

## Patterns of craniometric variability of *Neomys fodiens* and *Neomys anomalus* (Mammalia, Insectivora) in Bulgaria – role of abiotic and biotic factors

*Vasil V. Popov\**, *Sirma A. Zidarova*

Institute of Zoology, Bulgarian Academy of Sciences, 1 Tzar Osvoboditel Blvd., Sofia 1000, Bulgaria;  
E-mails: [popov@zoology.bas.bg](mailto:popov@zoology.bas.bg), [sirmazidarova@zoology.bas.bg](mailto:sirmazidarova@zoology.bas.bg)

**Abstract:** Morphological variation of two species of water shrews, *Neomys anomalus* (N=401) and *N. fodiens* (N=192), from 13 areas in Bulgaria was studied by taking 66 measurements of skull, mandible and dentition. Univariate and multivariate analyses (Principal Component Analysis, PCA and Canonical Variate Analysis, CVA) were used to reveal patterns of variation, trying to separate the effect of physical factors, presented by altitudinal gradient, from the effect of the supposedly most important biotic factor, competition, expressed as character displacement/release. PCA revealed two general groups of characters. The first group reflects the differences between the two species. CVA distinguishes within this group two characters strictly related to species differences (the height of the upper incisor and the height of coronoid process) and one character (rostral length), affected by altitudinal gradient. The characters in the second group reflect the differences between allopatric and sympatric populations of *N. anomalus*. The analysis of inter-specific morphological distances confirms this interpretation. The obtained results are consistent with the hypothesis that *N. anomalus* has undergone a character release where it is allopatric from *N. fodiens*.

**Key words:** water shrews, character displacement, competition, morphology