Bonn. zool. Beitr.	Bd. 45	H. 1	S. 1—16	Bonn, April 1994

The taxonomy of blind moles (*Talpa caeca* and *T. stankovici*, Insectivora, Mammalia) from south-eastern Europe

Boris Kryštufek

Abstract. Discriminant function analysis of 7 skull measurements, transformed to ratios with the condylobasal length of the skull as a denominator, suggests that the population of small blind moles from Ulcinj, Montenegro, with 2 n = 34, in fact belongs to *Talpa stankovici* and not to *T. caeca*. On the basis of studying additional cranial, dental and postcranial characters, it is described as a new subspecies: *T. s. montenegrina* ssp. n. Two subspecies are recognized within *T. caeca* from the western Balkans: *T. c. hercegovinensis* and *T. c. steini*. Neither *T. caeca* nor *T. stankovici* were similar to small blind moles from Asia Minor, which most probably represent an independent species, *T. levantis*.

Key words. *Talpa caeca*, *Talpa stankovici*, Balkan peninsula, taxonomy, distribution, new subspecies.

Introduction

Taxonomic studies of moles from the Balkan peninsula, most intensive at the end of the 1960's and at the beginning of the 1970's, resulted in the recognition of three taxa: *Talpa europaea*, *T. caeca*, and *T. romana stankovici* (Todorović 1970, Grulich 1971, Petrov 1971, 1974). More recent studies (Corti & Loy 1987, Filippucci et al. 1987) suggested that *T. stankovici* was an independent species. *Talpa europaea* is distinctive, not only by its karyotype (2 n = 34; Todorović et al. 1972) but also by having open eyes, i. e. the eyelids are not fused together. In the other two species the eyelids are fused together, and the eyes are completely covered by membranes (Petrov 1971). This character solved many problems since, in previous studies, *T. caeca* was segregated from *T. europaea* only by size, which caused much confusion. Petrov (1971) paid attention to the similarity between *T. caeca* and *T. stankovici* in Macedonia, but size permitted a clear distinction between the two species in this part of the Balkans, *T. caeca* being smaller. The diploid number in *T. stankovici* is 2 n = 34 (Todorović et al. 1972; figures with karyotypes are obviously mismatched in this paper) whilst *T. caeca* possesses an additional pair of small acrocentric autosomes, having 2 n = 36. Small blind moles ("*caeca*" morphotype) from Ulcinj, Montenegro, are characterized by the absence of the small acrocentric pair and have a "*stankovici*" karyotype, 2 n = 34 (Todorović et al. 1972).

The taxonomic position of moles with 2 n = 34 from Ulcinj remains unclear. Because of their small size they were usually regarded as *T. caeca* (Petrov 1974, 1992, Soldatović et al. 1986, Kryštufek 1991), although Todorović et al. (1972) initially reported them as *T. stankovici*.

The objectives of the present paper are to (i) establish the taxonomic position of blind moles with 2 n = 34 from Ulcinj, (ii) to describe geographic variation in blind moles from south-eastern Europe in the area between the Neretva and Vardar (Axios) Rivers, and (iii) to determine their subspecific status. Since *Talpa levantis* was recently reported from the eastern Balkans (Vohralik 1991), this species was also included in the analysis.

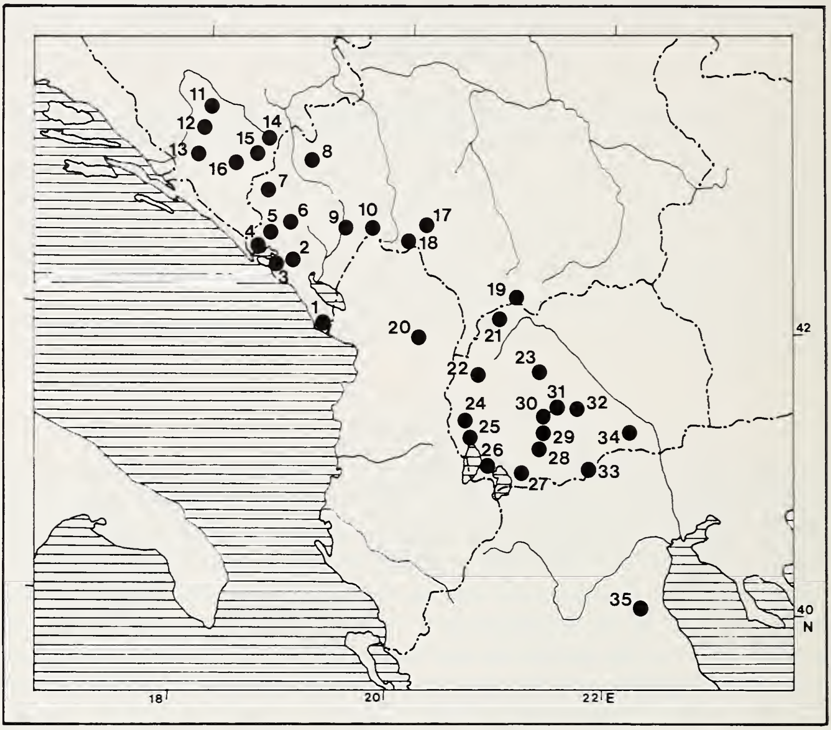


Fig. 1: Geographic distribution of the populations of the blind moles *Talpa caeca* and *Talpa stankovici* analyzed in this study.
Montenegro: 1 — Ulcinj, altitude 3—5 m; 2 — Cetinje, 670 m; Bjeloši, 1050 m; 3 — Mt Lovćen, Ivanova Korita, 1100—1200 m; 4 — Mt Orjen: Vrbanje, 1000—1200 m; Pakalj Do, 1350 m; 5 — Vilusi, 900—950 m; 6 — Nikšić: Donja Brezna, 980 m; Gvozd, Vućje, 1300 m; 7—11 km E Goslić, 1000 m; 8 — Durmitor Mts: Žabljak, 1500 m; Poljanak, 1580 m; Dobri Do, 1800 m; 9 — Monastry Morača, 1000 m; 10 — Mt Kom Vasojević, Štavna, 1800 m.
Herzegovina: 11 — Prenj Mts, Boračko jezero, 405 m; 12 — Rujište, 1100 m; 13 — Stolac; 14 — Čemerno, 1330 m; 15 — Gacko, 960 m; 16 — Mangrop, 1400 m.
Kosovo: 17 — Mt Žljeb, Kula, 1750 m; 18 — Rugovo, Kućište, 1300 m; 19 — Šar Planina Mts, Pavlov Kamen, 1750, 2000 m.
Albania: 20 — Trpojë.
Macedonia: 21 — Šar Planina Mts, Popova Šapka, 1750 m; 22 — Mt Bistra: Careva Češma, 1580 m; Brzovec, 2000 m; 23 — Mt Jakupica; 24 — Vratište, 700 m; 25 — Struga, 700 m; 26 — Mt Galičica, 1600 m; 27 — Mt Pelister: Magarevo, 1100 m; Begova Češma, 1430—1500 m; Golemo Ezero, 2200 m; 28 — Mogila, 585 m; 29 Topolčani, 585 m; 30 — Prilep, 700 m; 31 — Mt Babuna, Derven, 1100 m; 32 — Pletvar, 900 m; 33 — Kajmakčalan, Reder, 1780 m; 34 — Mt Kožuv, Dve Uši, 1650 m.
Greece: 35 — Mt Olympus, east slope, 800 m.

Material and Methods

I examined 166 skulls of blind moles from 35 localities (Fig. 1) in Herzegovina, Montenegro, Kosovo, Macedonia, Albania, and Greece. Eleven skulls of *Talpa levantis* from Asia Minor (including the type) were included in the analysis for comparative purposes.

Collections possessing the specimens listed under "Specimens examined" are: British Museum of Natural History, London (BMNH); Museo Civico di Scienze Naturali "E. Caffi", Bergamo (MCSN); Naturhistorisches Museum Wien, Vienna (NMW); Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK); Natural History Museum in Belgrade (PMBg); private collection of B. Petrov, Belgrade (BPC); Provincial Museum of Bosnia and Herzegovina, Sarajevo (ZMS); Slovene Museum of Natural History, Ljubljana (PMS).

Eight 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, IoC — interorbital constriction, BcB — braincase breadth, BcH — braincase height, RoC — rostral breadth over canines, RoM — rostral breadth over molars, MxT — maxillary tooth-row length, MdL — mandible length. Additional measurements were taken under the dissecting microscope: Rol — distance between the posterior alveolar margin of upper canine and the anterior alveolar margin of the fourth upper premolar, Ro2 — height of the rostrum at the posterior alveolar margin of the upper canine, Ro3 — height of the rostrum at the anterior alveolar margin of the fourth upper premolar.

Whenever available, skins and bones of the extremities and the pelvis were also examined.

Relations between geographic samples were assessed by discriminant function analysis and principal components analysis. The latter was based on the correlation matrix of z-standardized data. When comparing samples belonging to different karyotypes, the size effect was eliminated by dividing individual measurements by the condylobasal length (a single measurement best representing overall size), thus yielding ratios. As the ratios formed by size-related characters as denominators are shape measurers (Lemen 1983), the sexes were not separated when the statistical calculations were based on these ratios.

Results

Originally, moles ascribed to the "*caeca*" morphotype ("blind" specimens with CbL of 31.7 mm and less) were grouped into ten geographic samples. A discriminant function analysis of ratios suggested that the Ulcinj sample was the most distinct, showing very little overlap with the other groups (Fig. 2). Of the 74 specimens, 55 (74 %) were classified into the actual group while 19 (26 %) were not. All the Ulcinj specimens but one were allocated correctly. On the basis of the similarities suggested by this analysis, and taking into consideration their geographic origins, samples were pooled together, resulting in three groups. The data were then reanalyzed which resulted in a somewhat clearer representation, and formed a basis for my taxonomic conclusions (Fig. 3). All specimens from Ulcinj (group a in Fig. 3) were classified correctly, while there was some overlap between the other two groups. In total, 67 (91 %) specimens were allocated into the actual group, and only 7 (9 %) were misclassified. The most logical conclusion was to recognize three groups, designated at this step as OTU1 (sample 1), OTU2 (samples 2, 3, 4, 6, 7), and OTU3 (samples 8, 14, 15, 19, 21, 27, 31, 35). Moles of OTU1 were closer to OTU2 than to OTU3 in both the above analyses.

Once the original groups were defined, the discriminant function analysis permitted the classification of unknown specimens into the appropriate groups. Localities of single individuals were included in this analysis. Specimens from samples 5 and 16 were allocated to OTU2, and specimens from localities 9, 10, 11, 17, 18, and 34

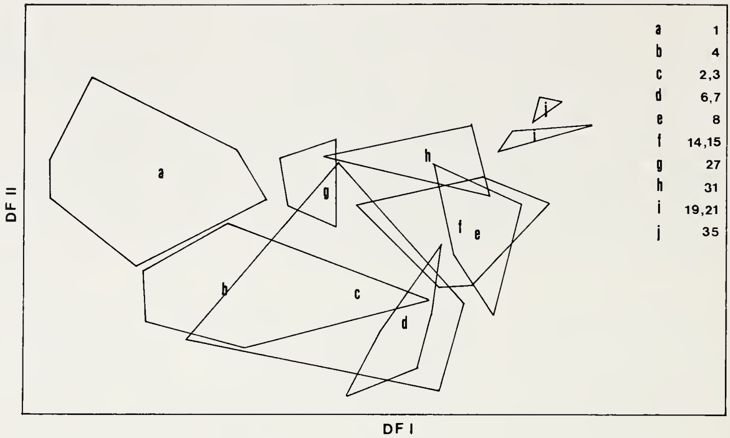


Fig. 2: Projection of ten locality groups of 74 moles of "*caeca*" morphotype on the first two discriminant functions. Polygons enclose scores for all individuals within a locality group, and letters are placed on group centroids. For identifying numbers see Fig. 1.

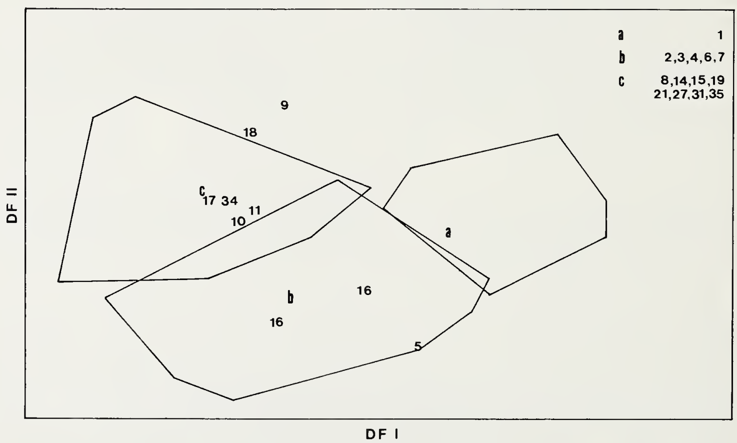


Fig. 3: Projection of three locality groups of 83 moles of "*caeca*" morphotype on the first two discriminant functions. Explanation as for Fig. 2.

to OTU3. These results were in accordance with the geographic origin of specimens.

When phenetic relations were established by recognizing three OTUs, another two taxa were introduced into the discriminant analysis. *Talpa stankovici* was of interest since Todorović et al. (1972) reported OTU1 to possess a "*stankovici*" karyotype. The same applies to *Talpa levantis* from Asia Minor, as this species was recently reported in the eastern part of the Balkans (Vohralik 1991). A discriminant function analysis,

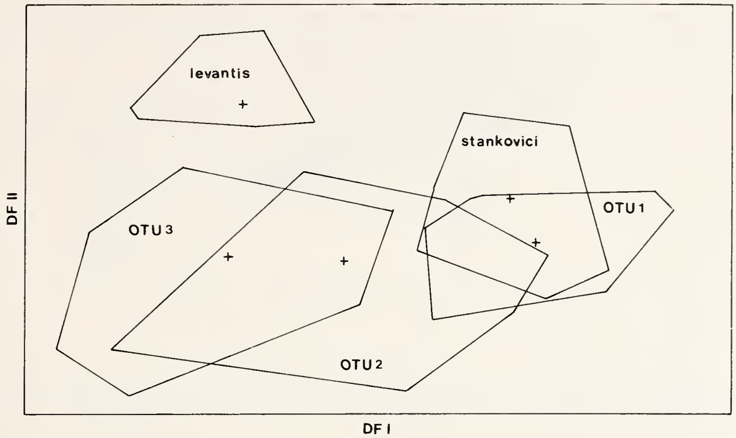


Fig. 4: Projection of five groups of 109 blind moles on the first two discriminant functions. Polygons enclose scores for all individuals within a group, and crosses are placed on group centroids. See text for explanation.

based on 109 skulls suggested that *T. levantis* was the most distinct (Fig. 4). Great overlap was evident on the one hand between *T. stankovici* and OTU1, i. e. the two groups of moles sharing the same "*stankovici*" karyotype (2 n = 34, NF = 66) and, on the other hand, between OTU2 and OTU3, the two taxonomic units with the "*caeca*" karyotype 2 n = 36, NF = 68 (Todorović et al. 1972). These results were in accordance with karyological evidence. Significant overlap between moles with "*stankovici*" and "*caeca*" karyotypes suggested a close similarity in skull shape between *T. stankovici* and *T. caeca*, already pointed out by Petrov (1971). In total, 87 (80 %) specimens were classified into the proper group.

This series of analyses indicated that the most logical classification for the blind moles of the Balkans was to regard OTU1 as *T. stankovici*, and to ascribe OTU2 and OTU3 to *Talpa caeca*, probably as two different subspecies. *Talpa levantis* appears to be an independent species and shows no phenetic relation to *T. caeca* from the western Balkans.

By a discriminant function analysis between OTU1 and the pooled sample of OTUs 2 and 3, 71 (96 %) specimens were classified into actual groups. Three measurements, IoC, BcB, and MxT, transformed to ratios with CbL as the denominator, had low discriminant function coefficients and contributed little to the discrimination between the groups; the reduction of parameters to four did not affect discrimination. All moles of OTU1 were classified into the proper group, whilst two specimens of OTU2 (both from Mt Orjen) and one of OTU3 (Mt Pelister), were allocated within the range of OTU1. The rostral breadth over the canines contributed most to the separation of the groups (Table 1). In general, the braincase was relatively higher and the rostrum broader in OTU1. A histogram showing the results of the discriminant function analysis is provided in Fig. 5.

Table 1: Standardized and unstandardized discriminant function coefficients for ratios of cranial characters formed with CbL as the denominator, permitting the discrimination between OTU1 and pooled OTUs 2 and 3. See also Fig. 5.

	Standardized Coefficients	Unstandardized Coefficients
BcB	0.457	36.085
RoC	0.740	162.932
RoM	0.267	29.874
MdL	0.440	47.934
Constant		—71.227

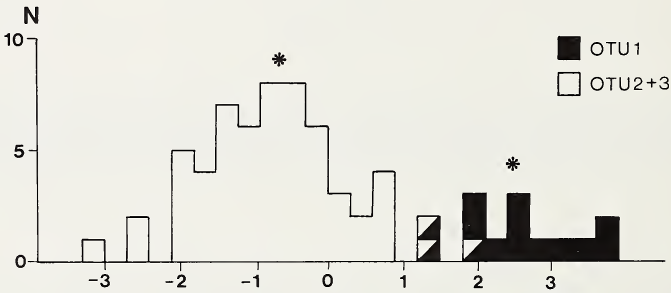


Fig. 5: A frequency histogram of the discriminant function for moles of "*caeca*" morphotype. Asterixes represent placement of group centroids.

Plotting the quotients of Ro1 : Ro2 against Ro1 : Ro3 provided a reasonable distinction between the groups defined previously (Fig. 6). Only three moles of OTU2 and one of OTU3 fell within the range of OTU1. *T. stankovici* overlapped with OTU1 and OTU2, but did not attain the lowest values of the former. The anterior part of the rostrum appeared to be the shortest and the highest amongst moles of OTU1.

I then tried to find qualitative characters in the skull, dentition and postcranial skeleton, which could confirm the individuality of the groups recognized previously.

Position of the anterior border of the infraorbital foramen (Fig. 7). Three morphotypes were distinguished:

Type A — the border was above the second upper molar;

Type B — the border was on the point of contact between the second and third upper molars;

Type C — the border was above the third upper molar.

Type A was characteristic of OTU1 and *T. stankovici* (Table 2), but the border of the foramen was even more anterior in the latter. The "intermediate" morphotype (B) was rare in these two groups, while type C was entirely absent. All three types were recorded in OTU2 and OTU3, but considerable regional differences were evident between the samples ascribed to OTU3. In the population from Herzegovina,

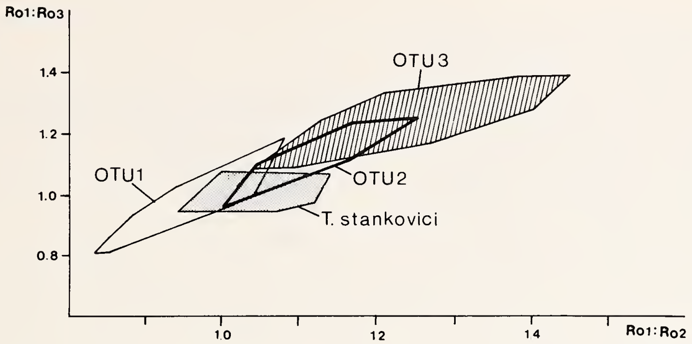


Fig. 6: Bivariate scatter plot of quotient Rol : Ro3 against quotient Rol : Ro2 for four groups of blind moles. Polygons enclose scores for all individuals within a group.

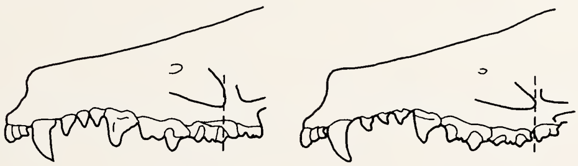


Fig. 7: Rostrum in two moles of "*caeca*" morphotype from Ulcinj (a) and Čemerno (b). The interrupted line indicates the position of the posterior border of the infraorbital foramen in relation to the second molar.

Table 2: Frequency of occurrence of different morphotypes in four groups of blind moles from the western Balkans. See text for explanation.

	T. stankovici	OTU1	OTU2	OTU3
For. infraorbitale	n = 11	n = 14	n = 32	n = 33
Type A	82 %	93 %	31 %	9 %
Type B	18 %	7 %	47 %	45 %
Type C			22 %	45 %
Palatinum	n = 22	n = 14	n = 13	n = 38
Type A	18 %		77 %	53 %
Type B	41 %	71 %	23 %	39 %
Type C	41 %	29 %		8 %
Pelvis	n = 19	n = 8	n = 13	n = 19
caecoidal	21 %	13 %	69 %	47 %
intermediate	37 %	50 %	23 %	26 %
europaeoidal	42 %	37 %	8 %	26 %

types B and C predominated. In Macedonian small blind moles type B was the most common, whilst type C was absent.

Posterior margin of palatine. The three morphotypes distinguished were based on the position of the medial part of the posterior palatine margin in relation to the line connecting the posterior alveolar borders of the last molars:
Type A — the palatine was anterior to the line;
Type B — the palatine was on the line;
Type C — the palatine was posterior to the line.

The palatine margin was more posterior in *T. stankovici* and OTU1 than in OTUs 2 and 3. Morphotype A, absent in OTU1 and rare in *T. stankovici*, predominated in the remaining groups. Morphotype C was not observed in OTU2, and was found only occasionally in OTU3.

First lower premolar (Fig. 8). A small distal cusp was always present and usually welldeveloped in *T. stankovici*. It was frequently absent in OTU1, but whenever present, it was always small. In OTU2 and OTU3 it was nearly always present, though frequently small. Its frequency was 100 % in *T. stankovici* (n = 19), 55 % in OTU1 (n = 11), 92 % in OTU2 (n = 13), and 95 % in OTU3 (n = 19).

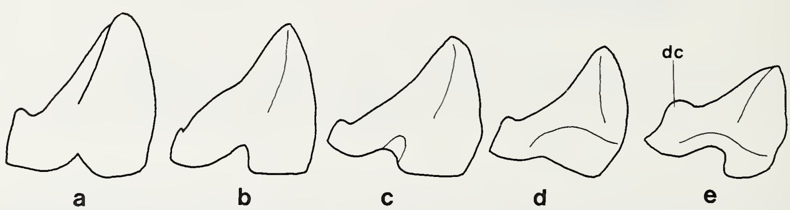


Fig. 8: Variability of the first lower premolar in blind moles from south-eastern Europe. a — *T. stankovici*; b — OTU1; c — OTU2 (Mt Orjen); d, e — OTU3 (d — Durmitor Mts; e — Prilep). The lingual side is shown; anterior is to the right; dc — distal cusp.

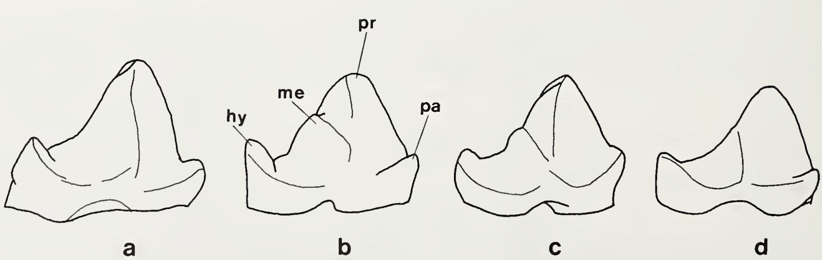
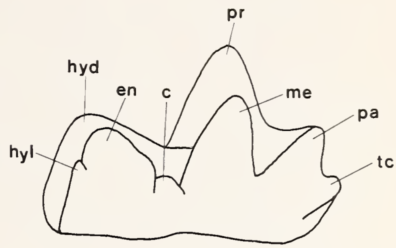


Fig. 9: Variability of the fourth lower premolar in moles of "*caeca*" morphotype. a — OTU1; b — OTU2 (Mt Orjen); c, d — OTU3 (Mt Pelister). The lingual side is shown; anterior is to the right; pr — protoconid, pa — paraconid, me — metaconid, hy — hypoconid.

Fig. 10: Third lower molar (scematic) of blind mole from Ulcinj. Lingual side; anterior is to the right; c — entocristid; en — entoconid; hyd — hypoconid; hyl — hypoconulid; me — metaconid; pa — paraconid; pr — protoconid; tc — thickening of cingulum.



Fourth lower premolar (Fig. 9). The metaconid was always absent in OTU1 and either missing or weakly developed in *T. stankovici*. In OTU2 it was nearly always present, and it was common in OTU3. Its frequency was 32 % in *T. stankovici* (n = 19), 0 % in OTU1 (n = 11), 92 % in OTU2 (n = 13), and 55 % in OTU3 (n = 31).

The hypoconid was usually higher than the paraconid in OTU1, whilst the opposite situation prevailed in OTU2 and OTU3. *T. stankovici* frequently had a somewhat reduced paraconid.

Third lower molar (Fig. 10). Entocristid was welldeveloped only in OTU1. It was weak or missing in OTU2 and OTU3, with the exception of one specimen from Mt Lovčen, on which it was clearly visible. In specimens of *T. stankovici* this cusp was either small or absent. Its frequency was 16 % in *T. stankovici* (n = 19), 40 % in OTU1 (n = 10), 9 % in OTU2 (n = 22), and 17 % in OTU3 (n = 29).

The hypoconulid was only welldeveloped in OTU1, and in two specimens from Orjen Mts (OTU2). In the other blind moles, OTU2 and OTU3, it was either absent, or if present, weakly developed.

Os falciformis (Fig. 11). The proximal part of this bone was more robust in OTU1 and *T. stankovici*, with a less conspicuous groove on the antero-lateral margin. The groove was well developed in OTU3, and in some specimens from OTU2.

Pelvis (Fig. 12). In the "europaeoidal" pelvis the bone bridge between the os sacrum and the ischia closes the 4th foramen sacrale from the caudal side. In the "caecoidal" pelvis such an anastomosis is missing, and the 4th sacral foramen is open caudally. Petrov (1971) reported the europaeoidal pelvis to be characteristic of *T. europaea* and of *T. stankovici*, and the caecoidal pelvis of *T. caeca*. Although the caecoidal pelvis prevailed in OTU2 and OTU3, a typical europaeodal condition was also recorded in 6 of 32 specimens (Table 2). In 8 additional specimens a bone bridge was formed, but it was either very thin and hardly closing the foramen, or else the sacrum and ischia were incompletely ossified in this region (designated as the "intermediate" condition in Table 2). In OTU1, typical europaeoidal and intermediate conditions prevailed.

Asymmetry was also observed in this region of the pelvis (Fig. 12d). In one specimen from OTU1, the bone anastomoses were perforated (Fig. 12c), a character not observed in the other moles examined.

None of the cranial, dental or postcranial characters analysed above provided a clear discrimination between OTUs. OTU1 showed several characters in common with *T. stankovici* (anterior border of infraorbital foramen, shape of posterior

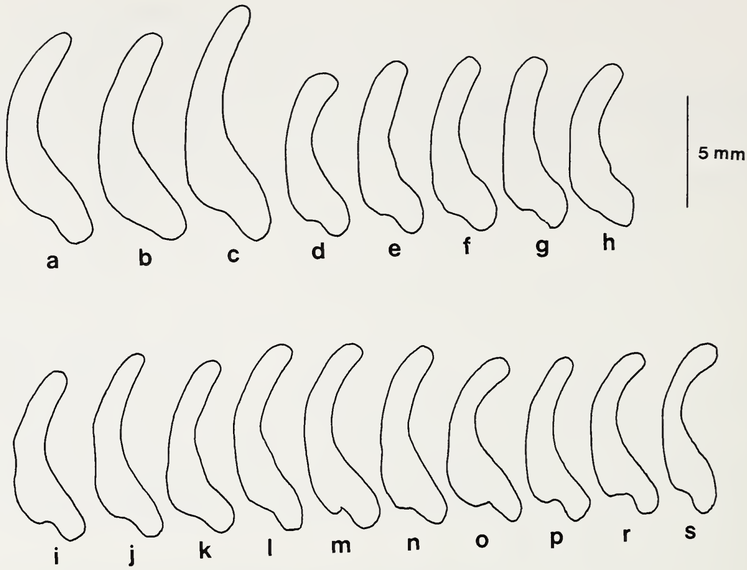


Fig. 11: Variability of the os falciformis in *Talpa stankovici* (a—c) and moles of the "*caeca*" morphotype from Ulcinj (d—h), Mt Lovčen (i), Mt Orjen (j—l), Vilusi (m), Vučje near Gvozd (n), Popova Šapka in Šar planina Mts (o), Derven (p), and Mt Pelister (r, s).

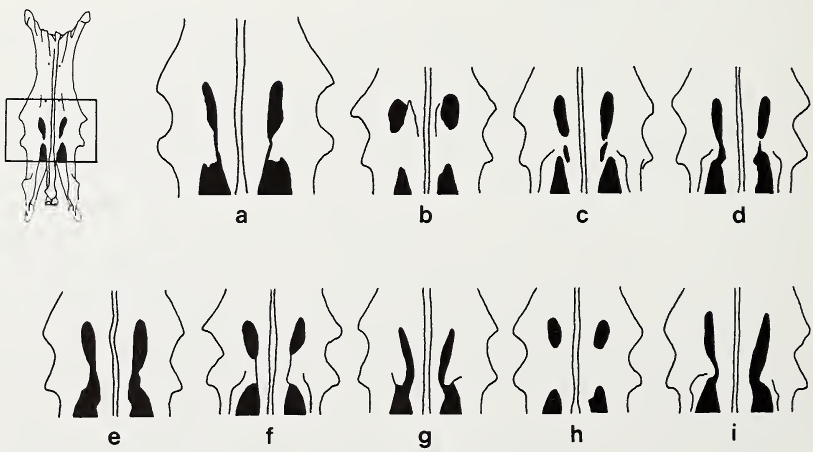


Fig. 12: Variability of the pelvis in the region of 4th foramen sacrale (dorsal side) in *Talpa stankovici* (a) and moles of the "*caeca*" morphotype from Ulcinj (b—e); Mt Lovćen (f); Vučje near Gvozd (g), and Mt Pelister (h, i). Morphotypes b and h are of the "europaeoidal" type; morphotypes a, d are asymmetrical; e, g, and i are of the "caecoidal" type; and morphotype f is of an intermediate type. Morphotype c ist atypical.

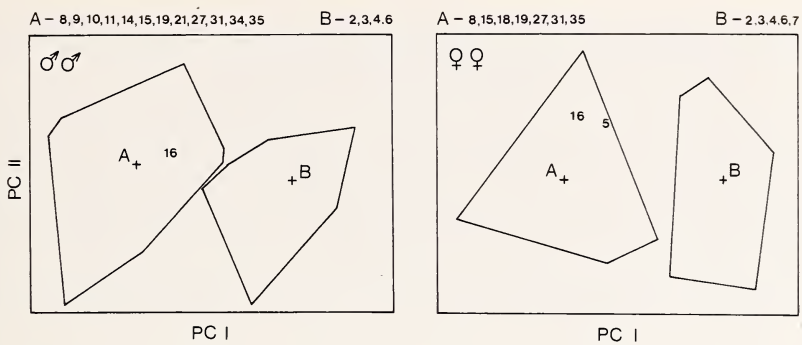


Fig. 13: Projection of (left) 43 male and (right) 21 female *Talpa caeca* on the first two principal components. Polygons enclose scores for all individuals within a group, and crosses are placed on group centroids. See Fig. 1 for identifying numbers.

palatine margin, metaconid on the fourth lower premolar, os falciformis, pelvis), although none of them clearly separated these two groups from OTUs 2 and 3. Taking into consideration the relatively common occurrence of the europaeoidal pelvis in *T. caeca* (OTUs 2 and 3), the separation of *T. caeca* and *T. europaea* also appeared difficult on skeletal characters alone. This result suggests an instability of meristic characters in the genus *Talpa*, and consequently great caution is needed when determining moles by morphological characters alone. Taxonomic conclusions are based on the results of discriminant function analysis, bivariate plotting, and published karyotypic data.

Taxonomy

Talpa caeca Savi

1822. *Talpa caeca* Savi. Type locality: Pisa, Italy.

Distribution: The Southern Alps of France, Italy and Switzerland, the Apennines, western Balkan Mountains between River Neretva and Mt Olympus. Findings below 1000 m rare in the Balkans, forming only 18 % of the records.

According to Corbet (1978) also known from Asia Minor and the Caucasus, but the pygmy moles of the Caucasus regarded as distinct (*T. caucasica* and *T. levantis*), a viewpoint supported by karyological evidence (Sokolov & Tembotov 1989). This study demonstrated *T. levantis* from Asia Minor to be phenetically distinct from the Balkan populations of *T. caeca*. Osborn (1964) listed pygmy moles from European Turkey as *T. caeca*, but Vohralik (1991) considered them, as well as the newly-collected material from the adjacent parts of Bulgaria, as *T. levantis*.

Diagnosis: Blind moles of small size (CbL below 31.7 mm); pelvis predominantly ceacoidal; posterior margin of infraorbital foramen mainly above the contact of the second and third upper molars or posterior to it; posterior border of palatinum frequently anterior to the line connecting the posterior alveolous of third molars; fourth lower premolar usually with metaconid; rostrum longer, lower (Fig. 6) and narrower than in *T. stankovici* (RoC makes 12–14 % of CbL, around 13 % on average; RoM makes 26–30 % of CbL, on average 28.2 %).

Karyotype: 2 n = 36, NF = 68. Specimens were analysed from Gacko, Mt Jakupica, and Mt Lovćen (Todorović & Soldatović 1969, Todorović et al. 1972).

Remarks: Only the western Balkan populations of this species are considered in this paper. They differ from the Alpine *T. caeca* in the fundamental number of chromosome arms: NF = 70 in the Alps, NF = 68 in the Balkans (Niethammer 1990).

Phenetic relations among geographic samples were re-estimated by the principal components analysis for males and females separately. Projection of samples onto the first two principal component axes (77.3 % and 72.1 % of variance explained for males and females, respectively) confirmed the existence of two groups (Fig. 13), as indicated by the previous discriminant function analyses. The groups were separated by principal component 1, which explained 65.8 % of the variance in the original data set in males, and 58.2 % of the variance in females. In both sexes this component had the highest eigenvector values for CbL and MdL, thus suggesting that the majority of interlocality variation in *T. caeca* was attributable to size. Moles from the coast of Montenegro (samples 2, 3, 4, and 6) were the largest. This group corresponds with OTU2 as defined by discriminant function analysis (Fig. 3). Moles from localities 5 and 16, allocated to OTU2 by discriminant function analysis, were placed within the polygon of smaller moles (group A in Fig. 13) in the principal components analysis: their subspecific position was left open. The second principal component (11.4 % and 13.8 % of variance explained in males and females, respectively) was mainly dependent on IoC and BcH, and was difficult to interpret.

Taxonomic conclusions were mainly based on the results of the principal components analysis. A group of small moles (A) was identified as *T. c. hercegovinensis*, and a group of large moles (B) as *T. c. steini*.

Talpa caeca hercegovinensis Bolkay

1925. *Talpa hercegovinensis* Bolkay.
1932. *Talpa olympica* Chaworth-Musters. Type locality: east slope of Mt Olympus, Greece, 800 m.
1971. *Talpa caeca beaucournui* Grulich. Type locality: Mt Pelister, Macedonia, 1800 m.

Holotype: An unsexed specimen, ZMS No. 293, mummified body in bad condition with a broken skull, obtained 18 May 1924. Type seen.
Type locality: Stolac, Herzegovina.
Geographic distribution: Mountains of Herzegovina, northern and north-eastern Montenegro, Kosovo, Albania, and Macedonia; Mt Olympus, Greece. Localities 8—15, 17—21, 27, 30, 31, 34, and 35 in Fig. 1. Vertical range between 405 and 2000 m asl; the majority of records (83 %) are from above 1000 m.
Diagnosis: Small subspecies, CbL below 29.7 mm (males), vs 28.4 mm (females).
Measurements: Listed in Table 3.
Specimens examined: (Total 54; see Fig. 1 for locality numbers). Montenegro: 8 — Durmitor Mts, 2 males, 1 female, 2 unsexed (1 PMS, 2 PMBg, 2 BPC); 9 — Monastry Morača, 1 male (PMS); 10 — Mt Kom Vasojević, 1 male (PMS); Herzegovina: 11 — Prenj Mts, Boračko jezero, 1 male (PMS); 12 — Rujište, 1 female (PMS); 13 — Stolac, 1 unsexed (ZMS; type of *hercegovinensis*); 14 — Čemerno, 1 male (PMS); 15 — Gacko, 12 males, 6 females, 1 unsexed (PMS); Kosovo: 17 — Mt Žljeb, 1 unsexed (PMS); 18 — Rugovo, 1 female (BPC); 19 — Pavlov Kamen, 1 male, 1 female (PMS); Albania: 20 — Trpojë, 1 unsexed (NMW); Macedonia: 21 — Popova Šapka, 1 male (PMS); 27 — Mt Pelister, 3 males, 2 females (4 PMS, 1 NMW); 30 — Prilep, 1 female (PMS); 31 — Mt Babuna, 1 male, 2 females (1 PMS, 2 BPC); 34 — Mt Kožuv, 1 male (BPC); Greece: 35 — Mt Olympus, 3 males, 5 females (BMNH, including type of *olympica*).

Talpa caeca steini Grulich

1971. *Talpa caeca steini* Grulich

Holotype: An adult male, collection of I. Grulich at the Institute of Systematic and Ecological Biology, Czechoslovak Academy of Sciences, Brno, No. 5446/114, obtained 22 June 1965. Type not seen.
Type locality: Mt Lovćen, Montenegro, 1300 m.

Geographic distribution: Montenegro: higher altitudes around the Boka Kotorska Bay, as far north as mountains just above Nikšić. Localities 2—4, 6, and 7 in Fig. 1. Vertical range between 670 and 1350 m asl; only two localities were below 1000 m.
Diagnosis: Large subspecies; Cbl above 29.5 mm (males), vs 28.2 mm (females).
Measurements: Listed in Table 3.
Specimens examined: (Total 40; for locality numbers see Fig. 1). — Montenegro: 2 — Cetinje and Bjeloši, 13 males, 2 females, 1 unsexed (MCSN); 3 — Mt Lovćen, 3 males, 3 females, 1 unsexed (4 PMS, 1 NMW, 2 BPC); 4 — Mt Orjen, 8 males, 3 females (7 PMS, 4 BPC); 6 — Nikšić, 3 males, 2 females (3 PMS, 2 BPC); 7—11 km E Goslić, 1 female (PMS).
Remarks: *Talpa caeca* is apparently larger in areas where not sympatric with other mole species, either *Talpa europaea* or the nominate subspecies of *T. stankovici*. Size reduction in the area of sympatry probably results from character displacement, following niche displacement.

Talpa stankovici V. & E. Martino

Geographic distribution: Western part of the central Balkans, west of the Vardar (Axios) River; north to Šar Planina Mts and Ulcinj; northern Greece (Mt Olympus and Ioannina) in the south; also the island of Corfu (Niethammer 1990, Petrov 1992). From sea level up to 2300 m.
Diagnosis: Blind moles; pelvis rarely typically caecoidal; posterior border of the infraorbital foramen usually above the second upper molar; metaconid on fourth lower premolar frequently missing; rostrum shorter, higher (Fig. 6) and broader than in *T. caeca* (RoC makes 12.6—15.1 % of CbL, above 13.5 % on the average; RoM makes 29.7—33.1 % of CbL, above 29 % on the average).
Karyotype: 2 n = 34, NF = 66 or 64. Animals analysed from Šar Planina Mts, Mt Jakupica, Mt Bistra, Mt Pelister, Ulcinj, Igoumenitsa, Corfu (Todorović et al. 1972, Soldatović et al. 1986, M. Macholan, pers. comm.).

Table 3: Mean (±SE) and range for eight skull characters of *Talpa stankovici montenegrina* ssp. n. and the two Balkan subspecies of *Talpa caeca*.

	T. c. hercegovinensis		*T. c. steini*		*T. s. montenegrina*	
	$\bar{x}$±SE	Range	$\bar{x}$±SE	Range	$\bar{x}$±SE	Range
Males	n = 22—28		n = 22—26		n = 9—10	
CbL	28.30±0.71	27.2—29.7	30.13±0.48	29.5—31.7	29.47±0.56	28.7—30.2
IoC	6.94±0.20	6.4— 7.4	7.07±0.20	6.6— 7.5	7.14±0.21	6.9— 7.6
BcB	14.11±0.37	13.5—15.1	14.67±0.36	13.7—15.3	14.60±0.30	14.2—15.0
BcH	8.13±0.36	7.4— 8.9	8.39±0.32	7.8— 9.3	8.33±0.19	8.0— 8.6
RoC	3.66±0.16	3.4— 4.0	3.91±0.15	3.6— 4.1	4.11±0.17	3.8— 4.3
RoM	7.63±0.26	7.2— 8.2	8.32±0.27	8.0— 9.1	8.54±0.28	8.2— 9.0
MxT	10.89±0.34	10.3—11.6	11.88±0.20	11.5—12.3	11.73±0.34	11.4—12.4
MdL	18.28±0.52	17.2—19.3	19.70±0.36	19.2—20.5	19.62±0.44	18.9—20.4
Females	n = 14—21		n = 8—12		n = 6—7	
CbL	27.84±0.37	27.1—28.4	29.19±0.50	28.2—30.0	28.98±0.31	28.4—29.3
IoC	6.94±0.20	6.6— 7.5	6.98±0.18	6.7— 7.4	7.20±0.10	7.1— 7.3
BcB	13.95±0.22	13.6—14.3	14.30±0.23	14.0—14.7	14.50±0.22	14.1—14.7
BcH	8.01±0.29	7.6— 8.5	8.05±0.42	7.5— 8.7	8.33±0.24	7.9— 8.6
RoC	3.63±0.17	3.4— 4.0	3.80±0.16	3.5— 4.0	4.10±0.08	4.0— 4.2
RoM	7.56±0.27	7.1— 8.2	8.28±0.36	7.8— 8.8	8.51±0.22	8.2— 8.7
MxT	10.85±0.23	10.3—11.3	11.56±0.28	11.0—11.9	11.53±0.16	11.2—11.7
MdL	17.91±0.41	17.1—18.5	19.10±0.34	18.4—19.5	19.21±0.23	18.8—19.5

Talpa stankovici stankovici V. & E. Martino

1931. *Talpa romana stankovici* V. & E. Martino

Holotype: An adult male, Zoological Institute, Academy of Sciences, Sanct Petersburg, No. 537 M. c., obtained 26 August 1928. Type not seen.
Type locality: Magarevo Village, Mt Pelister, Macedonia, 1000 m.
Geographic distribution: Macedonia, west of the River Vardar, and north to Šar Planina Mts. Southern border unknown; specimens from NW Greece differ from those from Macedonia (including type locality population) in the position of the centromere on 14th and 16th chromosome pairs (Soldatović et al. 1986).
Diagnosis: Large subspecies, CbL above 31.6 mm; distal cusp on lower premolar always present; metaconid on fourth lower premolar present in approximately one third of specimens.
Measurements: See Kryštufek (1987).
Specimens examined: (Total 52; for locality numbers see Fig. 1). — Macedonia: 21 — Popova Šapka, 5 males, 5 females (4 PMS, 6 BPC); 22 — Mt Bistra, 5 males, 2 females (6 PMS, 1 BPC); 23 — Mt Jakupica, 1 unsexed (PMS); 24 — Vratište, 2 males, 1 female (1 PMS, 2 BPC); 25 — Struga, 2 males (1 PMS, 1 BPC); 26 — Mt Galičica, 4 males, 1 female (4 PMS, 1 BPC); 27 — Mt Pelister, 3 males, 2 females (3 PMS, 2 BPC); 28 — Mogila, 5 males (2 PMS, 3 BPC); 29 — Topolčani, 2 males, 1 female (BPC); 30 — Prilep, 2 males (1 PMS, 1 BPC); 31 — Mt Babuna, 3 males, 2 females (1 PMS, 4 BPC); 32 — Pletvar, 1 male (BPC)); 33 — Mt Kajmakčalan, 2 males, 1 female (2 PMS, 1 BPC).

Talpa stankovici montenegrina, new subspecies

Holotype: An adult female, PMS 3205, skin, skull, and pelvis, obtained 14 November 1983 by B. Kryštufek and M. Štangelj.
Type locality: Ulcinj, Montenegro, approximately 5 m asl.
Geographic distribution: Known only from sandy beaches between the town of Ulcinj and the Bojana (Drini) River (point 1 in Fig. 1). All records are from the coastal area, between 3 and 5 m asl.
Diagnosis: Small blind mole with "*stankovici*" karyotype (Todorović et al. 1972). Easily distinguished from the nominate subspecies by smaller size alone (CbL below 31 mm). For other characters see Table 3 and text.

Because of its small size, it appears morphologically similar to *T. caeca*, but rostrum shorter, higher (Fig. 6) and broader. Posterior border of palatinum foramen in the majority of specimens not anterior to the line connecting the posterior margin of alveolus of last molars; metaconid on fourth lower premolar always absent. Other diagnostic characters as for the species.
Measurements: Measurements (in mm) of the holotype are as follows: CbL, 28.4; IoC, 7.2; BcB, 14.1; BcH, 7.9; RoC, 4.2; RoM, 8.7; MxT, 11.2; MdL, 18.8. Means and ranges of all specimens examined are listed in Table 3.
Etymology: Name according to the area of origin: Montenegro.
Specimens examined: (Total 17). Montenegro: Ulcinj, 9 males, 7 females, 1 unsexed (11 PMS, 2 ZFMK, 4 BPC).

Acknowledgements

I thank the following people who provided access to specimens in their care: P. Jenkins (BMNH), M. Valle (MCSN), F. Spitzenberger and K. Bauer (NMW), Đ. Mirić (PMBg), B. Petrov (BPC), and S. Obratil (ZMS). G. Džukić (Belgrade) provided useful information on the exact origin of Ulcinj moles collected by Z. Dunđerski for karyological analysis. M. Macholan (Brno) allowed to use unpublished karyological data of *Talpa stankovici* from the type locality, and H. Griffiths (Leeds) improved the English version. An anonymous reviewer provided valuable comments on the earlier draft of this paper.

Zusammenfassung

Kleine Blindmaulwürfe mit 2 n = 34 Chromosomen aus Ulcinj, Montenegro, gehören nach den Resultaten einer Diskriminanzanalyse von 7 Schädelmaßen nicht zu *Talpa caeca*, sondern zu *T. stankovici*. Auf der Basis weiterer Schädel-, Zahn- und Skelettstudien wird dafür ein neues Taxon, *T. s. montenegrina* ssp. n., aufgestellt. Bei *Talpa caeca* vom Balkan können zwei Unterarten getrennt werden, *T. c. hercegovinensis* und *T. c. steini*. Weder *T. caeca* noch *T. stankovici* ähneln den kleinen Blindmullen aus Kleinasien, die wohl eine eigene Art *T. levantis* darstellen.

References

Corbet, G. B. (1978): The mammals of the Palaearctic Region: a taxonomic review. — British Museum (Nat. Hist.) & Cornell Univ. Press, London.

Corti, M. & A. Loy (1987): Morphometric divergence in southern European moles (Insectivora, Talpidae). — Boll. Zool. 54: 187—191.

Filippucci, M. G., G. Nascetti, E. Capanna & L. Bullini (1987): Allozyme variation and systematics of European moles of the genus *Talpa* (Mammalia, Insectivora). — J. Mamm. 68: 487—499.

Grulich, I. (1971): Zur Variabilität von *Talpa caeca* Savi aus Jugoslawien. — Acta Sc. Nat. Brno 5 (9): 1—47.

Kryštufek, B. (1987): Skull variability of *Talpa romana stankovici* from Macedonia. — Acta theriol. 32: 463—474.

Kryštufek, B. (1991): Taxonomic review of *Talpa caeca* Savi, 1822 from Yugoslavia. — I. European congress of mammalogy, Lisboa, Abstracts, p. 140.

Lemen, C. A. (1983): The effectiveness of methods of shape analysis. — Fieldiana Zoology 15: 1—17.

Niethammer, J. (1990): *Talpa stankovici* V. et E. Martino, 1931 — Balkan-Maulwurf. — In: J. Niethammer & F. Krapp (eds.): Handbuch der Säugetiere Europas 3/1. AULA Verlag, Wiesbaden, pp. 141—144.

Niethammer, J. (1990): *Talpa caeca* Savi, 1822 — Blindmaulwurf. — In: J. Niethammer & F. Krapp (eds.): Handbuch der Säugetiere Europas 3/1. AULA Verlag, Wiesbaden, pp. 145—156.

Osborn, D. J. (1964): Notes on the moles of Turkey. — J. Mamm. 45: 127—129.

Petrov, B. M. (1971): Taxonomy and distribution of moles (genus *Talpa*, Mammalia) in Macedonia. — Acta Musei Macedonici Sci. Nat., Skopje 12 (6/107): 117—138.

Petrov, B. M. (1974): Einige Fragen der Taxonomie und die Verbreitung der Vertreter der Gattung *Talpa* (Insectivora, Mammalia) in Jugoslawien. — Symposium theriologicum II, Academia, Praha, pp. 117—124.

Petrov, B. M. (1992): Mammals of Yugoslavia — Insectivores and Rodents. — Nat. Hist. Mus. Suppl. 37, Beograd.

Sokolov, V. E. & A. K. Tembotov (1989): Mlekopitajuščie Kavkaza: Nasekomojadnie. — Nauka, Moscow.

Soldatović, B., Z. Dunđerski & M. Todorović (1986): A new mole karyotype from the Balkans. — Arhiv biol. nauka, Beograd 38: 9P—10P.

Todorović, M. (1970): Variability of the mole (*Talpa*) in Macedonia. — Arhiv biol. nauka, Beograd 19: 183—191.

Todorović, M. & B. Soldatović (1969): The karyotype of the subspecies *Talpa mizura hercegovinensis*. — Arhiv biol. nauka, Beograd 21: 5P—6P.

Todorović, M., B. Soldatović & Z. Dunđerski (1972): Karyotype characteristics of the population of the genus *Talpa* from Macedonia and Montenegro. — Arhiv biol. nauka, Beograd 24: 131—139.

Vohralik, V. (1991): A record of the mole *Talpa levantis* (Mammalia: Insectivora) in Bulgaria and the distribution of the species in the Balkans. — Acta Univ. Carolinae — Biol. 23: 119—127.

Dr. Boris Kryštufek, Slovene Museum of Natural History, Prešernova 20, PO Box 290, 61001 Ljubljana, Slovenia.