Zdzisław PUCEK & Georgi MARKOV

SEASONAL CHANGES IN THE SKULL OF THE COMMON SHREW FROM BULGARIA

SEZONOWA ZMIENNOŚĆ CZASZKI RYJÓWKI AKSAMITNEJ Z BUŁGARII

Seasonal changes in the skull of the common shrew were described for the first time by Dehnel (1949) in three species: *Sorex araneus* Linnaeus, 1758, *S. minutus* Linnaeus, 1766 and *S. caecutiens* Laxmann, 1788. The existence of changes in the skull was next confirmed in the case of several populations of *S. araneus* from the Palaearctic and also of other species of the genus *Sorex* L. (for references—see Pucek, 1963).

The aim of the present article is to trace the course taken by seasonal changes in the skull of *S. araneus* from Bulgaria and to compare amplitudes of fluctuations in the height of the braincase of shrews in populations geographically distant from each other: southern — from Bulgaria, and northern — from Białowieża (Poland).

The material studied was composed of 156 skulls of *S. araneus* Linnaeus, 1758 from Bulgaria (Vitoshya Mts. — 89, Balkan Mts. — 27, Rila Mts. — 27 [1]), Rhodope Mts. — 6, Osogovo — 6, Srednia Gora Mts. — 1). The majority of the material came from the collection in the Zoological Institute of the Bulgarian Academy of Sciences (133), and the remainder from collections in the Zoological Institute of the USSR Academy of Sciences in Leningrad (15) and the National Museum in Prague (6).

In connection with the state of preservation of the specimens the number of different craniometrical measurements is smaller than the sum total of specimens examined (Tab. 1). The age of the animals was determined on the basis of the extent to which the teeth were worn (chiefly unicuspid teeth), the state of the fur and the sutures of the skull. This made it possible to distinguish accurately between the subadult and old adult specimens. Simultaneously with the craniological examinations, a series of histological preparations were made from 8 specimens collected during the period from February to May 1964 in the Vitoshya Mts. The sections were stained both with haematoxylin and eosyne and also by Mallory's method, as modified by Cason (1950).

Table 1 presents the results of our craniometrical measurements. The present investigations confirm that the condylobasal length does not exhibit seasonal fluctuations (cf. also Dehnel, 1949 and others). In the shrews from Bulgaria this dimension varies within limits of 18.2—20.0 mm, although 80% of the specimens come within narrower limits of 18.8—19.6 mm. These divisions, and also the arithmetical means, are slightly shifted in plus in comparison with the shrews from the Białowieża Primaeval Forest (18.1—19.7 mm; $\bar{x}$ = 18.93; n = 275, according to Pucek, 1955).

The maximum breadth of the braincase varies from 9.1 to 10.0 mm. Divisions of variation for 95% of the specimens come within limits of 9.3—9.9 mm.

---

1) Measurements were also included of small winter specimens which had previously been described (Markov, 1957) as *Sorex macropygmaeus araneoides* Ognev, 1921 (= *S. a. petrovi* Martino, 1839). (Cf. also — Markov & Tatarinov, 1963).

Table 1.

Variations in some craniological measurements of *S. araneus* from Bulgaria.

Messurement	Season	Age	N	Min.	Max.	Avg.
Cb.–lenth	Whole material	S+A	147	18.2	20.0	19.09
Maximal breadth of the braincase	VI—X	S	48	9.3	9.9	9.58
	XI—II	S	17	9.1	9.6	9.41
	III—X	A	63	9.3	10.0	9.67
	Total	S+A	128	9.1	10.0	9.60
Depth of the braincase	VI—VIII	S	29	5.6	6.4	5.96
	IX—XI	S	31	5.5	6.1	5.76
	XII—II	S	18	5.0	5.6(5.8)	5.37
	III—V	A	28	5.4	6.0	5.69
	VI—VIII	A	35	5.5	6.1	5.75
	IX—X	A	12	5.4	5.9	5.58
	Total	S+A	153	5.0	6.4	—

S—subadult (=young animals), A—old adult

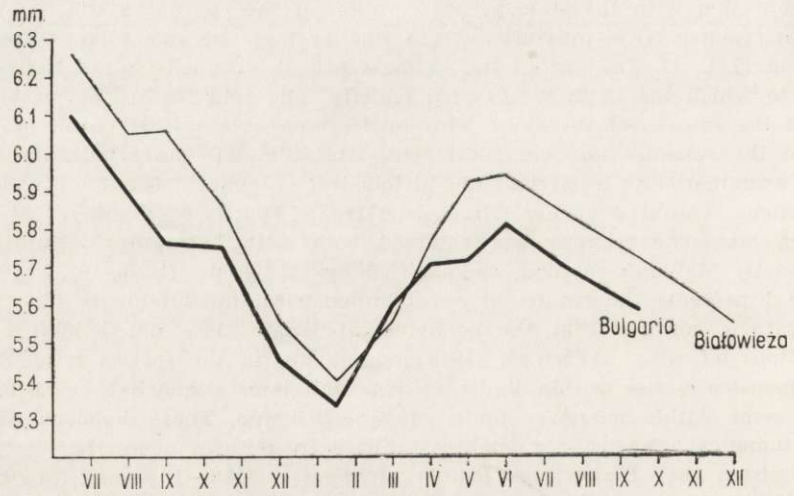

Fig. 1. Changes in the depth of the braincase in shrews from Bulgaria and Białowieża.

The skulls of shrews from the Białowieża population are slightly broader (9.2—10.3 mm, $\bar{x}$ = 9.75). In the material analysed here the maximum breadth of the braincase exhibits slight seasonal changes. In specimens from the winter months the skull is about 2% narrower than in the summer. Differences be-

tween the winter and old adults from the summer months are greater. In both cases these differences are statistically significant, with a probability, respectively, of $P<0.01$ and $P<0.001$. Similar differences have also been demonstrated by certain other authors (e. g. Dehnel, 1949; Schubarth, 1958; Pucek, 1963).

The height of the braincase measured per *bullae tympanici* exhibits distinct seasonal changes. Table 1 gives the limits of variation and arithmetical means for different seasons of the cycle of these animals, and the course taken by changes in these dimensions is illustrated in greater detail in fig. 1. It can be seen from these data that the height of the braincase is greatest in young specimens in the summer (5.6—6.4 mm). In the autumn and winter up to Febru-

Table 2.

Comparison of the seasonal changes in the depth of braincase in shrews from Bulgaria and Białowieża (Data for Białowieża according to Pucek, 1955).

Season		Bulgaria n	$\bar{x}$	σ	Białowieża n	$\bar{x}$	σ	Difference
1. Summer (VII—VIII)* subadult		27	5.95	0.1912	45	6.11	0.1784	significant $P<0.001$
2. Winter (I—II), subadult		12	5.33	0.1679	35	5.40	0.1917	insignificant
3. Summer (VI—VIII), old adult		35	5.75	0.1465	81	5.88	0.1387	significant, $P<0.001$
Difference:	1—2	—0.62 (—10.4%)			—0.71 (—13.1%)			
	2—3	+0.42 (+7.9%)			+0.48 (+ 8.9!)			

* Only two animals were caught in June.

ary inclusively the skull flattens and during the period from December-February this dimension varies within limits of 5.0—5.6 mm (exceptionally 5.8, in one specimen only from December). In old adults as from March the height of the braincase increases, attaining a second maximum in the life of the shrews in June ($\bar{x} = 5.81$, $n = 15$). Both the limits of variation and the arithmetical means of this dimension again decrease at the end of summer and in the autumn. This process continues until the animals' death. In the case of our material it proved possible to trace it only up to October ($\bar{x} = 5.58$, $n = 12$).

Variations in the microscopical structure of the bone can be considered both as a criterion of occurrence or absence of seasonal changes in the skull of the shrew. Material as abundant as is necessary in craniometrical examinations is not necessary for observations of this type. In our material no changes were observed in the microscopical structure of the sutures in specimens from February. In individuals caught in the spring period (April, May) distinct new-growths of cartilage and new bone tissue were visible on the margins of *ossa parietalia* and *occipito-interparietale*. Histological observations, like the differences in the macroscopical appearance of the sutures and bones of the arch of the skull in subadults and old adults, provide complete confirmation of the changes found in this species in the Białowieża population (Pucek, 1957).

Initial material on the geographical differences in the course taken by seasonal changes in the skull of the shrew was presented in an earlier paper (Pucek, 1963). The new material discussed in the present paper enabled a more detailed comparison of fairly extreme populations from Bulgaria and Białowieża to be made. Table 2 contains a comparison of the mean values at three principal points of the curve of changes in the skull. In order to increase the number of specimens in each of the groups compared, comparison was made not of single months but of seasons. In the first case the differences were appropriately greater. It is clear from the table referred to above that the arithmetical means in the height of the braincase during the summer period, both in subadult and in old adults, are smaller in Bulgaria than at Białowieża. These differences are statistically significant on the level of $P<0.001$ (t-Student test). During the winter no statistically significant differences were revealed between the groups compared.

The amplitude of seasonal variations is also different. As shown by Table 2, flattening of the skull before the winter is less marked in Bulgaria (— 10.4‰) than at Białowieża (— 13.1‰). Analogical differences are observed in the arching of the skull during the spring period. These two regions are separated from each other by 10° of geographical longitude, but lie in more or less the same east geographical longitude — 23—24°. Bearing in mind, however, that shrews in Bulgaria were caught only in mountain regions (1300—1800 m above sea level) very great climatic differences between the territories compared should not be expected. If, for instance, we examine the monthly means of atmospheric temperature it will be seen that they are about 2 °C higher in January and about 3 °C lower in July, in Bulgaria than in Białowieża. Differences of this order may in our opinion affect the shift in curves of variation in different areas (cf. also Niethammer, 1956). This may also apply to certain periods only in the life cycle of the shrew. Even so in both the areas compared here, during the summer, autumn and winter, both in subadults and in old adults, curves of variation in the height of the skull take almost parallel courses, and also at ± the same rate. During the spring period the two curves overlapped and therefore the spring arching in the skull of shrews from Bulgaria takes place at the same time (March-April) and more intensively. It is not until the later period (May) that this process slows down, while in shrews from Białowieża it continues to progress intensively.

REFERENCES

Dehnel A., 1949: Badania nad rodzajem *Sorex* L. Ann. Univ. M. Curie-Skłodowska, C *4:* 17—102. Lublin. Markov G., 1957: Nasekomojadnite bozajnici v B'lgarija. Fauna na B'lgarija *3:* 1—287. BAN, Sofija. Markov G., & Tatarinov A. K., 1963: Fauna ssavciv staroj planiny i Ukrainskih Karpat. Zbirnik prac zool. muz., *32:* 43—49. Kijev. Niethammer J., 1956: Das Gewicht der Waldspitzmaus, *Sorex araneus* Linné, 1758, im Jaresverlauf. Säugetierkdl. Mitt., *4:* 160—165. Pucek Z., 1955: Untersuchungen über die Veränderlichkeit des Schädels im Lebenszyklus von *Sorex araneus araneus* L. Ann. Univ. M. Curie-Skłodowska C *9:* 163—211. Pucek Z., 1957: Histomorphologische Untersuchungen über die Winterdenpression des Schädels bei *Sorex* L. und *Neomys* Kaup. Ibidem C *10:* 399—428. Pucek Z., 1963: Seasonal changes in braincase of some representatives of the genus *Sorex* from Palearctic. J. Mamm., *44:* 523—532. Schubarth H., 1958: Zur Variabilität von *Sorex araneus araneus* L. Acta theriol., *2:* 175—202. Białowieża.

Mammals Research Institute, Polish Academy of Science, Białowieża, Institute of Zoology, Bulgarian Academy of Sciences. Sofia.