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## EXPECTED AND UNEXPECTED RESULTS FROM <sup>14</sup>C DATING AND ZOOMS ON A LATE UPPER PALAEOLITHIC OSSEOUS PROJECTILE POINT FROM THE NOVÁ DRÁTENICKÁ CAVE IN THE MORAVIAN KARST (CZECH REPUBLIC)

### ABSTRACT

This contribution presents new information on a long-known Late Upper Palaeolithic site in the Moravian Karst in the Czech Republic: the Nová Drátenická Cave. Previous interpretations of the peculiar archaeological assemblage oscillated between attribution to the Epigravettian on the one hand and to the Magdalenian on the other, as both industries were present in Moravia

after the end of the Last Glacial Maximum. In either case, a rather early dating has been supposed. We reassessed the stratigraphy, lithic and osseous industry, and subjected an antler projectile point to <sup>14</sup>C dating and palaeoproteomic analysis. We did not find any evidence for stratigraphic mixing and, thus, propose that the assemblage of Nová Drátenická reflects a single or several successive occupa-

tions. On typo-technological grounds, we come to the conclusion that the finds are rather consistent with the Magdalenian. The radiocarbon date of the point is 16–15.7 ka cal BP, which places it in the first half of GS-2a. This is congruent with the identification of the raw material as reindeer through ZooMS. Hence, the Nová Drátenická Cave currently provides the earliest solid evidence for the

Magdalenian in the Moravian Karst. Together with the contemporaneous assemblages of Kniegrotte in eastern Germany, Dzierżysław 35 in southern Poland, and potentially also Vilshofen-Kuffing in south-eastern Germany and Hranice in Moravia, it probably attests to the first major expansion of the Magdalenian into eastern Central Europe at around 16 ka cal BP.

**Keywords:** Central Europe, Magdalenian, 14C chronology, ZooMS, FTIR, osseous industry, lithic industry

## Introduction

In 2009, Gerhard Bosinski contributed to a *Festschrift* offered to Stefan Karol Kozłowski with a paper discussing lithic-backed bladelets attached to organic projectiles of the Magdalenian. As an instructive example, he chose a set of three similar grooved antler points from the Nová Drátenická Cave in the Moravian Karst.<sup>1</sup> Since their discovery, these three points have been featured repeatedly in studies on the Late Upper Palaeolithic of Central Europe, sparking controversies regarding their age and cultural attribution because of their intriguing appearance, obvious interrelatedness, and characteristic morphology.<sup>2</sup> Within the extensive corpus of Central European Magdalenian osseous projectile points, the pieces from Nová Drátenická with their distinct combination of base morphology, arrangement of longitudinal grooves, and tip geometry are clear outliers.<sup>3</sup> Karel Valoch was well aware of this and assumed that the osseous and lithic assemblage from Nová Drátenická might in fact be attributable not to the Magdalenian but to the Epigravettian.<sup>4</sup> Gerhard Bosinski, on the other hand, interprets the Nová Drátenická points as a rare variety of Upper Magdalenian (16/15 ka cal BP) osseous projectiles.<sup>5</sup> Another facet to the discussion was added recently when a paper on the recolonisation of Central Europe after the Last Glacial Maximum highlighted some remarkable similarities between the Nová Drátenická points and certain published osseous projectiles from the early Epigravettian of Eastern Europe that date to the Last Glacial Maximum (c. 25–19 ka cal BP).<sup>6</sup> Based on this observation, it was stated that “this speaks in favour of a relatively early occupation of Nová Drátenická”.<sup>7</sup>

It becomes clear that there can be two mutually inconsistent vantage points on this site: firstly, in terms of

chronology (LGM vs post-LGM); and secondly, in terms of cultural attribution (Magdalenian vs Epigravettian). Our contribution in memory of Stefan Karol Kozłowski aims to revisit Nová Drátenická and discuss the pending questions of its dating and position within the Pleniglacial cultural landscape of eastern Central Europe through new physical age determinations and palaeoproteomics, as well as a revision of stratigraphy and the lithic and osseous assemblages of this and selected other sites.

## Nová Drátenická Cave site: excavation history, stratigraphy, and previous numerical dating

The Nová Drátenická Cave (ID 1119)<sup>8</sup> is situated in the middle part of the Moravian Karst (Fig. 1A–B) in Moravia, the Czech Republic, in the cadastre Březina u Křtin on the left bank of the stream Křtinský potok. Several small caves (e.g. Drátenická and Žitného) are situated in a prominent limestone cliff while the largest cave system on the left bank, the Výpustek Cave, with two natural and two artificial entrances, is located approximately 200 metres to the south-west of the cliff (Fig. 1D).

The Nová (New) Drátenická Cave belongs to a cave system consisting of a lower (Nová Drátenická) and upper floor (Stará Drátenická – Old Drátenická). The front part of Nová Drátenická, named Krápníkový kout (Stalactite Corner), is located 393 metres a.s.l. and 12 metres above the Křtinský potok stream. It has a natural entrance facing to the north (Fig. 1C). The entrance, originally filled with sediments (Fig. 2b), is 1.0–1.5 metres wide and gradually extends to where the Palaeolithic remains were found – the Stalactite Corner, which is 8–10 metres wide. From the rear part of this area, a cor-

<sup>1</sup> Bosinski 2009.

<sup>2</sup> E.g. Bosinski 2007; Klíma 1949; Maier *et al.* 2020; Valoch 1979; 1996; 2001; 2010.

<sup>3</sup> Cf. Pfeifer 2021.

<sup>4</sup> Valoch 1996; 2001; 2010.

<sup>5</sup> Bosinski 2009.

<sup>6</sup> Maier *et al.* 2020.

<sup>7</sup> Maier *et al.* 2020, 437.

<sup>8</sup> Musil (ed.) 1993.



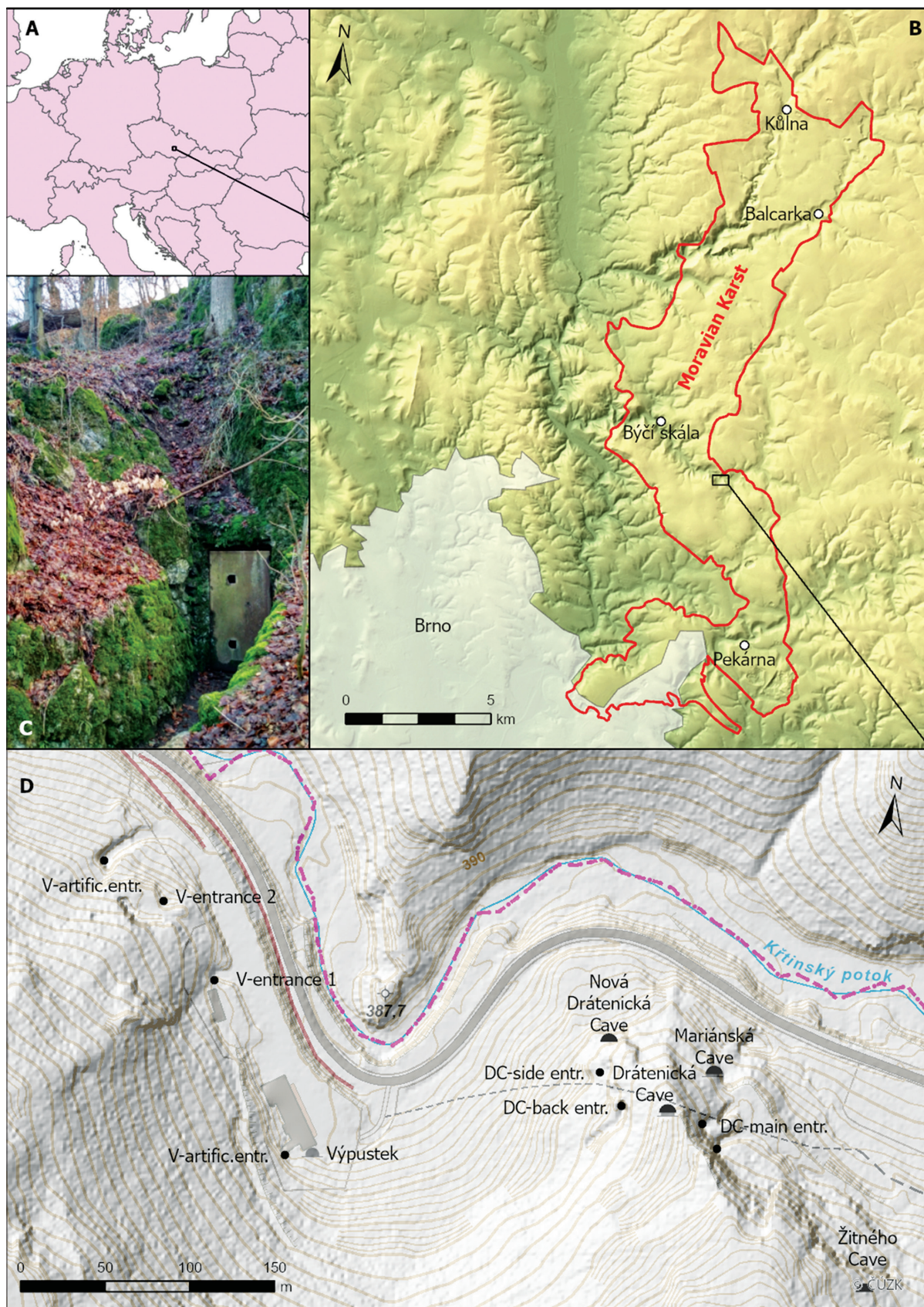


Fig. 1. Situation of the Nová Drátenická Cave on the map of Europe (A), the Moravian Karst in the Czech Republic (B), and in relation to the cluster of sites in the valley of the Křtinský potok stream (D). C – contemporary entrance to the cave, DC – Drátenická Cave, V – Výpustek Cave. Modelling and photo by P. Neruda.



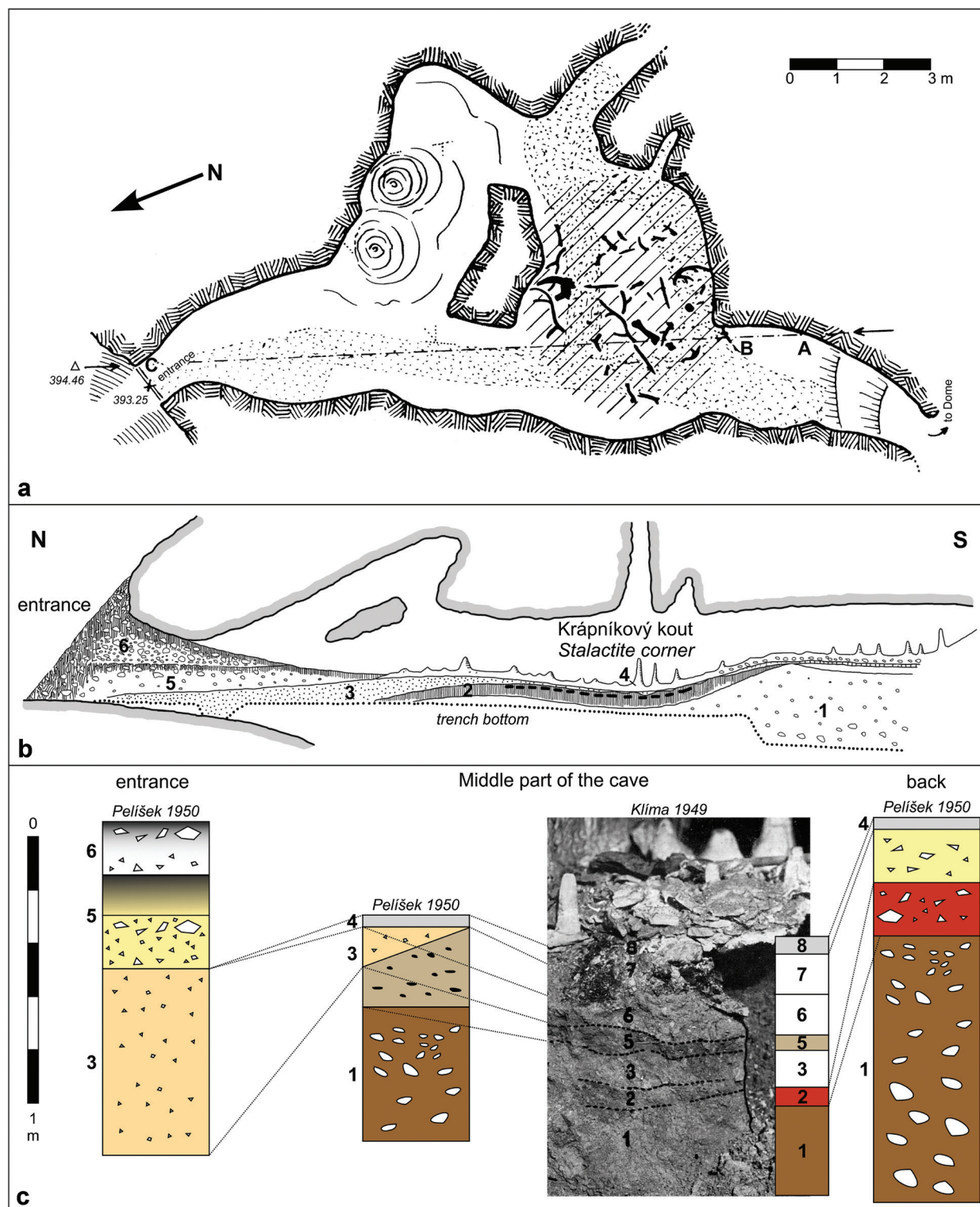


Fig. 2. Plan of the Stalactite Corner with the localisation of finds (a), longitudinal cross-section according to Pelíšek (b), and juxtaposition of Klíma's and Pelíšek's profiles (c). Digitisation and modelling by P. Neruda.

ridor heading to the south-west opens into the dome of the inner cave system (Fig. 2a).

The Nová Drátenická Cave was discovered in 1947 during a speleological prospection of the Stará Drátenická.<sup>9</sup> Both caves were artificially connected, and later speleologists reopened the sediment-filled natural entrance of Nová Drátenická.<sup>10</sup>

The cave was archaeologically investigated in July and November of 1948 by Bohuslav Klíma, who uncovered both archaeological and faunal remains in the Stalactite Corner and attributed them to the Late Upper Palaeolithic techno-complex of the Magdalenian.<sup>11</sup> This interpretation is still broadly accepted today.<sup>12</sup> J. Pelíšek, who participated in the excavations, documented the longitudinal profile of the site.<sup>13</sup> A detailed analysis of the faunal remains was carried out by Z. Hokr (see below).<sup>14</sup>

The rear part of the Stalactite Corner, that is, the findspot of the aforementioned archaeological and faunal remains, had a relatively simple stratigraphy (Fig. 2a). According to Klíma,<sup>15</sup> there was a sinter plate at the top (Fig. 2c: Layer 8) lying on sharp-edged limestone debris (Fig. 2c: Layer 7). Below, there was a loess sediment (Fig. 2c: Layer 6; loam according to Klíma) covering a grey-coloured loam containing the Palaeolithic artefacts (Fig. 2c: Layer 5). The aforementioned subjacent travertine horizon (Layer 4) is not visible in the trench (compare photo in Fig. 2c). At the bottom of the profile, there was a light loess-loam sediment (Fig. 2c: Layer 3, 10–20 cm), reddish sediment with fragments of limestone (Fig. 2c: Layer 2, 15 cm), and, finally, phosphate loam with coarse limestone clasts and boulders (Fig. 2c: Layer 1).

In order to better understand the formation processes, we must correlate this stratigraphy with Pelíšek's later description.<sup>16</sup> He divided the longitudinal profile into three different units: the rear part, the central part, and the entrance. In the rear part of the Stalactite Corner, a carbonate layer (Fig. 2b–c: Layer 4) covered a 10–20 centimetres thick light yellowish loam with small flat limestone debris that, again, laid on top of “heavy” reddish loam with limestone clasts, partly consolidated by carbonates. The lowermost layer was represented by “heavy” brown loam (Fig. 2b–c: Layer 1).

The central part of the profile recorded stratigraphy around the archaeological structure. Contrary to Klíma's description, we see a progression of layers towards the outside and inside of the cave. The most important is Layer 2 (Fig. 2c: Klíma's Layer 5) fading out towards the outside and inside of the cave. Its maximal depth was 20–30 centimetres. The archaeological horizon was situated in the upper part of this layer and covered by a plate with stalagmites (Pelíšek's Layer 4 – Klíma's Layer 8). Towards the entrance, a layer of ochre-yellow loess (Fig. 2b–2c: Pelíšek's Layer 3) was wedged between the stalagmite plate and Layer 2 (Klíma's Layer 5) or, where Layer 2 disappeared, laid on the limestone bedrock.

In the entrance area, the carbonate plate disappeared, and Layer 3 was covered by a layer of calcareous gravel with traces of yellow loess and humus containing the Rendzina horizon (Fig. 2b–c: Pelíšek's Layer 5). Layer 5 partly covered the carbonate plate and, therefore, must be younger. The uppermost part of the sequence is represented by calcareous gravel (Fig. 2b–c: Pelíšek's Layer 6) with humus containing the Rendzina horizon at the top.

Pelíšek correlated the layers 4, 5, and 6 with the Holocene.<sup>17</sup> According to him, Layer 4 represents the Atlantikum and, therefore, cannot be of as recent age as suggested by Klíma.<sup>18</sup> The Pleistocene sedimentation is reflected by Pelíšek's layers 1–3. Musil pointed out the problem of different positions of the reddish loam sediment (Klíma's Layer 2) in both profiles.<sup>19</sup> However, it is related to the development of sediments in different parts of the cave and does not affect the archaeological horizon.

The archaeological situation has been dated by three <sup>14</sup>C measurements on unmodified mammalian bones.<sup>20</sup> They yielded a long-time range spanning between 11,670 and 13,870 uncal BP. Only one dated antler sample can be associated with the archaeological horizon with certainty; the origin of two remaining bones is unclear (Tab. 1). Nevertheless, dating possibly related to human activities would be too young for the proposed Late Upper Palaeolithic occupation.<sup>21</sup>

<sup>9</sup> Klíma 1949.

<sup>10</sup> Musil (ed.) 1993.

<sup>11</sup> Klíma 1949.

<sup>12</sup> E.g. Maier 2015; Oliva 2005; Svoboda *et al.* 2009; Valoch 1960; 2001.

<sup>13</sup> Pelíšek 1950.

<sup>14</sup> Klíma 1949.

<sup>15</sup> Klíma 1949.

<sup>16</sup> Pelíšek 1950.

<sup>17</sup> Pelíšek 1950, 41.

<sup>18</sup> Klíma 1949, 128, fig. 3.

<sup>19</sup> Musil 2002, 77.

<sup>20</sup> Valoch 1996, 166.

<sup>21</sup> Cf. Valoch 2010.

Table 1. Overview of  $^{14}\text{C}$  dates for the Nová Drátenická Cave. Calibrated using OxCal 4.4 ver. 155, implementing the IntCal20 calibration curve.<sup>38</sup>

LabNo.	Date	Cal. BP (95.4%)	Material	Context
OxA-1953	13,870±140	15,826–15,023	Large mammalian bone	Situation 2, relation to human activities unclear
OxA-1954	12,900±140	17,285–16,388	Large mammalian bone	Probe IV, relation to human activities unclear
OxA-1952	11,670±150	13,987–13,185	Antler	Palaeolithic horizon
MAMS-55260	13,230±50	16,056–15,712	Antler point, N.Drat 8446	Palaeolithic occupation
MAMS-56122	12,170±40	14,184–13,875	Large mammalian bone, N.Drat 8444	Relation to human activities unclear
MAMS-56123	no collagen		Large mammalian bone in sinter, Lab. no. ND2022-3	Relation to human activities unclear

### Lithic artefacts

The collection of lithic artefacts from Nová Drátenická is not abundant in comparison to other Moravian caves with Late Upper Palaeolithic material. Seventeen lithic pieces were uncovered during the excavations in 1948 and another two a year later.<sup>22</sup> Today, the collection of lithic artefacts contains 11 tools and eight un-retouched blanks. Tools are represented by different types of backed pieces. One backed blade (Fig. 3. 1) has a regular abrupt retouch. The apical end is slightly pointed, and the proximal end is rounded and tapered with an abrupt retouch. We would like to note that the piece has no retouch on the proximal part of the ventral side, contrary to how it was previously drawn by B. Klíma.<sup>23</sup> A bi-truncated backed piece (Fig. 3. 2) is regularly retouched, with a concave distal truncation. The retouch of the lateral edge is straight and abrupt. A backed bladelet (Fig. 3. 3) has both ends recently damaged, and the retouch on the lateral edge is straight and abrupt. A transversally retouched backed micro-bladelet (Fig. 3. 4) has a fine marginal retouch at the distal end which could be of unintentional origin. Another backed bladelet (Fig. 3. 5) with a slightly rounded apical part has a straight and probably unfinished retouch on the lateral edge. The abrupt retouch at the apical part continues with a marginal and fine retouch.

Pieces previously classified as Gravette<sup>24</sup> (Fig. 3. 6) and micro-Gravette points (Fig. 3. 13) have no retouch in the apical parts of the ventral sides. The proximal part of the larger point is missing and unlike in all previous publications, the micro-point should be correctly oriented with the pointed end at the bottom. The distal part of the artefact is missing.

The backed blade (Fig. 3. 7) has a straight, discontinuous semi-abrupt retouch of the lateral edge. Two mesial parts of backed bladelets (Fig. 2. 11,12) are modified by straight and abrupt retouches – the second piece bears recent damage in the proximal part. A backed micro-bladelet (Fig. 3. 14) has a fine marginal retouch on one edge – the second edge is only discontinuously retouched on the margins. Burins or end-scrapers are absent. Finally, the collection of lithic artefacts also contains unretouched forms – one flake (Fig. 3. 10), three blades (Fig. 3. 8,15,19), a blade and a flake both with edge damages (Fig. 3. 16,18), and two undeterminable fragments, probably flakes (Fig. 3. 9,17).

Blades and bladelets are regular but in most cases fragmented, which makes it impossible to specify their original length. Only three blades are complete (Fig. 3. 1,5,19). The width of the retouched blades varies between 5.0 and 8.0 millimetres, with thickness ranging from 0.7 to 4.0 millimetres. The dorsal scar pattern indicates that

<sup>22</sup> Klíma 1952.

<sup>23</sup> Klíma 1952, 107.

<sup>24</sup> Klíma 1949, fig. 4: 6–7.

<sup>25</sup> Klíma 1949, 133–134.

<sup>26</sup> Klíma 1949, 134.

<sup>27</sup> Musil 1958a; 1958b; 2002.

<sup>28</sup> Musil 2002.

<sup>29</sup> Cf. Averbouh 2000; Pfeifer 2016.

<sup>30</sup> Langley 2015.

<sup>31</sup> Bosinski 2009.

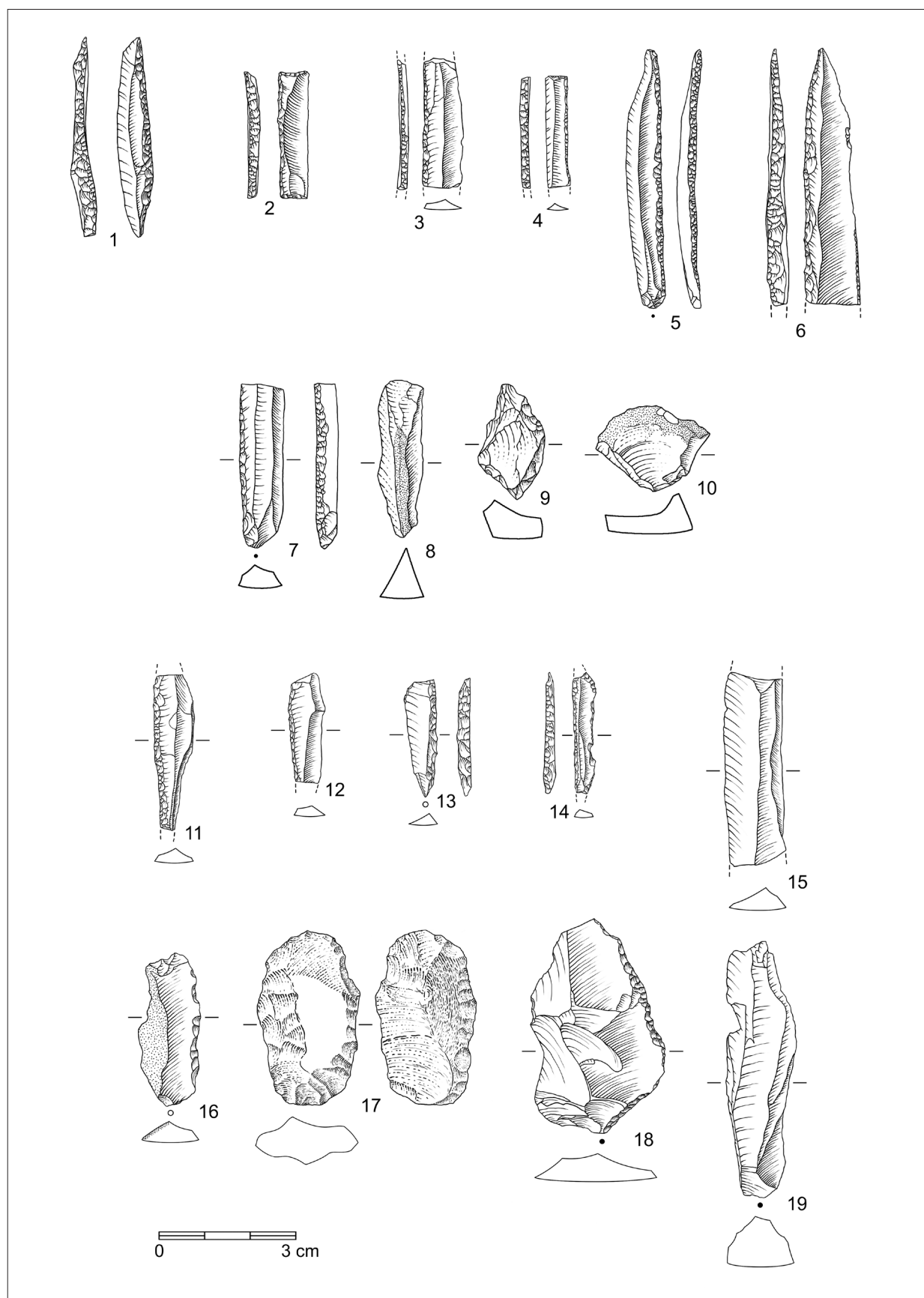


Fig. 3. Lithic artefact assemblage from the Nová Drátenická Cave. Raw materials: 1–7, 10–15, 18 – erratic flints; 8, 16 – calcites; 9 – orthoquartzite of the Drahaný type; 17 – (burnt); 19 – Jurassic chert. Drawing by T. Janků.



some of the blades were knapped from laminar bidirectional cores (Fig. 3. 7,11). The butts are preserved in only three cases (Fig. 3. 5,7,9) and all are punctiform.

The majority of lithic artefacts were made from erratic flint and were covered by a thick layer of white patina. Two pieces are made from calcite (Fig. 3. 8, 16), two from Jurassic chert (Fig. 3. 17, 19), and one irregular piece represents orthoquartzite of the Drahaný type (Fig. 3. 9). One chert (Fig. 3. 17) was exposed to heat. The thermic traces are preserved on both dorsal and ventral sides (Fig. 3. 17). Contrary to Klíma's and Valoch's pictures, we show the pieces in their correct orientation and with dorsal scar patterns.

### Faunal remains

The faunal analysis by Hokr determined 20 species. Mammals: *Tallpa europaea*, *Canis lupus*, *Vulpes vulpes*, *Alopex lagopus*, *Mustela erminea*, *Felis* cf. *silvestris*, *Ursus spelaeus*, *Rhinoceros* sp., *Bos* or *Bison* sp., *Equus* sp., *Cervus elaphus*, *Rangifer tarandus*, *Capra ibex*, *Lepus* sp., *Arvicola terrestris*, and *Dicrostonyx torquatus*. Birds: *Lagopus mutus*, *Lagopus altus*, *Falco peregrines*, and *Tatra ourogallus*.<sup>25</sup> Some remains could not be determined. Hokr also paid attention to the taphonomy of bones and divided them into two groups based on stratigraphy and preservation: an older one, represented especially by cave bear bones and originating from the lowest phosphate loam layer (Klíma's Layer 1), and a younger one, associated with the Palaeolithic occupation (Klíma's Layer 5), and comprising all other mammal and bird species with a predominance of reindeer. Hokr also noted potential anthropic impact on bone fragments coloured with red ochre and bearing fine but irregular striations. A cave bear talus bone was misidentified as human remains.<sup>26</sup>

The small collection of bones was not studied since then, with the faunal assemblage from Nová Drátenická featured only a few times in synthesising contributions focused on Weichselian or Late Upper Palaeolithic fauna.<sup>27</sup> Due to the predominance of reindeer over bones of other large mammals, such as ibex, bovid, and horse, the site was interpreted as a seasonal reindeer hunting camp.<sup>28</sup>

### Osseous projectile points

Nová Drátenická is known above all for three comparatively big and well-preserved osseous projectile points (ID N.Drat 8445–8447) which share an unusual morphology (Fig. 4). Each piece was made from cervid antler

with well-recognisable compact and spongy tissue. The *compacta* thickness ranges from 6.0 to 9.0 millimetres, indicating that the raw material originated from adult males.<sup>29</sup> The preservation is excellent, including the spongy part, and testifies to extensive longitudinal scraping and smoothing meant to obtain a very regular surface. Two pieces retain their complete length and one piece, N.Drat 8447 (Fig. 4. 3), features a use-related bevelled break on its basal part. In the current condition, the points measure 250, 266, and 276 millimetres, respectively. All specimens feature an oval cross-section and a double-bevelled base with incised zigzag lines whose likely function was to assist in attaching them to wooden hafts. Whereas N.Drat 8446 and N.Drat 8447 have long, well-defined base bevels (Fig. 4. 2,3), the base of N.Drat 8445 is markedly shorter and somewhat irregular (Fig. 4. 1). This may be due to rejuvenation,<sup>30</sup> which is also suggested by the longitudinal grooves running down onto the base of this piece. Longitudinal grooving is a characteristic feature of all three points and is always executed perpendicularly to the base bevels. N.Drat 8445 and N.Drat 8446 bear two juxtaposed grooves in both *compacta* and *spongiosa* (Fig. 4. 1,2) while N.Drat 8447 (Fig. 4. 3) has only a single one located in the *spongiosa*. The lengths of the grooves range from 133 to 257 millimetres. Following Bosinski's suggestion,<sup>31</sup> we regard these grooves as slots for small lithic insets, some of which have also been recovered on-site (see above). Lithic-backed bladelets used as projectile components are widespread in the European Late Upper Palaeolithic.<sup>32</sup> A distinctive feature of the Nová Drátenická points is their broad, flat, cutting tip section, which in two cases (N.Drat 8445 and 8447 – Fig. 4. 1,3) also notably broadens. Despite some deviations, the points are so similar to each other that it is quite likely that they used to be a set belonging to a single individual and deposited during one occupation event.<sup>33</sup> Doubtlessly, they share the same cultural background and dating.

### FTIR, <sup>14</sup>C dating, and ZooMS

As outlined above, Nová Drátenická did not yield any significant stratigraphy and the previously performed <sup>14</sup>C measurements on unmodified bones were ambiguous. Therefore, direct <sup>14</sup>C dating of the osseous points appears the only viable option for establishing a reliable chronology and getting a hint at the archaeological classification of the site.

Since the osseous points from Nová Drátenická are part of the National Cultural Heritage of the Czech

<sup>32</sup> E.g., Houmard 2003; Lengyel *et al.* 2021; Pétillon *et al.* 2011.

<sup>33</sup> Pfeifer 2017.



Fig. 4. Set of three antler projectile points from the Nová Drátenická Cave. 1 – N.Drat 8445; 2 – N.Drat 8446; 3 – N.Drat 8447. Moravian Museum. Note the glued sediment fracture on 8446 (arrow), dismantled for sampling. Note that different lighting may cause chromatic misinterpretations. Photos and drawings by Sebastian J. Pfeifer.



Republic, minimising the impact of sampling was mandatory. Firstly, we considered that all three points are typologically similar and have the same age. Therefore, we decided to subject only one of them to radiocarbon dating and ZooMS. Secondly, of key importance was to protect the original surface features. Point N.Drat 8446 was sediment-fractured and assembled from two fragments (Fig. 4. 2 – arrow). Disarticulation of this piece would therefore open the possibility of obtaining material from the inner part of the while minimising the risk of modern contamination or damaging its surface. Thirdly, since sufficient collagen preservation is mandatory for reliable  $^{14}\text{C}$  dates, we decided to conduct non-destructive infrared Fourier spectroscopy (FTIR) measurements on the surface before sampling. This analysis was carried out at the facilities of *CEITEC NANO* (Brno, the Czech Republic; Project Log 0662) in two different spots on

N. Drat. 8446 and two animal bones also belonging to the Upper Palaeolithic horizon.

Applying FTIR Vertex 70v with microscope Hyperion 3000 and ATR objective with Ge crystal, two spots on the point were measured. The results show that the surface was covered with a protective layer based on wax and nail polish, and hence no IR vibration lines of osseous material (amide or apatite) are visible in the absorbance spectrum. The same results were obtained for the surface of the glue in the fracture. Additionally, a large mammalian bone fragment from the Upper Palaeolithic layer (N.Drat 8444) and a large mammalian bone fragment extracted from a carbonate concretion (sample no. ND2022-3) were subjected to FTIR. Some powder was obtained from both bones and measured using a diamond crystal. Comparison with reference values for bone collagen<sup>34</sup> indicated the presence of organic material, probably collagen.

<sup>34</sup> Martinez-Cortizas, López-Costas 2020; Paschalis *et al.* 2011.

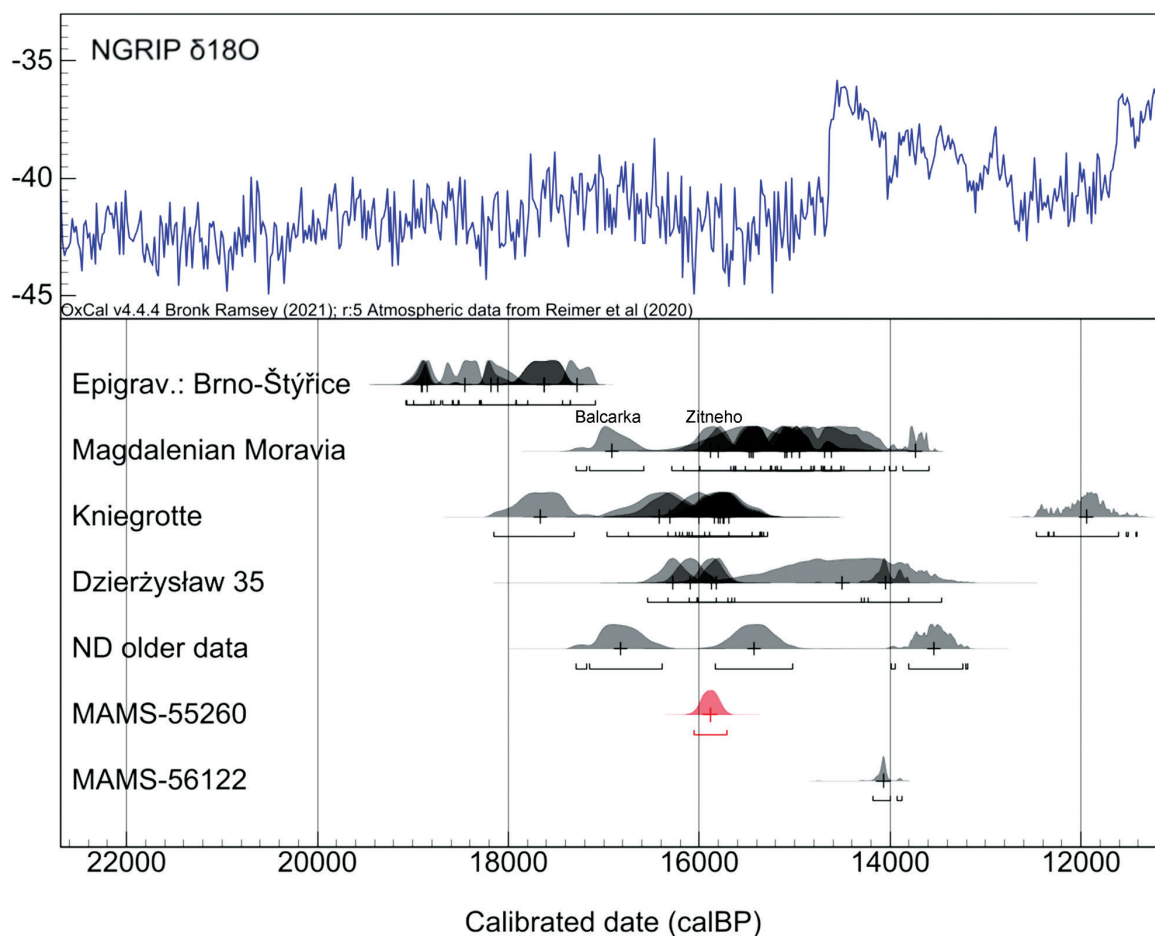


Fig. 5. Chronological position of the previous (ND) and latest  $^{14}\text{C}$  measurements from the Nová Drátenická Cave, distribution of the Magdalenian dates for Moravia, Kniegrotte, and Dzierżysław 35, and late Epigravettian dates from Brno-Štýřice. The point N.Drat 8446 is marked in red. Modelled in OxCal 4.4, calibration curve IntCal20. Modelling by P. Neruda.

Although the FTIR analysis of the projectile point was not successful in terms of identifying organic matter, the obtained data helped to find a suitable solvent for dismantling both parts for sampling. We decided to use pure acetone that was injected into the joint through small holes in the glue surface. Subsequently, the area was covered with soft paper soaked with acetone and then wrapped with food foil. After twelve hours of soaking, the point was easily dismantled, and the exposed fracture surfaces were cleaned with a *Dremel* tool. Next, small holes were drilled into the compact tissue of either fragment to obtain 300 milligrams of powder for  $^{14}\text{C}$  dating and 30 milligrams for ZooMS. The sampling equipment had previously been cleaned with a solution of water and bleach. The sample from N. Drat. 8444 was obtained by scraping the inner part of the bone. The third sample, ND2022-3, consists of a small fragment mechanically

extracted from the breccia of the bone and surrounding carbonate.

Ultrafiltration of the samples and  $^{14}\text{C}$  dating were performed at the MICADAS AMS facility of *Curt Engelhorn Zentrum Archäometrie* (Mannheim, Germany). As for the projectile point, collagen content was 3.0 %, and the C:N ratio of 3.3 indicated good collagen preservation. Thus, we deem the sample suitable for providing reliable results. It gave an age of  $13,230 \pm 50$   $^{14}\text{C}$  BP (MAMS 55260). Calibration was performed using OxCal v4.4, ver. 155<sup>35</sup> with the INTCAL 20 curve implemented<sup>36</sup> and resulted in 16,056–15,712 cal BP (95% probability) and 15,971–15,814 cal BP (68% probability), respectively. If this date is regarded as representative for all three osseous points from Nová Drátenická, then the pieces were manufactured during the first half of GS-2a, well before the onset of the Lateglacial Interstadial Complex.

<sup>35</sup> BronkRamsey 2021.

<sup>36</sup> Reimer *et al.* 2020.

The age of the points aligns well with the oldest dates for the Moravian Magdalenian as well as with the dating of the Magdalenian occupations of Kniegrotte in Germany and Dzierżysław 35 in Poland. Between the youngest Epigravettian occupation of the cluster of sites in Brno-Štýřice<sup>37</sup> and the point from Nová Drátenická, however, there is a gap of approx. 1 kyr (Fig. 5).

The second sample, N.Drat 8444, had a collagen content of 6.4 %, a C:N ratio of 3.4, giving it an age of 12,170±40 <sup>14</sup>C BP (MAMS-56122). After calibration, the age of the bone is 14,184–13,875 cal BP (95.4% probability), thus corresponding to GI-1 in the first half of the Lateglacial Interstadial Complex. The third sample, ND2022-3, yielded no collagen at all. 30 milligrams of material from the point were analysed by peptide mass fingerprinting (ZooMS) using the acid insoluble protocol. The species was identified as reindeer (*Rangifer tarandus*).

## Discussion

The question of homogeneity of the archaeological horizon from Nová Drátenická is an important part of the re-evaluation of the site and especially the three projectile points. The stratigraphic evidence suggests a single archaeological layer (Pelíšek's Layer 2) that, judging by the quantity and structure of finds, appears to be homogeneous. According to Pelíšek's data, finds are neither present in the underlying Layer 1 nor in the overlying Layer 3. No cryogenic processes have been recorded that could move artefacts between layers. During the Holocene, the cave's entrance was small and gradually filled with sediment. Nothing attests production of either lithic or osseous tools, as neither cores nor blanks from the preparation of cores are present. Instead, the composition of the archaeological and faunal assemblage corresponds to hunting activities. We consider the archaeological record as resulting from a single occupation or repeated short visits by the same group of Late Upper Palaeolithic humans.

Nevertheless, such a conclusion is in conflict with the results of radiocarbon dating. The obtained <sup>14</sup>C dates from animal bones cover a long-time range of 17.3–13.2 ka cal BP (Tab. 1). Both of the new dates also fall within this interval, with the gap between them amounting to nearly 2 kyr. There are three possible explanations for the wide range of dates (which may, of course, be partially complementary): a palimpsest of Late Upper and Final Palaeolithic occupation events, the impact of carnivores,

and the post-depositional processes. The palimpsest hypothesis is not supported by the character of the artefact collection, which does not show any mixing of types from several techno-complexes. On the other hand, the use of the cave by carnivores as a den cannot be ruled out, especially since none of the dated mammalian bones appears to have been processed by humans. Since the cave's entrance was not closed until the Holocene, the site was accessible to carnivores throughout the Late Glacial and, therefore, they could have accumulated bones over a longer period, both concurrently and non-concurrently to the human occupation. Lastly, individual samples could have been affected by post-depositional processes. The archaeological horizon lies under a carbonate layer with stalagmites and, therefore, individual bones could have been secondarily enriched with different amounts of carbon from carbonates. These influences must also be taken into account when determining the age of the archaeological horizon. Of all the radiocarbon dates obtained so far, the result from the antler point must be considered the most relevant, since it is demonstrably a human-made object. If we take into account that even this sample could have been secondarily enriched with carbon, which would render it too young, the period of human presence in the cave can be determined to be approximately 16.0–15.7 ka cal BP at the latest.

Classification of the archaeological assemblage from Nová Drátenická is not a trivial task, because the collection contains only a limited number of artefacts and features lithic types that can be found in several techno-complexes. The dating of the projectile point puts the site into a time range when both Magdalenian and Late Epigravettian (Epiaurignacian, respectively) could in principle have coexisted in southern Moravia (Fig. 6).<sup>38</sup> Perhaps this explains the difficulty in the cultural classification of Nová Drátenická. Its original interpretation by Klíma as Magdalenian was later challenged by Karel Valoch, who noted the presence of Gravette and micro-Gravette points as well as truncated backed bladelets. Based on that, he preferred attributing the assemblage to the "Gravettoid" industries rather than to the Magdalenian ones. According to our analysis, however, the lithic points from Nová Drátenická do not meet the criteria of Gravette points and, therefore, we do not classify them as such. Such "atypical" points can be found also in Magdalenian contexts<sup>39</sup> and bi-truncated backed pieces (Fig. 3. 2) are encountered both in the Magdalenian of Germany, Switzerland, and south eastern France, as well as in Central European Late Gravettian assemblages.<sup>40</sup>

<sup>37</sup> Nerudová, Neruda 2014; Nerudová *et al.* 2022.

<sup>38</sup> Wiśniewski *et al.* 2017.

<sup>39</sup> Demars, Laurent 1989.

<sup>40</sup> Demars, Laurent 1989; Polanská *et al.* 2020; Lengyel 2018; Wilczyński *et al.* 2015, 2020.



Table 2. Comparison of technological features between LUP techno-complexes and the lithic assemblage from the Nová Drátenická Cave (ND) not preserved, + presence, – absence.\* One organic antler hammer was preserved at the Epiaurignacian site of Albendorf (Austria),<sup>41</sup> while indirect evidence for the use of an organic hammer is mentioned in the context of an Epiaurignacian assemblage from Mohelno (the Czech Republic).<sup>42</sup>

Magdalenian	ND	Technological feature	Epiaurignacian	Epigravettian
+	?	Preparation of a core striking platform	-	-
+	-	Dorsal abrasion of the proximal part of a blank	Not frequent	Not frequent
+	?	Long regular blades	Not frequent	+ / Not frequent
+	?	Butts <i>en éperon</i>	-	-
+	+	Mineral (soft stone) hammer	+	+
+	?	Organic (antler) hammer	- / ? *	-
+	+	Direct percussion	+	+
-	?	Specific reduction strategy focused on microliths	+	-

The lithic artefacts are also ambivalent from the technological point of view. However, previous analyses of technological features of Gravettian, Epigravettian, Epiaurignacian, and Magdalenian industries suggest that these techno-complexes differed from each other,<sup>43</sup> the small number of lithics from the Nová Drátenická Cave complicates the characterisation of individual technological features and, as a result, distinguishing other Late Upper Palaeolithic techno-complexes in this cave.

Dorsal abrasion on the blanks was not applied, but preserved butts indicate the use of a mineral hammer typical for the Epigravettian (Tab. 2). On the other hand, the measurements and morphology of blades and bladelets as well as the presence of bipolar knapping do not preclude the Magdalenian classification of the Nová Drátenická lithic collection. Although the typo-technological information is limited, its general character aligns better with the Magdalenian than with the Epigravettian. Concerning the raw material composition, the collection is similar to other Magdalenian assemblages from the Moravian Karst. The geographic location of the site lends further support to attribution of the Nová Drátenická lithic industry to the Magdalenian. To date, no assemblage assigned to the Epigravettian or Epiaurignacian has been registered in the Moravian Karst.<sup>44</sup> Conversely, there are several small cave sites in the immediate

vicinity (e.g. Verunčina, Srnčí, Adlerova, or Žitného) that are clearly associated with the Magdalenian.<sup>45</sup>

How do the peculiar reindeer antler projectile points from Nová Drátenická relate to that? As their closest morphological analogy in Moravia, Valoch presents a grooved ivory point from the early excavations at the Kůlna Cave, also situated in the Moravian Karst.<sup>46</sup> However, judging from the depiction of this particular specimen (Fig. 6. 5), the longitudinal grooves are located in the same symmetry plane as the double-bevelled base rather than perpendicularly to it, while the tip tapers regularly without any noticeable broadening or cutting edges. Hence, the piece from Kůlna is actually more reminiscent of a standard Magdalenian point.<sup>47</sup> On the other hand, three distal point fragments from the Upper Magdalenian rock shelter of Fontalès (Dép. Tarn-et-Garonne, France), introduced previously by Bosinski,<sup>48</sup> are much more similar to Nová Drátenická's nos. 8445 and 8447, especially given their broadened, cutting tips and perpendicular orientation of the longitudinal grooves (Fig. 6. 2–4). As for morphological analogies from the east, the Early Epigravettian open-air site of Cosăuți in the Middle Dniester Valley (the Republic of Moldova) is of note. According to published drawings, the archaeological horizons 2–6, dated to around 23–21 ka cal BP and, thus, to the Last Glacial Maximum,<sup>49</sup> yielded several

<sup>41</sup> Steguweit 2010.

<sup>42</sup> Škrdlá *et al.* 2014.

<sup>43</sup> Nerudová, Moník 2019.

<sup>44</sup> Nerudová, Neruda 2015.

<sup>45</sup> Valoch 2001.

<sup>46</sup> Valoch 2001, 147.

<sup>47</sup> Cf. Pétillon 2016; Pfeifer 2021.

<sup>48</sup> Bosinski 2009, fig. 4.

<sup>49</sup> Noiret 2009.

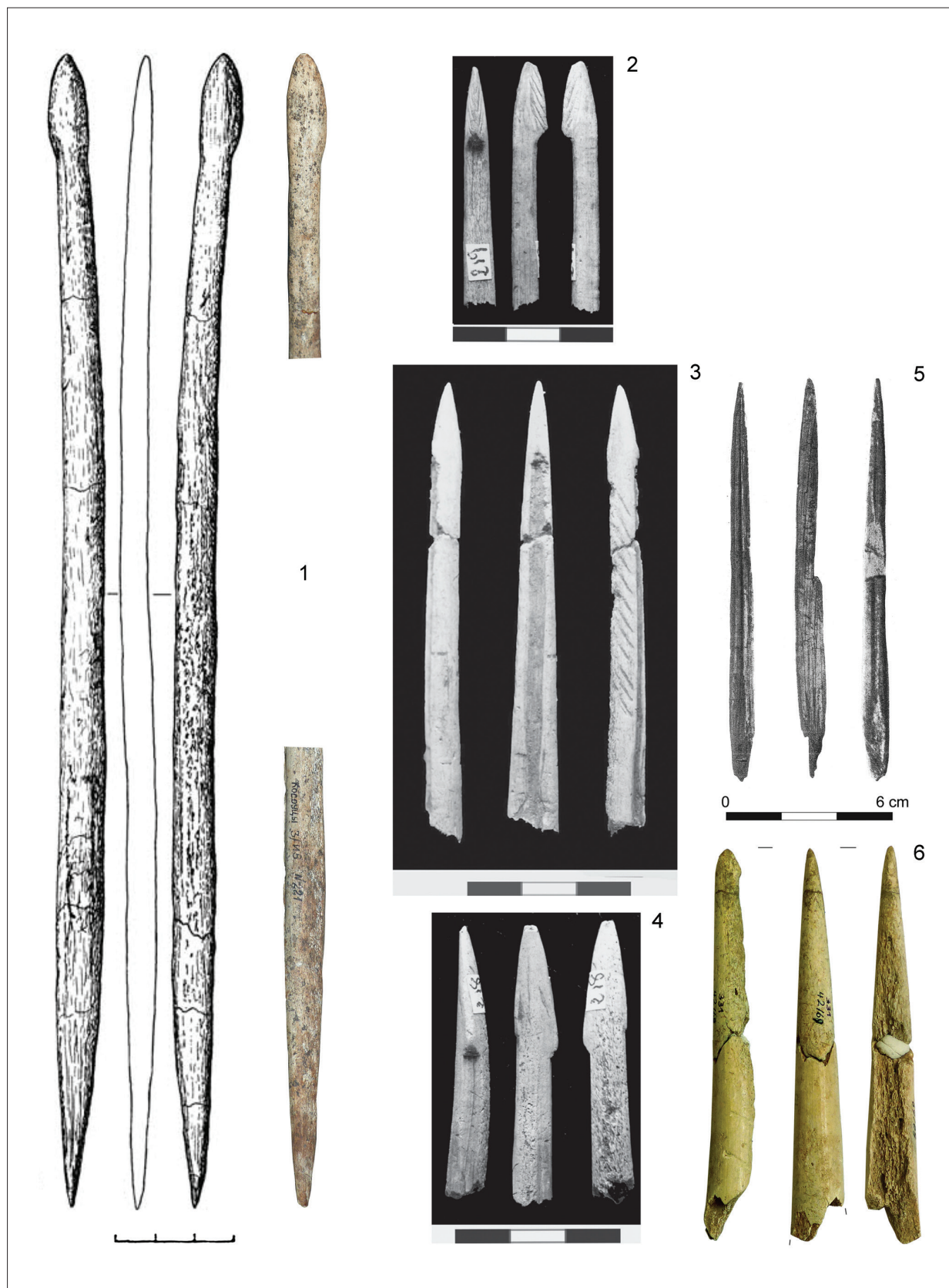


Fig. 6. Late Upper Palaeolithic osseous points with broadened, flattened tips. 1 – Cosăuți AH3 (after Covalenco, Croitor 2016); 2–4 – Abri Flageolet (after Bosinski 2009); 5 – Kůlna, old excavations (after Valoch 1979); 4 – Kniegrotte. 1 – National Museum of History of Moldova, inv.no. N221; 2–4 – Museum d'Histoire Naturelle in Toulouse; 5 – Moravian Museum; 6 – State Office of Cultural Heritage of Thuringia, inv.no. 42/69. Unless stated otherwise, the scale bar is 3 cm. Colour photos by Sebastian J. Pfeifer.

points with what looks like bevelled bases with incisions and broadened, cutting tips.<sup>50</sup> Closer examination of the original projectile points from Cosăuți carried out recently, however, reveals significant differences: firstly, they have massive or, rarely, tongue-shaped bases without bevels; and secondly, the few specimens with broadened, flattened tips lack longitudinal grooves (Fig. 6. 1).<sup>51</sup>

In line with the morphological differences from the projectiles from Cosăuți, the newly obtained dating of the Nová Drátenická antler points clearly separates them from the Early Epigravettian by at least five millennia. Therefore, currently, the most viable hypothesis is to associate the points with the Magdalenian, as suggested by the lithics and location of the site, and to see them as members of the same typological family as the pieces from Fontalès. The notion of projectile points with broadened, flattened tips being a Magdalenian variety is further corroborated by a sturdy specimen with refitted use-related fractures from the Kniegrotte cave site in Thuringia, eastern Germany. The piece now appears to be un-grooved, but it is preserved fragmentarily, with severe decomposition of the *spongiosa* (Fig. 6. 6).

But why is this projectile morphology so rare? A look into the typo-technological evolution of Magdalenian hunting equipment might provide a clue. Between 16 and 15.8 ka cal BP, a short-lived but very characteristic lithic tool type made its appearance in Magdalenian assemblages: scalene triangles.<sup>52</sup> In Central Europe, the aforementioned Kniegrotte is a well-known triangle-bearing site with over 200 pieces.<sup>53</sup> The weighted average of nine <sup>14</sup>C dates on humanly modified bones is 15.9 ka cal BP<sup>54</sup>. Another well-dated site with scalene triangles is Dzierżysław 35 in Poland,<sup>55</sup> with a weighted average of three dates resulting in the same age.<sup>56</sup> In Moravia, the open-air site of Hranice – Velká Kobylanka is of relevance, as it has yielded several scalene triangles. Unfortunately, no datable organic material accompanied the.<sup>57</sup> The same applies to the large collection from Vilshofen-Kuffing in Bavaria, Germany<sup>58</sup>. According to the radiometric dates, the Nová Drátenická points share the temporal horizon with the scalene triangles, and since these lithic tools are most likely insets of osseous points,<sup>59</sup> it could be hypothesised that the rarity of Nová Drátenická/Fontalès points may be due to the short timeframe when the scalene

triangles were in use. This view, as tempting as it may seem, is nevertheless problematic on several points. For one, the small lithic assemblage from Nová Drátenická does not contain any scalene triangles but rather ‘ordinary’ backed bladelets and blades (see above), which suggests that the latter were insets in this particular case, as already pointed out by Bosinski.<sup>60</sup> Three of these artefacts bear clear traces of dynamic impact (Fig. 3. 6,15 on both ends; probably also 11), but it should be noted that, given their dimensions and morphologies, not all of them appear to be suited for attaching to organic points (compare Fig. 3. 5 and Bosinski’s Fig. 2. 10). Although Kniegrotte yielded an antler point reminiscent of the Nová Drátenická specimen (see above), the majority of osseous projectiles from that site are of the common single- or double-bevelled Magdalenian varieties.<sup>61</sup> And lastly, there are two directly dated, double-bevelled projectile points without grooves from the Kesslerloch Cave (Schaffhausen, Switzerland) and Tunnelhöhle (Bavaria, Germany), both dated to 16,026–15,436 cal BP (OxA-5746)<sup>62</sup> and 16,231–15,840 cal BP (Erl-14814),<sup>63</sup> respectively. Considering these dating ranges, both points may well relate to the temporal horizon of scalene triangles. However, no such artefacts have been reported from either site. Therefore, it appears that at the turn of the Middle to the Upper Magdalenian, around 16 ka cal BP, a variety of osseous projectile points and lithic insets were used in Central Europe<sup>64</sup> and that the scalene triangles were not necessarily linked to a specific osseous point morphology.

To sum up, the three antler points from Nová Drátenická probably relate to the Magdalenian occupation of this site. Since the Magdalenian in the Moravian Karst appears to be fully established by around 15 ka cal BP at the latest,<sup>65</sup> their dating is of significance in that it corroborates the view that bearers of this techno-complex visited the region somewhat earlier. Several conspicuous osseous points from the Pekárna Cave (distr. Mokrý Horákov, the Czech Republic) may have witnessed their presence as early as the early Middle Magdalenian, at 19/18 ka cal BP<sup>66</sup>. Around 17 ka cal BP, ephemeral late Middle Magdalenian human presence in the Moravian Karst is suggested on typological grounds by a few characteristic osseous artefacts and ornaments from the caves of Pekárna and Balcarka (Ostrov u Macochy, Blansko,

<sup>50</sup> Noiret 2009.

<sup>51</sup> Comp. Covalenco, Croitor 2016, figs. 3–4.

<sup>52</sup> Maier 2015; 2020, 52–59.

<sup>53</sup> Bodenschatz *et al.* 2021; Feustel 1974; Höck 2000.

<sup>54</sup> Maier 2020, tab. 2.

<sup>55</sup> Ginter *et al.* 2005.

<sup>56</sup> Maier 2020, tab. 2.

<sup>57</sup> Klíma 1951; Neruda, Kostrhun 2002; Valoch 2001.

<sup>58</sup> Adaileh 2017.

<sup>59</sup> Höck 2000, Fototafel 6; Maier 2015, 59.

<sup>60</sup> Bosinski 2009.

<sup>61</sup> Höck 2000, Fototafel 6; Pfeifer 2020; 2021.

<sup>62</sup> Housley *et al.* 1997.

<sup>63</sup> Steguweit, Händel 2010.

<sup>64</sup> Langlais *et al.* 2016; Maier *et al.* 2020.

<sup>65</sup> Neruda 2010; Reade *et al.* 2021; Valoch, Neruda 2005.

<sup>66</sup> Maier *et al.* 2020, 439; Nerudová *et al.* 2019, 187.



the Czech Republic) with strong ties to southwestern Europe.<sup>67</sup> A conventional <sup>14</sup>C date from Balcarka is in line with that (Fig. 5), but whether it resulted from human activity remains unclear, since it was obtained from an unmodified mammalian bone. So far, the earliest solid evidence for post-LGM, probably Magdalenian, human presence in the Moravian Karst is, therefore, provided by the directly dated projectile point from Nová Drátenická and coincides with the transition from the late Middle to the early Upper Magdalenian between 16 and 15.8 ka cal BP. Together with the big contemporary sites of Kniegrotte, Dzierżysław 35, and potentially the nearby Žitného Cave with an unmodified mammalian bone dated to the same period (Figs. 1, 5), as well as the typologically related assemblage from Hranice, this suggests that the Magdalenian colonisation of eastern Central Europe gained momentum finally turning the Moravian Karst into a focal area with dozens of sites.<sup>68</sup>

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## Contributor roles

S. J. P.: conceptualisation, study of the osseous artefacts; P. N. & Z. N.: re-evaluation of the stratigraphy, analysis of the lithic assemblage, modelling of the <sup>14</sup>C dates; K. D.: performance and interpretation of the ZooMS analysis; A. N.: performance and interpretation of the FTIR analysis. S. J. P., P. N., Z. N., A. N., K. D.: writing the manuscript.

## Competing interests

The authors declare that there are no competing interests.

## Data handling

All relevant data are provided in the article.

<sup>67</sup> Lucas 2021; Pétillon, Sacchi 2013; Pfeifer 2017.

<sup>68</sup> Maier 2015, fig. 7.34; Nerudová *et al.* 2021, fig. 10; Reade *et al.* 2021; Valoch, Neruda 2005.

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