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A pre-Heinrich Event 3 assemblage at Fumane Cave and its contribution for understanding the beginning of the Gravettian in Italy

Ein vor das Heinrich 3-Ereignis datierendes Inventar aus der Fumane-Höhle und sein Beitrag zum Verständnis des Beginns des Gravettien in Italien

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[3] Consiglio Nazionale delle Ricerche. Istituto di Geologia Ambientale e Geoingegneria. Gruppo di Ricerche Stratigrafiche Vegetazione, Clima, Uomo. Laboratorio di Palinologia e Paleoecologia, Piazza della Scienza 1, 20126 Milano, Italy

Abstract - In Europe, the cultural trajectories of large-scale Upper Paleolithic cultural complexes, such as the Aurignacian and the Gravettian, represent highly debated topics. In this paper, we examine the evidence from the youngest anthropic layer D1d at Fumane Cave (Venetian Prealps, northeastern Italy) to investigate the nature of human settlement dynamics in the Great Adriatic-Padanian Region following the late Protoaurignacian cultural unit and before the advent of the Heinrich Event 3. We present an unusual charcoal feature unearthed during archaeological excavations and we conduct a careful techno-typological assessment of the lithic assemblage using a combination of reduction sequence analysis and attribute analysis. We thus explore the mode of occupation of the site and discuss the available radiocarbon dates on a regional and supra-regional scale. This study permits to assign layer D1d to the Gravettian as described in several sites south of the Alps and along the Italian peninsula. Moreover, the scarcity and general composition of the lithic assemblage supports the idea according to which human settlement at the edge of the Great Po Plain was sparse and intermittent in the early stages of this technocomplex. Finally, we address the early radiocarbon age estimation available for layer D1d and hypothesize different scenarios that need to be further explored.

Zusammenfassung - *In Europa stellen die Verläufe großmaßstäblicher Kulturkomplexe des Jungpaläolithikums, wie z.B. des Aurignaciens und des Gravettiens, stark debattierte Themen dar. In dem vorliegenden Beitrag untersuchen wir die Zeugnisse der jüngsten archäologischen Schicht D1d der Fumane Höhle (Venezianische Voralpen, Nordostitalien), um die Art der menschlichen Siedlungsdynamik in der Großen Adria-Padanischen Region nach dem späten Protoaurignacien und vor dem Aufkommen des Heinrich-Events 3 zu untersuchen. Wir präsentieren einen ungewöhnlichen Holzkohlebefund, das bei archäologischen Ausgrabungen zutage getreten ist, und führen eine sorgfältige techno-typologische Bewertung des lithischen Inventars durch, wobei wir eine Kombination aus Reduktionsfolge- und Attributanalyse anwenden. Auf diese Weise untersuchen wir die Art der Besiedlung der Fundstelle und diskutieren die verfügbaren Radiokarbondaten auf regionaler und überregionaler Ebene. Diese Studie erlaubt es, die Schicht D1d dem Gravettien zuzuordnen, wie sie an mehreren Standorten südlich der Alpen und entlang der italienischen Halbinsel beschrieben wurde. Die Seltenheit und allgemeine Zusammensetzung der lithischen Inventare unterstützt zudem die Hypothese, dass die menschliche Besiedlung am Rande der Grossen Poebene in den frühen Phasen dieses Technokomplexes spärlich und diskontinuierlich war. Schließlich befassen wir uns mit der frühen Radiocarbondatierung der Schicht D1d und stellen verschiedene Hypothesen auf, die zukünftig weiter untersucht werden müssen.*

Keywords - Early Upper Paleolithic, Lithic Technology, Foragers, Great Adriatic-Padanian Region
Frühes Jungpaläolithikum, Lithische Technologie, Foragers, Große Adriatisch-Padanische Region

Introduction

The Italian mid Upper Paleolithic is known from several cave and open-air sites. They are distributed in different environmental settings, from the pre-Alpine continental region to the eastern and western Mediterranean costal belt along the peninsula (Palma di Cesnola 2001; Mussi 2002). In Italy, like in

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other regions of Europe, the development of the Aurignacian and the appearance of another large-scale cultural complex, the Gravettian, are debated. According to recent reassessment conducted at Fumane Cave (Falcucci 2018) and Bombrini Rockshelter (Riel-Salvatore & Negrino 2018), the Protoaurignacian lasted well after the Campanian Ignimbrite volcanic eruption (Giaccio et al. 2008) and the partially contemporaneous Heinrich Event 4 (Bond & Lotti 1995), most likely up to 36 ka calBP. According to other authors, instead, the Protoaurignacian was replaced by the Early Aurignacian (e.g. Tejero & Grimaldi 2015; Degano et al. 2019). Whatever the definitive answer to this important question will be, the Aurignacian was at some point in time replaced by the Gravettian, whose techno-typological signatures seem to have spread in a rather short time-span across Europe (Reynolds & Green 2019). In Italy, the earliest known Gravettian assemblage is dated to ca. 33.9-32.8 ka calBP at Rio Secco Cave at the edge of the Great Po Plain (Talamo et al. 2014) and slightly later at Paglicci Cave in the southern Adriatic region (Palma di Cesnola 2004).

In order to elucidate the changes in human settlement dynamics that occurred under changing climatic conditions between 36 and 30 ka calBP, we need to construct a more comprehensive archeological database. This can be achieved through the discovery of new stratified sites with late Pleistocene deposits, but also with the assessment of unpublished assemblages dated to this time span. Here, we analyze for the first time the youngest anthropic layer discovered at Fumane Cave in northeastern Italy (Fig. 1) with the aim of clarifying its cultural attribution and the nature of human settlement dynamics in the Prealps following the late Protoaurignacian at ca. 36 ka calBP (Higham et al. 2009) and predating the Heinrich Event 3. This assemblage has received little attention because of the small number of artifacts recovered compared to the underlying Protoaurignacian, Uluzzian, and Mousterian layers. According to Bartolomei et al. (1992), the D1d assemblage can be assigned to a Gravettian *sensu lato*, although no technological and typological studies have been conducted to verify its cultural attribution, understand the modality and circumstances of the occupation of the cave, and discuss the reliability of the available radiocarbon dates. We will address these issues with the final goal to discuss the importance of the site in its regional setting and within the Italian mid Upper Paleolithic record.

The site of Fumane Cave

Fumane Cave is one of the most studied Paleolithic sites of Europe. Located in the Monti Lessini, Venetian Prealps, it was first excavated in 1988 (Bartolomei et al. 1992). Archaeological excavations have been conducted since then and are now under the direction of one of us (MP). The deposit has accumulated for most of the Late Pleistocene, and several Mousterian, Uluzzian, and Protoaurignacian layers document the repeated frequentation of the cave from both Neanderthals and modern humans (Bartolomei et al. 1992; Cassoli & Tagliacozzo 1994; Broglio et al. 2003; Broglio et al. 2005; Broglio & Dalmeri 2005; Higham et al. 2009; Peresani 2012; Benazzi et al. 2015; López-García et al. 2015; Peresani et al. 2016; Falcucci et al. 2017).

The youngest sedimentary succession – named macro-unit D – formed during a phase of climatic deterioration (Broglio et al. 2003; López-García et al. 2015), which resulted in different episodes of rock-collapse and aeolian sedimentation that progressively sealed the cave entrance. The last unit was only noticed at the entrance of the cave and in its internal part and was named D1 (Fig. 2). From a lithological point of view, it is mostly formed of very coarse materials (boulders and stones) mixed with sandy matrix.

Evidence of human presence are less dense if compared to the early and late Protoaurignacian layers. D1 was divided in different layers, from bottom to top: D1c, D1d, D1e, and D1f (Figs. 3 & 4). D1c was described as Aurignacian *sensu lato* (Bartolomei et al. 1992). The D1c lithic assemblage (n = 172) is mostly formed of flakes blanks (75 % of the total blanks). Among tools (n = 6), two endscrapers on flake, a retouched flake, a scaled piece, a bladelet with lateral retouch, and a blade with scaled retouch were collected. At the time being, we can only attribute this assemblage to an undifferentiated Upper Paleolithic. The overlying D1d, which is the focus of this paper, was assigned to the Gravettian *sensu lato* (Bartolomei et al. 1992; Broglio 1997). Finally, D1e and D1f were described as almost sterile layers. The discovery of several large-sized bones with gnawing marks points towards the presence of carnivores during the formation of D1e-f.

A few radiocarbon dates are available for layer D1d and the overlying layer D1e (Broglio & Dalmeri 2005; Higham et al. 2009). According to these dates, layer D1d formed between 35.9-33.2 ka calBP. If only the most recently obtained date was considered, the assemblage would date to ca. 35.9-35.0 ka calBP. A more roughly chronological framework for the formation of the stratigraphic sequence was provided by López-García et al. (2015) using the biostratigraphy of the small mammals assemblage. The authors identified the Heinrich Event 3, which took place at around 30 ka calBP (Bond & Lotti 1995; Hemming 2004), in the overlying layer D1e.

Materials and methods

In this study, we focus our attention to the youngest anthropic layer D1d, which comprises spits D1d base and D1d tetto. This layer, which was easily discernible during excavations, is only present in the cave entrance and cave mouth. An extended accumulation of macro- and micro-charcoals was found over a large extent of

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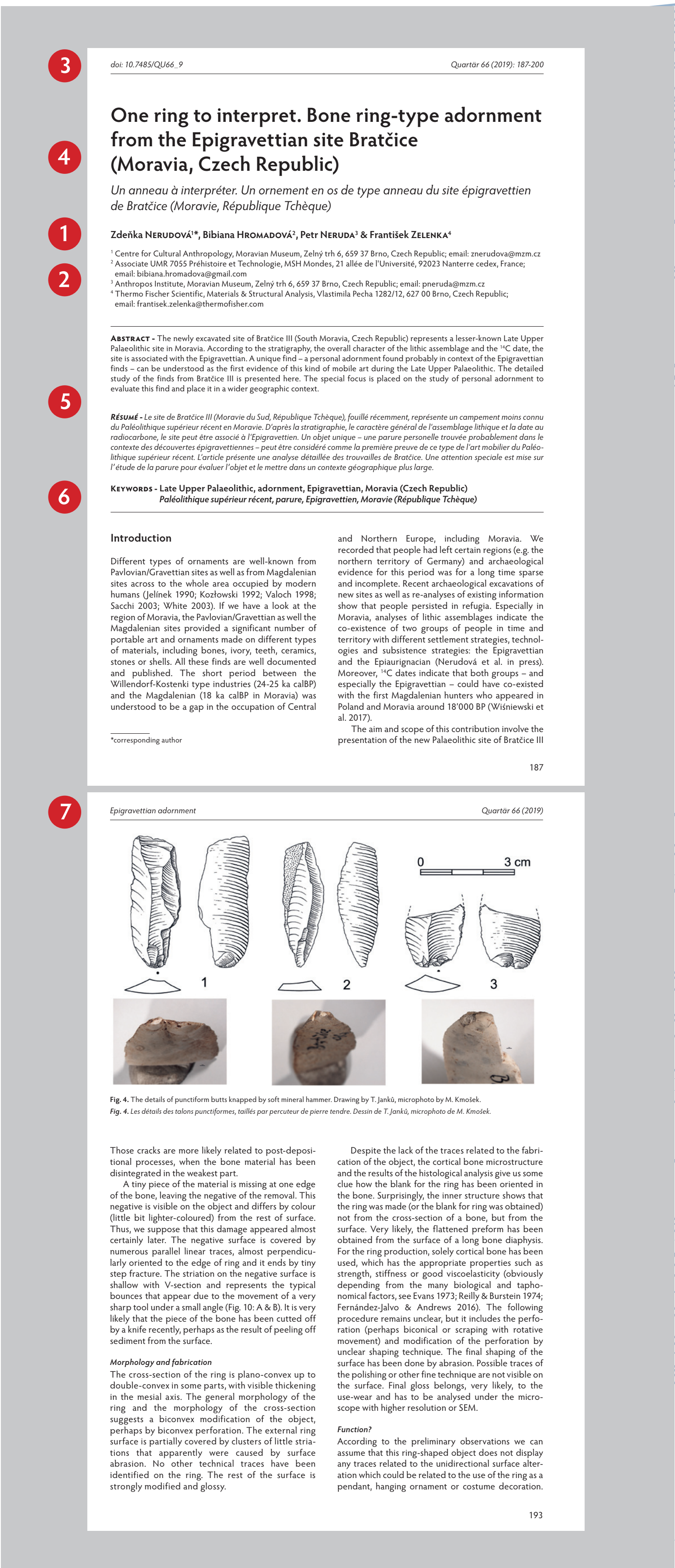

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One ring to interpret. Bone ring-type adornment from the Epigravettian site Bratčice (Moravia, Czech Republic)

Un anneau à interpréter. Un ornement en os de type anneau du site épigravettien de Bratčice (Moravie, République Tchèque)

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Abstract - The newly excavated site of Bratčice III (South Moravia, Czech Republic) represents a lesser-known Late Upper Palaeolithic site in Moravia. According to the stratigraphy, the overall character of the lithic assemblage and the ^{14}C date, the site is associated with the Epigravettian. A unique find – a personal adornment found probably in context of the Epigravettian finds – can be understood as the first evidence of this kind of mobile art during the Late Upper Palaeolithic. The detailed study of the finds from Bratčice III is presented here. The special focus is placed on the study of personal adornment to evaluate this find and place it in a wider geographic context.

***Résumé -** Le site de Bratčice III (Moravie du Sud, République Tchèque), fouillé récemment, représente un campement moins connu du Paléolithique supérieur récent en Moravie. D'après la stratigraphie, le caractère général de l'assemblage lithique et la date au radiocarbone, le site peut être associé à l'Epigravettien. Un objet unique – une parure personelle trouvée probablement dans le contexte des découvertes épigravettiennes – peut être considéré comme la première preuve de ce type de l'art mobilier du Paléolithique supérieur récent. L'article présente une analyse détaillée des trouvailles de Bratčice. Une attention speciale est mise sur l'étude de la parure pour évaluer l'objet et le mettre dans un contexte géographique plus large.*

Keywords - Late Upper Palaeolithic, adornment, Epigravettian, Moravia (Czech Republic)
Paléolithique supérieur récent, parure, Epigravettien, Moravie (République Tchèque)

Introduction

Different types of ornaments are well-known from Pavlovian/Gravettian sites as well as from Magdalenian sites across to the whole area occupied by modern humans (Jelínek 1990; Kozłowski 1992; Valoch 1998; Sacchi 2003; White 2003). If we have a look at the region of Moravia, the Pavlovian/Gravettian as well the Magdalenian sites provided a significant number of portable art and ornaments made on different types of materials, including bones, ivory, teeth, ceramics, stones or shells. All these finds are well documented and published. The short period between the Willendorf-Kostenki type industries (24-25 ka calBP) and the Magdalenian (18 ka calBP in Moravia) was understood to be a gap in the occupation of Central and Northern Europe, including Moravia. We recorded that people had left certain regions (e.g. the northern territory of Germany) and archaeological evidence for this period was for a long time sparse and incomplete. Recent archaeological excavations of new sites as well as re-analyses of existing information show that people persisted in refugia. Especially in Moravia, analyses of lithic assemblages indicate the co-existence of two groups of people in time and territory with different settlement strategies, technologies and subsistence strategies: the Epigravettian and the Epiaurignacian (Nerudová et al. in press). Moreover, ^{14}C dates indicate that both groups – and especially the Epigravettian – could have co-existed with the first Magdalenian hunters who appeared in Poland and Moravia around 18'000 BP (Wiśniewski et al. 2017).

The aim and scope of this contribution involve the presentation of the new Palaeolithic site of Bratčice III

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Epigravettian adornment — *Quartär 66 (2019)*

Fig. 4. The details of punctiform butts knapped by soft mineral hammer. Drawing by T. Janků, microphoto by M. Kmošek.
***Fig. 4.** Les détails des talons punctiformes, taillés par percuteur de pierre tendre. Dessin de T. Janků, microphoto de M. Kmošek.*

Those cracks are more likely related to post-depositional processes, when the bone material has been disintegrated in the weakest part.

A tiny piece of the material is missing at one edge of the bone, leaving the negative of the removal. This negative is visible on the object and differs by colour (little bit lighter-coloured) from the rest of surface. Thus, we suppose that this damage appeared almost certainly later. The negative surface is covered by numerous parallel linear traces, almost perpendicularly oriented to the edge of ring and it ends by tiny step fracture. The striation on the negative surface is shallow with V-section and represents the typical bounces that appear due to the movement of a very sharp tool under a small angle (Fig. 10: A & B). It is very likely that the piece of the bone has been cutted off by a knife recently, perhaps as the result of peeling off sediment from the surface.

Morphology and fabrication

The cross-section of the ring is plano-convex up to double-convex in some parts, with visible thickening in the mesial axis. The general morphology of the ring and the morphology of the cross-section suggests a biconvex modification of the object, perhaps by biconvex perforation. The external ring surface is partially covered by clusters of little striations that apparently were caused by surface abrasion. No other technical traces have been identified on the ring. The rest of the surface is strongly modified and glossy.

Despite the lack of the traces related to the fabrication of the object, the cortical bone microstructure and the results of the histological analysis give us some clue how the blank for the ring has been oriented in the bone. Surprisingly, the inner structure shows that the ring was made (or the blank for ring was obtained) not from the cross-section of a bone, but from the surface. Very likely, the flattened preform has been obtained from the surface of a long bone diaphysis. For the ring production, solely cortical bone has been used, which has the appropriate properties such as strength, stiffness or good viscoelasticity (obviously depending from the many biological and taphonomical factors, see Evans 1973; Reilly & Burstein 1974; Fernández-Jalvo & Andrews 2016). The following procedure remains unclear, but it includes the perforation (perhaps biconical or scraping with rotative movement) and modification of the perforation by unclear shaping technique. The final shaping of the surface has been done by abrasion. Possible traces of the polishing or other fine technique are not visible on the surface. Final gloss belongs, very likely, to the use-wear and has to be analysed under the microscope with higher resolution or SEM.

Function?

According to the preliminary observations we can assume that this ring-shaped object does not display any traces related to the unidirectional surface alteration which could be related to the use of the ring as a pendant, hanging ornament or costume decoration.

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4

2

2 Third heading level

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   - When a number is used with a unit, the numeral is used and the unit is abbreviated.
   - English: Commas are used to separate thousands and the decimal point to separate decimals (1,023.5 m)
   - German/French: Points are used to separate thousands and the commas to separate decimals (1.023,5 m)
   - In a range, all digits are repeated.

Middle Paleolithic of Geißenklösterle Cave *Quartär 66 (2019)*

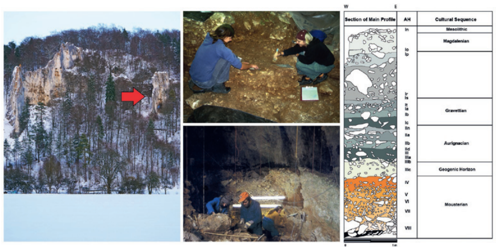

Fig. 2. Composite picture of the site and stratigraphy of Geißenklösterle. Left: View of the collapsed cave of Geißenklösterle from afar (red arrow). Middle bottom: Excavations by J. Hahn (center) with A. Scheer (right; source: Archäologie in Deutschland 1984). Middle top: Excavations into the Middle Paleolithic deposits in 2002 with M. Malina (left) and L. Giemsch (Photo: N. J. Conard). Right: Composite stratigraphy of the main profile for the entire archaeological sequence. The MP layers (AH IV-VIII) are highlighted in colors.

Abb. 2. *Überblick über die Fundstelle und Stratigraphie des Geißenklösterle. Links: Blick auf die eingestürzte Höhle des Geißenklösterle aus der Ferne (roter Pfeil). Mitte unten: Ausgrabungen durch J. Hahn (Mitte) mit A. Scheer (rechts; Quelle: Archäologie in Deutschland 1984). Mitte oben: Ausgrabung in den mittelpaläolithischen Schichten 2002 mit M. Malina (links) und L. Giemsch (Photo: N. J. Conard). Rechts: Stratigraphie des Hauptprofils (idealisiert) für die gesamte archäologische Sequenz. Die MP-Schichten (AH IV-VIII) sind farblich hervorgehoben.*

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layers, but opened only a test pit of 4 m² for the two uppermost MP levels (AHs IV & V; Hahn 1988) without reaching bedrock. In 2001 and 2002, N. J. Conard continued the fieldwork at GK using Hahn's excavation grid and stratigraphic designations, but added systematic 3D piece plotting of archaeological material with a total station assisted by the EDM program (Dibble & McPherron 1996) to the field methods. The new fieldwork focused on the deeper parts of the deposits (lower Aurignacian III-IIIb and MP layers), with the aim of recovering the entire vertical stratigraphy of the site. These renewed excavations recovered artifacts from all Neanderthal occupations (AHs IV-VIII) in 7-10 m² (Fig. 3) and reached bedrock in 6 m², uncovering a total thickness of roughly 5 m for the cave deposits (Conard & Malina 2002, 2003; Miller 2015). The majority of the MP assemblages studied here (99 % of lithic artifacts) were excavated with modern field methods by the excavations in 2001 and 2002.

The overall stratigraphy of the site encompasses 23 geological horizons (GHs), among which 20 AHs could be distinguished (Fig. 2; more details in Hahn 1988; Conard & Malina 2003; Miller 2015; Conard et al. 2019). The Mesolithic and UP occupations span AHs I-III (Magdalenian, Gravettian, Aurignacian) whereas the MP settlements encompass AHs IV-VIII (GHs 18-23). The MP deposits lie below a largely geogenic horizon of ca. 20 cm thickness (GH 17; AH IIIc) that separates the Neanderthal occupations from the early Aurignacian (Fig. 4). The stratigraphic discontinuity between the Aurignacian and uppermost MP layers is further attested by differences in lithic and faunal assemblages, a drop in find densities for all classes of finds at the base of the Aurignacian and 3D-plots of finds showing no overlap between the mostly horizontal archaeological horizons (Fig. 4; Conard & Malina 2002, 2003; Conard et al. 2006; Conard et al. 2019).

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The MP deposits amount to ca. 1.0 m, which include AHs IV-VIII that range in thickness from 10-35 cm. These five layers are characterized by varying quantities of limestone rubble in a silty matrix which contained variable, but generally low amounts of lithic artifacts, modified faunal remains and burnt bone. The archaeological material did not form clearly defined find horizons and no archaeological features were discerned (Fig. 4), as was also the case in later years at the MP deposits of Hohle Fels (Conard & Malina 2013). Previous observations on sediments, artifacts and extensive refitting (Hahn 1988) revealed that the original positions of stone artifacts and bones have been moved by cryo- and bioturbation after primary sedimentation, which also caused edge damage on lithics (Hahn 1988). Micromorphological studies have, however, found no mixing between the MP and UP layers (Miller 2015; Goldberg et al. 2019). The absence of diagnostic Aurignacian artifacts in the MP layers and the failure to produce any links between the Aurignacian and MP strata during refitting of

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Felsenhäusl-Kellerhöhle *Quartär 66 (2019)*

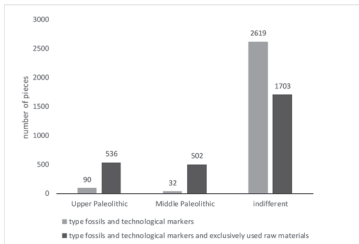

Fig. 19. Felsenhäusl-Kellerhöhle. Comparison between the artifact frequencies in basic assemblages and expanded assemblages of the Middle and Upper Paleolithic, and the frequencies of indifferent artifacts.

Abb. 19. *Felsenhäusl-Kellerhöhle. Vergleich der Artefakt-Häufigkeiten zwischen „Basis-Inventaren" und „Erweiterten Inventaren" sowie die Häufigkeit von Artefakten, die keinem der beiden Inventare zugeordnet werden konnten.*

4. The number of diagnostic pieces does not correspond to some kind of chronological sequence, but simply correlates with the growing number of finds.

All of these observations allow us to reject the hypothesis that the excavation spits reflect a chronological order. In consequence, the artifacts have to be treated analogous to a mixed collection.

Description of the Middle/Upper Paleolithic assemblage

By separating all artifacts of clear chronological origin, we were able to distinguish three assemblages: the Upper Paleolithic assemblage 1, the Middle Paleolithic assemblage 2 , and a third assemblage with artifacts undiagnostic with regard to both typo-technological and raw material aspects. In the following section, we will focus on a typo-technological description of assemblage 1 and assemblage 2. Unless otherwise stated, the sections below refer to both the "basic assemblages" and the "expanded assemblages".

Assemblage 1 (Upper Paleolithic) is composed of 90 diagnostic artifacts from the basic assemblage, plus 446 artifacts attributed to it via raw material exclusivities. In sum, the expanded assemblage 1 accounts for 536 artifacts. In the basic assemblage Jurassic hornstone is with 72 individual pieces by far most numerous, followed by Cretaceous hornstone with 13 and quartz with 4 (Fig. 21).

The classification as Upper Paleolithic is based on the combination of backed pieces, endscrapers, burins and unipolar as well as bipolar blade cores (Figs. 22, 23 & 24). There are three backed bladelets (Fig. 23: 5-7), which all have an abrupt lateral retouch with an angle of almost 90° ("total backing" according to L. Moreau 2009), and one backed point (Fig. 23: 8). endscraper (Fig. 23: 11 & 12) are outnumbered by different types of burins (Fig. 23: 1-4). Among the burins, five dihedral burins (Fig. 23: 2 & 3) dominate over one burin on truncation (Fig. 23: 1) and one burin on breakage (Fig. 23: 4). Most endscrapers are on blades, while one piece is thick and exhibits an almost carinated retouch (Fig. 23: 12). Furthermore, there are three pieces with a lateral retouch, which do not allow further classification and were included due to their corresponding raw material.

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In total, seven cores belong to assemblage 1 (Fig. 24: 1-5). In general, cores exhibit no cortex and were carefully prepared by adjusting the distal angles before starting the detachment of blades. One of the cores reaches a length of 15 cm and is best described as almost "flat-like" (Fig. 24: 1). The unipolar flaking surface is narrow and opposite to an equally narrow back, whereas the sides of the core are relatively wide. The remaining cores are much smaller and prismatic in form (Fig. 24: 5). Whereas the bulk of them is again unidirectional, there is one fragmented semi-prismatic core that has the only bidirectional flaking surface among the assemblage (Fig. 24: 4).

The main features of the flaking process, as evidenced by the attribute analysis of blades and cores, can be summarized as follows: the flaking aimed at the production of long and regular blades with primarily unipolar dorsal scar patterns (Fig. 24: 7 & 8). The bulbs of percussion are generally small. Bulbar scars are very rare and often accompanied by lips. In sum these technological features indicate direct

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Key style points: Formal style

Text formatting I

1. Emphasized words or phrases in running text are set in quotation marks.

2. Italics are used for species and genus names, mathematical/physical variables, prefixes in chemical compounds, and foreign words (if not yet in general use).

3. Foreign words being in general use (e.g., ad hoc, laissez-faire, a priori, in situ, et al., etc.) are formatted regular.

4. Reference citations are given in running text with author name(s) and year of publication in parentheses:
   - Able (1989) or (Able 1989)
   - Able & Becker (1990) or (Able & Becker 1990)
   - Three or more authors: Able et al. (1989) or (Able et al. 1989)
   - Manuscripts that are accepted for publication but not yet published: Able (in press)

5. Reference to unpublished materials:
   - (K. P. Able unpubl. data)
   - (K. P. Able pers. obs.)
   - (K. P. Able pers. comm.)

6. Series of references:
   - (Charley 1980; Able 1983, 1990; Able & Baker 1984)
   - (Baker 1989; Able 1992; Charley 1996)
   - (Able 1988a, b, c)

7. Reference to a certain page:
   - (Charley 1980: 232)
   - (Able 1983: 33ff.)
   - (Able 1983: Fig. 5)

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where they dominate - also scarce in these assemblages. It is also noticed that backed tools are present but not a dominant part of the tool composition.

Faunal analysis

The osteological material presented was collected during the excavations of 2018, and was found in all sublayers of layer 3. Since sublayer 3c was mostly excavated in 2019, the results for sublayer 3c presented in this paper are not conclusive. All excavated sediment was dry sieved, through sieves of 3 mm diameter. This enabled the collection of smaller fragments of large mammals, as well as remains of micromammals. Specimens were identified based on the comparative collections at the Laboratory for Bioarchaeology of the Department of Archaeology, Faculty of Philosophy - University of Belgrade. Remains of large mammals, micromammals, birds and fish were quantified separately.

The remains were quantified using two methods: NISP (Number of Identified Specimens) and MNI (Minimum number of Individuals) (Lyman 1994). For large mammals only specimens longer than 2 cm were counted, since for smaller pieces taphonomy features are often unobservable, and they can bias the NISP count. All specimens were closely observed in order to identify traces of human activity (cut marks, percussion marks, and evidence of burning), as well as marks resulting from weathering, trampling and predator gnawing (Shipman & Rose 1983; Olsen & Shipman 1988; Lyman 1994; Haynes 1980). Every specimen with marks suspected to originate from human activity was examined under low-power magnification. Location and orientation of such marks were recorded in order to link them to a specific butchery practice (skinning, disarticulation or filleting) (Binford 1981; Lyman 1987).

Due to the high level of fragmentation of the material throughout layer 3 and the low number of identified specimens, results for layer 3 can be completely presented, while only significant differences in sublayers 3a, 3b and 3c will be discussed.

Taphonomy

The osteological material is highly fragmented. Specimens between 2 and 5 cm in length are dominant in all layers (>80 %). Most of the bones in layer 3 are black and grey, with mineral oxide coating, and lightly polished surface. During the excavations none of the bones were discovered in anatomical order.

Faunal composition and skeletal representation

We analyzed 1'058 bones and teeth from different mammal species. Because the osteological material is highly fragmented only 4,6 % of specimens could be identified to taxon (NISP = 49), and 19 specimens were identified to a higher taxonomic category (Fig. 24). Among the mammals, the remains of hare are most numerous (NISP = 14), followed by fox (NISP = 13), steppe bison (NISP = 9) and horse (NISP = 7). Other taxa are mostly represented by one specimen.

The largest number of specimens belongs to hare (*Lepus* sp.) (NISP = 14). Hare remains were found in all sublayers, but most of them were found in layer 3b. Hare is represented mostly by long and short limb bones, but axial elements are present as well (Fig. 25). NISP comprises the complete layer 3, however, the fact that hare bones are found in all three sublayers it indicates a minimum of three individuals. The next most common taxon in the osteological material from Meča Dupka is fox (*Vulpes vulpes*). The fox remains belong to a minimum of two individual, found in layers 3a and 3b. Fox is represented only by limb bones. Phalanges are the most numerous (NISP = 10), followed by metatarsal bones (NISP = 2) and one calcaneus (Fig. 25).

Large mammals from Pleistocene layers at Meča Dupka cave are represented by remains of steppe bison (*Bison priscus*), horse (*Equus ferus*), red deer (*Cervus elaphus*), ibex/chamois (*Capra ibex/Rupicapra rupicapra*), and cave bear (*Usrsus spelaeus*). It should be noted that most of the remains were found in layer 3a (Fig. 26). Remains of steppe bison (*Bison priscus*) are the most numerous fragments among large mammals (NISP = 9). The remains of steppe bison are dominated by isolated complete and fragmented lower teeth (NISP = 5) (Fig 10: 1 & 2). Limb bones were also discovered including tibia (NISP = 3) and one fragment of a metacarpal bone (Fig. 25). Different

Fig. 24. Animal remains discovered during excavations in 2018, layer 3, expressed as NISP.

Abb. 24. *Tierreste, die bei Ausgrabungen im Jahr 2018 entdeckt wurden, Schicht 3, dargestellt als NISP.*

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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,

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Key style points: Formal style

Text formatting II

1 Radiocarbon dating

- ^{14}C dates (english)
- ^{14}C-Daten (german)

2 Results of radiocarbon dating

- 5,421 BP/BC
- 5 ka BP/BC
- 15,681 calBP/calBC
- 50 ka BP/BC

3 Some formal rules:

- ‚±‘ with a space before and after (e.g. 333 ± 33 BP)
- ‚-‘ without space before and after (e.g. 333-444 BP)
- numbers and units with a space between (e.g. 1 kg, 2 m)
- ‚%‘ with a space between (e.g. 100 %)
- ‚/‘ without space between (e.g. sheep/goat)
- ‚e.g.‘, ‚i.e.‘ and ‚z.B.‘ without space between
- ‚a.s.l.‘ and ‚ü.d.M.‘ without space between
- ‚N = 2‘ in capital letter with a space between
- ‚2 °C‘ with a space beetween
- ‚>10‘ and ‚<10‘ without space between
- angle of 45°
- temperature of 90°C

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other regions of Europe, the development of the Aurignacian and the appearance of another large-scale cultural complex, the Gravettian, are debated. According to recent reassessment conducted at Fumane Cave (Falcucci 2018) and Bombrini Rockshelter (Riel-Salvatore & Negrino 2018), the Protoaurignacian lasted well after the Campanian Ignimbrite volcanic eruption (Giaccio et al. 2008) and the partially contemporaneous Heinrich Event 4 (Bond & Lotti 1995), most likely up to 36 ka calBP. According to other authors, instead, the Protoaurignacian was replaced by the Early Aurignacian (e.g. Tejero & Grimaldi 2015; Degano et al. 2019). Whatever the definitive answer to this important question will be, the Aurignacian was at some point in time replaced by the Gravettian, whose techno-typological signatures seem to have spread in a rather short time-span across Europe (Reynolds & Green 2019). In Italy, the earliest known Gravettian assemblage is dated to ca. 33.9-32.8 ka calBP at Rio Secco Cave at the edge of the Great Po Plain (Talamo et al. 2014) and slightly later at Paglicci Cave in the southern Adriatic region (Palma di Cesnola 2004).

In order to elucidate the changes in human settlement dynamics that occurred under changing climatic conditions between 36 and 30 ka calBP, we need to construct a more comprehensive archeological database. This can be achieved through the discovery of new stratified sites with late Pleistocene deposits, but also with the assessment of unpublished assemblages dated to this time span. Here, we analyze for the first time the youngest anthropic layer discovered at Fumane Cave in northeastern Italy (Fig. 1) with the aim of clarifying its cultural attribution and the nature of human settlement dynamics in the Prealps following the late Protoaurignacian at ca. 36 ka calBP (Higham et al. 2009) and predating the Heinrich Event 3. This assemblage has received little attention because of the small number of artifacts recovered compared to the underlying Protoaurignacian, Uluzzian, and Mousterian layers. According to Bartolomei et al. (1992), the D1d assemblage can be assigned to a Gravettian *sensu lato*, although no technological and typological studies have been conducted to verify its cultural attribution, understand the modality and circumstances of the occupation of the cave, and discuss the reliability of the available radiocarbon dates. We will address these issues with the final goal to discuss the importance of the site in its regional setting and within the Italian mid Upper Paleolithic record.

The site of Fumane Cave

Fumane Cave is one of the most studied Paleolithic sites of Europe. Located in the Monti Lessini, Venetian Prealps, it was first excavated in 1988 (Bartolomei et al. 1992). Archaeological excavations have been conducted since then and are now under the direction of one of us (MP). The deposit has accumulated for most of the Late Pleistocene, and several Mousterian, Uluzzian, and Protoaurignacian layers document the repeated frequentation of the cave from both Neanderthals and modern humans (Bartolomei et al. 1992; Cassoli & Tagliacozzo 1994; Broglio et al. 2003; Broglio et al. 2005; Broglio & Dalmeri 2005; Higham et al. 2009; Peresani 2012; Benazzi et al. 2015; López-García et al. 2015; Peresani et al. 2016; Falcucci et al. 2017).

The youngest sedimentary succession – named macro-unit D – formed during a phase of climatic deterioration (Broglio et al. 2003; López-García et al. 2015), which resulted in different episodes of rock-collapse and aeolian sedimentation that progressively sealed the cave entrance. The last unit was only noticed at the entrance of the cave and in its internal part and was named D1 (Fig. 2). From a lithological point of view, it is mostly formed of very coarse materials (boulders and stones) mixed with sandy matrix.

Evidence of human presence are less dense if compared to the early and late Protoaurignacian layers. D1 was divided in different layers, from bottom to top: D1c, D1d, D1e, and D1f (Figs. 3 & 4). D1c was described as Aurignacian *sensu lato* (Bartolomei et al. 1992). The D1c lithic assemblage (n = 172) is mostly formed of flakes blanks (75 % of the total blanks). Among tools (n = 6), two endscrapers on flake, a retouched flake, a scaled piece, a bladelet with lateral retouch, and a blade with scaled retouch were collected. At the time being, we can only attribute this assemblage to an undifferentiated Upper Paleolithic. The overlying D1d, which is the focus of this paper, was assigned to the Gravettian *sensu lato* (Bartolomei et al. 1992; Broglio 1997). Finally, D1e and D1f were described as almost sterile layers. The discovery of several large-sized bones with gnawing marks points towards the presence of carnivores during the formation of D1e-f.

A few radiocarbon dates are available for layer D1d and the overlying layer D1e (Broglio & Dalmeri 2005; Higham et al. 2009). According to these dates, layer D1d formed between 35.9-33.2 ka calBP. If only the most recently obtained date was considered, the assemblage would date to ca. 35.9-35.0 ka calBP. A more roughly chronological framework for the formation of the stratigraphic sequence was provided by López-García et al. (2015) using the biostratigraphy of the small mammals assemblage. The authors identified the Heinrich Event 3, which took place at around 30 ka calBP (Bond & Lotti 1995; Hemming 2004), in the overlying layer D1e.

Materials and methods

In this study, we focus our attention to the youngest anthropic layer D1d, which comprises spits D1d base and D1d tetto. This layer, which was easily discernible during excavations, is only present in the cave entrance and cave mouth. An extended accumulation of macro- and micro-charcoals was found over a large extent of

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Upper Palaeolithic site of Temerești Dealu Vinii, Banat, Romania *Quartär 66 (2019)*

vectorized, starting in the valley floor and following geomorphological features such as spurs and side valleys. The polyline was interpolated with the ALOS-DSM to obtain a cross section of the valley slope. A hill shade model (azimuth 315°, altitude 45°) was calculated for visualization and geomorphological discussion.

Geochronology

Laboratory treatment of the OSL samples included sieving to isolate the 100–150 µm fraction, HCl (10 %) to remove carbonates, H_2O_2 (10 %) to remove organic material and $Na_2C_2O_4$ (0.01 N) to remove clay and perform density separation (ρ = 2.62 g/cm³ and ρ = 2.68 g/cm³) to isolate quartz. We etched the quartz fraction with hydrofluoric acid (37 %, 40 minutes) and finally washed it with HCl (10 %, 1.0 hours). We used an automated Risø TL/OSL DA 20 reader equipped with a calibrated ^{90}Sr beta source. Blue-light emitting diodes (470 nm, FWHM = 20) and a Hoya U-340 filter (7.5 mm) transmitting wavelengths of 330 ± 40 nm were used for optical stimulation and signal detection of the multi-grain aliquots (1 mm diameter of the grain layer). The net OSL signal was obtained using the first 0.5 seconds of the stimulation and background subtraction of the last 4 seconds. We used the single-aliquot regenerative-dose approach (SAR) for all measurements (Murray & Wintle 2000, 2003) and measured the response to IR stimulation at the end of the SAR cycle (Duller 2003). For a preheat plateau test, we employed preheat temperatures between 180 and 280 °C for 10 seconds, a cutheat temperature of 20 °C below the preheat temperature and OSL stimulation for 40 seconds at 125 °C (1 mm, 4 aliquots each temperature, samples C-L3669 and C-L3671). Additionally, we carried out dose recovery tests of the same samples (given dose: 15 Gy (C-L4769), 9 Gy (C-L4770) and 6 Gy (C-L4771) after OSL stimulation for 100 seconds at room temperature) using preheat temperatures between 180 and 240 °C and a cutheat temperature that tracked the preheat temperature by −20 °C, respectively (1 mm, 5 aliquots). The mean dose was calculated using an arithmetic mean.

The radionuclide concentrations of the surrounding sediments were measured using high resolution gamma ray spectrometry. The dose rate was calculated using DRAC (Durcan et al. 2015) and included conversion factors of Guérin et al. (2011) and the measured water content. The cosmic dose rate was calculated following Prescott & Hutton (1994).

The 18 samples for luminescence profiling using a portable luminescence reader were measured twice. First, a batch of samples was measured without any sample preparation, using two replicates. All measurements were done using the same volume. Secondly, a samples batch was dried, crushed gently and two further replicates were measured to compare untreated and pretreated material. The measurements were done in a portable luminescence reader of the Scottish Universities Environmental Research Centre (SUERC) equipped with infrared (880 ± 40 nm) and blue (470 ± 20 nm) Light emitting-diode for signal stimulation, UG11 filters and a 25 mm bi-alkali photomultiplier for signal detection (cf. Sanderson & Murphy 2010). The measurement protocol comprised 60 seconds of infrared stimulation (IRSL), followed by 60 seconds of blue stimulation (BSL), separated by 15 seconds intervals to record the background (BG) (15 s BG, 60 s IRSL, 15 s BG, 60 s BSL, 15 s BG).

Additionally, Accelerator Mass Spectrometry (AMS) ^{14}C dating of a micro-charcoal (3.3 mg) sample found at a depth of 46 cm was carried out by Beta Analytic (Beta-484031) and calibrated using the INTCAL13 calibration curve (Bronk Ramsey et al. 2009; Reimer et al. 2013). The sample was pretreated by gentle crushing and dispersal in deionized water and then washed in hot acid (HCl), followed by alkali (NaOH) and acid solutions and finally dried.

Results

Geochemical and sedimentological analyses

Below the top humic layer (c. 5 cm), no clear stratigraphic units were identified until the appearance of a gravel layer c. 55 cm that graded into the covering sediments. Most of the geochemical proxies confirm the simple stratigraphy of the sampled profile. CaO, as a proxy for soluble compounds such as carbonates, shows a small increase just below the uppermost humic layer. In the silty material below, only slightly declining trends were visible, until the underlying fluvial sediments, where the values decrease rapidly. Many other (soluble) elements follow the same pattern, other chemical compounds show little to no variation at all (Fig. 3). The Al_2O_3/K_2O-ratio shows the clear distinction between the terrace sediment at the base of the profile and the silty material above. The ratio increases slightly with depth until 50 cm. Below, it increases rapidly demonstrating no large variation within the terrace sediment. The matrix of the fluvial package is characterized by redoximorphic features that were optically visible and are supported by the geochemical data.

On average, the grain sizes for the sequence are within the coarse silt fraction (median: 40 µm). The median grain size ranges from 31 µm in the silty material to 102 µm within the gravel-rich sediment. The grain size distributions throughout the section are tri-modal (Fig. 4). The first mode is in the range of medium to coarse silt. This particular mode is subdivided into two separated shoulders. Within the upper half of the profile, this peak is narrow, whereas the lower half of the profile shows a larger scatter. The second peak is in the fine to medium sand fraction. It is prominent and the scatter is narrow particularly in the upper half. In the lower half of the section, the percentages of this fraction are lower and singular samples show larger variation. The last and most

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Key style points: Tables and lists

1. Table captions:
   - Table captions begin with the term Tab. in bold type, followed by the table number, also in bold type.
   - Previously published material is identified by a reference to the original source at the end of the caption.
   - Table captions ends with a punctuation.

2. Table captions should be submitted
   - in the language of the article
   - in the second language

3. Table rules are created during the typesetting. Manually inserted rules or shading of table rows and table cells cannot be retained.

4. Do not include „exotic symbols" (lines, dots, triangles, etc.) in table captions; either label them in the table legend or refer to them by name in the caption (e.g. triangles = scrapers).

5. Lists have one level:
   - Items are indicated by a bullet, point or a number.

6. Cross-references to sub-tables are indicated as (Tab. 12: a).

7. Tables are to be submitted as editable files (e.g. Excel, Word), not as pictures.
   - Do not submit tabular material as figures.

Quartär 67 (2020), Early View — *M. Kot*

No.	Site	Country	Analysed pieces	Symetric bifaces	Asymetric bifaces	Rectangular bifaces	1	2	3	4	5	6	No of identified features
1	Lenderscheid	Germany	9	-	5	4	2	3	2	+	+	+	6
2	Rörshain	Germany	28	6	7	1	3	-	4	+	+	+	5
3	Sajóbábony Méhész-tetö	Hungary	9	-	7	2	6	1	5	+	+	+	6
4	Korolevo II	Ukraine	6	-	4	1	2	-	1	+	+	+	5
5	Kösten	Germany	6	-	3	1	2	-	2	+	+	+	5
6	Mauern	Germany	12	-	12	-	9	-	6	+	+	+	5
7	Wahlen	Germany	15	4	11	-	8	2	4	+	-	+	5
8	Korolevo V	Ukraine	5	-	3	-	3	-	2	+	+	-	4
9	Musilievo	Bulgaria	16	-	7	-	3	1	1	+	+	-	4
10	Jezerany I	Czech Republic	5	-	5	-	5	-	1	+	-	-	3
11	Rykhta	Ukraine	2	-	2	-	2	-	-	+	-	-	2
12	Oceliwka	Ukraine	1	-	-	1	1	-	1	-	-	-	2
13	Reutersruh	Germany	1	-	-	1	-	-	2	-	-	-	1
14	Brno Bohunice	Czech Republic	1	-	1	-	1	-	1	-	-	-	2
15	Vedrovice V	Czech Republic	4	-	1	-	1	-	3	-	-	-	2
16	Ehringsdorf	Germany	2	-	1	1	1	-	-	-	-	+	2
17	Samuilica	Bulgaria	1	-	-	-	-	-	-	-	-	-	-
18	Ranis	Germany	2	-	-	-	-	-	-	-	-	-	-
19	Moravsky Krumlov IV	Czech Republic	3	-	-	-	-	-	-	-	-	-	-
20	Albersdorf	Germany	1	-	-	-	-	-	-	-	-	-	-
		Total	129	10	69	12	49	6	35				

Tab. 1. List of analysed broken bifaces with identified features: (1) A breakage in the middle of the operational chain; (2) the presence of notches; (3) a bend breakage with a visible point of percussion; (4) rRecurrence within group – the presence of more than one artefact with a broken base; (5) similarity in morphology to unbroken pieces; (6) the recurrence between groups – the presence of different types of tools with breakages.

Tab. 1. *Liste der analysierten gebrochenen bifaziellen Geräte und den identifizierten Merkmalen: (1) Ein Bruch in der Mitte der Operationskette; (2) das Vorhandensein von Kerben; (3) eine Bruchfläche mit einem sichtbaren Schlagpunkt; (4) Wiederholung innerhalb des Inventars – das Vorhandensein von mehr als einem Artefakt mit einer basalen Fraktur; (5) Ähnlichkeit in der Morphologie zu ungebrochenen Stücken; (6) die Wiederholung zwischen Inventaren – das Vorhandensein verschiedener Arten von Werkzeugen mit Brüchen.*

Based on identified features, intentional breakages can be determined with reasonable certainty in Lenderscheid, Rörshain, Walhen, Mauern, Kösten, Sajóbábony Méhész-tetö and Korolevo II and with high probability (3-4 out of 6 features) in Musilievo, Jezerany I and Korolevo Va.

The obtained results indicate that in order to indetify the use of intentional fraturing within the analysed assemblage one should take several features into consideration and their reccurence within the assemblage. The list of features proposed here is only of use when a number of artefacts from an assemblage are analysed.

If one considers the chronological framework of this group of sites, it should be stressed that not all of the assemblages are well dated. Lenderscheid (Luttropp 1955; Fiedler 2010; Junga 2009) and Wahlen (Fiedler et al. 1979) are surface collections, ascribed to the *Keilmesser Gruppe* (Bosinski 1967) due to typological and technological features only. In Wahlen, the assemblage can be divided into three main chronological horizons – the Palaeolithic, Bronze Age and medieval period, with Palaeolithic artefacts prevalent (Junga 2009). The consistency of the mechanically separated MP inventory can be questioned, as can its chronological position. Based on the dating of Korolevo Va (Koulakovska et al. 2010), one should state that the analysed phenomenon began at least as early as during MIS 7a and was continued in MIS 5 and 6 (Sajóbábony Méhész-tetö, Ringer & Adams 2000) up to MIS 3 (Fig. 10). Therefore, the chronological range of the described phenomenon seems to be very wide. It should be stressed that this paper does not aim to describe the full picture of the application of intentional fracturing during the MP. The main scope is to present the phenomenon and to provide tools for further analyses.

Conclusions

The results indicate that complete tools also appear among broken bifaces, which were actually broken intentionally during their manufacturing process. Among the analysed broken bifaces one can determine

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Intentional fracturing in bifacial tool production — *Quartär 67 (2020), Early View*

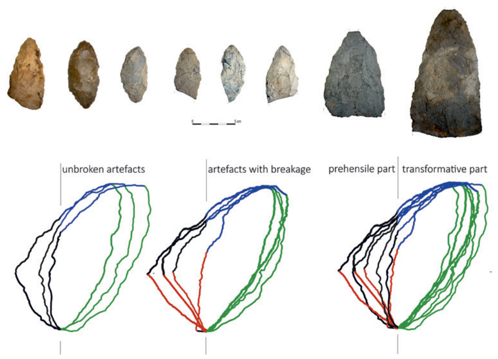

Fig. 9. A comparison of the shape of asymmetric tools with and without transversal breakages within the assemblages.
Abb. 9. *Vergleich der Umrisse assymetrischer Werkzeuge mit und ohne transversalen Bruchflächen innerhalb der Inventare.*

1975; Gladilin & Demidenko 1989; Hahn 1990; Ringer & Adams 2000; Fiedler 2001; Graßkamp 2001; Koulakovskaya 2001). Most of them show no traces of deliberate breakage. However, this study shows that in 16 out of 20 studied assemblages containing broken bifacial tools, one can find at least one piece which presents features that might indicate an intentional breakage.

Considering the strong argument based on the scar pattern analysis should be treated with some caution. A good example is the bifacial leafpoint from Vedrovice V, which was reworked after a transversal breakage (Kot 2013). The base was retouched and reused possibly as a cutting tool following sharpening edge retouch. However, the knapping sequences which appear after the breakage cannot be treated as proof of the deliberate breakage of the tool, all the more so as the tool changed its morphology after the breakage and was reshaped from a leafpoint into an asymmetric knife (Fig. 7).

Therefore, in order to determine intentional breakage, one should take into consideration a combination of multiple features. Table 1 presents the features which might be taken into consideration while identifying the use of intentional fracturing within the analysed assemblage:

Feature 1: A breakage in the middle of the operational chain;
Feature 2: A bend breakage with a visible point of percussion;
Feature 3: The presence of notches;
Feature 4: Recurrence within the group – the presence of more than one artefact with a broken base;
Feature 5: Recurrence between groups – the presence of different types of tools with breakages;
Feature 6: The similarity in morphology to unbroken pieces.

Features 1-3 are related to single tools, while features 4-6 refer to the whole assemblage or interrelation between different tool types. For this reason features 4-6 are not applicable to small samples. In case of ten sites with a small number of analysed pieces, five show up to two identified features (Tab. 1). Therefore, the hypothesis of a use of intentional fracturing should be treated with caution in case of Brno Bohunice, Vendrovice V, Ehringsdorf, Ocelivka or Rykhta. In the case of four sites (Samuilica, Ranis, Moravsky Krumlov IV, Albersdorf), one cannot see any of the determined features. Nonetheless, a group of seven sites show at least five out of the six above-mentioned features (Tab. 1), which can be a strong indication for the use of intentional fracturing within these assemblages.

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Key style points: Figures and illustrations I

1 Figure captions

- Figure captions begin with the term Fig. in bold type, followed by the figure number and point, also in bold type.
- Figure parts are identified by letters in parentheses.
- Previously published material is identified by a reference to the original source at the end of the caption.
- Copyright holders are to be named.
- Figure captions ends with a punctuation.

2 Figure captions should be submitted

- in the language of the article
- in the second language

3 Figure size

- 78 mm wide with the caption on the side
- 120 mm and 164 mm wide with the caption placed below the figure
- Max. height 220 mm

4 Figure lettering and labeling

- Minimum size of 2 mm (6 pt) for lettering (reference is the final figure size)
- Part figure labels in letters and/or numbers

5 Cross-references to sub-figures are indicated as

- (Fig. 12: a)
- (Fig. 12: 1)
- (Fig. 12: 3-6)
- (Fig. 12: 1, 2 & 5-8)
- (Fig. 12: 1 & 2)

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

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Fig. 10. Picture of sample Tr-222-12 after being cut for thin section. Thin sections at diverse magnifications are also shown. The source area of each photomicrograph is indicated in the general picture. A: Detail of the thin section at the limit between MA_CM and MA_MQC areas. Note that clay is the main component of the matrix. A small part of microcrystalline quartz can be observed. B: Thin section of the MA_CM area. C: Thin section photograph of the MA_MQC area. D: Detail of the thin section of the microcrystalline quartz cement and the relationship with grain framework. E: Thin section photograph of the OO area. F: Detail of the thin section of the OO area, exhibiting concavo-convex quartz grain limits and presence of syntaxial regrowth. α: Limit between MA_CM and MA_MQC facies. β: Limit between MA_MQC and OO facies.

Abb. 10. *Abbildung der Probe Tr-222-12 nach dem Zuschnitt für den Dünnschliff. Ebenfalls dargestellt sind Dünnschliffe in verschiedenen Vergrößerungen. Der Quellbereich jeder Mikrofotografie ist im allgemeinen Überblicksbild angegeben. A: Detail des Dünnschliffs an der Grenze zwischen den Bereichen MA_CM und MA_MQC. Man beachte, dass Ton die Hauptkomponente der Matrix ist. Ein kleiner Teil des mikrokristallinen Quarzes kann beobachtet werden. B: Dünnschliff des MA_CM-Bereichs. C: Dünnschliffbild des MA_MQC-Bereichs. D: Detail des Dünnschliffs des mikrokristallinen Quarzzements und die Beziehung zum Korngerüst. E: Dünnschliffbild des OO-Bereichs. F: Detail des Dünnschliffs des OO-Bereichs, der konkav-konvexe Quarzkorngrenzen und das Vorhandensein von synthetischem Nachwachsen zeigt. α: Grenze zwischen MA_CM- und MA_MQC-Fazies. β: Grenze zwischen MA_MQC- und OO-Fazies.*

Rift Valley in Africa (Soto et al. 2020). The presence of clastic grained texture (with and without matrix or cement), detrital quartz grains, syntaxially quartz overgrowths or concave-convex quartz grain limits described in this research clearly represent sedimentary processes. Some of these sedimentary features were also characterised in quartzites related with other archaeological contexts and were described for sites from Belgium (Blomme et al. 2012; Cnudde et al. 2013; Veldeman et al. 2012), the Iberian Peninsula (Prieto et al. 2019; Roy et al. 2017) or North America (Dalpra & Pitblado 2016). Therefore, the characterisation of these Tertiary quartzites as a material derived from sedimentary forces underscores the variability of rocks described under the term of quartzite by archaeologist.

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Key style points: Figures and illustrations II

1. Figures are to be submitted as image file (e.g. tif or jpg).
   - Grayscale and colour minimum resolution of 300 dpi
   - Line drawings (like artefacts) resolution of 1200 dpi
2. Illustrations and graphs are to be submitted as editable file (e.g. eps, ai or others).
3. Maps, plans, features, profiles etc. include
   - Cardinal direction
   - Scale
   - Legend
4. Photos and drawings of objects include
   - Scale
   - Legend

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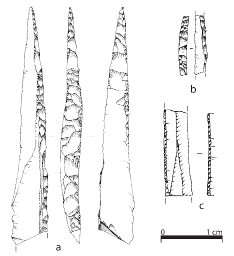

Fig. 12. Drawings of a selection of lamellar tools from unit D1d. (a) point of Vachon on bladelet; (b) fragmentary possible microgravette on burin spall; (c) bladelet with lateral alternate retouch (drawings: G. Almerigogna).

Abb. 12. *Zeichnungen einer Auswahl von Lamellenwerkzeugen aus Einheit D1d. (a) Vachon-Spitze an Lamelle; (b) Fragment einer mögliche Mikrogravette an Stichellamelle; (c) Lamelle mit seitlich alternierender Retusche (Zeichnungen: G. Almerigogna).*

steep (ca. 90°) retouch along the right side, completed by a low angle bilateral inverse retouch in the distal end of the tool. The backing operation results in a very slender product with a lateral steep cross section and a robust distal end (Fig. 12: a). This point well fits in the definition given by Simonet (2011), according to whom the retouching of a Vachon point answers to the need of obtaining a thick and narrow backed point with an axial symmetry.

Other findings

Besides from stone artifacts, other findings are rare in layer D1d. The first is a mesial portion of a bone tool made from an ulna of an indeterminate species. The artifact is broken in both extremities and anthropic modifications are very clear (e.g. longitudinal striations). It might be interpreted as a remnant of a pointed artifact with a triangular cross section. The second is a complete marine shell assigned to *Homalopoma sanguineum*, a species found in both the modern lower Adriatic, Ionian, and Tyrrhenian coasts (Bertola et al. 2013). This finding might attest to movement of foragers and/or circulation of goods across hundreds of kilometers as shown from findings in Central and Eastern Europe (e.g. Bosinski 1999; Nițu et al. 2019).

Discussion

The D1d lithic assemblage and site interpretation

The assemblage of layer D1d at Fumane cave is homogeneous in its defining features. Lithic technology is oriented towards the production of laminar blanks, using standardized reduction procedures. Bladelet production is based on the exploitation of narrow core faces with the objective of producing rather slender blanks with regular sub-parallel edges. This pattern differs the underlying early and late Protoaurignacian layers, where emphasis is placed in the isolation of convergent flaking surfaces with the goal to obtain bladelets with convergent outlines and pointed distal ends (Falcucci et al. 2017; Falcucci 2018; Falcucci & Peresani 2018). In D1d, the few discarded bladelet cores are exhausted or have knapping accidents that prevented the continuation of the production. On the other hand, blades were both obtained by means of independent reduction procedures, as well as during the early phases and maintenance of bladelet production. Independent blade production was likely carried out on-site, as suggested by the presence of few blanks related to the maintenance of blade cores, while non-exhausted blade cores were likely exported. Knappers used similar reduction procedures described for the bladelet production with the intention to obtain long products with low thickness values. Among retouched tools, two artifacts are particularly interesting. They are typical of the Gravettian technocomplex and have never been recovered in the underlying layers at Fumane Cave. A few bladelets with marginal retouch were also recovered. These tool types are common in the underlying Protoaurignacian layers as well (Falcucci et al. 2018).

Overall, the technological and typological features described point towards the assignment of the assemblage to the Gravettian (see chapter 'The Gravettian in Italy'). Moreover, the scarcity of the artifacts recovered, and the general composition of the assemblage are evidence of a rather short-time occupation of the cave. Most of the discarded backed points and retouched bladelets are broken, as well as the few domestic tools recovered. The western Monti Lessini is a region characterized by an abundance of high-quality chert (Bertola 2001; Longo & Giunti 2010; Bertola et al. 2018), and both Neanderthals and modern humans responsible for the formation of the earlier cultural units were aware of the potentialities of the raw material sources. For instance, exogenous tools are only exceptionally imported in Mousterian (Delpiano et al. 2019b) or early Protoaurignacian layers (Bertola et al. 2013; Falcucci et al. 2017). We thus believe that foragers took advantage of this favorable setting and produced new domestic tools and rejuvenated composite hunting weapons. The intense exploitation of bladelet cores and the overall paucity of laminar blanks support this interpretation. On the

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Neanderthals from Chagyrskaya Cave *Quartär 66 (2019)*

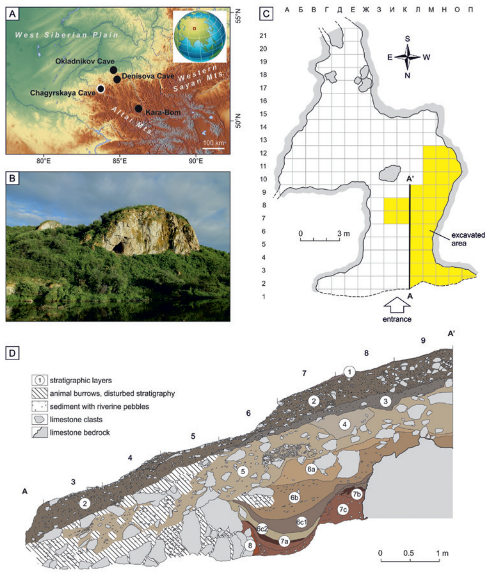

Fig. 1. Chagyrskaya Cave: A – localization of Chagyrskaya Cave and other Altai sites mentioned in the text; B – photograph of the cave entrance; C – plan of the cave with archaeological grid and excavated area; D – cross-section through the sediments along the A-A' line shown in the panel C.

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).

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Key style points: Figures and illustrations III

1 Workflow for the creation of a high quality object drawing for publication:

- Scan the drawings at grayscale modus at 600 dpi (or higher)
- Open the file in Photoshop
- Change from color to grayscale by opening the Drop-down menu (choose image/ mode/grayscale)
- Change from grayscale to Bitmap by opening Drop-down menu (choose image/ mode/bitmap)
- Save with resolution of 1200 dpi and 50 % threshold
- Don't forget a labeled scale bar !

2 When using Adobe Illustrator to label these bitmap figures, the following is crucially important:

- BEFORE importing a bitmap-file, you need to change the Document Raster Effects settings (Dokument-Rastereffekt-Einstellungen) to be found under the "Effects"-Menu. Change it to bitmap and set resolution 1200 dpi. Then import your bitmap file and put your labels, scale bar etc. in different layers.
- You may submit it as ai-file, with layers still separated.

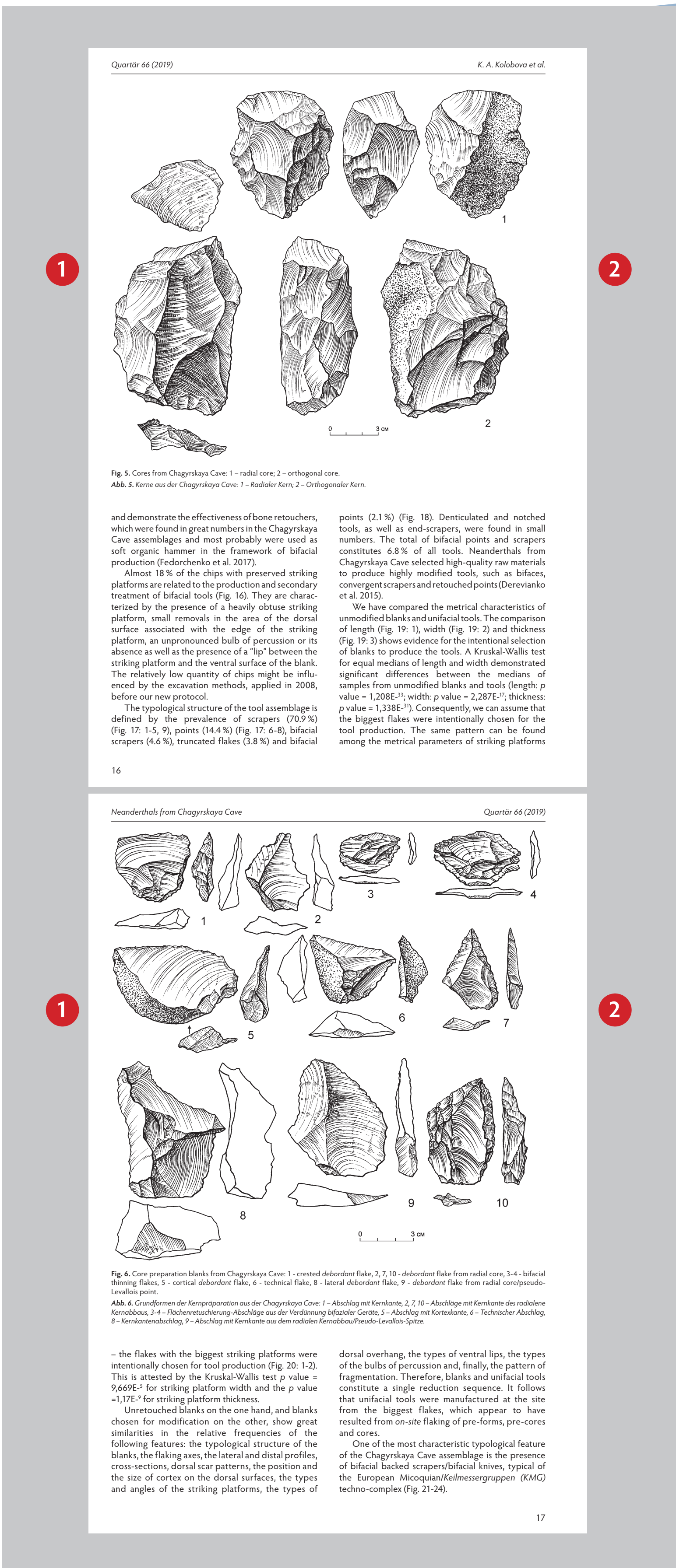

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Fig. 5. Cores from Chagyrskaya Cave: 1 – radial core; 2 – orthogonal core.
Abb. 5. *Kerne aus der Chagyrskaya Cave: 1 – Radialer Kern; 2 – Orthogonaler Kern.*

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).

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Neanderthals from Chagyrskaya Cave Quartär 66 (2019)

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).

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Key style points: References I

1 Each citation in text has to be in "Literature cited" section and vice versa.

2 List works by the same author(s) in chronological order, beginning with earliest date of publication. If more than one publication is from the same year, place in order by first citation in text; these works should be lettered consecutively (e.g. 1991a, b) and referenced as such in the text.

3 „In press" citations must have been accepted for publication, with the name of journal or publisher included, with year and volume number if known.

4 Journal article

5 Authored book & thesis

6 Edited book

7 Chapter in edited book

8 DOI numbers are not provided

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