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Cricetinae and *Murinae* (*Rodentia*) from Bacho Kiro Cave, Bulgaria

[4 text-figs.]

***Cricetinae* i *Murinae* (*Rodentia*) z Jaskini Baczo Kiro, Bułgaria**

Abstract. This paper deals with the metrical variation of molars in *Cricetulus migratorius*, *Cricetus cricetus*, *Mesocricetus newtoni*, *Apodemus sylvaticus*, *Apodemus flavicollis* and *Mus musculus* found in Bacho Kiro Cave. A comparison with subfossil and present-day populations is also carried out.

I. INTRODUCTION

The remains of *Cricetinae* and *Murinae* described in this paper come from Bacho Kiro Cave in Bulgaria (42°56'N, 25°25'E), which was explored by Polish and Bulgarian scientists in 1971—1975. After a series of preliminary reports (DAGNAN-GINTER et al. 1973, GINTER & SIRAKOV 1974, KOZŁOWSKI & SIRAKOV 1975, KOZŁOWSKI 1975) the final results of the investigation were published in the multi-author work "Excavation in the Bacho Kiro Cave, Final Report, 1982". That work contains a complex survey of stratigraphical, sedimentological, palaeozoological and anthropological data and final conclusions drawn from them. For this reason the present paper is confined only to a fairly detailed description of the materials of *Cricetinae* and *Murinae*, the subject only touched on in general in the "Final Report".

II. METHOD

The lengths of tooth-rows (LM^{1-3}, LM_{1-3}) and the lengths (L) and widths (W) of particular molars were measured to an accuracy of 0.01 mm, using a measuring microscope with a cross platform.

The anterior width of *Cricetinae* teeth (Wf) was measured at the protocone-paracone height on upper molars and the protoconid-metaconid height on the lower ones and the posterior width (Wb) at the hypocone-metacone and the hypoconid-entoconid height, respectively.

As regards the teeth of *Murinae*, width measurements (W) were always taken in the widest place.

The length of mandibles (Lmd) was measured from the postero-supero-medial edge of the incisor alveolus to the tip of the condylar process using a slide calliper to an accuracy of 0.1 mm.

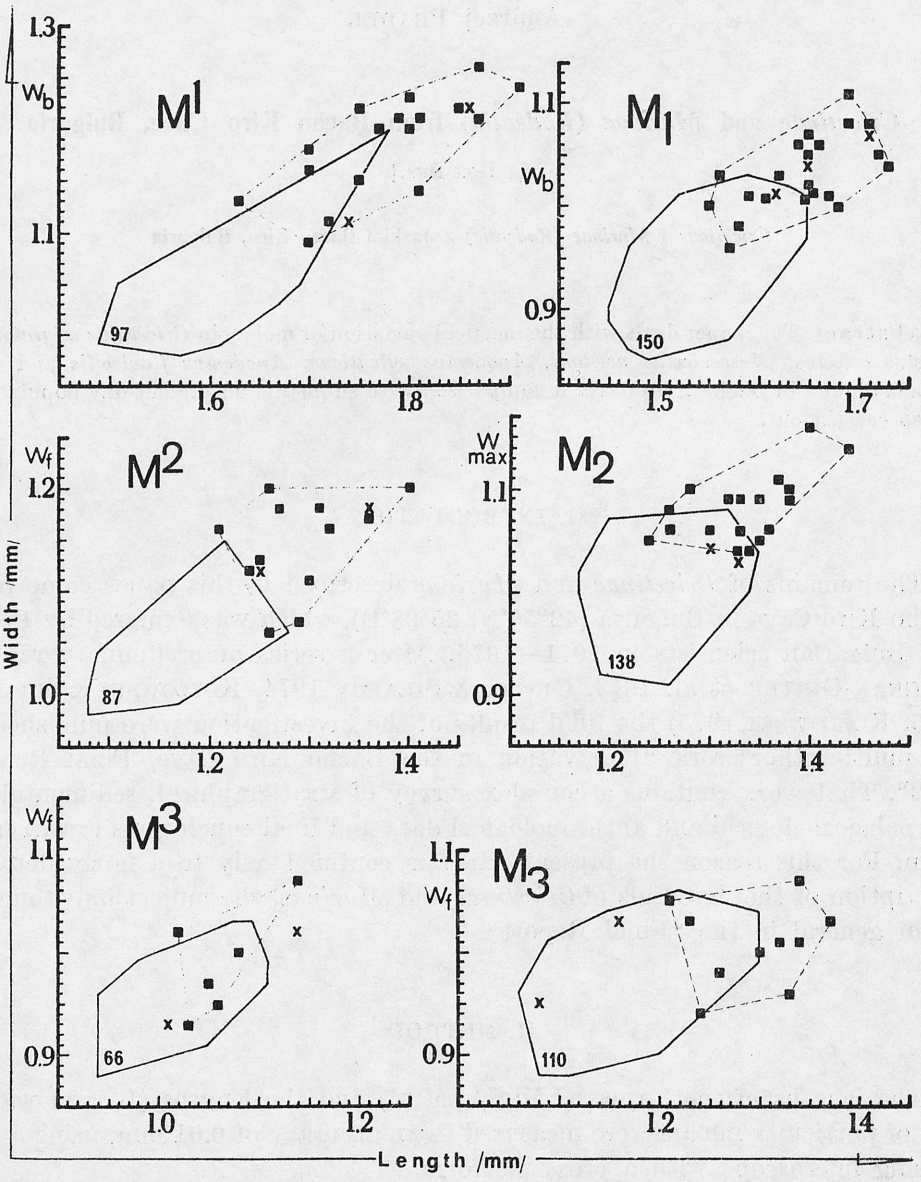

Fig. 1. *Cricetulus migratorius*. L/W diagram of molars. Squares and broken line — specimens from Bacho Kiro Cave. Crosses — specimens from the last glaciation of southern Poland (Author's own data, in press). Solid line — ranges of variation of L/W in present-day C. migratorius from Syria; numbers of specimens given (PRADEL 1981a)

III SYSTEMATIC PART

Family: *Cricetidae* ROCHENBRUNE, 1883
Genus: *Cricetulus* MILNE-EDWARDS, 1867

Cricetulus migratorius PALLAS, 1773

Material: MF/1053/73, 87 teeth altogether: 17 M^1, 13 M^2, 7 M^3, 20M_1, 18M_2, 12 M_3, among them 5 M^{1-3} and 10 M_{1-3}.

Teeth of this species were found in nearly all layers (Table VI), most numerously in layer 12 (N = 36) and at the boundary between layers 12 and 13 (N = 12). The teeth are in a fairly good state of preservation, their morphology being identical with that of the present-day *C. migratorius* from Syria (PRADEL 1981a) only that they are slightly larger. The measurements obtained are

Table I

Critetulus migratorius. Statistical analysis of the measurements of molars and tooth-rows

		M^1	M^2	M^3	M_1	M_2	M_3
L	N	17	13	7	20	18	12
	min-max	1.63—1.91	1.21—1.40	1.02—1.14	1.55—1.73	1.24—1.44	1.21—1.37
	$\bar{x}$	1.778	1.291	1.073	1.644	1.334	1.294
	SD	0.074	0.051	0.047	0.053	0.052	0.050
	V	4.17	3.97	4.36	3.25	3.92	3.88
Wf	N	17	12	6	20	18	10
	min-max	1.03—1.20	1.06—1.20	0.93—1.07	0.83—0.97	1.01—1.16	0.94—1.07
	$\bar{x}$	1.115	1.145	0.990	0.902	1.071	1.008
	SD	0.048	0.047	0.051	0.031	0.039	0.040
	V	4.33	4.12	5.15	3.39	3.69	3.96
Wb	N	17	12		20	18	
	min-max	1.09—1.26	0.95—1.12		0.96—1.11	1.02—1.14	
	$\bar{x}$	1.186	1.063		1.031	1.068	
	SD	0.048	0.048		0.037	0.034	
	V	4.06	4.56		3.63	3.18	

	LM^{1-3}
N	5
min-max	3.83—4.08
$\bar{x}$	3.968
SD	0.097
V	2.45

LM_{1-3}	M_2Wmax
10	18
3.80—4.31	1.04—1.16
4.128	1.082
0.172	0.033
4.17	3.06

presented in Table I and their graphical interpretation in an L/W diagram in Fig. 1.

In size the teeth of *C. migratorius* from Bacho Kiro more resemble the teeth of this species from the last glaciation in Poland than those of the now living

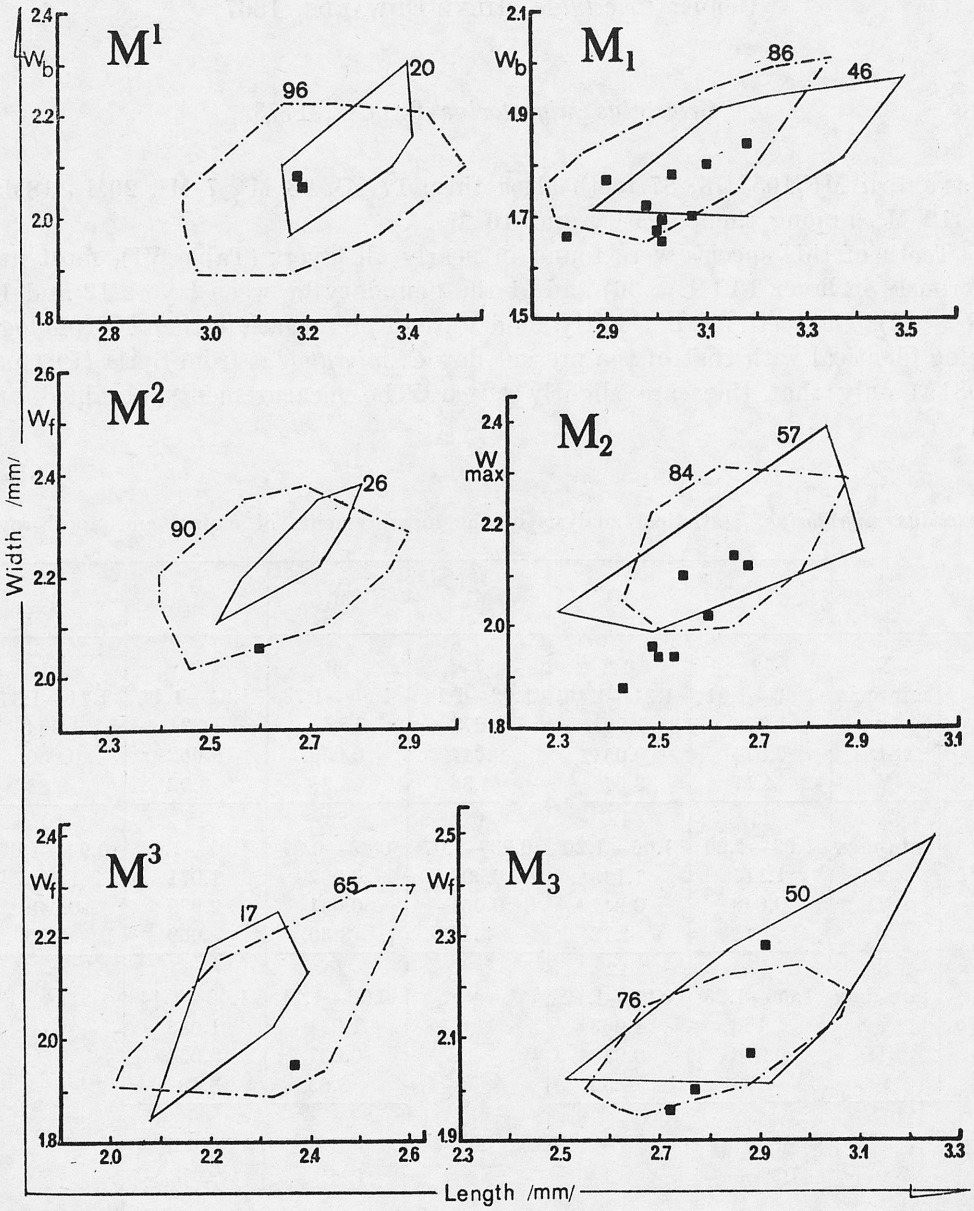

Fig. 2. *Cricetus cricetus*. L/W diagram of molars. Black squares — specimens from Bacho Kiro Cave. Broken line — range of variation found for present-day *C. cricetus* from Poland (Author's own data, in press). Solid line — *C. cricetus* from the last glaciation of southern Poland. The author's data (1981b) supplemented with specimens from 9 other localities (in press). The figures represent the number of specimens

C. migratorius of Syria. They are also equal to the teeth of this species described by STORCH (1974) from Bastam. The measurements of tooth-rows are also accordingly larger.

The hamster *C. migratorius* still occurs in south-eastern Bulgaria nowadays.

Genus *Cricetus* LESKE, 1779
Cricetus cricetus (LINNAEUS, 1758)

Material: MF/1048/73, 27 molars altogether: 2 M^1, 2 M^2, 1 M^3, 10 M_1, 8 M_2, 4 M_3. Two lower tooth-rows, one undamaged mandible.

This scanty material did not occur in all layers and layers 1, 7, 6c and 13 contained only one molar each (Table VI). Morphologically these teeth are identical with the dentition of the hamster of the last glaciation from southern Poland (PRADEL 1981b) and with that of *C. cricetus* living in Poland now. The measurements obtained are given in Table II and their graphical interpretation in an L/W diagram in Fig. 2.

As can be seen from Fig. 2, in respect of measurements the teeth of the hamster from Bacho Kiro Cave correspond closely with those of both populations compared with them, although they seem slightly smaller (especially M_1 and

Table II

Cricetus cricetus, Measurements of dentition and mandible

	L	Wf	Wb		L	Wf	Wb
M^1	3.18	1.98	2.08	M_2	2.65	2.08	2.14
	3.16	1.97	2.09		2.43	1.88	1.87
					2.50	1.94	1.89
M^2	2.60	2.06	1.86		2.55	2.08	2.10
	—	2.27	—		2.68	2.09	2.12
					2.53	1.94	1.93
M^3	2.37	1.95			2.49	1.96	1.96
					2.60	2.02	1.97
M_1	3.01	1.61	1.65	M_3	2.91	2.28	
	3.18	1.78	1.84		2.77	2.00	
	3.10	1.69	1.80		2.88	2.07	
	3.00	1.61	1.67		2.72	1.96	
	3.01	1.61	1.69				
	3.07	1.65	1.70				
	3.03	1.69	1.78	LM_{1-3}	8.58		
	2.82	1.61	1.66		8.07		
	2.98	1.60	1.72				
	2.90	1.66	1.77	Lmd	27.0		

M_2). This small difference may be explained by the fact that the subspecies *C. c. nehringi*, living in Bulgaria till now, is somewhat smaller than the nominative subspecies.

The material of *C. cricetus* is the least abundant of the teeth of *C. migratorius*, *M. newtoni* and *Apodemus* sp. from the same locality. This may be so because it is a bigger, stronger and more aggressive animal and, what follows, it is able to defend itself more successfully. Having other small rodents at choice, owls take it unwillingly and then usually juveniles or weak senile specimens. An analysis of the wear of the tooth crowns in the material under discussion confirms this supposition.

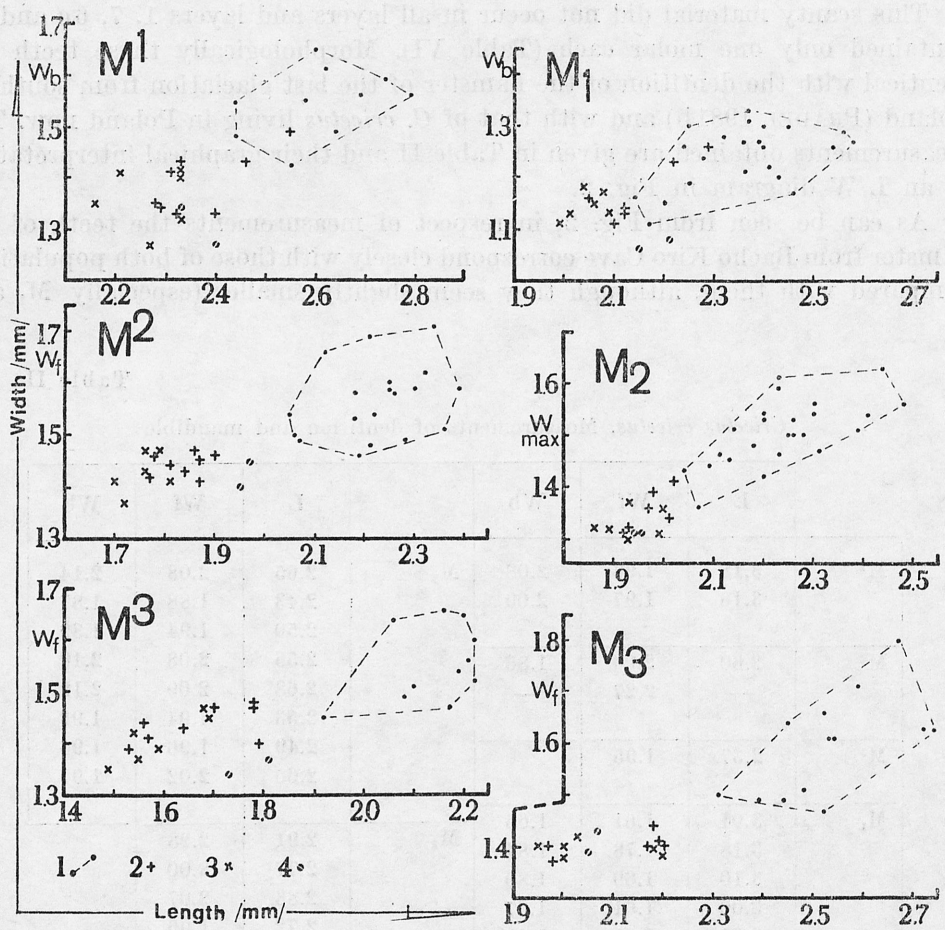

Fig. 3. *Mesocricetus newtoni*. L/W diagram of molars. Points and broken line — specimens from Bacho Kiro Cave. X — *M. auratus* from A. RUPRECHT'S collection, Białowieża. + — *M. auratus* raised in the laboratory of the Jagiellonian University, Collection of the Institute of Systematic and Experimental Zoology, P. A. Scs. o — *M. auratus*, present-day specimen from Bulgaria, Collection of the Inst. of Syst. and Exper. Zoology

Genus *Mesocricetus* NEHRING, 1898
Mesocricetus newtoni (NEHRING, 1898)

Material: MF/1059/73, 100 molars altogether: 10 M^1, 19 M^2, 11 M^3, 22 M_1, 24 M_2, 14 M_3. One mandible, one upper tooth-row and three lower rows.

The results of measurements are given in Table III and their graphical interpretation in an L/W diagram in Fig. 3.

KOWALSKI and NADACHOWSKI (1982) refer this material to *Mesocricetus auratus* (WATERHOUSE, 1839). The teeth of *M. auratus* and *M. newtoni* are almost identical as regards morphology, their measurements are however decidedly different. Figure 3 shows that the molars of *M. newtoni* are considerably larger and that in most cases their ranges of variation do not even overlap. The same is also true of the remaining parameters:

M. newtoni from Bacho Kiro		*M. auratus* ,recent *	
	N	min. — x — max.	N
Lmd 23.0	1	18.8 — 21.2 — 24.6	44
LM^{1-3} 6.32	1	5.26 — 5.54 — 5.92	42
LM_{1-3} 7.04 6.69 6.43	3	5.50 — 5.82 — 6.27	44

* Author's own data obtained from material given in the explanation for Fig. 3.

And so the material discussed must decidedly be ascribed to *M. newtoni*, which still appears in Bulgaria today.

Family *Muridae* GRAY, 1821
Genus *Apodemus* KAUP, 1829
Subgenus *Sylvaemus* OGNEV et VOROBEV, 1923

Apodemus sylvaticus LINNAEUS, 1758 and
Apodemus flavicollis MELCHIOR, 1834

Material: MF/1046/73, MF/1054/73, 78 teeth altogether, for the most part set in bone fragments, 2 or 3 teeth in each. 8 M^1, 4 M^2, 4 M^3, 37 M_1, 22 M_2, 3 M_3.

These species are treated here both together, because there is no morphological character in the dentition differentiating these two species from each other and the ranges of variation of L/W of their molars overlap to a considerable extent.

The remains were present in nearly all layers of the profile but they were distributed irregularly (Table VI).

KOWALSKI and NADACHOWSKI (1982) identify all the specimens found in

Table III

Mesocricetus newtoni. Statistical analysis of the measurements of dentition

		M^1	M^2	M^3	M_1	M_2	M_3
L	N	10	19	11	22	24	14
	min-max	2.44—2.79	2.05—2.39	1.92—2.22	2.14—2.58	2.04—2.48	2.31—2.74
	$\bar{x}$	2.609	2.224	2.139	2.360	2.239	2.534
	SD	0.115	0.099	0.092	0.121	0.115	0.121
	V	4.41	4.46	4.31	5.13	5.12	4.78
Wf	N	10	19	11	22	24	13
	min-max	1.39—1.60	1.46—1.71	1.45—1.66	1.00—1.20	1.35—1.58	1.47—1.80
	$\bar{x}$	1.511	1.566	1.554	1.110	1.458	1.596
	SD	0.063	0.071	0.074	0.049	0.065	0.099
	V	4.18	4.55	4.78	4.43	4.48	6.22
Wb	N	9	19		22	24	
	min-max	1.42—1.65	1.29—1.52		1.11—1.37	1.34—1.59	
	$\bar{x}$	1.553	1.431		1.243	1.502	
	SD	0.067	0.068		0.059	0.065	
	V	4.31	4.78		4.75	4.35	

	LM^{1-3}	LM_{1-3}	M^2Wmax	Lmd
N	1	3	24	1
min-max			1.36—1.59	
$\bar{x}$	6.32	7.04	1.505	23.0
SD		6.69	0.063	
V		6.43	4.20	

layer 1 (MF/1054/73) as *Apodemus* cf. *flavicollis* — in the L/W diagram these specimens are marked with the letter A — and the remaining ones (MF/1046/73) as *A. sylvaticus*, suggesting at the same time that a fauna exchange took place here: *A. sylvaticus*, occurring in the Pleistocene, was replaced by *A. flavicollis* in the Holocene. However, the specimens from layer 1 do not differ morphologically from the teeth from the other layers and for the most part are equal to them in dimensions, as well. Only one tooth from layer 1, detached M_1 ($1.96 \times \times 1.09$), is much larger. Out of the remaining teeth, 5 specimens are somewhat larger and it is in some measure probable that these teeth belong to *A. flavicollis*. They are: detached M_1 from layer 5 (1.85×1.15), M_{1-2} (1.96×1.16, 1.32×1.14) from layer 11 and M_{2-3} ($1.26 \times 1.14 \times 1.14$, 1.03×0.99) from layer 13 h. In the L/W diagram (Fig. 4) these teeth are marked with the latter B. In the diagram the dimensions of the teeth from Bacho Kiro Cave are compared with those of the subfossil molars of *A. sylvaticus*+*A. flavicollis* from Dużej Sowy Cave. The points representing the size of the teeth from Bacho Kiro Cave are situated

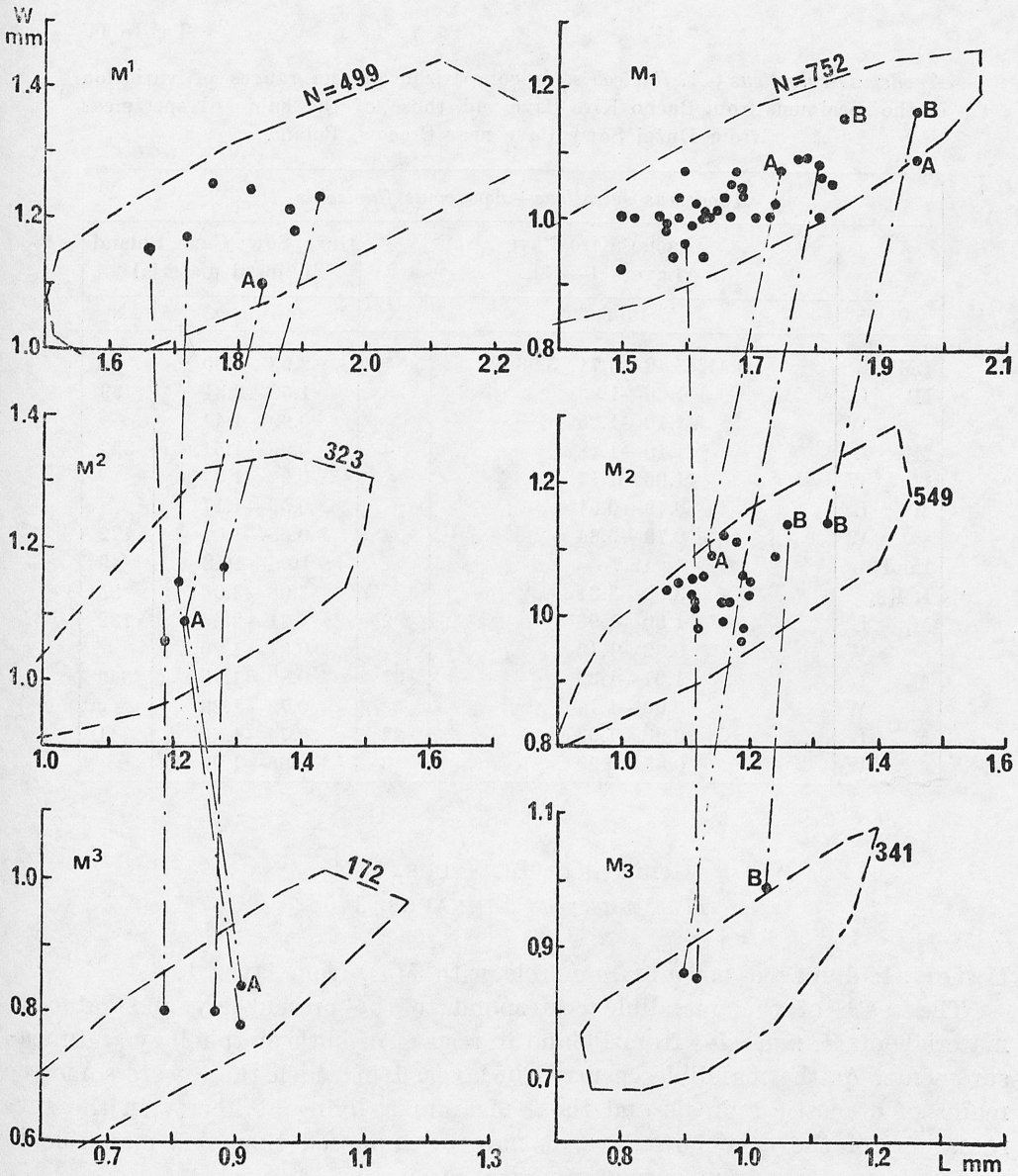

Fig. 4. *Apodemus sylvaticus*+*A. flavicollis*. L/W diagram of molars. Points — specimens from Bacho Kiro Cave. Broken lines with given numbers — specimens from Dużej Sowy Cave, near Cracow; subfossil material. A— specimens described as *A.* cf. *flavicollis* by Kowalski and Nadachowski (1982). B — presumable *A. flavicollis*

right in the middle of the ranges of variation of L : W for the measurements of the molars from Dużej Sowy Cave and, what is more important, show no tendency to group in their lower or upper regions. The explicit division of this material and its assignment to a definite species is impossible.

Table IV

Apodemus sylvaticus+*A. flavicollis*. A. comparison of the ranges of variation of the specimens from Bacho Kiro Cave and those of the subfossil specimens from Dużej Sowy Cave near Cracow, Poland

Apodemus sylvaticus+*Apodemus flavicollis*					
		Bacho Kiro Cave Layers 1—13h.		Dużej Sowy Cave, Poland Subfossil material	
		min-max	N	min-max	N
LM^{1-3}		3.41, 3.42—3.71, 3.96	4	2.93—4.30	88
M^1	L	1.66—1.93	8	1.50—2.31	499
	W	1.10—1.25		0.99—1.44	
M^2	L	1.19—1.28	4	0.95—1.51	323
	W	1.06—1.17		0.90—1.34	
M^3	L	0.79—0.91		0.56—1.17	
	W	0.78—0.84	4	0.58—1.01	172
Lmd		12.7	1	10.5—16.2	49
LM_{1-3}		3.60—3.81		3.08—3.96	55
M_1	L	1.50—1.96	2	1.31—2.06	752
	W	0.92—1.16		0.81—1.26	
M_2	L	1.07—1.32	37	0.89—1.45	549
	W	0.96—1.14		0.79—1.29	
M_3	L	0.90—1.03	22	0.74—1.20	341
	W	0.85—0.99	3	0.68—1.08	

Genus *Mus* Linnaeus, 1758
Mus musculus Linnaeus, 1758

Material: damaged body of mandible with M_{1-2} from layer 1.

The teeth of this mandible correspond to the present-day and subfossil materials of *M. musculus* from Poland in respect of both morphology and measurements. As the mandible occurred in layer, 1 in which there were some remains of domestic animals and those of animals living at liberty in the surroundings of the cave nowadays, it may be supposed that this mandible is subfossil or comes from a contemporary specimen.

IV. CONCLUSIONS

The material described in this paper, irrespective of the time of its origin, is very uniform inside species. The tooth crowns show no additional or atypical characters and the differences observed lie within the range of individual variation of the given species.

Neither are there any major metrical changes, the dispersion of the points in the successive L/W diagram being small and the coefficients of variation

(V) calculated for the species, wherever it was justified, having values usually characteristic of uniform populations. Small differences that have been found may illustrate inter-population variation or, at the most, be connected with subspecies.

This very morphological and metrical uniformity within each species is surprising in the material which is known to come from a fairly long period (about 50 000 years, Table VI), and so from diferent climatic phases. I rather

Table V

Mus musculus. A comparison of the measurements of the tooth-row from Bacho Kiro Cave with those of the subfossil specimens from Dużej Sowy Cave near Cracow, Poland

	Mus musculus			
	Bacho Kiro Cave Layer 1.	Dużej Sowy Cave Poland Subfossil material		
		min—x—max		N
LM_{1-3}	2.96	2.81—2.92—3.03		17
LM_{1-2}	2.36	2.21—2.39—2.56		75
M_1 L	1.44	1.35—1.47—1.69		103
W	0.91	0.73—0.85—0.98		
M_2 L	1.00	0.88—0.97—1.12		84
W	0.88	0.80—0.86—0.94		
M_3 L	0.57	0.52—0.59—0.64		20
W	0.55	0.55—0.58—0.63		

think that the cause of this uniformity is both the fact that the effect of the last glaciation was smaller in the territory of Bulgaria than in northern and central Europe as far as the line of the Alps and Carpathians (Balkan refuge) and the derivation of these remains from a mountainous area. Migrations of animals following the shifting zones of vegetation were made over a distance of hundreds of metres and not hundreds of kilometres.

Data concerning very various populations were used as comparative material in this paper. This material is not the best but I had only such data at my disposal. All the species discussed here have survived in Bulgaria till the present time and it would be expedient to compare these fossil remains from Bacho Kiro Cave with the present-day specimens.

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Table VI

Numbers of molars in successive layers of Bacho Kiro Cave. In one case this was a toothless mandible (md). Radiocarbon dating after Mook (1982)

Radiocarbon Dating	Species / Layers	*C. migratorius*	*C. cricetus*	*M. newtoni*	*A. sylvaticus* *A. flavicollis*	*M. musculus*
	1	1	1	1	6	3
	2	2	—	1	2	—
	3	—	—	1	1	—
	4	2	—	3	—	—
	3a	—	—	1	—	—
	5	—	—	1	2	—
	4a	3	—	5	—	—
	4b	2	—	1	2	—
29 150±950 ———	6a	10	—	14	5	—
	7	—	1	—	3	—
32 700±300 ———	6b	1	—	3	—	—
	8	2	—	3	—	—
	6c	5	1	4	—	—
	9	—	—	—	md	—
	10	—	—	—	—	—
< 43 000 ———	11	6	4	10	2	—
	11a	2	7	4	7	—
	12	48	12	33	31	—
47 500 ———	13	3	1	9	4	—
	13h	—	—	6	13	—
	14	—	—	—	—	—

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STRESZCZENIE

W pracy opisano zmienność metryczną trzonowców *Cricetulus migratorius*, *Cricetus cricetus*, *Mesocricetus newtoni*, *Apodemus sylvaticus*, *Apodemus flavicollis* i *Mus musculus* z Jaskini Bacho Kiro w Bułgarii i przeprowadzono porównanie z populacjami subfosylnymi lub współczesnymi wymienionych gatunków.

Redaktor pracy: dr Adam Nadachowski