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LATE PLEISTOCENE RODENTS (MAMMALIA: RODENTIA) FROM THE BARANICA CAVE NEAR KNJAŽEVAC (EASTERN SERBIA): SYSTEMATICS AND PALAEOECOLOGY

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Abstract. Baranica is a cave in the Balkan mountain range in the eastern part of Serbia. It contains four layers of sediments of Quaternary age. The Upper Pleistocene deposits (layers 2-4) have yielded a rich and diverse assemblage of vertebrate fauna, including fish, amphibians, reptiles, birds, and small and large mammals. In this work, preliminary results of a study of the rodent fauna from the Upper Pleistocene deposits of the Baranica Cave (Knjaževac, eastern Serbia) are presented. The fossil material comes from the 1995 archaeological excavation. The remains of 10 rodent species are described herein: *Spermophilus* cf. *citelloides, Castor fiber*, *Sicista subtilis*, *Cricetulus migratorius*, *Cricetus cricetus*, *Mesocricetus newtoni*, *Apodemus* ex gr. *sylvaticus-flavicollis, Spalax leucodon, Dryomys nitedula,* and *Muscardinus avellanarius.* Along with eight vole species, this makes altogether 18 species of rodents found in this locality.

Both layers 2 and 4 (layer 3 is very poor in fossils) have yielded a rodent fauna typical for the cold periods of the Late Pleistocene on the Balkan Peninsula, with a prevalence of open and steppe inhabitants, but some forest dwellers were also present. The assemblages from these layers are similar, but there are some differences in the composition of the fauna, which may indicate a slight shift towards drier conditions. They have also been compared to rodent associations from some Serbian and Bulgarian localities of the same age and their similarities and differences are discussed.

Riassunto. Baranica è una grotta nella catena balcanica nella Serbia orientale (Knjaževac). In essa sono stati rinvenuti quattro livelli di sedimenti di età quaternaria. Nei depositi del Pleistocene superiore (livelli 2-4) è stata rinvenuta una ricca fauna a vertebrati, inclusi pesci, anfibi, rettili e uccelli, nonché mammiferi di piccola e grande taglia. In questo articolo viene presentato lo studio di una fauna a roditori. Il materiale fossile proviene da degli scavi archeologici effettuati nel 1995: Vengono descritti i resti di 10 specie di roditori: *Spermophilus* cf. *citelloides, Castor fiber*, *Sicista subtilis*, *Cricetulus migratorius*, *Cricetus cricetus*, *Mesocricetus newtoni*, *Apodemus* ex gr. *sylvaticus-flavicollis, Spalax leucodon, Dryomys nitedula,* e *Muscardinus avellanarius.* Unitamente a 8 specie di arvicole, nella località sono stati rinvenuti complessivamente 18 specie di roditori.

Entrambi i livelli 2 e 4 (il livello 3 è povero di fossili) hanno fornito una fauna a roditori tipica dei periodi freddi del Pleistocene superiore nella Penisola Balcanica con una prevalenza di abitatori di ambienti steppici ed aperti, ma anche con qualche specie più tipica dell'ambiente forestale. Le associazioni dei due livelli sono simili, ma vi sono alcune differenze nella composizione della fauna, che potrebbero indicare una tendenza verso condizioni più aride. Le associazioni sono confrontate con associazioni coeve di altre località in Serbia e Bulgaria.

Introduction

Baranica is a cave system which consists of three small caves – Baranica I, II and III. It is situated in the south-eastern part of Serbia, four kilometres south of Knjaževac, on the right bank of the Trgoviški Timok River (Fig. 1). Its altitude is approximately 400 meters (Mihailović 2004). In this paper, the fossils of rodents from Baranica I are described.

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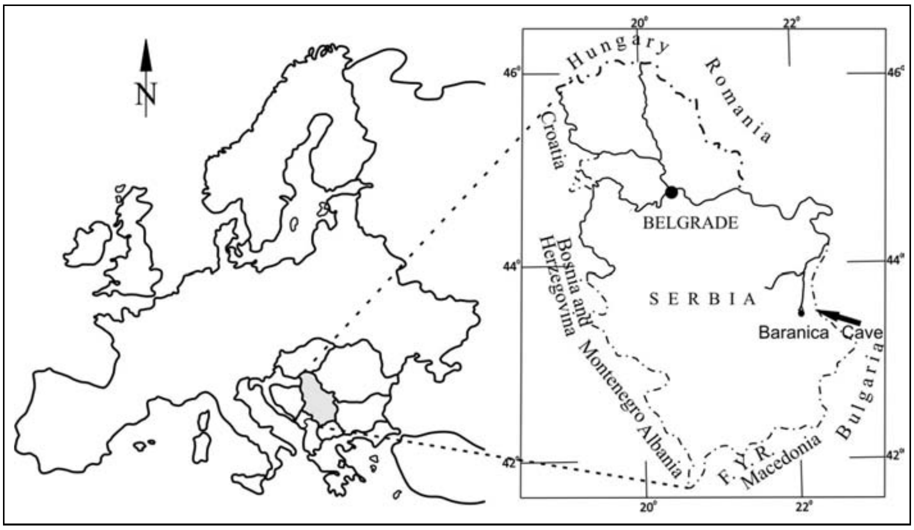

Fig. 1 - Geographical position of the Baranica Cave.

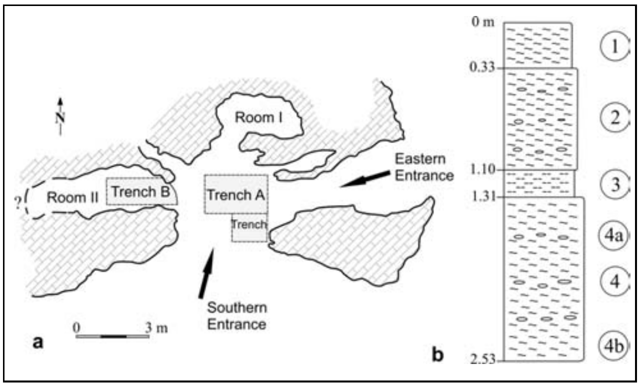

Fig. 2 - (a) Plan of Baranica I with the position of the trenches, after Sladić & Jovanović 1996 – (b) Section of the Upper Pleistocene deposits in the Baranica Cave. The descriptions of the layers are given in the text.

During the 1994-1995 excavations, three small trenches were opened – trench A (2.5 x 1.5 m) generally oriented east-west; trench B in the entrance of one of the side rooms and trench C in the southern entrance of the cave (Fig. 2a). The trenches were dug to depths of between 2 and 2.5 meters, but the bedrock was not reached (Mihailović 2004).

The excavations revealed four layers of cave deposits (Fig. 2b):

1) Surficial clay of Holocene age. Fragments of prehistoric and Roman pottery were found in this layer, which indicates a Holocene age (30 cm).

2) Yellowish clay with coarse rock fragments and the remains of large and small mammals. Two horizons were distinguished in this unit, 2a and 2b, which differ mainly in colour (2b being somewhat darker) (80 cm).

3) Ash grey homogenous silt with rare small mammal remains. It underlies Layer 2 in the northern part of trench A. The upper part (3a) contains rare small mammal remains, while the lower one (3b) is palaeontologically sterile (20 cm thick).

4) Dark brown clayey silt with coarse rock fragments (more than 120 cm thick). In this sediment two horizons could also be differentiated:

4a – compact sediment with rock fragments

4b – homogenous sediment without rock fragments.

The investigations in Baranica I began in 1994. From 1995 to 1997, some Upper Palaeolithic artefacts were found in Baranica I (Mihailović et al. 1997) and some large mammal remains in Baranica I and II (Dimitrijević 1997b, 1998). In Layer 2 several artefacts were recovered, which probably belong to the Gravettian culture (although the diagnostic tool types were not recorded). The material from Layer 4 (about ten artefacts, including an atypical endscraper) belongs, with no doubt, to the initial Upper Palaeolithic which has been already documented in the nearby Bulgarian localities – Kozarnika, Temnata and Bacho Kiro (Kozlowski 1982; Drobniewicz et al. 2000; Tsanova 2008).

The abundance of remains of both large and small mammals was already noticed in the early phase of the research. In addition to the mammal remains, this cave also yielded some remains of other animals and plants (birds, reptiles, amphibians, fish, gastropods and seeds). Some pollen grains were also extracted from hyena's coprolites (Argant & Dimitrijević 2007). These remains of flora and fauna are described in several papers (Argant & Dimitrijević 2007; Bogićević 2004; Brunet-Lecomte et al. 2001; Dimitrijević 1997b, 1998, 2004; Forsten & Dimitrijević 2004), but the study of small mammal fauna is still in progress. A separate paper has been dedicated entirely to the study of arvicoline remains (Bogićević et al. in press) and some of the results obtained in it will also be included here. The preliminary analysis of the rodent fauna (excluding voles) is the subject of this paper.

Material and Methods

The rodent material described in this paper is a result of sampling undertaken during the 1995 archaeological excavation. Sediment samples were taken at 22 sampling points in Baranica I: 6 in Layer 2, one in Layer 3 and 15 in Layer 4. All samples were screen-washed on three screens of 2, 1 and 0.5 mm mesh. All bones were picked out under a binocular microscope, but for taxonomical identifications almost only teeth and fragments of upper and lower jaws were used. In total, more than five hundred teeth are included in this study.

Dimensions (most often length and width) are given in mm. The methods of measurements are described in Heinrich (1978) – for sciurids – and Maul (2001) – for cricetids, murids, castorids and glirids. For murids, the terminology of Storch (1987) is employed; for sciurids, Stehlin & Schaub (1951); glirids, Bruijn (1967); castorids, Stirton (1935) and cricetids Daams & Freudenthal (1988). The teeth were drawn under a binocular microscope. For the purpose of identification, comparative collections of recent and fossil rodent teeth of the Department of Palaeontology were used.

The material described in this paper is stored at the Department of Palaeontology of Belgrade University, under the inventory numbers BAR 2/1-5, 2/16-17, BAR 3/1-6 and BAR 4/1-11, 4/26-31. Data on the Pleistocene distribution of species were taken mainly from Kowalski (2001). The relative abundance of the different taxa was calculated according to MNI (minimum number of individuals; after White 1953).

Systematic palaeontology

Family Sciuridae Gray, 1821

Spermophilus Cuvier, 1825

Spermophilus cf. **citelloides** (Kormos, 1916)

Fig. 3

Material and dimensions: Layer 2: M^{1-2} dext. (2.06 x 2.83). BAR 2/1. Layer 4: M^{1-2} sin. (2.11 x 3.0), 3 M^{1-2} dext. (1.89 x 2.61; 2.06 x 2.72; 2.11 x -), M^3 dext. (2.72 x 2.67), 2 P_4 dext. (2.11 x 2.21; 1.75 x 1.68), M_1 sin. (2.21 x 2.46), M_1 dext. (1.86 x 2.21), M_3 sin. (2.76 x 2.24), M_3 dext. (3.31 x 2.52). BAR 4/1-2

Description. The upper molars (Fig. 3a, b) of the ground squirrels are subtriangular in shape, with three major cusps (lingually – protocone and labially – paracone and metacone) connected by ridges that form together a letter "V". An anterior ridge (anteroloph) is also well developed. The upper molars have three roots. On three out of five M^{1-2}, a metaconule is distinct.

The lower premolar (Fig 3c) and molars (Fig. 3d, e) have a rhomboidal to trapezoidal outline with three ridges that connect cusps (metaconid, protoconid, hypoconid and entoconid) and encircle the talonid basin in the centre of the tooth. The posterolophid is thin.

Remarks. Teeth of the recent species *S. citellus* (Linnaeus, 1766) and *S. suslicus* (Güldenstaedt, 1770), as well as the fossil species *S. citelloides*, are very similar in structure. This makes the identification of the fossil material, mostly composed of isolated teeth, very difficult. Except for having a similar structure, the dimensions of teeth of these species also overlap each other.

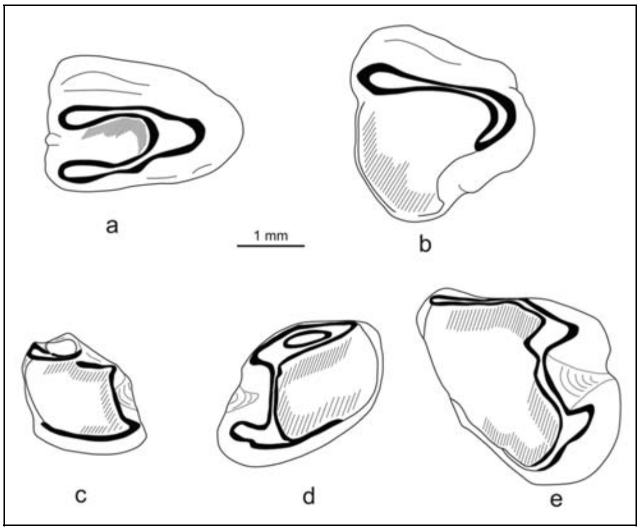

Fig. 3 - *Spermophilus* cf. *citelloides* (Kormos, 1916). (a) $M^{1,2}$ dext., (b) M^3 dext., (c) P_4 dext., (d) M_1 sin., (e) M_3 dext.

Due to this, especially in older literature, Late Pleistocene remains of ground squirrels have usually been referred to the recent species *S. citellus*, instead of to its extinct ancestor – *S. citelloides* (Kowalski 2001).

The structure of the posterior root of P_4 can sometimes be used for species determination: an undivided posterior root is characteristic for *S. citellus*, while in *S. citelloides* and *S. suslicus*, this root is divided into two parts in the majority of cases (50 – 80 %, after Kowalski & Nadachowski 1982). However, on the P_4 from Burgtonna (described as *S. citelloides*), the posterior roots are fused on more than 80 % of the teeth, hence this criterion is not entirely reliable for species determination (Koenigswald 1985). Both premolars from Baranica have only two roots, without any sign of bifurcation of the posterior root.

In western and central Europe, two groups of species lived during the Pleistocene. The larger ones [such as *Spermophilus dietrichi* Kretzoi, 1965, *S. polonicus* (Gromov, 1965), *S. primigenius* (Kormos, 1934), *S. superciliosus* Kaup, 1839] lived under arctic conditions up to the end of the Pleistocene. The second group comprises smaller ground squirrels: *S. citelloides*, and its probable descendants, the extant species *S. citellus* and *S. suslicus*, typical inhabitants of steppes (Kowalski 2001). The teeth from Baranica can clearly be attributed, on the basis of their dimensions, to representatives of the second group. For example, they are much smaller than the molars of *S. superciliosus* from central Europe (Heinrich 1983) and Poland (Black & Kowalski 1974). On the other hand, their dimensions correspond quite well to the dimensions of *S. citelloides* from Polish localities (Black & Kowalski 1974).

S. citelloides is a rather common element of the Late Pleistocene fauna of western and central Europe.

In addition to Baranica, its remains have been found in some other caves in Serbia (the Smolućka Cave, the Hadži Prodanova Cave, and the Vrelska Cave) and in a fissure filling in the quarry of Kamenjak on Venčac (Bogićević 2008).

It inhabited steppe areas, in a warmer climate than *S. superciliosus* (Black & Kowalski 1974).

Family Castoridae Gray, 1821

Castor Linnaeus, 1758

Castor fiber Linnaeus, 1758

Fig. 4

Material and dimensions: Unknown layer: P^4 sin. (9.37 x 8.12), BAR 22/1; $M^{1/2}$ sin. (7.5 x 7.5), BAR 16/2; $M^{1/2}$ dext. (8.0 x 8.5), BAR 20/7; molar fragment (BAR 1/11), phalanx III (L_{max} =16.25 mm), BAR 95/26/1.

Description. The beavers' teeth are of subquadratic shape. The upper teeth have three transverse enamel folds (para-, meso- and metaflexus) on the labial side and one on the lingual side (hypoflexus). The central syncline is the longest and is inclined relative to longitudinal axis of the teeth. Its walls have an undulated pattern (Fig 4a, b, c).

The third phalanx has an almost circular articular surface with a structure typical for the genus.

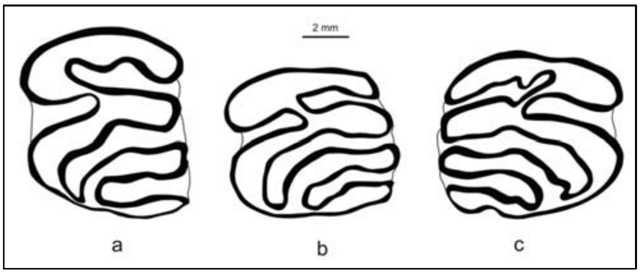

Fig. 4 - *Castor fiber* Linnaeus, 1758. (a) P^4 sin., (b) $M^{1,2}$ sin., (c) $M^{1,2}$ dext.

Remarks. This species has lived in Europe since the Early Pleistocene. Several species of the genus *Castor* from Pleistocene deposits of Europe were erected, but more recently it is held that all of them represent a single evolutionary line (Kowalski 2001).

Only one lower incisor from the Upper Pleistocene deposits of Serbia (the Risovača Cave near Arandjelovac) was attributed to this species (Rakovec 1965; Dimitrijević 1997a). In Montenegro, some rare findings come from Medena Stijena (Dimitrijević 1996) and Odmut (Srejović 1977); both from Holocene deposits.

Family Dipodidae Fischer de Waldheim, 1817

Sicista Gray, 1827

Sicista subtilis (Pallas, 1773)

Fig. 5

Material: Layer 2: M^1 sin. (1.11 x 1.14), M_1 sin. (1.29 x 0.99), M_2 sin. (1.17 x 0.93), M_2 dext. (1.17 x 0.96). BAR 2/2. Layer 4: 2 max. dext. (P^4-M^3), 2 max. sin. (P^4-M^1), 2 max. dext. (P^4-M^1), max. sin. (M^1-M^2), max. dext. (M^1-M^2), 4 max. dext. (M^1), max. dext. (M^2-M^3); 11 M^1 sin., 5 M^1 dext., 11 M^2 sin., 17 M^2 dext., mand. sin. (M_1-M_3), mand. dext. (M_1-M_3), 2 mand. sin. (M_1-M_2), mand. sin. (M_1), mand. dext. (M_1), 2 mand. sin. (M_2), 12 M_1 sin., 13 M_1 dext., 11 M_2 sin., 4 M_2 dext., M_3 dext. BAR 4/3-5. (For dimensions: see Table 1).

	n	min.	max.	mean	SD
P^4-M^3 Length	2	3.25	3.75	3.50	
P^4 Length	6	0.48	0.54	0.52	0.02
Width		0.63	0.72	0.69	0.04
M^1 Length	26	1.08	1.26	1.17	0.05
Width		1.00	1.26	1.15	0.06
M^2 Lenght	33	1.02	1.23	1.13	0.07
Width		0.93	1.29	1.11	0.08
M^3 Length	2	0.72	0.75	0.73	
Width		0.72	0.78	0.75	
M_1-M_3 Length	1			3.40	
M_1 Length	31	1.14	1.32	1.23	0.05
Width		0.81	1.02	0.95	0.06
M_2 Length	19	1.11	1.26	1.19	0.05
Width		0.81	1.02	0.93	0.06
M_3 Length	3	0.93	0.99	0.97	0.03
Width		0.54	0.78	0.62	0.14

Tab. 1 - Dimensions of the teeth of *Sicista subtilis* (Layer 4).

Description. Relatively numerous remains of this species were found in Baranica. The material contains two maxillae and two mandibulae with complete dentition, as well as many jaw fragments and isolated teeth.

The teeth of this species are quadrituberculate (with four main cusps) (Fig. 5). They could be distinguished from those of the species *S. betulina* (Pallas, 1773) by size (*S. betulina* is smaller) and a simpler structure of the occlusal surface (absence of additional "spurs") (Pucek 1982). M_1 of *S. betulina* have a more rounded occlusal outline, while in *S. subtilis* it has a shallow concavity where the ectoflexid comes to the lateral edge of the tooth (Kalthoff et al. 2007). All the specimens from Baranica (29 in total) have this feature, more or less distinctly developed.

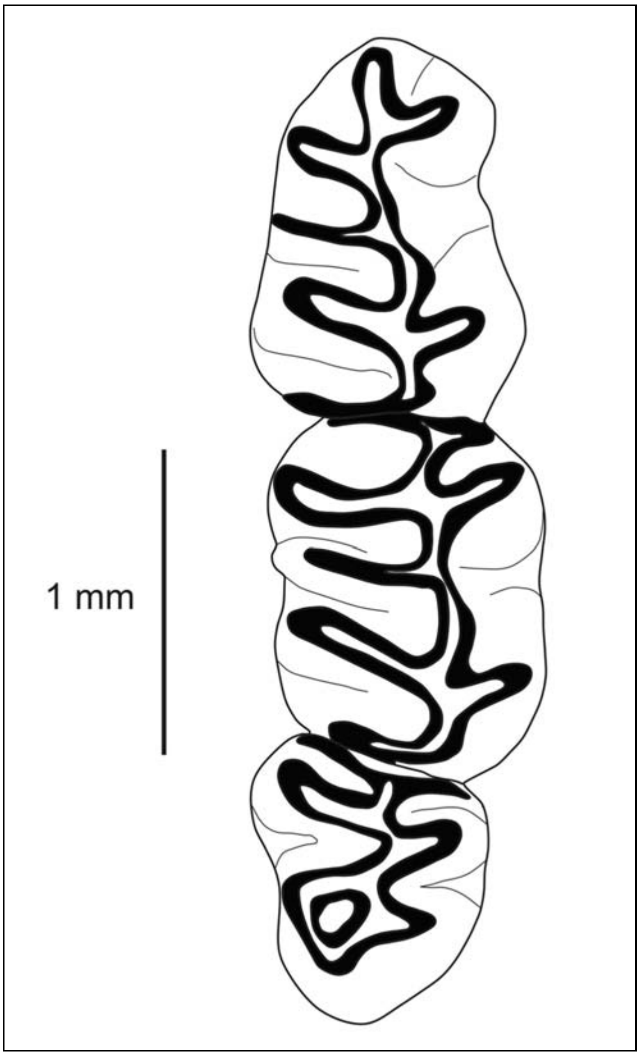

Fig. 5 - *Sicista subtilis* (Pallas, 1773). M_1-M_3 dext.

	n	min.	max.	mean	SD
M^1-M^3 Length	1			4.40	
M^1 Length	10	1.70	2.00	1.90	0.11
Width		1.10	1.35	1.20	0.09
M^2 Length	6	1.30	1.45	1.42	0.06
Width		1.10	1.25	1.18	0.05
M^3 Length	1			1.20	
Width				1.10	
M_1-M_3 Length	2	4.35	4.40	4.37	
M_1 Length	7	1.70	1.90	1.81	0.06
Width		1.10	1.20	1.16	0.03
M_2 Length	7	1.35	1.45	1.41	0.04
Width		1.15	1.25	1.20	0.03
M_3 Length	6	1.25	1.55	1.42	0.14
Width		1.00	1.10	1.04	0.06

Tab. 2 - Dimensions of the molars of *Cricetulus migratorius* (Layer 4).

Remarks. Considering its size, the described material belongs to *Sicista subtilis*, and not to *Sicista betulina*. The teeth of the second species are significantly smaller and their dimensions can almost always be easily separated (Pucek 1982; Popov 1985). For example, the length of M^1 in *S. subtilis* is always greater than 1 mm, and in *S. betulina* it is smaller (Pucek 1982). All M^1 from Baranica are longer than 1 mm. The molars from Baranica are also larger than those of recent populations of *S. subtilis* in Romania (Pucek 1982).

The first fossil remains of this species appeared in the Early Pleistocene, although the taxonomic position of them is still controversial: they could belong to *S. praeloriger* Kormos, 1830 (Kowalski 2001). On the territory of Serbia, remains of *S. subtilis* were first found in the Smolućka Cave and several years later also in the Vrelska Cave (Dimitrijević 1997a; Bogićević 2008).

Family Cricetidae Fischer, 1817

Cricetulus Milne-Edwards, 1867

Cricetulus migratorius (Pallas, 1773)

Fig. 7

Material: Layer 2: 2 M^1 sin., M_2 sin. BAR 2/3. Layer 4: max. dext. (M^1-M^3), max. sin. (M^1-M^2), max. dext. (M^1-M^2), max. sin. (M^1), max. dext. (M^1), max. sin. (M^2), M^1 sin., 2 M^1 dext., M^2 sin., M^2 dext., 2 mand. dext. (M_1-M_3), mand. dext. (M_1-M_2), mand. sin. (M_2-M_3), 2 mand. sin. (M_1), mand. dext. (M_2); M_1 dext., 2 M_2 sin., M_3 sin., 2 M_3 dext. BAR 4/6-7 (For dimensions: see Table 2).

Description. The smallest hamster species of this site is represented by several complete and fragmented maxillae and mandibulae, as well as by isolated teeth (Fig. 7a, b).

Remarks. The molars of three species of hamsters that are common in the Upper Pleistocene deposits of Serbia and neighbouring countries have a similar structure. They could be most easily differentiated by their dimensions (*Cricetus cricetus* is the largest and *Cricetulus migratorius* the smallest of them; Fig. 6), and by the presence of a mesolophid in the lower molars of *Mesocricetus newtoni.*

According to their morphology and size, *Cricetus* and *Mesocricetus* can be excluded. Two other cricetine species similar in size could be taken into consideration: *Phodopus sungorus* (Pallas, 1773) and *Allocricetus bursae* Schaub, 1830. The molars of a small hamster from Baranica have an identical dental pattern as those of the recent *Cricetulus migratorius*, with a posterolophid on M_1 and a mesolophid on M_3 (Fig. 7a). The mean value of width/length ratio in M_1 is 0.64, the same as in *Cricetulus migratorius* from Bacho Kiro, and very similar

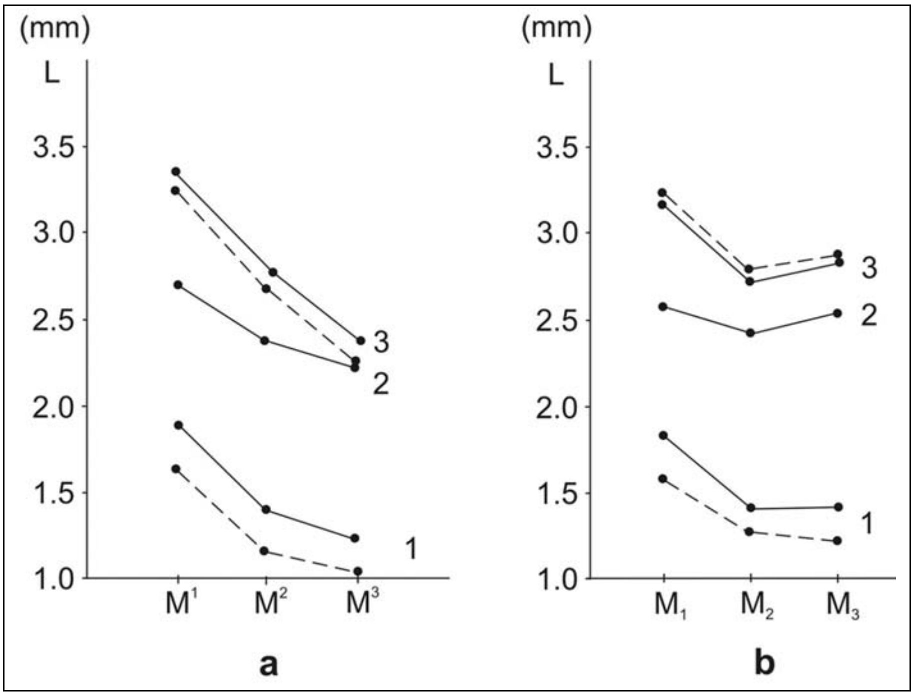

Fig. 6 - Diagram showing the mean length of cricetid teeth from Baranica (Layer 4). (a) – upper teeth. (b) – lower teeth. 1 – *Cricetulus migratorius* (Pallas, 1773) (solid line – population from Baranica; dashed line – recent population from Krak des Chevaliers (Syria), after Pradel 1981a); 2 – *Mesocricetus newtoni* Nehring, 1898 from Baranica; 3 – *Cricetus cricetus* Linnaeus, 1758 (full line – population from Baranica; dashed line – recent population from Saspowska Cave (Ojców, Poland), after Pradel 1981b).

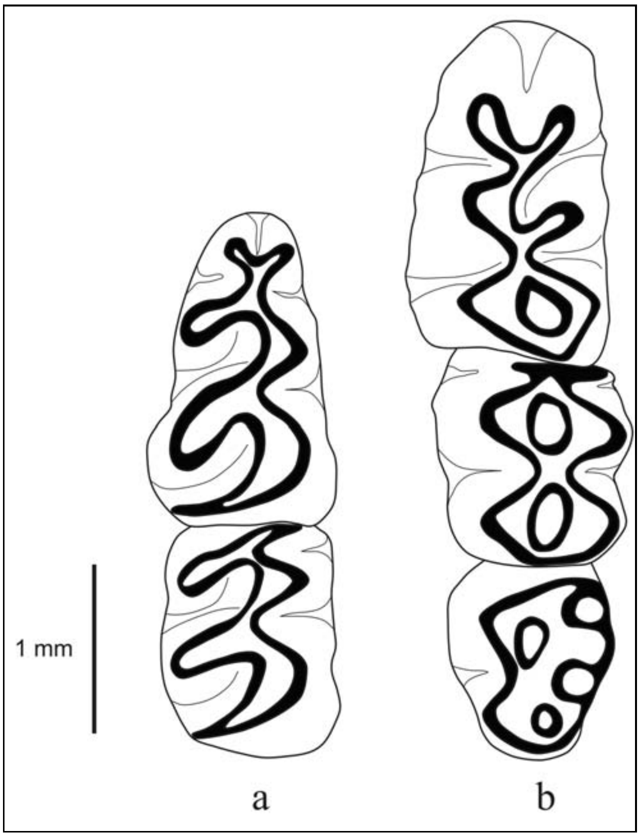

Fig. 7 - *Cricetulus migratorius* (Pallas, 1773). (a) M_1-M_2 dext., (b) M^1-M^3 sin.

to recent populations (0.65; after Kowalski & Nadachowski 1982). The same molars in *Allocricetus bursae* are somewhat narrower: width/length ratio in the population of this species from Subpiatra, Romania is 0.61 (Hir & Venczel 1991) and 0.60 in Somssich-hegy 2 (Hir 1998), while in *Phodopus sungorus*, this ratio reaches 0.69 (Kowalski & Nadachowski 1982).

In recent populations of *Cricetulus migratorius*, the dimensions vary considerably, depending on climate. The northern forms are, as a rule, larger than the southern ones, and the fossil ones are larger than recent (Popov 1994). The molars from Baranica are considerably larger than those of recent populations from Syria (Pradel 1981a).

Cricetulus migratorius has been present in Europe since the Middle Pleistocene. In the Late Pleistocene, it was widespread throughout much of western, central and southeastern Europe (Niethammer 1982a). Relatively numerous remains of this species were found in the Smolućka Cave in Serbia (Dimitrijević 1991), and a few in Mališina Stijena (Bogićević & Dimitrijević 2004) and Trebački krš (Dimitrijević 1994b) in Montenegro.

Cricetus Leske, 1779

Cricetus cricetus Linnaeus, 1758

Fig. 8

Material: Layer 2: max. sin. (M^2-M^3), max. dext. (M^2), 2 M^1 sin., M^1 dext., M^2 sin. BAR 2/4. Layer 4: max. sin. (M^2), 2 M^1 sin., 4 M^1 dext., 2 M^2 sin., 2 M^2 dext., M^3 dext., M_1 sin., M_1 dext., 3 M_2 sin., M_2 dext., 2 M_3 sin. BAR 4/8-9. (For dimensions: see Table 3).

Description. This species is represented mostly by isolated teeth, but also by some fragments of maxillae and mandibulae with teeth. Between the opposed tubercles of the upper molars, funnel-like structures are

Tab. 3 - Dimensions of the molars of *Cricetus cricetus*.

	layer 2					layer 4				
	n	min.	max.	mean	SD	n	min.	max.	mean	SD
M^1 Length	3	3.25	3.40	3.32	0.08	6	3.20	3.55	3.35	0.12
Width		1.90	2.25	2.10	0.18		2.00	2.30	2.14	0.12
M^2 Length	1			2.85		3	2.80	2.95	2.85	0.09
Width				2.30			2.10	2.20	2.17	0.06
M^3 Length	1			2.40		1			2.35	
Width				1.90					1.90	
M_1 Length						1			3.15	
Width									1.85	
M_2 Length						4	2.55	2.85	2.72	0.13
Width							2.05	2.30	2.13	0.11
M_3 Length						2	2.85	2.90	2.87	
Width							2.05			

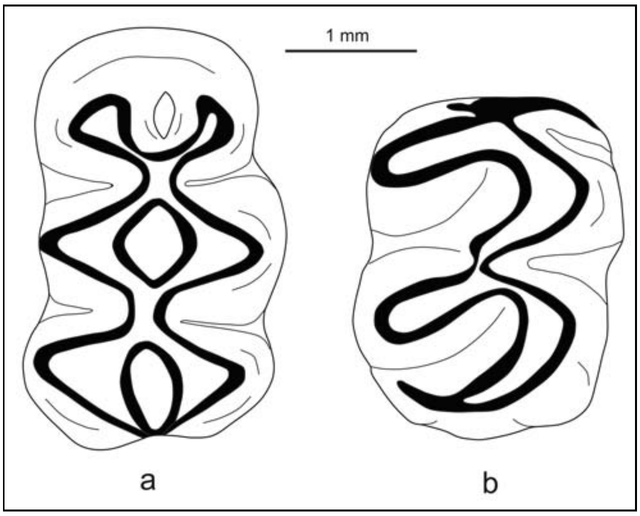

Fig. 8 - *Cricetus cricetus* Linnaeus, 1758. (a) M^1 sin., (b) M_2 dext.

developed (Fig 8a). The lower molars have no mesolophid (Fig. 8b).

Remarks. Some "giant" hamster species of Pleistocene age have also been described (*C. major* Woldrich, 1880; *C. runtonensis* Newton, 1999; *C. praeglacialis* Schaub, 1930), morphologically very similar to the extant species; but they can be excluded here, since the material from Baranica is distinctly smaller.

The common hamster was a relatively frequent element in Pleistocene faunas throughout Europe, especially in cold and dry periods (Dimitrijević 1997a). The remains of this species were also recorded in the Vrelska Cave (Marković & Pavlović 1991), and the Mirilovska Cave (Dimitrijević & Jovanović 2002) in Serbia, and in the Trebački krš in Montenegro (Dimitrijević 1994b).

Mesocricetus Nehring, 1898

Mesocricetus newtoni Nehring, 1898

Fig. 9

Material: Layer 2: max. sin. (M^2-M^3), max. dext. (M^2-M^3), 6 M^1 sin., M^1 dext., M^2 sin., 4 M^2 dext., M^3 sin., M^3 dext., 3 M_1 sin., 5 M_1 dext., 2 M_2 sin., 5 M_2 dext. BAR 2/5. Layer 3: M_2 dext. BAR 3/1. Layer 4: 2 max. sin. (M^1-M^2), max. dext. (M^1-M^2), max. sin. (M^1), 3 max. dext. (M^1), max. sin. (M^2-M^3), 2 max. dext. (M^2-M^3), 5 max. sin. (M^2), 2 max. dext. (M^2), max. sin. (M^3), max. dext. (M^3), 9 M^1 sin., 21 M^1 dext., 26 M^2 sin., 13 M^2 dext., 8 M^3 sin., 6 M^3 dext., 12 M_1 sin., 16 M_1 dext., 16 M_2 sin., 11 M_2 dext., 10 M_3 sin., 11 M_3 dext. BAR 4/10-11. (For dimensions: see Table 4).

Description. The teeth of this species are medium-sized (smaller than those in *Cricetus cricetus* and larger than in *Cricetulus migratorius*; Fig. 6). The upper molars are similar to those of two previous cricetine species (Fig. 9a). The most conspicuous feature of the lower molars is the presence of a mesolophid between the meta- and entoconid. It is rather slight on M_1 (Fig. 9b), but always much more pronounced on M_2 (Fig. 9c) and M_3. The third molars (both upper and lower) are less reduced than in *Cricetus cricetus* and *Cricetulus migratorius* (Niethammer 1982b).

Remarks. Pleistocene findings of this species are restricted to the Balkans – Bulgaria, Romania, Greece, Montenegro and Serbia (Kowalski 2001).

Mesocricetus newtoni is one of the most common rodent species in the Upper Pleistocene deposits of Serbia. Numerous remains were found in the Smolućka, Mirilovska, Vasiljska and Vrelska Cave (remains from the last cave were earlier erroneously referred to as *Cricetus* sp.) (Dimitrijević 1997a; Dimitrijević & Jovanović

	layer 2					layer 4				
	n	**min.**	**max.**	**mean**	**SD**	**n**	**min.**	**max.**	**mean**	**SD**
$\mathbf{M^1}$ Length	6	2.65	2.95	2.81	0.10	36	2.30	2.90	2.72	0.13
Width		1.60	1.80	1.70	0.09		1.35	1.80	1.59	0.11
$\mathbf{M^2}$ Length	7	2.10	2.55	2.41	0.16	52	2.15	2.75	2.43	0.16
Width		1.55	1.90	1.74	0.09		1.40	2.05	1.70	0.13
$\mathbf{M^3}$ Length	3	1.95	2.45	2.22	0.25	19	2.00	2.35	2.23	0.10
Width		1.50	1.75	1.60	0.13		1.40	1.80	1.62	0.11
$\mathbf{M_1}$ Length	8	2.45	2.70	2.55	0.08	28	2.30	2.75	2.54	0.12
Width		1.30	1.50	1.40	0.08		1.20	1.55	1.36	0.09
$\mathbf{M_2}$ Length	7	2.35	2.55	2.48	0.08	26	2.15	2.55	2.39	0.09
Width		1.50	1.70	1.61	0.08		1.45	1.75	1.55	0.09
$\mathbf{M_3}$ Length						21	2.20	2.80	2.53	0.15
Width							1.40	1.90	1.65	0.11

Tab. 4 - Dimensions of the molars of *Mesocricetus newtoni.*

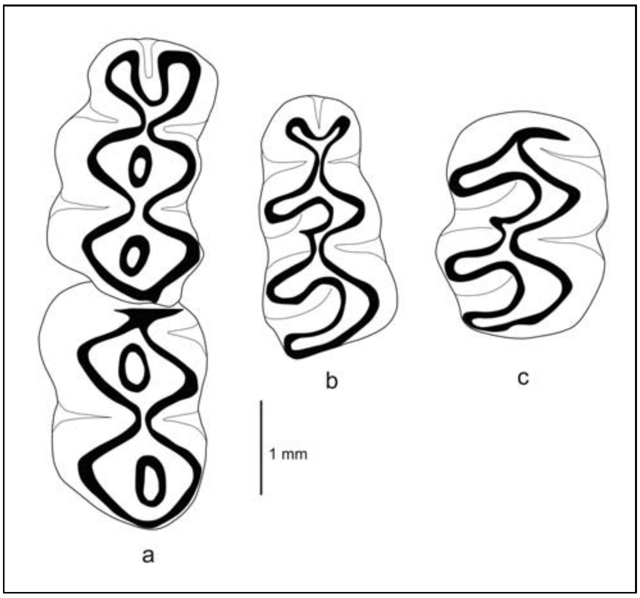

Fig. 9 - *Mesocricetus newtoni* Nehring, 1898. (a) M^1-M^2 sin., (b) M_1 dext., (c) M_2 dext.

2002; Bogićević 2008). Mališina Stijena near Pljevlja is the only Pleistocene locality in Montenegro where this species has been found (Bogićević & Dimitrijević 2004).

Subfamily Arvicolinae Gray, 1821

Since the vole remains from Baranica are described in detail elsewhere (Bogićević et al. in press), we give here only the list of species. However, the conclusions that have been drawn in that work, concerning the age and ecological preferences of the fauna, will be included in the later chapters.

Arvicola terrestris (Linnaeus, 1758)
Chionomys nivalis (Martins, 1842)
Microtus (Microtus) arvalis (Pallas, 1778) and *M. (Microtus) agrestis* (Linnaeus, 1761)
Microtus (Stenocranius) gregalis (Pallas, 1779)
Microtus (Terricola) subterraneus (de Sélys-Longschamps, 1836)
Clethrionomys glareolus (Schreber, 1780)
Lagurus lagurus (Pallas, 1773)

Family Muridae Illiger, 1811

Apodemus Kaup, 1829

Apodemus ex gr. **sylvaticus-flavicollis** (Linnaeus, 1758)/ (Melchior, 1834)

Fig. 10, 11

Material and dimensions: Layer 2: mand. sin. (M_1-M_2) (M_1: 1.66 x 1.1; M_2: 1.14 x 1.03) BAR 2/16. Layer 4: max. dext. (M^1-M^3), max. sin. (M^1), max. dext. (M^1), max. dext. (M^3); 3 M^1 sin., 3 M^1 dext., 3 M^2 sin., 2 M^2 dext., 2 M^3 sin., mand. sin. (M_1-M_2), mand. sin. without teeth, mand. sin. (M_2), 2 mand. dext. (M_2), 5 M_1 sin., 3 M_1 dext., 3 M_2 sin., 6 M_3. BAR 4/26. (For dimensions: see Table 5).

Description. On the first upper molar, the cusps t1-t3 are connected. T3 often has a short but distinct posterior spur. The posterior cusps (t4-t9) are often connected and form a continuous ring (Fig. 10a). In the opinion of Gaffrey (1953), the species *A. sylvaticus* and *A. flavicollis* could be separated according to the structure of t7 of that tooth (well developed in *A. flavicollis* and weak in *A. sylvaticus*), but most researchers agree that it is very difficult to distinguish isolated teeth of the two species.

M^2 shows a structure of the posterior range of cusps similar to that in M^1, and t1 is bigger than t3. M_1

	n	min.	max.	mean	SD
M^1 Length	9	1.65	1.92	1.77	0.08
Width		1.17	1.29	1.23	0.03
M^2 Length	5	1.20	1.35	1.27	0.05
Width		1.08	1.20	1.14	0.06
M^3 Length	4	0.90	1.08	0.97	0.08
Width		0.78	0.87	0.83	0.04
M_1 Length	9	1.56	1.86	1.69	0.09
Width		0.96	1.11	1.00	0.05
M_2 Length	6	1.11	1.41	1.16	0.04
Width		0.97	1.20	1.03	0.05
M_3 Length	6	0.86	0.97	0.91	0.04
Width		0.79	0.90	0.86	0.04

Tab. 5 - Dimensions of molars of *Apodemus* ex gr. *sylvaticus-flavicollis* (Layer 4).

has, in most cases, three additional labial cusplets, of which the distal one is usually connected to the hypoconid. M_2, has, in addition to four main cusps, three additional cusplets – two on the labial side and one on the talonid. The anterior labial cusp is prominent, while the distal one is small and in some specimens indistinct (Fig. 10b).

Remarks. Three morphologically similar species of the subgenus *Sylvaemus* Ognev [(*A. sylvaticus* (Linnaeus, 1758), *A. flavicollis* (Melchior, 1834), *A. uralensis* (Pallas, 1811)], can be distinguished based on the dimensions (*Apodemus flavicollis* is the largest while *A. uralensis* is the smallest), although they overlap considerably.

The dimensions of the teeth of *Apodemus* from Baranica, both the extreme and average values, correspond best to *A. sylvaticus* (Fig. 11a, b). The lengths of the M^1 are also very similar to those of the same species from the Smolućka Cave (1.62 – 1.85 mm) (Dimitrijević 1991). On the other hand, the value of the length:width ratio in M_2 (1.06-1.18, mean value 1.12) is closer to the species *A. flavicollis* (Pasquier 1974). Due to this, the murine remains from Baranica are referred to as *Apodemus* ex gr. *sylvaticus-flavicollis*.

Remains of the genus *Apodemus*, described mostly as *A. sylvaticus*, although not abundant, were found in the Upper Pleistocene deposits of many caves in Serbia: the Smolućka, Vasiljska, Vrelska, Petnička, Prekonoška and Popšička Cave (Dimitrijević 1997a).

Family Spalacidae Gray, 1821

Spalax Guldenstaedt, 1770

Spalax leucodon (Nordmann, 1840)

Fig. 12

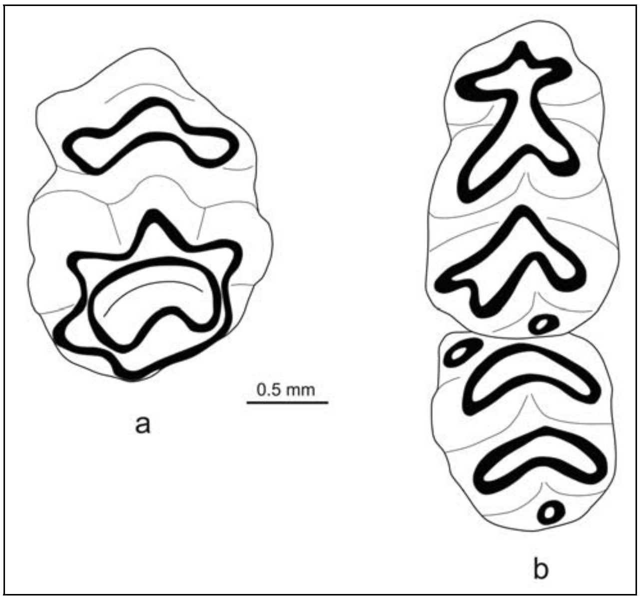

Fig. 10 - *Apodemus* ex gr. *sylvaticus-flavicollis* (Linnaeus, 1758)/(Melchior, 1834). (a) M^1 dext. (b) M_1-M_2 sin.

Material and dimensions: Layer 2: M_2 sin. (2.7 x 2.6), M inf. sin. BAR 2/17. Layer 3: M_2 dext. (2.4 x 2.25) BAR 3/6. Layer 4: 2 M^1 dext. (2.8 x 2.55; 2.55 x 2.5), $M^{1/2}$ sin., 2 M^3, 2 M_3 sin. (2.35 x 2.3; 2.65 x 2.5). BAR 4/27.

Description. The molars are cylindrical with a characteristic S-shaped occlusal surface. M^1 in young individuals has two labial folds and one lingual (Fig. 12a). M^2 is similar to M^1, but has only one labial fold (Fig. 12b). M^3 has two convergent folds in the shape of the letter "C".

The lower molars have two roots, the latter of which is often divided into two parts. The inner fold on the anterior part of the tooth is inclined forwards and the posterior one backwards (Fig. 12c). The inner fold in M_1 and M_2 has a small additional fold which with age becomes separated as a small islet near the top of the outer fold.

Remarks. In the territory of Serbia and Montenegro, some remains of this species have been found in Pleistocene deposits of several caves – the Smolućka, Vrelska and Mirilovska Cave (Dimitrijević 1997a; Dimitrijević & Jovanović 2002). The Pleistocene age of the Risovača remains has not been confirmed (Rakovec 1965).

Family Gliridae Muirhead, 1819

Dryomys Thomas, 1906

Dryomys nitedula (Pallas, 1778)

Fig. 13

Material: Layer 4: 4 M^1 dext., 2 M^2 dext., 4 M^3 sin., 2 M_1 sin., 2 $M_{1/2}$, M_3 dext. BAR 4/28-29. (For dimensions: see Table 6).

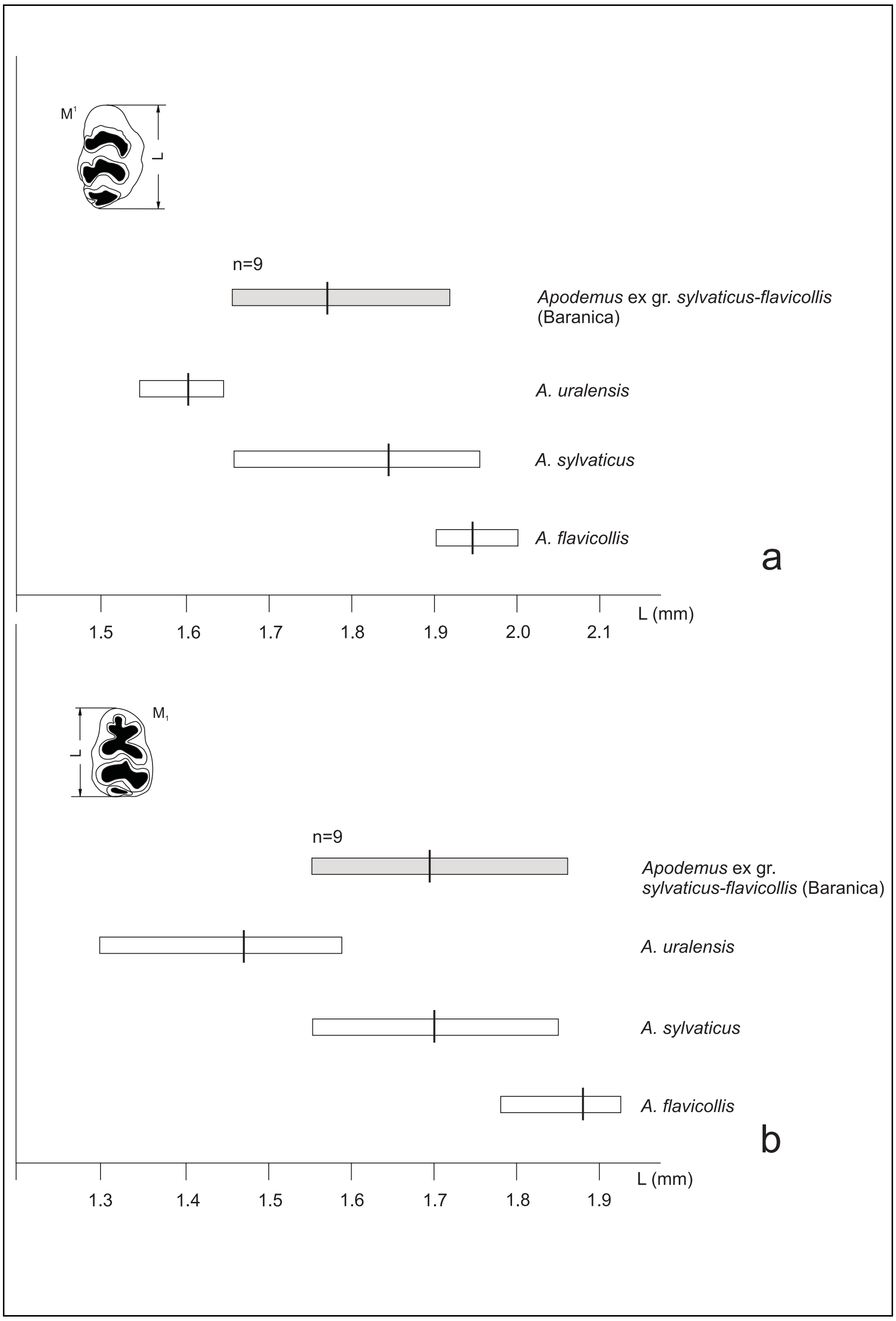

Fig. 11 - Diagram showing the lengths of M^1 (a) and M_1 (b) in three species of *Apodemus*. The rectangles represent the range and the vertical lines – the mean values. The white rectangles denote extant populations of *A. uralensis* (Pallas, 1811), *A. sylvaticus* (Linnaeus, 1758) and *A. flavicollis* (Melchior, 1834) (after Popov 1985).

Description. The upper molars have three roots. In M^1 and M^2, the anteroloph is lingually connected to the endoloph (Fig. 13a). The centrolophs are relatively well developed. The lower molars have four main and three additional crests (Fig. 13b, c).

Remarks. With the exception of two Early Pleistocene localities in Poland and Romania, there are no remains of this species in deposits older than Middle Pleistocene (Kowalski 2001).

Findings of this species in the Late Pleistocene of Serbia are very sparse: two isolated teeth from the Smolućka Cave, and a single tooth from both the Vasiljska and Petnička Cave (Dimitrijević 1994a, 1997a).

Muscardinus Kaup, 1829

Muscardinus avellanarius (Linnaeus, 1758)

Fig. 14

Material: Layer 4: 4 M^1 sin., 3 M^1 dext., 4 M_1. BAR 4/30-31. (For dimensions: see Table 7).

Description. The molars of *Muscardinus* have a flat occlusal surface with several almost straight and parallel crests. M^1 has an elongated occlusal surface with five transverse enamel crests, separated by wide valleys (Fig. 14a). The first and second crests are inclined back-

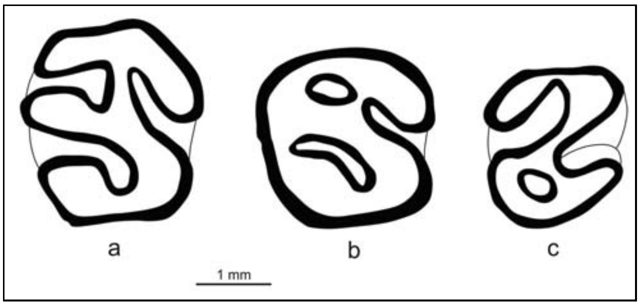

Fig. 12 - *Spalax leucodon* (Nordmann, 1840). (a) M^1 dext., (b) M^2 dext., (c) M_2 dext.

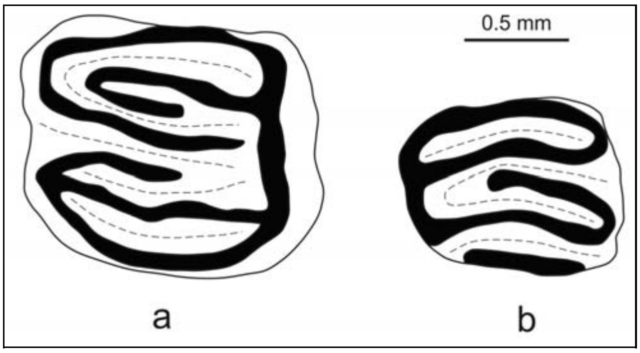

Fig. 13 - *Dryomys nitedula* (Pallas, 1778). (a) M^2 dext., (b) M^3 sin.

	n	min.	max.	mean	SD
M^1 Length	4	1.02	1.08	1.05	0.02
Width		1.05	1.23	1.12	0.08
M^2 Length	2	1.14	1.14	1.14	
Width		1.14	1.17	1.15	
M^3 Length	3	0.81	0.84	0.82	0.02
Width		1.05	1.11	1.07	0.03
M_1 Length	2	1.08	1.17	1.12	
Width		0.96	1.05	1.00	
M_3 Length	1			0.84	
Width				1.02	

Tab. 6 - Dimensions of molars of *Dryomys nitedula.*

wards. The second crest is longer than the first one and often lingually connected to the third, fourth and fifth crests. The third crest is sometimes separated from the others. The fourth and fifth crests are approximately parallel to the short axis of the tooth.

Four out of six M^1 from Baranica have a typical structure for the species, as described above (Fig. 14a). In one specimen, the third crest is not separated (Fig. 14b). In the other specimen, a small additional crest arises from the second crest (Fig. 14c). In one M_1, the second and the third crests are rather undulated (Fig. 14d), in contrast to other teeth in which they are more

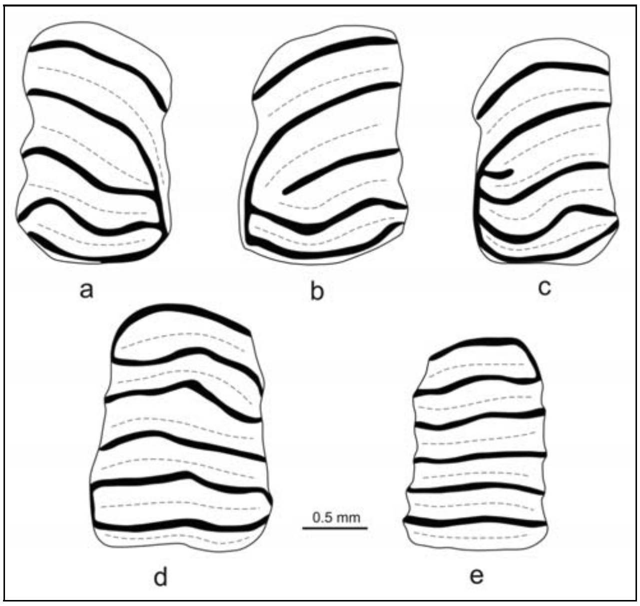

Fig. 14 - *Muscardinus avellanarius* (Linnaeus, 1758). (a) M^1 dext., (b) M^1 sin., (c) M^1 sin., (d) M_1 sin., (e) M_1 dext.

	n	min.	max.	mean	SD
M^1 Length	5	1.68	1.92	1.81	0.10
Width		1.17	1.35	1.27	0.07
M_1 Length	3	1.68	1.89	1.76	0.11
Width		1.20	1.29	1.23	0.05

Tab. 7 - Dimensions of molars of *Muscardinus avellanarius.*

or less straight. The molars from Baranica are somewhat larger than those of recent populations (Storch 1978) and similar to Pleistocene representatives of the same species in Bulgaria (Popov 2000).

Comments. The oldest finding of this species comes from the Late Pliocene of Poland and Romania (Kowalski 2001). Remains of *Muscardinus avellanarius* are rare in the Upper Pleistocene cave deposits of Serbia. Only a few isolated teeth are known from the Smolućka, Vasiljska and Hadži Prodanova Cave and a single tooth from both the Petnička and Vrelska Cave (Bogićević 2008; Dimitrijević 1997a).

Discussion

Taphonomy

The rodent remains in the Baranica cave are very abundant. All parts of rodent skeletons are present in the material but some of them are more common, more complete and better preserved. For example, isolated teeth, parts of long bones, caudal vertebrae, metapodial bones and phalanges are rather common, while other kinds of vertebrae, skull bones and most short bones, because of their fragile structure and small size, are much more rarely found. Most of the teeth are isolated, but there are also some maxillae/mandibles with teeth. Long bones are, in most cases, broken. None of the species is a cave-dweller, so their remains must have been brought inside.

There are no traces of transport by water. The bones are often broken and have sharp edges; but they are never water-rounded.

All of these data support the assumption that most of the rodent bones from Baranica are prey remains. A more detailed taphonomical analysis is required to reveal which predator is responsible for the accumulation of the rodent bones.

Palaeoecological implications

The analysis of the whole material from the Baranica Cave has not finished yet, but some conclusions, based on the analysis of rodent fauna (including 8 arvicoline species described in a separate paper – Bogićević et al. in press) and the previous knowledge of large mammals and pollen remains (Argant & Dimitrijević 2007), will be presented here.

The list of all mammal species from the Baranica Cave that have been found and identified is shown here (Tab. 8). The diversity of the rodent fauna, 18 species belonging to 7 families, must be stressed.

According to their ecological preferences and requirements, the rodent species from Baranica may be arranged into the following groups:

A: woodland species: *Apodemus* ex gr. *flavicollis-sylvaticus, Clethrionomys glareolus, Dryomys nitedula, Muscardinus avellanarius;*

B: species inhabiting moist meadows and river banks (*Microtus subterraneus, Arvicola terrestris, Castor fiber*);

C: mountain dwellers and petrophilous species (*Chionomys nivalis*);

D: inhabitants of intermediate (xero-mesophilous) environments – meadows, grasslands, bushes and forest-steppe (*Microtus arvalis* and *M. agrestis, Mesocricetus newtoni, Spalax leucodon, Spermophilus* cf. *citelloides*);

E: species of steppe and semi-arid regions (*Cricetus cricetus, Cricetulus migratorius, Sicista subtilis, Lagurus lagurus, Microtus gregalis*).

In terms of the number of remains, the inhabitants of open, rather dry and steppe habitats (D+E) were predominant in both layers 2 and 4, while those living in more humid, warm or forest habitats were much less common (Fig. 15). The percentages of the groups C, D and E in layers 2 and 4 are strikingly similar; there are only slight differences in the frequency of forest and meadow elements: more forest and less meadow species

Order	**Species**
Lagomorpha	*Lepus* sp.
	Ochotona pusilla (Pallas, 1769)
Carnivora	*Canis lupus* Linnaeus, 1758
	Vulpes vulpes (Linnaeus, 1758)
	Ursus spelaeus Rossenmüller & Heinroth, 1794
	Gulo gulo (Linnaeus, 1758)
	Martes martes Linnaeus, 1758
	Meles meles (Linnaeus, 1758)
	Mustela nivalis Linnaeus, 1766
	Crocuta spelaea (Goldfuss, 1823)
	Panthera spelaea (Goldfuss, 1810)
	Panthera pardus (Linnaeus, 1758)
	Felix silvestris Schreber, 1777
Proboscidea	*Mammuthus primigenius* (Blumenbach, 1799)
Perissodactyla	*Coelodonta antiquitatis* (Blumenbach, 1799)
	Equus ferus Boddaert, 1785
	Equus hydruntinus Regalia, 1907
Artiodactyla	*Megaloceros giganteus* (Blumenbach, 1799)
	Cervus elaphus Linnaeus, 1758
	Bos primigenius Bojanus, 1827
	Bison priscus (Bojanus, 1827)
	Capra ibex Linnaeus, 1758
	Rupicapra rupicapra (Linnaeus, 1758)
Rodentia	*Spermophilus* cf. *citelloides* (Kormos, 1916)
	Castor fiber Linnaeus, 1758
	Sicista subtilis (Pallas, 1773)
	Cricetulus migratorius (Pallas, 1773)
	Cricetus cricetus Linnaeus, 1758
	Mesocricetus newtoni Nehring, 1898
	Arvicola terrestris (Linnaeus, 1758)
	Chionomys nivalis (Martino, 1842)
	Microtus (*M.*) *arvalis* (Pallas, 1778) & *M.* (*M.*) *agrestis* (Linnaeus, 1761)
	Microtus (*Stenocranius*) *gregalis* (Pallas, 1779)
	Microtus (*Terricola*) *subterraneus* (de Sélys-Longschamps, 1836)
	Clethrionomys glareolus (Schreber, 1780)
	Lagurus lagurus (Pallas, 1773)
	Apodemus ex gr. *sylvaticus-flavicollis* (Linnaeus, 1758)/(Melchior, 1834)
	Spalax leucodon (Nordmann, 1840)
	Dryomys nitedula (Pallas, 1778)
	Muscardinus avellanarius (Linnaeus, 1758)
Insectivora indet.	
Chiroptera indet.	

Tab. 8 - List of mammal taxa found in the Caves Baranica I and II (after Argant & Dimitrijević 2007 and Bogicevic et al. in prep.).

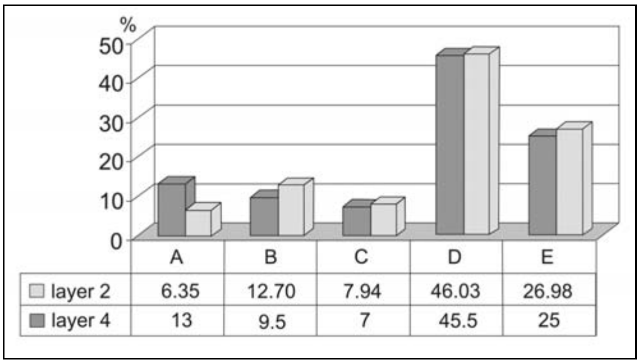

Fig. 15 - Distribution of rodents with different ecological preferences in Layers 2 and 4 in the Baranica Cave. A – woodland species, B – species inhabiting moist meadows and river banks, C – mountain dwellers and petrophilous species, D – inhabitants of xero-mesophilous environments, E – inhabitants of steppe and semi-arid regions.

Species	Relative abundance in %		
	Layer 2	Layer 3	Layer 4
Spermophilus cf. *citelloides*	1.59		1.5
Sicista subtilis	1.59		12
Cricetulus migratorius	3.17		3
Cricetus cricetus	4.76		7.5
Mesocricetus newtoni	9.52	9.1	12.5
Arvicola terrestris	1.59	9.1	2
Clethrionomys glareolus	4.76		5
Microtus subterraneus	11.11	27.3	7.5
Microtus arvalis & *M. agrestis*	33.33	27.3	30.5
Chionomys nivalis	7.94		7
Microtus gregalis	6.35		
Lagurus lagurus	11.11	18.2	2.5
Apodemus ex gr. *sylvaticus-flavicollis*	1.59		4
Spalax leucodon	1.59	9.1	1
Dryomys nitedula			2
Muscardinus avellanarius			2

Tab. 9 - The relative abundances of the rodent species (based on MNI) in different layers in Baranica.

in Layer 4. This indicates the existence of a mosaic of habitats in the vicinity of the Baranica cave.

The relative abundances of the rodent species (based on MNI) in different layers in Baranica are presented in Table 9.

The diversity of rodent fauna observed in Baranica is rather high, corresponding to more temperate countries (Montuire et al. 1997). In both layers 2 and 4, voles are the most common element of the rodent fauna (77.4% in Layer 2; 54.7% in Layer 4). They are usually considered as indicators of a cold climate – the number of species is said to depend on temperature. The number of arvicoline species in Baranica (8 species in Layer 2 and 7 in Layer 4) corresponds to some "cold" localities of central Europe (Montuire 1996).

Remains of large mammals have been found in both Baranica I and II. The composition of fauna in these two caves is very similar. It could not be determined in which layers the remains of particular species were found (a complete description of the large mammal fauna has not yet been published), but, according to some earlier reports (Mihailović et al. 1997), it could be concluded that most of them come from Layer 2. The large mammals fauna contains some "cold" species, such as *Gulo gulo* (Linnaeus, 1758) and *Coelodonta antiquitatis* (Blumenbach, 1799), while "warm" species, such as roe deer and wild boar are completely absent (Argant & Dimitrijević 2007).

Several pollen grains found in a hyena's coprolite from Baranica indicate an open landscape with the presence of steppe taxa (Argant & Dimitrijević 2007).

The rodent fauna of Baranica has been compared to faunas from three cave localities of the similar age from Bulgaria (Kozarnika, Bacho Kiro and Cave 16) and one from Serbia (Smolućka Cave). Since deposits from these localities consist of many layers, only those of the appropriate age (i.e., the Last Glacial) were taken into consideration. The similarity of the associations is evident: in all of them arvicolines are the most numerous rodents, and among them, the species *Microtus arvalis/agrestis* were (almost always) the most common element. Ten out of 18 species occurred in all localities; the inhabitants of open areas usually prevail. Such associations of rodents are typical of the Last Glacial of this part of the Balkan Peninsula (Popov 2000; Popov & Marinska 2007). As Kowalski (1982) has already stated, in these kind of localities, the frequency of steppe species is higher than in central Europe, and forest species are almost always present (although represented by rare specimens), even during the coldest periods.

However, there are also some differences: *Sicista* is much more common in Baranica than in any of the mentioned localities, while *Lagurus* and *Chionomys nivalis* are not as frequent as in the three Bulgarian caves. In Bulgarian caves dormice are either absent or found very rarely (as in Cave 16), while in Layer 4 in Baranica, two dormice species were found. This could mean that the climate of Baranica (at least of Layer 4) was a little warmer and more humid, with more forest and less steppe and mountain species; but the differences in faunal composition could also be due to taphonomical reasons.

According to the analysis of the rodent fauna from Baranica, the environment of this part of Serbia during the Last Glacial could be inferred: it was probably open, dry and rather cold, with the presence of some forested areas.

Age of the fauna

Even during the preliminary investigations, it was established that the deposits of Baranica (layers 2-4) are of Late Pleistocene age. This could be proved by the presence of a large mammal assemblage typical of Late Pleistocene (*Ursus spelaeus*, *Crocuta spelaea*) and by the archaeological artefacts found in these layers.

There are no extinct forms in the rodent assemblage. Nevertheless, the rodent fauna from Baranica differs considerably from the recent one by containing species that are no longer present in the extant fauna of Serbia – *Lagurus lagurus, Cricetulus migratorius* and *Mesocricetus newtoni*; or in the vicinity of the cave: *Microtus agrestis, Sicista subtilis, Castor fiber, Cricetus cricetus.* The species composition and the ecological appearance of the rodent assemblages are typical for the glacial episodes of the Late Pleistocene in the Balkan Peninsula (Popov 2000; Popov & Marinska 2007).

The greater size of M_1 of *Arvicola terrestris* and the predominance of progressive morphotypes in *Lagurus lagurus* are also typical for the Last Glacial (Bogićević et al. in press).

A more precise age of the assemblages, however, could be obtained by measurement of the so-called SDQ index on *Arvicola* teeth, the method initially proposed by Heinrich (1978). SDQ index (the enamel thickness quotient) has been measured in a few M_1 of *Arvicola terrestris* from Baranica. Its values are: 90.11 in Layer 2 (measured in only one tooth) and 92.48 (with a range of 89.37-94.66; n=3) in Layer 4. It is generally held that the lower values of the index (less than 100), such as these, are typical for younger (Last Glacial and Holocene) and recent populations of *A. terrestris* (Heinrich 1978, 1987).

The values of SDQ index in both layers are slightly higher than in some Central European localities (Kemathenhöhle, Germany: an estimated age of about 31,400 years B.P. – the value of SDQ index – 89.23; Peskö, Hungary (34,600 B.P.): 89.31 and Istállóskö, Hungary (36,400 B.P.): 89.54), and much lower than in Burgtonna in Germany, with an estimated age of about 80,000 B.P. – 99.65 (Heinrich 1987). So, it could be supposed that the age might be a little older than in the former localities, but much younger than in the latter one. Nevertheless, it was shown (Röttger 1987) that the extant populations of the species in southern Europe have higher values of the SDQ index than the northern ones, so layers 2 and 4 might be of similar or slightly greater age than in the mentioned localities – Kemathenhöhle, Peskö, and Istállóskö – about 30,000-35,000 B.P. (Bogićević et al. in press).

Lately, some bone remains from Baranica have been dated at the Oxford laboratory by AMS method: a second phalanx of a giant deer (BAR 97/19/16; OxA-13827) from Layer 2 in Baranica I has been dated as 23,520±110 B.P. ($\delta^{13}C$ -19.415), while a third molar of a cave bear (BAR 97/80/1; OxA-13828) from Layer 4 has been dated as 35,780±320 B.P. ($\delta^{13}C$ -20.980) (Stuart & Lister, unpublished data; after Pacher & Stuart 2008 and Dimitrijević in press.). These data are rather consistent with the age estimated on the basis of rodent remains.

Conclusion

As already mentioned, these results should be regarded as preliminary. A more detailed morphometric analysis of the rodent remains needs to be conducted, and other elements of vertebrate fauna (large mammals, birds, reptiles, amphibians, and fish) should also be studied. It is hoped that the ongoing taphonomic analysis will clarify the origin of the assemblages. Nevertheless, some early conclusions could be derived.

In the Baranica Cave (eastern Serbia), along with remains of large mammals, a rich and diverse association of rodents from the Last Glacial was found. In this paper, the remains of ten species of rodents from Layers 2, 3 and 4 are analyzed and described, while the vole remains are described elsewhere.

The composition of the rodent assemblage indicates to a mosaic of habitats in the vicinity of the cave – dwellers of open and rather dry areas prevail, forest inhabitants are also present, although they play a subordinate role. Layer 2 is marked by a decrease in the percentage of forest dwellers, which may indicate a local shift to a drier climate at the beginning of the Last Glacial Maximum.

Based on the faunal composition, the fauna from Baranica is very similar to some contemporary faunas from Serbia and Bulgaria, but there are also some interesting differences, possibly due to local climatic conditions.

By measuring of the SDQ index on the *Arvicola terrestris* teeth, it has been established that the values of this index in layers 2 and 4 from Baranica are similar to those from the Last Glacial localities in Central Europe, with age of about 30,000-35,000 B.P. The more recent radiometric dating gives the age of 23,520±110 B.P. for Layer 2 and 35,780±320 B.P. for Layer 4, which is consistent with the estimates obtained by measuring of the SDQ index.

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