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Edited by
Michal Filippi
Pavel Bosák

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Cover photos (some photos were adjusted/cropped)
Top left – José Bidegain, on his way for the recovery Marcel Loubens' body. Author unknown. For details see the paper by A.A. Cigna.
Top right – "Walking Mammoth" – a prehistoric drawing from the Kapova Cave, Russia. Photo by O. Minnikov. For details see the paper by Y. Lyakhnitsky et al.
Bottom left – "Astronaut" David Saint-Jacques (CSA) collecting microbiological samples for the scientific programme of the ESA CAVES course. Photo by V. Crobu. For details see the paper by Bessone et al.
Bottom right – The long-legged cave centipede Thereuopoda longicornis – a typical species of Lao caves. Photo by H. Steiner. For details see the paper by H. Steiner.

BAROVÁ (SOBOLOVA) CAVE, MORAVIAN KARST (CZECH REPUBLIC) UPPER PLEISTOCENE FOSILIFEROUS IN-CAVE SEDIMENTS INSTRUCTIVE PALEONTOLOGICAL EXCAVATIONS

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Since the discovery of Barová Cave in 1947, three periods of excavations in the inner part of the cave had been done until present, in context with both caving activities connecting distand parts of the cave and archeological/paleontological research projects proceeded within the cave entrance. Fossil bone remains of typical Upper Pleistocene fauna (Weischelian glaciation) were excavated, exspecially bone remains of the cave bear (*Ursus* ex gr. *spelaeus*). These activities followed by intensive speleological work led to the filling up all the entrance parts with huge slag deposits. Then the locality became unclear and taken as paleontologically completely excavated. As the consequence of the underlying sediments slide succesion in the northwest part of the "Shaft II", new layers of bone rich sediments were opened in the basis of the old excavation sites and their surroundings. Subsequently, new restoration of old excavation sites was done, the terrain had been cleaned, newly topographically measured and used as the entrance to more distand parts of the cave. New instructive profiles have been opened in front of the fossiliferous debris tongue. Fossil bone remains excavated during these works belong to these taxa: *Ursus* ex gr. *spelaeus*, *Panthera spelaea*, *Crocuta spelaea*, *Canis lupus*, *Vulpes* sp., *Rangifer tarandus*, *Cervus* sp., *Capra ibex*, *Lepus* sp., *Aves* gen. sp. Most of the samples still wait for identification, which will proceed next season. No remains of Pleistocene small mammal fauna were found yet, the washing result is still negative (rodent bones found in there are recent), as well as the palynologic analysis. One of the valuable founds is almost complete skull of the subadult cave lion (*Panthera spelaea*) female with part of her postcranial skeleton. Researches, excavations and recovery works still run in the cave, the goal is to create educative site of the Pleistocene paleonthology for the next student or speleologist generation didactical use.

1. Introduction

Paleontological researches inside the caves of Moravian Karst have their rich tradition. Many of the caves here became the "classic" localities of Quaternary paleontology, used since the start of 19th century and, naturally, exploated by bone collectors and for some magic purpose since almost ancient times. Some of them were hugely devastated and destroyed, when only a small part of paleontological founds is now kept in some european museums, some classic localities are now used as open-for-public sights and very recent excavations were going on mostly as salvage activities, when turistical use had priority. The finds of these localities were scientifically processed and now are kept in public collections in museums and other institutions. Keeping at least a part of the original sediments, bone layers of Pleistocene fauna, stone beds, artefacts or local finding situation is presented in case of very important archeological or paleoantropological sites in entrance part of caves like Kůlna Cave. In-cave sediments left in shape of the instructive cross-section, profile, or intact layer sequence, these are much rarer. Mostly they had been built in caves not allowed for public visitors, ones of the most important are those in Holštejnská – Nezaměstnaných Cave and Malý lesík Cave. Here in the caves of active speleological work the goal is to discover a new part of the cave or connect it with another underground place. Profiles and cross-sections are one of more consequences only. Most of the Pleistocene "bear caves" with bone rich sediments of the Upper Pleistocene has been already exploated, processed and used for another purpose, they are already empty. Intending to visit some in-cave fossiliferous Upper Pleistocene sediments (once so typical for many Moravian Karst caves), at least partially preserved, one must look after elsewhere. It's worth to look at the cave where works began later, i.e. the cave was discovered later, and the terrain, cave shape, inaccesibility, or inatractivity (of course, the in-cave facie does not offer such rich variety of results and discoveries, there are no rich stratigraphically important fossils, above all small mammals and molluscs) caused saving the cave off the very interest. However, even there are some complications here.

Figure 1. Second Shaft in Barová Cave, shape in 2007, V. Káňa.

Barová (Sobolova) Cave, situated in the central part od Moravian Karst on the right side of Josefovské údolí Valley, had been discovered in 1947 by Dr. A. Sobol and hid companions, digging through the debris at the entrance under the wall of "Krkavčí skála" limestone rock cliff. Now the entrance lays in 346 m above sea level. The cave is complicated polygenetic system of vertical and horizontal corridors and shafts. The active Jedovnický potok Creek

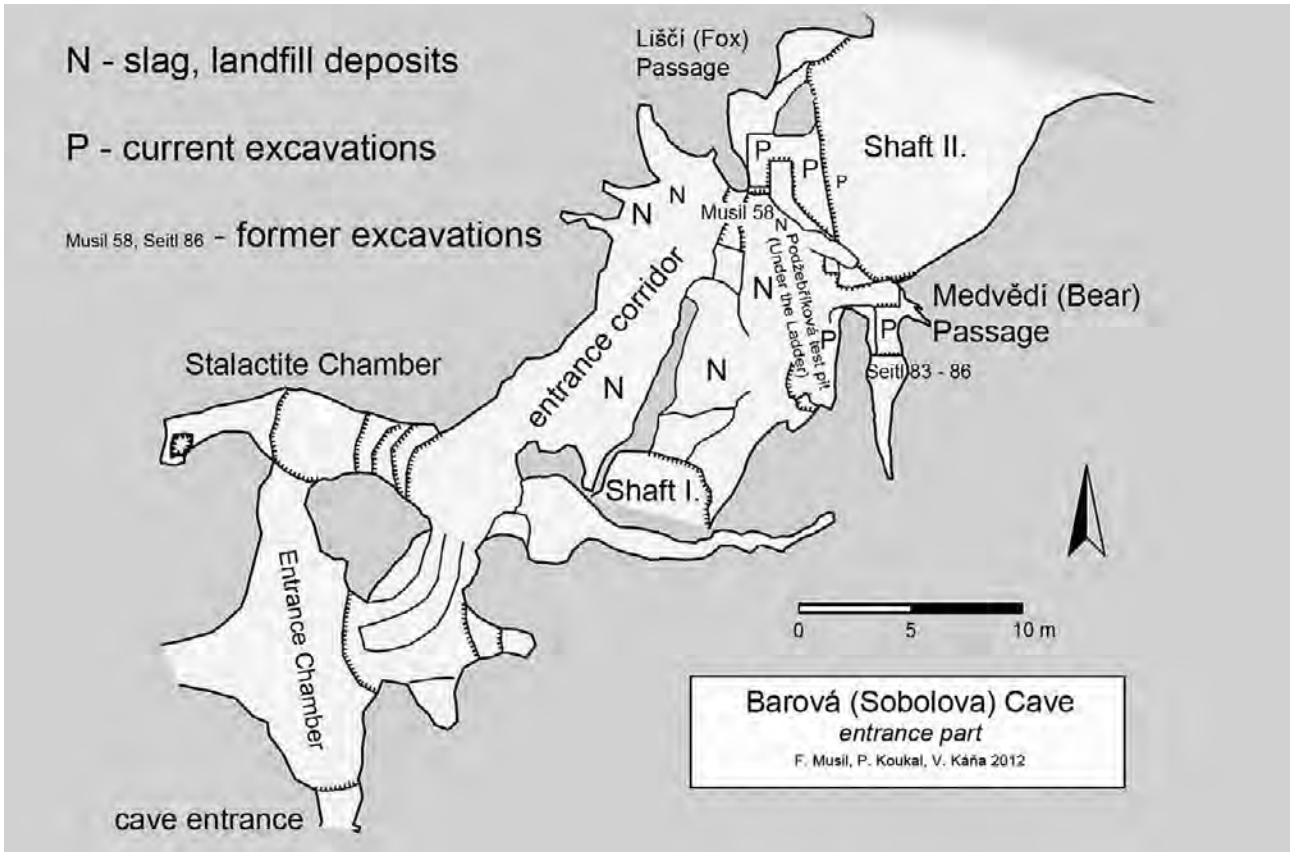

Figure 2. Entrance part of Barová Cave, measured by F. Musil and P. Koukal 2012.

flows through the underneath level. It is the part of Býčí skála – Rudické propadání cave system, the second longest in the Czech Republic. Total denivelation of the Barová Cave reaches 60 meters, the length is app. 900 m. There are three levels of the cave, each has the different shape and formation. The upper level is mostly vertical, chimneys are or filled with sediment (Jurassic and cretaceous origin) or already emptied. The entrance corridor is such an emptied chimney, filled at the base with fossiliferous Pleistocene sediments. The middle level in shape of six shaftlike domes is created by sedimental fallings and slides filling otherwise unbroken underground corridor, approximately 100 m long (see Fig.1). The names of these shafts correspondent with the time of discovery in 1947 (First, Second, Third…, in following we use I., II.). The underneath level is, in fact, the system of siphons and corridors on the flow of Jedovnický potok Creek. Two of shafts protrude to the creek (I. and II.). There were lots of actions and speleological works done at the underneath level of the cave from 2006 to 2012, including water pumping and hydro-mining, digging and new discoveries.

2. Previous paleontological excavations and researches

The first paleontological excavations were done by A. Sobol and his companions in 1947–1956, some bones of Pleistocene mammals were taken from the ground in the entrance corridor, from some small excavations and connective passages dug between the entrance and the Shaft II (see Fig. 2). Some paleontological material had been found directly on the surface of the entrance corridor and small cavities near Shaft II. From the collection of A. Sobol (now in Moravian Museum Brno) is to list long bones and jaws of cave bear cubs (*Ursus* ex gr. *spelaeus*), numerous bones of the woolf *(Canis lupus)*, and the cave lion *(Panthera spelaea).* Sadly, all space on the ground of the cave between the entrance and the Shaft II. had been covered by very thick layer of slag deposits.

In 1958, R. Musil opened the test pit at the beginning of the passage between entrance corridor and the Shaft II. He sketched basic stratigraphy of the sediments as the debris cone, excavated Upper Pleistocene large mammals bone remains and, based on these excavations, characterized the cave as the typical cave bear den (Musil 1959, 1960). From these excavation finds the brain case of the cave hyena (*Crocuta spelaea*), the part of ibex *(Capra ibex)* skull and two hemimandibulae of the cave lion *(Panthera spelaea)* are worth to be reminded here. These finds show that the cave served to cave hyenas as a den, too. There were clearly cave hyenas transporting their prey body parts to the cave as they still do with their prey and den in Africa. Sadly here again, lots of debris, slag, huge quantity of sandy and clay material had been deposited within the cave, too.

The next phase followed between 1983 and 1986, when in terms of the research project, L. Seitl managed comparatively extended excavations within the cave. Most of excavations were concentrated in the entrance parts, archeology and sedimental cone in front of the cave. Some in-cave sediments were excavated at the branch called Medvědí (Bear Branch). Three layers were distinguished, upper loess-like, middle bone sediments and underlying reddish clay, all covered by calcite sinter plate. Bone remains belonged mostly to cave bear and cave hyena, very interesting was pelvis fragment of the wooly rhinoceros *(Coelodonta antiquitatis)*, chewed by hyenas. Most sediment was taken away from the cave, washed and purely controlled, in case of the in-cave sediments with negative result.

Other speleological works (digging, excavations, washing, measuring) were then concentrated in the distand parts of the cave, fossiliferous sediments yet unexploated

Figure 3. Excavations in the probe "Pod žebříkem" in November 2012, photo by M. Maláč.

dissapeared under the slag deposits, the corridor nearby was used only to pass to the next parts of the cave, excavation sites were abandoned, only some small test pits made by cavers appeared and disappeared. Only important natural proces inside the cave was continual falling of the underlying sediments in the northwestern part of the Shaft II. The shaft had changed many times, continuous slides of the complexed sands, clay, and gravel sediment of uncertain age formed the shape of the shaft (Hypr and Koudelka 1995). The strongest slides took place from 2008 to 2011, when the space of the Shaft II increased by one third. The new cross-section through fossiliferous sediments emerged nearby both older excavation sites Musil 1958 and Seitl 1986. Then, immediately, the reconstruction of all former excavation sites started, the new passage between entrance corridor and the other parts of the cave was made and after that, new test pit through the debris cone at the centre of the fossiliferous sedimental tongue was started to dig and explore. The place has been named Podžebříková sonda (Testpit Under the Ladder, see Fig. 3). The branch of the sedimental tongue near former Musil 1958 pit, on the northwestern border of the Shaft II, has been named Liščí chodba (Fox Passage). These three test pits (Liščí – Fox, Medvědí – Bear, Podžebříková – Under the Ladder) are the places, where we process current excavations and research.

3. Material, methodology and osteological analysis

The excavated area is the front of large sedimental tongue spreading from northwest, ending on the border of the Shaft II. It's topography follows the ceiling relief almost without difference. The parts cropped by pendants have thickness to 2.5 m, the main part is a lot thinner, about 30–40 cm. Only some parts are covered by the sinter plate, most parts are buried under slag and debris or sandy deposit.

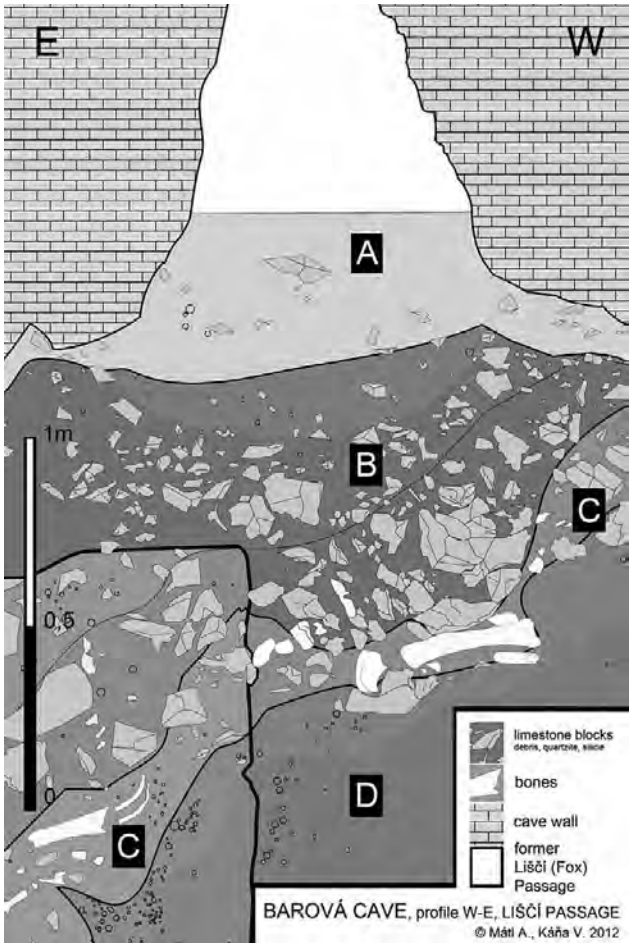

Figure 4. Liščí (Fox) Passage test pit profile, shape of December 2012, A. Mátl, V. Káňa.

The fossiliferous sediments appear in all test pits consisting of three layers. Layer A is overlaying, consisting of sands, clay and loess-like sediments and rarely contains Pleistocene bones, the remains of recent rodents *(Apodemus, Microtus)* are present. It reaches thickness up to 60 cm in terminal parts of the tongue, where originally the calcite plate covered it (Seitl 1988). Layer B is constituted by limestone blocks, debris, sinter and calcite fragments, quartzite, silicite stones, sand, clay and disarticulated Pleistocene bones in mass from 10 cm to 1.2 m. Layer C is incontinual base of the layer B, consisting of red clay, corroded limestone blocks, sinter plates and the clusters of crashed and compressed Pleistocene bones (see Fig. 4). It is from 5 cm to 80 cm thick. The sediments of the layers B and C were washed, the result was negative yet, palynological analysis was made from the sample of the layer C in Liščí (Fox) test pit, it is negative, too (Doláková in verb. 2012).

Numerous osteological materials are found in both Liščí (Fox) Passage pit and Medvědí (Bear) pit, and so in currently

excavated test pit Podžebříková (Under the Ladder). Bones are not in situ, they were transported vertically and horizontaly as a part of rocky sediments of the debris cone. Consequently, bones are not in anatomical position, their affiliation with skeletons is unrecognizable. Larger bones like skulls, pelves, long bones, are often badly fragmented, although it is possible to reconstruct most of them.

Bone determination of paleontological finds is processed using comparative collection of Anthropos Institute, MM and osteological handbooks, atlasses and monographies (Hue 1907, Lavocat 1966, Pales and Lambert 1971, Schmid 1972). Ontogenetical age of the bone remains is reckoned by Habermehl (1985). Minimal number of individuals (MNI) is to reckon using methodics of Chaplin (1971), cave lion dentical measurment by Driesch (1976).

All osteological, taphonomical and paleontological analyses is just beginning, the research is still running, all results are to be taken as preliminary. Dominant species within all finds is the cave bear from the group of *Ursus spelaeus*, what corresponds to the situation published by Musil (1959, 1960) and Seitl (1988). Until now, these taxa were validated from our current excavations within all three test pits:

Ursus ex gr. *spelaeus* Rosenmüller, 1794

Panthera spelaea (Goldfuss, 1810)

Canis lupus Linnaeus, 1758

Crocuta crocuta spelaea (Goldfuss, 1823)

Capra ibex Linnaeus, 1758

Rangifer tarandus (Linnaeus, 1758)

Cervus sp. Linnaeus, 1758

Vulpes sp. Frisch, 1775

Lepus sp. Linnaeus, 1758

In comparation with frequency of remains of the cave bear, other taxa, lions, hyenas and wolves exceptional, bone remains of ibex, reindeer, deer, hare and foxes are very rare, but present.

Only a part of the osteological finds from current ecavations in Barová Cave could be analysed until today. The first analysed sample is from Liščí chodba excavations. As is visible from results, 95.3 % of determined bones come from cave bear (*Ursus* ex gr. *spelaeus*), both wolves and cave lions are 2.3 %. No other taxa were found in the sample. Following samples are to be analysed and the taxa ratio can be different.

The cave bear bones processed until now (December 2012) belong to at least 4 individuals, (MNI = 4), the bone remains of wolf and lion both belong to just one individual (MNI = 1). In case of the cave bear, all parts of skeleton are present here, presumably no alimentar transport (at least out of the cave) or only slight manipulation with carcasses took place. Basing on the teeth development and wearing, epiphysal merging and cranial suture shape it shows, that most present remains of the cave bear belong to young adult individuals, bear cubs or senile individuals are present more rarely. Both sexes are present in case of the cave bear. Bone remains of the cave lion and wolf from Liščí chodba test pit belong to adult individuals.

Figure 5. Situation in the time of the cave lion (Panthera spelaea) skull excavation in October 2012, photo by I. Harna.

Very important find comes from newly excavated test pit Podžebříková (Under the Ladder). Here almost complete skull of the cave lion *(Panthera spelaea)* subadult female has been found, including complete mandible, and a part of postcranial skeleton (see Fig. 5). Basing on the age, size, bone shape and situation, these bones appear to belong to the skull: axis, atlas, three cervical vertebrae, one thoracal vertebra, two lumbar and seven caudal, five sternal segments, ulna, two metacarpals, two tibiae, patella, calcaneus, all metatarsals of the left hindlimb, and several individual carpals, tasals and phalanges. In spite of fact, that the excavation is still at the beginning, the number of bone remains belonging to this individual can increase in the future.

Most of the cranial sutures are still open, the individual is young, about two to thre years old, until the discovery of this skull supposed as a female. Dental measurment of lower praemolares p4 and molares m1 were accomplished in comparation with data of the works of F. G. Baryshnikov (2011). In the article, there the data of the length and width p4 and m1 from many European localities are present (Baryshnikov 2011, pp. 205–206, tab. 3). The data from the individual of Barová Cave correspond with female shape (see Tab. 1 and Fig. 6, Fig. 7). The individual is a young, not fully grown female with already permanent teeth, unique in the region of Moravian Karst and this part of the central Europe by its well-preserved state.

4. Discussion

Individual fossiliferous sediment layers in Barová Cave are presumably not a consequence of more in-cave landsliding events, the base (layer C) is the result of relatively slow sedimentation gravitationally transported bones and other components to shallow waters or muddy pits on the surface of underlying sediments, where the bones were crashed and fragmented by stones overlaying consequently. Faunal structure in individual parts show slight difference (no hyenas present in Liščí test pit, at least some hyenas in others), taphonomical state is slightly different too, it suggests that different parts of sedimental tongue have different origin, e.g., places of source. The shape of sediments in the entrance corridor shows the possibility, that the animals during Upper Pleistocene time used this part of the cave, which was more complex, large sized underground dome, as a den, the transport of bone remains

Table 1. Length (L) and width (W) of cave lion (Panthera spelaea) lower molars m1 from European localities, according to Baryshnikov (2011). Molars m1 from Barová Cave (bold print) fall into the range of females.

Males			Females		
Locality	**L**	**W**	**Locality**	**L**	**W**
Kent's Cavern, England	30,0	14,7	Kent's Cavern, England	26,7	12,5
Kent's Cavern, England	29,8	15,7	Kent's Cavern, England	28,0	14,8
Kent's Cavern, England	30,8	15,3	Jaurens, France	27,9	14,2
Jaurens, France	29,9	15,1	Jaurens, France	28,0	14,1
l'Herm, France	31,3	15,3	Circeo, Italy	25,9	13,8
Widkirchli, Switzerland	31,2	16,5	Zoolithen Cave, Germany	28,1	14,4
Wierzchowska Górna, Poland	31,1	17,0	Wierzchowska Górna, Poland	27,8	13,5
Wierzchowska Górna, Poland	30,9	16,2	Wierzchowska Górna, Poland	27,1	12,8
Schusteriucke, Austria	30,3	16,0	Předmostí, Czech Republic	26,7	12,8
Lautscher, Austria	29,7	16,9	Předmostí, Czech Republic	27,9	12,6
Předmostí, Czech Republic	30,2	14,1	Švédův Stůl, Czech Republic	25,8	13,4
Kodak, Ukraine	29,9	15,5	**Barová Cave, Czech Republic**	**27,3**	**14,1**
Krasnyi Yar, Russia	32,0	16,7	**Barová Cave, Czech Republic**	**27,4**	**13,9**
Sukhoi Log, Russia	28,9	14,1	Starye Duruitory, Moldova	25,9	12,4
Kurtak, Russia	30,1	14,9	Krishtaleva, Crimea, Ukraine	25,9	12,4
			Krasnyi Yar, Russia	27,0	13,3
			Shubnoe, Russia	27,5	13,5
			Medvezhiya Cave, Russia	26,2	13,6

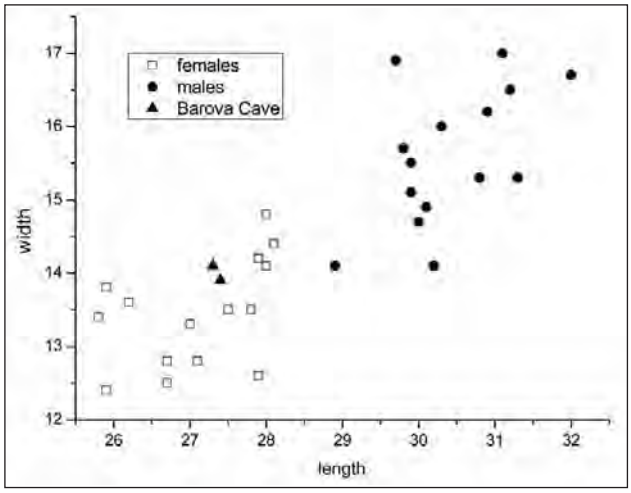

Figure 6. Ratio of length to width of cave lion molars m1 from European localities (see Tab. 1, according to Baryshnikov 2011). Molars of males and females are clearly divided on the basis of size. Molars from Barová cave fall into the range of females decidedly.

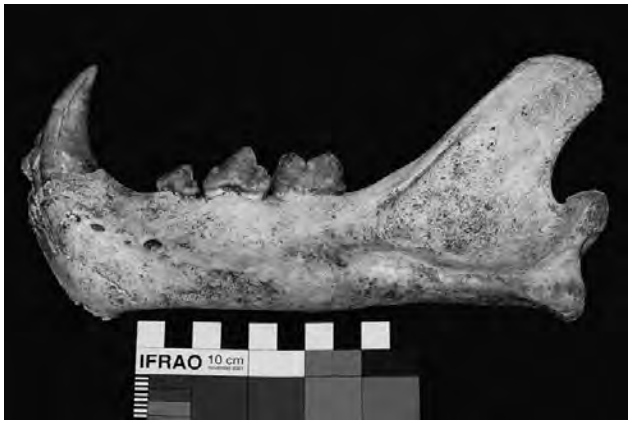

Figure 7. Young cave lioness left lower jaw, excavation "Pod žebříkem" in Barová cave.

could not be for a long horizontal and even vertical distance (Complete skull of young lioness could not "survive such transport"). So the entrances had to be different and maybe numerous, being now buried (along with most of the entrance corridor) under meters of Holocene sediments, debris and man-made deposits.

Most of the cave entrance part served as wintering habitat for cave bears, while (probably in periods, when bears were not present) some parts could be a hyena den or a shelter for cave lions. Although the most finds are remains of the cave bears, increasing number of other taxa promises that, in following seasons, the locality can bring some more important finds opening the view at the paleoecological state of the Upper Pleistocene in the central part of Moravian Karst.

5. Conclusion

Although the fauna is not much varied, the place still seems to be an ideal training site for Pleistocene paleontology. The goal is not what we remove from the cave, it is about something different. The most important is, what remains in the cave as an instructive educational locality shaped for in situ teaching. We will form the locality in Barová Cave to the didactic tool for university students of paleontology, geology, karsology etc., cavers, speleologists, instructed visitors. It is presumable, that the rest of our test pit in Podžebříková will grant more various fauna than any others in Barová and as such can be ideal cross-section profile for the next studies. As well as the teachers and specialized public get unique place to see rests of intact Pleistocene bone sediments. The excavation in Liščí chodba test pit now already serves as such teaching profile. The restoration of other parts of the cave continues.

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