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Boris KRYŠTUFEK:

European Sousliks (*Spermophilus citellus;* Rodentia, Mammalia) of Macedonia

Tekunica (*Spermophilus citellus;* Rodentia, Mammalia) v Makedoniji

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European Sousliks (*Spermophilus citellus;* Rodentia, Mammalia) of Macedonia

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ABSTRACT - Two subspecies of ground squirrels are known from Macedonia, living in strikingly different habitats. *Spermophilus citellus gradojevici* is linked to the lowlands along the River Vardar, south of Demir Kapija, while *S. c. karamani* populates mountain pastures in the Jakupica and Karadjica Mountains. Spot distribution maps with identifying numbers, and a list of diagnostic characters are presented for each subspecies. *Spermophilus citellus gradojevici* and *S. c. karamani* differ in terms of size, skull shape, their nasals and foramina incisiva, and in tail coloration.

Key words: *Spermophilus citellus,* Macedonia, taxonomy, distribution

POVZETEK - TEKUNICA (*SPERMOPHILUS CITELLUS;* RODENTIA, MAMMALIA) V MAKEDONIJI - Na ozemlju Makedonije živita dve podvrsti tekunic na povsem različnih habitatih. *Spermophilus citellus gradojevici* živi v nižavju vzdolž Vardarja, južno od Demir Kapije, *S. c. karamani* pa na planinskih pašnikih Jakupice in Karadžice. Za obe podvrsti sta bili izdelani arealni karti in seznam morfoloških znakov, ki omogoča njuno prepoznavanje. *Spermophilus citellus gradojevici* se razlikuje od *S. c. karamani* po velikosti, obliki lobanje, obliki nosnih kosti in nebne špranje ter barvi repa.

Ključne besede: *Spermophilus citellus,* Makedonija, sistematika, razširjenost

1. Introduction

Since 1921, when the European souslik was reported from Macedonia for the first time (DOFLEIN 1921), it has continued to attract the attention of researchers from different points of view: taxonomy, zoogeography, ecology, and plant protection. Consequently, a considerable amount of information has accumulated on this species in comparison with the other rodents living in Macedonia. The aim of the present article is to review the distributional and taxonomic status of the European souslik or European ground squirrel in Macedonia.

2. Material and Methods

A list of specimens is given in the Appendix. In the majority of cases both skins and skulls were available. External measurements were recorded from the specimen labels. Their abbreviations are: HB - head and body length, TL - tail length, HF - hind foot length, E - ear length, and W - weight.

Ten linear measurements were taken from each of the skulls using a vernier calliper, accurate to the nearest 0.1 mm. The abbreviations used are; CbL - condylobasal length, DiL - diastema length, MxT - maxillary tooth row length, NaL - nasal length, ZgB - zygomatic breadth, BcB - braincase breadth, IoC - interorbital constriction, PoC - postorbital constriction, MdL - mandible length, MdL - mandibular tooth row length (Fig. 1).

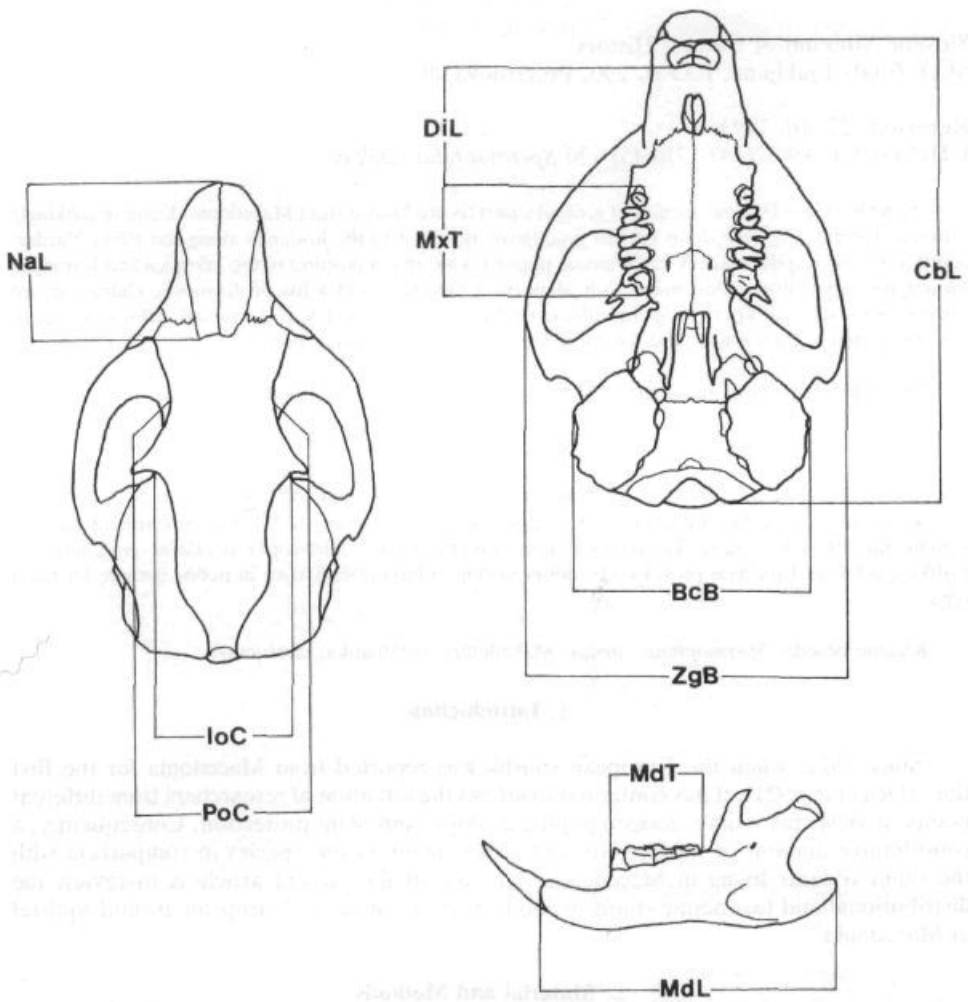

Fig. 1. Cranial and mandibular measurements of *Spermophilus citellus* used in this study. See text for abbreviations.

Sl. 1. Dimnezije lobanje in spodnje čeljustnice, ki so bile merjene pri *Spermophilus citellus*.

Variations in mensural characters among geographic samples and sexes were analysed by using the standard and multivariate analyses. Standard statistical tests (mean and standard deviation) were applied in all comparisons involving a single character. Only adults, i.e. specimens that had hibernated at least once, were incorporated into statistical tests. For simultaneus estimation of phenetic differentiation between sexes and populations, the raw skull measurements were subjected to discriminant function analysis. Sexual dimorphism was studied according to subspecies. The data were z-standardized and subjected to Principal Components Analysis. This kind of analysis reduces the number of variables that need to be considered to a small number of principal components; these represent linear combinations of the original measurements (MANLEY 1986).

3. Results and Discussion

3.1. Distribution

Two isolated souslik populations are known from Macedonia, living in strikingly different habitats. One population is linked to the mountain pastures of the Jakupica and

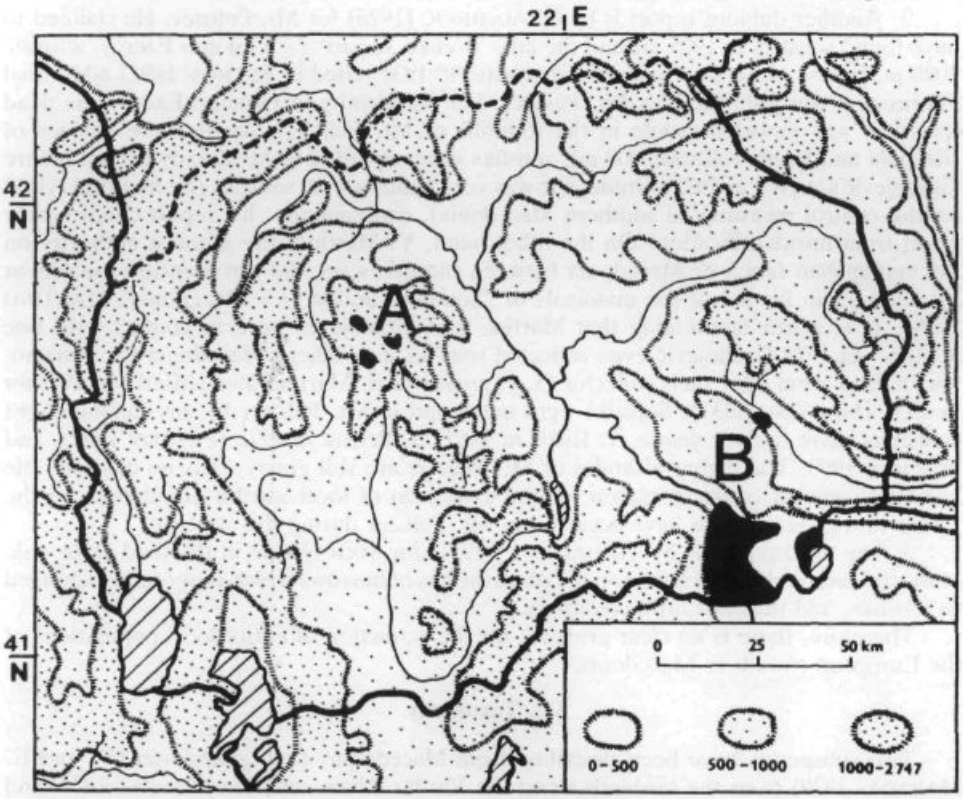

Fig. 2. Present distribution (black) of mountain (A) and lowland (B) populations of the European souslik *Spermophilus citellus* in Macedonia. See Figs. 16 and 21 for details.

Sl. 2. Razširjenost (črno) planinske (A) in nižinske (B) populacije tekunice, *Spermophilus citellus*, v Makedoniji. Za podrobnosti glej sliki 16 in 21.

Karadžica Mountains, at altitudes from 2000 to 2200 m. Another population inhabits the lowlands along the River Vardar south of Demir Kapija, from which its area extends further south into northern Greece (Fig. 2). Distributional details are discussed for the individual subspecies.

Further three regions have been reported in the literaure to be populated by sousliks. As none of these reports have been confirmed by subsequent field studies, they have been largely ignored (RUŽIĆ 1967, 1978). Recently PETROV (1992) considered these to represent historical records of the places where sousliks had become extinct, providing a reason for reviewing them here.

1. DOFLEIN (1921), who worked in Macedonia during World War I, mentioned sousliks in Üsküb (= Skopje). Approximately 15 years after Doflein's stay in Macedonia, KARAMAN (1931) wrote that sousliks did not live in the Skopje Basin, despite an abundance of suitable habitats there. Karaman, who went to Skopje in 1924, was closely familiar with the Macedonian fauna, and also knew sousliks from the Karaťžica-Jakupica Mts. Consequently, it is highly unlikely that sousliks, if present around Skopje, would have escaped his attention. Since Doflein's reports are generally reliable, this one most probably results from a mistake.

2. Another dubious report is by GRADOJEVIĆ (1928) for Mt. Pelister. He claimed to have found sousliks in 1925 around the lake "Veliko Jezero" (= Golemo Ezero), altitude 2000 m. In one of his later papers (GRADOJEVIĆ 1931; cited in PETROV 1992) additional information was published for Mt. Pelister. For the vicinity of Golemo Ezero, one dead specimen was reported, while in the foothills of Mt. Pelister, between the villages of Nižepole and Bačila (altitude 900 m), sousliks were supposed to be already extinct before Gradojević's survey in 1925. Gradojević was very familiar with sousliks (he had supervised souslik control measures in southern Macedonia), consequently, his report could hardly result from misidentification. On the other hand, V. Martino, the greatest authority on the mammalian fauna of Macedonia between the two wars, did not mention sousliks at Mt. Pelister in his list of the mammals of "Southern Serbia" (= Macedonia; MARTINO 1939). It is worth mentioning that Martino and Gradojević were in contact with one another. In 1928 Gradojević even collected sousliks in southern Macedonia for Martino, who named them after their collector (*S. c. gradojevici*). Martino also visited Mt. Pelister in 1937 (MARTINO 1937). Sousliks were not found in Mt. Pelister by any mammalogist collecting there in later years: A. Ružić in 1967, B. Petrov in 1972 (PETROV 1992), and myself in 1990. The higher altitudes of Mt. Pelister are still grassy, thus no considerable habitat change (a common reason for the extinction of local souslik populations in the recent times), is likely to have occurred in Mt. Pelister during this century.

3. The third report is by TROJANOVIĆ (1931) for Sveti Nikole in the field Ovče pole (eastern Macedonia). It is based on the observations of burrows which supposedly belonged to sousliks, and thus has little credibility.

Therefore, there is no clear evidence for the extinction of entire local populations of the European souslik in Macedonia.

3.2. **Taxonomy**

Two subspecies have been described from Macedonia: *S. c. gradojevici* (V. and E. MARTINO 1929) from the lowlands along the Vardar River, and *S. c. karamani* (V. and E. MARTINO 1940) for Mt. Karadžica. *S. c. gradojevici* was described on the basis of its large and robust skull (CbL 43 - 46 mm, average 44.5 mm; ZgB 29.5 - 32 mm, average 30.4 mm) and a more yellow, uniform colour. In the original description, *S. c. karamani* was compared only with the nominate race. Its diagnostic characters were as follows:

larger zygomatic breadth, broader braincase, weaker molars, and relatively shorter lower toothrow. V. and E. MARTINO (1940) also prepared a key for the determination of the four races of the European souslik. The dichotomy of *gradojevici* versus the other three races (the nominate one and also *karamani* and *laskarevi* were consided) concerned colour (back, belly and tail) and size. *S. c. gradojevici* was larger than any other race. MARTINO (1939) explains size differences between lowland and mountain subspecies of the Macedonian sousliks by "Hinton's rule", according to which size is greater in animals from regions with a longer vegetation period. Such an explanation is consistent with the hypothesis that body size follows the duration of the annual pulse of productivity, and predicts small body sizes at higher altitudes (GEIST 1987).

MIRIĆ (1970) discriminates the two Macedonian subspecies by the size only; HF is said to permit clear distinction (above of 38.5 mm in *gradojevici* and below 37.5 mm in *karamani*). RUŽIĆ (1978) confirmes the validity of both taxa, but provides very few diagnostic characters. *S. c. gradojevići* was diagnosed as a large race with a pale pelage. Similar conclusions were made by PETROV (1992).

Karyotype was found to be quite stable amongst the six *S. citellus* subspecies from south-eastern Europe, being characterized by a diploid number of 2n = 40, and fundamental number NF = 80 (SOLDATOVIĆ et al. 1984). The only interpopulation differences involve the position of the centromere on the X and Y chromosomes. In both Macedonian races, the X chromosome is submetacentric with a submedial centromere, and the Y chromosome is the smallest submetacentric (SAVIĆ et al. 1971). On the basis of the frequency of occurrence of 21 discrete nonmetric cranial traits, I (KRYŠTUFEK 1990) give a high value of Mean Measure of Divergence index (MMD) between the two Macedonian races, in marked contrast to the low MMD's of between Pannonian populations. As suggested by MMD, divergence between the two of the Macedonian races was of approximately the same duration as was their isolation from Pannonian populations.

As a first step in morphometric analysis, the two races were subjected to discriminant analysis. The results were in accordance with the geographic origin of the samples (Fig. 3) and both races were classified into their actual groups (Table 1). In *S.c. gradojevici*, 81 % of specimens were allocated to the actual sex, and 83 % in *S.c. karamani*. The two

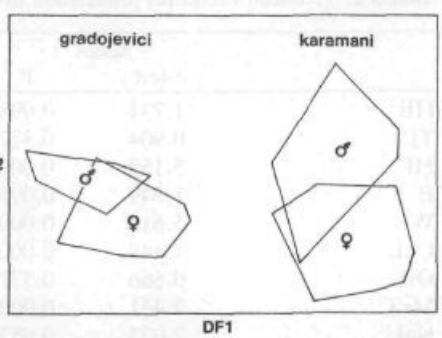

Fig. 3. Projection of male and female sousliks of *S. c. gradojevici* and *S. c. karamani* on the first two discriminant functions. Polygons enclose scores for all individuals within a group, and symbols for sex are placed on group centroids.

Sl. 3. Projekcija samcev in samic tekunic *S. c. gradojevici* in *S. c. karamani* na prvi dve diskriminacijski funkciji. Poligoni obkrožajo vse osebke v skupini. Simboli za spol so na skupinskih centroidih.

races were discriminated by the first discriminant function, which was responsible for 86.6 % of the variance in the original data set. The sexes were discriminated by discriminant function 2, which explained 12.1 % of the variance. In both races, males had higher scores for discriminant function 2. It was evident that phenetic distances between subspecies strongly exceeded sexual dimorphism within the subspecies, consequently, the recognition of the two subspecies has reasonable grounds.

Table 1. Classification table for discriminant analysis of male and female sousliks of *S. c. gradojevici* and *S. c. karamani*. Rows are actual groups and columns are predicted groups.

Tabela 1. Klasifikacijska tabela za diskriminacijsko analizo samcev in samic dveh podvrst tekunic iz Makedonije. Vrstice so dejanske, stolopci pa napovedane skupine.

Number	Group	n	1	2	3	4
1	*gradojevici* males	6	5	1		
2	*gradojevici* females	15	3	12		
3	*karamani* males	15			14	1
4	*karamani* females	21			2	19

In the next step I tried to extract morphometric characters that permit simple and faithful discrimination between the two subspecies. Arithmetic means of 8 measurements (W, HF, and six cranial dimensions) differ significantly between subspecies in both sexes (Table 2). Eight characters showed significant differences in males, and 10 in females. T-tests were highly significant ($p<0.001$) for the majority of these variables, i.e. six in males and eight in females. In both sexes, t-test values were highest for mandible measurements (MdT in males; MdT and MdL in females). Among external characters, weight and hind foot length were found to provide the best discrimination between the two subspecies. Only the weight of spring animals before parturition (*gradojevici, karamani*) or just after it (*gradojevici*) was available to me. Consequently, the weights of the two races were comparable. Hind foot length, although a useful diagnostic character, did not prove to segregate all specimens of *gradojevici* from all *karamani*, as suggested by MIRIĆ (1970). Three cranial dimensions (MxT, MdL, MdT) showed the least overlap between the two subspecies.

Table 2. Estimated t-statistics with probabilities (p) for intersubspecific differences in sousliks from Macedonia. Sexes are treated separately.
n.s. - not significant; * $p<0.05$; ** $p<0.01$; *** $p<0.005$; *** $p<0.001$.

Tabela 2. Vrednosti t-testa pri primerjanju dveh podvrst tekunic iz Makedonije. Spola sta ločena.

	Males			Females		
	t-test	P		t-test	P	
HB	1.734	0.098	n.s.	3.743	0.007	**
TL	0.904	0.377	n.s.	1.999	0.054	n.s.
HF	5.159	0.000	****	8.081	0.000	****
E	1.749	0.095	n.s.	1.466	0.156	n.s.
W	5.610	0.000	****	7.586	0.000	****
CbL	4.448	0.000	****	5.403	0.000	****
DiL	0.566	0.577	n.s.	0.437	0.665	n.s.
MxT	7.431	0.000	****	8.661	0.000	****
NaL	2.033	0.053	n.s.	1.234	0.225	n.s.
ZgB	3.399	0.003	***	4.831	0.000	****
BcB	1.741	0.960	n.s.	3.658	0.000	****
IoC	2.118	0.045	*	2.850	0.007	**
PoC	0.540	0.594	n.s.	0.910	0.369	n.s.
MdL	6.629	0.000	****	10.941	0.000	****
MdT	10.539	0.000	****	9.463	0.000	****

Better results for the means of discrimination between *gradojevici* and *karamani* were obtained by bivariate plots of selected variables (Figs. 4-9), particularly by plotting IoC against MdT (Fig. 9) and MdT against MxT (Fig. 7).

Colour was frequently used to distinguish subspecies of European sousliks, summer pelage mainly being used for taxonomic purposes. In early spring, just after hibernation and when they appear on the surface, sousliks are of different colors /see PETROV (1940) for *gradojevici*, and Plate I for *karamani*/.

The summer colour of the upperparts was described as "more yellow and uniform" with "the speckles nearly absent" in *gradojevici* and as "more greyish or brownish, with

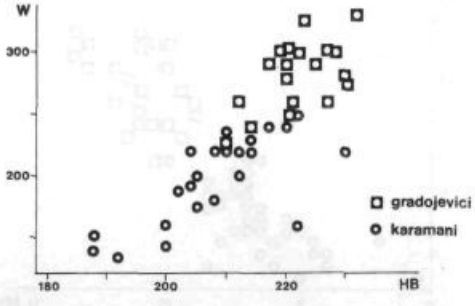

Fig. 4. Bivariate scatter plot of weight against head and body length for *Spermophilus citellus gradojevici* (squares) and *S. c. karamani* (circles) from Macedonia.

Sl. 4. Teža kot funkcija telesne dolžine pri tekunici *Spermophilus citellus gradojevici* (kvadrati) in *S. c. karamani* (krogi) iz Makedonije.

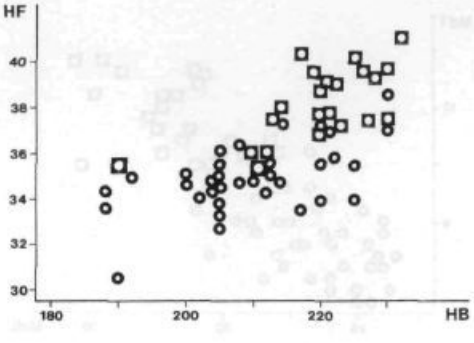

Fig. 5. Bivariate scatter plot of hind foot length against head and body length for *S. c. gradojevici* and *S. c. karamani* from Macedonia. Explanation as for Fig. 4.

Sl. 5. Dolžina stopala kot funkcija dolžine telesa pri *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Simboli kot na sliki 4.

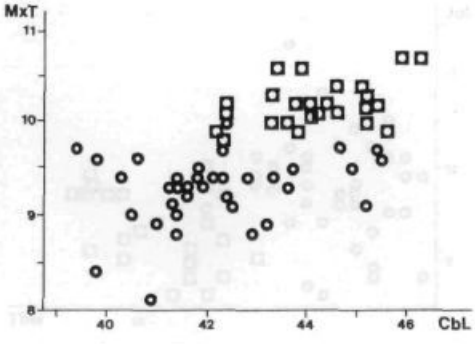

Fig. 6. Bivariate scatter plot of maxillary tooth row length against condylobasal length of skull for *S. c. gradojevici* and *S. c. karamani* from Macedonia. Explanation as for Fig. 4.

Sl. 6. Dolžina gornjega niza zob kot funkcija kondilobazalne dolžine lobanje pri tekunici *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Simboli kot na sliki 4.

lighter cinnamon-pinkish buff speckles" in *karamani* (MARTINO V. & E. 1940). Yellowish summer coat was also taken to be a diagnostic character of *gradojevici* by RUŽIĆ (1978) and PETROV (1992). The underparts are reported by MARTINO V. & E. (1940) to be buff-yellow in *gradojevici* and cream-buff or buff-whitish in *karamani*. According to MIRIĆ (1970), *karamani* has the same coloration of the belly as *gradojevici*, i.e. pale buff-yellow. As regards the tail, MARTINO V. & E. (1940) describe a "dark subterminal band on the tail hair-pencil" to be "scarcely developed, usually light brownish" in *gradojevici* and "clearly developed, blackish" in *karamani*. The subsequent authors did not mention this character.

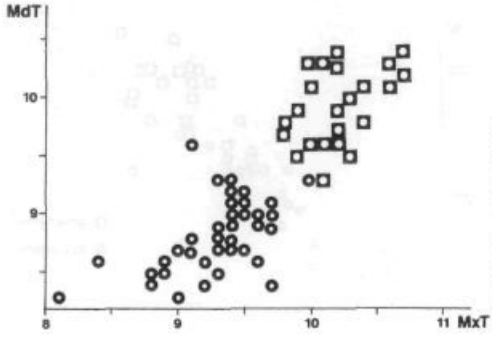

Fig. 7. Bivariate scatter plot of mandibular tooth row length against maxillary tooth row length for *S. c. gradojevici* and *S. c. karamani* from Macedonia. Explanation as for Fig. 4.

Sl. 7. Dolžina gornjega niza zob kot funkcija spodnjega niza zob pri tekunici *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Simboli kot na sliki 4.

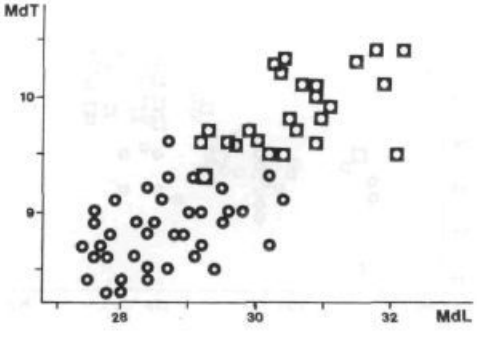

Fig. 8. Bivariate plot of mandibular tooth row length against mandible length in *S. c. gradojevici* and *S. c. karamani* from Macedonia. Explanation as for Fig. 4.

Sl. 8. Dolžina spodnjega niza zob kot funkcija dolžine spodnje čeljustnice pri tekunici *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Simboli kot na sliki 4.

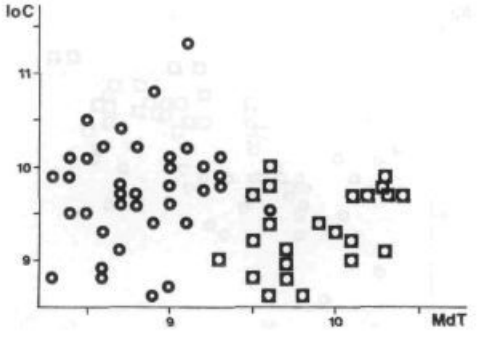

Fig. 9. Bivariate plot of interorbital constriction against mandibular tooth row length for *S. c. gradojevici* and *S. c. karamani* from Macedonia. Explanation as for Fig. 4.

Sl. 9. Medočnična širina lobanje kot funkcija dolžine spodnje čeljustnice pri tekunici *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Simboli kot na sliki 4.

In a simultaneous comparison of 20 adult summer pelts of *gradojevici* with 5 adult summer pelts of *karamani*, I failed to find any differences between the two. Not only did the palest specimen belong to *gradojevici*, but so did the darkest one. A single paratype of *gradojevici* from Martino's collection (PMS 6029) was amongst the palest sousliks from Macedonia, and the only adult with a buff belly. In the other adults of both subspecies the belly was either yellowish or yellowish white. A buff belly was observed also in seven subadults of *gradojevici*, all collected in July. As regards colour, I agree with MIRIĆ (1970) that there are no significant differences between *karamani* and *gradojevici*.

The tail, particularly on its ventral side, is paler and more yellow in *gradojevici*. Also, the subterminal band was usually present in *karamani* but missing in *gradojevici*, as stated by MARTINO V. & E. (1940). This character is best seen from the ventral side.

MARTINO V. & E. (1940) also mentioned two ratios in which *karamani* is said to differ from Pannonian sousliks:

Ratio 1 = CbL : ZyB
Ratio 2 = CbL : MdT

The mandibular tooth row is said to be relatively shorter in *karamani* (higher values of Ratio 2). In all 26 adults of *gradojevici* Ratio 2 was below 4.7, whilst one quarter (= 25 %) of 36 adults of *karamani* had Ratio 2 equal to 4.7 or lower. In this character *S. c. karamani* appears to be more variable than *gradojevici*. Scores for Ratio 1 broadly overlap between the two subspecies. *S. c. karamani* is also more variable in this respect (Fig. 10).

MARTINO V. E. (1940) describe the lower border of the zygomatic arch of *karamani* as usually without a convex lobe. In the specimens available to me, the zygomatic arch is frequently thinner and with a straight ventral margin in *karamani*, and heavier with a convex margin in *gradojevici*, but the overlap between the two extremes is considerable (Fig. 11).

When comparing *karamani* with the nominate subspecies of *S. citellus*, MARTINO V. & E. (1940) note that the "furrows on the surface of the upper molars /were/ longer, occupying larger part of a transverse diameter of the tooth" in the former. This character is strongly affected by tooth wear, i.e. the furrows become shallower as wear advances. Consequently, I compared only specimens with unworn or moderately worn teeth. The furrows of the first and second upper molars appear to be deep in the majority of specimens of both subspecies (Table 3). In this particular point I was unable to distinguish *karamani* from the Pannonian sousliks. The few skulls from eastern Serbia that I examined also had deep furrows.

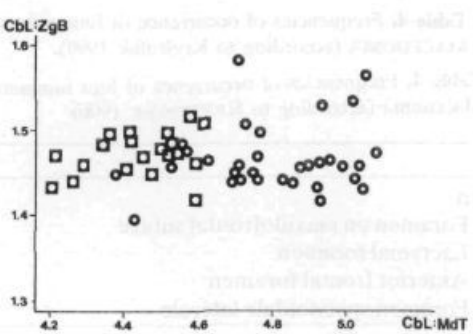

Fig. 10. Bivariate plot of two ratios for *S. c. gradojevici* and *S. c. karamani* from Macedonia. See text for further explanation. Symbols as for Fig. 4.

Sl. 10. Odnos med dvema indeksoma pri tekunici *S. c. gradojevici* in *S. c. karamani* iz Makedonije. Razlaga je v besedilu. Simboli kot na sliki 4.

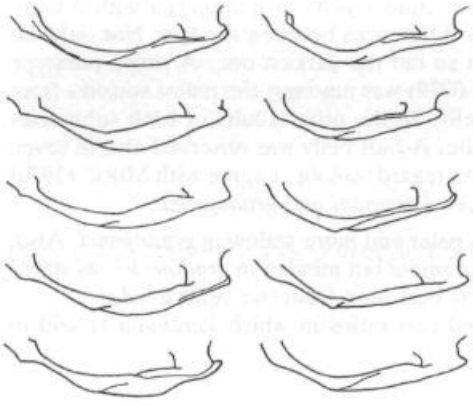

Fig. 11. Shape of left zygomatic arch in *S. c. gradojevici* (left) and *S. c. karamani* (right). Anterior is to the left. PMS numbers. Left column: 7055, 6108, 7058, 7053, 6111. Right column: 7090, 7089, 7092, 7074, 7095.

Sl. 11. Oblika levega ličnega loka pri tekunici *S. c. gradojevici* (levo) in *S. c. karamani* (desno). Anteriorna stran je levo.

Table 3. Occurrence of the two morphotypes, based on the development of the furrows on M^1 and M^2 in the two subspecies of sousliks from Macedonia. Furrow deep: deeper than one half of the transverse diameter of the molar; furrow shallow: shallower than one half of the transverse diameter of the molar.

Tabela 3. Pojavljanje dveh morfotipov glede na globino zajede na površini M^1 in M^2 pri dveh podvrstah tekunic iz Makedonije.

	S.c. gradojevici M^1/M^2	*S.c. karamani* M^1/M^2
Furrow deep	22/21	19/19
Furrow shallow	2/2	4/5

Among 25 nonmetric (epigenetic) cranial characters listed by me (KRYŠTUFEK 1990) from five souslik populations from Serbia and Macedonia, the foramen on the maxillofrontal suture was found only in *S. c. karamani*. Three other epigenetic characters also indicate divergence between *gradojevici* and *karamani* (Table 4).

Table 4. Frequencies of occurrence of four nonmetric cranial traits in two subspecies of sousliks from MACEDONIA (according to Kryštufek 1990).

Table 4. Frequencies of occurrence of four nonmetric cranial traits in two subspecies of sousliks from Macedonia (according to KRYŠTUFEK 1990).

	S. c. gradojevici	*S. c. karamani*
n	19	27
Foramen on maxillofrontal suture	0	20.4
Lacrymal foramen	0	40.7
Anterior frontal foramen	2.6	75.9
Foramen sphenoidale laterale	32.4	0

Several new characters could be introduced to assist in dicrimination of the two Macedonian subspecies:

Skull shape - Skull of *gradojevici* is more angular; supratemporal ridges fused into a short posterior crest in more than one half of all adult skulls. In *karamani* the crest was found in only one of 27 skulls.

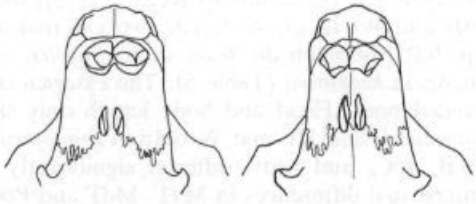

Fig. 12. Ventral side of rostrum in (left) *S. c. gradojevici* (PMS 7054) and (right) *S. c. karamani* (PMS 7090).

Sl. 12. Spodnja stran rostruma pri tekunici (levo) *S. c. gradojevici* in (desno) *S. c. karamani*.

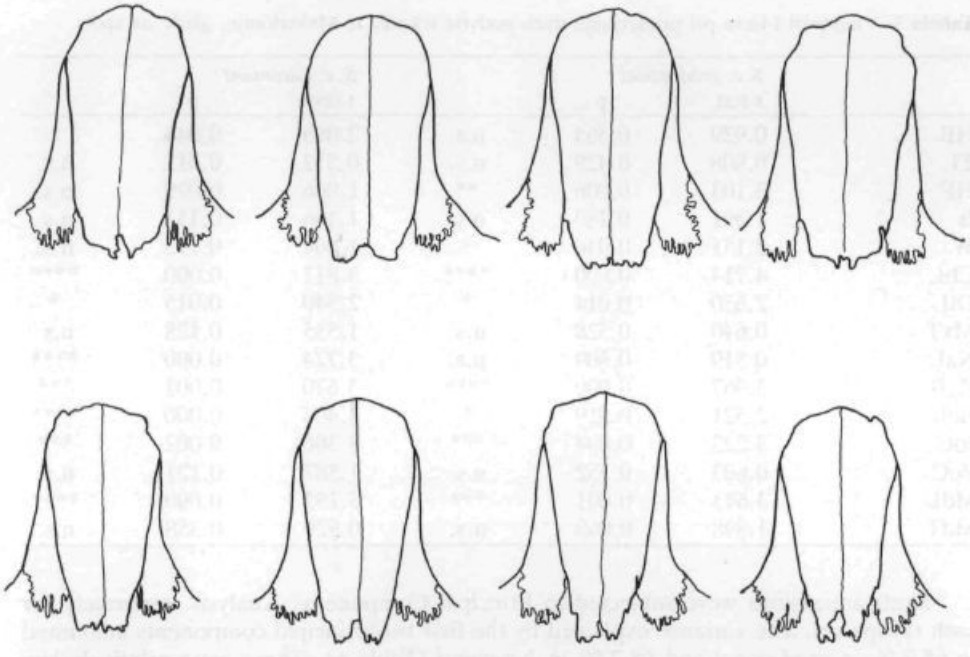

Fig. 13. Nasal bones in *S. c. gradojevici* (upper row) and *S. c. karamani* (lower row). PMS numbers (from left to right). Upper row: 7048; 7058; 7053; 7047. Lower row: 7066; 7069; 7077; 7091.

Sl. 13. Oblika nosnice pri tekunici *S. c. gradojevici* (zgornja vrsta) in *S. c. karamani* (spodnja vrsta).

Foramina incisiva - Longer in *karamani*. Distance between the anterior margin of for. incisiva and the posterior alveolar margin of the upper incisor shorter than for. incisiva in *karamani*; longer in half of specimens of *gradojevici* examined (Fig. 12).

Nasals - Broader posteriorly in *gradojevici* (Fig. 13).

3.3. **Sexual dimorphism**

Secondary sexual dimorphism has been reported in European souslik, with the males being larger. According to RUŽIČ (1978), the differences are most obvious in CbL, HF, HB and W. In my material, two external and six skull dimensions differ significantly ($p<0.05$) between the sexes in *gradojevici*, and one external and seven cranial measurements in *karamani* (Table 5). The external characters were less affected by sex than the cranial ones. Head and body length only showed significant intersexual differences in *karamani*, and HF and W only in *gradojevici*. Of the skull dimensions, CbL Dil, Zgb, BcB, IoC, and MdL differed significantly in both subspecies, while there were no intersexual differences in MxT, MdT and PoC.

Table 5. Estimated t-statistics with probabilities (p) for intersexual differences in sousliks from Macedonia. The subspecies are treated separately. Explanation as in Table 2.

Tabela 5. Vrednosti t-testa pri primerjanju dveh podvrst tekunic iz Makedonije, glede na spol.

	S. c. gradojevici			*S. c. karamani*		
	t-test	p		t-test	p	
HB	0.929	0.365	n.s.	2.089	0.044	*
TL	0.808	0.429	n.s.	0.512	0.612	n.s.
HF	3.103	0.006	**	1.806	0.079	n.s.
E	1.391	0.180	n.s.	1.466	0.151	n.s.
W	2.151	0.046	*	1.404	0.173	n.s.
CbL	4.714	0.000	****	3.811	0.000	****
DiL	2.630	0.014	*	2.540	0.015	*
MxT	0.640	0.528	n.s.	1.555	0.128	n.s.
NaL	0.519	0.609	n.s.	3.774	0.000	****
ZgB	3.967	0.000	****	3.670	0.001	***
BcB	2.521	0.019	*	4.404	0.000	****
IoC	3.223	0.004	***	3.306	0.002	***
PoC	0.603	0.552	n.s.	1.587	0.121	n.s.
MdL	3.643	0.001	***	5.152	0.000	****
MdT	1.898	0.069	n.s.	0.929	0.358	n.s.

Skull dimensions were subjected to Principal Components Analysis, separately for each subspecies. The variance explained by the first two principal components amounted to 65.3 % in *gradojevici* and 68.2 % in *karamani* (Table 6). These were relatively low values, since approximately one third of the variance in the original data sets remained unexplained by the first two components for both subspecies. In both subspecies, the highest character loadings for the first principal component were for CbL, DiL, ZgB, BcB, and MdL. The first principal component (PC1) is defined as that vector in hyperspace

Table 6. Character loadings for the first two principal components in the two subspecies of sousliks from Macedonia.

Tabela 6. Vrednosti koeficientov za prvi dve glavni komponenti pri dveh podvrstah tekunic iz Makedonije.

	S. c. gradojevici		*S. c. karamani*	
Principal component	1	2	1	2
Percentage of variance explained	47.9 %	17.4 %	48.9 %	17.4 %
CbL	0.920	0.239	0.859	-0.066
DiL	0.759	0.461	0.697	0.434
MxT	0.422	-0.176	0.299	-0.777
Nal	0.572	0.233	0.699	0.212
ZgB	0.913	-0.161	0.813	0.230
BcB	0.755	-0.179	0.855	-0.115
oC	0.491	-0.613	0.845	0.286
PoC	0.050	-0.891	0.240	0.454
MdL	0.863	0.246	0.888	-0.040
MdT	0.688	-0.311	0.365	-0.736

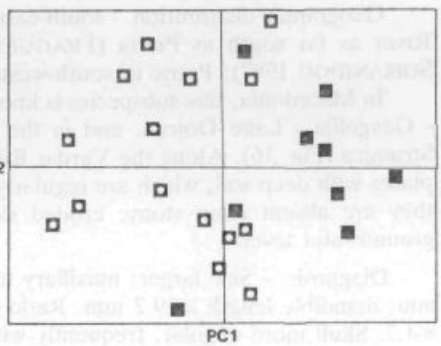

Fig. 14. Projection of 24 specimens *S. c. gradojevici* on the first two principal components. Closed symbols - males; open - females.

Sl. 14. Projekcija 24 primerkov tekunice *S. c. gradojevici* na prvi dve glavni komponenti. Polni simboli - samci; prazni - samice.

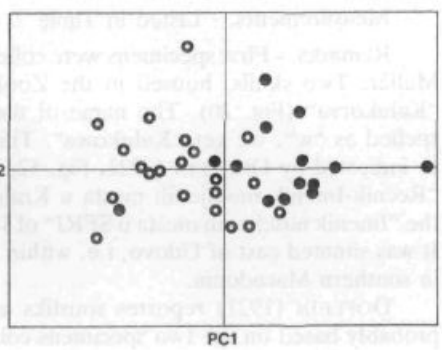

Fig. 15. Projection of 35 specimens of *S. c. karamani* on the first two principal components. Explanation as for Fig. 14.

Sl. 15. Projekcija 35 primerkov tekunice *S. c. karamani* na prvi dve glavni komponenti. Simboli kot na sliki 14.

which explains the maximum possible variation of the data (LEMEN 1983). Since highest character loadings for PC1 were by CbL and MdL, this component was highly size-correlated. Consequently, it is explained as a "size factor".

The first two principal components for the sousliks are shown in Figs. 14. and 15. Males had higher scores for the first component in both subspecies, resulting from their greater size. The overlap between the sexes was much more evident in *karamani*, with the smallest male approaching the size of the smallest females, i.e. specimens with the highest negative scores for PC1. With regard to the second principal component there was no segregation between the sexes, suggesting that the differences between the sexes were primarily those of size, not of shape.

3.4. **Subspecies**

***Spermophilus citellus gradojevici* (V. & E. Martino, 1929)**

1929. *Citellus citellus gradojevici* V. & E. Martino

Holotype. - An adult male, Zoological Institute, St. Petersburg No. 33,844, skin and skull, obtained 30 May 1928. Type not seen.

Type locality. - Gevgelija ('Djevdjelija' in older transliteration), Macedonia. In the original description, the type locality was misspelled as "Djerdjelija".

Geographic distribution. - south-eastern Macedonia; northern Greece along the Axios River as far south as Pieria (FRAGUEDAKIS-TSOLIS & ONDRIAS 1985, VOHRALIK & SOFIANIDOU 1987); Petrič in south-western Bulgaria (PEŠEV 1955, MARKOV 1957).

In Macedonia, this subspecies is known along the River Vardar in the triangle Udovo - Gevgelija - Lake Dojran, and in the valley of the River Strumica near the town of Strumica (Fig. 16). Along the Vardar River, sousliks are associated with dry, warm, open places with deep soil, which are regularly grazed by domestic animals (Figs. 17-19); while they are absent from stony, eroded slopes of hills, as well as lowlands with a high groundwater level.

Diagnosis. - Size larger; maxillary tooth row $\geq$9.8 mm; mandibular tooth row $\geq$9.3 mm; mandible length $\geq$29.2 mm. Ratio of mandibular tooth row to condylobasal length $\leq$4.7. Skull more angular, frequently with supratemporal ridges fused posteriorly into a crest. Nasals broader posteriorly. Foramina incisiva shorter, placed more posteriorly. Ventral side of tail uniformly buff-yellow.

Measurements. - Listed in Table 7.

Remarks. - First specimens were collected in 1917 by the German herpetologist Lorenz Müller. Two skulls, housed in the Zoologische Staatssammlung München, are labeled "Kalukorva" (Fig. 20). The name of the locality is Turkish, and if the letters "rv" are spelled as "w", we get "Kalukowa". This place is probably identical with "Kaluckova", as indicated by DOFLEIN (1921, Fig. 52, page 97). Kaluckova was still to be found in the "Rečnik-Imenik naseljenih mesta u Kraljevini Jugoslaviji" of 1930, but it is absent from the "Imenik naseljenih mesta u SFRJ" of 1985 (M. MILENKOVIĆ, personal communication). It was situated east of Udovo, i.e. within the known current distributional area of sousliks in southern Macedonia.

DOFLEIN (1921) reportes sousliks around "Hudova" (= Udovo). His statement is probably based on the two specimens collected by Müller at Kaluckova. DOFLEIN (1921)

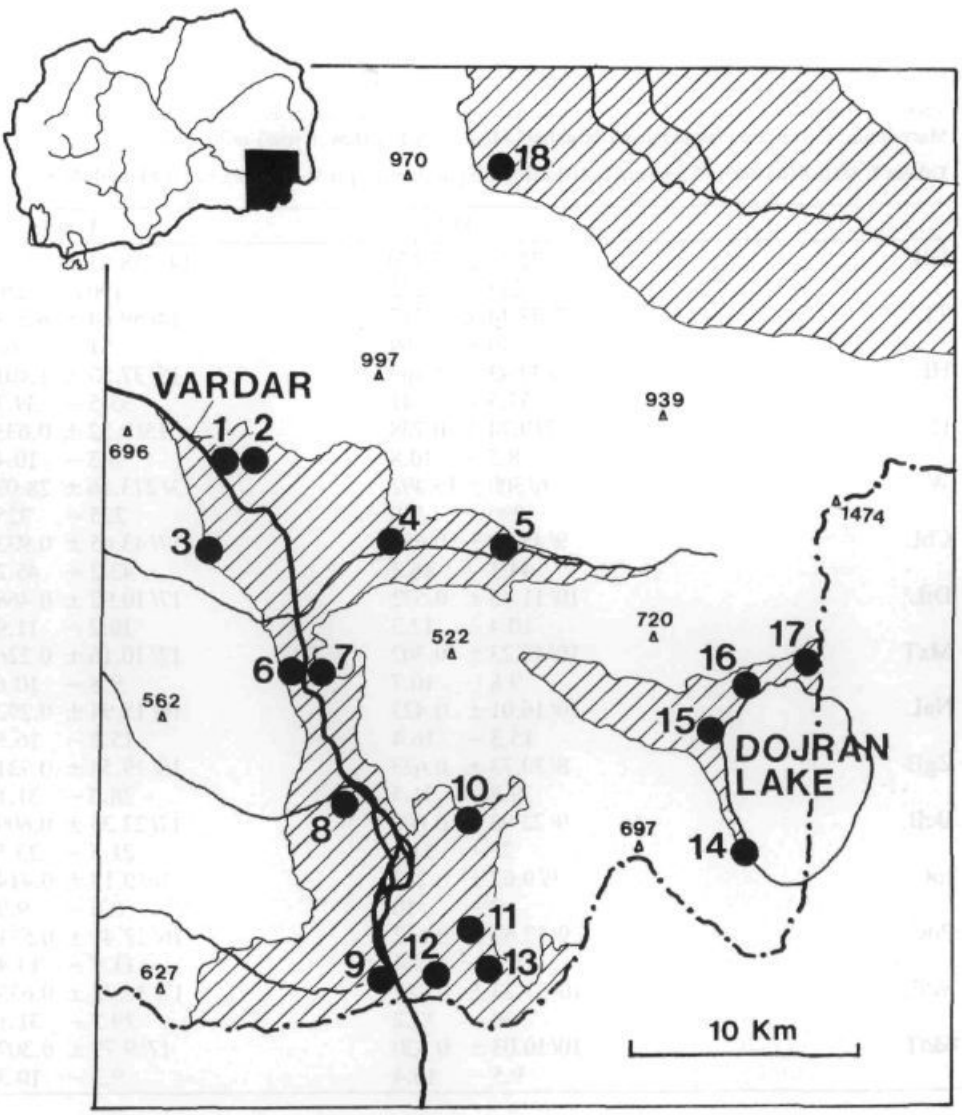

Fig. 16. Distribution of *S. c. gradojevici* in Macedonia. Shaded - lowlands; triangles - mountain peaks. List of localities: 1 - Udovo; 2 - Kaluckova; 3 - Miravci; 4 - Anska Reka; 5 - 1.5 km SE Rabrovo; 6 - Smokvice; 7 - Grčište; 8 - Prdejci; 9 - Gevgelija; 10 - Bogdanci; 11 - Stojakovo; 12 - Bogorodica; 13 - 3 km E Bogorodica; 14 - Star Dojran; 15 - Nov Dojran; 16 - Ačikot; 17 - Nikolić; 18 - 4.5 km NW Strumica (records "bei Strumica, nordwestlich der Stadt, am Fusse des Smrdeš-Gebirges" /RUŽIĆ 1969/, "Strumica" /RUŽIĆ 1978/ and "5 km W Strumica /PETROV 1992/ apparently based on PMS specimens 9657-9, labelled "4.5 km NW Strumica"). Corresponding references: (1) - PETROV 1940; (3, 6, 8, 9, 11, 12) - GRADOJEVIĆ 1931; (4) - PETROV 1992; (17) - SAVIĆ et al. 1971.

Sl. 16. Razširjenost *S. c. gradojevici* v Makedoniji. Senčeno - nižine; trikotniki - vrhovi.

Table 7. Estimated statistics for five external and ten skull characters of *S. c. gradojevici* from Macedonia. Given are: (upper row) Number/ Mean ± S.E.; (lower row) min. - max.

Tabela 7. Statistična ocena 5 telesnih in 10 lobanjskih parametrov pri *S.c. gradojevici* iz Makedonije.

	Males	Females
HB	7/ 222.29 ± 6.370	14/ 218.21 ± 10.59
	213 – 232	190 – 230
TL	7/ 57.14 ± 7.313	14/ 59.64 ± 6.371
	49 – 69	51 – 68
HF	7/ 39.43 ± 1.163	15/ 37.53 ± 1.401
	37.5 – 41	35.5 – 39.7
E	7/ 9.74 ± 0.738	15/ 9.32 ± 0.635
	8.5 – 10.8	8.3 – 10.4
W	6/ 300 ± 15.492	13/ 273.46 ± 28.02
	290 – 330	225 – 325
CbL	9/ 45.30 ± 0.654	17/ 43.65 ± 0.933
	44.1 – 46.3	42.2 – 45.2
DiL	10/ 11.45 ± 0.572	17/ 10.92 ± 0.468
	10.4 – 12.3	10.2 – 11.9
MxT	10/ 10.23 ± 0.302	17/ 10.16 ± 0.226
	9.8 – 10.7	9.8 – 10.6
NaL	10/ 16.01 ± 0.423	16/ 15.94 ± 0.292
	15.3 – 16.4	15.2 – 16.5
ZgB	8/ 30.73 ± 0.623	16/ 29.54 ± 0.721
	29.8 – 31.5	28.3 – 31.1
BcB	9/ 22.98 ± 0.602	17/ 22.35 ± 0.609
	22 – 23.6	21.5 – 23.5
IoC	9/ 9.63 ± 0.283	16/ 9.13 ± 0.414
	9 – 10	8.6 – 9.9
PoC	9/ 12.62 ± 0.612	16/ 12.48 ± 0.571
	11.3 – 13.4	11.7 – 13.4
MdL	10/ 31.23 ± 0.787	17/ 30.22 ± 0.635
	30 – 32.2	29.2 – 31.1
MdT	10/ 10.03 ± 0.320	17/ 9.79 ± 0.307
	9.5 – 10.4	9.3 – 10.3

Plate I. Adult *Spermophilus citellus gradojevici*. Photographed in Ačikot at Dojransko Ezero Lake on May 9th 1989 by D. Šere.

Priloga I. Odrasel primerek *Spermophilus citellus gradojevici*. Fotografiran v Ačikotu na Dojranskem jezeru, 9. maja 1993 (Foto D. Šere).

Fig. 17. High density habitat of *S. c. gradojevici* at Ačikot, lake Dojransko Ezero.

Sl. 17. Habitat z visoko populacijsko gostoto tekunice *S. c. gradojevici* pri Ačikotu, na obali Dojranskega jezera.

Fig. 18. Entrance to the den of *S. c. gradojevici* with faeces in front of it. Detail from the locality in Fig. 17.

Sl. 18. Vhod v rov tekunice *S. c. gradojevici*. Detajl s slike 17.

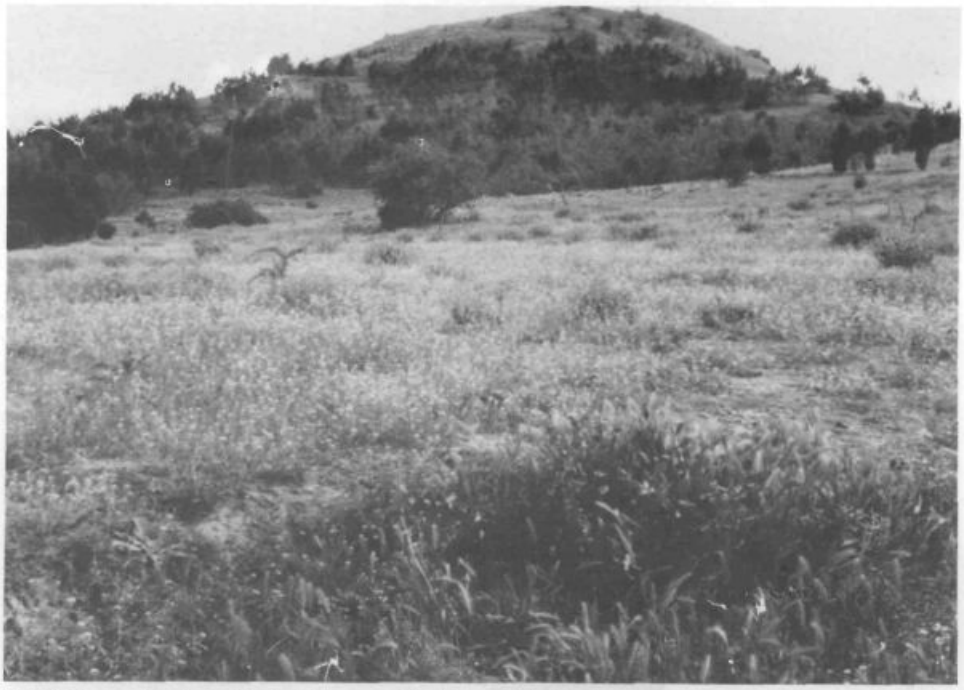

Fig. 19. Low density habitat of *S. c. gradojevici* near Bogdanci.

Sl. 19. Habitat z nizko populacijsko gostoto tekunic *S. c. gradojevici*. Okolica Bogdancev.

Fig. 20. Labels of two sousliks, collected by Lorenz Müller in 'Kaluckova', Macedonia (Zoologische Staatssammlung München).

Sl. 20. Etiketi dveh tekunic, ki ju je Lorenz Müller ujel na lokaciji 'Kaluckova' v Makedoniji.

Plate II. *Spermophilus citellus gradojevici*. Variability in coloration of the summer coat. Front: PMS 6029, back: PMS 7055.

Priloga II. *Spermophilus citellus gradojevici*. Variabilnost v barvi poletne dlake. Spredaj: PMS, zadaj: PMS 7055.

Plate III. *Spermophilus citellus gradojevici*. Left: adult female (PMS 6098), right: young (PMS 6104). Note the white spot on the front of the young animal.

Priloga III. *Spermophilus citellus gradojevici*. Levo: odrasla samica (PMS 6098), desno: mladič (PMS 6104). Mladič ima na čelu belo pego.

states that sousliks were rare around Udovo. GRADOJEVIĆ (1928) reports that they became a pest in the same area "in the last years", and their number was controlled by fumigating their dens. In the period between 1947-49, RUŽIĆ (1979) estimated population densities around Gevgelija at 6.1 sousliks per hectare, and around Bogdanci at 3/ha; the highest densities were on pastures. Twenty years later (1965-1968), lower densities were recorded, namely, 3.2/ha in Gevgelija and 1.2/ha in Bogdanci (RUŽIĆ l.c.). Such decreases were the result of abondoning pastures and their cultivation, turning most of them into vineyards and fields. In the subsequent decade, the trend for population declines continued. In 1977, densities were estimated at 0.9/ha in Gevgelija and 0.4/ha in Bogdanci. In three decades, the population decreased by 3-8 times (RUŽIĆ l.c.).

Towards the end of the 1980's, I found only a single large population (over 100 sousliks) at the tourist settlement of Ačikot at Dojransko Ezero Lake. Small colonies (about 10 animals each) were spread thinly along the northern shores of the lake, and along the Vardar. They populated small clearings amongst bushes which were used as pasture for horses and donkeys. Only single individuals were seen in small patches of grassland between cultivated land or along roads also grazed by horses. Although sousliks still populate the major part of their previous distributional area, population fragmentation already appears to be critical.

The females collected in May 1988 and 1989 already had placental scars and were in lactation (5 pairs of mammae). All females examined in that period participated in reproduction. Litter size, based on placental scars, varied between 4 and 7 ($\bar{x}$ = 5.7, n = 12). For this population Ružić (1978) reports females with 5 to 9 embryos ($\bar{x}$ = 7.4, n = 28). In Vardar Valley, young sousliks start to emerge from their burrows at the end of May (W 60-75 g; HB 130-138 mm). On the other hand, young sousliks of a similar size (W 60-70 g) were found near Strumica on 23 June 1967. Postnatal growth is rapid. Young specimens of the same year, collected near Nov Dojran on 20-22 July 1975, were nearly as large as adults (HB 200-225 mm).

Specimens examined. - Total = 54 (see Appendix).

***Spermophilus citellus karamani* (V. & E. Martino)**

1940. *Citellus citellus karamani* V. & E. Martino

Holotype. - An adult male, BMNH No. 1938.12.27.1, skin and skull, obtained 1 August 1938. Type seen.

Type locality. - Above Patiška, Mt. Karadjica (= Karadžica), 30 km South of Skopje, Macedonia. Altitude 2000 m.

Geographic distribution. - Endemic to mountain pastures of the Karadžica and Jakupica Mountains in central Macedonia. Three localities are known (Fig. 21):

1. Gorno Begovo (1950 - 2000 m), Mt. Jakupica. High density population on the eastern part of the field Gorno Begovo.

2. Solunsko pole (2100), Mt. Jakupica. Dispersed population with a much lower density than on Gorno Begovo.

3. "Above Patiška" (= Patiška reka; 2000 m), Mt. Karadžica. Sousliks were collected there by Martino in 1938. No subsequent records are available.

According to the information provided by shepherds, sousliks are locally common along the path from Gorno Begovo to Karadžica.

According to the same source, sousliks live in Mt. Dautica (KRYŠTUFEK & PETKOVSKI 1990).

Diagnosis. - Smaller, maxillary tooth row ≤10.0 mm; mandibular tooth row ≤9.6 mm; mandible length ≤30.4 mm. Ratio of mandibular tooth row length to condylobasal

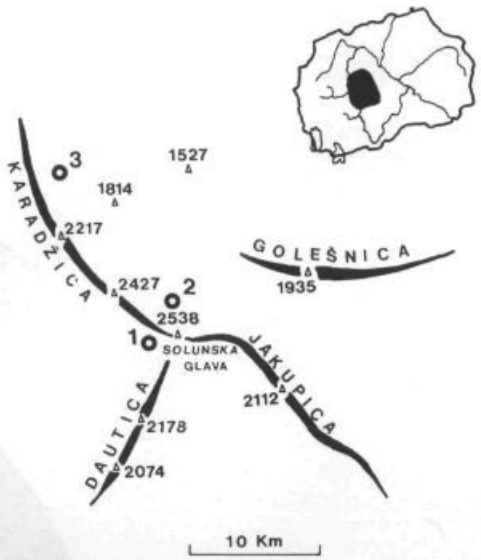

Fig. 21. Distribution of *Spermophilus citellus karamani*. List of localities: 1 - Solunsko pole; 2 - Gorno Begovo; 3 - Karadžica, above Patiška Reka (MARTINO V. & E. 1940).

Sl. 21. Razširjenost tekunice *Spermophilus citellus karamani*.

length ≥4.7 in 75 % of specimens. Skull less angular, supratemporal ridges very exceptionally fused posteriorly into a crest. Nasals narrower posteriorly. Foramina incisiva longer, placed more anteriorly. Ventral side of tail more greyish, with subterminal band.

Measurements. - Listed in Table 8.

Remarks. - DOFLEIN (1921) was the first to report sousliks for "Golesniza Planina" (= Mt. Golešnica), at altitudes of 2000-2200 m. Mt. Golešnica forms part of the Jakupica - Karadžica mountain system, but its highest peak (Lisec, 1935 m) is less than 2000 m (KRYŠTUFEK & PETKOVSKI 1990). Namely, Doflein used Golešnica for what is now called the Jakupica - Karadžica Mts. The locality of three specimens in the Zoologische Staatssammlung München, collected by Doflein, is given as "Begovatal" (Fig. 22). This shows that Doflein found sousliks at Gorno Begovo below the peak of Solunska glava. Recent reports of sousliks for "Goleschnica" (e.g. RUŽIĆ 1967) obviously result from the incorrect citation of Doflein's report.

DOFLEIN (1921) was amazed by the abundance of sousliks on Gorno Begovo. The next reports of sousliks in these mountains were by Karaman: Jakupica at 2000-2300 m (KARAMAN 1931) and Solunsko pole on Jakupica at 2200 m (KARAMAN 1937). He also states that sousliks were "extremely abundant" (KARAMAN 1931). In the summer of 1937, V. Martino collected specimens in the "Karadjica Mts. above Patiška (= Patiška Reka)". Later authors were rarely precise in reporting exact localities, referring only to Mt. Jakupica, Karadžica or Golešnica. KRYŠTUFEK & PETKOVSKI (1990) found sousliks on Gorno Begovo (1950 - 2000 m) and Solunsko pole (2100 m).

In 1989, I observed a large colony on the eastern part of the field Gorno Begovo, around the Alpine hut "Isak Ruso", at an altitude of 1982 m (Figs. 23-25). Only single specimens have been seen on the more karstic field of Solunsko pole.

Females collected on 11 May 1989 were already pregnant, but the time of conception, judged by the size of the embryos (length between 8 and 36 mm), was more prolonged

Plate IV. *Spermophilus citellus karamani.* Front: winter pelage (PMS 7093), Back: summer pelage (PMS 7072). Drawings in Plates II.-IV. by J. Mikuletič.

Priloga IV. *Spermophilus citellus karamani.* Spredaj: žival v zimski dlaki (PMS 7093), zadaj: žival v poletni dlaki (PMS 7072). Risbe v prilogah II.-IV. J. Mikuletič.

Table 8. Estimated statistics for five external and ten skull characters of *Spermophilus citellus karamani* from Macedonia. Explanation as for Table 7.

Tabela 8. Statistična ocena 5 telesnih in 10 lobanjskih parametrov pri *S. c. karamani* iz Makedonije.

	Males	Females
HB	16/213.56 ± 12.50	22/206.64 ± 7.938
	188 – 230	188 – 225
TL	15/54.93 ± 4.217	20/55.75 ± 4.983
	45 – 60	47 – 67
HF	16/35.41 ± 1.895	22/34.60 ± 0.806
	30.5 – 38.5	32.7 – 36.1
E	16/9.29 ± 0.501	22/9.04 ± 0.520
	8.7 – 10.5	8.1 – 10.2
W	11/209.09 ± 37.53	15/190.67 ± 29.46
	140 – 250	134 – 235
CbL	16/43.22 ± 1.292	23/41.57 ± 1.368
	40.6 – 45.5	39.4 – 45.2
DiL	16/11.32 ± 0.578	23/10.84 ± 0.573
	10.0 – 12.1	9.6 – 12.2
MxT	16/9.39 + 0.264	23/9.21 ± 0.408
	8.8 – 9.7	8.1 – 10
NaL	17/16.48 ± 0.656	23/15.74 ± 0.578
	15.2 – 17.4	14.3 – 16.7
ZgB	15/29.43 ± 0.974	22/28.43 ± 0.679
	27.5 – 31.2	27.2 – 29.5
BcB	15/22.52 ± 0.636	22/21.7 ± 0.496
	21.5 – 23.6	20.9 – 22.6
IoC	17/10.06 ± 0.562	23/9.53 ± 0.445
	8.6 – 11.3	8.7 – 10.2
PoC	16/12.52 ± 0.353	23/12.34 ± 0.330
	11.9 – 13.4	11.4 – 12.9
MdL	17/29.23 ± 0.740	22/28.19 ± 0.525
	27.6 – 30.4	27.4 – 29.2
MdT	17/8.52 ± 0.255	23/8.76 ± 0.367
	8.4 – 9.3	8.1 – 9.6

Fig. 22. Labels of two sousliks, collected by Franz Doflein in 'Begovatal', today Gorno Begovo, Mt. Jakupica (Zoologische Staatssammlung München).

Sl. 22. Etiketi dveh tekunic, ki ju je Franz Doflein ujel na lokaciji 'Begovatal', danes Gorno Begovo, Jakupica.

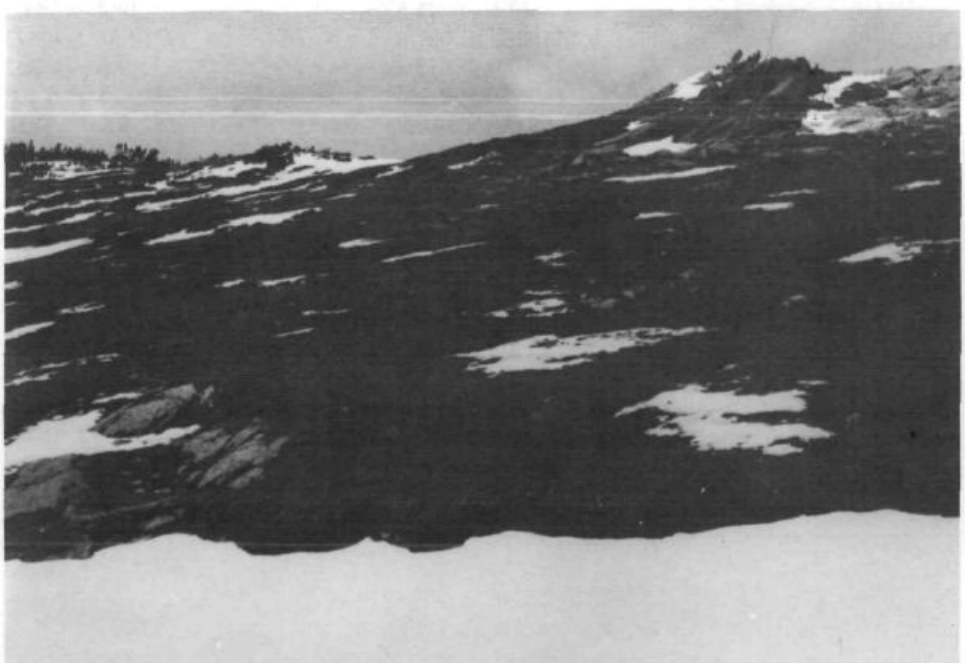

Fig. 23. Spring aspect of the habitat of *Spermophilu citellus karamani* in Gorno Begovo, Mt. Jakupica (altitude approximately 2000 m), on 11 May 1989. The sousliks were active.

Sl. 23. Spomladanski videz habitata tekunice *S. c. karamani* na mestu Gorno Begovo, 11. maja 1989. Tekunice so bile aktivne.

Fig. 24. Footprints of *Spermophilus citellus karamani* in snow. Gorno Begovo, 11 May 1989.

Sl. 24. Sledovi tekunice *S. c. karamani* v snegu. Gorno Begovo, 11. maja 1989.

Fig. 25. Summer aspect of the habitat of *Spermophilus citellus karamani* at Gorno Begovo.

Sl. 25. Poletni videz habitata tekunice *S. c. karamani* na mestu Gorno Begovo.

than in the lowland form. Of 13 females, 9 had embryos, and one had placental scars, while the remaining three had probably been fertilized. Two females, collected on 27 June 1989, were with placental scars. Litter size, estimated from these data, was between 2 and 7 ($\bar{x}$ = 4.2, n = 12). Young sousliks, collected between 30 July and 3 August 1937, had HB 124 - 181 mm, and were smaller than their counterparts from Dojransko Ezero, although originating from the same period.

KARAMAN (1931) repeatedly observed 'Aquila pennata' (= *Hieraaetus pennatus*) in the vicinity of sousliks, and was of the opinion that this eagle was their only predator.

Specimens examined. - Total = 49 (see Appendix).

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Povzetek

V Makedoniji živita dve podvrsti tekunice. Podvrsta *Spermophilus citellus gradojevici* je poznana iz trikotnika Udovo - Gevgelija - Dojransko jezero in iz doline reke Strumice. Najdemo jo v odprtih habitatih (pašniki) z globokim slojem prsti, kjer se redno pase živina, medtem ko je ni na erodiranih pobočjih gričev in na območjih z visokim nivojem talne vode. Podvrsto prepoznamo po večjih telesnih dimenzijah, bolj oglati lobanji z izrazitim puščičnim grebenom, nosnih kosteh, ki so v zadnjem delu širše, po krajši nebni špranji in po enakomerno rumeno obarvani spodnji strani repa.

Podvrsta *Spermophilus citellus karamani* živi na planinskih pašnikih Jakupice in Karadžice, poznana pa je s treh nahajališč. Ta podvrsta je manjša, puščični greben je le izjemoma razvit, nosne kosti so v zadnjem delu ožje, nebna špranja daljša, spodnja stran repa pa je bolj siva s temnim pasom pred koncem repa.

Pri obeh podvrstah se kaže sekundarni spolni dimorfizem. Samci so večji od samic. Dimorfizem je bolj viden v lobanjskih dimenzijah, kot pa v telesnih. Očitnejši je pri podvrsti *S. c. gradojevici*.

Appendix

The following is a tabular presentation of the measurements of sousliks from Macedonia examined in this study. This includes all specimens from the Slovene Museum of Natural History, the British Museum (Natural History), the National Museum Prague, and the Zoologische Staatssammlung München. The column "Identification" gives collection, catalogue number, locality statement and date of collection. Five external (HB, TL, HF, E, W) and ten cranial (CbL, DiL, MxT, NaL, ZgB, BcB, IoC, PoC, MdL, MdT) measurements are listed. All measurements are given in millimetres, weight in grams. See the "Material and Methods" section for the abbreviations of measurements.

Abbreviations

Collections:
PMS - Slovene Museum of Natural History, Ljubljana
BMNH - British Museum (Natural History), London
NMP - National Museum, Prague
ZSM - Zoologische Staatssammlung München, Munich

Sex:
M - male
F - female

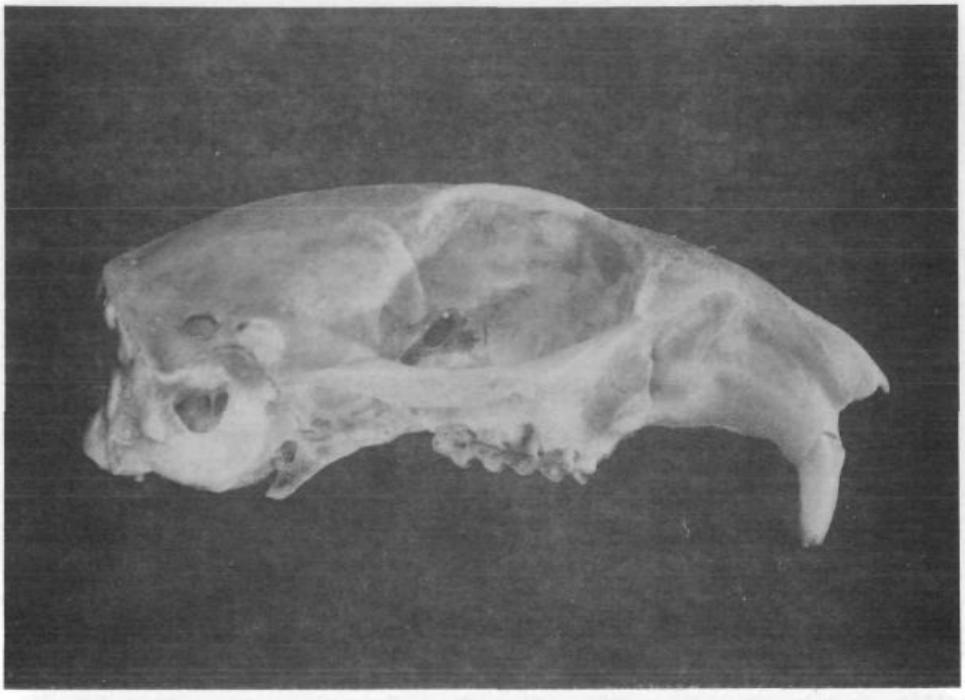
Growth groups:
Determination was based on the degree of wear of tooth enamels as examined under 10 times magnification. Growth groups are according to RUŽIĆ (1966).
juv1 (juveniles 1): age 1 - 1.5 month
juv2 (juveniles 2): age 1.5-2.5 months
sad (subadults): age 3-5 months
ad1 (adults 1): before and just after the first hibernation
ad2 (adults 2): second calendar year and spring following the second hibernation
ad3 (adults 3): third calendar year and spring following the third hibernation
sen (senes): autumn before fourth hibernation and following months

Identification			Sex	HB	TL	HF	E	W	Remarks
Spermophilus citellus gradojevici									
PMS 196	Nov Dojran	20 July 1975	M	217	71	38.7	8.1	...	
197	Nov Dojran	"	M	200	72	37.2	8.1	...	
198	Nov Dojran	"	M	205	65	37.8	7.9	...	
218	Nov Dojran	22 July 1975	F	207	59	37.7	7.9	...	
219	Nov Dojran	"	M	210	71	38.9	8.5	...	
220	Nov Dojran	"	M	215	69	37.3	8.8	...	
221	Nov Dojran	"	M	225	47	35.1	8.6	...	
5649	Dojran, Ačikot	30 July 1987	F	...	..	....	...	...	Alcohol
6106	Dojran, Ačikot	31 May 1988	F	212	53	36.0	8.2	260	
6107	Dojran, Ačikot	"	F	219	..	39.5	8.5	300	
6108	Dojran, Ačikot	"	F	220	54	37.0	9.7	280	
6109	Dojran, Ačikot	"	F	220	51	37.7	9.5	300	
6110	Dojran, Ačikot	"	M	227	53	39.4	9.5	300	
6111	Dojran, Ačikot	"	M	220	49	38.7	9.6	290	
7050	Dojran, Ačikot	8 May 1989	F	210	66	36.0	10.4	225	
7051	Dojran, Ačikot	9 May 1989	M	217	65	40.3	10.0	290	
7052	Dojran, Ačikot	"	M	225	58	40.1	10.8	290	
7053	Dojran, Ačikot	"	M	232	69	41.0	9.5	330	
7054	Dojran, Ačikot	"	M	222	53	39.0	10.3	300	
7055	Dojran, Ačikot	"	F	228	62	39.3	9.8	300	
7056	Dojran, Ačikot	"	F	214	65	38.0	8.8	240	
7057	Dojran, Ačikot	10 May 1989	F	230	65	37.5	9.1	275	
7058	Dojran, Ačikot	"	F	227	52	37.4	9.7	260	
NMP 1868	Star Dojran	19 May 1968	M	...	..	....	...	...	
1884	Star Dojran	"	F	...	..	....	...	...	
1885	Star Dojran	"	M	...	..	....	...	...	
1898	Star Dojran	"	F	...	..	....	...	...	
1899	Star Dojran	"	F	...	..	....	...	...	
1905	Star Dojran	"	F	...	..	....	...	...	
PMS 6029	Gevgelija	22 June 1928	M	213	53	37.5	8.5	...	Paratype 29E
BMNH 33.4.4.3	Gevgelija	6 June 1928	F	190	65	35.5	8.5	...	Paratype 28E
PMS 6098	Grčište	30 May 1988	F	223	65	37.2	8.7	325	
6099	Grčište	"	M	132	47	32.5	7.6	75	
6100	Grčište	"	M	135	43	32.5	8.6	70	
6101	Grčište	"	M	130	40	32.4	8.0	65	
6102	Grčište	"	F	135	47	32.7	7.6	70	
6103	Grčište	"	F	135	44	34.4	8.6	60	
6104	Grčište	"	F	135	40	33.5	9.0	70	
6105	Grčište	"	F	138	47	32.6	8.2	70	
7047	1.5 km SE Rabrovo	8 May 1989	F	230	53	39.7	10.0	280	
7048	Bogorodica	"	F	221	63	39.0	9.9	250	
7049	3 km E Bogorodica	"	F	221	68	37.7	9.4	260	
BMNH 66.3965	Udovo	6 April 1939	F	190	65	35.5	8.5	...	
31.11.11.35	Udovo	"	M	...	..	....	...	...	
31.11.11.36	Udovo	"	M	216	56	31.0	8.0	...	
31.11.11.37	Udovo	"	M	...	..	....	...	...	
31.11.11.38	Udovo	"	F	...	..	....	...	...	
31.11.11.39	Udovo	"	F	215	..	38.0	9.0	...	
31.11.11.40	Udovo	"	F	218	51	38.0	10.0	...	
PMS 9657	4 km E Strumica	23 June 1967	F	131	36	30.2	8.9	65	
9658	4 km E Strumica	"	M	126	33	29.6	7.3	60	
9659	4 km E Strumica	"	M	136	..	31.6	7.9	70	
ZSM I	Kaluckova	1 July 1917	F	...	..	....	...	...	
2	Kaluckova	4 July 1917	M	...	..	....	...	...	

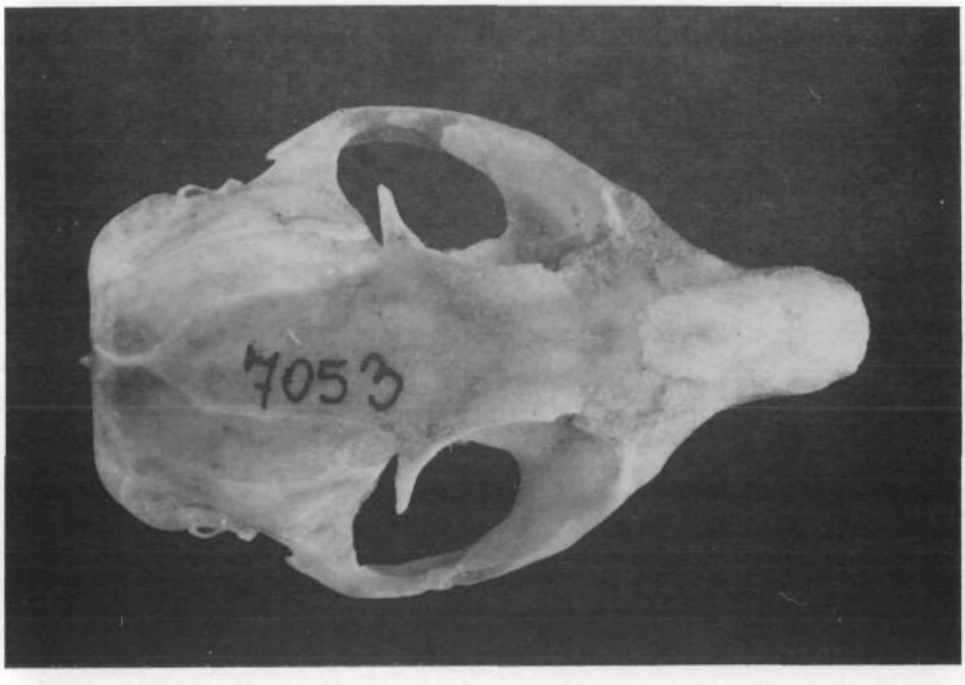
Identification			Sex	HB	TL	HF	E	W	Remarks
Spermophilus citellus karamani									
PMS 7059	Gorno Begovo	11 May 1989	F	210	56	34.8	10.0	235	
7060	Gorno Begovo	"	F	208	52	34.7	10.2	180	
7061	Gorno Begovo	"	F	204	52	34.4	9.5	192	
7062	Gorno Begovo	"	F	205	55	33.8	9.4	175	
7063	Gorno Begovo	"	M	200	56	34.8	9.3	160	
7064	Gorno Begovo	"	F	192	56	35.0	9.0	200	
7065	Gorno Begovo	"	F	200	53	35.0	8.2	144	
7066	Gorno Begovo	"	F	202	52	34.0	9.2	188	
7067	Gorno Begovo	"	F	188	..	33.6	9.5	152	
7068	Gorno Begovo	"	M	230	60	38.5	10.3	220	
7069	Gorno Begovo	"	M	210	51	35.0	8.9	220	
7070	Gorno Begovo	"	F	205	52	33.3	9.0	200	
7071	Gorno Begovo	"	F	212	52	35.6	9.3	200	
7072	Gorno Begovo	"	M	188	55	34.3	8.8	140	
7073	Gorno Begovo	"	M	220	50	37.1	9.1	240	
7074	Gorno Begovo	"	M	221	60	37.0	9.6	250	
7075	Gorno Begovo	"	F	205	55	36.1	8.0	200	
7076	Gorno Begovo	"	F	205	53	32.7	8.8	200	
7077	Gorno Begovo	"	M	222	58	35.8	9.5	160	
7078	Gorno Begovo	"	F	205	58	34.5	8.7	...	
7089	Gorno Begovo	27 June 1989	F	204	55	34.8	8.1	220	
7090	Gorno Begovo	"	M	217	59	33.5	9.3	240	
7091	Gorno Begovo	"	F	214	..	34.7	8.6	220	
7092	Gorno Begovo	28 June 1989	F	212	57	34.2	8.4	220	
7093	Solunsko pole	"	M	208	54	36.3	9.0	220	
7094	Solunsko pole	"	M	221	60	37.0	9.6	250	
7095	Solunsko pole	"	M	212	..	35.5	9.4	220	
ZSM 3	Gorno Begovo	25 June 1918	M						Doflein's Collection
5	Gorno Begovo	"	F						Doflein's Collection
6	Gorno Begovo	"	F						Doflein's Collection
BMNH 47.1104	Patiška Reka	30 July 1937	M	225	60	35.5	9.0	...	Paratype *karamani*
66.3955	Patiška Reka	"	F	225	65	34.0	9.0	...	Paratype *karamani*
66.3956	Patiška Reka	"	F	210	67	35.0	9.0	...	Paratype *karamani*
47.1107	Patiška Reka	"	M	124	35	29.0	9.0	...	
47.1105	Patiška Reka	31 July 1937	M	220	54	34.0	9.2	...	Paratype *karamani*
47.1106	Patiška Reka	"	M	210	55	35.0	9.0	...	Paratype *karamani*
66.3957	Patiška Reka	"	F	220	49	35.0	9.0	...	Paratype *karamani*
66.3958	Patiška Reka	"	F	220	47	35.5	8.8	...	Paratype *karamani*
38.12.27.1	Patiška Reka	1 August 1937	M	190	45	30.5	9.0	...	Type *karamani*
47.1109	Patiška Reka	3 August 1937	F	148	43	33.0	8.0	...	
66.3959	Patiška Reka	"	F	154	53	33.5	9.0	...	
47.1108	Patiška Reka	7 August 1937	M	230	54	37.0	10.5	...	Paratype *karamani*
66.3961	Patiška Reka	"	F	210	64	35.0	9.0	...	Paratype *karamani*
66.3962	Patiška Reka	"	F	205	60	35.5	9.0	...	Paratype *karamani*
66.3960	Patiška Reka	11 August 1937	M	154	53	33.0	8.8	...	
66.3963	Patiška Reka	"	F	205	54	35.0	9.5	...	
66.3964	Patiška Reka	"	F	175	58	33.0	9.0	...	
47.1110	Patiška Reka	12 August 1937	F	181	49	36.0	9.0	...	

Identification	GG	CbL	DiL	MxT	NaL	ZgB	BcB	IoC	PoC	MdL	MdT
Spermophilus citellus gradojevici											
PMS 196	sad	43.8	10.5	10.6	15.3	29.1	23.0	9.1	12.6	30.4	9.6
197	sad	41.8	10.2	10.5	14.9	27.9	21.8	8.1	13.1	29.1	9.8
198	sad	42.4	9.9	10.4	15.5	28.7	22.2	8.6	12.8	29.5	9.9
218	sad	42.2	10.0	10.3	14.9	28.8	21.6	8.4	13.2	29.4	9.8
219	sad	43.4	10.3	10.6	15.2	....	22.2	8.7	12.5	30.2	10.1
220	sad	43.0	10.1	10.6	15.1	28.0	22.6	9.0	12.4	30.0	9.5
221	sad	42.1	10.0	10.1	15.7	29.0	22.3	8.9	13.5	29.4	9.5
6106	ad2	42.3	10.7	9.8	15.9	28.3	22.1	9.1	13.1	29.3	9.7
6107	ad2	44.2	11.2	10.1	15.7	30.3	23.0	9.9	13.4	30.3	10.3
6108	ad2	43.6	11.0	10.0	16.1	29.4	21.5	8.6	12.2	29.6	9.6
6109	ad3	43.3	10.6	10.0	16.2	30.2	22.7	9.7	13.1	30.3	10.3
6110	ad1	44.6	10.6	10.4	15.8	29.8	22.7	9.7	12.4	30.9	10.1
6111	ad1	44.1	10.4	10.2	15.5	30.2	22.4	10.0	13.4	30.0	9.6
7050	ad1	42.4	10.2	10.1	15.2	28.7	22.3	9.0	12.9	29.2	9.3
7051	ad2	45.4	11.3	10.2	16.3	31.2	23.4	9.8	12.6	31.5	10.3
7052	ad1	45.9	11.8	10.7	16.4	31.1	23.4	9.7	13.2	30.3	10.2
7053	ad2	46.3	11.8	10.7	16.3	31.5	23.4	9.7	12.6	31.8	10.4
7054	ad2	45.2	11.5	10.0	16.4	31.2	23.5	9.0	13.1	31.9	10.1
7055	ad2	44.1	10.6	10.1	15.7	31.1	23.0	9.8	12.8	30.9	9.6
7056	ad1	42.4	10.2	10.2	15.8	28.5	21.6	8.6	12.4	29.7	9.6
7057	ad1	43.8	10.8	10.2	15.8	29.7	21.5	8.8	12.4	29.9	9.7
7058	ad3	45.2	11.6	10.3	15.9	30.2	22.2	9.3	11.8	30.9	10.0
NMP 1868	ad1	45.6	12.3	9.9	16.1	30.7	23.6	9.7	12.5	32.1	9.5
1884	ad3	....	11.5	9.8	15.6	....	....	...	....	30.5	9.8
1898	ad1	43.8	11.2	9.9	16.1	29.1	22.1	8.8	11.9	30.2	9.5
1899	ad1	42.2	10.5	9.9	....	29.3	22.5	...	....	31.1	9.9
1905	ad3	44.6	11.9	10.1	16.1	....	22.1	9.4	11.8	29.2	9.6
PMS 6029	ad1	44.6	10.6	10.4	15.8	29.8	22.7	9.7	12.4	30.9	10.1
BMNH 33.4.4.3.	ad1	43.4	11.1	10.6	15.8	29.5	22.2	9.1	13.0	30.4	10.3
PMS 6098	ad1	44.4	11.0	10.2	15.9	29.3	22.6	9.0	11.8	30.6	9.7
6099	juv1	36.7	8.8	....	11.7	22.8	19.9	8.3	12.7	25.6	...
6100	juv1	36.1	8.9	....	12.2	22.8	19.7	8.6	12.8	25.0	...
6101	juv1	35.8	8.2	....	11.8	22.9	19.8	8.5	13.3	25.2	...
6102	juv1	36.5	8.6	....	12.2	23.0	19.7	8.2	12.4	25.7	...
6103	juv1	37.0	8.9	....	12.1	23.7	20.2	7.7	12.5	25.8	...
6104	juv1	36.0	8.4	....	11.8	23.5	20.0	8.0	12.9	24.8	...
6105	juv1	35.9	8.5	....	11.2	22.8	19.2	8.3	12.6	25.2	...
7047	ad1	45.1	11.5	10.4	16.5	30.0	23.3	8.6	11.7	31.0	9.8
7048	ad1	43.9	10.7	10.6	16.2	29.6	23.5	9.2	13.0	30.7	10.1
7049	ad2	43.3	10.8	10.3	16.1	29.4	21.7	9.2	12.3	30.4	9.5
BMNH 31.11.11.35	ad1	44.0	11.5	10.4	15.6	29.5	21.9	9.0	12.4	29.4	9.9
31.11.11.36	ad1	44.5	11.1	9.9	15.6	29.5	22.3	10.0	12.7	30.3	9.8
31.11.11.37	ad1	41.4	10.3	9.9	15.4	28.8	22.1	9.0	11.9	29.5	9.4
31.11.11.38	ad2	41.4	9.5	9.4	14.9	27.4	20.6	8.4	11.7	28.0	8.8
31.11.11.39	ad1	43.3	10.4	10.3	15.7	29.2	22.2	8.8	11.8	29.8	9.2
31.11.11.40	ad1	43.5	10.9	9.7	15.0	29.4	22.5	9.2	12.5	29.9	9.8
PMS 9657	juv1	34.0	8.0	....	11.6	21.8	18.8	8.0	12.8	24.8	...
9658	juv1	33.2	7.6	....	11.7	21.0	18.3	7.8	12.5	24.5	...
9659	juv1	34.5	8.4	....	11.1	22.1	18.9	8.3	13.2	25.0	...
ZSM I	juv2	41.1	10.3	10.3	14.7	....	22.5	...	13.9	29.5	9.3
2	juv2	41.9	9.6	10.8	14.5	17.6	22.3	10.0	12.8	28.6	9.8

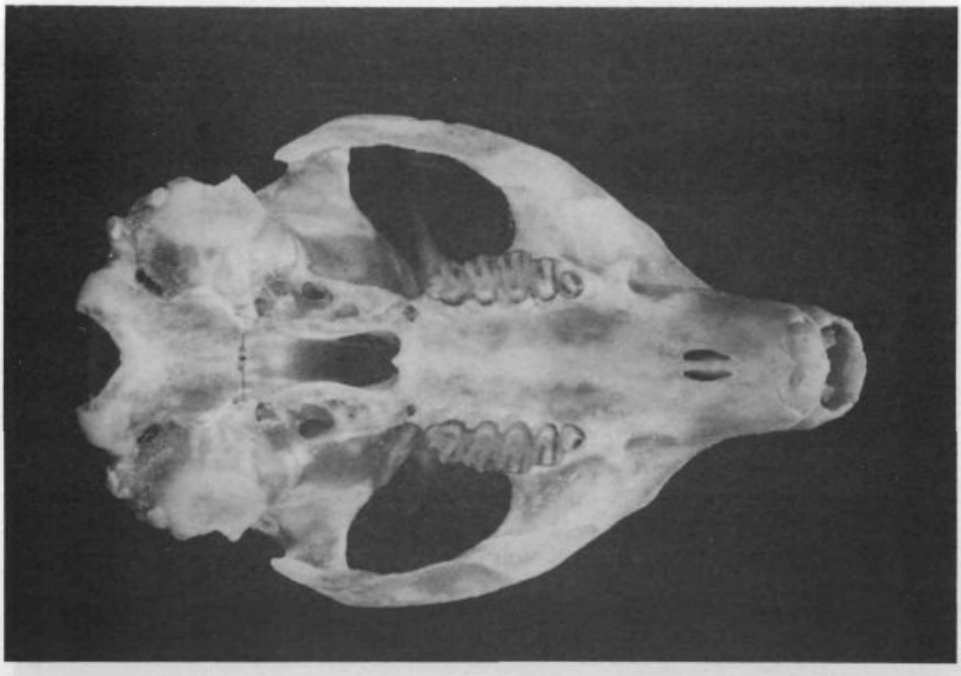
Identification	GG	CbL	DiL	MxT	NaL	ZgB	BcB	IoC	PoC	MdL	MdT
Spermophilus citellus karamani											
PMS 7059	sen	42.5	11.4	9.1	15.5	29.5	22.1	10.2	12.6	28.8	8.8
7060	ad1	41.6	10.6	9.2	15.6	28.4	21.9	9.9	12.6	28.0	8.4
7061	ad1	41.8	10.8	9.4	16.2	29.0	22.0	9.4	12.3	28.5	8.9
7062	ad2	41.0	11.2	8.9	14.9	27.4	21.7	9.3	11.4	28.2	8.6
7063	ad1	41.6	10.6	9.3	15.8	27.6	21.8	9.7	12.5	28.9	8.8
7064	ad1	39.8	9.9	9.6	15.4	27.2	21.4	8.8	12.5	27.8	8.6
7065	ad1	40.3	10.3	9.4	16.3	28.9	21.6	9.4	12.7	27.9	9.1
7066	ad1	40.5	10.6	9.0	15.8	27.8	21.2	8.8	12.2	27.8	8.3
7067	ad1	39.4	9.6	9.7	15.4	27.2	21.1	8.7	12.2	27.6	9.0
7068	ad1	45.4	12.1	9.7	17.4	31.2	23.6	11.3	12.9	30.4	9.1
7069	ad3	43.2	11.8	8.9	15.5	29.3	22.1	10.5	13.4	28.7	8.5
7070	ad2	41.4	10.8	9.0	16.0	28.2	21.2	9.1	11.9	27.7	8.7
7071	ad2	41.9	11.2	9.3	15.7	28.7	21.4	9.5	12.4	28.4	8.5
7072	ad1	40.6	10.0	9.6	15.2	27.5	21.5	8.6	12.6	27.6	8.9
7073	ad2	43.7	11.5	9.5	16.4	30.4	22.9	9.6	12.4	29.8	9.0
7074	ad1	43.6	11.6	9.3	17.1	29.9	23.1	10.8	12.3	29.5	8.9
7075	ad2	40.9	12.2	8.1	15.3	28.9	21.5	9.9	12.6	28.0	8.3
7076	ad3	41.4	10.7	9.3	14.3	28.7	22.2	9.6	12.5	28.4	8.8
7077	ad2	42.8	11.3	9.4	16.5	29.9	23.2	10.4	12.5	29.2	8.7
7078	ad1	41.4	10.7	9.4	16.3	28.7	21.7	9.6	12.4	29.2	8.7
7089	ad1	39.8	10.0	8.4	15.4	27.2	21.1	8.9	12.9	27.6	8.6
7090	ad1	42.3	11.2	9.7	16.3	29.0	22.0	10.1	12.3	28.4	8.4
7091	ad1	41.3	10.8	9.3	15.8	28.5	21.0	9.7	12.1	27.4	8.7
7092	sen	41.4	10.8	8.8	15.5	....	20.9	9.5	12.5	27.5	8.4
7093	ad1	42.4	11.5	9.2	16.6	29.1	21.9	10.2	13.0	29.1	8.6
7094	ad1	43.6	11.6	9.3	17.1	29.9	23.1	10.8	12.3	29.5	8.9
7095	ad1	42.9	11.7	8.8	16.9	30.0	22.8	10.1	12.7	29.4	8.5
ZSM 3	ad1	44.7	12.0	9.7	10.6	29.2	22.4	9.9	12.4	28.2	8.9
5	ad2	41.9	11.4	9.4	16.2	28.8	22.2	9.6	11.9	27.8	8.8
6	ad2	41.3	11.2	9.1	15.8	28.6	21.4	10.2	12.3	....	8.7
BMNH 47.1104	ad1	....	11.5	9.3	17.1	....	....	10.1	....	30.2	9.3
66.3955	ad1	44.9	10.7	9.5	15.0	29.4	22.1	10.2	12.6	28.6	9.1
47.1107	juv1	34.1	....	...	....	....	....	....	....	....	...
47.1105	ad1	45.5	11.0	9.6	16.7	29.1	21.9	9.8	12.5	29.2	9.0
47.1106	ad2	43.3	11.8	9.4	16.3	29.7	22.5	10.0	12.4	29.5	9.2
66.3957	ad3	42.9	11.5	9.3	16.4	29.3	21.6	10.2	12.2	28.7	9.2
66.3958	ad1	45.2	11.6	9.1	16.7	28.6	22.3	9.5	12.2	28.7	9.6
38.12.27.1	ad1	42.3	10.5	9.4	16.4	29.2	23.3	10.1	12.3	29.0	9.0
47.1109	juv2	36.2	....	....	....	....	....	....	....	....	...
66.3959	juv1	37.0	....	....	....	....	....	....	....	....	...
47.1108	ad1	43.6	....	....	17.4	....	....	10.0	11.9	29.6	9.0
66.3961	ad1	42.1	11.2	9.4	16.0	28.9	22.5	9.8	12.5	28.7	9.3
66.3962	ad1	42.4	11.0	10.0	16.3	28.7	21.4	9.9	12.6	29.1	9.3
66.3960	juv1	38.1	....	....	....	....	....	....	....	....	...
66.3963	ad1	41.8	10.7	9.5	16.7	28.2	22.6	9.8	12.0	28.4	9.2
66.3964	sad	42.7	9.7	9.3	15.3	26.5	21.2	9.2	12.3	26.9	8.9
47.1110	sad	40.1	10.0	9.8	16.0	27.7	21.6	9.2	12.4	27.6	9.0



26a



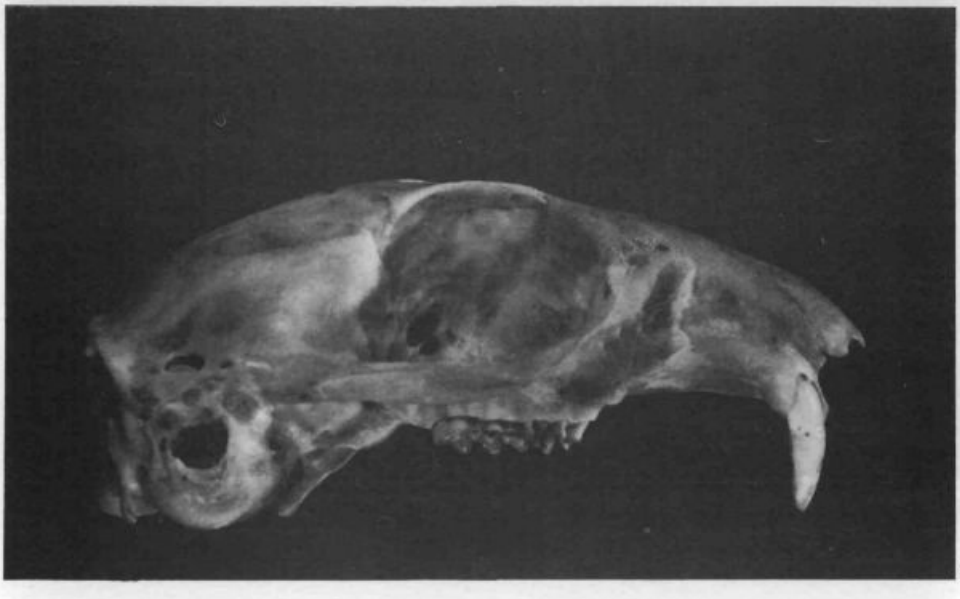
26b



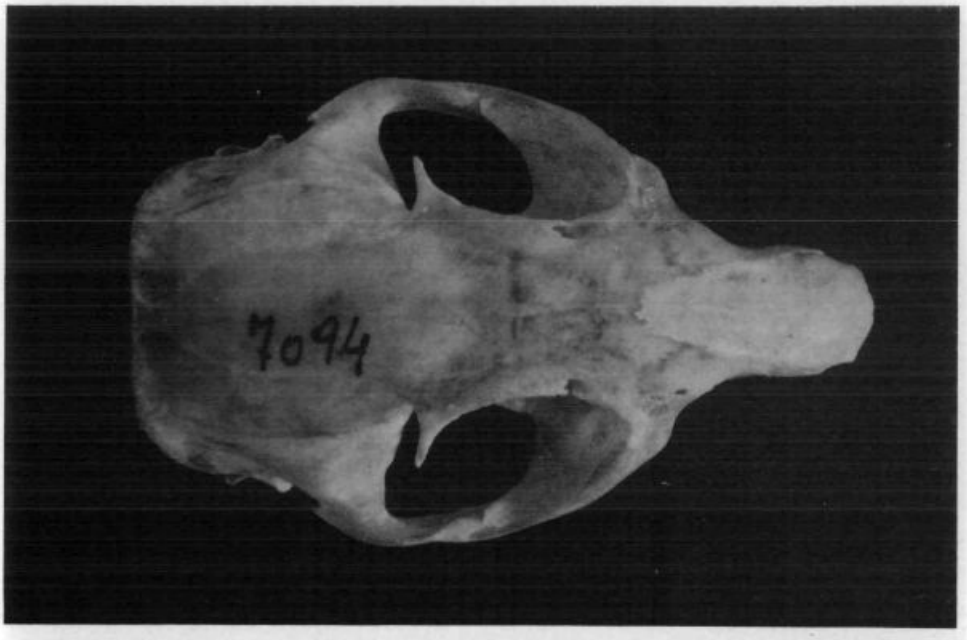
26c

Fig. 26. Skull of *Spermophilus citellus gradojevici* (adult male, PMS 7053) in (a) lateral, (b) dorsal and (c) ventral view.

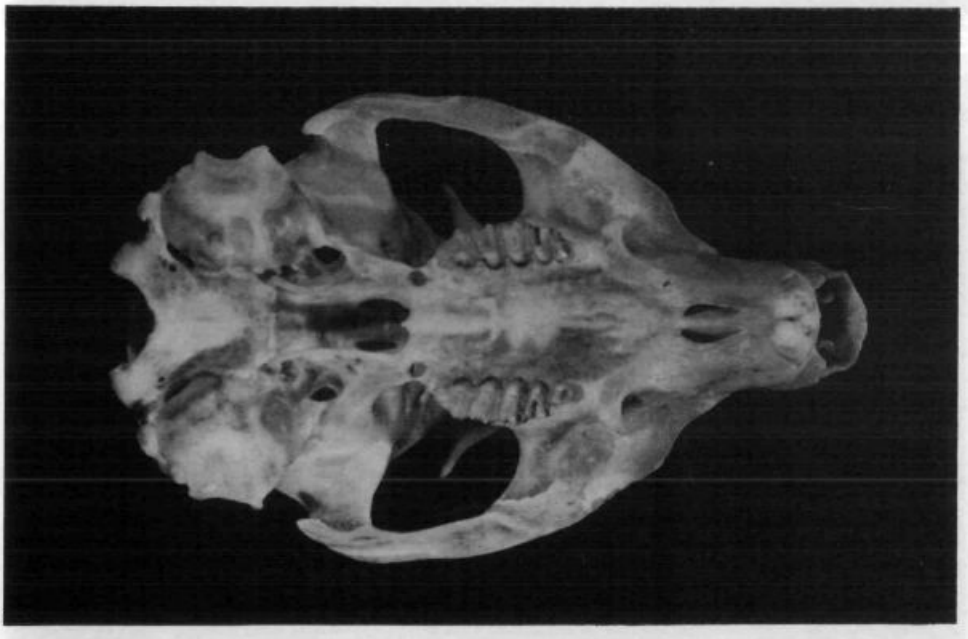
Sl. 26. Lobanja tekunice *Spermophilus citellus gradojevici* (a) z boka, (b) s hrbtne in (c) trebušne strani.



27a



27b



27c

Fig. 27. Skull of *Spermophilus citellus karamani* (adult male, PMS 7094) in (a) lateral, (b) dorsal, and (c) ventral view.

Sl. 27. Lobanja tekunice *Spermophilus citellus karamani* (a) z boka, (b) s hrbtne in (c) trebušne strani.

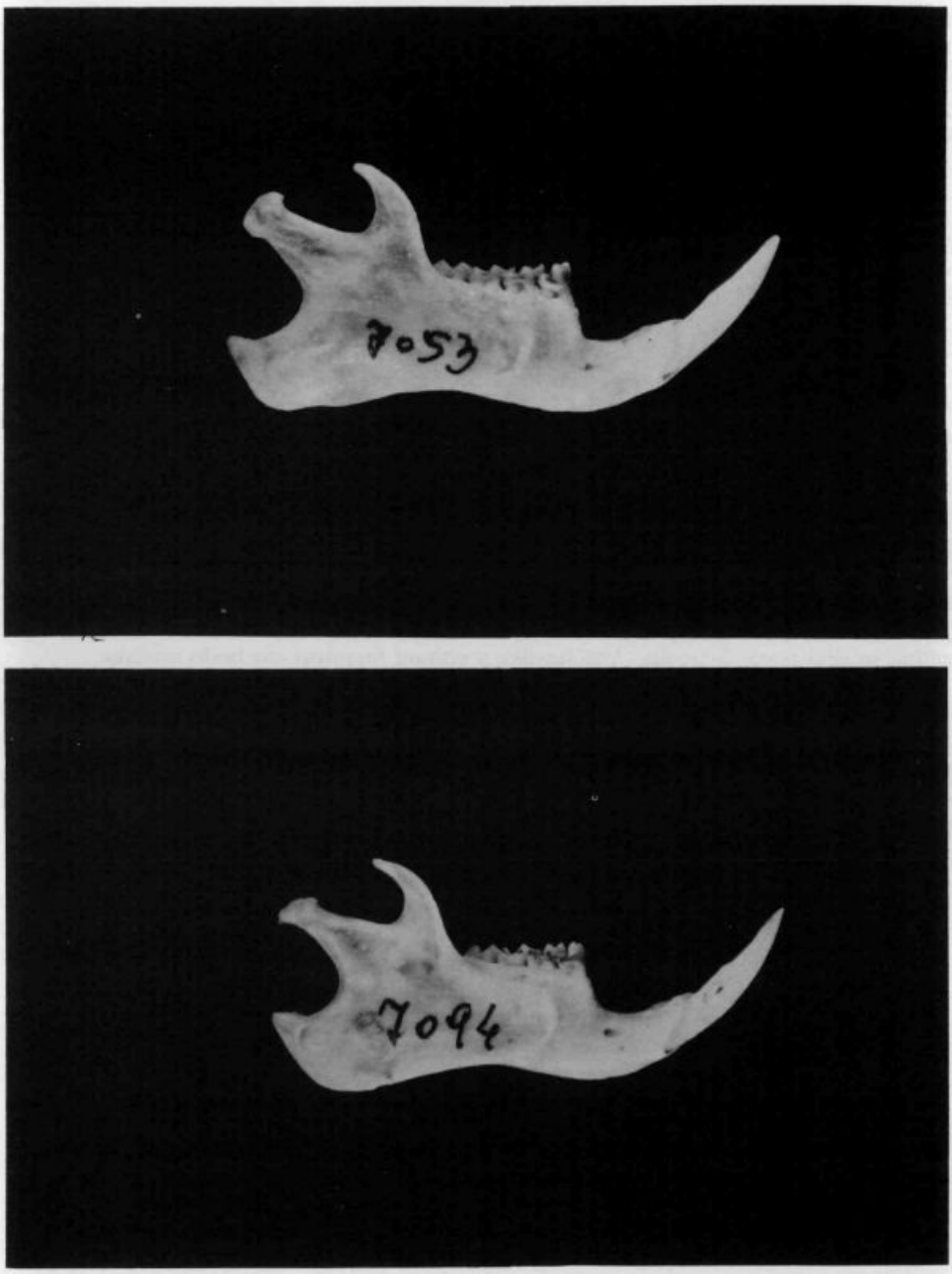


Fig. 28. Lateral side of the right mandible of (a) *Spermophilus citellus gradojevici* and (b) *S. c. karamani*.

Sl. 28. Bočna stran spodnje čeljustnice pri (a) tekunici *Spermophilus citellus gradojevici* in (b) *S. c. karamani*.