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## Editorial

Vážení přispěvatelé a čtenáři časopisu *Přehled výzkumů*,

poměrně nedávno, konkrétně v čísle 57-1 jsme si připomněli malé výročí: uběhlo 60 let od rozhodnutí tehdejších pracovníků Archeologického ústavu ČSAV v Brně založit a vydávat časopis *Přehled výzkumů*. Jak již název napovídá, jeho cílem bylo referovat nejen o aktuálních terénních výzkumech, ale taktéž publikovat analytické příspěvky a teoretické stati. Protože vydavatel i redakce musejí reagovat na aktuální situaci v oboru i na trhu publikací, snaží se o neustálé zkvalitňování časopisu. Toto nikdy nekončící úsilí bylo aktuálně oceněno zařazením časopisu *Přehled výzkumů* do mezinárodní databáze SCOPUS, konkrétně od ročníku 58 (v databázi ERIH+ a na seznamu recenzovaných časopisů vydávaných v ČR zůstává i nadále). Protože časopis je již několik let k dispozici nejenom v tištěné, ale i elektronické formě (open access), bylo mu od ročníku 59 přiděleno též ISSN 2571-0605 pro jeho elektronickou verzi.

Studie v čísle 59-1 prezentují výzkum v jeskyni Pod hradem v Moravském krasu se zaměřením na objev baltského jantaru (L. Nejman et al.), nový detailní rozbor materiálu z lokality tzv. Pomoravského aurignacienu v Hlinsku (Yu. Demidenko et al.), výzkum klasické lokality pavlovienu Dolní Věstonice I v 90. letech minulého století (J. Svoboda et al.), studii o vybraných aspektech nakládání s lidskými ostatky v pavlovienu (S. Sázlová et al.) a příspěvek k možnostem modelování tras tažení římské armády proti Marobudovi (M. Vlach). Rádi bychom, aby publikované příspěvky byly přínosným stimulem do diskusí nad dotčenými tématy. Jako každoročně, část nazvaná *Zprávy o výzkumech* předkládá základní informace o archeologických terénních aktivitách na Moravě a v české části Slezska v roce 2017.

*V Brně, 30. června 2018,  
Petr Škrdla jménem redakční rady*

STUDIE A KRÁTKÉ ČLÁNKY  
CASE STUDIES AND SHORT ARTICLES  
STUDIEN UND KURZE ARTIKEL

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# PUZZLING PAIRS FROM PAVLOV AND MORTUARY DIVERSITY IN THE MID UPPER PALEOLITHIC

## PROBLEMATIKA PÁRŮ RUKOU A NOH Z PAVLOVA A RŮZNORODOST POHŘBÍVÁNÍ VE STŘEDNÍ FÁZI MLADÉHO PALEOLITU

SANDRA SÁZELOVÁ, JAROSŁAW WILCZYŃSKI, PIOTR WOJTAL, JIŘÍ SVOBODA,  
ERIK TRINKAUS

### Abstract

*Taphonomic, paleopathological, and paleodemographic analyses of human remains from the Mid Upper Paleolithic of western Eurasia are increasingly documenting a diversity of mortuary behaviors among these successful Late Pleistocene foragers. These considerations are joined by three associated pairs of otherwise isolated appendicular remains from the site of Pavlov I (the Pavlov 31 partial hands and the Pavlov 37 and 38 tarsometatarsal skeletons), previously described morphologically but not assessed in terms of their taphonomy. They are described here with respect to their contexts and patterns of preservation to assess possible taphonomic and/or mortuary implications of these sets of antimeres. Subchondral articular bone that is free of carbonate encrustation on at least the Pavlov 37 pedal remains suggests some degree of articulation in situ. Although root etched, the elements lack carnivore or other vertebrate damage, as well as cut marks. Even though associated unilateral hand or foot remains are unexceptional among the fur-bearing faunal remains, the bilateral presence of these human remains raises questions concerning the taphonomic and behavioral/mortuary processes responsible for their preservation: do they represent portions of abandoned human bodies, remains of naturally disturbed burials, extremities left from secondary burials, and/or intentionally manipulated human body portions? Any combination of these processes expands current perceptions of the mortuary diversity among these early modern humans.*

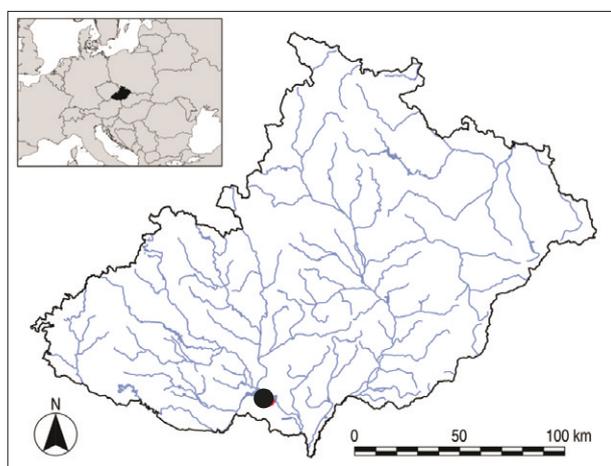
### Keywords

*Upper Paleolithic; Taphonomy; Pedal; Manual; Moravia; Postcranial; Czech Republic*

The western Eurasian Mid Upper Paleolithic, or Gravettian *sensu lato*, is well known for its intentional burials, varying from ones with little elaboration to ones with localized ochre and a few beads to ones with extensive ochre, 100s-1000s of beads, and mobiliary art objects (for inventories, see Henry-Gambier 2008; Trinkaus *et al.* 2014a; Vanhaeren, d'Errico 2002). The burials appear to have an elevated representation of biologically unusual individuals and are age and sex biased towards adolescent/adult males (Formicola 2007; Trinkaus *et al.* 2014a; Zilhão, Trinkaus 2002). These often elaborate graves have generated considerable discussion as to their social implications (see e.g., Pettitt 2011), given the close relationship between mortuary and social behaviors (Powell 1880; see also Binford, 1971; Parker-Pearson 2000; Tainter, 1973). What has received less attention, in a mortuary context beyond human morphological considerations, are the scattered, fragmentary and isolated human remains from Mid Upper Paleolithic sites (but see Henry-Gambier *et al.* 2013a; Trinkaus *et al.* 2000, 2010; Trinkaus, Buzhilova, 2018).

The scattered and isolated human remains are primarily known from sites without burials, but there

are also examples of sites with both isolated human teeth and/or fragmentary skeletal elements as well as intentional burials (e.g., Dolní Věstonice I and II, Krens-Wachtberg, Paglicci, Pavlov I, Předmostí, Sungir, and probably Cro-Magnon and Miesslingtal; Einwögerer *et al.* 2006; Holliday *et al.* 2006; Mac-

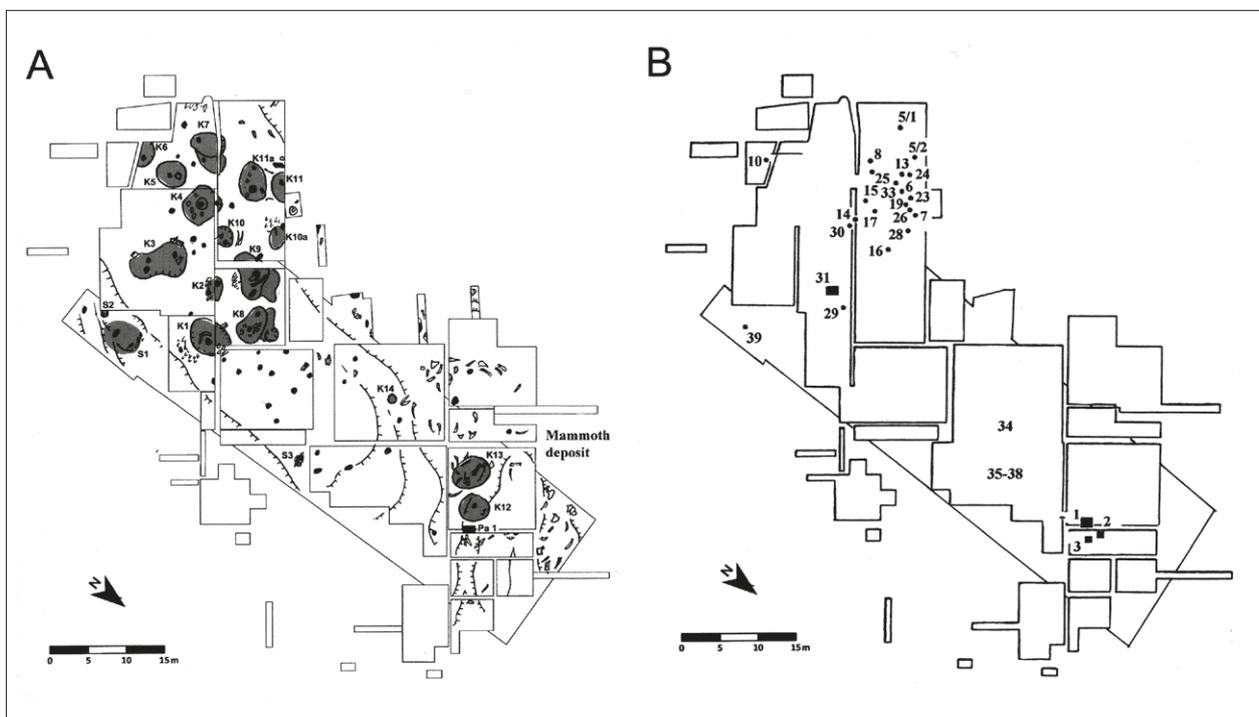


Location of the site on a map of Moravia.  
*Poloha studované lokality na mapě Moravy.*

Curdy 1924; Mallegni, Palma di Cesnola 1994; Matiegka 1934; Svoboda 2008; Trinkaus *et al.* 2010, 2014a; Vallois, Billy 1965). There are a variety of mortuary and taphonomic processes that could account for the presence of the remains of isolated skeletal or dental remains at sites with (or without) clear burials. These processes include, but are not limited to, post-depositional geological disturbance, carnivore scavenging of bodies left on the surface or in shallow graves, disturbance from burrowing mammals, and secondary mortuary treatment of human remains. Non-buried human bodies may result from differential social status, abandonment of the infirm, and/or frozen ground at the time of death, all in the context of these highly mobile Late Pleistocene foraging populations. In this context, there is one case of an apparently intentional placement of a human cranium (Sunghir 5), and another case of the probable manipulation of adult

and immature human remains (Pataud 1 to 6) (Bader 1998; Henry-Gambier *et al.* 2013a; Trinkaus, Buzhilova 2018). In addition, there are three and possibly four pairs of postcranial antimeres from one site (Pavlov I) (Trinkaus *et al.* 2010, 2017), whose pattern of preservation raises questions regarding their treatment and/or disturbance.

These pairs of appendicular antimeres, the Pavlov 31 hands remains, the Pavlov 37 and 38 tarsometatarsal skeletons, plus possibly the Pavlov 34 and 35 patellae, have been described morphologically (Trinkaus *et al.* 2010, 2017), and preliminary taphonomic issues regarding Pavlov 31 have been raised (Henry-Gambier *et al.* 2013a; Trinkaus *et al.* 2010). However, the relevant assessment of the contexts and preservation of these remains and the possible taphonomic (including mortuary) processes responsible for their survival as



**Fig. 1.** Plans of the Pavlov I site. A: the distribution of the settlement units K1–K14 (Klíma excavations) and S1–S3 (Svoboda excavations). B: human fossil find locations. Pavlov I Northwest is to the lower right with the locations of Pavlov 1 to 3 indicated, and Pavlov I Southeast is in the upper left with the positions of the other Pavlov I human remains provided (all isolated elements except for the Pavlov 1 partial skeleton and the Pavlov 31 partial hands). The approximate positions of the Pavlov 34 to 38 remains in Pavlov I Centre are provided; their precise positions are unknown, but the root traces on them suggest the northern portion where the loess coverage was shallow. The oblique rectangular outline indicates the 2013–2015 salvage excavations, done prior to the building of the modern site museum. This excavation added the last fossil, Pavlov 39. Scales: 15 meters. Graphics: J. Svoboda, P. Hájková.

**Obr. 1.** Plány lokality Pavlov I. A: distribuce sídelních jednotek K1–K14 (výzkumy B. Klímy) a S1–S3 (výzkumy J. Svobody). B: lokalizace lidských fosilií. Pavlov I severozápad vpravo dole s naznačeným umístěním fosilií Pavlov 1 až 3; Pavlov I jihovýchod vlevo nahoře s vyznačením všech izolovaných fragmentů (vyjma částečně zachované kostry Pavlov 1 a kostí rukou Pavlov 31). Přibližná pozice pro Pavlov 34 až 38 se nachází v centrální části lokality Pavlov I. Jejich přesná lokalizace není známa, přesto by stopy po kořincích rostlin mohly naznačovat spíše severní polohu, kde je relativně mělký překryv spraší. Dále je naznačen záchranný výzkum z let 2013–2015 v půdorysu stavby moderního muzea. Během výzkumu byla zaznamenána poslední fosilie, Pavlov 39. Měřítko: 15 m. Grafika: J. Svoboda, P. Hájková.

isolated manual or pedal (or patellar) pairs have not been adequately presented. Therefore, what processes could have resulted in the preservation of isolated sets of paired hands and feet (or patellae), separate from other portions of the individuals' skeletons?

## The Context

### The site of Pavlov I

Pavlov I is a large ( $\approx 90 \times \approx 50$  m) open air site (Fig. 1), originally on a raised ridge overlooking the Dyje River valley, on the lower northern slopes of the Pavlov Hills ( $48^\circ 52'$  N,  $16^\circ 40'$  E; 190–200 m a. s. l.) (Klíma 1954; Svoboda *et al.* 2016). The primary archeological horizons consist of a series of occupation levels within the loess deposits, in places blended as palimpsests and containing a series of features (hearths, pits, structure “hut” foundations) that have been related to 17 settlement units across the site. It was excavated between 1952 and 1972 by the late Bohuslav Klíma, and recently (2013–2015) by JS and colleagues in preparation for a museum on the site.

The site's stratigraphy consists, generally, of an overlying last glacial maximum (LGM) loess, a 50–70 cm thick loess complex with interstratified anthropogenic layers containing artifacts, faunal remains and features, and an underlying 15–40 cm thick paleosol. The deeper paleosol yielded radiocarbon dates between 36 and 38 ka cal BP, along with an Early Upper Paleolithic lithic assemblage, whereas the primary cultural layers provided radiocarbon dates of 29 to 33 ka cal BP, indicating an early to middle Gravettian (Pavlovian) sequence (30 dates, calibrated using OxCal 4.2 / IntCal 13; Bronk Ramsey 2009; Reimer *et al.* 2013; see Svoboda *et al.* 2016). It is this complex of anthropogenic layers, variably separate or blended post-depositionally into archeological palimpsests, that has provided the wealth of archeological materials, as well as the human remains of concern here.

The extremely rich lithic assemblage is predominantly attributed to the middle Gravettian (Pavlovian); along with the roughly contemporaneous and nearby sites of Dolní Věstonice I and II, the site provides an exceptional archeological record for this time period (Svoboda 2016). In addition to the abundant faunal remains and the large lithic assemblage made mostly on non-local raw materials, Pavlov I has yielded patterned structures, an elaborated organic technology, ceramic figurines, textile impressions, and evidence for both plant and animal food processing. To these aspects can be added similar features and artifacts, as well as burials with ochre and jewelry, from the nearby sites of Dolní Věstonice I and II.

### The Pavlovian human remains

Dolní Věstonice I and II have yielded human burials (Dolní Věstonice 3, 4, and 13 to 16), an associated partial infant's dentition (Dolní Věstonice 36), and an abundance of isolated human remains (including portions of 11 crania, 17 teeth from 11 specimens, and 28 postcranial elements) (Holliday *et al.* 2006; Trinkaus *et al.* 2010). All of the Dolní Věstonice burials except the Dolní Věstonice 4 child's burial retain portions of all of their anatomical regions. The burials were either adjacent to (Dolní Věstonice 3, 4, and 13 to 15) or within (Dolní Věstonice 16) structure foundations, and the isolated elements were similarly scattered through the occupation areas of the sites (Svoboda 2016; Trinkaus *et al.* 2018).

Pavlov I Northwest yielded, in 1957, the associated partial skeleton of an adult male (Pavlov 1), post-depositionally disturbed but apparently originally buried. The skeleton retains the cranium, the mandible, nine vertebrae, one rib, clavicles, scapulae, humeri, ulnae, radii, a metacarpal 3, femora, tibiae and a fibula. The bones were found disarticulated but in close association, within an erosional gully in the northwestern portion of the site. Given its non-articulated *in situ* position, it is possible that it represents a secondary burial, given the general absence of the bones of the hands and feet (see Redfern 2008; Roksandic 2002). Secondary burials can take on many forms (Duday *et al.* 1990), but the preservation of vertebral elements from the C2 to a lumbar facet, plus a middle rib and a third metacarpal, make intentional displacement of the skeletal remains less likely. Moreover, the evidence for geological disturbance makes it far more probable that the bones were naturally rearranged, damaged and partially lost post-deposition and post-decomposition.

Associated with Pavlov 1 in Pavlov I Northwest were the fragmentary Pavlov 2 to 4 maxilla and mandibles (Vlček 1997). In addition, 29 teeth (Pavlov 5 to 28, 30, 32 and 39, three of them pierced, and including two pairs and 9 exfoliated deciduous teeth) derive from Pavlov I Southeast, along with the Pavlov 29 and 33 isolated immature hand phalanges and the associated Pavlov 31 hand remains. Pavlov I Centre has yielded two patellae (Pavlov 34 and 35), an isolated metacarpal (Pavlov 36), and two pairs of partial tarsometatarsal skeletons (Pavlov 37 and 38) (Trinkaus *et al.* 2017).

The human remains from Pavlov I Northwest and Southeast were either identified *in situ* by Klíma or identified among the faunal remains by PW and JW (Pavlov 29 to 33) and SS (Pavlov 39). Almost all of them are localized to excavation squares, and they derive from the areas of concentration of the settlement units. Pavlov 36 to 38 were recently identified among the faunal remains by PW and JW, but their precise proveniences within Pavlov I Centre are not

known (the excavation plans for those years have not been located among Klíma's archives). However, the Pavlov 35 patella and the Pavlov 37 and 38 paired pedal remains were curated together and therefore derive from the same location in the site. They also share a hard gray carbonate encrustation not present on Pavlov 34 and 36. It is not evident from where in Pavlov I Centre the Pavlov 34 and 36 remains derive relative to the others, but their association with fauna excavated in 1961 indicates that they come from the middle of Pavlov I Centre. Traces of root-etching and erosion, more intensive than elsewhere, may suggest deposition under a shallow layer of loess, which was the case in the northern (downslope) part of Pavlov I Centre.

Therefore, the sites of Pavlov I and Dolní Věstonice I and II have yielded a series of intentional burials, a partial infant's dentition, numerous isolated teeth and skeletal elements, and three or four sets of appendicular antimeres. The burials and isolated elements raise a series of questions regarding the associated mortuary behaviors, but the puzzling pairs raise additional issues.

## The Puzzling Pairs from Pavlov

### The Pavlov 31 hand remains

The Pavlov 31 associated hand remains consist of 16 carpals, metacarpals and proximal phalanges excavated in 1953 from Klíma's square 3/III (13/8 following the unified site grid) in Pavlov I Southeast (Fig. 2). The carpal bones include the left capitate and scaphoid bones and the right and left trapezia. The metacarpals are the right and left first and second ones, plus the right third and fifth metacarpals. The proximal phalanges include both pollical ones, and one each from the four ulnar digits. Only the pollical and third proximal phalanges can be reliably assigned to side (as arranged in Fig. 2), and the other phalanges are positioned as right given the greater preservation of right metacarpals. It is not known whether the Pavlov 31 hand remains were in articulation *in situ*, because they were identified as human from the faunal remains.

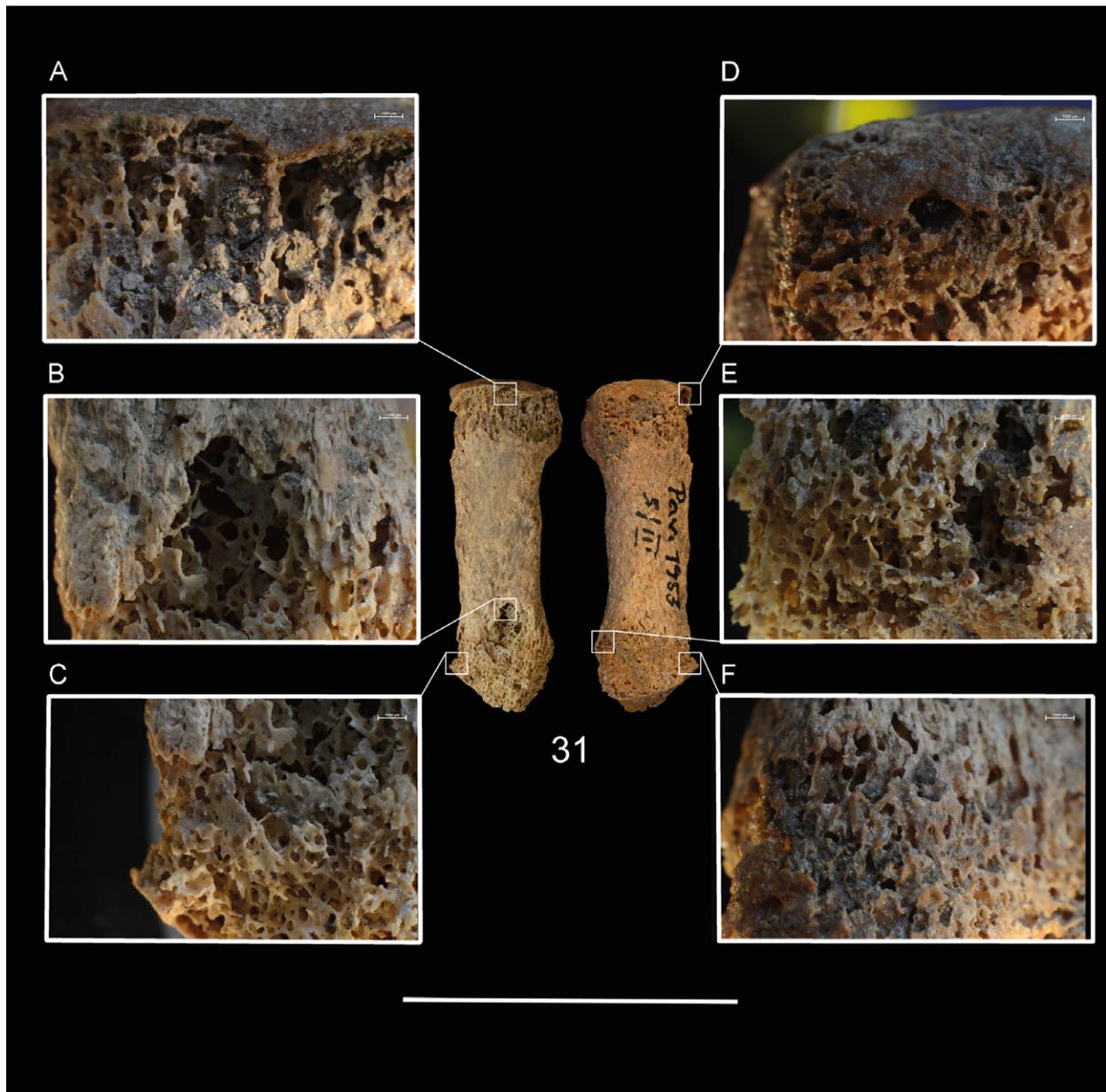
Of these remains, there are four bilateral pairs (Fig. 2), the trapezia, the first and second metacarpals, and the pollical phalanges (two proximal phalanges originally listed as fourth [Trinkaus *et al.* 2010] are best considered as second and fourth, as arranged in Fig. 2). The association of these pairs is based on the marked morphological and morphometric similarities of the antimeres, despite minor variations and the ubiquitous erosion of the articular ends. Pavlov 31 therefore documents the original presence of bilateral hand remains of one individual.

The closest *in situ* human skeletal element was the Pavlov 29 immature manual middle phalanx (from square 1/I in Pavlov I Southeast), and the other human remains known from Pavlov I Southeast (Fig. 1) are isolated or paired teeth, 9 of which are deciduous and were shed antemortem (Hillson 2006). The Pavlov 36 left second metacarpal, from 25–30 m away in Pavlov I Centre, duplicates the Pavlov 31 left metacarpal 2. With an estimated articular length of  $\approx 69$  mm, it is also substantially shorter than the Pavlov 31 metacarpal 2 (77.1 mm). The Pavlov 1 associated skeleton retains a left third metacarpal, which is rather smaller than the Pavlov 31 right one (Sládek *et al.* 2000; Trinkaus *et al.* 2010), and it was  $\approx 45$  m away in Pavlov I Northwest. The extensive manual remains of Dolní Věstonice 3 and 16 (32 and 39 bones respectively, including all of their metacarpals except the Dolní Věstonice 16 left metacarpal 1) duplicate the Pavlov 31 remains, as does the presence of one or both second metacarpals for Dolní Věstonice 13 to 15 (Sládek *et al.* 2000). Pavlov 31 therefore does not derive from any of the associated skeletons from Pavlov I or Dolní Věstonice I and II. Nor can it be anatomically associated with any of the other isolated remains from Pavlov I.



**Fig. 2.** The Pavlov 31 metacarpals and proximal manual phalanges in dorsal view. The vertical bar separates the right and left elements, bearing in mind that the proximal phalanges 2, 4 and 5 are not diagnostic as to side. The right and left trapezia and the left capitate and scaphoid bones are not shown. The preserved antimeres are the trapezia, metacarpals 1 and 2, and proximal phalanges 1. Scale bar: 5 cm. Photo: E. Trinkaus.

**Obr. 2.** Pavlov 31 kosti záprstní a proximální prstní články v dorzálním pohledu. Vertikální linie odděluje pravou a levou ruku s poznámkou, že druhý, čtvrtý a pátý proximální prstní článek nelze s určitostí stranově přiřadit. Pravá a levá kost mnohohranná, levá kost hlavatá a lod'kovitá nejsou součástí fotografie. Zachovaný pár tak představují kosti mnohohranné, první a druhé kosti záprstní a první proximální prstní články. Měřítka: 5 cm. Foto: E. Trinkaus.

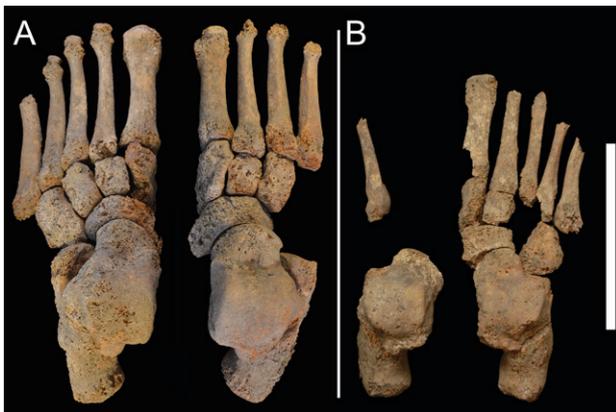


**Fig. 3.** The right first metacarpal of Pavlov 31 with surface bone and exposed trabeculae reflecting taphonomic processes: A) dorsal head with post-depositional damage; B) post-depositional trabecular damage and proximal cortical diaphyseal bone affected by root etching; C) non-specific surface erosion on proximo-radio-dorsal bone; D) root etching on radial side of the palmar head, E) non-specific surface erosion on ulnar side of proximal palmar diaphysis; and F) bone surface eroded by root etching on radial side of the palmar base. The presence of gray carbonate encrustations on and into the damaged trabeculae in each enlargement indicates that the damage was in situ prior to excavation. Scale bars: macro-level 5 cm and micro-level 1000 microns. Photo: S. Sázellová, E. Trinkaus.

**Obr. 3.** První pravá kost zápěstní Pavlov 31, jejíž povrch a exponovaná trámčina naznačují tyto tafonomické procesy: A) hlavička s dorzálním postdepozičním poškozením; B) postdepoziční poškození trámčiny a povrch v proximální části diafýzy poškozen kořinkou rostlin; C) nespecifická koroze na proximo-radio-dorzální straně kosti; D) otisky kořinek rostlin na radiální straně hlavičky v palmárním pohledu; E) nespecifická povrchová koroze na ulnární straně proximální části diafýzy v palmárním pohledu; F) povrch kosti rozrušen kořinkou rostlin na radiální straně báze v palmárním pohledu. Přítomnost šedých konkrecí uhlíkatého vápenatého na povrchu i uvnitř poškozené trámčiny naznačují, že k poškozením došlo in situ. Měřítka: makro úroveň 5 cm a mikro úroveň 1000 mikronů. Foto: S. Sázellová, E. Trinkaus.

It should also be noted that the Pavlov 31 hand remains are among the longest of the Dolní Věstonice/Pavlov and Mid Upper Paleolithic ones. Among the former, Dolní Věstonice 3, 13, 15, 16, and 59 provide metacarpal 2 articular lengths of 59.3, 69.7, 68.6, 71.5 and 79.5 mm respectively, plus Pavlov 36 at  $\approx$ 69 mm. In the pooled Mid Upper Paleolithic sample ( $n = 16$ ), only Dolní Věstonice 59 and Grotte-des-Enfants 4 (79.5 and 79.3 mm) have lengths close to or greater than that of Pavlov 31. The left Dolní Věstonice 59 metacarpal 2, and the associated Dolní Věstonice 58 metacarpal 3, however, are longer and substantially more gracile than those of Pavlov 31; they do not make appropriate antimeres.

All of these manual elements are extremely fragile (Fig. 2 and 3). The diaphyseal cortical bone is lightweight and soft, and those areas originally with thin cortical bone over trabeculae (the carpals and the articular ends of the metacarpals and phalanges) are variably porous, damaged or absent. Even the denser subchondral bone of the articulations is mostly absent, being present primarily at the pollical metacarpophalangeal and interphalangeal articulations. Only one metacarpal head is largely present (the left second), and none of the metacarpal base or ulnar phalangeal articulations are intact. The bones also show extensive fine surficial root etching.



**Fig. 4.** Dorsal views of the articulated Pavlov 37 right and left tarsometatarsal skeletons (A) and the right Pavlov 38 tarsometatarsal skeleton with the left talus, calcaneus and metatarsal 4 (B). Scale bar: 10 cm. Photo: E. Trinkaus.

**Obr. 4.** Dorzální pohled na artikulované části kostí nártních a zánártních Pavlov 37 z pravé a levé strany (A) a kosti nártní a zánártní Pavlov 38 z pravé strany společně s levou kostí hlezenní, patní a čtvrtou kostí zánártní (B). Měřítko: 10 cm. Foto: E. Trinkaus.

### The Pavlov 37 and 38 pedal remains

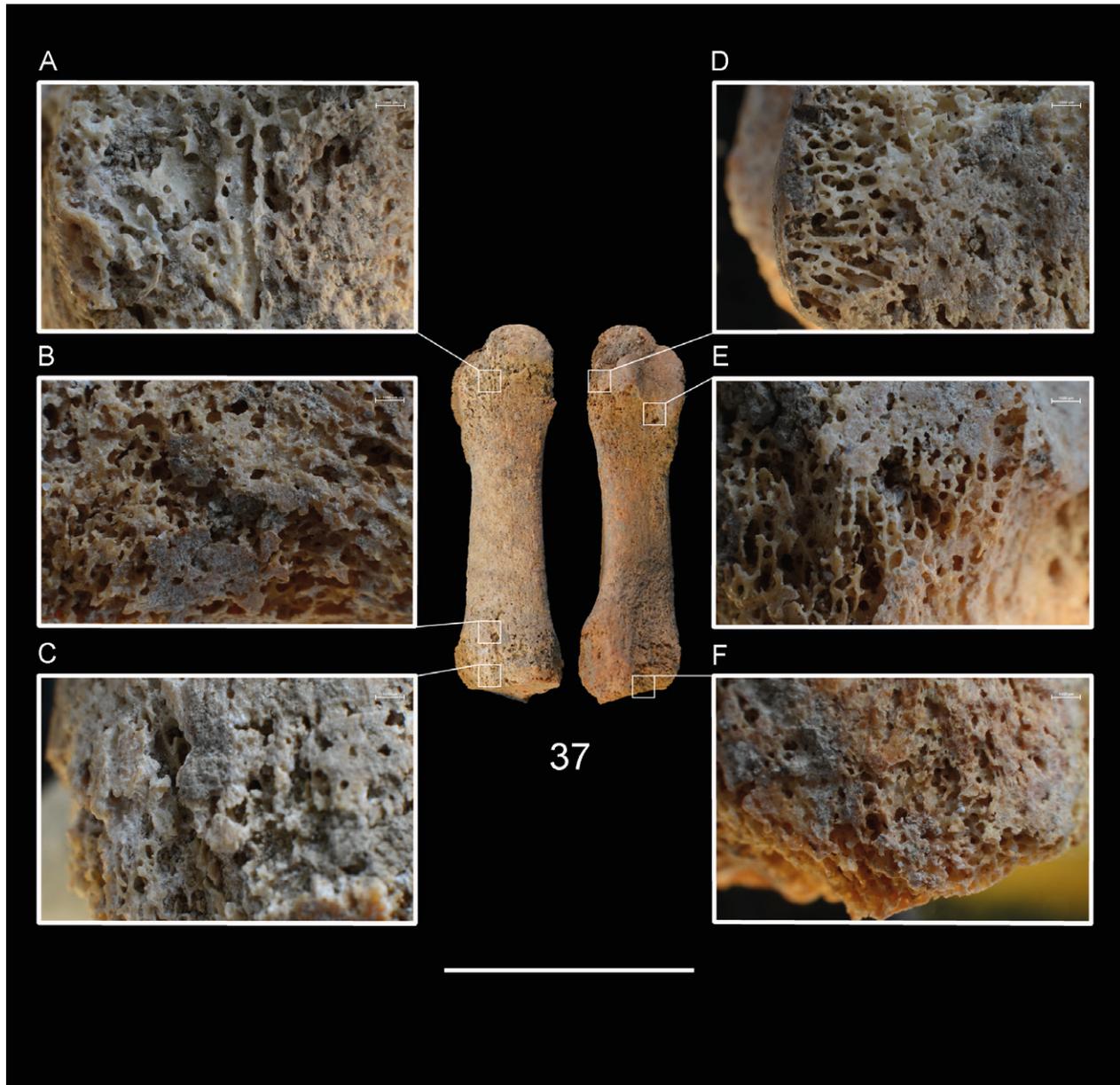
The Pavlov 37 and 38 pedal remains (Fig. 4) were excavated in the early 1960s in Pavlov I Centre and stored in the Moravian Museum – Budišov osteological depository, boxed together and labeled as number 177, “*C. lupus, Ursus arctos*.” Recognized as human by PW and JW, they were sorted into two pairs of feet by ET.

Pavlov 37, the larger individual, preserves 22 elements of the right and left tarsometatarsal skeletons, missing only the right cuboid and fifth metatarsal. None of the phalanges nor any portions of the leg long bones were located. The bones are better preserved than those of Pavlov 31 (and 38), but the bone is nonetheless lightweight and fragile (Fig. 4 and 5). Only the metatarsal diaphyses (Fig. 4) and some articular surfaces of the right talus (Fig. 6) do not show extensive erosion and porosity. Most of the intertarsal and tarsometatarsal subchondral bone is sufficiently intact to permit reliable articulation of the adjacent bones. However, only the left metatarsal 1 and 3 heads are mostly present, with portions of the subchondral bone or eroded trabeculae present for the right metatarsal 1 and the other metatarsals 2 to 4. Both the diaphyseal cortical bone and the exposed trabeculae exhibit extensive root etching.

Most of the external surfaces of the bones are covered with a thin, fine, gray, hard layer of adhering calcium carbonate aggregation. However, several of the intertarsal adjacent articular facets are largely free of the carbonate concretion; the right talonavicular facets are the best example of this phenomenon (Fig. 7), in which there are large and matching areas of the talar head and navicular talar facet that are carbonate free and more orange in color. This pattern suggests that these articulations, especially in the right foot, remained in close articulation *in situ*, and that each of the tarsometatarsal skeletons was largely articulated from burial to excavation.

The Pavlov 38 pedal remains were mixed with the Pavlov 37 ones in the Moravian Museum – Budišov osteological depository, boxed together and labeled as number 177, and recognized as human by PW and JW. Pavlov 38 retains of 14 tarsals and metatarsals, 11 of which derive from the right foot (Fig. 4). The right ones articulate appropriately, despite the extensive erosion of all but the talocalcaneal and dorsal tarsometatarsal 2 articular facets. The right and left tali and calcanei and the fourth metatarsals are morphologically and metrically appropriate antimeres (Fig. 4 and 6).

The Pavlov 38 remains are similar to those of Pavlov 31 in preservation (Fig. 4 and 8). They are light and fragile, and they have extensive erosion and porosity to all the surfaces except portions of the metatarsal diaphyses. Even the denser subchondral bone of the tali (Fig. 6) is heavily eroded. None of the metatarsal



**Fig. 5.** The right first metatarsal of Pavlov 37 with surface bone and exposed trabeculae reflecting taphonomic processes: A) root etching on medial side of the dorsal head; B) dorsal root etching of the metaphyseal (proximal) region; C) non-specific surface erosion on medial side of the dorsal base; D) root etching on the lateral side of the plantar head, E) non-specific surface erosion of the distal plantar diaphysis adjacent to the plantar head, and F) non-specific surface erosion on the plantar base. The presence of gray carbonate encrustations on and into the damaged trabeculae in each enlargement indicates that the damage was *in situ*, prior to excavation. Scale bars: macro-level 5 cm and micro-level 1000 microns. Photo: S. Sázellová, E. Trinkaus.

**Obr. 5.** První pravá kost nártní Pavlov 37, jejíž povrch a exponovaná trámčina naznačují tyto tafonomické procesy: A) otisky kořinek rostlin na mediální straně hlavičky v dorzálním pohledu; B) otisky kořinek rostlin v proximální části metafýzy v dorzálním pohledu; C) nesespecifická koroze povrchu na mediální straně báze v dorzálním pohledu; D) otisky kořinek rostlin na laterální straně hlavičky v plantárním pohledu; E) nesespecifická povrchová koroze na distální části diafýzy v blízkosti hlavičky v plantárním pohledu; F) nesespecifická koroze na plantární straně báze. Přítomnost šedých kongrecí uhličitánu vápenatého na povrchu i uvnitř poškozené trámčiny naznačují, že k poškozením došlo *in situ*. Měřítka: makro úroveň 5 cm a mikro úroveň 1000 mikronů. Foto: S. Sázellová, E. Trinkaus.

articulations are complete, although the metatarsal 1 retains most of its distal dorsal portion and the metatarsal 2 has its dorsal margin (Trinkaus *et al.* 2017, Fig. 18 and 25). Little remains of the non-articular surfaces of the anterior tarsals. The right talocalcaneal facets are largely free of adhering gray calcium carbonate, suggesting close articulation *in situ*, but the other surfaces are variably covered with the same hard gray matrix as is on the Pavlov 37 remains (Fig. 8).



**Fig. 6.** The Pavlov 37 and 38 paired tali in dorsal view (left) and the Pavlov 34 right and 35 left patellae in anterior and posterior views (right). Scale bar: 5 cm. Photo: E. Trinkaus.

**Obr. 6.** Pár kostí hlezenných Pavlov 37 a 38 v dorzálním pohledu (vlevo) a pár čéšek z pravé Pavlov 34 a levé Pavlov 35 strany v anteriorním a posteriorním pohledu (vpravo). Měřítko: 5 cm. Foto: E. Trinkaus.



**Fig. 7.** The Pavlov 37 tali in distal view (above) and navicular bones in proximal view (below) showing the matching articular surfaces without the adhering gray carbonate. It is particularly evident on the right talonavicular articulations. Scale bar: 5 cm. Photo: E. Trinkaus

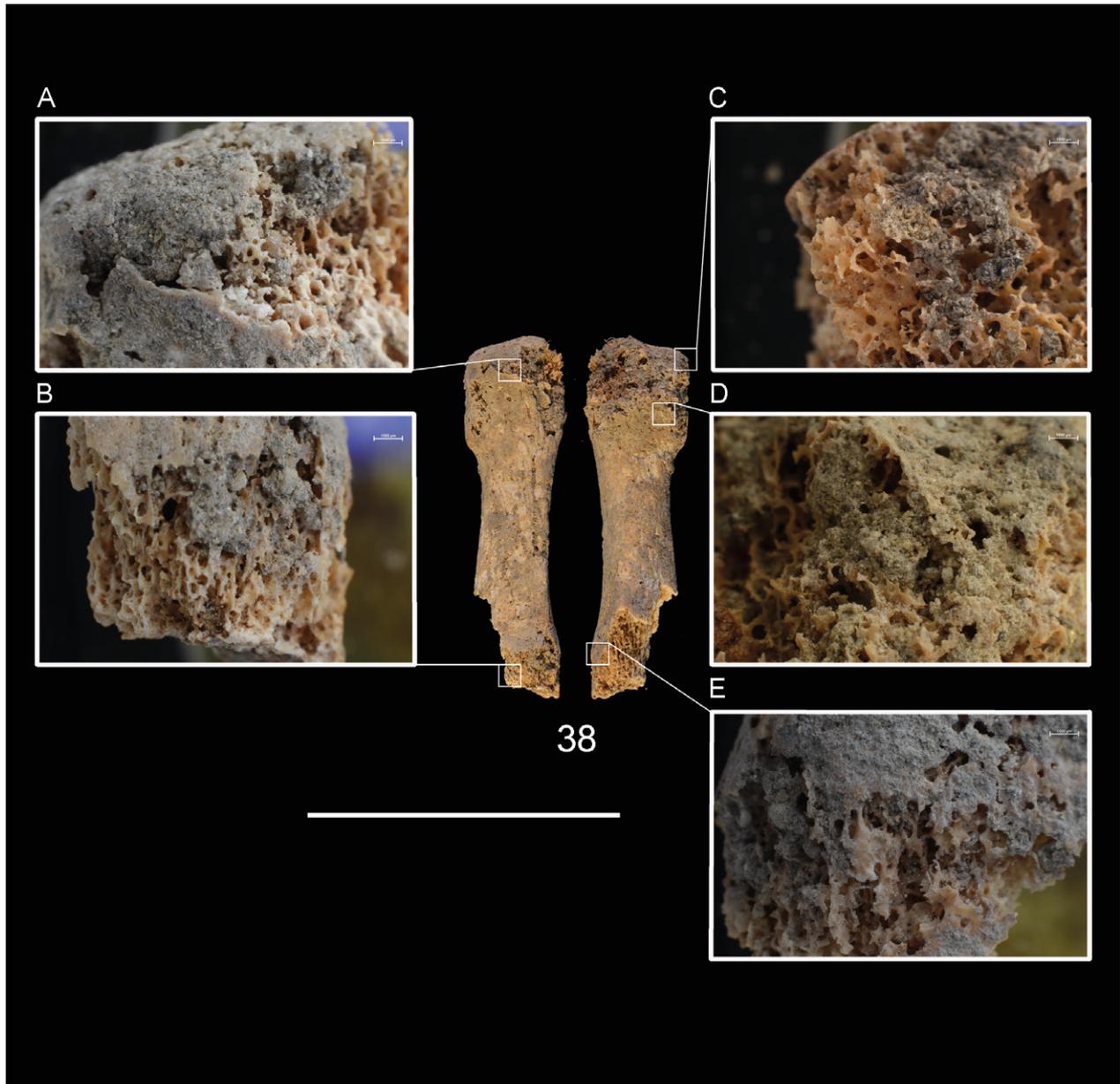
**Obr. 7.** Pavlov 37 kost hlezenná v distálním pohledu (nahore) a kost loďkovitá v pohledu proximálním (dole) naznačující, že přilehlé kloubní plochy nejsou pokryty šedou uhlíčitou konkrecí. Nejzřetelněji na pravém talonavikulárním kloubním spojení. Měřítko: 5 cm. Foto: E. Trinkaus.

The Pavlov 37 and 38 pedal remains overlap anatomically with the tali of Dolní Věstonice 3, 13, 15 and 16 and with the calcaneus of Dolní Věstonice 14, as well as with other tarsals and metatarsals in the Dolní Věstonice burials. They therefore do not derive from any of the Dolní Věstonice associated skeletons. Pavlov 1 lacks pedal remains and the distal tibiae, so that it is not possible to assess anatomically whether Pavlov 37 or 38 could derive from that individual. However, the long bones of Pavlov 1 together provide a stature estimate of 178 cm, and the femora alone provide one of 172 cm (Trinkaus 2006). The tali and first metatarsals of Pavlov 37 each provides a stature estimate of 188 cm (following Pablos *et al.* 2013); the same bones for Pavlov 38 provide estimates of 162 and 170 cm respectively. It is therefore possible, given the errors inherent in these stature calculations (Trotter, Gleser 1952; Pablos *et al.* 2013) that Pavlov 1 and 38 derive from the same individual, if the Pavlov 1 long bones over-estimate the stature and the pedal remains under-estimate it. It would be exceptional, however, for Pavlov 1 and 37 to be from the same individual.

#### The Pavlov 34 and 35 patellae

The faunal collections from Pavlov I Centre also yielded two largely intact right and left patellae, Pavlov 34 and 35, which appear superficially as probable antimeres (Fig. 6). Pavlov 35 derives from the same box (No. 177) as the Pavlov 37 and 38 pedal remains. Pavlov 34 was found separately, with a label of “1961.” It is not known how close they were *in situ*. The Pavlov 34 right patella is well-preserved, with erosion primarily to the proximomedial and posterodistal non-articular portions, the areas of thin cortical bone over trabeculae. The surfaces are largely clean of adhering calcium carbonate. The Pavlov 35 left one is similarly intact, with surface erosion in the same areas, but it exhibits the hard, gray carbonate, in places moderately thick, that is evident on the Pavlov 37 and 38 remains.

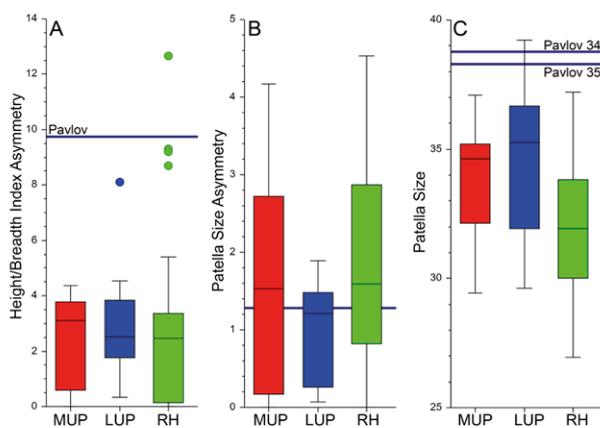
These patellae were numbered separately, given different contexts, slightly different preservation, and minor morphological differences. The articular crest is more medial on the right one, the lateral facet is flatter on the left one, and there is a vertical sulcus on the right medial facet which appears to be absent from the left one. The anterior (quadriceps femoris) surfaces are very similar, but the right patella is slightly higher (46.3 vs.  $\approx$ 44.6 mm) and the left one is slightly wider (51.5 vs. 48.5 mm). Together these measurements provide an absolute asymmetry value (see Auerbach, Ruff 2006) for the height/breadth index of 9.73. This value is a high outlier relative to Upper Paleolithic and recent human values (Fig. 9A), although it is close to one Late Upper Paleolithic value (San Teodoro 1) and a few recent humans. In combination with the articular facet differences, this metric asymmetry strongly suggests that they derive from separate individuals.



**Fig. 8.** The right first metatarsal of Pavlov 38 with surface bone and exposed trabeculae reflecting taphonomic processes: A) dorsal head with post-depositional crushing, erosion and carbonate encrustation; B) non-specific surface erosion on the dorsal base, with carbonate sediment partially on the exposed trabeculae; C) medial part of the plantar head with root etching, D) non-specific surface erosion on the distal plantar diaphysis, adjacent to the head; and E) root etching affecting original bone surface and exposed trabeculae, together with postdepositional damage on lateral side of base. The presence of gray carbonate encrustations on and into the damaged trabeculae in each enlargement indicates that the damage was *in situ*, and not from excavation. Scale bars: macro-level 5 cm and micro-level 1000 microns. Photo. S. Sázelová, E. Trinkaus.

**Obr. 8.** První pravá kost nártní Pavlov 38, jejíž povrch a exponovaná trámčina naznačují tyto tafonomické procesy: A) dorzální strana hlavičky s postdepozičním lomem, erozí a sintrovou krustou; B) nesespecifická postdepoziční koroze na dorzální straně báze s exponovanou trámčinou, částečně překrytou sintrovou; C) mediální část hlavičky s otisky kořínků rostlin v plantárním pohledu; D) nesespecifická koroze povrchu na distální části diafýzy a přilehlé hlavičky v plantárním pohledu a E) otisky kořínků rostlin postihly původní povrch kosti a odhalily trámčinu, společně s postdepozičním poškozením laterální strany báze. Přítomnost šedých kongrecí uhličitanu vápenatého na povrchu i uvnitř poškozené trámčiny naznačují, že k poškozením došlo *in situ*. Měřítka: makro úroveň 5 cm a mikro úroveň 1000 mikronů. Foto: S. Sázelová, E. Trinkaus.

However, the Pavlov 34 and 35 patellae are very similar in size; geometric means of the three maximum dimensions (38.8 and 38.3 mm) provide an asymmetry of 1.28% (Fig. 9B). Moreover, the geometric means of both of these patellae are at the top of the Mid Upper Paleolithic size range (Fig. 9C), approached only by that of Bausu da Ture 1 (37.1 mm) and 2.23 and 2.02 standard deviations from the Mid Upper Paleolithic mean ( $33.8 \pm 2.2$  mm,  $n = 13$ ). They are exceeded only by the Late Upper Paleolithic Laugerie Basse 4



**Fig. 9.** Absolute asymmetry and size comparisons of the Pavlov 34 and 35 patellae to Eurasian Upper Paleolithic and recent human samples (MUP: Mid Upper Paleolithic; LUP: Late Upper Paleolithic; RH: recent humans). A: asymmetry in maximum height to breadth ratios; B: asymmetry of the geometric means of the maximum heights, breadths and thicknesses; C: the values of the geometric means of the maximum heights, breadths and thicknesses. Comparative sample Kruskal-Wallis p-values: A: 0.728; B: 0.242; C: 0.0002 (the last reflecting the smaller recent human sample). Respective sample sizes: A and B: 6, 10, 53; C: 13, 16, 62. Based on E. Trinkaus data.

**Obr. 9.** Srovnání absolutní asymetrie a velikosti čéšek Pavlov 34 a 35 ve vztahu k souborům z evropského mladého paleolitu a současnosti (MUP: střední fáze mladého paleolitu, LUP: pozdní fáze mladého paleolitu; RH: současní lidé). A: asymetrie v poměru maximální výšky a šířky; B: asymetrie geometrických průměrů maximálních výšek, šířek a tloušťek; C: hodnoty geometrických průměrů maximálních výšek, šířek a tloušťek. Srovnání souborů testem Kruskal-Wallis p-hodnoty: A: 0.728; B: 0.242; C: 0.0002 (poslední odráží menší velikost současného souboru). Odpovídající velikosti souborů: A a B: 6, 10, 53; C: 13, 16, 62. Založeno na datech E. Trinkause.

patella, and they are well above the average values of 35.3, 35.1 and 35.8 mm for the Dolní Věstonice 13, 14 and 16 males and further from those of Dolní Věstonice 3 and 15 (30.4 and 31.2 mm).

It is therefore not possible to confirm or reject that these two patellae derive from one individual, but their proportions and articular details suggest separate individuals. They are therefore treated as non-anti-meric. At the same time, their unusually large size for a Mid Upper Paleolithic (or Pavlovian) human argues for neither one coming from Pavlov 1.

The Pavlov 37 pedal remains are also at the top of the Mid Upper Paleolithic size range (Trinkaus *et al.* 2017), and it may therefore be possible that Pavlov 34 or 35 derives from the same individual. A ratio of patellar geometric mean to talar length for Pavlov 35 and 37 is 0.612 (0.620 for Pavlov 34 and 37); a Mid Upper Paleolithic sample ( $n = 10$ ) provides a mean of  $0.648 \pm 0.030$  (Late Upper Paleolithic:  $0.650 \pm 0.034$ ,  $n = 15$ ; recent humans:  $0.646 \pm 0.032$ ,  $n = 46$ ). It is therefore not possible, on the basis of relative size, to reject an association of Pavlov 35 (or Pavlov 34) and Pavlov 37. Given the storage proximity (and by inference *in situ* proximity) of Pavlov 35 with Pavlov 37 and 38 and the presence of gray encrustations on Pavlov 35 but none on Pavlov 34, it is more likely that the association would be Pavlov 35 and 37. Neither patella is likely to be associated with Pavlov 38, given patella to talus ratios of 0.725 and 0.716 for Pavlov 34 and 35 respectively.

## Discussion

### Preservation implications

The Pavlov 31 and 38 skeletal elements are very poorly preserved, with extensive porosity, marginal erosion, exposed trabeculae and general loss of bone tissue (Fig. 2 to 4, 8). The Pavlov 34 and 35 patellae and the Pavlov 37 tarsals are in better condition, but the Pavlov 37 metatarsals are less well preserved, especially distally (Fig. 4 and 5). To a large extent, the damaged areas are those where trabecular bone is covered by thin layers of subperiosteal cortical bone, with slightly more intact subchondral articular surfaces. The metatarsal diaphyseal cortical bone is generally well-preserved. This pattern follows the general distribution of relative cortical thicknesses in these bones (e.g. Tsegai *et al.* 2017).

These osseous conditions of the Pavlov 31, 34, 35, 37 and 38 remains therefore raise taphonomic questions regarding their pre- and post-depositional histories. Given the paleoclimatic context of the site (Svoboda *et al.* 2016), the considerations focus on taphonomic processes in cold and dry climates.

The poor osseous preservation of these human bones is similar to that seen in the burials from Dolní Věstonice I and II, especially the Dolní Věstonice 3 and 16 skeletons and to a lesser extent those of Dolní Věstonice 13 to 15. In the first two burials in particular, the postcrania are characterized by relatively solid diaphyses of the larger long bones, combined with variably complete thinner diaphyses and poorly preserved epiphyses, especially those of manual and pedal remains. This condition contrasts with the abundant faunal remains, which are generally solid with well-preserved epiphyses (see discussions and figures in Wojtal *et al.* 2012, 2016). This human/faunal contrast could well reflect the differential presence of soft tissue on the bones at the times of burial, in that decomposing soft tissue harbors abundant microorganisms, which in turn invade the bone tissue and promote erosion and especially porosity, further weakening the bone to sediment compaction and damage. In cold environments, the decay process changes such that outside decomposition with insect and external soil microorganism invasion predominates (4°C is the lowest temperature boundary in which bacterial growth dependent on humidity is effective) (Jans *et al.* 2004; Micozzi 1997; Nielsen-Marsh *et al.* 2007). Further assessment of this interpretation would require histological sectioning of the bone, which is not permitted for these Pleistocene human remains. Yet, the poor osseous tissue preservation of these Pavlov bones, in conjunction with the non-encrusted matching articulations of the Pavlov 37 tarsals, therefore strongly suggests that they were in articulation with adherent soft tissue at the time of burial.

These Pavlov human remains also exhibit ubiquitous mild root-etching, which is evident on external surfaces and into the exposed trabeculae. It is not clear to what extent the root etching occurred in Marine Isotope Stage 3 after initial burial or recently as a result of proximity to the modern land surface. Although root etching is present on almost all of the faunal remains from Pavlov (Wojtal *et al.* 2012, pers. observ.), as well as on a number of the remains from the Dolní Věstonice sites (both isolated remains and the *in situ* superior surfaces of the Dolní Věstonice 13-to-15 burial) (Trinkaus *et al.* 2000, 2010; Trinkaus, Svoboda 2006; Wilczyński *et al.* 2015; Wojtal *et al.* 2016), the surface etching on Pavlov 31 and 34 to 38 is greater than elsewhere.

There is no evidence of carnivore gnawing on the Pavlov human remains. However, carnivore gnawing and puncture marks, probably all from wolves, were found on only 23 of the 16,406 indefinable Pavlov I Southeast bones (Wojtal *et al.* 2012); similarly low frequencies (2 of 6,841 NISP and 16 of 7384 NISP respectively) were found at Dolní Věstonice I and II (Wilczyński *et al.* 2015; Wojtal *et al.* 2016). The relevant carnivores are able to swallow large articulated

pieces, but their gastric acids leave traces, in particular smoothed margins and thinned compact bone with pits of irregular depth and size running into the trabecular bone (Lyman 1994; Fernández-Jalvo, Andrews 2016; Haynes 1980; Willey, Snyder 1989). The erosion pattern on Pavlov human remains does not correspond to such alterations. In addition, in recent forensic cases of canid scavenging of human remains, the hands, feet and patellae are the skeletal elements with lowest frequencies of recovery (less than 39%), and they are rarely found after a couple of months of exposure (Haglund *et al.* 1989; Haglund 1997). Mammalian carnivore involvement in the differential preservation of the Pavlov human remains is therefore unlikely.

Birds of prey and ravens account for 44 % of the avifauna NISP at Pavlov I (Bochenski *et al.* 2009; Wertz *et al.* 2015), and they are equally able to manipulate human hands and feet (Cugnasse, Riols 1987), although most probably not antimeres at the same time. The pressure fractures often left by avian beaks or the etching from their gastric acids (Andrews 1990; Laudet, Selva 2005) were not observed on the Pavlov human remains. Vultures (*Gyps fulvus* was present at Pavlov I) are capable of defleshing human bodies with little disarticulation of the bones (Pilloud *et al.* 2016), but it is unclear whether they would then displace portions of the skeleton. Furthermore, the types of damage and osseous erosion left by other regular and/or occasional scavengers, such as bears, rodents, reindeer and insects (Holden *et al.* 2013; Klippel, Synsteliën 2007; Shipman, Rose 1983; Sutcliffe 1973), are not present.

Cut marks are also absent from the Pavlov human remains, especially in the areas of tendon insertions (e.g., anterior patellae and calcaneal tuberosities) and articular ligaments (e.g., talocrural ones) where disarticulation marks would occur. Such marks are moderately common in the Pavlov I Southeast faunal sample (n = 330; 2.01%), occurring especially on 164 reindeer bones (4.95%, NISP = 3,313), primarily for disarticulation (Wojtal *et al.* 2012); slightly lower frequencies are evident at Dolní Věstonice I (n = 122; 1.78%) and II (n = 69; 0.93%) (Wilczyński *et al.* 2015; Wojtal *et al.* 2016). There is therefore no evidence of intentional human or carnivore damage or the processing of the human remains, although the extensive erosion of Pavlov 31 and 38 would probably obscure most such indications.

#### Association versus separation

At the same time, the Pavlov 31, 37 and 38 remains occur as antimeric pairs. The association of Pavlov 34 and 35 appears unlikely, even though they are both exceptionally large. All of these remains overlap anatomically with those of the Dolní Věstonice burials and therefore could not derive from them. None of them clearly associate with Pavlov I based on

size, although Pavlov 38 comes closest. Should Pavlov 38 be associated with Pavlov 1, their separation by  $\approx 15$  m on the site would imply intentional displacement of one or both, rather than being the result of erosional processes.

It remains uncertain whether any of the lower limb remains from Pavlov I Centre could derive from the same individual as the Pavlov 36 metacarpal 2 (Pavlov 31 cannot anatomically); the Pavlov 36 estimated length ( $68.6 \pm 3.0$  mm) is close to those of Dolní Věstonice 13, 15 and 16 and average for a Mid Upper Paleolithic human ( $68.3 \pm 5.8$ ,  $n = 17$ ; see above), but it is well below that of Pavlov 31 (77.1 mm). Its estimated length provides a modal stature estimate of 168 cm (Meadows, Jantz 1992); given estimation ranges, it might therefore derive from the same individual as Pavlov 38 or (less likely) Pavlov 1, based solely on size (see above).

It is also of concern whether either of Pavlov 37 or 38 could, based on size, derive from the same individual as the Pavlov 31 hands. Comparing metacarpal 1 and 2 articular lengths to talar length, Pavlov 31 versus 37 provides ratios of 0.779 and 1.241; Pavlov 31 versus 38 has ratios of 0.991 and 1.441. These values all bracket the means for a Mid Upper Paleolithic sample ( $n = 13$ ):  $0.879 \pm 0.066$  and  $1.335 \pm 0.068$ . None of the ratios support or reject an association. However, if Pavlov 31 and one of the pairs of feet were associated, some process must have moved both hands or both feet together, for 30–35 m.

Pavlov 31 and the human bones from Pavlov I Centre (Pavlov 34 to 38) were also unassociated with any other similarly sized, anatomically adjacent human limb bones; of especial relevance being arm bones for Pavlov 31 and leg long bones for Pavlov 34, 35, 37 and 38. Given the recovery by Klíma of small elements (as in the Pavlov 31 carpals, the Pavlov 38 cuneiform bones, and the Pavlov 29 and 33 immature middle phalanges) and the identification of small articular “faunal” remains as human by PW and JW (see Trinkaus *et al.* 2000, 2010), any human remains other than diaphyseal fragments around these Pavlovian bones are likely to have been collected during excavation and identified as such during faunal analysis. This would apply in particular to the distal radii for Pavlov 31 given the preservation of bilateral carpal bones, and the distal tibiae and fibulae for Pavlov 37 and 38 given the bilaterally preserved tali and calcanei for each set of pedal remains. Indeed, Dolní Věstonice 55 is such an isolated eroded distal tibia, identified from the faunal remains of Dolní Věstonice II (Trinkaus *et al.* 2010).

In addition to the absence of other associated appendicular remains, it is the presence of three sets of antimeric hand and foot remains (with or without

associations with Pavlov 35 and 36) that is unusual. The sites of Pavlov I and Dolní Věstonice I and II have yielded a number of partial foot skeletons of faunal remains, especially of fox and wolf (Absolon 1938; Svoboda 2016; Svoboda *et al.* 2016). However, the associations of those extremities are in the context of the hunting of those animals for furs, as well as for meat (Wojtal *et al.* 2012, 2016), given the normal separation of the paws from the long bones during the skinning (Binford 1981). Two articulated feet of wolverine were found next to each other at Dolní Věstonice I (Absolon 1938), but the other associated carnivore feet from these sites are in partial skeletons of these fur bearers. To our knowledge, the only other Paleolithic human case of an isolated pair of antimeres is the La Quina 1 Neandertal tali, but the context for those bones is poorly known (Martin 1910; Verna 2006).

The human body has a decay sequence (comparable to other middle to large sized mammals), beginning with separation of the temporomandibular joint, head, cervical and lumbar vertebrae, sternocostal junctions and pubic symphysis followed by patellae, hands and feet (with the disarticulation process proceeding more slowly in a frozen body) (Miccozi 1991, 1997; Ubelaker 1997). Delayed decay of manual or pedal ligaments will hold hand or foot bones together during decomposition; the evidence for *in situ* articulation of Pavlov 37 and the osseous decay of most of these bones support the burial of these three pairs as intact hands or feet.

### Alternative taphonomic scenarios

The questions therefore involve the macroprocesses by which these three pairs, plus possible Pavlov 35–37 and 36–38 associations, came to be preserved and excavated.

1. Are they natural occurrences from the differential burial of individuals? Isolated human remains (mostly teeth and postcranial elements) are known from Pavlov I and Dolní Věstonice I and II (Holliday *et al.* 2006; Trinkaus *et al.* 2010, 2017). They are also known from other sites with burials (see above) and  $\approx 20$  other Mid Upper Paleolithic sites (see Amirhanov 2009; Arsuaga *et al.* 2002; Gambier, Houët 1993; Orschiedt 2000, 2002; Rougier *et al.* 2017; Schulting *et al.* 2005; Teschler-Nicola, Trinkaus 2001; Trinkaus *et al.* 2001, 2014b; Vercoûtère *et al.* 2008; Villotte *et al.* 2017). Moreover, the discovery of a number of them in faunal collections suggests that these known remains are only part of the original sample of isolated Gravettian human elements. Are these Pavlov pairs the remains of non-burial individuals, some of whose bones were still articulated when they became cov-

ered by sediment and preserved. If so, how does one explain associated pairs rather than isolated hands and feet?

2. Were they the remains of naturally disturbed burials? If Pavlov 31, 37 and 38 represent three separate burials (with or without Pavlov 35 and 36), given the separation in space of Pavlov 31 from the other two, they could represent those bones that were left behind when the rest of each skeleton was removed through carnivore scavenging, mammalian borrowing or geological erosion. If one of these processes was responsible, and assuming some degree of radiocarpal and talocrural decomposition, why would there be just hands or feet (plus a patella and metacarpal) and none of the remainder (especially the radii, ulnae, tibiae and fibulae, as well as the humeri and femora) of the skeletons? The pairs of feet could have been left *in situ* adjacent to each other at the end of an extended burial (as with the Dolní Věstonice 13 to 16 burials), unless the individuals were buried in tightly flexed positions (as with the Dolní Věstonice 3 burial). For the Pavlov 31 hands to be preserved together, the individual would have to have been buried on its side with the hands together and ventral; otherwise, the hands would have been separate if placed alongside of the body or mixed into the axial remains if laid across the trunk.
3. Were they the remains of secondary burial, in which the other portions of the skeletons were intentionally removed but the hands or the feet were left behind, especially the feet if the original burials were extended or partly flexed. It would not be unusual for portions of a skeleton to be left in the ground with secondary burial (Duday 2009), but such a scenario does not account for the complete absence of other possibly associated bones with Pavlov 31 and only a patella and possibly a metacarpal respectively with Pavlov 37 and 38. As noted above, it is unlikely on geological grounds that the Pavlov 1 partial skeleton represents a secondary burial; although the representation of mostly the larger bones suggests such a process, the presence of scattered vertebrae from the length of the vertebral column and a metacarpal and the *in situ* evidence for an erosional gully indicate natural processes.
4. Alternatively, could the articulated pairs of hands or feet have been removed from the bodies and each pair placed together in the ground? Ethnology certainly provides a wealth of analogies for body manipulation and their social/symbolic contexts (e.g., Bogoras 1904–1909; Czaplicka 1914; Dioszegi 1968; Schiefenhövel 1986; Yarrow 1880; see Bonogofsky 2011; Duday 2009; Testart 2008, and references therein), including one case of ritual sep-

aration of the hand bones (Mellor 2006). Numerous cases have been identified in Holocene archaeological contexts (see Bocquentin *et al.* 2016; Bonogofsky 2011; Chenal *et al.* 2015; Duday 2009; Knüsel, Robb 2016; Mires 1991; Testart 2008, and references therein), as well as other cases from the Upper Paleolithic (see below). Such a scenario would imply intentional manipulation of human body parts, as part of a complex mortuary behavior integrated with other sociocultural dynamics.<sup>1</sup> The possible associations of the Pavlov 35 patella with Pavlov 37 and (less likely) of Pavlov 36 with Pavlov 38 would complicate this scenario, since they are unlikely to have been intentionally displaced with the hands or feet in the absence of the intervening bones.

There are therefore at least these four (not mutually exclusive) scenarios to account for the antimeric pairs at Pavlov I. Each one would explain part of the pattern. The first scenario invokes an apparently relatively common process in the Mid Upper Paleolithic of leaving bodies on the surface, but it does not account for the association of antimeres. The second one would involve other biotic and/or abiotic post-burial activities or processes, but it does not explain the dearth of other skeletal elements. The third scenario invokes intentional removal of portions of the bodies, post-decomposition, as part of human mortuary behavior. The last one would imply human mortuary manipulation of the hands and feet; it is not likely to explain the possibly associated patella or metacarpal.

### The Gravettian mortuary context

As noted above, the focus of Mid Upper Paleolithic mortuary behavior and the taphonomy of human remains has been on the often impressive burials, with their variable degrees of elaboration. Isolated human remains have been identified, in sites both with and without burials. Yet, there are other cases of apparent differential treatment of human remains.

The Sunghir 5 cranium was placed with a man-upport (in loess) and ochre (Bader 1998; Trinkaus, Buzhilova 2018). The late Gravettian mature remains from the Abri Pataud underwent a complex process of disturbance, displacement and loss of large elements that cannot be explained by carnivore activity, weathering or post-depositional geological processes (Henry-Gambier *et al.* 2013a; Villotte *et al.* 2015a). Most notable is the excellent preservation of the Pataud 1 skull, hyoid, partial hip bones, antimeric pairs of patellae and partial hands and feet, plus a few vertebrae, clavicle and distal humerus, but the complete absence of femora, tibiae, forearms and right humerus. The other adults (Pataud 3 and 5) are represented by variably complete upper limbs. A parallel situation was

present at the Late Upper Paleolithic site of Arene Candide, with multiple rearrangements of the skeletal elements from the burials (Sparacello *et al.* 2018). It has also been suggested for the disturbed Magdalenian El Mirón 1 skeleton (Marín-Arroyo 2015), although the remains also have canid damage. In addition, the human remains in the Grotte de Cussac, of multiple individuals in three loci within the decorated cave, implies a complex (if unclear) mortuary behavior (Henry-Gambier *et al.* 2013b; Villotte *et al.* 2015b). A similar situation may have existed at Les Garennes (Henry-Gambier *et al.* 2007).<sup>2</sup>

The manipulation of human remains in the Mid Upper Paleolithic, including what would be considered as secondary burial, is therefore becoming increasingly well documented. Each *in situ* case presents complexities, given the palimpsest and often disturbed natures of Paleolithic sites. It adds another dimension to the mortuary behaviors of these Interpleniglacial foragers, beyond those associated with the ritual burials. They also join increasing evidence that the ritual burials, although generally similar in terms of the presence of ochre and body decoration, exhibit considerable diversity within and between sites (Henry-Gambier 2008; Henry-Gambier *et al.* 2007; Svoboda 2008; Trinkaus, Buzhilova 2018; Villotte *et al.* 2015b, 2017).

## Conclusion

The earlier Gravettian (Pavlovian) site of Pavlov I has yielded three pairs of antimeric hands and feet. They are spatially associated at Pavlov I only with either isolated teeth and an immature phalanx (in the case of Pavlov 31) or a metacarpal and a patella (in the case of Pavlov 37 and 38). Only Pavlov 38 could possibly derive from the Pavlov I partial skeleton 15 to 45 m away, they do not derive from any of the Dolní Věstonice burials, and any association with the other isolated human remains from Pavlov I Northwest or Southeast (as well as Dolní Věstonice I and II) cannot be established. They therefore pose the question as to what taphonomic processes (including human mortuary behavior) were responsible for their preservation as antimeric pairs separate from other portions of their skeletons (except for the possible association of the Pavlov 35 patella with the Pavlov 37 feet). Surface abandonment of the bodies with partial preservation does not appear likely, given the isolated antimeric pairs. Geological, carnivore or burrowing mammal disturbance does not fully account for their preservation. Partial removals of portions of the skeletons or intentional deposition of the paired (and articulated) sets of bones appear reasonable. The ultimate processes involved in the preservation of these puzzling pairs from Pavlov are unclear, but they nonetheless join other examples of Mid Upper Paleolithic mortuary behavior other than ritual burial of the deceased.

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## Notes

- <sup>1</sup> Possibly related to the antimeric hands and feet at Pavlov I, separate animal and human legs were frequently modeled in clay (and fired into ceramics). Focusing on visible fractures, Klíma (1983) suggested that the separate limbs resulted from deliberate fragmentation of figurines, whereas Farbstein and Davies (2015), using the *chaîne-opératoire* approach, saw them as additive elements to be attached to bodies. Both interpretations find support in aspects of the evidence, but the number of the limbs surpasses all other body fragments significantly. At least some of them were modeled and fired as complete images of separate limbs (Farbstein, Davies 2015; Klíma 1983).
- <sup>2</sup> The Mid Upper Paleolithic cases of displaced human remains are joined by the presence of human teeth being used as body decoration, modified in the same manners as the ubiquitous pierced and notched faunal teeth. There are examples from Pataud and Les Vachons (Vercoûtère *et al.* 2008), plus the Dolní Věstonice 8 and Pavlov 15, 25 and 39 incisors (Absolon 1945; Hillson 2006; Vlček 1991). Additional examples are known from the Aurignacian (Vercoûtère *et al.* 2008; Verna *et al.* 2012). There is also evidence for body modification of the living at the Pavlovian sites (Willman 2016), as part of their complex social behavior.

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## Resumé

Přibývající tafonomické, paleopatologické a paleodemografické analýzy lidských kosterních pozůstatků ze střední fáze mladého paleolitu dokumentují různorodost v pohřebním chování těchto úspěšných pozdně pleistocenních lovců z území západní Eurasie. V této studii se zabýváme tafonomickým pohledem na morfologicky již popsané tři až čtyři oboustranné páry kostí rukou a noh z lokality Pavlov I (částečně zachované ruce Pavlov 31, kosti nártních a zánártních částí noh Pavlov 37 a 38, a česky Pavlov 34 a 35, obě pravděpodobně rovněž z jednoho páru). Při dokumentaci předpokládaných pohřebních praktik se u zmíněných párů snažíme zohlednit kontext nálezů i míru jejich zachování. Na povrchu kostí rukou i noh jsme zaznamenali vysokou porozitu, včetně oblastí, kde subchondrální povrch kosti nebyl pokryt sintrem (uhlíčitánem vápenatým), což by mohlo naznačovat, že byly původně pohřbeny jako dosud artikulované

části s měkkými tkáněmi. Na povrchu kostí jsme dále dokumentovali masivní korozi způsobenou kořínky rostlin, naproti tomu činnost šelem nebo jiných obratlovců, včetně člověka (absence zářezů), zaznamenaná nebyla. Přestože artikulované apikální části předních a zadních končetin kožešinové zvěře nejsou na našich lokalitách výjimkou, nacházíme je nejčastěji jako jednostranné elementy. Oboustranná přítomnost lidských pozůstatků proto vzbuzuje otázky ohledně tafonomických procesů a behaviorálně/pohřebních praktik, které se mohly podílet na jejich zachování. Představují části již zapomenutých lidských těl, zbytky po narušeném pohřbu, či záměrnou manipulaci s lidskými těly? Přestože nemůžeme potvrdit ani vyloučit žádný z těchto scénářů, můžeme již nyní konstatovat, že různorodost v pohřebních praktikách je u těchto časných anatomicky moderních lidí velmi vysoká.

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**PŘEHLED VÝZKUMŮ NA MORAVĚ A VE SLEZSKU 2017**

PALEOLIT

NEOLIT

ENEOLIT

DOBA BRONZOVÁ

DOBA ŽELEZNÁ

DOBA ŘÍMSKÁ A DOBA STĚHOVÁNÍ NÁRODŮ

