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A 15,000-year history of Early Upper Paleolithic hunters moving through the Pustý Žleb valley – Artefacts and chronology of Pod Hradem Cave, Moravian Karst, Czech Republic

15 000 let přítomnosti časně mladopaleolitických lovců v Pustém žlebu – artefakty z jeskyně Pod Hradem a jejich datace, Moravský kras, Česká republika

– Ladislav Nejman, Petr Škrdla, Duncan Wright, Jaroslav Bartík, Antonín Přichystal –*

KEYWORDS

Middle-Upper Paleolithic transition – chronostratigraphy – stone artefacts – EUP cultures

ABSTRACT

Archaeological evidence shows that Paleolithic hunters occasionally used the difficult-to-access Pod Hradem Cave for short-term visits. The small collection of artefacts spanning a c. 15,000-year period were made from a range of different raw materials collected from known sources in the surrounding regions up to 120 km away. In this paper, we interpret the sum of the archaeological evidence associated with artefacts from Pod Hradem Cave against an updated chronology, and report a previously unpublished stone artefact. Combined, this information suggests variable cave use throughout the site history. During the Early-Upper Paleolithic this likely involved visits by small, mobile bands using Pod Hradem Cave as a short stop over while passing through the Pustý Žleb valley.

1. Introduction

Pod Hradem Cave, located in the central part of the Moravian Karst, has some of the best paleoenvironmental records published for cave sediments in Central Europe for the Late Pleistocene period spanning approximately 22,000 years (Nejman et al. 2018b; Lisá et al. 2018). Excavations in Pod Hradem Cave began in the late 19th century (Trampler 1898, Knies, 1901) with another major excavation program in the 1950s (Valoch 1965). Valuable information was recovered about past animal use of the cave by Musil (1965) and Gargett (1996), and ephemeral use by humans (Valoch 1965; Nerudová et al. 2012b). These studies demonstrated that the large majority of the bones excavated from this cave belonged to cave bears (e.g. Musil 1965). A major study in the 1990s also reached the conclusion that this cave is primarily a paleontological site used by denning cave bears (Gargett 1996).

The re-excavation of Pod Hradem Cave (a 3 × 1 m trench) took place over three field seasons in 2011, 2012 and 2016 (Nejman et al. 2018a). Multidisciplinary analyses including micromorphology, microfauna, pollen, charcoal (see Nejman et al. 2018b for an exhaustive list of the analyses' results) show relatively humid and warm phases interspersed by cold events and a range of paleoenvironments. Important in this space was recognition, following a targeted study of the Pod Hradem stratigraphy and sediment, that the concept of the Pod Hradem Interstadial, defined in 1966 as a chronologically specific warm climate phase, is now redundant due to the much greater complexity of climatic and depositional environments than was originally envisioned in the 1960s (Lisá et al. 2018).

The sparse archaeological record indicates that humans visited this cave infrequently, but repeatedly throughout the site history, including the Paleolithic and medieval periods. The most sustained period of use during this early period dates between 48,240–44,590 cal BP (Nejman et al. 2017). The 2011–2016 re-excavation programme clearly supports the conclusion that the site is primarily a paleontological site that had been used for denning by cave bears, but new, intriguing archaeological finds (Fig. 1). have expanded our knowledge about the human use of this site. For example, a unique, decorative tubular bone rod and a knapped tooth were recovered from an Early Upper Paleolithic context in layer 6 (Wright et al. 2014; Nejman et al. 2017). The former, recovered from early-Aurignacian related deposits and typologically similar to other similarly dated artefacts in Eastern and Western Europe, is unique for this region.

* Corresponding author – E-mail address: lnejman81@gmail.com

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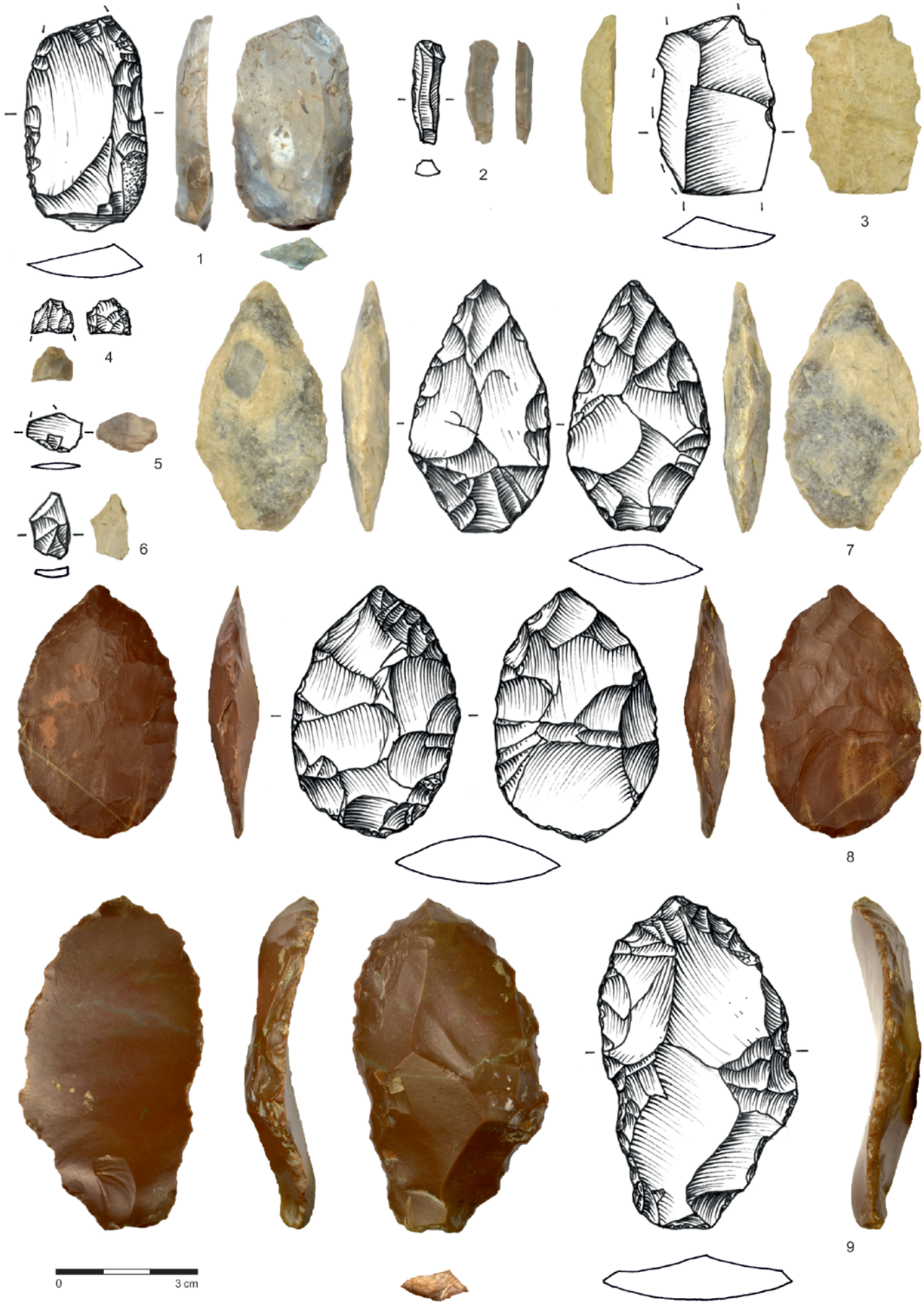
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2. Reassessing the Pod Hradem chronology

Radiocarbon dating results from the 2011–2016 excavation (see Tab. 1) have been published in Nejman et al. (2017). The dates were calibrated using the IntCal13 calibration curve (Reimer et al. 2013) and a Bayesian model was developed using OxCal software (Bronk Ramsey 2009). Here we provide a newer version using the updated calibration curve Intcal 2020 (Reimer et al. 2020) and CalPal software (Weninger, Jöris 2008). As an alternative to the previously published Bayesian model (Nejman et al. 2017), we present single dates rather than modelled ages and we use the stratigraphic position of the dated samples to test the integrity of the individual stratigraphic layers as they were originally identified. We also superimpose the Pod Hradem Cave dating results on all available Moravian IUP / EUP dates in order to fit them into the local cultural developmental scheme (Fig. 2).

Layer, XU	Lab code	14C age (BP)	±
3, 2	SANU-30907	24600	220
5, 6	SANU-33736	31240	470
6, 7	SANU-33737	35660	810
6, 9	SANU-30911	28190	340
6, 9	SANU-30910	41900	1800
6, 8	SANU-30909	35400	810
7, 10	SANU-33738	35140	760
7, 9	SANU-30906	34290	710
7, 11	SANU-30905	36990	980
8, 12	SANU-29026	43000	2000
10, 17	OxA-28116	42100	1000
10, 18	SANU-29029	44900	2600
	SANU-29032	44900	2600
10, 17	SANU-29030	44000	2300
10, 17	SANU-29027	43400	2200
11, 23	SANU-29031	45400	2800
12, 27	SANU-30904	45000	2600
	SANU-30912	46400	3100

Tab. 1. Radiocarbon dates for Pod Hradem Cave (for details, see Nejman et al. 2017).

Tab. 1. *Radiokarbonová data z jeskyně Pod Hradem (více informací viz Nejman et al. 2017).*

3. Reassessing the Pod Hradem stone artefacts

A total of 21 stone artefacts and one bone artefact were recovered during the 1950s excavation (Valoch 1965; Nerudová et al. 2012a; 2012b). Their chronostratigraphic position was used to argue for a Szeletian, Aurignacian and Gravettian presence in the cave. A further nine stone artefacts were excavated during 2011–2016 field research (Fig.1) with layers 5–10 producing stone artefacts while layers 3, 4, 11 and 12 were sterile (see Nejman et al. 2017). Although most of these artefacts have already been presented in Nejman et al. (2017), we provide in the following section additional detail and report another stone artefact (A011), discovered several years after the excavation ended during detailed sorting of the wet-sieved material (see Tab. 2). Considering that artefacts were recovered from stratigraphically well-defined contexts, they possess high information potential. For this reason, this paper will also reassess artefact chronology based on a re-calibration of radiocarbon dates.

4. Results and discussion

In contrast to the Bayesian analysis graph (Nejman et al. 2017, 140, Fig. 4) which presents the sedimentary deposition more as a chronological continuum, plotting of the unmodelled calibrated age estimates displays three discrete chronological pulses. The calibrated results cluster into three separate phases that occasionally span multiple stratigraphic layers. In the following text, we discuss each phase separately.

The first phase is represented by a single, culturally undiagnostic artefact, recovered from layer 5. A date from layer 5 was obtained from a cave bear phalanx (see Fig. 2). This layer, corresponds in age to Aurignacian level artefacts from Švédův stůl Cave (Klíma 1962), also located in the southern part of the Moravian Karst. Additionally, Mladeč Caves in Javoříčko Karst near Upper Morava River Valley yielded Aurignacian human fossil remains supplemented with a collection of osseous artefacts, pendants, and isolated stone artefacts and it is interpreted as a funerary cave (Svoboda 2006). Furthermore, Middle Aurignacian open-air sites (Svoboda, Valoch 2003 with ref.) are known in the Brno Basin, located 20.5 km (in direct line) to the south of the cave. This phase chronologically overlaps with the Moravian Middle Aurignacian (Aurignacian II or AH-4 in Willendorf, cf. Demidenko et al. 2017) dates covering the time span from GI-8 to GI-7 (cf. Škrdla 2017a, b).

The second phase combines layers 6 and 7, a grouping consistent with sedimentological analyses which suggested interrelated formation processes (Nejman et al. 2017, 137). This stratigraphic horizon yielded a radiolarite leafpoint, a porcelanite blade fragment, a knapped tooth and a single bone bead (Wright et al. 2014). The single porcelanite artefact is crucial evidence that links this horizon with a number of artefacts from Valoch's excavation (Nerudová et al. 2012a). Valoch recovered several artefacts, including one from layer 15, that were made from this raw material whose presence is very unusual in Moravia. A single porcelanite leafpoint from layer 15 fits well with a single radiolarite leafpoint from layer 7. In addition, we note a currently lost radiolarite leafpoint found by J. Simon (Valoch 1965) that fits with this horizon both in the case of raw material and typology. The dates from layers 6 and 7 cover the time span from HE-5 to GI-11 and overlap with time ranges reported for the Szeletian, Bohunician, and Líšeň/Podolí I type industries (Fig. 2). This also corresponds with artefact chrono-typologies, see, for example, comparable tubular bone beads found in Early Aurignacian deposits in Eastern and Western Europe. The Early Aurignacian (AH-3) known from Willendorf II 150 km to the southwest from Pod Hradem has not been documented in stratified and directly dated deposits in Moravia to date however, some Moravian collections have been attributed to the "Early Aurignacian" based on their stratigraphic context (cf. Valoch et al. 1985).

Fig. 1. Lithic artefacts excavated in Pod Hradem Cave during 2011, 2012, and 2016 field seasons. Photo by J. Bartík, drawing by L. Dvořáková.

Obr. 1. *Kamenné artefakty získané během výzkumu jeskyně Pod Hradem v letech 2011, 2012 a 2016. Foto J. Bartík, kresba L. Dvořáková.*

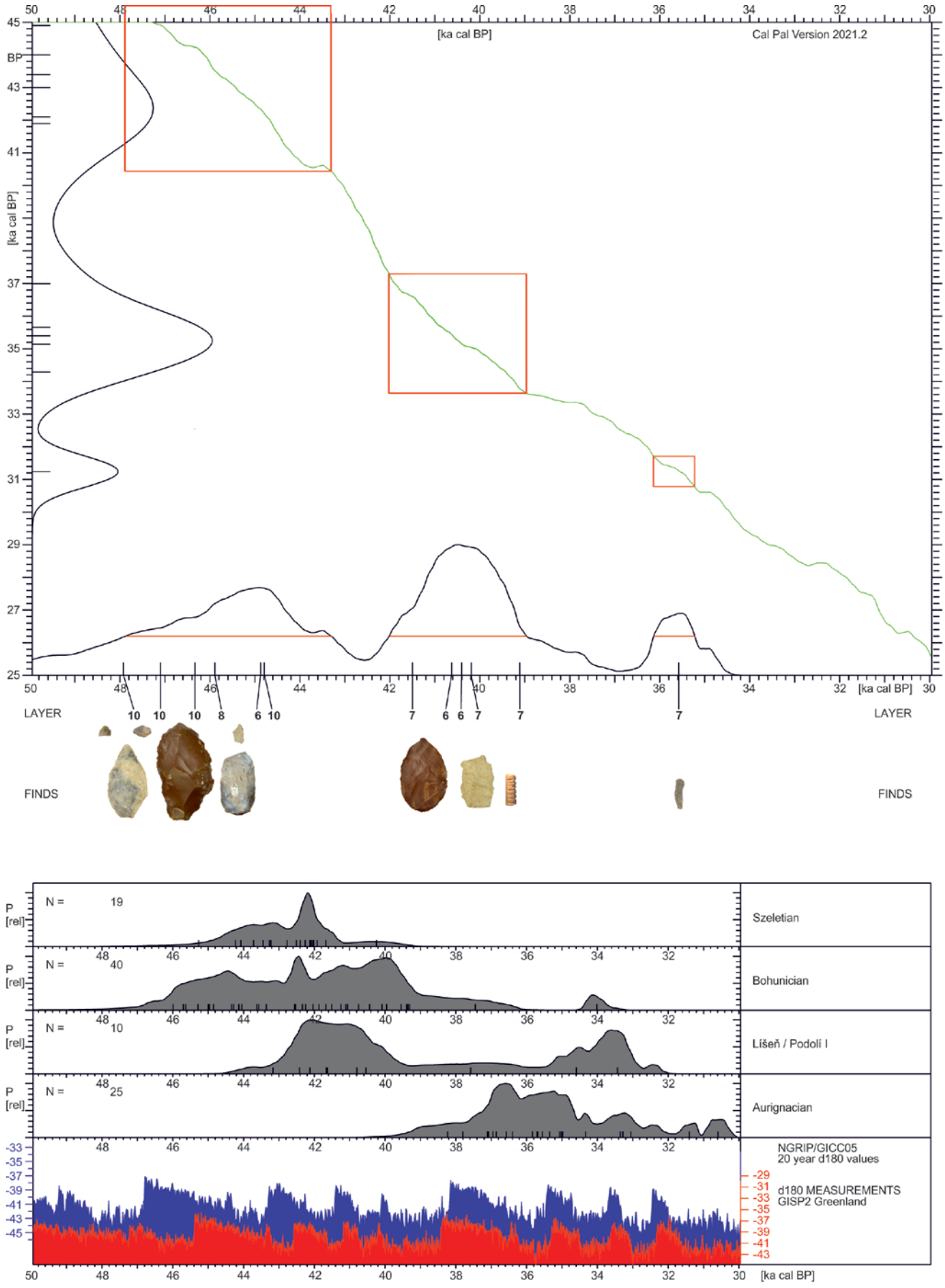

Fig. 2. Top: Calibrated ^{14}C dates grouping into three phases separated on a probability envelope curve. Bottom: Probability envelope curves constructed for Moravian Szeletian, Bohunician, Líšeň/Podolí I, and Aurignacian dates. Graphic by P. Škrdla.

Obr. 2. *Nahoře: Kalibrovaná 14C data rozdělená do tří skupin na základě pravděpodobnostní obalové křivky. Dole: Obalové pravděpodobnostní křivky vytvořené na základě dat pro moravský szeletien, bohunicien, Líšeň/Podolí I a aurignacien. Grafické zpracování P. Škrdla.*

Artefact Code, Context (sq., layer, XU) Figure	Size (mm) L × W × T	Raw material	Colour	Magnetic susceptibility (SI)	Technology/typology	Comments
A001 C, L8, 13 Fig. 1: 1	46 × 25 × 9	Moravian Jurassic chert	2.5Y 7/1 Light-grey	0.000 × 10-3 SI	Bilaterally retouched (dorsal) blade with a broken distal end (a point?).	Light-grey (2.5Y 7/1) is the dominant colour. The light-grey siliceous mass contains many small fossils, which cannot be identified. Sporadic irregular white stains up to 10 mm in size with micro-brecciated appearance are present. Darker colour near the bulb of percussion suggests that this stone was a pebble.
A002 A, L9, 14 Fig. 1: 9	69 × 41 × 10	Radiolarite	5YR 3/2 Greyish-brown	0.024 × 10-3	Endscraper on a large flake. Bilaterally retouched, lateral margins are irregularly denticulated, retouch scars are stepped, grading into blunting retouch. Distal end is shaped like a bec with two ventral retouch scars. Coarsely facetted platform.	Stone is very homogeneous with occasional greenish veinlets, radiolaria of two different sizes (>0.2 mm and <0.1 mm), sometimes with spikes. The larger radiolaria consist of transparent chalcedony, occasionally a white substance. The colour does not closely correspond to radiolarite specimens from the closest source – Vršatské Podhradí in the White Carpathian Mountains – the most common colours there are 10R 3/4 – 10R 4/2.
A003 C, L6, 9	9 × 2	Carnivore bone			Tubular bone rod.	See Wright et al. 2014.
A004 L7 Fig. 1: 8	54 × 34 × 10	Radiolarite	5R 4/2 Greyish-red	0.021 × 10-3	Bifacially retouched leafpoint with a concave base.	Distinct radiolaria infilled by transparent chalcedony. Radiolarite contains parallel oriented smudges – indication of layering. Transverse green veinlet 0.5 mm thick.
A005 C, L8,16 Fig. 1: 6	14 × 6 × 2	Erratic flint	Strong patina	0.000 × 10-3	Strongly patinated small flake.	A range of microfossils, including Bryozoa (moss animals), are visible through the homogeneous white patina.
A006 C, L10, 18 Fig. 1: 7	53 × 29 × 10	Spongolite	Strong patina		Bifacially retouched leafpoint, slightly asymmetrical with a straight base.	Patinated piece composed of two different parts: large white non-translucent inclusion ("petrosilex") in more translucent light brown siliceous mass. Transversal or perpendicular cross-sections of numerous sponge spiculae are typical.
A007 B, L5, 6 Fig. 1: 2	22 × 6 × 4	Moravian Jurassic chert	10YR 5/1 grey	0.000 × 10-3	Morphologically resembles a burin spall.	No visible microfossils. Probably originates from the Rudice layers.
A008 B, L6, 9		Tooth			Knapped flake.	See Nejman et al. 2017.
A009 B, L6, 7 Fig. 1: 3	39 × 25 × 9	Porcelanite	5Y 7/2 Yellowish-grey	0.032 × 10-3	Medial segment of a blade. Broken surface on the distal end is truncated. This truncation and a notch on the right lateral margin form a bec-shaped protrusion.	Strongly patinated raw material with yellowish grey (5Y 7/2) patina. Newly formed quartz forms in short, curved veinlets. Some small clastic grains of quartz also visible. The rock is almost identical with other porcelanite artefacts described from Pod Hradem Cave by Z. Nerudová, A. Přichystal, P. Neruda (Nerudová et al. 2012a; 2012b).
A010 B, L10, 17 Fig. 1: 5	7 × 12 × 1	Spongolite	Strong patina	0.005 × 10-3	A small flake originating from the fine preparation of a larger artefact.	Sponge spiculae cross sections are visible in some parts of the surface.
A011 B, L9, 16 Fig. 1: 4	7 × 8 × 4	Krumlovský les chert, variety II	10YR 5/1 grey	Too small for measurement	Small, irregularly shaped artefact with impact traces – this artefact may have been the tip of a leafpoint.	Grey colour is dominant in the translucent siliceous mass, there are no non-translucent inclusions (petrosilexes). Contains light-coloured microfossils with some identifiable as sponge spiculae. The colour and other properties suggest this silicic material can be identified as Krumlovský les chert, variety II.

Tab. 2. Descriptions of all artefacts recovered from Pod Hradem Cave in 2011, 2012, and 2016 (squares A, B and C).

Tab. 2. *Popisy všech artefaktů získaných v letech 2011, 2012 a 2016 z jeskyně Pod Hradem (čtverce A, B a C).*

The most characteristic stone artefact from this horizon is the leafpoint. Isolated leafpoints have been reported from other caves in the Moravian Karst (e.g. Rytířská cave – Jarošová 2002; Neruda, Valoch 2007), however, more detailed chronostratigraphic data is not available. Leafpoints have also been found during prospecting of open-air sites in the Brno Basin (c. 20 km to the South; Svoboda 1987), Bořitov area (c. 10 km to the northwest; Oliva, Štrof 1985), and Prostějov area (c. 25 km to the east; Svoboda 1980). Although the leafpoints are generally affiliated with the Early Szeletian in Moravia (Oliva 1991; Nerudová, Neruda 2017), they were also excavated from a stratified Bohunician context at the Bohunician-type site Brno-Bohunice (Valoch 1976; Tostevin, Škrdla 2006). Furthermore, leafpoints are known from the Late Szeletian of western Slovakia (Kaminská et al. 2011). In addition, personal ornaments are known from the Aurignacian layers in Geissenklösterle and Vogelherd (Otte 1993) and Líšeň/Podolí I type assemblages (Škrdla 2017b). With the currently available information, we are not able to distinguish which Early Upper Paleolithic technocomplex or industrial group bearers are responsible for the artefacts in the second phase group.

The 4 dates from layer 10 supplemented by a single date from layer 8 and another single date from layer 6 (SANU-30910, 40,900±1800) compose the third probability peak on the time scale. Dates are dispersed over 4 millennia with large probabilities. Of the 16 radiocarbon dates obtained from the 2011–2016 excavations, only two are significant outliers (both in layer 6) which suggests some mixing in this part of the stratigraphy (Nejman et al. 2017). The radiolarite endscraper from layer 9 (A002) is likely to date to the same period as the artefacts in layer 10 as these two layers were deposited during the same depositional "pulse". There is a distinctive difference in artefact raw materials for this group, many of which appear to be locally sourced (e.g. spongolite).

From a chrono-cultural perspective, the time range for this horizon (i.e. the third phase) is equivalent to the Late Middle Paleolithic occupation known from Kůlna Cave (Neruda, Nerudová 2014) and Švédův stůl Cave in the Moravian Karst (unpublished data from the recent project, cf. Nejman et al. 2020). However, it also slightly overlaps with the earliest radiocarbon dates from both the Bohunician (known in Brno Basin, c. 20 km to the south, and Prostějov area, c. 25 km to the east), and Szeletian (stratified sites in Bobrava area c. 30 km to the southeast and Krumlovský les area, c. 40 km to the southwest). Although the time span significantly overlaps with TL dates for the Brno-Bohunice type site, the radiocarbon dates are younger (Richter et al. 2008), the artefacts are different and the most characteristic Bohunician implement in the Brno Basin – the Levallois point made from Stránská skála-type chert, is not present. In contrast to the Bohunician, the artefacts from this horizon fit typologically with a Szeletian toolkit, however, the Szeletian attribution is not strongly supported by the time range using the available dates (probability overlap is only minor) for the Szeletian. As the artefacts fit well typologically and technologically with the local Middle Paleolithic tool kit as well, it is currently the most probable attribution for the artefacts in this horizon.

The new chronology should not detract from previous ones. Here we recognise that there has been limited site disturbance, however, even with disturbance we are able to see three clear pulses of sedimentation. Concurrently, a remarkably intact stratigraphy has been recorded at Pod Hradem Cave and the chronostratigraphy remains important.

5. Conclusion

The extremely sparse archaeological evidence from Pod Hradem Cave points to high mobility during the Early Upper Paleolithic, with artefacts sourced to regions many tens (sometimes hundreds) of kilometres away in many directions. This is particularly the case for the first and second groups of artefacts, with the third group primarily consisting of locally sourced raw materials. This suggests substantial alterations in hominin activity during and after the M-UP Transition. Considering the very small number of artefacts, it also demonstrates that even ephemeral visitation sites such as Pod Hradem Cave can play a significant role in reaching conclusions about mobility and raw material movements during these periods (cf. Nejman et al. 2017). The elevated, jagged limestone rock formations of the Moravian Karst would have attracted the attention of the highly mobile Early Upper Paleolithic people and the Pustý Žleb valley likely acted as one of the major conduits for people moving through this microregion, a situation arguably rather different to previous Neanderthal use of this area.

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Resumé

Archeologické nálezy z jeskyně Pod Hradem dokládají, že lovci tuto těžko přístupnou jeskyni výjimečně navštěvovali. Počtem drobná kolekce artefaktů, které jsou často vyrobeny ze surovin importovaných z různých vzdálených zdrojů (do 120 km), pokrývá časový úsek 15 000 let (tab. 1). Přestože výsledky výzkumů v letech 2011, 2012 a 2016 již byly publikovány v několika příspěvcích (Lisá et al. 2018; Nejman et al. 2017, 2018a, b; Wright et al. 2014), nález dalšího drobného artefaktu, dodatečně vytříděného při zpracovávání výplavu, nás přiměl k předložení aktuálního příspěvku. Při té příležitosti jsme se také zaměřili na upřesnění popisu artefaktů, včetně detailní analýzy surovin, ze kterých jsou vyrobeny (obr. 1, tab. 2). Současně jsme se pokusili o roztřídění artefaktů podle radiokarbonových dat získaných z jednotlivých vrstev a následně o test integrity jednotlivých v terénu definovaných vrstev. Oproti předchozí publikaci (Nejman et al. 2017), kde byla data kalibrována pomocí software OxCal (Bronk Ramsey 2009) na kalibrační křivce IntCal 2013 (Reimer et al. 2013), jsme nyní použili software CalPal (Weninger, Jöris 2008) a kalibrační křivku IntCal 2020 (Reimer et al. 2020).

Na základě obalové křivky pravděpodobností radiokarbonového datování jsme vyčlenili 3 chronologické skupiny a k nim přidělili odpovídající artefakty (obr. 2). Do první z těchto skupin patří ojedinělý artefakt morfologicky odpovídající rydlové třísce z moravského jurského rohovce (obr. 1: 2), který byl nalezen ve vrstvě 5, která na základě data odpovídá střednímu aurignacienu. Do druhé chronologické skupiny, která zahrnuje vrstvy 6 a 7 a odpovídá intervalu vymezenému HE-5 až GI-11, byly přiřazeny listovitý hrot s konkávní bází z červeného radiolaritu (obr. 1: 8), zlomek čepele z porcelanitu (obr. 1: 3), štípaný zub a kostěný korálek (Wright et al. 2014). Důležitý je nález porcelanitového artefaktu, který spojuje tento horizont s dřívějšími nálezy z této suroviny (včetně listovitého hrotu), které byly získány během výzkumu K. Valocha (Nerudová et al. 2012a). Zmínit je třeba i dnes ztracený listovitý hrot z radiolaritu nalezený J. Simonem (Valoch 1965), který je morfologicky srovnatelný s výše popsaným hrotem. Druhá chronologická skupina se překrývá s časovým rozpětím moravského bohunicienu, szeletienu a industrií typu Líšeň/Podolí I. Korálek má analogie v časném aurignacienu východní i západní Evropy (Wright et al. 2014). Aktuálně tyto artefakty nejsme schopni spolehlivě přiřadit k žádné z časně mladopaleolitických industrií.

Do třetí – nejstarší chronologické skupiny, která odpovídá vrstvám 8–10 (ojedinělé datum z vrstvy 6 pokládáno za kontaminaci), spadá největší počet artefaktů. Kolekce zahrnuje škrabadlo s bilaterální zoubkovanou retuší na větším úštěpu červeného radiolaritu (obr. 1: 9), listovitý hrot ze spongolitu (obr. 1: 7), bilaterálně retušovanou čepel s odlomeným distálním koncem (hrot?) z moravského jurského rohovce (obr. 1: 1), malé úštěpy z eratického silicitu (obr. 1: 6) a spongolitu (obr. 1: 5) a drobný distální zlomek nepravidelně retušovaného artefaktu se stopami impaktů (možná špička listovitého hrotu) z rohovce typu Krumlovský les, varieta II (obr. 1: 4). Chronologicky se tato skupina překrývá s daty pro pozdní fázi středního paleolitu z jeskyně Kůlna (Neruda, Nerudová 2014) nebo jeskyně Švédův stůl (nepublikovaná data z aktuálního projektu, cf. Nejman et al. 2020), ale minoritně se překrývá i s nejstaršími radiokarbonovými daty pro bohunicien a szeletien. Výrazný je naopak překryv s termoluminiscenčními daty z Bohunic (Richter et al. 2008), přiřazení k bohunicienu je ale problematické, protože artefakty postrádají charakteristické rysy tohoto technokomplexu. Nejpravděpodobnější se tak jeví příslušnost souboru k pozdní fázi středního paleolitu.

Většina nečetných artefaktů ve vrstvách 6–9 jeskyně Pod Hradem byla vyrobena ze surovin, které pocházejí ze zdrojů vzdálených desítky (někdy stovky) kilometrů různými směry, což dokládá vysokou mobilitu časně mladopaleolitických populací, tedy vymezených chronologických skupin 1 a 2. Oproti tomu ve skupině 3 je vyšší podíl lokálních surovin, což naznačuje podstatný rozdíl v lidských aktivitách. I takto malý počet artefaktů z příležitostně navštěvované lokality, jako představuje jeskyně Pod Hradem, je třeba vzít v úvahu při závěrech ohledně mobility populací ve sledovaném období (cf. Nejman et al. 2017).

Moravský kras mohl přitahovat vysoce mobilní časně mladopaleolitické populace a Pustý žleb zřejmě fungoval jako důležitá spojnice pro lidi procházející tímto mikroregionem, což je situace odlišná od předchozího neandrtálského osídlení oblasti.

Contacts

Ladislav Nejman
School of Archaeology and Anthropology
Banks Building, The Australian National University
44 Linnaeus Way
AU-0200 Canberra
lnejman81@gmail.com
&
Archeologický ústav AV ČR, Brno, v. v. i.
Čechyňská 19
CZ-602 00 Brno

Petr Škrdla
Archeologický ústav AV ČR, Brno, v. v. i.
Čechyňská 19
CZ-602 00 Brno
skrdla@arub.cz
ORCID: 0000-0002-4364-2594

Duncan Wright
School of Archaeology and Anthropology
Banks Building, The Australian National University
44 Linnaeus Way
AU-0200 Canberra
duncan.wright@anu.edu.au
ORCID: 0000-0003-2546-0559

Jaroslav Bartík
Archeologický ústav AV ČR, Brno, v. v. i.
Čechyňská 19
CZ-602 00 Brno
bartik@arub.cz
ORCID: 0000-0003-1078-5799

Antonín Přichystal
Ústav geologický věd, Přírodovědecká fakulta
Masarykova univerzita
Kotlářská 2
CZ-611 37 Brno
prichy@sci.muni.cz
ORCID: 0000-0001-6653-0416