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Early Pleistocene Small Mammals (Eulipothyphla, Chiroptera, Lagomorpha and Rodentia) from Futjova Cave, North Bulgaria

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Abstract: Sediments in the entrance of the Futjova Cave (North Bulgaria) yielded four species of insectivores, two bats, two lagomorphs and 12 rodents. On the basis of the evolutionary level of *Microtus (Allophaiomys) hintoni, Lagurus transylvanicus* and *Mimomys* cf. *blanci*, the assemblages from layers 4c and 4b were classified into the Nagyharsanyhegi phase of Biharian (Early Pleistocene). In the upper fossiliferous layer 4a, *M. hintoni* was replaced by *Microtus (Terricola) arvalidens.* This layer was referred to the beginning of the Templomhegy phase of Biharian. The fossil assemblages were dominated by open country and steppe dwellers (*L. transylvanicus, M. hintoni, M.* cf. *blanci, Beremendia fissidens, Spermophilus* cf. *nogaici, Ochotona pusilla, Nannospalax* cf. *odessanus*, *Allocricetus bursae, Cricetus cricetus* and *C.* cf. *nanus*). The presence of *Rhinolophus* ex gr. *ferrumequinum, Miniopterus schreibersii, Hystrix* sp. and *Myomimus* cf. *roachi* indicates a relatively warm and arid climate. This was confirmed by the circumstance that the species associated with humid habitats (*Talpa europaea*, *Sorex subaraneus*, *Pliomys episcopalis, Desmana* sp.) were very rare.

Key words: Small mammals, fossil cave fauna, early Pleistocene, cave deposits, stratigraphy, environmental change

Introduction

From 1984 onwards the Archaeological Institute and Museum of the Bulgarian Academy of Sciences (Sofia); Institute of Archaeology of the Jagellonian University (Krakow, Poland) and the Institute of Quaternary, University of Bordeaux I (Talence, France) carried out a series of excavations in Karlukovo karst area. The realisation of the project was accompanied by a program of archaeological surveys of the karst areas in the central part of the Praebalkan region through using test trenches in some caves (Sirakov 1992). Within this program, the Futjova Cave was an object of a pilot excavation in July 1990. The aim was to examine the archaeological potential of the cave in expectation to contribute to the data already obtained from excavations in the Karlukovo karst area. The excavations demonstrated that the sediments were devoid of any archaeological materials. This paper focuses on the small mammals and provides short paleontological descriptions, an attempt to reconstruct the ecological conditions of the fossil fauna and an incorporation of our finds into a more general small mammal biostratigraphy.

Material and Methods

The Futjova Cave is located near the village of Karpatchevo (43°13’50”N 24°59’2”E), Lovec District, North Bulgaria (Fig. 1A). The cave has a south facing opening, situated at 270 m a.s.l. and extends more than 400 m in a north direction. The test trench was situated near the entrance (Fig. 1B). Five stratigraphic layers were identified (Fig. 1C). The sediments consisted of a brown-reddish loam and were relatively homogeneous in terms of colour, structure and composition. Layers 1, 2, 3 and

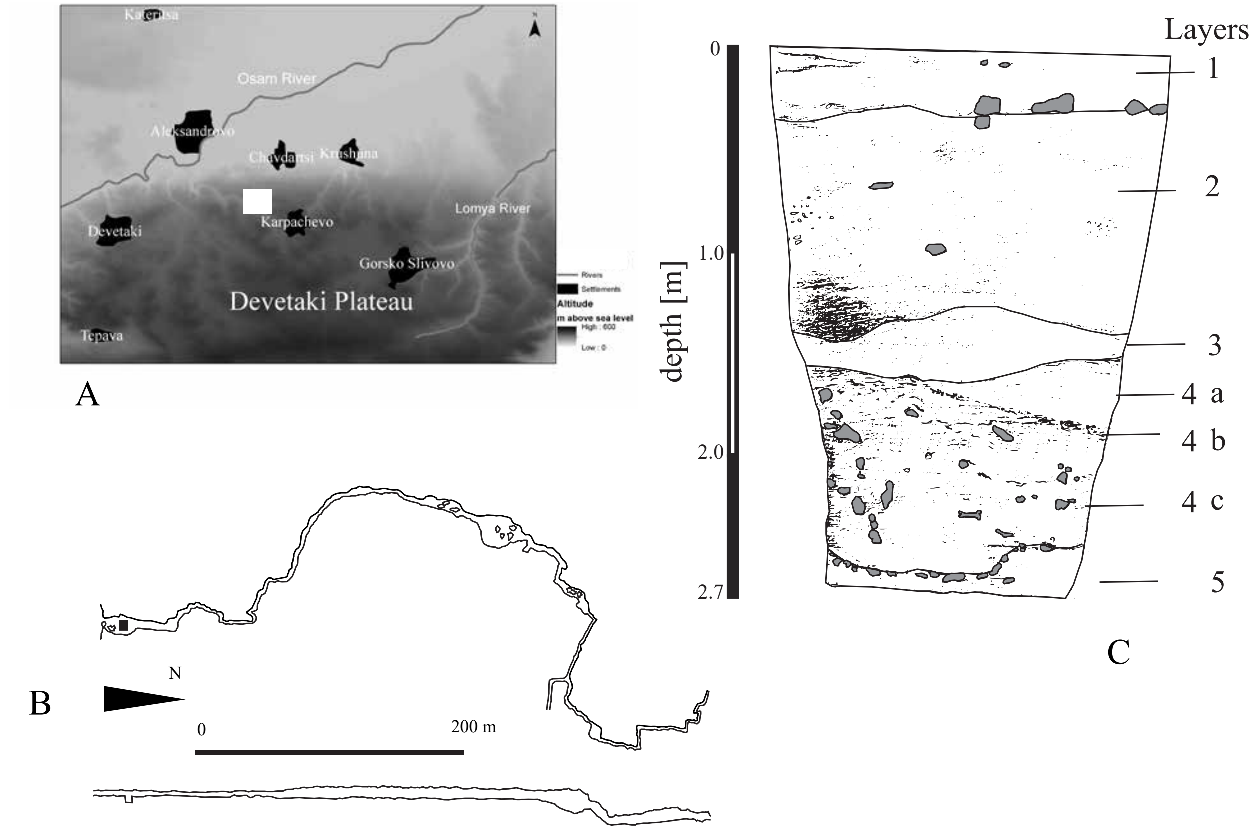

Fig. 1. A. Northern margin of Devetaki Plateau and location of Futjova cave – white square; B. Map of Futjova cave and position of the trench – black square; C. Lithostratigraphic context of the Futjova Cave sediments

4a had a dense structure without embodying materials. Layers 4c and 5 had the same matrix but with a relatively large density of gravel. The boundaries between layers were sharp.

The sediments were divided according to the recorded lithological units and sampled separately. The volume of the sediment samples varied from 0.12 to 0.60 m^3 according to the nature of the deposits. The sediment samples from a particular layer were sieved in water (using mesh of 1 mm aperture), dried and sorted under magnification of 2x. Layers 1 – 3 and 5 were sterile of paleontological remains. The bone concentration in the other sampled layers, 4a and 4b, was extremely low. The small mammal bones were collected mostly from layer 4c. The small mammal material consisted mainly of isolated teeth. More than 400 items were collected, representing at least 20 species of small mammals (Table 1).

Identifications and enumeration of small mammals were based primarily on isolated teeth, rarely on jaw fragments and postcranial bones. The specimens were deposited in the collection of the Institute of Biodiversity and Ecosystem Research (Bulgarian Academy of Sciences).

The measurements were made with a measuring microscope. All measurements are given in millimetres and ratios in percentages. Statistical abbreviations are as follows: X – mean, O.R. – observed range of variation, SD – standard deviation of the mean, N – number of specimens measured. Length (L) and width (W) measurements of cheek teeth always refer to the maximum possible measurement. For the first lower molars of voles the measuring system of Van der Meulen (1973) was adopted; the third upper molar was measured as in our previous paper (Popov 1988). The nomenclature of vole molars follows Van der Meulen (1973) which is an extension of the descriptive terminology introduced by Hibbard (1950).

Results and Discussion

Systematic palaeontology

Order Eulipothyphla Waddell, Okada and Hasegawa, 1999

Family Talpidae Fischer von Waldheim, 1817

Genus *Desmana* Güldenstaedt, 1777

***Desmana* sp.**

Material and measurements: Layer 4b: 1 ? i3 (2.62 x 1.95)

Remarks: Single rooted tooth with extended forward crown. Its size and morphology indicated that it should be referred to the group of the large-sized water moles such as *Desmana moshata* L. and

D. thermalis Kormos. Unfortunately, the very scanty and uncharacteristic specimen made its more precise identification impossible.

Genus *Talpa* Linnaeus, 1758

***Talpa europaea* Linnaeus, 1758**

Material: Layer 4c: 1 m3 (2.42 x 1.25), 1 radius (Length = 12.8).

Description: m3- talonid considerably narrower than the trigonid; both anterior and posterior accessory cusps well developed. Radius with normal mole pattern.

Remarks: The size and morphology of the remains were identical with the recent comparative material of *Talpa europaea*. The radius from the Futjova Cave was larger than those of *Talpa* cf. *fossilis* Petenyi, 1864 from Monte Peglia (Van der Meulen 1973).

Table 1. The small mammal fauna (Eulipothyphla, Lagomorpha, and Rodentia) from the Pleistocene sediments of Futjova Cave and number of items identified (mainly teeth)

Species	Layer			
	4a	4b	4c	Total
Desmana sp.	-	1		1
Talpa europaea	-	-	2	2
Beremendia fissidens	-	-	1	1
Sorex subaraneus	-	-	4	4
Rhinolophus ex gr. *ferrumequinum*	-	-	4	4
Miniopterus schreibersii cf.	-	-	7	7
Lepus sp.	-	-	11	11
Ochotona pusilla	1	-	2	3
Spermophilus cf. *nogaici*	-	11	7	18
Hystrix sp.	-	-	2	2
Myomimus cf. *roachi*	-	-	1	1
Microspalax cf. *odessanus*	-	5	9	14
Allocricetus bursae	2	-	23	25
Cricetus cricetus	-	-	4	4
Cricetus cf. *nanus*	-	-	1	1
Pliomys episcopalis	-	-	6	6
Lagurus transylvanicus (m1 and M3)	4	3	54	61
Mimomys cf. *blanchi*	-	2	21	23
Microtus hintoni (m1 and M3)	-	2	65	67
Microtus arvalidens (m1 and M3)	5	-	-	5
Arvicolidae indet. (M1, M2, m2, m3)	32	8	389	429

Family Soricidae Fischer von Walsheim, 1817

Genus *Sorex* Linnaeus, 1758

***Sorex subaraneus* Heller, 1958**

1958 – *Sorex subaraneus* n. s,. Heller, p. 15, Taf. 1: 10 – 11, Abb. 3

1972 – *Sorex kennardi hundscheimensis* nov. ssp. Rabeder, p. 404 – 411, Taf. 5: 12 – 15

1973 – *Sorex* cf. *kennardi* Hinton, 1911. Koenigswald, p. 28

1988 – *Sorex subaraneus* Heller, 1958. Popov, p. 196, Fig. 1: 1 – 6, Fig. 3: 5

1989 – *Sorex subaraneus* Heller, 1959. Popov, p. 566.

1991 – *Sorex subaraneus* Heller, 1958. Rzebik-Kowalska, p. 374 – 377, text-fig. 10.

Material: 2 mandibular fragments with m1-m2 and m2-m3.

Measurements: see Table 2.

Remarks: The available material showed features, characteristic for the genus *Sorex* (Repenning 1967): pigmented tips of the molars, m1 with a well-developed entoconid crest, m3 with unreduced heel and the location of the mental foramen under the first half of m1. The size of the studied specimens was below the range of the recent *Sorex araneus* Linnaeus, 1758, but larger than the fossil *Sorex runtonensis* Hinton, 1911. In this respect they were nearly identical with the remains of *Sorex subaraneus* from Varbeshnitsa (Popov 1988), lower layers of the Morovitsa Cave (Popov 1989) and Kozi Grzbiet, Poland (Table 2). The occurrence of this species in layer 4c of the Futjova Cave as well as the records from Poland (Rzebik-Kowalska 1991) point out that the stratigraphic range of this species is wider and it cannot be considered as an index fossil for the lower part of the Middle Pleistocene – "*Sorex subaraneus* range zone" of Van der Meulen (1973).

Table 2. Measurements of *Sorex subaraneus* from layer 4c of Futjova Cave in comparison with material from Poland

Measurements	Futjova Cave	Kozi Grzbiet (Rzebik-Kowalska 1991)		
		N	O. R.	X
Length m1-m3	3.75	20	3.60 – 4.03	3.74
Height of mandible below m2 (lingually)	1.36	45	1.21 – 1.46	1.31
Length of m1	1.47	60	1.40 – 1.53	1.45
Width of m1	0.87	61	0.85 – 0.95	0.95
Length of m2	1.26 – 1.32	46	1.25 – 1.38	1.29
Width of m2	0.73 – 0.76	46	0.76 – 0.88	0.83
Length of m3	0.96	29	1.04 – 1.21	1.13
Width of m3	0.50	29	0.60 – 0.71	0.65

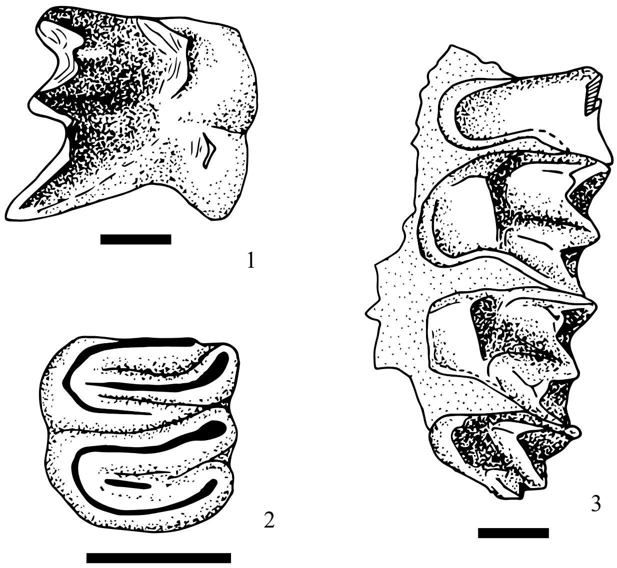

Fig. 2. 1.M1 of *Beremendia fissidens*, 2. M2 of *Miomymus* cf. *roachi*, 3. P4-M3 of *Rhinolophus* ex gr. *ferrumequinum*. Bars represent 1 mm

Genus *Beremendia* Kormos, 1939

***Beremendia fissidens* (Petenyi, 1864)**

Fig. 2: 1

Material and measurements: Layer 4c: 1 M1 (2.52 x 2.57).

Description: Para- , proto- and metacone pigmented in pale red. Hypocone low and not pigmented. U-shaped crest connects protocone with the bases of both para- and metacone. A trace of a cingulum presents below the protocone.

Remarks: The molar from the Futjova Cave did not differ from the material of *Beremendia fissidens*, described in the monographs of Rzebik-Kowalska (1976) and Reumer (1984).

Order Chiroptera Blumenbach, 1779

Family Rhinolophidae Lesson, 1827

Genus *Rhinolophus* Lacepede, 1799

***Rhinolophus* ex gr. *ferrumequinum* (Schreber, 1774)**

Fig. 2: 3

Material: Maxillary fragment with P4 – M3.

Measurements: see Table 3.

Remarks: Many species of large-sized horseshoe bats have been described from the Pliocene and Early Pleistocene of Europe (for a summary see Topal 1979). The differences between those species are not notable and are limited to the relative size of particular teeth or minor details in the pattern which can be evaluated on the basis of large samples only.

Table 3. Measurements of *Rhinolophus* ex gr. *ferrumequinum* from Futjova Cave in comparison with recent and fossil populations of large sized horseshoe bats

Measurement	Futjova Cave	*Rh. ferrumequinum* Recent, Bulgaria, N=19		*Rh. macrorhinus anomalidens* (Topal 1979)
		O. R.	X	O. R.
Length P4-M3	7.12	6.47 – 6.89	6.68	6.17 – 6.70
Length M1-M3	5.65	5.19 – 5.61	5.40	4.68 – 5.49
Length P4	1.57	1.27 – 1.55	1.41	1.22 – 1.50
Width P4	2.65	2.02 – 2.42	2.22	2.13 – 2.54
Length M1	2.27	2.01 – 2.21	2.11	1.90 – 2.23
Width M1	2.82	2.34 – 2.98	2.66	2.72 – 3.32
Length M2	2.07	1.92 – 2.14	2.03	1.72 – 2.08
Width M2	2.65	2.13 – 2.77	2.45	2.41 – 3.00
Length M3	1.50	1.29 – 1.49	1.39	1.18 – 1.40
Width M3/	2.30	2.07 – 2.37	2.22	2.03 – 2.31

Table 4. Measurements of mandible of fossil and recent *Miniopterus schreibersii*

Measurement	Futjova Cave		Recent, Bulgaria N=5
	N	O. R.	O. R.
Height of mandible below m2 (lingually)	4	1.64 – 1.80	1.46 – 1.57
Height of procesus coronoideus	1	3.00	2.80 – 3.00
Length of m1 – m3	2	3.75 – 4.00	3.92 – 4.10
Length of i1 – m3	2	7.40 – 8.00	7.60 – 7.70
Length of m2	2	1.42 – 1.46	1.36 – 1.51
Width of m2	2	0.90 – 0.94	0.85 – 1.02
Length of m3	2	1.22 – 1.29	1.25 – 1.34
Width of m3	2	0.77 – 0.81	0.85 – 1.02

The scarce material available lacked many important taxonomical features and did not permit exact determination. The fossil material showed a lower degree of posterior emargination of P4 – M2 in comparison with *Rhinolophus ferrumequinum* (Fig. 1-3). It had a somewhat more robust cheek teeth, especially P4 and M1, and respectively showed a longer tooth row than the recent species (Table 3). These features make it similar to some early Pleistocene forms, such as *Rhinolophus macrorhinus anomalidens* Topal, 1979 (Table 3).

Family Vespertlionidae Gray, 1821
Genus *Miniopterus* Bonaparte, 1837
***Miniopterus* cf. *shreibersii* (Kuhl, 1819)**

Material: 3 mandibular fragments without teeth, 2 fragments of mandible with m2-m3.

Measurements: see Table 4.

Remarks: The combination of the following characters clearly fits with that of the genus *Miniopterus*: shape of the coronoid process, nyctalodont lower molars,presence of two roots on p2 – p4. The fossil specimens differed from the recent comparative material of *Miniopterus schreibersii* in having a more massive body of the mandible and the lower position of the articular process in comparison with the coronoid process. The tips of these processes are at one level in the extant species. The scarce material did not permit to evaluate taxonomically these differences, so the material was conditionally referred to the extant species.

Order Lagomorpha Brandt, 1855
Family Leporidae Gray, 1821
Genus *Lepus* Linnaeus, 1758
***Lepus* sp.**

Fig. 3: 1-5

Material: layer 4c: 2 P2, 5 upper and 3 lower molariform teeth, 1 m3.

Description: P2 – With three reentrant folds on anterior wall of tooth. Central fold (paraflexus) the deepest, extending postero-latterally, reaching the middle of the occlusal surface. Two shallow externally and internally situated valleys (mesoflexus and hypoflexus). Trace of additional external fold (metaflexus) presents. Paraflexus filled with cement.

Upper molariform teeth – Shape of hypostria variable. Most often both margins with pronounced crenulation. In one specimen the margins were quite smooth, only slightly undulated.

Lower molariform teeth – Trigonid and talonid separated by a deep enamel fold with smooth margins, reaching the lingual wall of the tooth.

m3 – Tooth of two isolated parts – trigonid and talonid with a rounded occlusal surface.

Remarks: The available P2s were different from those of *Hypolagus* in having three well-pronounced reentrant folds on the anterior margin. In *Hypolagus* as a rule only the paraflexus is well pronounced while the mesoflexus is extremely shallow or lacking; the hypoflexus is completely absent (Sych 1965). The teeth were largely the same as in the genus *Lepus*, in general, and as in the *Lepus capensis europaeus* (Pallas, 1778) in particular. However, the lack of the diagnostic p3 did not permit a more precise analysis and a conclusive identification.

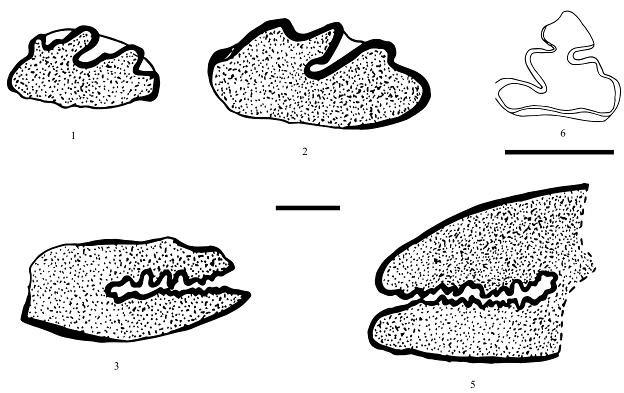

Fig. 3. 1 – 5. *Lepus* sp. (1 – 2, P2; 3, 5, upper molariform teeth) 6. P3 of *Ochotona pusilla* . Bars represent 1 mm

Family Lagomyidae Lilljeborg, 1866
Genus *Ochotona* Link, 1795
***Ochotona pusilla* (Pallas, 1768)**

Fig. 3: 6

Material and measurements: Layer 4c – 2 M, layer 4a – 1 p3 (1.05 x 1.29)

Remarks: The general appearance of the p3 was typical for the subgenus *Lagotona* Kretzoi, 1941 (Erbaeva 1988). Both the structural details and the measurements of this tooth pointed to *Ochotona pusilla*.

Order Rodentia Bowdich, 1821
Family Sciuridae Gray, 1821
Genus *Spermophilus* Cuvier, 1825
***Spermophilus* cf. *nogaici* (Topatchevskyi, 1957)**

Material: Layer 4c: 1P4, 3M1-2, 1M3, 3ml-2;

Layer 4b: 3M1-2, 1M3, 2p4, 3m1-2, 2m3.

Measurements: Ml-2: 2.07 x 2.57, 2.32 x 2.85, 2.20 x – , 2.12 x 3.05, 2.27 x 2.85, 2.10 x 2.70.

M3: 2.52 x 2.77, 2.67 x 2.80.

p4: 2.12 x 2.00, 2.12 x 2.10.

ml-2: 2.65 x 2.70, 2.25 x 3.00, 2.17 x 2.62.

m3: 3.20 x 2.60, 2.92 x 2.70.

Description: P4 – Subtriangular shape of occlusal surface due to the much-expanded parastyl. Metacone connected with the protocone but completely separated from metacone by an interruption of the metaloph.

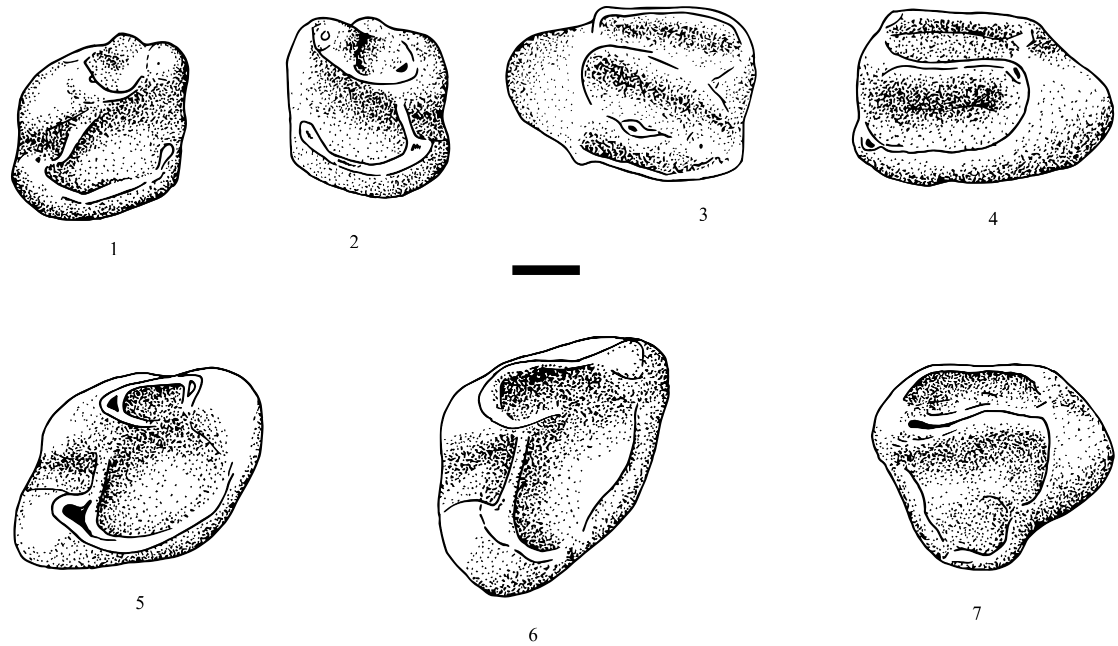

Fig. 4. *Spermophilus* cf. *nogaici* from layer 4b. 1 – 2. p4. 3 – 4. M1-2. 5. m1-2. 6. m3. 7. M3. Bar represents 1 mm.

Ml-2 – Protoloph and metaloph nearly parallel, connecting with protocone to form a U-shaped pattern. Metaconule present on metaloph in four out of the seven specimens. When present, metaconule distinctly individualised by a constriction of the metaloph just labial to protocone and by lowering of this ridge lingually to metacone. The mesostyl very small.

M3 posteriorly expanded. Protoloph high and transverse, metaloph extremely low or absent.

p4 – With two roots. Anteroconid a slender but distinct cusp, separated from metaconid, trigonid basin open anterolingually. Anterior and posterior widths of crown equal. Entoconid small, incorporated in posterolophid.

m1 – 2 – Entoconid not well pronounced, incorporated in posterolophid. Mesostylid very small. Metalophid complete in some specimens and indistinct and short or absent in others.

m3 – Entoconid not distinct, but separated from posterolophid in the unworn teeth. No trace of metalophid.

Remarks: In general, the dental pattern of the material from the Futjova Cave is similar to that of the extant *Spermophilus citellus*. However, taking into account the great uniformity of the tooth pattern in the genus, some minor differences deserve special attention. The fossil material is distinguishable from the extant species in the proportions of the crown of p4. The two teeth available were longer than wide, unlike in the recent comparative material of *S. citellus* (Linnaeus, 1766) (N = 30). Furthermore, the fossil M3s showed a metaloph, although poorly developed. This ridge is incomplete or absent in the extant species. These characters of the fossil form may be interpreted as primitive. Based on these features it is similar to *S. primigenius* (Kormos, 1934) and *S. nogaici*, as described and figured in the literature (Gromov et al. 1965). On the other hand, *S. primigenius* is somewhat larger than *S. nogaici* and our fossil material. It is difficult to ascertain whether this difference has systematic value or not. Since no reliable additional differences between these two species have been given so far, the identification of our small sample of isolated teeth as *S. nogaici* was only tentative.

Family Hystricidae Burnett, 1830

Genus *Hystrix* Linnaeus, 1758

***Hystrix* sp.**

Material: Layer 4c: 1 second phalanx, 1 fragment of lower incisor.

Measurements: Length of the second phalanx = 11.1 mm.

Proximal width = 8.8 mm

Pr. antero-posterior diameter = 6.5 mm.

Incisor: width = 7.00 mm; antero-posterior diameter = 7.5 mm.

Remarks: Phalanx very similar in size and proportions to recent comparative material of *Hystrix cristata* Linnaeus, 1758, but slightly larger. At the same time it differs from the genus *Castor*, which shows a comparable size, with the lower values of the antero-posterior diameter and some details of the shape. The incisor fragment was also very similar to that of the extant *Hystrix cristata*.

Family Gliridae Thomas, 1897
Genus *Myomimus* Ognev, 1924
***Myomimus* cf. *roachi* (Bate, 1937)**

Fig. 2: 2

Material and measurements: 1 m2 (1.23 x 1.27).

Description: Molar two-rooted. Occlusal surface almost square, somewhat wider anteriorly than posteriorly. With four main ridges (antero-, meta-, meso- and posterolophids) and two supplementary ones – a centrolophid and a small extra-ridge in the valley between meso- and posterolophids. Centrolophid relatively large, reaching medial axis of occlusal surface.

Remarks: The relatively long centrolophid and the presence of an extra-ridge in the posterior valley gave a slightly more primitive appearance to this tooth in comparison with the extant species *M. bulgaricus* Rossolimo, 1976 (= *M. roachi bulgaricus*, cf. Storch 1978) and with the Middle/Late Pleistocene *M. roachi* from Greece (Van de Weerd 1973). These features of the molar make it similar to the Pliocene *Myomimus maritsensis* de Bruijn, 1970 (de Bruijn et al. 1970); it differs from this species in having a larger size. On the other hand, the Middle Pleistocene material from the Isle of Chios, described as *Myomimus roachi*, also shows a complicated occlusal pattern (Storch 1975, fig. 7, 8). As shown by Kowalski (1963), the extant species from Bulgaria may also bring an extra ridge on m1. The measurements of our specimen were somewhat smaller compared with the data for the extant *Myomimus roachi bulgaricus* (Rossolimo 1976) but fell in the ranges of the population from Chios (Storch 1975). On the basis of these considerations, we tentatively referred this specimen to a primitive form of the extant species.

Family Spalacidae Gray, 1821
Genus *Nannospalax* Palmer, 1903
***Nannospalax* cf. *odessanus* (Topacevski, 1969)**

Fig. 5

1969 – *Microspalax odessanus* Topacevski, sp. nov. Topacevski, p. 163-169, Fig. 58-60.

Material: Layer 4c: 1 m1, 3 m2, 2 m3, 1 M1, 2 M2.

Layer 4b: 2 M2, 1 M3, 1 m3.

Measurements: m1: 2.37 x 1.92.

m2: 1.95 x 1.80; 2.10 x 2.17; 1.80 x 1.82.

m3: 1.55 x 1.45; 1.62 x 1.50; 2.00 x 1.27.

Ml: 2.12 x 1.92.

M2: 1.92 x 1.70; 1.30 x 1.37; 1.92 x 1.87.

M3: 1.50 X 1.55.

Description: m1 with two roots, anterior and posterior. Occlusal surface with two labial and two lingual reentrant folds. Anterolabial one very shallow and lacking at high level of the crown.

Posterolingual fold quickly becomes an enamel islet since the well-developed entoconid fuses with posterior cingulum when the tooth is slightly worn.

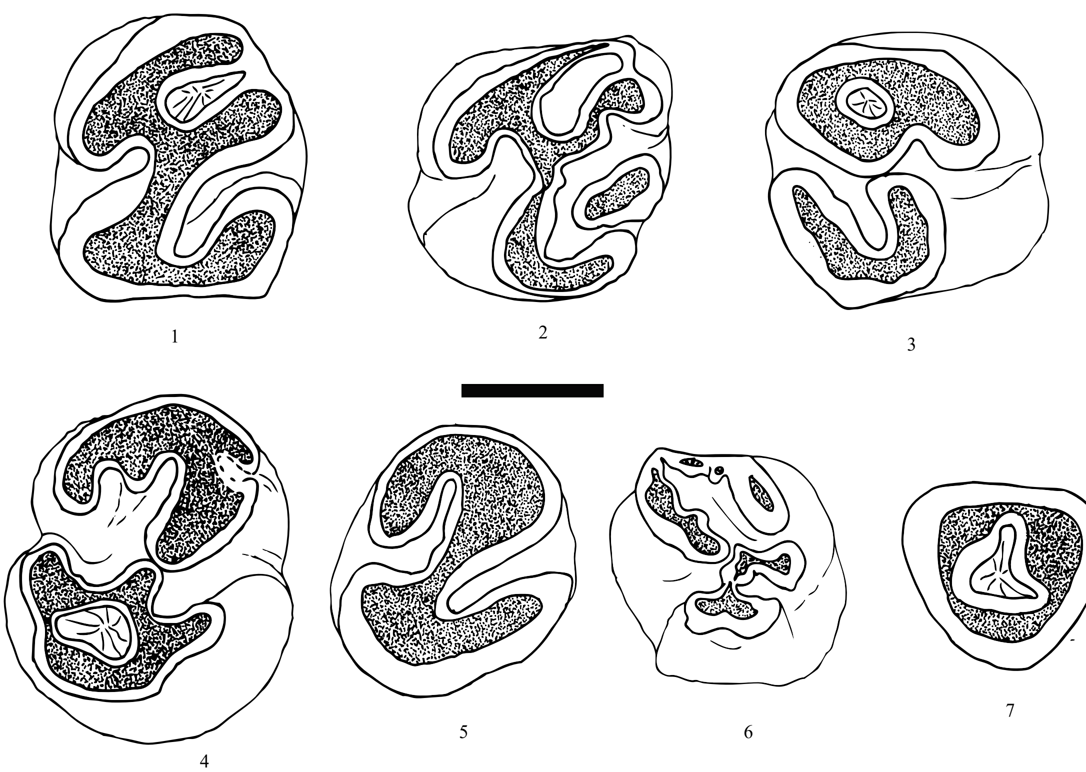

Fig. 5. *Nannospalax* cf. *odessanus* from layer 4c. 1. M1, left. 2 – 3. M2, left and right. 4. m1, right. 5. m2, right. 6. m3, left. 7. M3, right. Bar represents 1 mm

m2 with two roots, sometimes anterior root divided in two in its lower part. Always only two reentrant folds, one labial and one lingual. Posterolingual fold still indicated by an enamel island in two specimens, a result of the fusion of the well-developed entoconid with the posterior cingulum.

m3 with only one well-developed labial reentrant fold and two lingual ones. Entoconid also well developed.

M1 with three roots – one large lingual and two small labial ones. Occlusal pattern of two labial and one lingual reentrant fold. Anterolabial one becomes an island in worn specimens.

M2 – Roots arranged as in M1. In one specimen (layer 4c) occlusal surface of two parts – anterior and posterior ones, paracone not connected with hypocone. Molar from layer 4b with connected cusps, metacone separated from posterior cingulum. Anterior part of occlusal surface of both specimens composed of anterior cingulum, proto- and paracones: anterolabial reentrant fold presented as an island.

M3. Occlusal surface of one dentine field around large enamel island.

Remarks: Determination of fossil mole rats on the basis of dental characters meets with some difficult since the dental pattern is extremely variable with wear. This renders the evaluation of the differences between small samples of fossil teeth rather arbitrary. Nevertheless, the studied molars showed some features that allowed comparisons. Pending the revision of fossil and extant mole rats, Topatchevskyi (1969) distinguished the following Early Pleistocene species: *Prospalax rumanus* Simionescu, 1930 (the status needs to be verified, see Hordijk & de Bruijn 2009), *P. priscus* (Nehring, 1897) (later on this genus was included in Anomalomyidae, see Bolliger 1999), *Microspalax macoveii* (Simionescu, 1930), *M. odessanus* and *Spalax minor* Topacevski, 1959. The complicated structure of the occlusal surface of the available molars differentiates them from the genus *Prospalax*. They differ from *S. minor* in the well-developed entoconid on m1 and the greater number of roots in upper molars. The teeth from the Futjova Cave differed from those of the probably older *M. macoveii* by the structure of m1 occlusal surface – the absence of a mesoconid, the connection between entoconid and posterior cingulum in the earliest stages of wear, while the metaconid and entoconid remained separated even in worn molars. The dental pattern of the molars available comes nearest to *M. odessanus*, as described by Topatchevskyi (1969). As the available material was rather scanty, we refrained from a conclusive identification.

Family Cricetidae Fischer von Waldheim, 1817

Genus *Allocricetus* Schaub, 1930

***Allocricetus bursae* Schaub, 1930**

Fig. 6: 1

Material: Layer 4c: 1 fragm. of mandible with m2-m3, 1 fragm. with m2, 5 m1, 5 m2, 1 m3, 5 M1, 2 M2, 2 M3. Layer 4a: 1 fragm. of mand. with ml-m2. layer 4b: palate with 2 M1.

Measurements: ml: 1.95 x 1.22, 1.93 x 1.22, 1.96 x 1.25, 1.93 x 1.23, 1.89 x 1.09, 1.86 x 1.16.

m2: 1.54 x 1.29, 1.62 x 1.34, 1.48 x 1.34, 1.54 x 1.37, 1.57 x 1.23, 1.48 x 1.29, 1.54 x 1.22, 1.71 x 1.29.

m3: 1.49 x 1.25, 1.40 x 1.18.

Ml: 1.99 x 1.34, 2.07 x 1.46, 2.03 x 1.36, 1.93 x 1.27, 1.99 x 1.29, 1.90 x 1.33, 2.06 x 1.27.

M2: 1.51 x 1,41, 1.54 x 1.36.

M3: 1.47 x 1. 15, 1.48 x 1.22.

Remarks: The overall features and size of the molars belonging to small hamsters from the Futjova Cave concurred with the Quaternary genus *Allocricetus* (Pradel 1988). In order to distinguish between the two species of this genus and to compare our material with the data from the literature (Popov 1988, Pradel 1988), scatter-diagrams of the paired observations of L and W of each molar were composed. The two species, *A. bursae* and *A. ehiki*, were separated on the diagram by a dotted line, as proposed by Pradel (1988) (Fig. 7). The size of our molars was intermediate between those of *A. bursae* and *A. ehiki*. Since the studied material formed a rather tight clusters, it could likely had derived from a single species. This was confirmed by the circumstance that some teeth belonging to the same tooth row fell within the size ranges of different species (Fig. 7). These observations lead to the conclusion that the assemblage could be assigned to a large form of *Allocricetus bursae*.

Genus *Cricetus* Leske, 1779

***Cricetus cricetus* (Linnaeus, 1758)**

Fig. 6: 2-4

Material: Layer 4c: 1 fragm. of maxillae with M2 (2.27 x 2.10)and M3 (2.32 x 2.00), 2 m2 (2.37 x 2.05; 2.42 x 1.95).

Remarks: The occlusal pattern of the available molars was largely the same as in the recent comparative material of *C. cricetus*. The measurements of the teeth, however, were in the lower part of the variability of the extant species or slightly below it. The material was too limited to evaluate these size differences.

***Cricetus* cf. *nanus* (Schaub, 1930)**

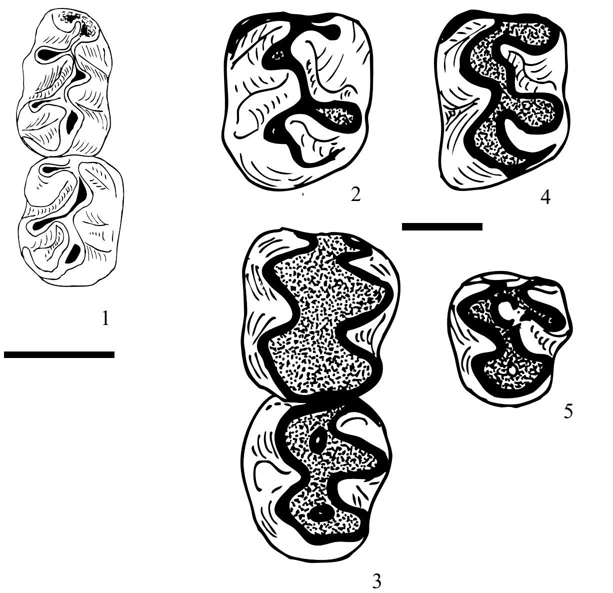

Fig. 6. 1. *Allocricetus bursae* (right m1 – m2). 2 – 4. *Cricetus cricetus,* 2 – 3. m2, left, 3. M2 – M3, left. 5. *C.* cf. *nanus*, M3, left. Bars represent 1mm

Fig. 6: 5

Material and measurements. Layer 4c: 1M3 (1.87 x 1.72).

Description: Two fossets enclosed between paracone and protocone and between the reduced hypocone and metacone. Strong antero1ingual and anterolabial cingula. Tooth with three roots.

Remarks: This peculiar tooth was considerably smaller than the respective molars of *C. cricetus* but larger than in *Allocricetus ehiki*. In this respect it was similar to *Mesocricetus newtoni*, but different in the proportions. As a rule the molars of *Mesocricetus* are narrower. Moreover, the reduction of the posterior part of M3 was greater than in *Mesocricetus*. This molar was very similar morphologically to *Cricetus* cf. *kormosi* Schaub, 1930 as presented by De Brujin et al. (1975) but was larger. In this respect it was close to *C. c. nanus* Schaub, 1930. Taking into account the co-occurrence of two forms of the genus in

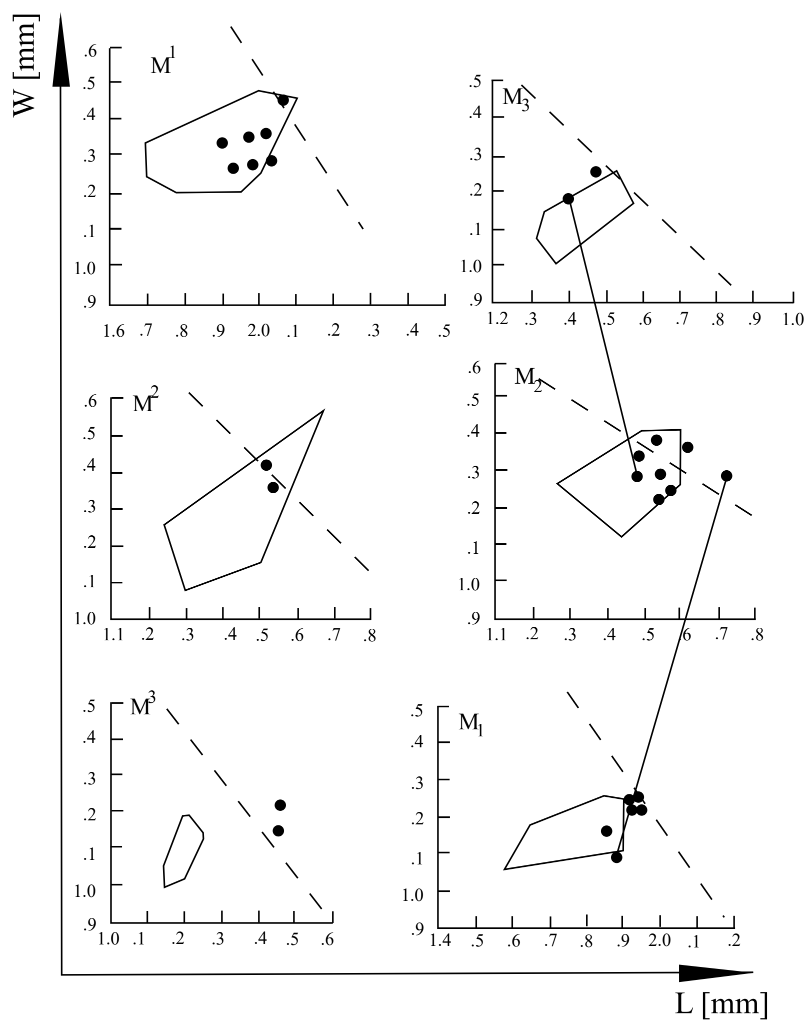

Fig. 7. Scatter-diagrams of the paired observations of L and W of each molar of *Allocricetus bursae* from Futjova Cave (black circles); dotted line – demarcation between *A. bursae* and *A. ehiki* (Pradel 1988); polygons represent the variability of the molars of *A. bursae* from Varbeshnitsa (Popov 1988)

one assemblage it seems unlikely that the small form migh be a subspecies of *C. cricetus*. That was why we considered this form as a separate species.

Family Arvicolidae Gray, 1821
Genus *Pliomys* Mehely, 1914
***Pliomys episcopalis* Mehely, 1914**

Fig. 8

1914 – *Pliomys episcopalis*, n. sp. Mehely, p. 198-203, pl. IV: 9-14, pl. V: 1-10.

1926 – *Dolomys episcopalis* Mehely. Hinton, p. 342-343.

1973 – *Pliomys episcopalis* Mehely, 1914. Van der Maúlen, p. 36-37, pl. IV: 11-13.

1981 – *Pliomys episcopalis* Mehely, 1914, Rabeder, p. 261-268, fig. 159-163.

1985 – *Pliomys episcopalis* Mehely 1914. Nadachowski, p. 23-24, figs. 47-49.

1988 – *Pliomys episcopalis* Mehely, 1914, Popov, p. 216, fig. 10: 5, 5a.

Material: Layer 4c: 3 m1 (Length: 2.65, 2.45, 2.4), 1 M3 (Length: 1.77), 1 M2.

Description: m1 with two roots. As a rule, dentine fields of triangles, anterior and posterior lops well separated from each other. Anterior cap rounded lingually, labial side with well-pronounced salient angle (BSA4) followed by a shallow reentrant valley in the same juvenile specimen. Enamel thicker on the anterior side of triangles. Dentine tracks high.

M3 – Anterobuccal triangle (T2) reduced, separated from T3 but in large confluence with AL1. T4, T5 and short PCI formed one dentine field. Enamel free areas high.

Remarks: The material available agrees well with the original description but seems to be more advanced than the specimens from the type locality (Betfia) in having a better separation between the dentine fields and more elaborated posterior part of the M3. In these respects our material was comparable with that from Monte Peglia (Van der Meulen 1973) but one of the specimens from the Futjova Cave was slightly larger. At the same time the described teeth were nearly identical with the material from Deutsch-Altenburg 2C1 and 4B (Rabeder 1981). However, there was no trace of crown cementum in the studied molars.

Genus *Lagurus* Glager, 1842
Subgenus *Prolagurus* Kormos, 1938
***Lagurus (Prolagurus) transylvanicus* Terzea, 1989**

Fig. 9

1930 – *Lagurus pannonicus* n. sp. (partim). Kormos, p. 244-246.

1938 – *Lagurus pannonicus* Korm. (partim). Kormos, p. 374 – 378, pl. III, fig. 1, 4, 5, 7, 8.

1965 – *Lagurus praepannonicus* sp. nov. (partim). Topatchevskyi, p. 129, fig. 35: 18-21.

1972 – *Lagurus pannonicus* (partim). Chaline, p. 182? fig. 67-5.

1978 – *Lagurus pannonicus ssp.* Terzea, p. 143

1988 – *Lagurus pannonicus.* Popov, p. 218-220, fig. 15.

1989 – *Lagurus transylvanicus.* Terzea, p. 65

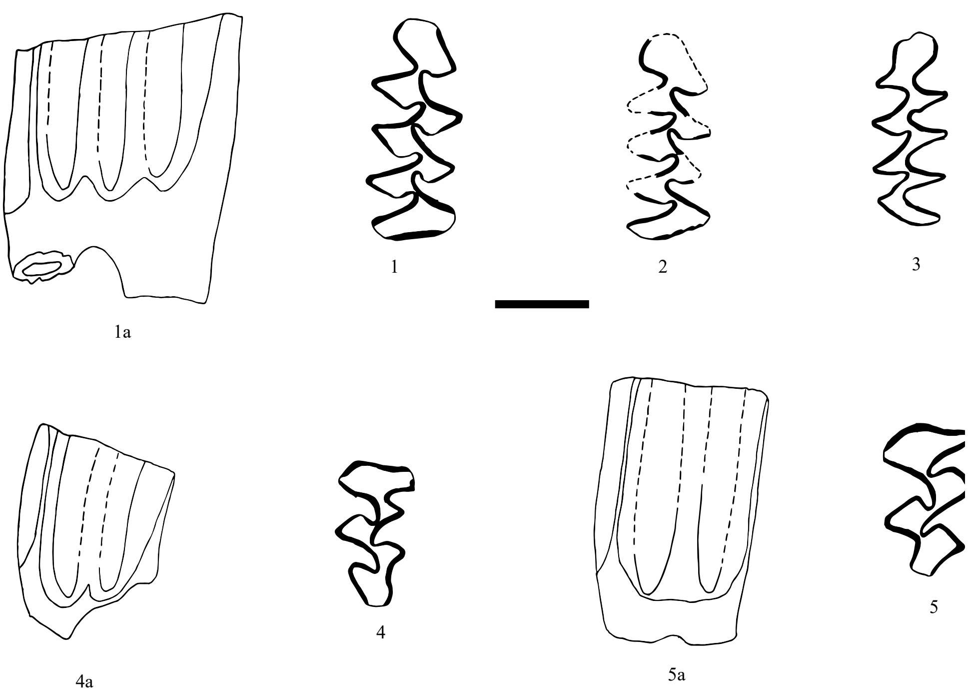

Fig. 8. *Pliomys episcopalis*, layer 4c. 1 – 3. m1; 1 – 2. right, 3. left. 4 – 4a. M3, left. 5 – 5a. M2, left. 1 – 5. occlusal view. 1a. labial view. 4a – 5a. lingual view. Bar represents 1 mm

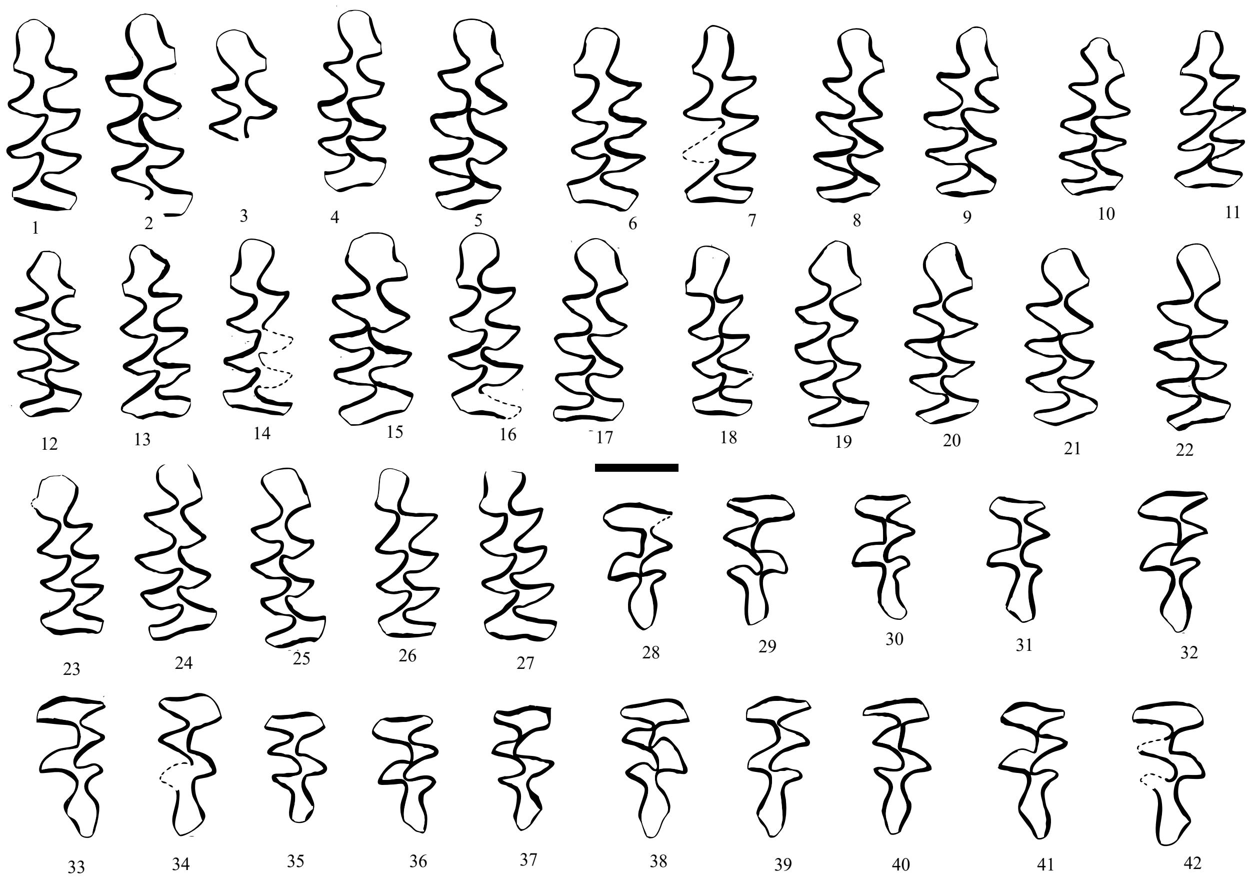

Fig. 9. *Lagurus (Prolagurus) transylvanicus*. 1 – 27: m1, 28 – 42: M3. 1 – 4: layer 4a, 5 – 42: layer 4c. Bar represents 1 mm

– 67, fig. 5

Material: Layer 4c: 39 m1, 15 M3. Layer 4b: 3 m1. Layer 4a: 1 fragm. of m1, 3 M3.

Measurements: see Table 5.

Description: m1 – Eleven molars with morphotype "arankae": with large confluence between parts of the anteroconid complex and prominent "Mimomys ridge" (BSA3); the rest (17) with morphotype "transylvanicus", with narrow neck of AC2 and occasionally with less prominent "Mimomys ridge". In these cases AC2 with more or less angular ("luteoid" sensu Kormos 1930) shape due to shallow BRA3. In all specimens "Mimomys ridge" reached base of crown and always with "Mimosinuid". Anterobuccal side of AC2 with an enamel band.

Remarks: *Lagurodon arankae* and *Prolagurus transylvanicus* are two successive evolutionary stages which replace each other gradually (Terzea 1989b, 1996). So, the occurrence of intermediate specimens can be expected in the transitional assemblages. For example, in the assemblage from layer 4c there were some specimens with a large confluence of the dentine fields of the anteroconid complex, similar to *L. arankae*. However, the distributions of b/W and c/W did not allow the distinction of more than one species. The variability within the whole assemblage (Fig. 9) showed that the extreme variants with a large "neck" were linked with these with a narrow "neck" by a series of intermediates. Moreover, the primitive "arankoid" morphotypes from the studied assemblages had greater values of a/L (Table 5) than the true *L. arankae* populations from earlier Bulgarian localities (Popov 1986, 1994). These observations have showed that the boundary between the two species (evolutionary stages) is conditional and must be defined biometrically. *Prolagurus transylvanicus* was already described from the Late Biharian locality of Varbeshnitsa (Popov 1988) under the name *Prolagurus pannonicus*. The studied material was close to that previously described form in the shape of the anterior cap of the dominant morphotype. However, the m1 sample from the Futjova Cave had a more primitive aspect in terms of the large confluence between the dentine fields of T4 and T5 and the occurrence of specimens with large "neck". These differences appeared more distinctly in the biometrical comparisons (Table 5 and Popov 1988, table VII). Furthermore, the M3 from the Futjova Cave was more primitive than the form from Varbeshnitsa in having a short and simple posterior part.

Genus *Mimomys* Forsyth Major, 1902

***Mimomys* cf. *blanci* (Van der Meulen, 1973)**

Table 5. Measurements [mm] and ratios [%] of m1 of *Lagurus (Prolagurus) transylvanicus* from Futjova Cave. Layer 4 c. Abbreviations: L – length, a – length of the anteroconid complex W – width, c – width of the connection between the dentine fields of the basic triangles of the anteroconid complex, b – width of the "neck" of the anterior cap (for details see Van der Meulen 1973, Popov 1988)

Morphotype	Measurement	O.R.	X	SD
"arankae" N=11	L	2.10 – 2.52	2.34	0.133
	a	1.02 – 1.29	1.16	0.08
	W	0.83 – 0.99	0.90	0.05
	c	0.13 – 0.29	0.19	0.04
	b	0.10 – 0.25	0.18	0.05
	a/L	45.78 – 51.19	49.42	1.79
	b/W	11.49 – 26.37	19.60	5.14
	c/W	14.94 – 29.29	21.52	3.83
"intermediate" N=11	L	2.20 – 2.49	2.38	0.09
	a	1.12 – 1.30	1.19	0.06
	W	0.70 – 0.94	0.81	0.06
	c	0.13 – 0.22	0.19	0.03
	b	0.03 – 0.10	0.06	0.02
	a/L	47.86 – 52.21	50.05	1.36
	b/W	3.70 – 11.76	7.7	2.61
	c/W	15.29 – 31.43	24.12	5.23
"transylvanicus" N=6	L	2.32 – 2.52	2.41	0.07
	a	1/13 – 1.19	1.17	0.02
	W	0.77 – 0.88	0.82	0.05
	c	0.14 – 0.25	0.21	0.04
	b	0.03 – 0.08	0.06	0.02
	a/L	46.82 – 49.14	48.42	0.87
	b/W	3.61 – 9.21	7.41	2.20
	c/W	18.18 – 31.58	26.14	5.02

Fig. 10

Material: Layer 4c: 4 m1, 3 m2, 2 m3, 6 M1, 4 M2, 3 M3. Layer 4b: 2 m1.

Measurements:

L	a	W
2.75	1.05	0.97
2.75	1.12	0.95

Description: All molars two-rooted; crown cementum present and abundant in worn specimens; enamel thickness differentiated after "Mimomys" type, i. e. thinner bands at the concave sides of prisms, thicker parts at the convex sides; dentine tracks high and as a result enamel on occlusal surface interrupted in the earliest stages of wear.

m1 – Basic triangles somewhat rounded in worn specimens, connected with each other and with PL and ACC by communications of a variable width. ACC forming single field consisting of T4, T5 and short asymmetrical AC2 always poses a slightly protruding BSA4 (sensu Van der Meulen 1973). This salient angle is most probably a remnant of the "Mimomys ridge" in ancestral forms (see below).

m2 and m3 -Tips of opposite lingual and buccal reentrant angles meet and as a result occlusal surface displays three fields, consisting of PL, T1-T2 and T3-T4, respectively.

Ml and M2 – Dentine fields of prisms well separated from each other. Ml with three salient angles on each side, while M2 lingually with two salient angles.

M3 – Occlusal surface with three deep reentrant folds – one lingual (LRA2) and two (BRA1 and BRA2) buccal. LRA2 followed by shallow LRA3, remnant of the "M3 insel fold" in more primitive species. Tips of LRA2 and BRA2 meeting and separating occlusal surface in two dentine fields.

Remarks: In this paper, we refer to the genus *Mimomys* for all vole molars having roots, crown cementum and "Mimomys" pattern of enamel differentiation. The Early Pleistocene small *Mimomys* species with a simple anteroconid complex (absence of "*Mimomys* ridge" and an enamel ring) can be divided into two groups on the basis of the M3 occlusal pattern (Zazhigin 1980, Topatchevskyi et al. 1987).

The first group comprises species with deep LRA3. This pattern should be considered as a primitive one since it is initial for the voles. According Hinton's (1926) description of *Mimomys newtoni* and to the figure of the teeth of the type specimen of *M. tornensis* (Janossy & Van der Meulen, 1975) , these two species belong to this group. On the basis of the M3 occlusal pattern of the earliest *Microtus* forms, such as *Microtus (Allophaiomys) deucalion* (Popov 1986) it could be assumed that they derived from *Mimomys* species of this group.

The second group shows a simplification of the occlusal surface of M3 as a result of the reduction by insulation of the inner part of LRA3. In the evolutionary advanced forms the islet is an ephemeral structure to be observed only in unworn teeth. As a result the posterior part of the occlusal surface consists of one dentine field and LRA3 is always barely marked. Among the Early Pleistocene species, two forms could be assigned to this group – *Mimomys pusillus* and *Mimomys blanci*. Most probably they derived from a species which has complicated m1 (presence of *Mimomys* ridge and enamel ring) such as *M. reidi*.

According to Van der Meulen (1973) the differences between *M. pusillus* and *M. blanci* concern the complete absence of *Mimomys* ridge and/or enamel ring in m1 of *M. blanci*, which may be present in adult *M. pusillus*. Moreover, *M. blanci* is

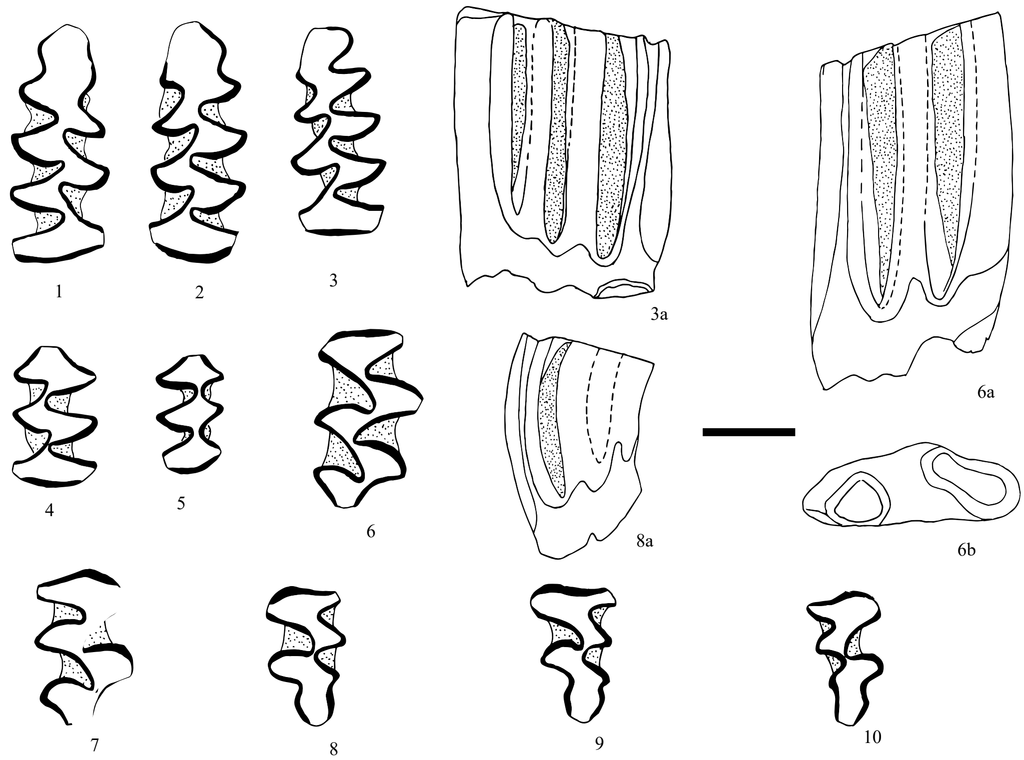

Fig. 10. *Mimomys cf. blanci*. 1 – 2: layer 4b, 3 – 10. layer 4c. 1 – 3. m1; 1 – right, 2 – 3. left. 4. M2, left. 5. M3, right. 6. M1, right, 7. M2, left. 8 – 9. M3, right; 1 – 10. occlusal view; 3a, 6a, 8a: labial view, 6b – root view. Bar represents 1 mm

smaller. Taking into account that the simplification of the anterior part of m1 is an evolutionary trend in the late *Mimomys* species, these two forms may be considered as successive evolutionary stages (Rabeder 1981).

Having in mind that according to the m1 material only one *Mimomys* species occurred in the sediments of the Futjova Cave, all third upper molars with roots, with "*Mimomys*" type of differentiation of the enamel thickness and with crown cementum can be safely referred to the same species. The m1 – M3 assemblage showed that this species belonged to the second group as defined above.

After comparison with both Mehely's (1914) and Van der Meulen's (1973) figures of *M. pusillus* and *M. blanci* from the type localities (Betfia 2 and Monte Peglia), the assemblage from the Futjova Cave seemed to be more advanced than the first species and it was nearly at the same evolutionary stage as *M. blanci*. The only difference was that the studied specimens were somewhat larger than the Italian form. In this respect our material was similar to the assemblage from Casablanca I (Spain) determined as *M. tornensis* (Esteban Aenlle & Lopez Martinez 1987). Judging, however, from the M3 occlusal pattern, the Spanish material is different from the type specimen of *M. tornensis* (Janossy & Van der Meulen 1975, Fig. 4b) and has to be placed in the second group as defined above. On the other hand, the assemblage from Casablanca I seems to be more primitive than ours since some of the first upper molars have three roots. In view of the scarce material from the Futjova Cave it was still impossible to make more detailed comparisons and to present a conclusive identification.

Genus *Microtus* Schrank, 1798

***Microtus (Allophaiomys) hintoni* (Kretzoi, 1941)**

Fig. 11

1941 – *Pitymys hintoni* n. sp. Kretzoi, p. 319, Abb. 3/1.

1970 – *Pitymys hintoni* Kretzoi. Terzea, p. 508, Fig. 4 a-j.

1972 – *Allophaiomys pliocaenicus nutiensis* nov ssp. Chaline, p. 95 – 99, Fig.24: 1-13.

1973 – *Microtus (Allophaiomys)* sp. A. Van der Meulen, p. 97 – 98, PI. VII: 1-18.

1981 – *Microtus (Allophaiomys) hintoni* Kretzoi, 1941. Rabeder, p. 215 – 217: Abb. 116: 4

Material: Layer 4c: 48 m1, 17 M3. Layer 4b: 2 m1.

Description: Enamel thickness well differentiated after "Microtus type". Cement abundant in the reentrant angles.

m1 – According to Van der Meulen (1973) the morphological variability of the anteroconid complex is considered in terms of the following morphotypes (arranged from the most primitive to the most progressive):

"Arvicolid" (Fig. 11: 3-6). Here we include also the morphotypes "pliocaenicus" and "laguroides" of Chaline (1972). AC2 broadly confluent with T4 and T5. AC2 usually rounded, but sometimes an incipient LSA5 may be present. This morphotype is rare – 8 %.

"Hintonid" (Fig. 11: 7-20, 25-27). AC2 in a narrow connection or separated from the triangles of anteroconid complex. LSA5 always well pronounced, sometimes followed by a shallow LRA5. Buccal side of AC2 usually rounded, but occasionally with an incipient BRA5 (Fig. 11: 17, 18). The most common morphotype – 68 %.

"Gregalid" (Fig. 11: 21-24). AC2 elongated with a rounded buccal side. LSA5 prominent and LRA5 well developed. Anteroconid triangles (T4 and T5) tend to be separated. Rare morphotype – 12 %.

"Nivalid" (Fig. 11: 28-29). AC2 with BSA4 and LSA5 while respective anteriorly situated reentrant angles poor or lacking. Rare morphotype – 8 %.

The distinction of these morphotypes is arbitrary because they are connected by intermediates.

M3 – Shape of occlusal surface simple. PC1 very short and largely connected with T5. Occasionally a shallow LRA4 present. This complex (PC1 – T5) usually separated from T4. Dentine fields of basic triangles (T2 and T3) and anterior lobe (AL) well separated.

Measurements: see Table 6.

Remarks: Type locality for *P. hintoni* is Püspökfürdö 5 (Roumania) (Kretzoi 1941) (= Betfia

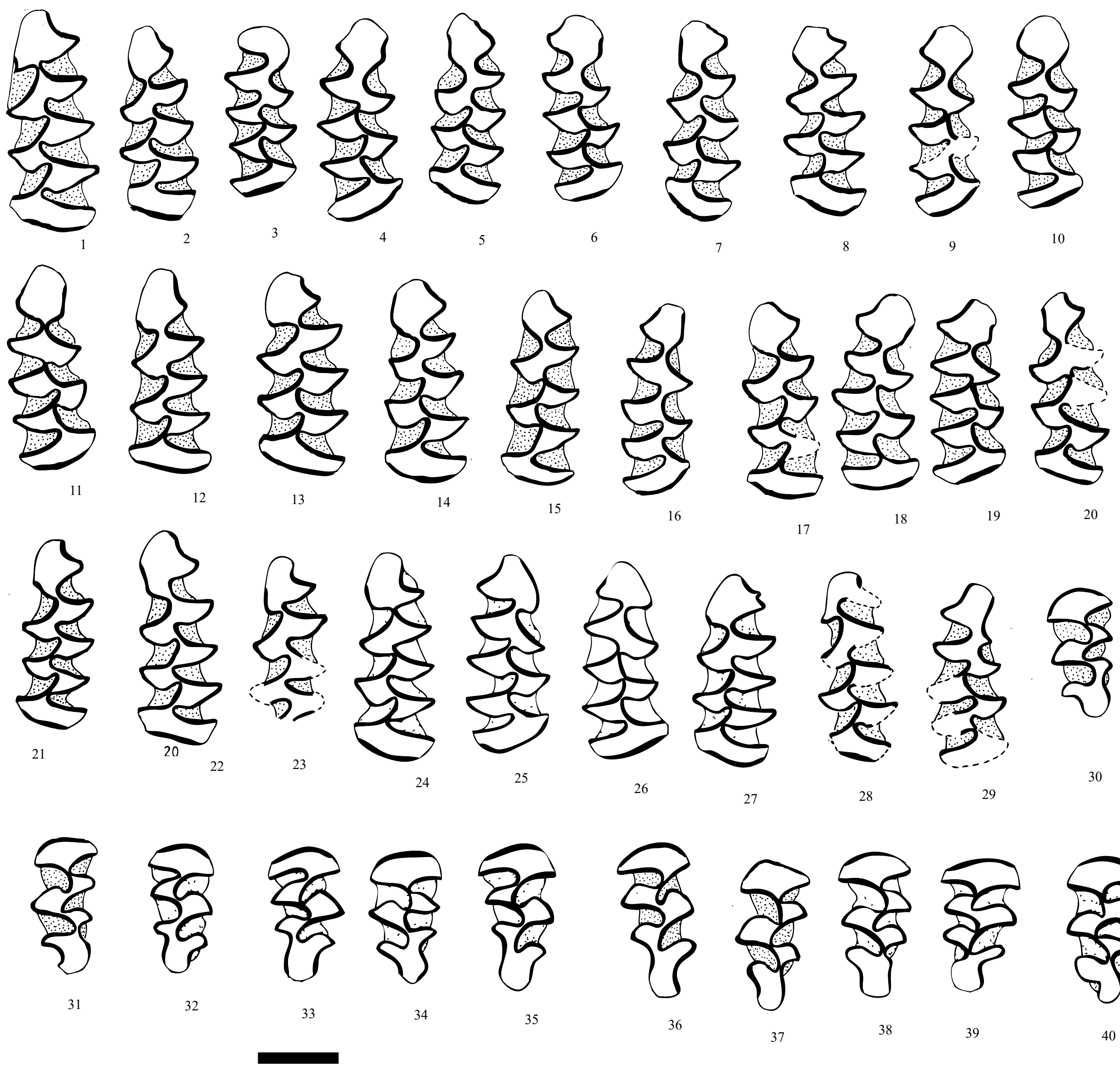

Fig. 11. *Microtus hintoni*, 1 – 29 – m1, 30 – 40 – M3, 1 – 2 – layer 4a, 3 – 40 – layer 4c. Bar represents 1 mm

Table 6. Measurements [mm] and ratios [%] of m1 and M3 of *Microtus hintoni* from Futjova Cave, layer 4c. For abbreviations, see Table 5

Tooth	Measurement	O.R.	X	SD
m1 N=33	L	2.17 – 2.85	2.46	0.16
	a	0.95 – 1.39	1.16	0.10
	W	0.69 – 0.97	0.83	0.06
	c	0.10 – 0.25	0.21	0.04
	b	0.03 – 0.14	0.06	0.04
	a/L	42.99 – 51.32	46.96	1.54
	b/W	3.09 – 23.25	7.19	4.84
	c/W	12.34 – 32.14	27.41	4.39
M3 N=15	L	1.61 – 1.86	1.73	0.07
	a	0.74 – 0.95	0.80	0.06
	c	0.25 – 0.36	0.30	0.04
	d	0.31 – 0.45	0.35	0.04
	a/L	40.80 – 51.07	46.38	2.70
	c/d	71.05 – 100.00	85.86	8.47

V). The variability of m1 from this locality is presented by Terzea (1970). The visual comparison with this assemblage shows that the material from the Futjova Cave is very close to the Romanian population. However, the lack of detailed biometrical data from Betfia V prevents a more precise comparison. The same is true when comparing our material with *Allophaiomys pliocaenicus nutiensis* from Les Valerots (France) (Chaline 1972). In general, the variability of the shape of the anteroconid complex in the studied material was comparable with that of the French assemblage. Our specimen No Ft4/4c was similar to the holotype (Chaline 1972, Fig. 24:11), which this author refers to the morphotype "*hintoni*". However, the assemblage from the Futjova Cave seemed to be more progressive, since the morphotype "*pliocaenicus*" (Fig. 11: 4), which is abundant in Les Valerots (Chaline 1972, p. 95), and subsequently described as a separate species, *M. (Allophaiomys) valerotensis* (Lapana et al. 2000), was rare in our material. On the other hand, on the basis of the biometric data (index LRPA s.u.) presented for the revised French material (Lapana et al. 2000) the form from the Futjova Cave, seemed more primitive than both "*pliocaenicus*" and "*hintoni*" morphotypes from Les Valerots, described as *Microtus (Allophaiomys) valerotensis* and *Microtus (Allophaiomys) hintoni nutiensis*, respectively (Lapana et al. 2000). It should be borne in mind however that the index used to characterise the relative length of the anteroconid complex (LRPA s.u) was not completely identical to a/L index (Lapana et al. 2000).

The material from Monte Peglia (Italy), described as "*Microtus (Allophaiomys)* sp. A" (Van der Meulen 1973) is also very similar to the assemblage from the Futjova Cave. The biometric data available for both assemblages (Table 6, and Van der Meulen 1973, table VI) permited more detailed comparisons. Fig. 12 gives the mean values of a/L and b/W to illustrate the evolution of the anteroconid complex through time. These data lead to the conclusion that the form from the Futjova Cave is biometrically intermediate between the population of *M. hintoni* (= *M. (Allophaiomys)* sp. A) from Monte Peglia and *"Pitymys" gregaloides* from some Hungarian localities.

The form from the Futjova Cave is more primitive than the Romanian subspecies *Microtus hintoni gilpius* described from the Biharian locality Chiscau-1 (Terzea 1989a). The mean value of a/L in the Romanian form is 47.60 (n=98), i. e. it is significantly greater than in *M. hintoni* from the Futjova Cave.

According to the data on a/L values for various species of *Microtus* (s. l.) summarised by Maul (2001) the population from the Futjova Cave (Table 6) was close to the following forms from the "hintonid" – lineage: *Microtus ratticepoides* from Voigtstedt (a/L=46.95), *Microtus nutiensis* from Zalesiaki- 1/A-13 (46.93) and *Microtus ratticepoides* from Sommich-hegy 2 (46.77).

Having in mind the biometrical criteria proposed by Van der Meulen (1973) for separation between *M. (A.) pliocaenicus*, *M. (A.) hintoni* and *M. gregaloides*, the population from the Futjova Cave might be considered as a transitional one between *M. hintoni* and *H. gregaloides*.

The specimens of the "nivalid" morphotype may in fact belong to another species, for instance "*Pitymys" nivaloides* (Hinton 1926) or *Allophaiomys burgondiae* (Chaline 1972). However, taking into account that this morphotype was rare in the studied assemblage (only two specimens) it could be considered as an extreme variant of *Microtus hintoni* (cf. Van der Meulen 1973).

***Microtus (Terricola) arvalidens* Kretzoi, 1958**

Fig. 13

1923 – *Pitymys arvaloides* n. sp. Hinton, p. 541.

1958 – *Microtus (Pitymys) arvalidens* nov. nam. Kretzoi, p. 57.

1972 – *Allophaiomys pliocaenicus pitymyoides* nov. ssp. (partim), Chaline, p. 101-103, Fig. 30: 12-14.

Materials: Layer 4a: 2 fragm. of m1, 1 fragm. of mandible with m1, 2 M3.

Measurements:

m1:

L	a	W	c	b	a/L	b/W	c/W
2.77	1.42	0.94	0.17	0.03	51.26	3.19	18.08
-	1.17	0.90	0.21	0.10	-	1.11	23.33
-	1.37	0.88	0.19	0.03	-	3.40	21.59

M3:

1.74	0.80	-	-	-	45.98	-	-
1.64	0.80	-	-	-	48.78	-	-

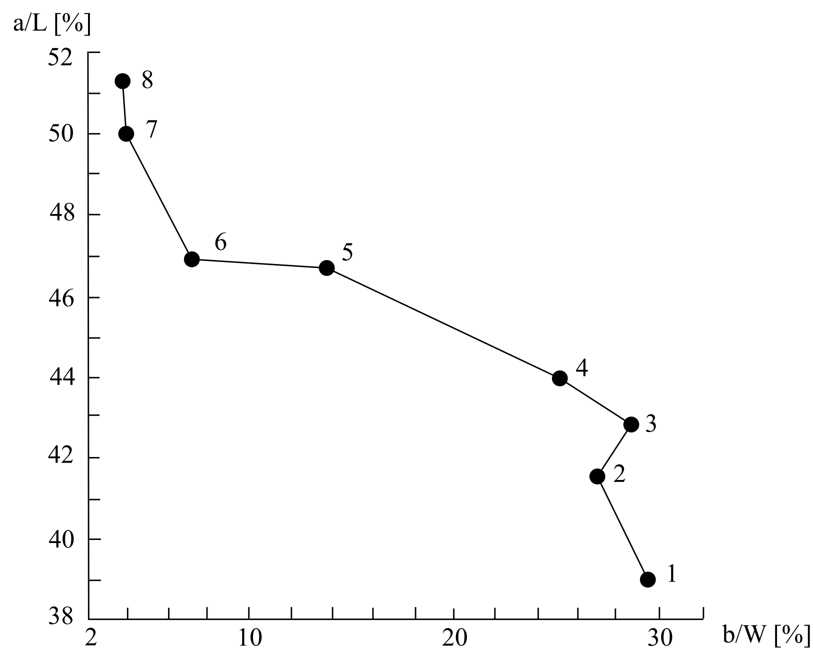

Fig. 12. Mean values of a/L and b/W of the anteroconid complex of the first lower molar of some Microtini species. 1. Temnata Cave, *Allophaiomys deucalion*; 2. Cave 15, Y-unit, *Allophaiomys pliocaenicus* 3. Cave 15 – R-unit, *Allophaiomys pliocaenicus*; 4. Betfia 2, *Allophaiomys pliocaenicus*; 5. Monte Peglia, *Allophaiomys* sp. A; 6. Futjova Cave, *Microtus hintoni*, 7. Villany 8/III-VII, 8. Villany 6. *Microtus gregaloides*

Remarks: This species was one of the most advanced among the Early Pleistocene voles in the acquisition of a more complicated anteroconid complex – appearance of T6, T7 and AC3. The basic triangles of the ACC remained in a broad connection. AC3 occasionally was poorly differentiated but as a rule it was distinct and had an “arvalid” shape.

Taphonomy and palaeoecological interpretation

The paleoecological interpretation of the small mammal fossil assemblages cannot be usefully discussed without first considering how the material came to be in the cave deposits. It is widely accepted that the birds of prey were of particular importance of deposition of small mammal bones in the sediments of large cave entrances, such as that of the cave under consideration. The preservation of the material may be useful for the more detailed interpretation. Some of the bones were much eroded as a result of the activity of the digestive acids of the predators. Moreover, the material was very fragmented, consisting mainly of isolated teeth. This fragmentation may also be attributed to the predator activity since there were no traces of erosion caused by water transport. These evidences showed that most probably diurnal birds of prey were responsible for the bone accumulation. As a rule these birds digest their prey very thoroughly: the skeleton parts were highly fragmented and the bones were relatively eroded (Mayhew 1977). This was confirmed by the relatively large amount of such diurnal species as souslic (*Spermophilus*). The stratigraphic assemblages were very similar to each other as outlined above and the whole small mammal fauna was treated as being the diet of diurnal birds of prey. Many species of these birds feed on small vertebrates over a variety of habitats. Consequently, the fossil remains accumulated in this way can be considered good indicators

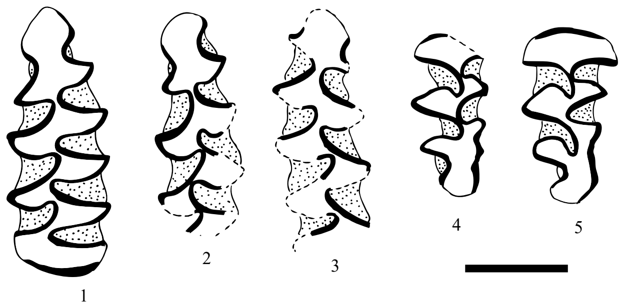

Fig. 13. *Microtus arvalidens*, layer 4a. 1 – 3. m1. 4 – 5. M3. Bar represents 1 mm

of habitat differentiation in the vicinity of the cave (Chaline 1977).

The studied assemblages comprised some extinct species (*Mimomys* cf. *blanci, Pliomys episcopalis* and *Beremendia fissidens*) which have no direct living descendants. These species are commonly considered as suggestive for a warm climate. Their disappearance towards the end of the early Pleistocene corresponds to the gradual cooling of the climate (Fig. 14). The presence of *Hystrix* sp., *Rhinolophus* ex gr. *ferrumequinum*, *Miniopterus schreibersii*, *Myomimus* cf. *roachi* in the assemblages under consideration also indicates a fairly warm climate since these forms are closely related to, or identified with, species which are distributed nowadays in the southern parts of Europe. This is consistent with the colour (reddish) and the lithology of the deposits (loam without angular rubble), suggestive for the prevailing chemical erosion.

Beside these species which give some information about the temperatures, the majority of small mammals being tolerant of a rather wide range of temperatures are much more useful for the reconstruction of the overall environment. The habitat availability is generally more important for these species than the temperature regime. The vegetation type (wood, grassland, shrubs, etc.) are of particular importance in this respect. On the other hand, the character of the vegetation is closely related to the humidity (more precisely to the effective moisture – the relation between temperatures and precipitation). As a rule, forests and meadows are associated with a humid. more or less temperate climate, while steppes grow under an arid and continental climate. In this respect the most important feature of the assemblages was the great number of species, associated with open vegetation, including steppes, as it may be assumed from the ecological requirements of their descendants or relatives. The following species were attributed to this group: *Spermophilus* cf. *nogaici*, *Nannospalax* cf. *odessanus*, *Ochotona pusilla*, *Allocricetus bursae*, *Lagurus transylvanicus* and *Microtus hintoni*. In addition, *Beremendia fissidens* is regarded as an open country dweller by Sulimski (1964). According to Van der Meulen (1973), *Mimomys blanci* was also assumed to have had an open country habitat.

Some species can be considered as bush dwellers, characteristic for xerophilous shrubby vegetation – *Myomimus* cf. *roachi*, *Hystrix* sp., *Rhinolophus* ex gr. *ferrumequinum*.

The forest or meadow inhabiting species, indicative of more or less humid climate, were few and were presented by a small number of remains. *Sorex subaraneus* and *Talpa europaea* belong to this group. According to Fejfar (1961) and Janossy (1965), *Pliomys episcopalis* was presumably also a forest dweller. *Desmana* sp. favoured swamp biotopes. The presence of only one tooth of this species indicated that such biotopes were far from the locality.

Layer 4c. This assemblage was predominated by open country dwellers. The most abundant species were *Lagurus transylvanicus* and *Microtus hintoni*. It seems reasonable that the assemblage was derived from a dry environment with steppe vegetation. The extension of such vegetation in this part of Europe is usually considered to correspond to the glacial periods in Northern Europe. This interpretation is not in contrast with the evidences for warm climates, since at this latitude the Quaternary environmental changes were influenced by humidity rather than temperature (Van der Hammen et al. 1971). Moreover, the early glaciations were not as drastic as these during the Late Pleistocene.

Layer 4b. This assemblage contained only a limited number of specimens and respectively species (Table 1) so it is difficult to present any conclusive paleoenvironmental interpretation. In general, the ecological appearance did not differ from that of the previous assemblage.

Layer 4a. The assemblage was also very poor. However, one important feature requires special attention – here *M. hintoni* was replaced by *M. arvalidens*. Taking into account that the majority of the recent ground voles (*Terricola*) inhabit in humid and more or less forested habitats, it can be assumed that this layer has been deposited in wetter conditions than layers 4c and 4b. The lithology of the sediments from the Futjova Cave is consistent with this interpretation. The transition between layer 4b and 4a was sharp and erosive, suggesting a paleoenvironmental change.

Biostratigraphy and correlations

All assemblages under consideration contained *Lagurus (Prolagurus) transylvanicus*. According

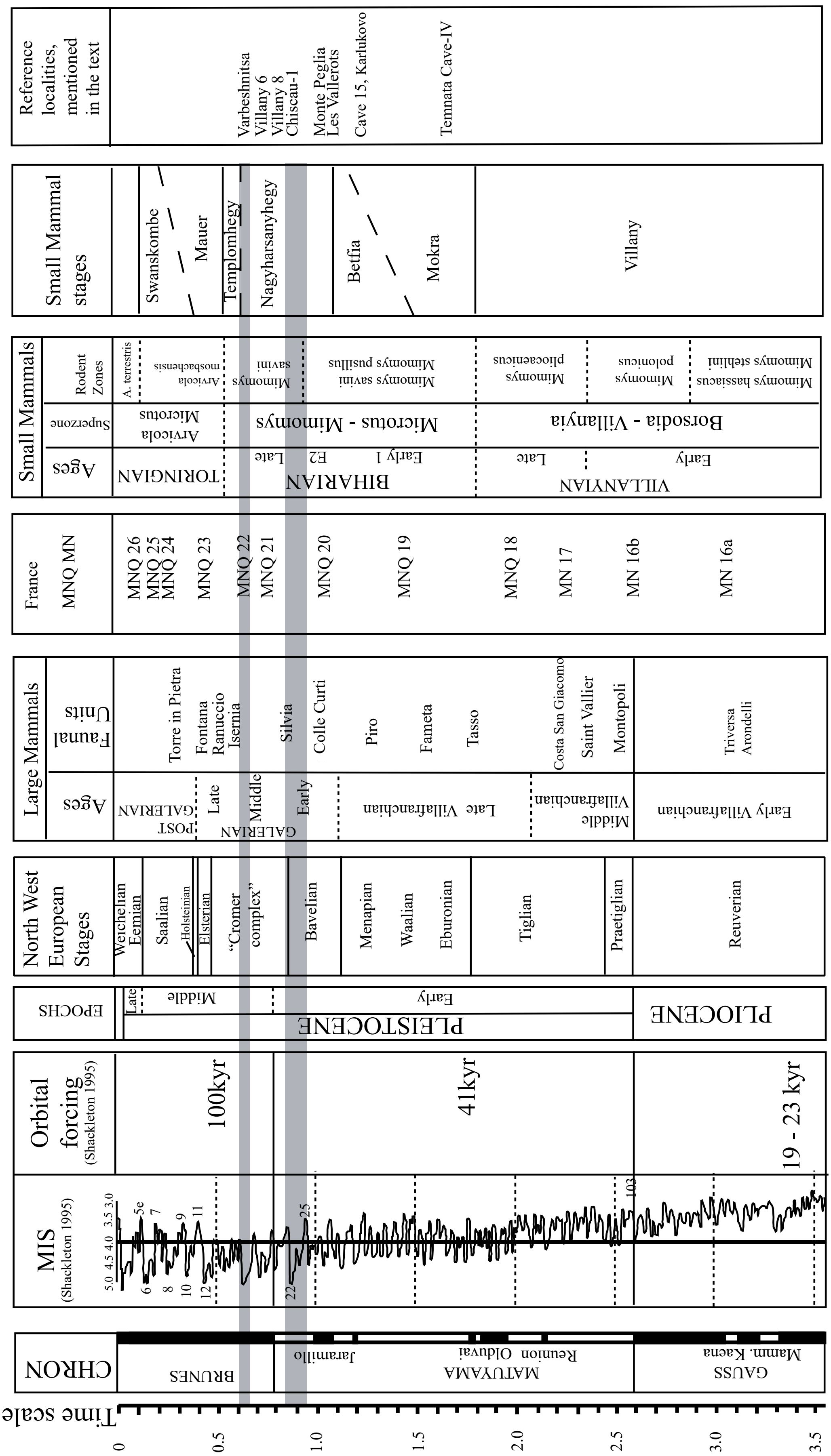

Fig. 14. Integrated stratigraphic scheme for the Late Pliocene–Pleistocene. The grey stripes indicate the position of assemblages from Futjova Cave

to Terzea (1989, 1996) the presence of this species characterises the upper part of the Lower Biharian (phase Betfia) and the first half of Upper Biharian (phase Nagyharsanyhegy). More precise correlation of the particular assemblages was possible on the basis of the evolutionary stages of the *Microtus* species (Fig. 14).

Layer 4c. As follows from the taxonomical analysis this assemblage contained a progressive population of *Microtus hintoni*, comparable with the evolutionary stage of the population from Les Valerots, designed (Chaline 1972) as a separate species, *Microtus nutiensis* (Chaline 1972) or subspecies *M. hintoni nutiensis* (Lapana et al. 2000). Rabeder (1981) considers *Microtus hintoni, M. nutiensis*, and *Microtus gregaloides* as three successive stages within a single evolutionary lineage, and he divided the middle part of Biharian, the so-called Montepeglian (=Nagyharsanyhegy), in two biozones – "*Microtus hintoni*" and "*Microtus nutiensis*". The beginning of the next phase, Templomhegian (biozone "*Microtus arvalidens*", cf. Rabeder 1981) corresponds to the appearance of *M. gregaloides*.

On the basis of the biometrical comparisons our material should be somewhat more progressive than *M. nutiensis* from Monte Peglia (Fig. 12). Consequently it can be referred to the upper part of Nagyharsanyhegy (=Montepeglian of Rabeder 1981). According to Rabeder (1981) this evolutionary stage falls in the interval between Jaramillo paleomagnetic event and the beginning of the Brunhes normal paleomagnetic epoch.

As it was noted above, this small mammal assemblage was believed to be a sample of a "glacial" fauna. Thus, as suggested by the range chart, biometrics, paleoecological interpretation and biozonation presented by Van der Meulen (1973) our assemblage may be correlated with the "cold " climatic episode of the upper part of Monte Peglia (breccia).

Layer 4b. This poor assemblage is considered to represent the same stage of faunal development, on the basis of the presence of *M. hintoni*, indistinguishable from the material of the previous layer.

Layer 4a. The small mammal assemblage from layer 4a consisted of four species only. Nevertheless, a fairly precise correlation was possible due to the replacement of *M. hintoni* by *M. arvalidens*. According to Van der Meulen (1973) this change marks the boundary between "*Allophaiomys* sp. A range zone" and "*Pitymys arvalidens* partial range zone". This corresponds to the lowermost part of the Templomhegian (cf. Rabeder 1981). The paleoenvironmental interpretations presented above show that the biostratigraphical boundary between these phases was also environmentally determined.

In conclusion, the early Pleistocene fossiliferous layer sequence from the Futjova Cave (layer 4 c – 4 a) marks the transition between the two phases of the Upper Biharian – Nagyharsanyhegyian and Templomhegyian (Fig. 14).

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