Přehled výzkumů 61/1, 2020 ● 59–70

Last Glacial Maximum landscape and Epigravettian horse hunting strategy in Central Europe: The case of Stránská skála IV

Krajina posledního glaciálního maxima a strategie lovu koní ve střední Evropě: příklad lokality Stránská skála IV

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KEYWORDS:

Last Glacial Maximum – Epigravettian – Moravia – horse hunting strategy

ABSTRACT

With the end of MIS3, the unity of larger Gravettian settlements based predominantly on mammoth exploitation split into a mosaic of smaller Epigravettian sites with specific behaviors and economies. Based on C14 chronology, the site of Stránská skála IV (together with Grubgraben, Ságvár and Kašov), correlates with a brief warm period after the Last Glacial Maximum around 22 ka calBP. We detected two main accumulations of predominantly horse bones under a rock cliff suggesting that the site was not a regular settlement but rather a specialised hunting site. No features or hearths were recovered. Lithic raw materials were imported from long distances, and the horse hunting strategy profitted from the specific geographic qualitites of the site. Preferential location of Epigravettian sites in secluded valleys is a pattern generally recognized in Moravia and usually explained as a response to the harsh MIS2 climates.

The Last Glacial Maximum in eastern Central Europe

Whereas the culmination of the Upper Paleolithic in eastern Central Europe during the Gravettian receives considerable attention, the process of the collapse of this complex cultural system during the Last Glacial Maximum (LGM) is shrouded in mystery. In recent years, some clarification has emerged. The paleoenvironmental events are being synchronised, taking in account zonal patterns and declining climatic variability on a global scale (Clark et al. 2009; Lowe et al. 2008; Rehfeld et al. 2018), paleogenetic studies suggest a bottleneck in Europe (Posth et al. 2016), archaeological comparative studies show mosaic-like variability in settlement structures and hunting strategies across eastern Central Europe (Soffer, Gamble eds. 1990; Street, Terberger 1999; Verpoorte 2004; Svoboda, Novák 2004; Nerudová, Neruda 2015; Lengyel 2016; Škrdla et al. 2016). Several recently excavated Epigravettian sites in this region document individual behavioral responses to these changes (Grubgraben, Brno-Vídeňská, Mohelno-Plevovce). The new examination of Stránská skála IV, one of the earlier excavated sites, has the potential to elucidate changes in behavioral patterns and horse hunting strategy.

Stránská skála: Location and research history

Stránská skála hill (310 m a.s.l., Fig. 1), one of the key Paleolithic sites of central Europe, is a remarkable cliff (cuesta) of Jurassic limestone in the city of Brno (Moravia, Czech Republic). It is renowned as a Lower/Middle Pleistocene slope deposit (site I, Valoch 2003) and a complex of Early Upper Paleolithic sites on the upper plain (sites II–III, Bohunician and Aurignacian, Svoboda, Bar-Yosef eds. 2003).

In 1984–1985, a 1.8 km long gas pipeline excavation (1.4–0.8 m wide and 1.5 m deep) cut through the northern foothills. Our stratigraphic survey along the excavation revealed a loess deposit more than 1.5 m thick, interlain with horizons of sharp-edged limestone and chert blocks, especially at the base, and first horse bones in combination with two lithic artefacts in the upper part of the loess deposit (site IV, 275 m a.s.l.). In consequence, the 1985–1986 excavation opened five trenches A–E, located along the main NW-SE axis in total length of 25 m, parallel with the pipeline (Figs. 2, 3). We detected two main accumulations (western and eastern) of horse bones and limestone scree, suggesting that the new site was not a regular settlement, but rather a specialised hunting site (for preliminary reports see Svoboda 1990; 1991; West 1997). Here we analyse several aspects of the site in greater detail from an interdisciplinary perspective.

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pv.arub.avcr.cz/61_1_06.pdf

Competing interests: The authors have declared that no competing interests exist.

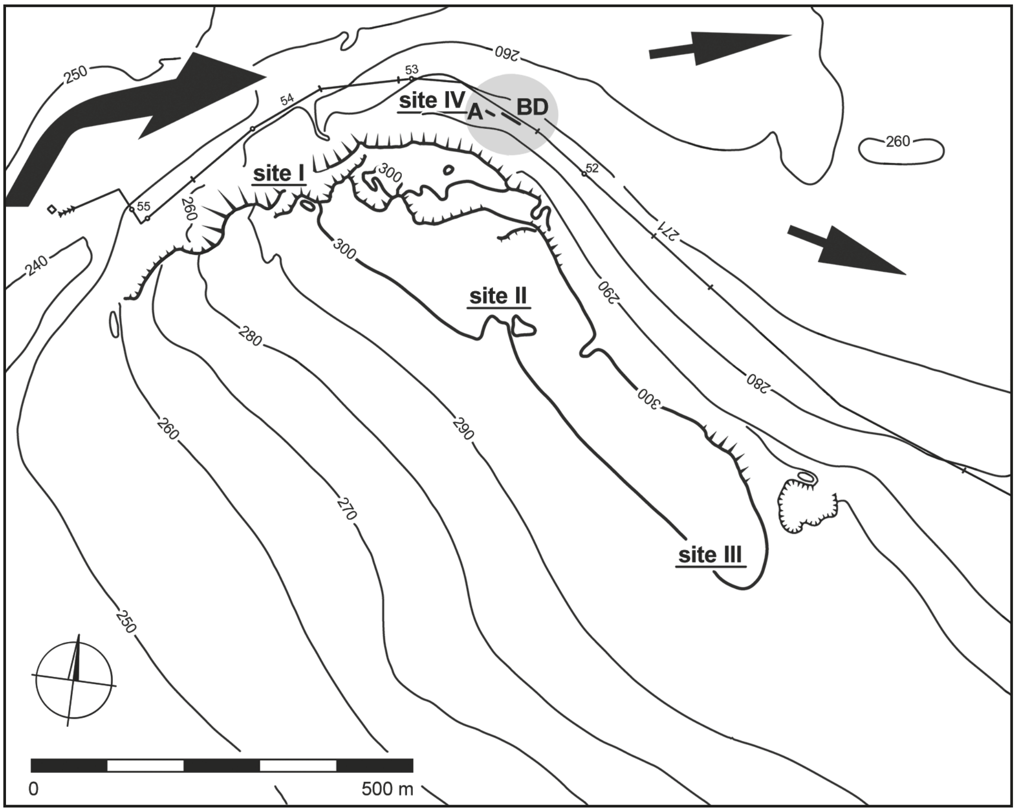


Fig. 1. Plan (above) and photo (bottom)of the Stránská skála hill, showing location of sites I–IV. The black arrows indicate optimal herd movements. Graphic by M. Huňová and P. Hájková, photo by J. Svoboda.

Obr. 1. *Plán (nahoře) a snímek (dole) Stránské skály a poloha lokalit I–IV. Černé šipky naznačují optimální pohyby koňských stád. Grafika M. Huňová a P. Hájková, foto J. Svoboda.*

Spatial structure of site IV

The western part (trench B) displays two structural features (Fig. 2): in the west a band of bones, evidently redeposited downslope and possibly filling an erosional chanel 1–2 m wide and 7 m long, and in the east a circular concentration of bones and limestone blocks, 5–6 m in diameter, with 46 lithic artefacts (increasing in density downslope).

The eastern part (trench D) is formed by a single concentration of limestone blocks (up to 0.7 m long) and bones, 5–7 m in diameter, with 43 lithic artefacts (dispersed across the whole area).

Trenches A, C and E represent site peripheries, with a decrease in density of osteological material and artefacts (only 4 pieces from sector A, 1 piece from C, and 12 from E). Additional 36 artefacts were collected from other contexts, mostly from the surface.

No structures or hearths were recorded at the site. Given the location of the site on a slope below a limestone cliff, the limestone blocks should be interpreted as scree accumulations formed during the LGM. Removal of artefacts along the slope is best visible in trench B: the band of bones oriented downslope, with a concentration of artefacts in the lower part (Fig. 3).

Fig. 2. *Planigraphy of trenches at Stránská skála IV, showing (above) location of limestone boulders (white) and bones (black) and (bottom) lithic artefacts (points; triangle – an obsidian flake). Graphic by J. Svoboda and P. Hájková.*

Obr. 2. *Planigrafie sond na lokalitě Stránská skála IV s vyznačením (nahoře) polohy vápencových balvanů (bíle), kostí (černě) a (dole) kamenných artefaktů (body; trojúhelník – obsidiánový úštěp). Grafika J. Svoboda a P. Hájková.*

Fig. 3. Trench B, cleaning a downslope oriented band of horse bones (above and right). Photo by J. Svoboda.

Obr. 3. *Sonda B, začišťování po svahu rozvlečeného pásu koňských kostí (nahoře a vpravo). Foto J. Svoboda.*

Stratigraphy and dating

The position of the Epigravettian layer within the stratigraphy was shallow (Fig. 4). It was located in the uppermost part of the Last Glacial loess (layer 4a), partly affected by Holocene pedogenesis (layer 3).

1. Recent refill (20–50 cm, increasing thickness downslope)
2. Recent soil
3. Brownish B-horizon, bones and artifacts at the base
4.a Loess; in the uppermost part horizon composed of limestone boulders, bones and artifacts
4.b Loess of more than 1.4 m thickness; in the lower part lies a horizon of sharp-edged limestone and chert debris

There are three radiocarbon dates available for the site (Tab. 1). First two dates were obtained from bone collagen and assigned the human occupation to the LGM period. A new date was obtained on a horse molar and is consistent with the first two dates. After calibration using OxCal with 95.4% probability (Reimer et al. 2013), the site can be dated to between 22.8 and 21.1 cal BP. This period corresponds to the GS-2.1c stadial period in the Greenland glacial chronology (Rasmussen et al. 2014), during which the Eurasian Ice Sheet reached its maximum extent in Central Europe (Hughes et al. 2016); however the record from Stránská skála IV indicates relatively mild conditions.

Site	No sample	Uncal BP	Reference	OxCal 4,2 (22. 2. 2018)
Brno – Stránská skála IV	GrN-13954	18220±120	Svoboda 1991	22390-21800
Brno – Stránská skála IV	GrN-14351	17740±90	Svoboda 1991	21796-21162
Brno – Stránská skála IV	Poz-101463	18670 ± 110	new date	22841-22333
Mohelno-Plevovce KSA	Poz-57891	16280±80	Škrdla 2015	19935-19444
Mohelno-Plevovce KSB	Poz-76196	19100±110	Demidenko et al. 2018	23395-22670
Mohelno-Plevovce KSA	Poz-76195	18970±110	Demidenko et al. 2018	23152-22511
Brno-Štýřice, Kamenná street	OxA-24105	14235±60	Nerudová 2010	17536-17116
Brno-Štýřice III	GrN-9350	14450±90	Valoch 1996	17895-17358
Brno-Štýřice III	GrA-20002	14820±120	Verpoorte 2004	18343-17725
Brno-Štýřice III	OxA-26961	15625±75	Nerudová, Neruda 2015	19043-18710
Brno-Štýřice III	OxA-28114	14870±90	Nerudová, Neruda 2015	18332-17862
Brno-Štýřice III	OxA-28298	15215±70	Nerudová, Neruda 2015	18669-18302
Brno-Štýřice III, Hospital	GdA-459	15650±70	Škrdla et al. 2005	19062-18738
Velké Pavlovice	GrN-16139	14460±230	Svoboda, Fišáková 1999	18186-16995

Tab. 1. Stránská skála C14 dates in context of Epigravettian dates from Moravia (Czech Republic).

Tab. 1. *Radiokarbonová data ze Stránské skály IV v kontextu dalších epigravettských dat z Moravy (Česká republika).*

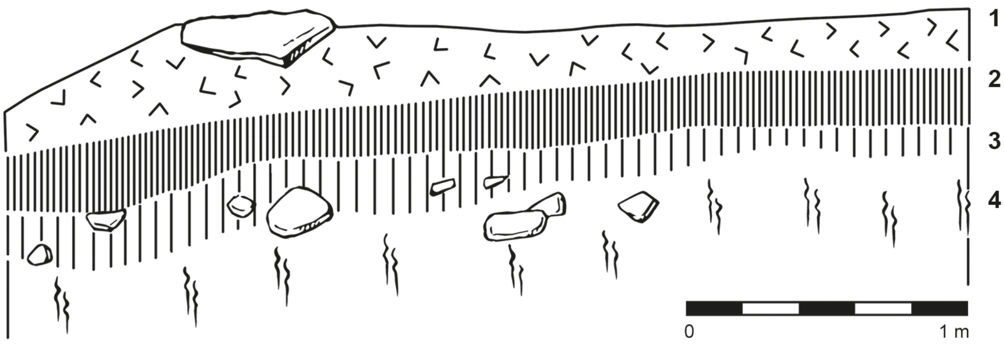


Fig. 4. Stránská skála IV, stratigraphic section. 1 – Recent refill (20–50 cm, downslope increasing thickness). 2 – Recent soil. 3 – Brownish B-horizon, bones and artifacts at the base. 4a – Loess; in the uppermost part the horizon is composed of limestone boulders, bones and artifacts. 4b – Loess of more than 1.4 m thickness; in the lower part (out of picture) lies a horizon of sharp-edged limestone clasts and chert debris. Graphic by B. Ludikovská.

***Obr. 4.** Stránská skála IV, profil. 1 – Recentní navážka (20–50 cm, mocnost po svahu narůstá). 2 – Recentní půda. 3 – Hnědavý B-horizont, na bazi probíhá poloha kostí a artefaktů. 4a – Spraš; v nejvyšší části pokračuje poloha vápencových bloků, kostí a artefaktů. 4b – Spraš o mocnosti více než 1,4 m; ve spodní části (mimo obr.) probíhá poloha ostrohranných vápencových klastů s úlomky rohovce. Grafika B. Ludikovská.*

Vegetation

One pollen sample was taken from the upper part of the loess (layer 4a) and analysed by Helena Svobodová Svitavská (manuscript report, Institute of Archaeology, 197/88) using the heavy liquid technique; 10 slides (20 × 20 mm) were counted.

The results of pollen analysis are as follows:

AP: *Pinus* (5 pollen grains), *Betula* (27), *Salix* (3), *Corylus* (2), *Alnus* (8), *Tilia* (8). In total 53 arboreal pollen grains.

NAP: Cyperaceae (3), Poaceae (8), *Artemisia* (1), Asteraceae Subfam. Tubuliflorae (1), Ericaceae (1), *Lythrum* (1), Chenopodiaceae (1), Caryophyllaceae (1), undetermined (4). In total 21 non-arboreal pollen grains.

Spores: Polypodiaceae (29), Sphagnum (1).

Despite the collection of many samples, very few pollen grains (74 individual pollen grains in total) were detected. Although the interpretive value of the result is not high, it documents an entirely unique situation, worthwhile discussing here. In the pollen spectrum, trees (AP) predominate over herbs (NAP). Among the woody species are thermophilic elements – hazelnut (*Corylus*) and lime (*Tilia*). These results are quite surprising given the LGM age of the loess layer. Nevertheless, the main component of the pollen spectrum is birch (*Betula*), which is a strong pollen producer, so the environment was not necessarily forested. This was certainly suitable for horses, the remains of which were found in great numbers at the site. It is somewhat more difficult to explain the occurrence of thermophilic trees. One option, less likely, is their origin from reworked older sediments. In fact, both trees could actually occur as shown by comparison with contemporaneous pollen spectra from the nearby Western Carpathians (Jankovská, Pokorný 2008), or by a recent analogy from South Siberia where lime occurs in isolated relict populations in conditions of a cold, strongly continental climate, analogous to the climatic conditions of Central Europe during the LGM (Novák et al. 2014).

Faunal remains

The osteological assemblage numbers a total of 3,363 fragments (NISP) of which 20.2% has been taxonomically identified (Tab. 2; Boriová et al. 2019, 2020.). The most frequent species is horse (*Equus ferus*) represented by 9 adult and 1 young/subadult individuals. Their incomplete skeletal parts are regularly distributed (Fig. 5). Three species are represented by minimum of one individual each: reindeer (*Rangifer tarandus*) documented by an antler fragment, carpal and tarsal bones and a naturally perforated first phalanx; woolly rhinoceros (*Coelodonta antiquitatis*) is represented by a right humerus fragment and first left metatarsal bone; and a large bovid (*Bos/Bison* sp.) by a fragment of the second phalanx. The indeterminate fragments smaller the 10 cm account for nearly 61 % of the whole assemblage. The bone and teeth surfaces are covered by concretions of manganese, ferric or carbon origin. Root etching was observed on more than 10% of material. The surface weathering conforms to Behrensmeyer's stages III.–IV. (Behrensmeyer 1978; in more than 60% cases), making an analysis of cut marks and other human or vertebrate traces difficult (Fig. 6).

Post-depositional breakages from sediment pressure/movement, trampling or weathering cracks are documented on more than 20% of the horse bones. Spiral breakages on fresh metapodium, radius and tibia are displayed on nearly 2% of the bones; if caused by humans (Outram 2002; Karr, Outram 2012) then they support West's (1997) conclusion of butchering rather than bone marrow extraction.

The fore and hind limbs are well represented at the site by scapula and pelvis fragments, together with bones from forearms, shins and apical ends however, horse heads are absent which is striking given that the expected number of individuals is at least ten. The head, with its weight around 15–20 kg, represents a suitable body part for displacement and transport due to its high content of bone fat and marrow (Outram, Rowley-Conwy 1998). This disparity can be best explained by transport to a base camp, as already proposed by D. West (1997). Taphonomic explanations such as carnivore activity and gnawing or lower resistance of skull bones to attacks of abiotic agents when compared to long bones (Haynes 1983; Lyman 1984) are less likely given the absence of gnaw marks and a small number of preserved teeth. Ribs, vertebras, humerus and femurs are underrepresented. Given the fact that these bones are covered with muscles of middle to high meat quality, transport to base camp seems likely; however the thin compact bone with a high amount of spongy bone within axial skeletal parts cannot exclude their selective dispersal due to various taphonomic agents. The representation of horse skeletal parts differs from that observed in natural mass death sites, where skulls and innominates prevail, followed by upper limb elements, occasional presence of lower limbs and very rare occurrence of foot bones (Haynes 1983).

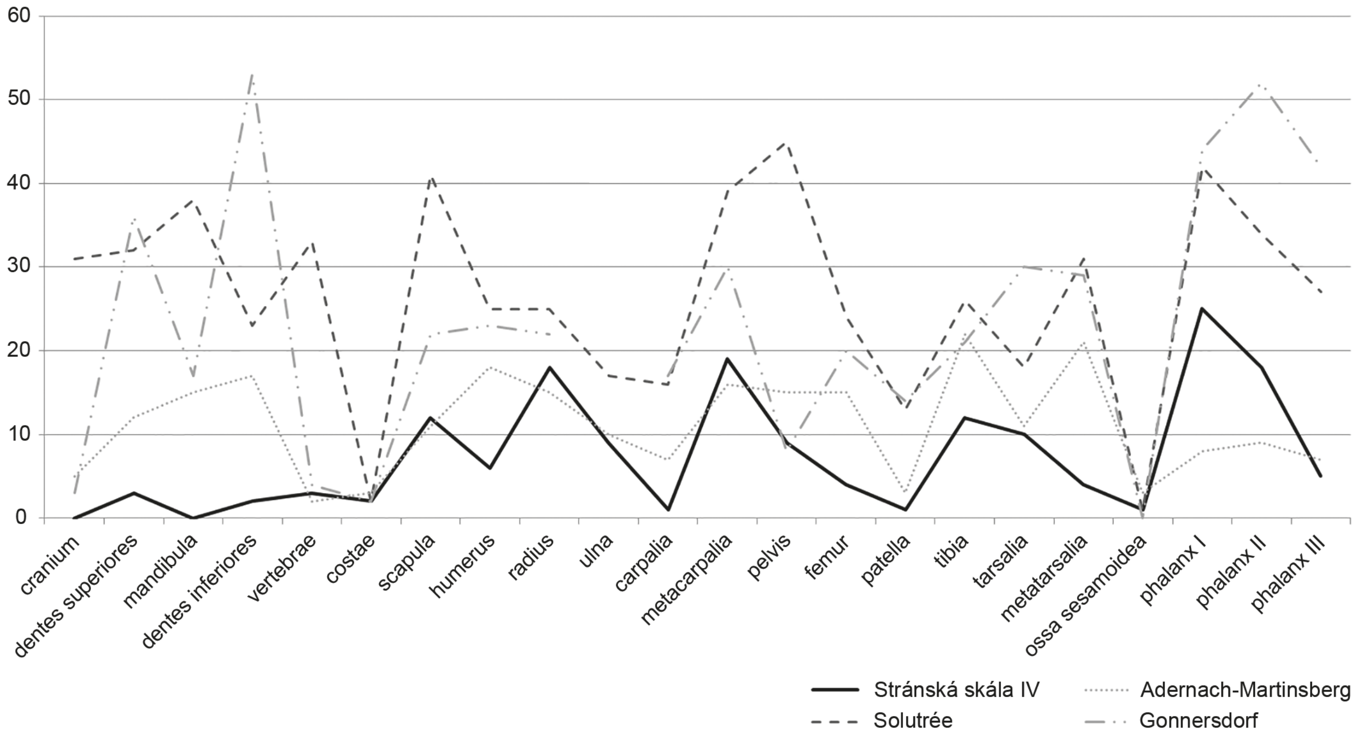
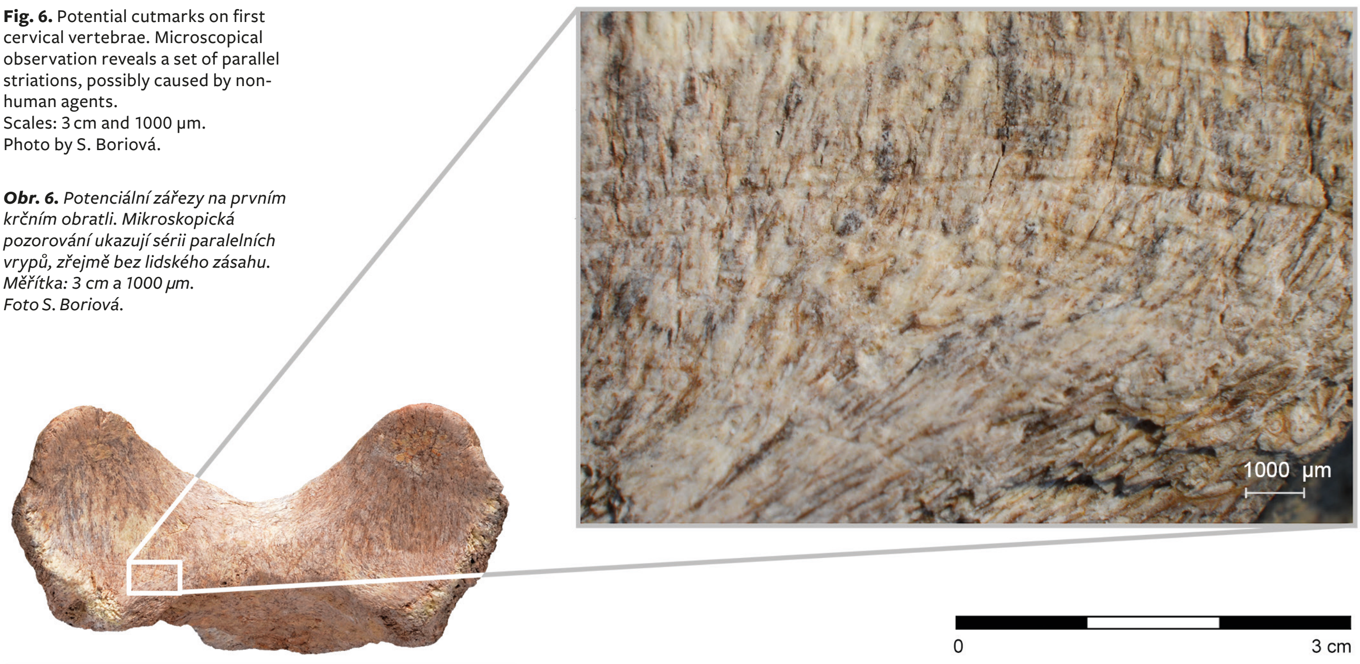


Fig. 5. Representation of horse skeletal parts in MNI from Stránská skála IV compared to Adernach-Martinsberg (Street 1993), Solutré (Turner 2002) and Gönnersdorf (Street, Turner 2012). Abbreviations: MNI = minimum number of individuals estimated here separately for individual anatomic part. The Stránská skála IV data are slightly overestimated due to incorporation of fragments with indeterminable sides which do not fit to the elements with siding. Graphic by S. Sázelová.

Obr. 5. *Zastoupení částí koňských koster, vyjádřené v MNI pro Stránskou skálu IV, Adernach-Martinsberg (Street 1993), Solutré (Turner 2002) and Gönnersdorf (Street, Turner 2012). Zkratky: MNI = minimální počet jedinců stanovený na počtu individuálních anatomických částí. V porovnání s ostatními lokalitami je Stránská skála IV mírně nadhodnocena, neboť jsou uvedeny i ty skeletální části, které nebylo možno stranově určit. Grafika S. Sázelová.*

Fig. 6. Potential cutmarks on first cervical vertebrae. Microscopical observation reveals a set of parallel striations, possibly caused by non-human agents.
Scales: 3 cm and 1000 μm.
Photo by S. Boriová.

Obr. 6. *Potenciální zářezy na prvním krčním obratli. Mikroskopická pozorování ukazují sérii paralelních vrypů, zřejmě bez lidského zásahu. Měřítka: 3 cm a 1000 μm. Foto S. Boriová.*



Species	NISP	NISP %	MNE	MNE %
Coelodonta antiquitatis	15	0.4	2	0.1
Bos/Bison	1	0.03	1	0.03
Rangifer tarandus	29	0.9	6	0.2
Equus ferus	633	18.8	356	12.3
subtotal	**678**	**20.2**	**365**	**12.6**
extra-large sized mammal	7	0.2	3	0.1
large/extra-large sized mammal	22	0.7	19	0.7
large sized mammal	357	10.6	272	9.4
middle/large sized mammal	220	6.5	187	6.5
middle sized mammal	27	0.8	12	0.4
small/middle sized mammal	4	0.1	4	0.1
subtotal	**637**	**18.9**	**497**	**17.2**
indeterminate bone fragment 5–10 cm	103	3.1	100	3.5
indeterminate bone fragment 3–5 cm	326	9.7	320	11.1
indeterminate bone fragment 2–3 cm	506	15	500	17.3
indeterminate bone fragment 1–2 cm	527	15.7	527	18.2
indeterminate bone fragment 0–1 cm	584	17.4	583	20.1
Indeterminate tooth fragment 0–1 cm	2	0.06	2	0.1
subtotal	**2048**	**60.9**	**2032**	**70.2**
TOTAL	**3363**	**100**	**2894**	**100**

Tab. 2. Stránská skála IV. Overall faunal species representation.

Tab. 2. *Stránská skála IV. Celkový přehled zastoupené fauny.*

Lithics: Raw materials, metrics and techno/typology

A total of 140 lithic artefacts were analysed for raw material, metrics and techno/typology. Compared to the Early Upper Paleolithic industries of Stránská skála II–III (Svoboda, Bar-Yosef eds. 2003), we observe a strong decrease in the proportion of local Stránská skála cherts; in contrast to the Late Gravettian (Kozłowski 2013), there is a decrease in representation of the northern (Polish and Ukrainian) silicites. Instead, we record a variety of local Moravian and imported Carpathian materials, including rare long-distance imports such as obsidian (Tab. 3).

Materials of local or near-local origin (about 72% of the raw materials) include cherts from the Jurassic limestone massif of Stránská skála, or from the slope debris along the same hill, cherts with relics of the subrounded surface (Moravian Jurassic cherts), cherts with relics of the dark to black pebble surface with whitish spots (cherts of the Krumlovský les type III), and various Jurassic cherts and spongolites, possibly from the nearby gravels of the Pliocene Líšeň river terraces. The long-distance imports include radiolarite and radiolarian chert (14%) of reddish-brown, dark green or greenish-grey varieties, without relics of the pebble surface. There is a high probability that they originate in the Carpathian Klippen Belt in the Bílé Karpaty Mountains.

Other materials are represented by individual pieces only. Gravels including the Troubky-Zdislavice chert are situated halfway to the Bílé Karpaty Mountains. Considerably further south-east lies the source of volcanic glass obsidian. Given the translucency, fluidal structure and relic of sculpted surface of this material, its origin can be assumed to be the Carpathians 1a source, i.e. between Cejkov and Brehov in the Zemplín Hills in south-eastern Slovakia. Rock crystal and porcellanite were brought from the opposite, north-westerly direction, i. e. from the area of the Moravian-Bohemian Highland and the Kunětická hora Hill in eastern Bohemia. The third direction of transport is represented by erratic flints and silicites of the "flint" type from fluvioglacial deposits of northern Moravia, or adjacent Silesia.

Raw material	Orientation, minimum distance (km)	pieces	%
Stránská skála cherts	0	66	47.1
Cherts from Stránská skála or from surrounding gravels	0	11	7.9
Moravian Jurassic cherts from gravels	0	10	7.1
Cherts intermediary between Moravian Jurassic cherts and Krumlovský Les cherts	0	6	4.3
Cretaceous spongolites	0	6	4.3
Quartz pebble	0	1	0.7
Zdislavice-Troubky cherts	E, 40	1	0.7
Radiolarite	ESE, 110	15	10.7
Radiolarian chert	ESE, 110	5	3.6
Obsidian	ESE, 380	1	0.7
Silicites (erratic flints) from fluvioglacial deposits	NE, 125	3	2.2
Silicites of the "flint"-type	NE, 125	7	5.0
Porcellanite of the Kunětická hora-type	NW, 115	2	1.4
Rock crystal	NW, 40	2	1.4
Undetermined	-	4	2.s9
TOTAL		**140**	**100**

Tab. 3. Stránská skála IV. Lithic raw materials.

Tab. 3. *Stránská skála IV. Kamenné suroviny.*

The lithic technology (Fig. 7, Tab. 4) was blade-oriented; the majority of cores are blade cores. Flakes are mainly byproducts of this technology. There are 12 complete blades which allowed the documentation of all the technological features of blade production. Blades are mostly rectilinear in profile (n = 8). All the blade cores are unidirectional, but only three of the blades possess unidirectional dorsal scars, while five specimens have opposite scars, and four have perpendicular scars. This shows that the striking platform was changed during blade debitage and re-shaping of the core also occurred. The blades have mostly plain platforms, there are 2 with dihedral and 2 with faceted platforms. Soft hammer technique was mostly used to detach the blades which can be deduced from the frequency of overhang abrasion (n = 8). The mean length of the blades is 49 mm (n = 12, std = 17.08) and the median is 46.42 mm for a series of specimens between 22.28 and 88.02 mm.

The complete flakes (n = 23) are mostly rectilinear in profile (n = 18), have unidirectional scars (n = 13), and plain platform (n = 18). The frequency of impact points (n = 15) and intact overhangs (n = 21) shows that hard hammer technique was mostly applied to remove flakes, which is consistent with the general characteristic of blade technology where core shaping and maintenance are frequently done by hard hammer technique while the blade knapping is executed by the soft hammer technique. The mean length of the flakes is 28.5 mm (n = 23, std = 12.15) and the median is 25.27 mm for a series of specimens between 13.81 and 53.5 mm.

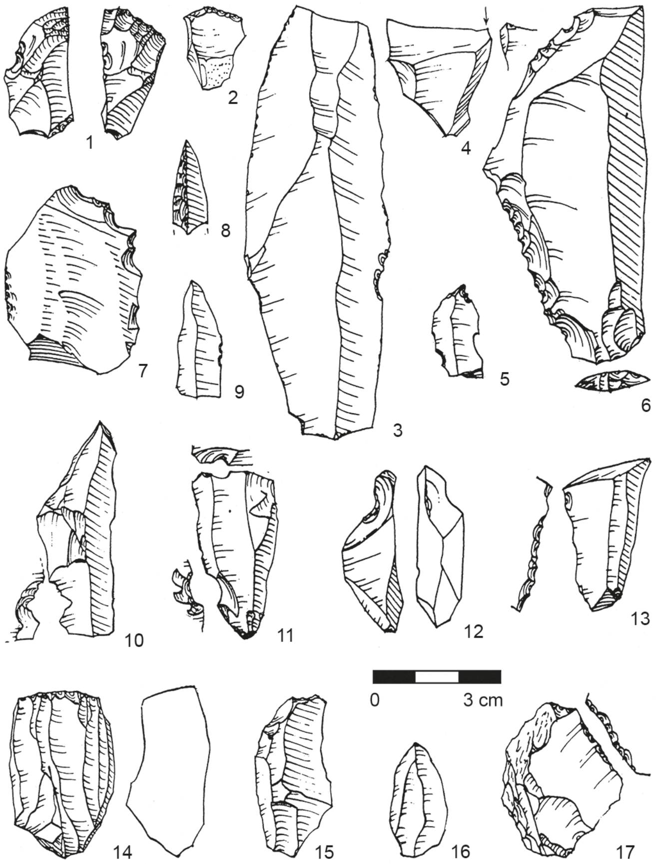


Fig. 7. Selection of lithic artefacts from Stránská skála IV. Graphic by J. Svoboda.
Obr. 7. *Výběr kamenné industrie ze Stránské skály IV. Grafika J. Svoboda.*

	Frequency	Percent
flake	52	37.1
blade/let	54	38.6
debris	15	10.7
rejuvenating flake	2	1.4
crested blade	2	1.4
neo-crested blade	5	3.6
burin spall	2	1.4
blade/let core	6	4.3
flake core	2	1.4
Total	140	100.0

Tab. 4. Stránská skála IV. Structure of the lithic assemblage.
Tab. 4. *Stránská skála IV. Celkový přehled kamenné industrie.*

The tools (Tab. 5) were mostly made of blades (including neo-crested and crested blades). Edge retouched specimens are the most frequent, and the toolkit is composed of simple Upper Palaeolithic tool types. The armature component that consists of a backed truncated bladelet and a retouched point made of a neo-crested blade/let is low. The presence of these types and the low frequency of armature in the toolkit is typical for the Epigravettian industries dated to the LGM in eastern Central Europe. The preceding Late Gravettian period and the post LGM Epigravettian usually have a higher percentage and wider spectrum of armature (Lengyel 2016).

tooltypes	flake	blade/let	crested blade	neo-crested blade	
endscraper	2	0	0	0	***2***
burin	0	2	0	1	***3***
edge-retouched	3	1	1	0	***5***
borer	1	1	0	0	***2***
armature	0	1	0	1	***2***
Total	6	5	1	2	***14***

Tab. 5. Stránská skála IV. Lithic typology.
Tab. 5. *Stránská skála IV. Typologie kamenné industrie.*

Horse hunting strategy

The terrain situation at Stránská skála IV (where the height difference between the rock summit at 310 m a.s.l. and site IV at 275 m a.s.l. makes 35 m) suggests that the rock wall played a role in the hunting strategy, either by driving the animals from the upper plain over the cliff (as at the North American jump sites) or, rather, from the bottom of the dry valley upwards against the rock wall (Figs. 8–9). Using landscape landmarks for horse and bison hunting during the time-span around and after LGM finds parallels both in the east and west Europe (Solutré, Amvrosievka).

Horse predominated in both accumulations of Stránská skála IV, although one of them presented three additional species (rhinoceros, reindeer and bovid). Following West (1997), nine adult horses and one individual under three and a half years old were dispatched, probably (following dermestid life cycle) during summer seasons. It seems that the animals were extensively dismembered at the site, their heads were probably transported away (for fat?) and various postcranial bones were left at the site. Although surface of some of the bones was weathered, no cutmarks were observed.

Furthermore, according to West (1997), the horse remains from Stránská skála IV represent a "bachelor group" where the herd consists of young stallions with weak relationships between individuals if compared to social organization in a harem herd with mares and foals. Such a male-herd can migrate for long distances and cover large areas, however their movements and behavior is less predictable and thus risky for both predators and human hunters (in situations of danger/escape or dispersale in any direction, and/or could be more aggressive in their behaviour, if compared to a harem herd; Tilson 1988; Christensen et al. 2002; Zarkikh, Andersen 2009). Summer/early autumn hunting season, as expected at Stránská skála IV, is similar to the Solutré site (Olsen 1989; West 1997). Horse hunting during their migration to winter refuges when the animals display the best nutritional state seems to be a good offset in such risky costs (West 1997; Brabender et al. 2016) and as we know from current ethnological analogies, the hunters are ready to undergo such danger (Hawkes 1991).

At **Solutré**, the height difference between the rock top (La Roche, 492 m a.s.l.) and the sites below (around 400 m a.s.l.) reaches up to 100 m. Several hypotheses suggest usage of horse migratory trails along frequented valleys and hunting at an appropriate place, either by driving upslope (Olsen 1989), or just waiting in ambush close to the trail and killing before the herd panicked and took flight (Turner 2002). Olsen (1989) concluded that the lack of structures and hearths, seasonality, vast number of horses, articulated units of horse bones, scarcity of butchery marks, low numbers of spiral fractures as a possible result of

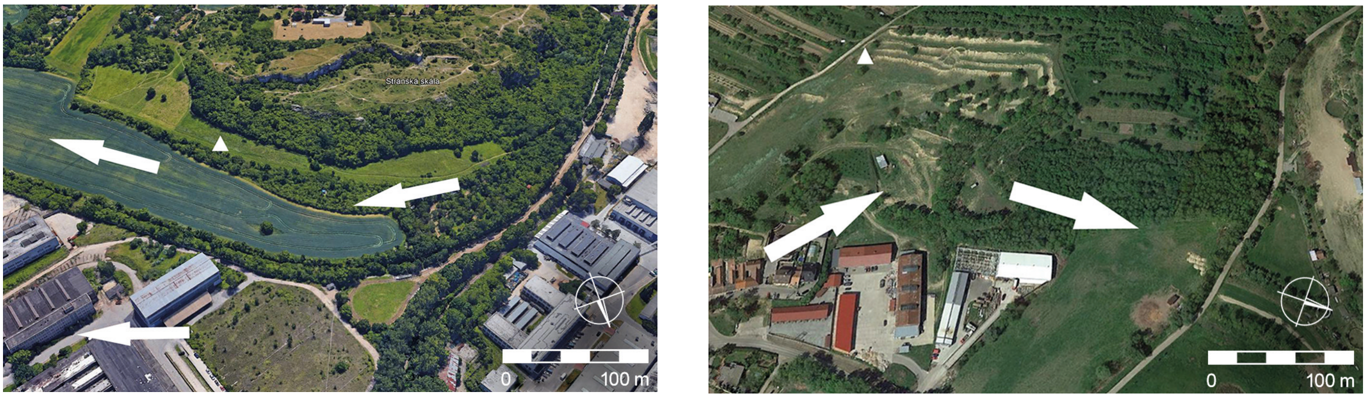


Fig. 8. Strategic location of two horse hunting sites in the south Moravian landscape: Stránská skála (left) and Velké Pavlovice (right). Background mapy.cz.

***Obr. 8.** Strategická poloha dvou koňských lovišť v krajině jižní Moravy: Stránská skála (vlevo) a Velké Pavlovice (vpravo). Podklad mapy.cz.*

Fig. 9. Comparative views of herd hunting landscapes in North America. Vore Buffalo Jump, South Dakota, using a karstic sinkhole (left) and Muddy Creek, Wyoming, using drives in the lansdscape (right). Photo by J. Svoboda.

***Obr. 9.** Lovecké krajiny severní Ameriky jako srovnání. Vore Buffalo Jump, Jižní Dakota, využívající krasový závrt (vlevo) a Muddy Creek, Wyoming, využívající přirozených úžlabin v krajině (vpravo). Foto J. Svoboda.*

marrow extraction and lack of evidence of transportation of meat-bearing bones out of the site indicates several separate episodes of killing, with underexploitation of the carcasses. Fig. 5 shows that distribution of the horse skeletal parts at Stránská skála IV is closer to Solutré than to residential sites of Andernach and Gönnersdorf. Pollen spectra from Solutré are similar to Stránská skála IV – which does not mean more that the hunting took place in a similar environment.

Back in southern Moravia, a smaller but comparable site was **Velké Pavlovice** in the Trkmanka River valley, a tributary of Dyje River (Svoboda, Fišáková 1999). During the 1980s, industrial mining of a sandpit located on the steep eastern slopes north of the village was surveyed by O. Jeřábek who recorded individual finds (horse bones, a rhino tooth, a mammoth tusk with cutmarks, a radiolarite flake and a siltstone fragment). In 1988, we opened a stratigraphic section in upper part of the pit, with the following stratigraphy: about 1.5 m of Holocene refill; a shallow loessic layer; a grey-to-brownish horizon with charcoal, molluscs and accumulation of horse bones; loess deposit; and a complex of Upper Pleistocene paleosols. The complete horse bone assemblage recovered from this excavation was immediately transferred to the Central Geological Institute in Prague which moved premises, changed names (now Czech Geological Survey) and the assemblage was lost. One tibia fragment is preserved in our collection, it has been C14 dated and the date from the bone collagen suggests an Epigravettian age (Tab. 1). The associated mallacofauna was determined by J. Kovanda as *Succinea oblonga* Drap., *S. oblonga elongata* Sndb., *Pupilla muscorum* (L.), *Columella columella* (Mart.), *Trichia hispida* (L.) and *T. plebeia x sericea*. The Trkmanka valley is eroded into sandy deposits of Tertirary age, making horse drives possible in the valley and along one of its steep flanks.

Given the geography of all the mentioned sites, we reject the jump-site hypothesis. We observed that horse hunting took place in deeper side-valleys rather than on the main migratory routes: Solutré is adjacent to the nearby Rhone valley, Stránská skála and Velké Pavlovice lie next to the Moravian riverine network of Svratka and Dyje. Therefore, our reconstruction of the hunting strategy is driving herds from their main migratory routes to suitable places serving as a *cul de sac*.

Conclusion

With the end of MIS3, the unity of larger Gravettian settlements based predominantly on mammoth exploitation split into a mosaic of smaller Epigravettian sites with specific behaviors and economies. Stránská skála IV provides an example of radical and complex changes in all aspects of hunter-gatherer behavior. Based on the C14 chronology, this site (together with Grubgraben, Ságvár and Kašov) correlates with a brief warm period around 22 ka calBP, which in the moment is difficult to compare with individual fluctuations of the GISP system.

No settlement features or hearths were recovered and horse bones are among the most numerous objects. The Epigravettian lithic production was based upon a variety of lithic materials from Moravia and the Carpathian basin, in contrast to Late Gravettian assemblages which also contain lithic raw materials of Polish and Western Ukrainian origin (Kozłowski 2013). This shift in the raw material provenience may be correlated with the glacier advance in the north that oriented the hunter-gatherer groups to areas south of the Sudettes and the Carpathians (as also observed at Ságvár; Lengyel 2014).

The horse hunting strategy took advantage of the particular geographic characteristics of the site. Preferential location of Epigravettian sites in secluded valleys is a pattern generally recognized in Moravia and usually explained as a response to harsh MIS2 or LGM climates. In addition to the protective function, valleys also provided food resources, be it fishing in river valleys (Mohelno-Plevovce, Jundrov, Pístovice II), herd hunting in dry valleys (Stránská skála IV), or both (Velké Pavlovice).

Acknowledgement

J. W. was supported by the National Science Centre (NCN), Poland, decision No: UMO-2018/29/B/HS3/01278. G. L. was supported by the National Science Center (NCN), Poland decision No. DEC-2016/23/P/HS3/04034, the ÚNKP-19-4P New National Excellence Program of the Ministry for Innovation and Technology (TNRT/1419/51/2019), and the Bolyai János Research Fellowship (BO/00629/19/2) of the Hungarian Academy of Sciences (MTA). This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 665778. J. S., S. B. and S. S. were supported with Czech national institutional support RVO: 68081758 – Czech Academy of Sciences, Institute od Archaeology, Brno, and Masaryk University, Faculty of Science institutional support 2222/315010 (A.P.).

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Resumé

Po skončení relativně příznivější periody MIS3 se původní jednota velkých gravettských sídlišť, převážně závislých na exploataci mamutů, proměňuje v mozaiku menších stanovišť epigravettienu (MIS2), které dokládají specifické chování a loveckou ekonomiku případ od případu.

V letech 1985–1987 jsme pod skalním srázem na severním úbočí Stránské skály prozkoumali dvě centrální nálezové kumulace o průměru 5–7 m, tvořené převážně koňskými kostmi, prostoupené vápencovou sutí a nečetnou štípanou industrií epigravettienu (obr. 1–3; předběžně Svoboda 1990; 1991). Nálezy byly uloženy v nejvyšší části pleistocenní spraše, místy postižené následnou pedogenezí (obr. 4). Nebyly odkryty žádné sídelní struktury, tedy objekty ani ohniště, což ukazuje na specializované loviště využívající příhodný terén. Na základě radiokarbonové chronologie periody MIS2 a posledního glaciálního maxima (LGM) koreluje lokalita Stránská skála IV (spolu s lokalitami Grubraben, Ságvár a Kašov) s chladným obdobím GS-2.1c kolem data 22 ka calBP (Clark et al. 2009; Rasmussen et al. 2014; Hughes et al. 2016), ale podle paleobotanických analýz (viz níže) nebyly lokální klimatické podmínky tak drastické, jak bychom v této době očekávali.

Vegetace

Rekonstukce vegetace je možná na základě pylové analýzy jediného vzorku z horní části zkoumaného sprašového profilu (z vrstvy 4a). Analýzu provedla Helena Svobodová Svitavská. Ve zjištěném pylovém spektru převládají dřeviny nad bylinami. Dominuje bříza, která je silným pylovým producentem, takže prostředí můžeme i tak rekonstruovat jako převážně bezlesé. Vzhledem k datování do období LGM jsou poměrně překvapující nálezy pylových zrn lísky a lípy. Pokud se nejedná o redeponovaný materiál, lze tento nález interpretovat jako doklad příznivých mikroklimatických podmínek. Takové interpretaci by nahrávalo srovnání se stejně starými pylovými spektry z nedalekých Západních Karpat (Jankovská, Pokorný 2008), nebo recentní analogie z jižní Sibiře, kde lípa roste v izolovaných reliktních populacích v podmínkách, které jsou analogické klimatickým poměrům ve střední Evropě během LGM (Novák et al. 2014).

Fauna

V obou akumulacích osteologického materiálu dominoval kůň, doprovázený ojediněle zastoupeným nosorožcem, sobem a velkým bovidem (obr. 5). Potvrdili jsme pozorování D. West (1997), která zde určila 9 dospělých jedinců koní a jednoho mladšího pod tři a půl roku, kteří byli uloveni pravděpodobně během léta nebo brzkého podzimu. Předpokládáme, že jejich těla byla silně rozbourána přímo na lokalitě, přičemž hlavy byly

pravděpodobně odneseny, zatímco některé části postkraniálního skeletu byly ponechány na místě (přesto nebyly na povrchu kostí pozorovány žádné zářezy; obr. 6). Dále se domníváme, že se mohlo jednat o tzv. bakalářské stádo mladých hřebců, kteří mají tendenci migrovat na velké vzdálenosti a jsou mezi nimi menší vazby než ve stádech s klisnami a hříbaty (Tilson et al. 1998). Pokud je podobné stádo napadeno lovci nebo predátory, chovají se samci méně předvídatelně (mohou být velmi agresivní v porovnání s harémovým stádem s klisnami, nebo se mohou rozprchnout do různých stran). Nutriční výtěžnost jedince ve vrcholné kondici však převáží rizika podobného typu lovu a lovci je velmi rádi postoupí, jak víme i ze současné etnologické analogie.

Kamenné suroviny

Na surovinách štípaných artefaktů je pozoruhodná významná přítomnost dalekých importů, přestože jurské vápence Stránské skály obsahují hojné rohovce včetně kvalitních variet, které se v paleolitu běžně využívaly. Další jurské i křídové rohovce mohly být sbírány ve štěrcích třetihorního nebo čtvrtohorního stáří, které leží přímo na skalním masivu nebo v jeho blízkém okolí. Tyto lokální materiály dosahují 71 % ze studované kolekce. Z importů jsou to především barevně nápadné radiolarity či radiolariové rohovce (14 %), které téměř určitě pocházejí od JV z Bílých Karpat. Tímto směrem ukazuje i ojedinělý rohovec typu Troubky-Zdislavice (1 %) a mnohem vzdálenější obsidián (1 %). Suroviny od S až SV představují pazourky z ledovcových sedimentů severní Moravy a Slezska (až 7 %). Naopak 4 artefakty z křišťálu a porcelanitu (3 %) mají svůj původ na Z až SZ od Stránské skály (Českomoravská vrchovina, Kunětická hora u Pardubic). Asi 3 % surovin se nepodařilo spolehlivě určit. Surovinové složení podporuje představu o specializovaném lovišti, u kterého se mohly ve vhodném období setkávat lovecké skupiny z různých míst Českého masivu a Západních Karpat.

Techno/typologická struktura industrie

Kamenné nástroje jsou vyrobeny převážně na čepelích, přičemž okrajové retuše a další úpravy formují typy škrabadel, rydel a vrtáčků (obr. 7). Skupinu malých nástrojů reprezentuje čepelka s otupeným bokem a s příčnou retuší a retušovaný hrot. Taková typologická skladba je sice oproti běžným sídlištím redukovaná, ale rámcově odpovídá epigravettienu té doby.

Lovecké strategie

Terénní situace lokality Stránská skála IV (kde výškový rozdíl mezi lokalitou ve 275 m n.m. a vrcholem dosahujícím 310 m n.m. činí 35 m) naznačuje, že skalní sráz hrál ve strategii lovu koní svou roli, ať už naháněním seshora (typ *jump-site*) nebo spodem, tedy dnem suchého údolí proti skalní stěně. Dnes je sráz sice poškozen lomem, ale jeho původní průběh je rekonstruovatelný. Využívání výrazných krajinných prvků (údolí, svahy, srázy) při lovu koní nebo bizonů lze v době kolem glaciálního maxima předpokládat také na dalších lokalitách na Moravě (Velké Pavlovice, obr. 8) a v širší Evropě (Solutré, Amvrosievka). Četné paleoetnologické paralely nacházíme také v severní Americe (obr. 9).

Po srovnání loveckých aktivit a lokalit (Olsen 1989; West 1997; Turner 2002) se přikláníme k hypotéze o nahánění stád zespoda, ve směru z hlavních migračních tras do bočních údolí (lokalita Solutré přiléhá k údolí řeky Rhony, Stránská skála a Velké Pavlovice k říčnímu systému Dyjskosvrateckého úvalu). Podíl importů ve skladbě kamenné industrie zřejmě indikuje zvýšenou mobilitu populace. Pokud jde o synchronní epigravettská sídliště na Moravě, jejich opakující se poloha v chráněných údolích je zřejmě adaptační reakcí na celkové zhoršení klimatu během a po MIS2.

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