

## RETOUCHERS FROM MAMMOTH TUSKS IN THE MIDDLE PALAEOLITHIC: A CASE STUDY FROM KŮLNA CAVE LAYER 7a1 (CZECH REPUBLIC)

### *Abstract*

The existence of retouchers made from hard animal tissues in the Middle Palaeolithic was first identified in the early 20<sup>th</sup> century, but only in recent years have researchers been paying more attention to this phenomenon. The overwhelming majority of retouchers are fragments of bones without modifications to the shape of the objects. In the collection of these *ad hoc* tools from the Micoquian layer 7a1 in Kůlna Cave (Czech Republic) we also identified two retouchers of mammoth ivory. So far, the use of this material for retouchers at Kůlna Cave remains unique in the Middle Palaeolithic of Europe. A diachronic comparison of Taubachian and Micoquian assemblages of hard animal tissues with anthropic impact suggests that the utilisation of mammoth ivory in the Micoquian was not just a random phenomenon, but it was probably related with the overall change in Neanderthal behaviour towards mammoths as a source of raw materials.

### *Keywords*

Micoquian; Taubachian; Mammoth tusk; Retoucher

### **Introduction**

Increasingly detailed analyses of archaeological and osteological materials from the European Middle Palaeolithic continue to bring evidence of premeditated manipulations of hard animal tissues, many of which are not directly linked with subsistence practices. Quite often, we encounter fragments of bones and teeth, and sometimes whole bones, bearing scratches on their surfaces resulting from use in lithic tool production. For the Middle Palaeolithic, this type of object was first described in the works by Henri-Martin (1906, 1907, 1907-1910), who identified retouchers at the well-known site of La Quina in

France. A comprehensive overview by Tauté (1965) and experimental analyses by Feustel (1973) and Chase (1990) are counted among the major contributions towards the identification and functional understanding of these items. A significant move towards the codification of retouchers was made in 2002, when the Commission de Nomenclature sur l'Industrie de l'os Préhistorique (Société Préhistorique Française) published an influential volume entitled *Retouchoirs, Compresseurs, Percuteurs... Os à Impressions et Éraillures*, which standardised the definitions and descriptions of these artefacts

**Table 1** Contextual data for retouchers of mammoth ivory from Kůlna Cave.

Inventory number	Field ID	Layer	Sector	Unit	Depth from recent surface	Cultural classification
106743	K-5698/66	7a1	G2	S/29-30	240-270 cm	Micoquian
107432	K-5261/66	7a1	G3	R/33-38	240-290 cm	Micoquian

(several authors in Patou-Mathis, 2002). Over the last few years, the issues of identifying these objects at Middle Palaeolithic sites and applying suitable documentary techniques have received considerable attention (e.g., Jaubert et al., 2008; Jéquier et al., 2012; Mallye et al., 2012; Khlopachev, 2013; Abrams et al., 2014; Daujeard et al., 2014; Mozota, 2015; van Kolfschoten et al., 2015; Moigne et al., 2016).

An important collection of retouchers made on hard animal tissues comes from the Middle Palaeolithic layers in Kůlna Cave (Moravian Karst, Czech Republic). The complex stratigraphy allows a diachronic study of how these *ad hoc* tools were used within two techno-complexes: Taubachian and Micoquian. Early on, Valoch (1988b) highlighted the existence of retouchers at Kůlna Cave, and he also correctly discriminated two items of mammoth ivory in layer 7a1 bearing scars resulting from retouching lithic tools (Table 1). Both items were mentioned in synthetic works on the use of bones in the Middle Palaeolithic (Vincent, 1993) and mammoth ivory in the Palaeolithic of Czechoslovakia (Oliva, 1995). In a detailed analysis of retouchers from the sites of Biache-Saint-Vaast (Pas-de-Calais, France) and Kůlna Cave, Auguste (2002) only referred to one mammoth ivory retoucher without a more detailed description. Likewise, later works only mention the objects (e.g., Tartar, 2004). Within the project “Neanderthals and modification of bones – interdisciplinary analyses and cultural implications”, which primarily focused on identification of non-utilitarian uses of hard animal tissues (Neruda et al., 2011), a new analysis of retouchers was performed on individual stratigraphic layers 11, 11c, 7c, 7a and 6a at Kůlna Cave, with due regard to both retouchers of mammoth ivory (see Table 1). The aim of the present study is to highlight anew the existence of

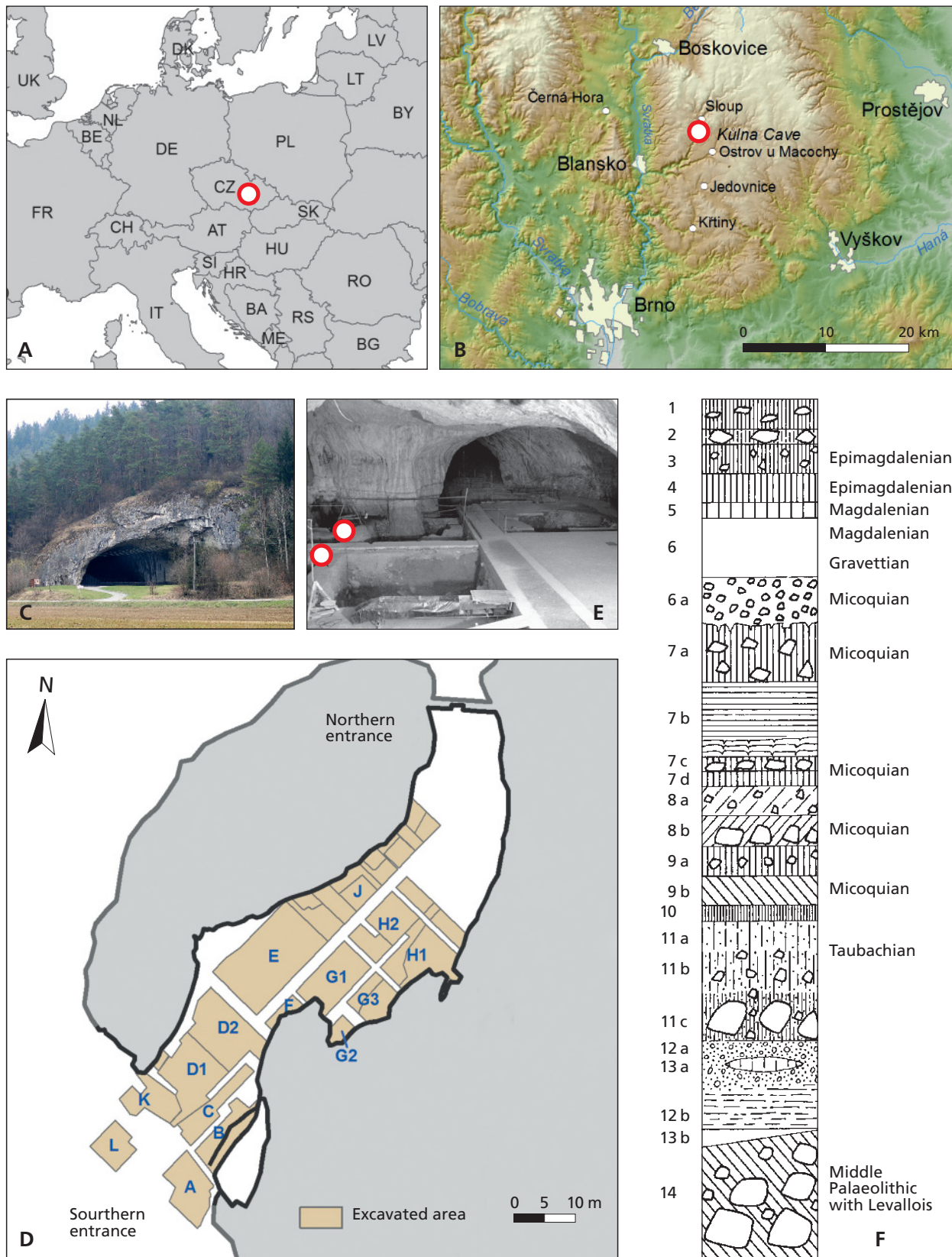
these unique objects, and put them in a broader context of the other retouchers and hard animal materials with anthropic impacts at Kůlna Cave.

### Kůlna Cave state of research

Kůlna Cave is located in the northern part of the Moravian Karst approximately 30 km from Brno, in the municipality of Sloup (Figures 1A, 1B). The vast, tunnel-shaped cavern has a large southwest-oriented portal and a smaller northern entrance (Figures 1C, 1D). The length of the cave is approximately 87-91 m; its maximum width is 25 m, and the maximum height is 8 m.

Extensive and systematic investigations at Kůlna Cave were undertaken in 1961-1976 by Valoch (1988b), who collected a considerable number of artefacts and established a chronostratigraphic division of the sedimentary record. A small part of the cave filling in sectors B and C was excavated in 1995-1997 (Valoch, 2002). The total explored area amounted to 900 m<sup>2</sup> (Valoch et al., 2011). Archaeological items were discovered mainly in the entrance (sectors A-D2, L and K) and central part of the cave (sectors E-G3; Figure 1D), whereas the area adjacent to the northern entrance (sectors H1-3) is archaeologically rather sterile, and was also greatly damaged during World War II (Břečka, 2011; Neruda, 2013).

In the course of his excavation, Valoch (1988b) differentiated a very complex stratigraphy; sector D comprised 14 geological layers with numerous sub-layers (Figure 1F). The inner part of the cave contained only part of the stratigraphic sequence (from layers 8/7c to 5), probably due to the morphology of the cave bedrock that indicates the rock step stretching across the space ca. 20 m from the en-



**Figure 1** Location of Kůlna Cave (circles) in Europe (A) and DEM of Moravian Karst (B) with the position of Kůlna Cave (created by P. Neruda); (C) view of the southern entrance of the cave (photo P. Neruda); (D) ground plan of the cave (created by P. Neruda); (E) view from the inner part of the cave to the southern entrance (photo K. Valoch) – circles indicate approximate position of retouchers; (F) ideal stratigraphic sequence of Kůlna Cave (modified from Valoch 1989, fig. 1).

trance. Due to heavily damaged stratigraphy during World War II it was impossible to follow distinct layers continuously from the southern entrance to the inner part of the cave. In such cases, Valoch (1988b) correlated layers according to their stratigraphical position in profiles and distinguished them using a denomination of sub-layers (e.g., 6a in the entrance and 6b inside to cave). The Middle Palaeolithic is recorded in the lower and middle part of the idealised sequence (**Figure 1F**), from layer 14 (probably end of MIS 6) to layer 6a (MIS 3), where we are able to distinguish three main techno-complexes.

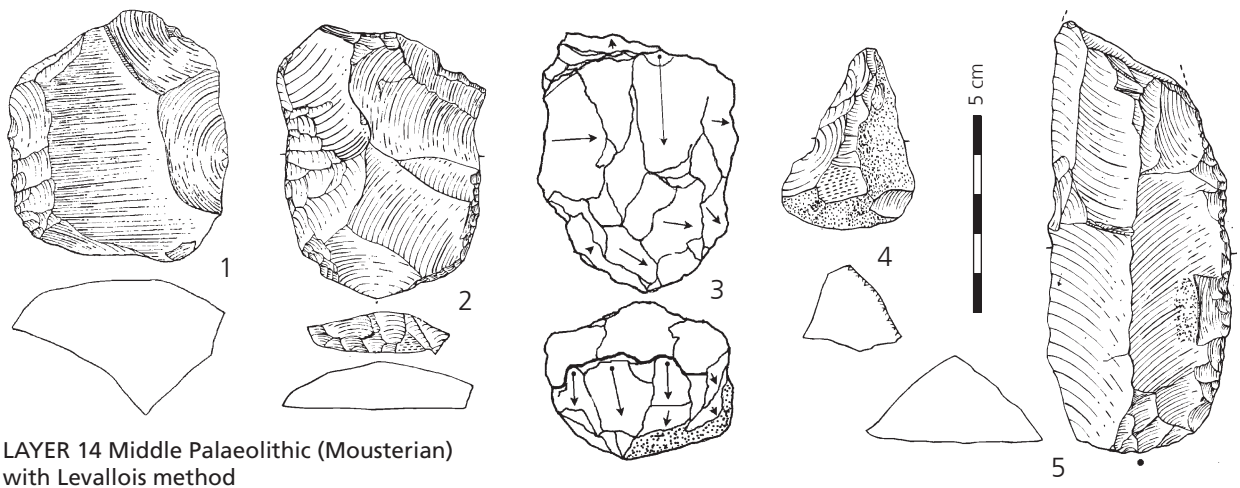
The lowermost layer 14 yielded a small lithic assemblage (100 pieces) classified as Middle Palaeolithic (Mousterian) with Levallois method. Besides Levallois cores and flakes (**Figure 2: 1-3, 5**), simple prismatic cores and archaic points (**Figure 2: 4**) were uncovered. Neanderthals used mostly local raw materials. Valoch (1988b, 1989) correlated this horizon with the end of the penultimate glacial. This layer was not included into the analysis due to the very limited area that was excavated.

The second techno-complex is represented by a Taubachian occupation of the cave (layers 13a-10). The largest archaeological assemblage was obtained from layer 11 and sub-layer 11c and encompassed lithic artefacts and faunal remains, including hard animal tissues with anthropic impacts (Valoch, 1984, 1988a, 1988b). The lithic artefacts (**Figure 2: 6-11**) are characteristically small in dimension, and the majority were made from quartz, quartzite, and spongolite originating from sources up to 15 km away. On the other hand, we noted raw materials from more distant sources (50-100 km; Neruda, 2001). In the manufacture of stone tools, Neanderthals used mainly the volumetric method for core reduction, specifically the discoid method (Boëda, 1993) in several variants (**Figure 2: 6, 8**; Moncel and Neruda, 2000; Neruda, 2011). Besides discoid cores *sensu lato*, simple prismatic-like cores were noted (**Figure 2: 7**). Cores are preserved in all stages of reduction (compare **Figures 2: 6, 8**). Among the tools, simple side scrapers (**Figure 2: 11**), notches and denticulates, and archaic points (**Figure 2: 9-10**) predominate (Valoch, 1984, 1988a, 1988b). The assemblage

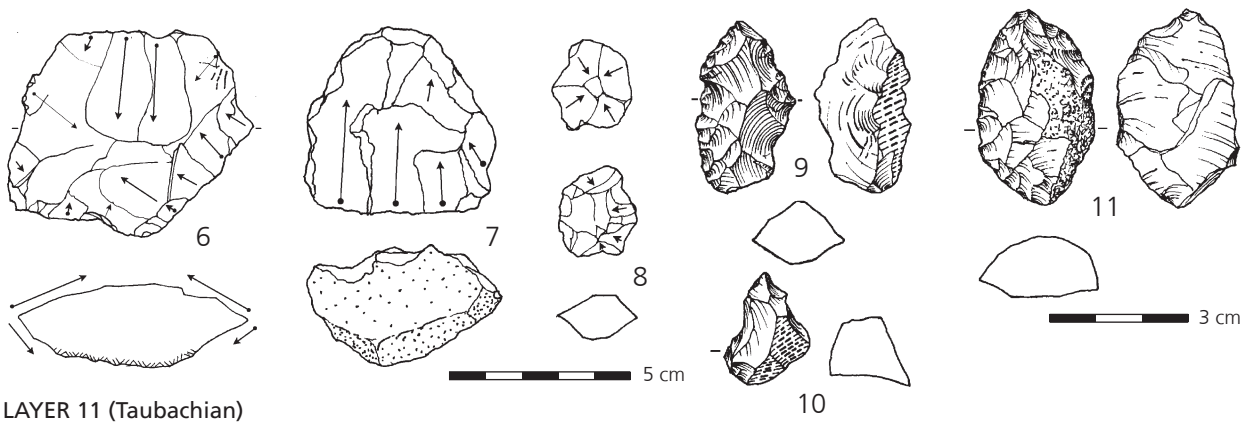
of hard animal tissues contains more than 60 retouchers made mostly from bones of large-bodied mammals (Auguste, 2002; Neruda et al., 2011). The cave probably served as a base camp. Based on malacological analysis and higher humus content in sediment layer 11 (Valoch et al., 1969), the Taubachian techno-complex (layers 13-10) dates to the end of the last interglacial or to the beginning of the last glacial (Valoch, 1989, 2002).

The third Middle Palaeolithic unit is the Micoquian occupation, recognised in layers 9b, 8a 7d, 7c, 7a and 6a. All layers contain typical Micoquian industries based on the reduction of volumetric discoid cores (mostly two types, **Figure 2: 12**), indicating the production of large flakes. Such blanks were modified into complex side scrapers (**Figure 2: 17**), often resembling bifacial knives (**Figure 2: 16**). Another *debitage* method is represented by blade production from Upper Palaeolithic-like cores (Neruda, 2010). The second important method of tool production is bifacial shaping: *façonnage* (Boëda, 1995) of bifacial side scrapers, hand-axes (**Figure 2: 18**) and especially bifacial backed knives in different stages of reduction, which can be considered as the *fossile directeur*. Raw material economy (Féblot-Augustin, 1993, 1997) was based on the exploitation of quality sources from minimal distances of about 10 km. We noted the decreasing number of raw materials from distant sources, indicating a different mode of mobility and economy, which, unlike the Taubachian, was more tied to the region of South Moravia (Neruda, 2010, 2011). In the Micoquian layers, bone tools are represented by retouchers from hard animal tissues (Auguste, 2002; Neruda et al., 2011). Layer 7a represents a base camp settled during the winter and early spring (Nerudová et al., 2014). Comparing all available data, we can codify two chronological markers within the Micoquian horizons in Kůlna Cave. Layer 9b is dated to 69 cal ka BP (ESR; Rink et al., 1996), and layer 7a was deposited around 50 cal ka BP (ESR and <sup>14</sup>C; Mook, 1988; Rink et al., 1996; Neruda and Nerudová, 2014).

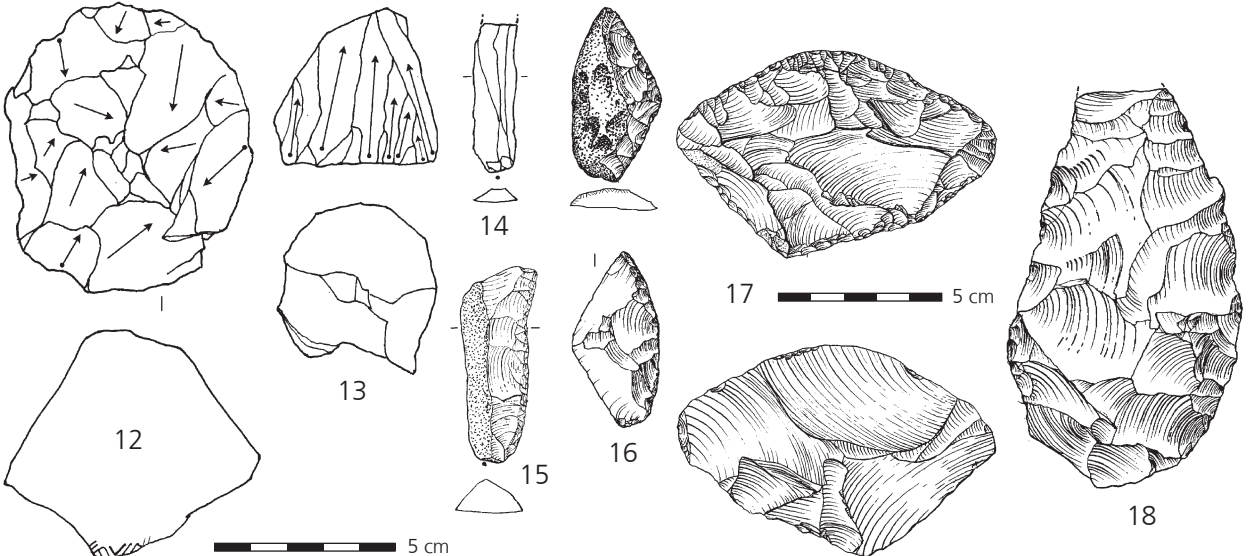




LAYER 14 Middle Palaeolithic (Mousterian) with Levallois method



LAYER 11 (Taubachian)



LAYER 7c - 6a (Micoquian)

Figure 2 Lithic artefacts from Mousterian with Levallois method (1-5), Taubachian (6-11) and Micoquian (12-18) layers.

## Materials and methods

For the analysis of the Middle Palaeolithic collections, we primarily utilised the well-stratified finds from Taubachian layer 11 and Micoquian layers 7c, 7a, and 6a. The processing of hard animal tissues was aimed to review the circumstances of recovery for all finds, using original field notebooks and drawings, in order to facilitate an analysis of the spatial distribution of the studied objects. The locations of all hard animal tissue finds with anthropic impacts and retouchers were compared with other groups of archaeological remains to evaluate the functions of find concentrations (Neruda, 2017). Taking into account that in the course of Valoch's excavations finds were localised into areas of varying sizes defined by the square metre grid it was not possible to precisely visualise the positions of most unearthed artefacts. In most cases, find places were defined by an area of several square metres. However, by means of randomised coordinates, we generated kernel density maps for various find groups, thereby defining the functions of the individual concentrations with greater accuracy; and, in the case of the two mammoth ivory retouchers, we were able to assess their positions within the spatial divisions of the cave.

Osteological analysis focused on taxonomic designations of the individual items of hard animal tissues. Because of a high degree of fragmentation of the material, in most cases it was only possible to determinate animal size groups. At the same time, we selected pieces eligible for bearing the designation of retouchers. Into this group, we included artefacts on which it was possible to observe a concentration of impacts (retouch scratches or *stigmata*), most often grouped into scar fields (use areas or *plages*) with varying sizes and shapes.

These pieces were verified and described using various methods of microscopic analysis. In the course of the analysis we concentrated on the objects in three stages: the physical properties of the hard animal tissue fragments, the morphology and morphometry of the areas of retouch damage, and the individual traces of retouching (Neruda et al., 2011). All pieces were examined using a Nikon

SMZ645 stereo zoom microscope. We applied both laser scanning electron microscope (LEXT) and scanning electron microscopy (SEM) for selected pieces of hard animal tissues with anthropic impacts. The ivory retouchers were documented by CT scans performed in the X-ray micro CT and nano CT research laboratory of the Central European Institute of Technology (CEITEC) in Brno. Both pieces were scanned using 120 kV voltage, 350  $\mu$ A current, and 85  $\mu$ m resolution.

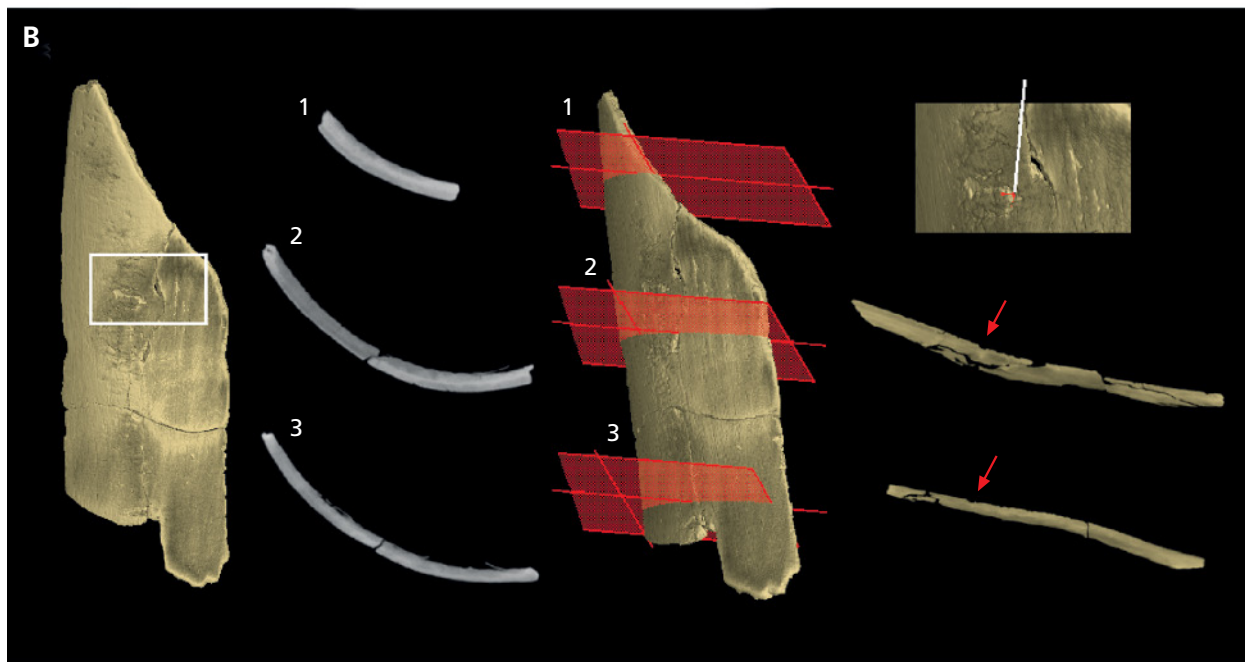
To calculate the diameters and radii of curved parts of the retouchers we applied the circular arc method. Radius ( $r$ ) was calculated using the formula  $h/2+c^2/8h$ , where  $c$  stands for width of the arc and  $h$  is its height measured at the midpoint along the base of the arc. These results must be taken as approximate values, since the amount of post-depositional changes cannot be determined with certainty. One of the retouchers had been glued together from four parts, and as the contact areas are very thin, we cannot exclude a minor deflection in the arc radius. Simultaneously, it is possible that the arc radius might have been altered because of the pressure exerted by the sediment in which it was deposited. Deviations linked with both post-depositional deformations and the precision of the measurements are quite standard for this type of calculation, since a deviation of arc height on the order of 0.5 mm will result in up to a 2 cm difference in the radius of the measured arc.

## Results

### *Description of retouchers from mammoth ivory*

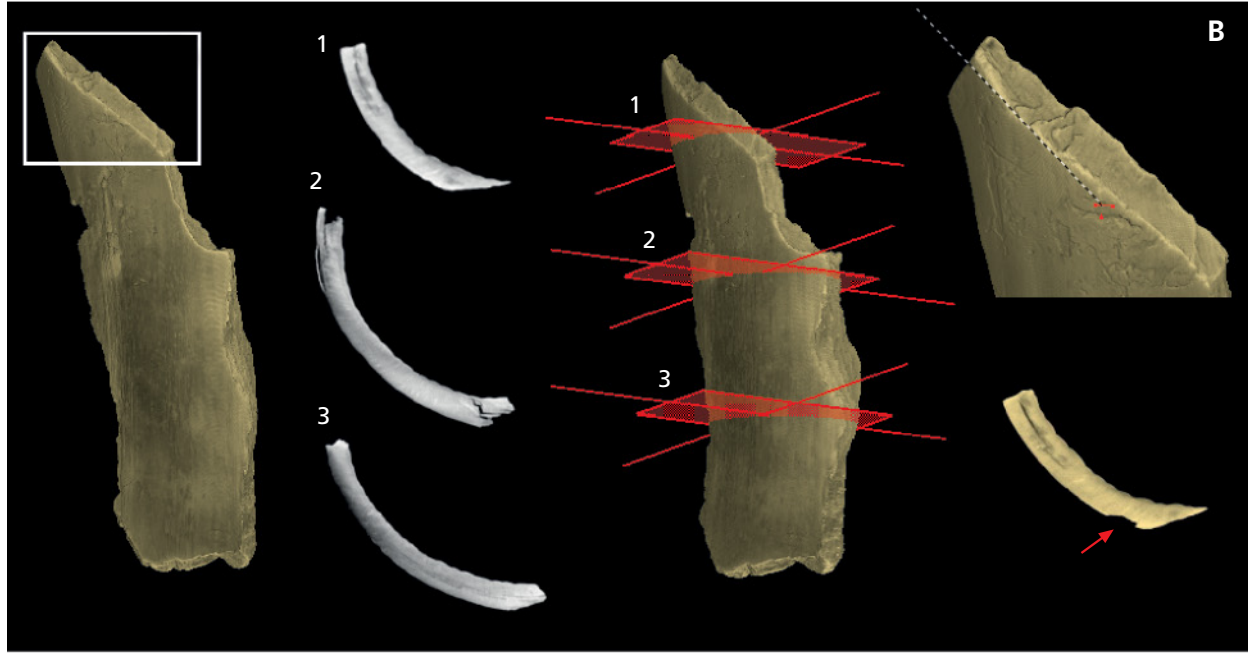
#### ID 106743

The retoucher ID 106743 (Table 1; Figure 3) is a fragment of a thin, convex-concave layer of ivory glued together from four parts. The maximum preserved length and width are 125.3 mm and 44.2 mm, respectively. The thickness of the layer varies from 1.71 to 3.35 mm. The convex side of the artefact bears two types of *stigmata* indicative of scla-



**Figure 3** Retoucher 106743 from a mammoth tusk: (A) inverse and reverse of the retoucher (photo K. Jursa), (a) detail of a scar field (8x), (b) scraping (8x); (B) CT scan.





**Figure 4** Retoucher 107432 from a mammoth tusk: (A) inverse and reverse of the retoucher (*photo K. Jursa*), (a-b) detail of a scar fields (8x), (c) preservation of the artefact surface (8x); (B) CT scan.



ping, and a grouping of use-wear scars perpendicular to the long axis of the artefact. The concave side is without traces of anthropic impact.

The state of artefact surface preservation is poor and repair of the object is not precise. Both glue and a thick layer of protective finish, which permeates the ivory and partly fills out grooves and retouch scars, impede more detailed observation. The finish peels off on the concave side. The artefact also suffered a recent fracture on its proximal end.

Reconstructed diameter of the original tusk amounted to 65-70 mm in the middle part of the retoucher. On its longitudinal axis, the retoucher is concave, with a curvature diameter of ca. 660 mm. This calculation may be slightly distorted because of inaccurate joining of the object from several parts.

Fracture edges are markedly smoothed in its distal (convergent) part and on both edges. At the proximal end, the thinnest part of the retoucher, fractures are due to post-depositional damage. A recent fracture is apparent in the lower left portion of the object as shown in **Figure 3**.

One edge of the object on the convex side bears traces of scraping in the form of long grooves on the surface. We also observe a continuous scar field related to retouching lithic tools situated along the entire longitudinal axis, slightly offset from the apical extremity. On the opposite extremity (proximal), the scar field is damaged by the previously mentioned fractures.

The entire scar field is indicative of intense use, since the individual scars overlap. The scar field can be divided into two zones with the highest concentration of marks: the upper third of the object and its apical convergence.

ID 107432

The artefact ID 107432 (**Table 1**; **Figure 4**) is preserved in the form of a fragment, one layer of mammoth ivory, with a maximum length of 157 mm and 52.8 mm width. The thickness of the layer varies between 4.1 mm and 4.7 mm.

Retouch scratches resulting from use are concentrated in the scar fields near the fracture edge on

the convex side of the artefact altered by dry transport (*charriage-à-sec*; d'Errico and Giacobini, 1988); the concave side bears no use traces.

The diameter of the tusk from which the artefact originates measured 48-58 mm at a minimum. In its longitudinal axis, the retoucher is concave, with a curvature diameter amounting to ca. 680 mm.

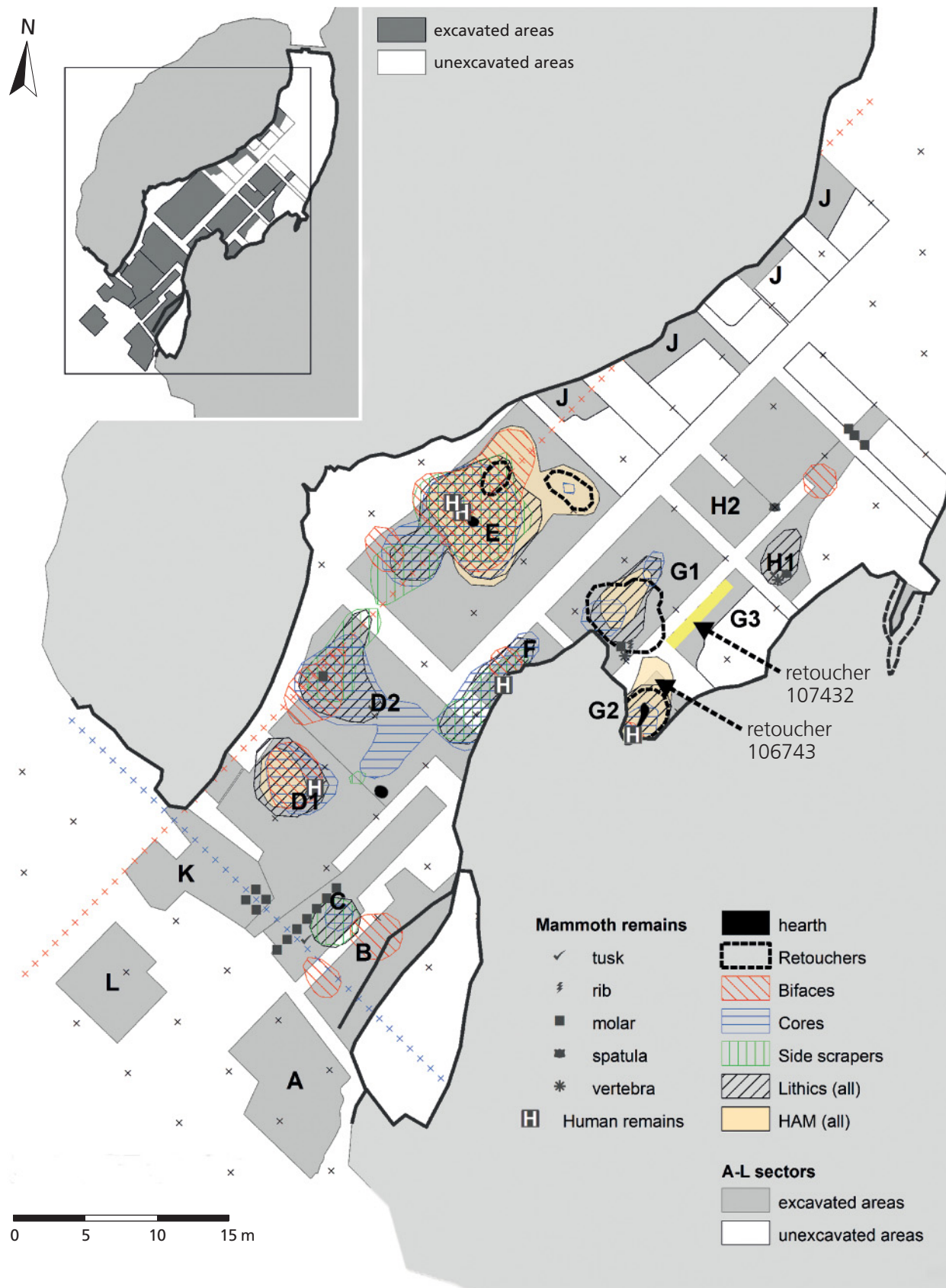
A preservative substance peels off only in the upper third of the item on the convex side, close to the left edge near the recent fracturing, as shown in **Figure 4**, which was probably caused during excavation. Except for this area, the edges are slightly smoothed. In the distal part of the object the edges are convergent, and the apex is shifted off-centre towards the left side. In the central part of the right edge, and in its lower third, the original surface of the convex area of the object has been broken off. In this case, the breakage surface is coarse and exposes the laminated ivory structure.

The surface on the outer, convex side of ivory is preserved in two hues: light ochre in the distal part of the object and grey-brown in the remaining two thirds. These dissimilar colours may correspond with different sediment chemistry during various stages of exfoliation. The part of the tusk that escaped decomposition was "protected" against the sediments and its colour remained unaltered (C. Heckel, personal communication). Chemical alteration of hard animal tissues was likewise observed during the previous excavations in Kůlna Cave (Patou-Mathis et al., 2005; Michel et al., 2006a; Michel et al., 2006b).

Contrary to the first artefact (ID 106743), retouch scratches do not form a continuous scar field; instead, they are scattered over the surface. We can identify a single concentration near the margin of the sloping edge in the distal part of the piece.

### Archaeological context

Both objects can be incorporated into the spatial analysis of find distributions in layer 7a, or 7a1 (Valoch, 1988b; Neruda, 2017). According to field notebooks, retoucher number 106743 was situated within the area of squares S/29-30 in sector G2



**Figure 5** Spatial distribution of distinct groups of finds in layer 7a (7a1). Arrows and the yellow strip indicate the area where retouchers were found.

and retoucher 107432 within area R/33-38 in sector G3 (Figure 5). If we look into the composition of artefacts in the nearest accumulations, it becomes evident that a number of activities took place in this part of the cave (including sector G1), many of which were linked with the production of lithic tools.

In sector G2, a concentration of hard animal tissues with anthropic impacts was noticed, which also included a marked presence of bone retouchers and one ivory retoucher (ID 106743). Their application might relate to the production of bifacial artefacts, which are relatively abundant in this sector (Neruda, 2017). The production of tools and/or their reutilization was carried out around the elongated combustion zone in this area of the cave.

The location of the second ivory retoucher (ID 107432) is less precise, falling within an area of 6 x 1 m in sector G3, as the finds from this area were merged together by Valoch. The closest accumulation of retouchers of hard animal tissues was found in sector G1, where mainly lithic flakes and cores occurred. However, a more significant representation of side scrapers and bifacial artefacts that were produced using retouchers of hard animal tissues was found missing in the area. Consequently, this could be the location where the entire process of tool manufacture, from exploitation of blanks through retouching, took place, but the tools were used and deposited at another place within the cave (Neruda, 2017).

## Discussion

### *Problem of a contamination*

First we must ask whether the unearthed retouchers from mammoth ivory are indeed linked with Neanderthal activities in the Middle Palaeolithic. Kříž (1903) found a small ivory cylinder ornamented with tiny indentations in trench VI, which was situated in what is now sector G2. Therefore, we come to a possibility that the ivory retouchers in the Middle Palaeolithic layers may represent a more recent contamination.

Currently we are no longer able to correlate Kříž's trenches with the stratigraphy defined by Valoch, mainly because the original ground level in the G sectors had been removed prior to the construction of a factory during World War II (Břečka, 2011). However, analysis of remnant sediments on the cave walls (Neruda, 2013) revealed that the original surface was situated 1 m above the factory floor, i.e., more than 1 m above the upper level of the original, intact sediments studied by Valoch. Kříž's discovery was reported to have come from a depth of 0.95 m. This would lie above the level of the uppermost layers under the concrete floor, from which Valoch measured find depths during his excavations. Both ivory retouchers were discovered at a depth exceeding 2.4 m (see Table 1), i.e., at least 3.4 m from the original Holocene surface of the cave. This clearly rules out any contamination from more recent layers excavated by Kříž.

The fact that layer 7a1 is separated from the uppermost Middle Palaeolithic layer 6a and from the lowermost Upper Palaeolithic layer 6 containing both Gravettian and Magdalenian finds, is also of importance. Although in some parts of the cave (e.g., the southern entrance) it is difficult to make a lithological differentiation of layer 6a from Upper Palaeolithic sedimentation (Lisá et al., 2013; Neruda and Nerudová, 2014), in the G sectors that yielded the retouchers, the Middle Palaeolithic layer 6a can be clearly differentiated from the Upper Palaeolithic sequence. Layer 7a, also comprising layer 7a1 inside of the cave, does not show any contaminations with more recent material in the outcomes of <sup>14</sup>C dating (Neruda and Nerudová, 2014). The technological and morphological character of the retouchers is also in correspondence with these conclusions, since we are not aware of this type of *ad hoc* tool in the Upper Palaeolithic material of Moravia. Perhaps the most similar artefact is a bone with impact scars from the Magdalenian sequence in Pekárna Cave, but the scars in this item are oriented more or less parallel to the longitudinal axis of the bone fragment; therefore, its function may have been different (Lázničková-Galetová, 2010). Yet, research focused directly on the identification of retouchers in



Upper Palaeolithic assemblages may reveal other examples. Such items from the sites of Geißenklösterle Illa and Vogelherd in Germany, or Isturitz in France, stand as evidence (e.g. Taute, 1965; Leroy-Prost, 2002; Schwab, 2002; Conard et al., 2006; Wolf, 2015; Camarós et al., 2016).

### *Synchronic and diachronic comparison*

The ivory retouchers bring about the issue of human and mammoth interactions at Kůlna Cave. The appearance of retouchers can be explained by random choice of this material from the remains of hard animal tissues found within the cave. Nevertheless, in Kůlna we have the option to study the utilization of hard animal tissues both from synchronic (comparing raw materials) and diachronic (Taubachien vs. Micoquian) perspectives, which can be helpful for interpreting these finds.

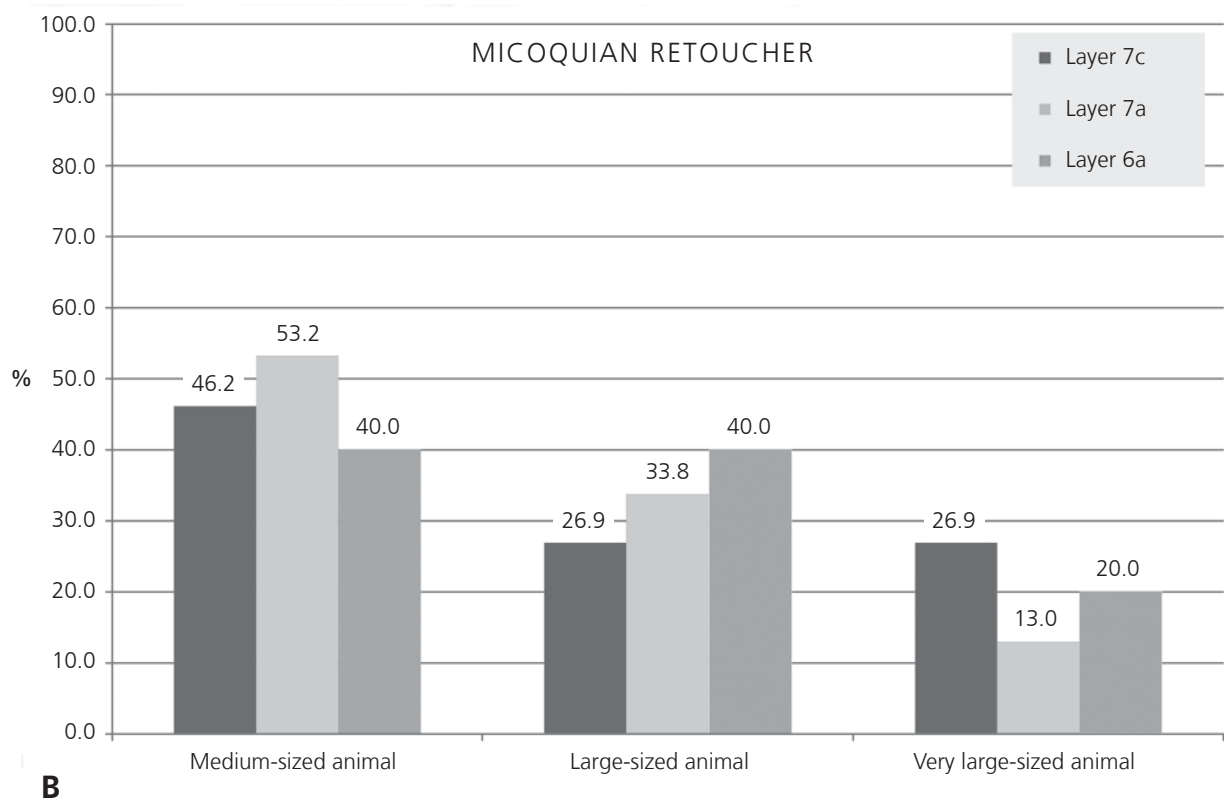
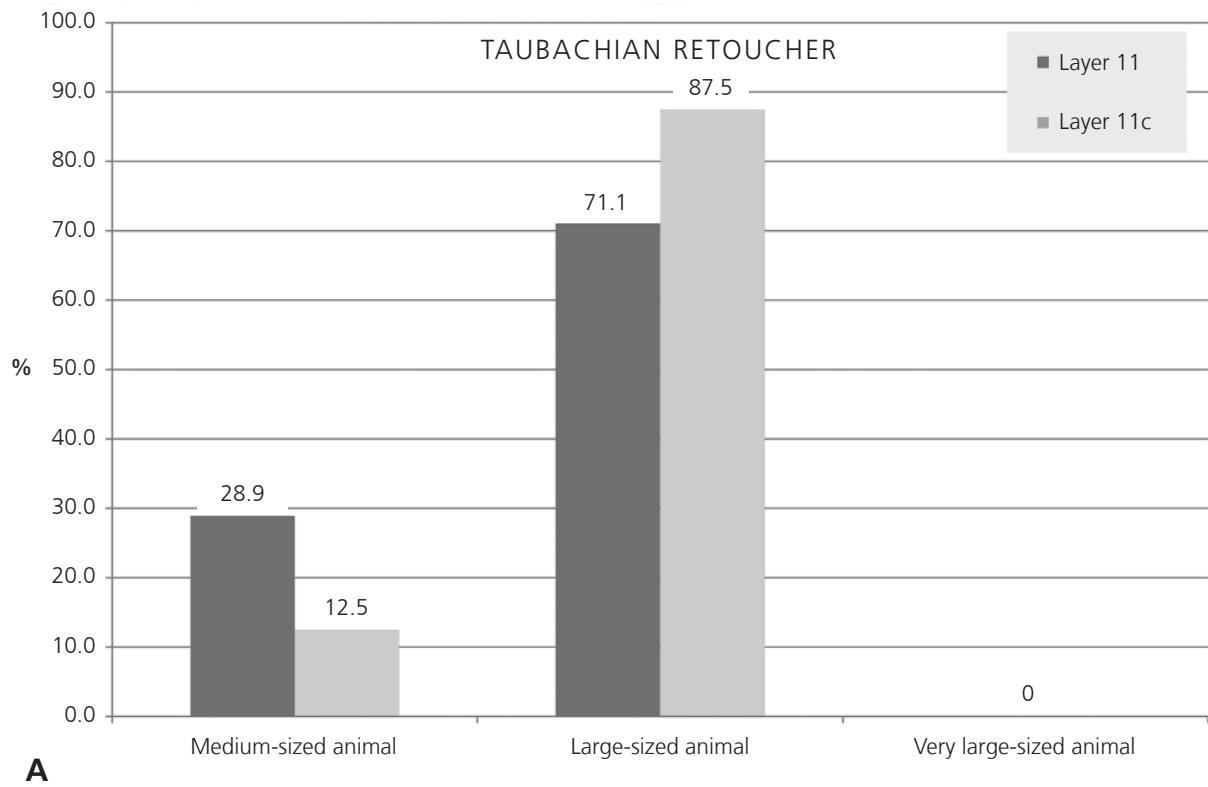
Interestingly, the assemblages of non-ivory retouchers from the Taubachian and the Micoquian are very similar, in that primarily fragments of long bones were used in both techno-complexes. On the surfaces of the retouchers, we can often observe sub-parallel grooves running along the longitudinal axis of the object (scraping). Auguste (2002) recognised differences in the use of blanks in the Taubachian, with a prevalence of metapodials, and the Micoquian, with tibias prevailing; however, these differences are only a matter of several per cent. Likewise, morphometric differences cannot be applied as distinctive features for classifying individual pieces to Taubachian or Micoquian assemblages (Neruda et al., 2011). Similarly, Auguste (in Patou-Mathis et al., 2005) observed the absence of significant differences between the Taubachian and Micoquian sequences in his summary of the Middle Palaeolithic layers from Kůlna Cave.

More essential differences are connected with taxonomic identification of hard animal tissue fragments used for retouching lithic tools. Auguste (2002) states that the use of bison (*Bison priscus*) bones is typical for the Taubachian, whereas mainly reindeer (*Rangifer tarandus*) were utilised in the Micoquian. In general, this corresponds to the com-

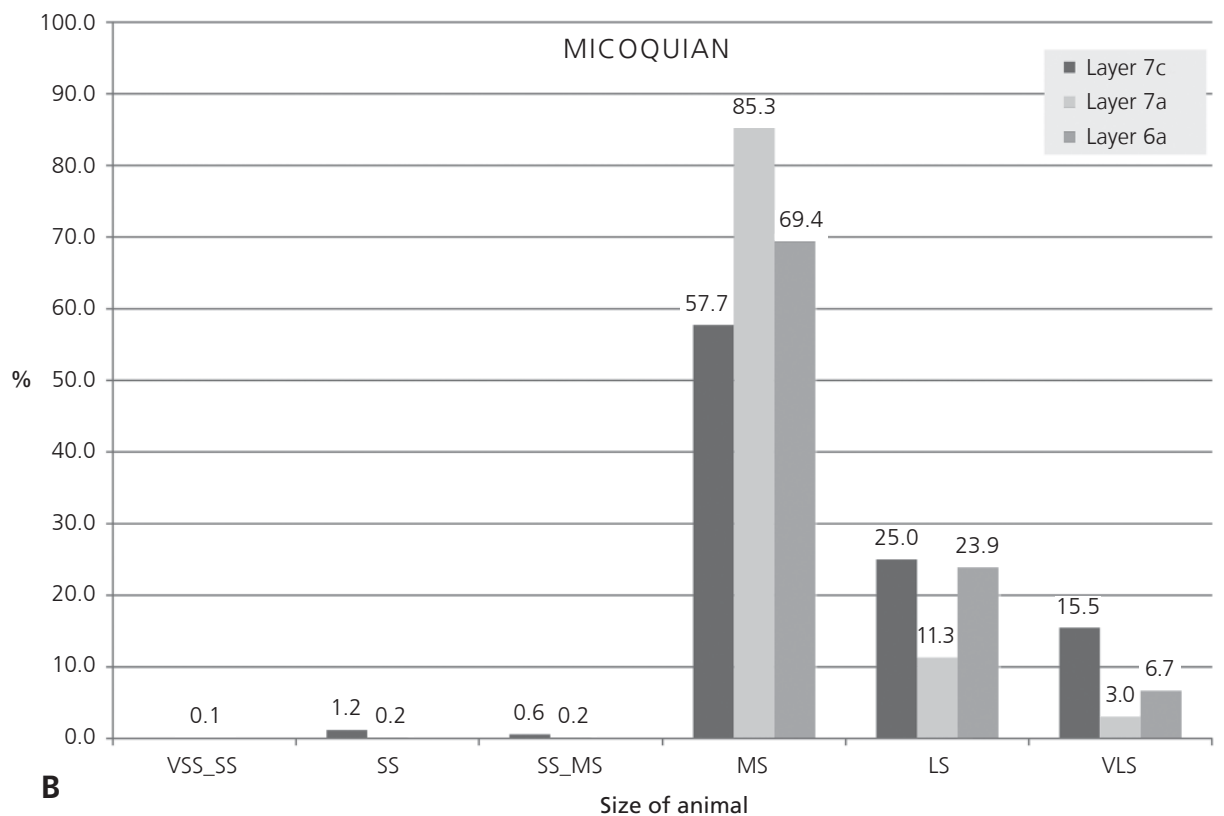
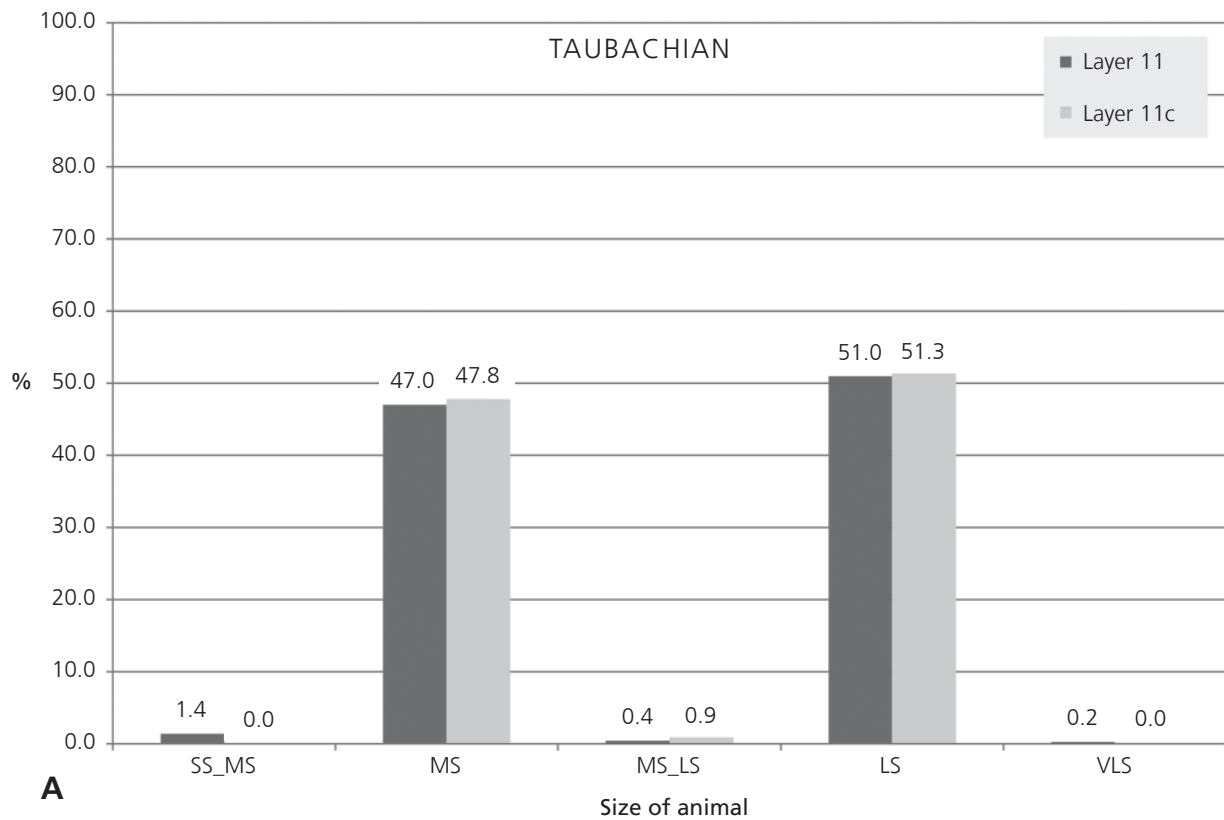
parison of size categories we carried out in relation to the great degree of fragmentation of the faunal remains in both techno-complexes (Neruda et al., 2011). For the Taubachian (**Figure 6A**), large animals such as bison (~70%) prevail, whereas medium-sized animals represent less than 30%. The use of very large animals, like mammoth or rhinoceros, was not recorded. In contrast to Auguste (2002), we hold the opinion that this comparison suggests a certain selection of blanks. In the collection of all hard animal tissues with anthropic impacts from the Taubachian sequence (**Figure 7A**), the ratio of medium (47%) to large animals (51%) is more or less balanced. At the same time, it is apparent that although the Taubachian sequence yielded remains of very large animals, evidence of their utilisation is missing. Moreover, the percentage in the graph is markedly lower, since in the entire osteological collection consisted mainly of mammoth molars, on which we are unable to detect intentional anthropic modifications. A conspicuous increase of large animals in the retoucher group and a total absence of very large animals indicates that Neanderthals indeed had certain preferences, perhaps related with compact bone thickness or total retoucher weight.

In the Micoquian we observe different strategies in the use of blanks, and the principal trends are the same in all studied layers 7c, 7a, and 6a (Neruda et al., 2011). Among retouchers, fragments of long bones from medium-sized animals prevail (**Figure 6B**), which is in conformity with Auguste's (2002) conclusions. The share of large animals is much smaller than in the Taubachian, but retouchers from bones of very large animals appear (Neruda et al., 2011). In this case, it is perhaps impossible to refer to a specific selection of blanks (cf. Auguste, 2002), since in the entire assemblage of hard animal tissues the trend is the same, the difference being the markedly higher prevalence of medium-sized animals (**Figure 7B**).

The relevant fact concerning the Micoquian collection is an increase in the proportion of very large animals, including mammoth, which is also manifested in the assemblage of retouchers. Importantly,



**Figure 6** Percentage of animal size groups in assemblages of retouchers.



**Figure 7** Percentage of animal size groups in assemblages of hard animal tissues. SS – small-sized, MS – medium-sized, LS – large-sized, and VLS – very large-sized animals.



these animals are not represented only by teeth that could have been sought by Neanderthals as curiosities, but long bones and ribs appear as well (Neruda et al., 2011). This could indicate a change in the interaction between humans and mammoths occurring in the Micoquian, not only at the technological level as a source of blanks for retouchers used in the manufacture of lithic tools, but also as a major constituent of subsistence strategies arising in the Late Middle Palaeolithic (e.g., Patou-Mathis et al., 2005; Bocherens, 2009). The high proportion of very large herbivores, such as woolly rhinoceros and woolly mammoth, in the Saint-Césaire I (France) Neanderthal diet, when viewed in comparison to that of the scavenging hyenas, suggests that Neanderthals could not acquire these animals entirely through scavenging; they probably had to hunt for proboscideans and rhinoceros (Bocherens et al., 2005). Due to the considerable fragmentation of mammoth bones in the Micoquian sequence in Kůlna, which can be related to acquiring highly nutritive tissues (e.g., Patou-Mathis, 1995; Bocherens et al., 2001; Sorensen and Leonard, 2001; Marean, 2005; Snodgrass and Leonard, 2009), it seems probable that mammoths constituted a valuable source of food at Kůlna Cave. Whether these very large animals were acquired through hunting or scavenging during the Micoquian at Kůlna Cave could not be determined (Patou-Mathis et al., 2005).

The approach of Neanderthals to these animals must have been different in the Taubachian. Theoretically, the absence of retouchers of hard tissues from very large animals, like mammoth and rhinoceros, could be explained by ecosystem requirements of these animals. The Taubachian sequence falls roughly into the terminal period of the last interglacial or to the beginning of the last glacial, with a rather forested environment related to a warmer climate. On the contrary, we generally associate mammoth and rhinoceros with cold steppes during cold phases of glacial periods. Had this been the case, the remnant tissues of these animals must have been manuports, collected as curiosities randomly found in the sediments of the Moravian Karst. Some studies show, however, that the behaviour

we assume for Pleistocene animals could have undergone significant changes, and that mammoths might have occurred also in forested environments of the last interglacial (e.g., Bocherens, 2014). Consequently, the Taubachian hunters could have had opportunities to use relatively fresh tissues of these animals, acquired by scavenging at the very least, and made them part of the subsistence and technological chain similarly to the Micoquian hunters later on. But, for the time being this does not seem to have been the case.

A change of human behaviour towards mammoths or other very large herbivorous animals could have been expressed at the non-utilitarian level. It is interesting that in Kůlna Cave Micoquian layer 7 $\alpha$  (equivalent of layer 7c in sector F) Valoch (1988b) discovered three mammoth tusks hidden in a vertical cavity. He excluded their natural deposition (K. Valoch, personal communication); thus, the only explanation is that for some reason the tusks were deposited into the cavity directly by Neanderthals. Regrettably, due to their poor preservation, the tusks were taken out incomplete (Valoch et al., 2011) and are not eligible for analysis to identify any intentional modifications. Nevertheless, it is important to point out that the share of mammoth remains with anthropic impact is the highest in layer 7 $\alpha$  compared to other Micoquian layers.

The retouchers from layer 7a1 open up yet another important issue about whether Neanderthals developed some specific technology for processing mammoth ivory. Similar to bone material, scraping marks were found on the surface of the ivory retouchers. Grooves were also noted on the surfaces of other preserved tusk fragments from Kůlna (Vincent, 1993; Oliva, 1995). On the thin layers of ivory from which retouchers are produced, the modifications related to shaping are difficult to decipher. It seems that Neanderthals were able to produce fragments of ivory by means of dynamic fracture. Such modification is demonstrated from the Middle Palaeolithic horizon at Hohlenstein-Stadel, Germany (Kind et al., 2013), where two pieces of mammoth tusks about 17 cm long are altered to form a chisel-like shape on both ends.

On the other hand, it is obvious that processing of teeth for use as retouchers is more likely a phenomenon of the Upper Palaeolithic. Aurignacian horizons AH IV and AH V at Vogelherd (Germany) yielded retouchers of ivory that are similar to Middle Palaeolithic artefacts (Wolf, 2015). From the Aurignacian layers of other sites in the Swabian Jura, we have some evidence that modern humans also utilised canine teeth of carnivores as retouchers (e.g., Taute, 1965; Hahn, 1977; Leroy-Prost, 2002; Camarós et al., 2016).

Prior to comparing the Middle and Upper Palaeolithic treatment of ivory, it is necessary to comprehensively analyse individual pieces of ivory with the aim of determining how this material was modified and to define the possible technological *chaîne opératoire* as precisely as possible. Thereafter, it would be worthwhile to assess whether there were technological innovations exclusive to Neanderthals. Research on materials from the Micoquian horizons can be crucial in this respect. According to our findings so far, the Kůlna Cave ivory retouchers come from the period preceding the arrival of modern humans; therefore, the creation of these implements was not influenced by the process of acculturation (for discussions on the Middle/Upper Palaeolithic transition, see Conard, 2006a; Conard 2006b; Svoboda, 2006; Smith, 2008; Higham, 2011; Nigst, 2012; Neruda and Nerudová, 2013; Conard and Bolus, 2015; Davies et al., 2015).

## Conclusion

Numerous retouchers come from both Taubachian and Micoquian layers in Kůlna Cave. In the Micoquian period, remains of hard tissues of mammoth or some other very large animal were also used for retouching. At present, the two retouchers of mammoth ivory are unique to the Middle Pleistocene at Kůlna Cave. Both objects were found in an area of the cave where retouchers of other hard animal tissues were recovered. These locations were areas of lithic tool production or reutilization, and both ivory retouchers played a role in those activities.

From the comparison of animal size categories in the assemblage of other hard animal tissues, a marked change in the relation of Neanderthals and mammoths occurred in the Micoquian, not only in terms of technology, but also on subsistence and symbolic levels. With regard to the age of the Kůlna Micoquian layers, these findings can contribute to future discussion on the mental capacities of Neanderthals and their interactions with anatomically modern humans.

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