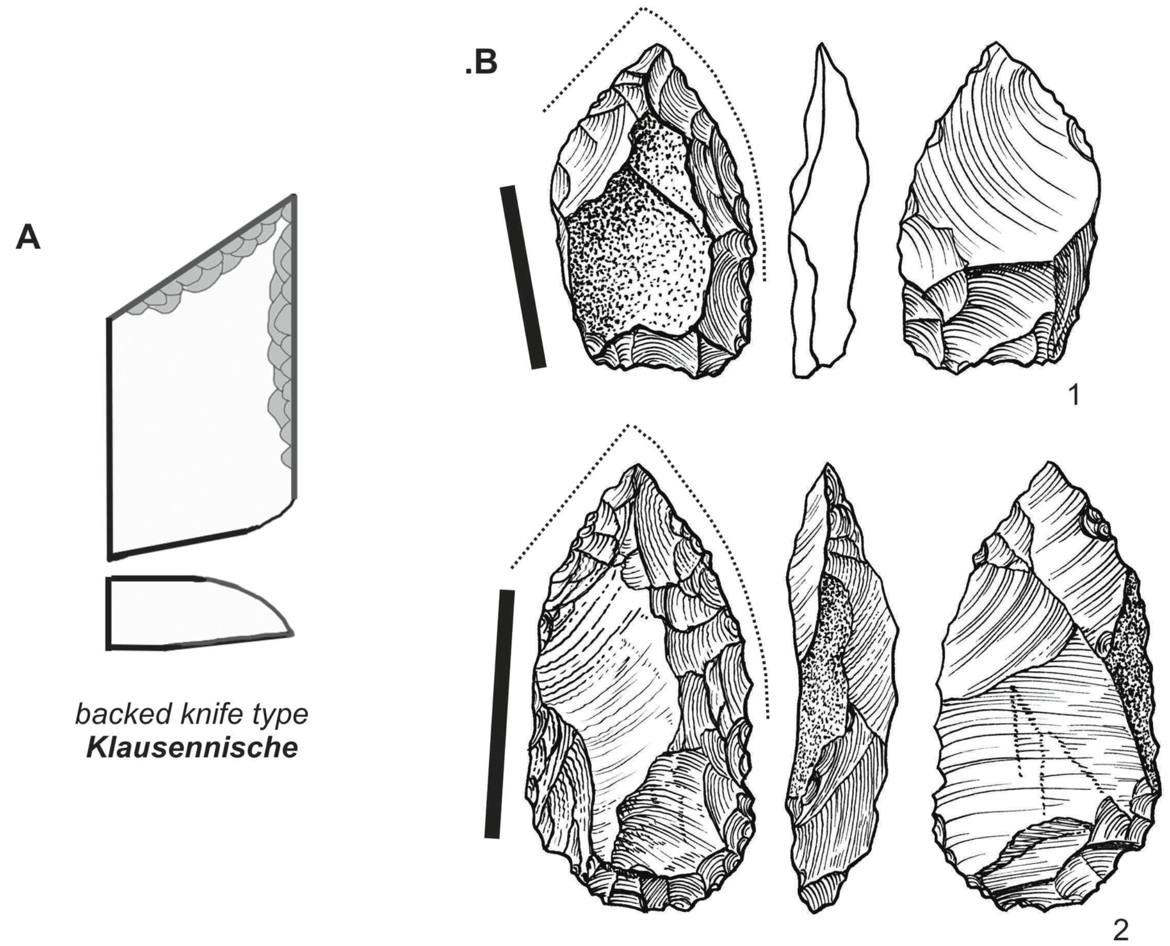

Fig. 21. A – Scheme of Klausennischemesser, modified after Joris, 2006; B – 1-2 Klausennischemesser from Chagyrskaya Cave.
Abb. 21. *A - Schema for Klausennischemesser, verändert nach Jöris 2006; B – 1-2 Klausennischemesser aus der Chagyrskaya Cave.*

and to the *Kiik-Koba facies*, which shows a higher degree of occupation intensity and tool transportation to the site (Fig. 25). This relation became known as the reduction formula of the Crimean Micoquian (Chabai 2004). We performed a more detailed comparison using three-dimensional nmMDS based on the average values in the morphology of the unifacial tools. The nmMDS plot demonstrates a high degree of similarity between the assemblages from sublayer 6c/1 of Chagyrskaya Cave and the different Crimean facies included in the 95 % confidence interval. We performed the analysis based on the following variables: portion of simple scrapers, double scrapers, triangle scrapers, trapezoidal/rectangular, crescent and leaf-shaped scrapers (Fig. 26).

The Chagyrskaya site assemblage is typical of a recurrently visited base camp with the complete sequence of lithic reduction and tool production conducted on the site. In the context of the activity pattern of the Crimean Micoquian, it is consistent with camps of type A (Chabai 2004; Chabai & Uthmeier 2006), or with "central camps" (larger groups, seasonal route of prey) (Richter 2016). Unfortunately, only two cave sites with Micoquian techno-typological characteristics, Chagyrskaya and Okladnikov Cave, have been found in the Altai region. At the current stage of investigation, the reconstruction of the complete mobility pattern of the easternmost Neanderthals is hardly possible. Nevertheless, the data obtained from Chagyrskaya Cave demonstrated the existence of the same settlement pattern than that of Central and Eastern Europe.

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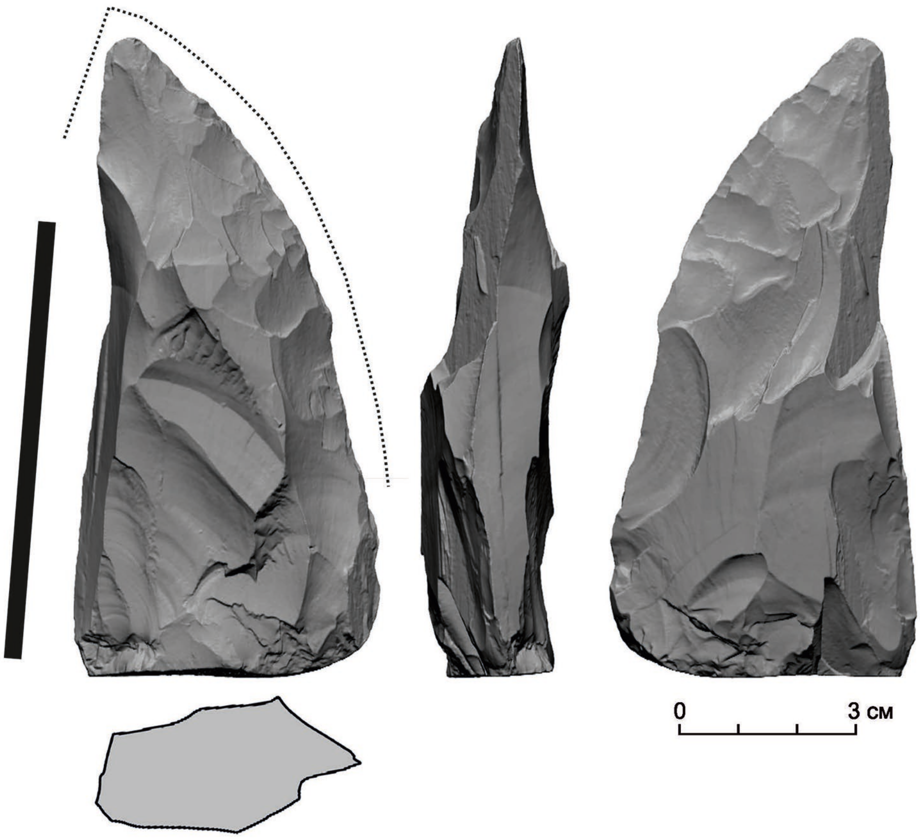

Fig. 22. *Klausennischemesser* from Chagyrskaya Cave.
Abb. 22. *Klausennischemesser aus der Chagyrskaya Cave.*

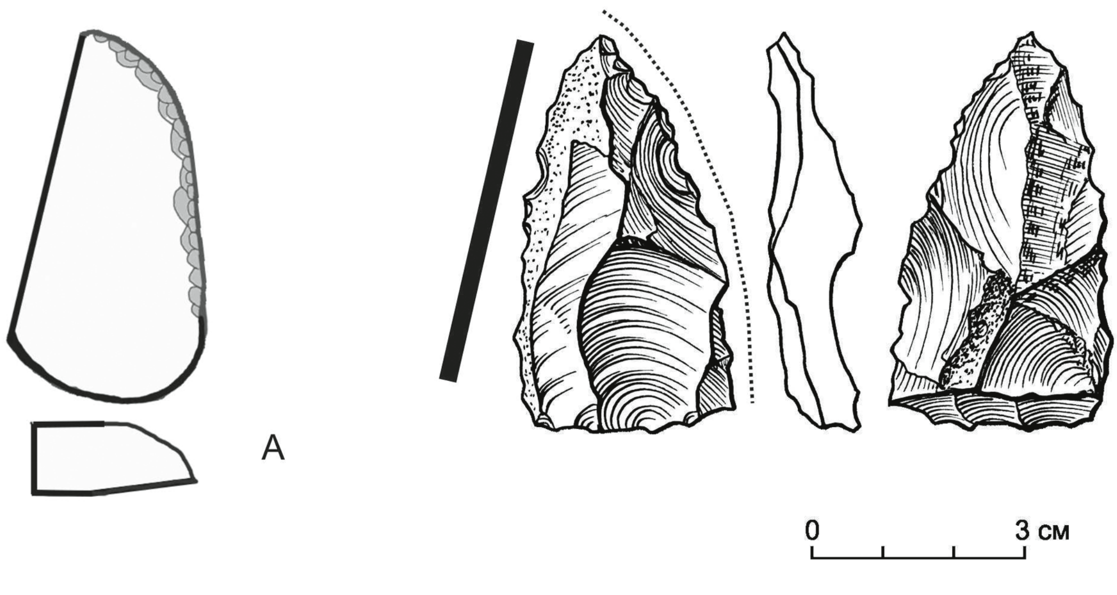

Fig. 23. A - Scheme of Bocksteinmesser, modified after Joris, 2006; B – Bocksteinmesser from Chagyrskaya Cave assemblage.
Abb. 23. *A - Schema for Bocksteinmesser, verändert nach Jöris 2006; B –Bocksteinmesser aus der Chagyrskaya Cave.*

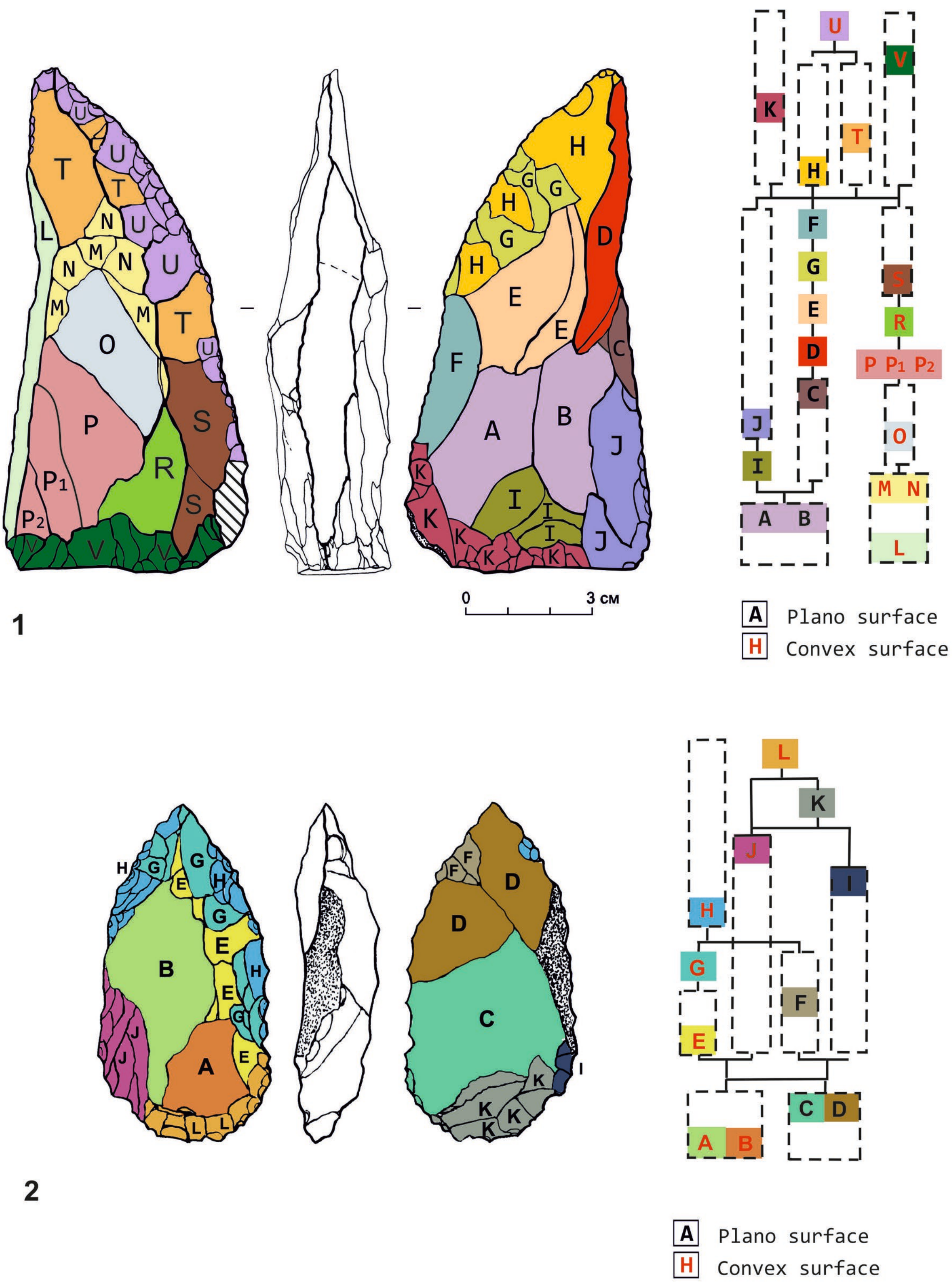

Fig. 24. Scar pattern scheme of bifacial backed knifes from Chagyrskaya Cave.

Abb. 24. *Schema der Arbeitsschritte zur Herstellung von Keilmessern in der Chagyrskaya Cave.*

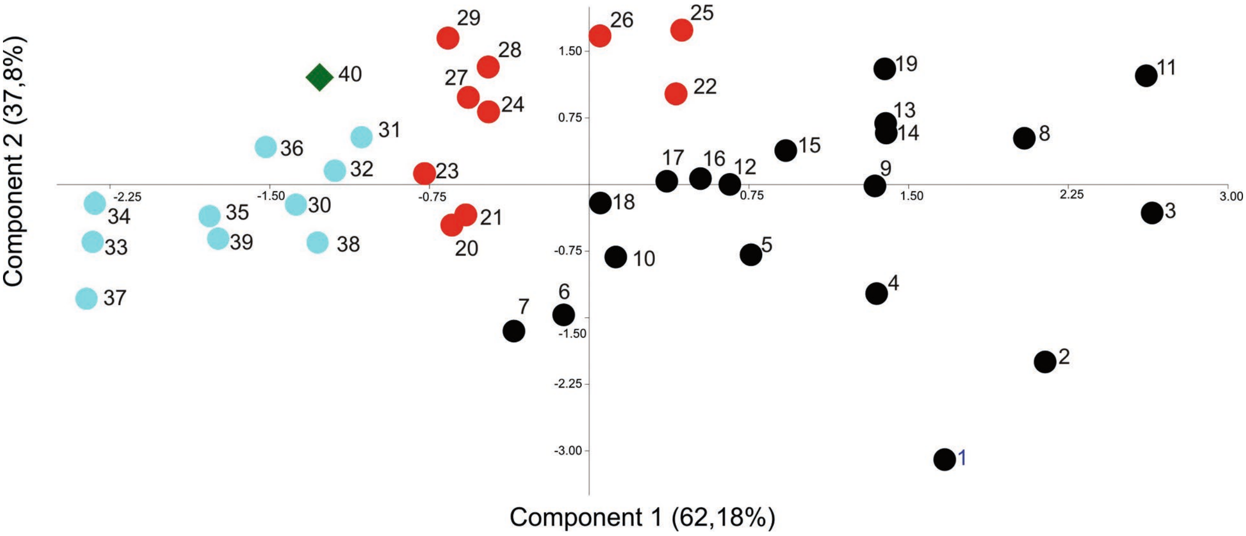

Fig. 25. Principal component analysis of Chagyrskaya Cave and Crimean Micoquian assemblages. Ak-Kaya facies: 1– Kabazi II, units -VI; 2– Sary Kaya (1985-1986); 3 – Chokurcha I, subunit IV/1; 4 – Zaskalnaya V, unit III (2013); 5 – Zaskalnaya VI, unit II; 6 – Chokurcha I, subunit IV-M; 7 – Zaskalnaya V, unit V; 8 – Kabazi II, unit III; 9 – Chokurcha I, unit IV; 10 – Zaskalnaya V, subunit IIIA (2013); 11 – Sary Kaya (1977); 12 – Kabazi V, subunits II/4A–II/7; 13 – Zaskalnaya V, unit II; 14 – Karabai I, layer 4; 15 – Zaskalnaya V, unit III; 16 –Zaskalnaya V, subunits II-IIA (2013); 17 – Zaskalnaya V, unit VI; 18 – Kabazi V, subunit III/2; 19 – Zaskalnaya VI, unit III; Starosele facies: 20 – Kabazi V, subunit III/1; 21 – Kabazi V, subunit III/1A; 22 – Prolom II, unit III; 23 – Zaskalnaya VI, unit V; 24 – Prolom II, unit II; 25 – Chokurcha I, subunit IV-O; 26 – Kabazi V, subunit III/5; 27 – Starosele, level 1; 28 – Zaskalnaya VI, unit IV; 29 – Prolom II, unit IV; Kiik-Koba facies: 30 – Zaskalnaya V, unit I; 31 – Zaskalnaya V, unit IV; 32 – Buran Kaya III, layer B; 33 – Kiik Koba, upper level; 34 – Prolom I, lower level; 35 – Prolom I, upper level; 36 – Buran Kaya III, layers 7-8; 37 – Zaskalnaya V, unit I (2013); 38 – Zaskalnaya V, unit IV (2013); 39 – Zaskalnaya V, subunits IV/4-IV/6 (2013); 40 - Chagyrskaya cave.

Abb. 25. *Hauptkomponenten-Analyse fur Inventare des Crimean Micoquian und der Chagyrskaya Cave. Ak-Kaya facies: 1– Kabazi II, units V-VI; 2– Sary Kaya (1985-1986); 3 – Chokurcha I, subunit IV/1; 4 – Zaskalnaya V, unit III (2013); 5 – Zaskalnaya VI, unit II; 6 – Chokurcha I, subunit IV-M; 7 – Zaskalnaya V, unit V; 8 – Kabazi II, unit III; 9 – Chokurcha I, unit IV; 10 – Zaskalnaya V, subunit IIIA (2013); 11 – Sary Kaya (1977); 12 – Kabazi V, subunits II/4A–II/7; 13 – Zaskalnaya V, unit II; 14 – Karabai I, layer 4; 15 – Zaskalnaya V, unit III; 16 –Zaskalnaya V, subunits II-IIA (2013); 17 – Zaskalnaya V, unit VI; 18 – Kabazi V, subunit III/2; 19 – Zaskalnaya VI, unit III; Starosele facies: 20 – Kabazi V, subunit III/1; 21 – Kabazi V, subunit III/1A; 22 – Prolom II, unit III; 23 – Zaskalnaya VI, unit V; 24 – Prolom II, unit II; 25 – Chokurcha I, subunit IV-O; 26 – Kabazi V, subunit III/5; 27 – Starosele, level 1; 28 – Zaskalnaya VI, unit IV; 29 – Prolom II, unit IV; Kiik-Koba facies: 30 – Zaskalnaya V, unit I; 31 – Zaskalnaya V, unit IV; 32 – Buran Kaya III, layer B; 33 – Kiik Koba, upper level; 34 – Prolom I, lower level; 35 – Prolom I, upper level; 36 – Buran Kaya III, layers 7-8; 37 – Zaskalnaya V, unit I (2013); 38 – Zaskalnaya V, unit IV (2013); 39 – Zaskalnaya V, subunits IV/4-IV/6 (2013); 40 - Chagyrskaya cave.*

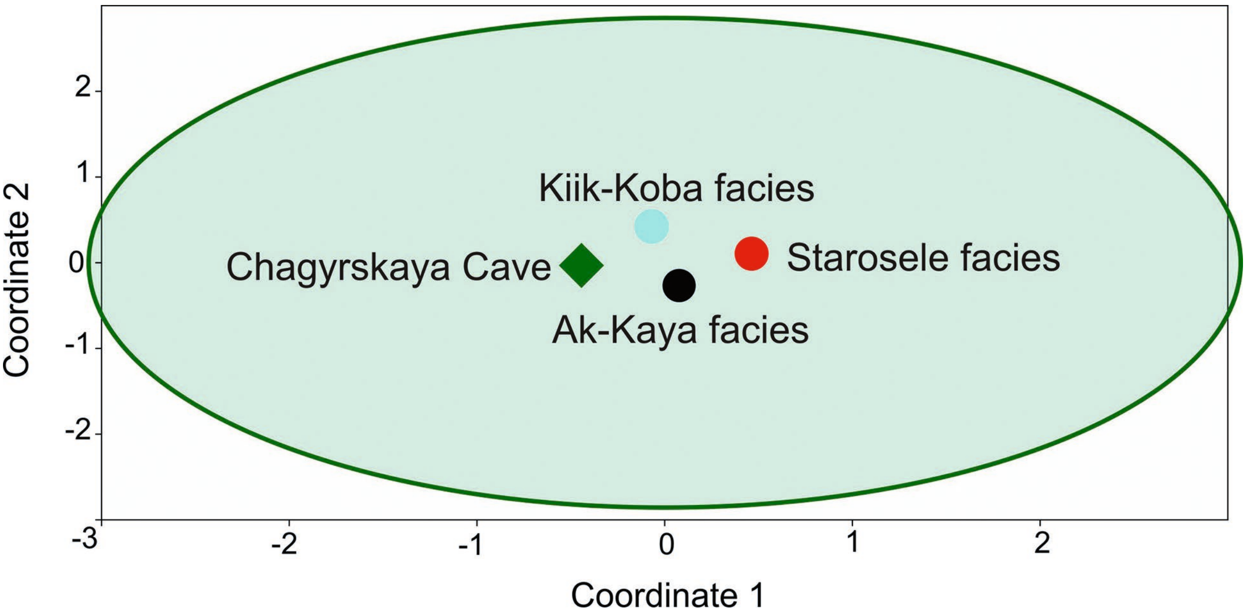

Fig. 26. Non-metric multidimensional (3D) scaling of Chagyrskaya Cave and Crimean Micoquian facies (stress value = 0).

Abb. 26. *Nicht-metrische multidimensionale Skalierung (3D) für die Chagyrskaya Cave und Fazies des Crimean Micoquian (Stress-Faktor = 0).*

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Inhalt - *Contents*