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CRANIAL EPIGENETIC POLYMORPHISM AND POPULATION DIFFERENTIATION OF THE FOREST DORMOUSE (DRYOMYS NITEDULA PALL., 1779) IN BULGARIA

G. MARKOV

Institute of Zoology, 1 Tzar Osvoboditel, 1000 Sofia, Bulgaria
E-mail: geomar@datacom.bg

Variability of non-metric traits was studied on skulls of 75 individuals of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) from three populations located in the Mountain systems: Stara planina – Central Balkans, Vitosha Mountain and mountain territories in Southeastern Bulgaria and populations originating from hill forests in northeastern Bulgaria. The analysis of epigenetic variability of the four groups of *D. nitedula*, based on 12 epigenetic characters, revealed that it is similar in all the populations studied from the mountain systems varying from Vi = 0.087 to Vi = 0.06208. The epigenetic variability of the population of Forest dormouse from hill forests in Northeastern Bulgaria scores relatively higher than the average for the mountain populations of this species (Vi = 0.10807).

The occurrence frequency of the non-metric characters studied was used to determine the mean measure of inter-population divergence. The cranial epigenetic polymorphism found in the Forest dormouse of Bulgaria and its population differentiation reveal the lack of clearly distinct epigenetic population differentiation excepting the population inhabiting the mountain territories in Southeast Bulgaria, where the population expresses the micro-geographic epigenetic fragmentation of the Forest dormouse in Bulgaria.

Key words: epigenetic polymorphism, Forest dormouse, *Dryomys nitedula*, population differentiation

INTRODUCTION

The high degree of ecological adaptation of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) allows it to cover a large area of the European continent (KRYŠTUFEK 1999). The presence of bushes and thick undergrowth are the main habitat requirements of this species (AIRAPET'YANTZ 1983) and it occurs mainly in deciduous and coniferous woodlands in Bulgaria, wherever suitable conditions are present (MARKOV 1959). In the forest ecosystems throughout Bulgaria, the Forest dormouse inhabits biotopes which are quite variable in their physical geographical conditions (TISHKOV 1976).

The distribution of the Forest dormouse in Bulgaria is relatively well known (MARKOV 1959). By contrast, a good description of its somatometric and cytotaxonomic characteristics (MARKOV *et al*. 1997), knowledge of its micro-geographical cranial variability (MARKOV 2001), the non-metric epigenetic character-

istics of its populations in relation to the differentiation of its habitats with diverse ecological conditions are so far unknown.

This determined the goal of the present study: to establish the frequencies of non-metric cranial characters, on the basis of which to determine the epigenetic variability and the mean measure of divergence between Forest dormouse populations from its main habitats in the country, which are characterized by a diversity of ecological conditions.

MATERIAL AND METHODS

Variability of non-metric traits was studied on skulls of 75 individual Forest dormice from four Bulgarian populations. Three of them are located in the mountains: Stara planina (Population 1–23 specimens, female = 11, male = 12), mountain territories in Southeastern Bulgaria (Population 2–21 specimens, female = 10, male = 11), Vitosha Mountain (Population 3–20 specimens, female = 10, male = 10), and one population originating from hill woodlands in northeastern Bulgaria (Population 4–11 specimens, female = 6, male = 5) (Fig. 1). Age was determined after LOZAN (1961).

The appearance of 12 cranial traits, representing orifices of nerves and blood vessels, was recorded. These traits were chosen from the ones used by BERRY (1963), BERRY and SEARLE (1963) and HEDGES (1969) for rodents and were observed on the skull's left side. Their status was read as follows: 1. Fenestra flocculy – present; 2. Preorbital foramen – double; 3. Anterior frontal foramen – present; 4. Posterior frontal foramen – present; 5. Maxillary foramen I – present; 6. Maxillary foramen II – present; 7. Foramen sphenoidale medim – present; 8. Processus pterygoideus – present; 9. Foramen ovale – double; 10. Foramen hypoglossi – double; 11. Foramen basioccipitale – present; 12. Foramen mental – double.

The independent appearance of the features studied in different age and sexual groups was examined by applying the χ^2-test using the statistical package Statistica for Windows (1993).

The epigenetic variability (Vi) and the measure of uniqueness (MU) for each of the 4 examined populations, as well as the mean measure of divergence (MMD) between each population and all the others were computed on the grounds of the established frequency distribution of the 12 examined epigenetic traits. The statistical analysis of the epigenetic diversity and differentiation between the four Forest dormouse populations was carried out using the methods proposed by BERRY (1963, 1968), SJŘVOLD (1973) and SMITH (1981).

RESULTS

The appearance of the epigenetic characteristics of the Forest dormouse in the different age (juvenile and adult individuals) and sex (males and females) groups is similar. The test for independence of the frequency distribution of the studied cranial traits revealed that they do not depend on sex ($\chi^2 = 0.2223 < \chi^2_{0.001;11} = 31.264$) or on age of the studied animals ($\chi^2 = 0.2018 < \chi^2_{0.001;\,11} = 31.264$). The proven absence of sexual dimorphism and age dependence in the expression of the studied

Table 1. Frequency distribution of the non-metric craniological traits within populations of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) from Bulgaria: 1 = Stara Planina, Central Balkan, 2 = mountain territories in southeastern Bulgaria, 3 = Vitosha Mountain, 4 = hill forests in northeastern Bulgaria

No. of traits	Populations			
	1	2	3	4
	N = 23	N = 21	N = 20	N = 11
1	0.4783	0.4000	0.5715	0.6250
2	0.1304	0.1000	0.2857	0.5000
3	0.0435	0	0.1429	0.1250
4	0.0870	0	0.0714	0.1250
5	0.2174	0	0.0714	0.2500
6	0.0870	0.0500	0	0.1250
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0.6522	0.4000	0.9286	0.7500
11	0.0870	0.1500	0	0.1250
12	0	0	0	0

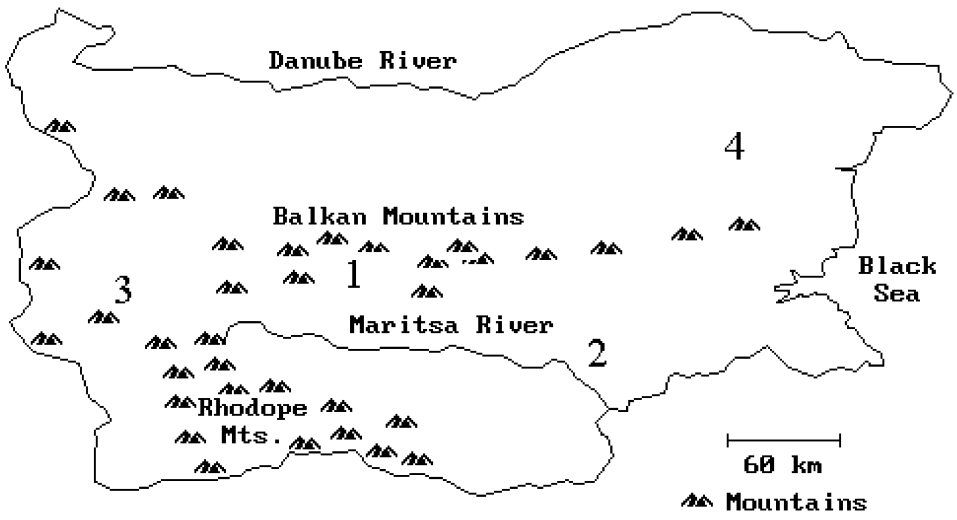

Fig. 1. Geographic locations of the epigenetically studied populations of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) from Bulgaria: 1 = Stara Planina, Central Balkan, 2 = mountain territories in southeastern Bulgaria, 3 = Vitosha Mountain, 4 = hill forests in northeastern Bulgaria

traits permitted us to pool the males and females of each population in a common sample.

The frequency distribution of the non-metric traits within the main populations of the Forest dormouse in Bulgaria is shown in Table 1. Four of the studied traits ("Foramen sphenoidale medim – *present*"; "Processus pterygoideus – *present*"; "Foramen ovale – *double*" and "Foramen mental – *double*") expressed null frequency in all the studied populations. Traits "Anterior frontal foramen – *present*", "Posterior frontal foramen – *present*", "Maxillary foramen I – *present*", "Maxillary foramen II – *present*" and "Foramen basioccipitale – *present*" expressed null frequency in only one of the studied populations. The trait "Foramen hypoglossi – *double*" shows the highest degree of expression in all of the studied populations. The poorest expression in the studied populations was found for the trait "Posterior frontal foramen – *present*". The biggest part of the traits exhibiting polymorphic statements was revealed in the populations from Stara planina and hill woodlands in Northeastern Bulgaria. Null expression was found in 33.3 % of the traits in these populations. The highest variability of Forest dormouse was similar in the three mountain populations. Its mean value in the studied populations from the mountain systems is Vi = 0.072346. The average value of the absolute population epigenetic variability of Forest dormouse in Bulgaria was 0.080245.

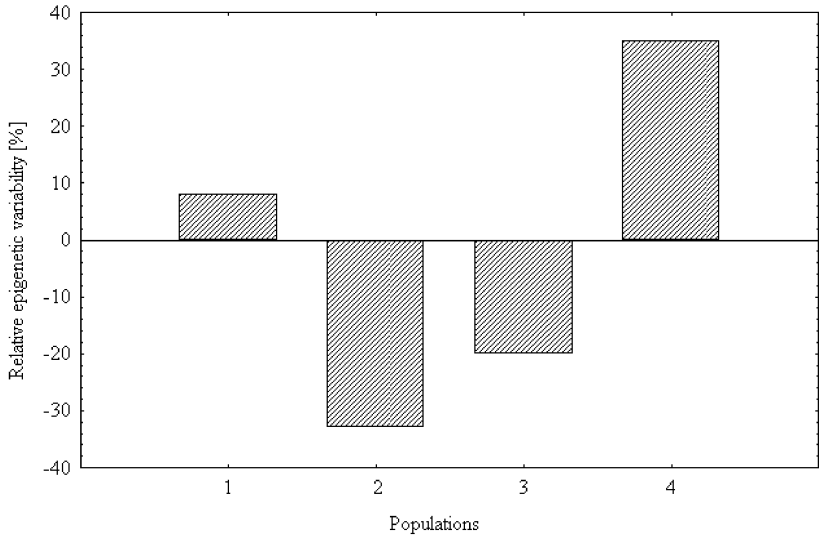

Fig. 2. Population epigenetic variability of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) from: 1 = Stara Planina, Central Balkan, 2 = mountain territories in southeastern Bulgaria, 3 = Vitosha mountain, 4 = hill forests in northeastern Bulgaria, in relation to the average for the species in Bulgaria

The populations from mountain territories in Southeastern Bulgaria and Vitosha Mountain manifested lower relative population epigenetic variability than the species' average epigenetic variability in Bulgaria. The other two populations – from Stara planina and hill woodlands in Northeastern Bulgaria – had higher than the national average epigenetic variability (Fig. 2). The highest positive relative population epigenetic variability was revealed in the Forest dormouse from hill woodlands in Northeastern Bulgaria and the lowest relative population epigenetic variability is typical for the population from Vitosha Mountain.

The only statistically significant epigenetic distances were those between the population of mountain territories in Southeastern Bulgaria and populations from Vitosha Mountain and from hill woodlands in Northeastern Bulgaria.

The inter-population epigenetic distances between the Stara Planina mountain system population and all other studied Bulgarian populations are not statistically significant. The population from the mountain territories in Southeastern Bulgaria has the highest epigenetic uniqueness, followed by the Vitosha population and by the population from the hilly territories of Northeastern Bulgaria (Table 2).

DISCUSSION

The distribution of the non-metric characters studied shows that not all of them exhibit polymorphic expression in the Forest dormouse of Bulgaria. The comparative analysis of relative epigenetic variability of Forest dormice from its

Table 2. Epigenetic distances (MMD) (the upper line) and their standard deviation (the lower line in italic), uniqueness (MU) and epigenetic variability (Vi) of the studied populations of the Forest dormouse (*Dryomys nitedula* PALLAS, 1779) from Bulgaria: 1 = Stara Planina, Central Balkan, 2 = mountain territories in southeastern Bulgaria, 3 = Vitosha Mountain, 4 = hill forests in northeastern Bulgaria. The statistically significant epigenetic distances between the studied populations are marked with an asterisk

Pop. numb.	2	3	4	MU	Vi
	0.05360	0.03912	–0.0462	–	0.08664
1	*0.04206*	*0.0371*	*non*		
		0.2308*	0.2028*	0.4336	0.06208
	2	*0.0848*	*0.0881*		
			0.0286	0.2308	0.06419
		3	*0.0344*		
				0.2028	0.10807
			4		

main habitats in the country revealed the presence of inter-population phenotypic diversity. High values of epigenetic variability of Forest dormouse populations were established in biotopes with different specific ecological factors – in Central Stara planina (which has a montane climate) and in hilly woodlands in Northeastern Bulgaria (with pronounced continental climatic conditions). At the same time, the Forest dormouse populations manifesting the most similar values of epigenetic variability within the population are found in mountain areas with relatively similar ecological conditions – one occurs in the Vitosha Mountain, while the other inhabits mountain regions in Southeastern Bulgaria.

The cranial epigenetic polymorphism found in the Forest dormouse of Bulgaria reveal the lack of clearly distinct epigenetic population differentiation except for the population inhabiting the mountain territories in Southeast Bulgaria, where the population expresses the micro-geographic epigenetic fragmentation of the Forest dormouse in Bulgaria.

The relatively low epigenetic differentiation of the Bulgarian Forest dormouse populations and comparatively well expressed degree of inter-population craniometric similarity of the species (MARKOV, 2001) within Bulgaria suggest that probably both the differences in the ecological conditions of their habitats and their geographic isolation had not reached the extent needed to promote the various micro-evolution processes that result in subspecies differentiation within the Forest dormouse populations of Bulgaria.

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REFERENCES

AIRAPET'YANTZ, A. (1983) *Dormice*. Leningrad Univ. Publ. House, Leningrad, 188 pp. [in Russian]

BERRY, R. J. (1963) Epigenetic polymorphism in wild populations of Mus musculus. *Gen. Res. Camb*. **4**: 193–220.

BERRY, R. J. & SEARLE, A. G. (1963) Epigenetic polymorphism in rodents. *Proc. Zool. Soc., Lond*. **140**: 577–615.

BERRY, R. J. (1968) The biology of non-metrical variation in mice and men. Pp. 103–113. *In* BROTHWELL D. R. (ed.): *The skeletal biology of earlier human populations.* London, Pergamon Press.

HEDGES S. R. (1969) Epigenetic polymorphism in populations of Apodemus sylvaticus and Apodemus flavicollis (Rodentia, Muridae). *J. Zool*. **159**: 425–442.

LOZAN, M. (1961) Age determination of Dryomys nitedula Pall. and Muscardinus avellanarius L. *Zool. Zhurnal* **40**(11): 1740–1743. [in Russian with English summary]

KRYŠTUFEK, B. (1999) Dryomys nitedula. Pp. 300–302. *In* MITCHELL-JONES, A. J., AMORI, G., BOGDANOWICZ, W., KRYŠTUFEK, B., REIJJNDERS, P. J. H., SPITZENBERGER, F., STUBBE, M., THISSEN, J. B. M., VOHRALIK, V. & ZIMA, J. (eds): *Atlas of European Mammals*. The Academic Press, London. 469 pp.

MARKOV, G. (1959) *Mammals in Bulgaria*. Sciences and Art, Sofia, 155 pp. [in Bulgarian]

MARKOV, G., TZOCHEVA, K. & DOBRYANOV, D. (1997) Karyotaxonomic characterization of Forest Dormouse (Dryomys nitedula Pall., 1779) in Bulgaria. *Acta zool. Bulg*. **49**: 13–19.

MARKOV, G. (2001) Cranial sexual dimorphism and microgeographical variability of the Forest dormouse (Dryomys nitedula Pall., 1779). *T. U. J. Sci. Res. B* **2**(2): 65–186.

SJŘVOLD, T. (1973) The occurrence of minor, non-metrical variation in the skeleton and their quantitative treatment for population comparison *Homo* **24**: 204–233.

SMITH, M .F. (1981) Relationships between genetic variability and niche dimensions among coexisting species of Peromyscus. *J. Mamm*. **62**(2): 273–285.

STATSOFT (1993) *Statistica for Windows.* Release 4.3. Tulsa.

TISHKOV, C. (1976) *The climate of the mountain regions in Bulgaria*. Bulgarian Academy of Sciences, Sofia, 210 pp. [in Bulgarian]

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