

MAPPING THE DISTRIBUTION OF TWO CLOSELY RELATED SPECIES OF WATER SHREWS, GENUS NEOMYS, IN HUNGARY

Gábor Rácz¹ and András Demeter². (1) Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM-87131, USA, (2) Division of Nature Conservation, Authority for Nature Conservation, Ministry of Environment of Regional Policy, Budapest, K¹lt¹ u. 21, H-1121 Hungary

Two species of water shrews (Insectivora: Neomys) occur sympatrically in most part of Europe; in some localities, the two species (*N. fodiens* and *N. anomalus*) co-exist in syntopy. Distinction between the two species can be difficult because external characters are highly variable. The two species also are very similar in skull characters. Some differences also have been described in characters of the glans penis and the hipbone. Earlier studies in addition found differences in measurements of the mandible, specially in the height of the coronoid process. Several authors stated that multiple characters help discriminate between the two species, but these findings have been questioned by others. Multivariate analysis can help discriminate between the two species with a low error rate (probability of misidentification).

The aim of the present study was to examine *Neomys* material in the collection of the Hungarian Natural History Museum, Budapest. We captured images of the mandibles of 256 trapped specimens. The coordinates of 17 landmarks were digitized, or the outline of the mandible was recorded using the software IMAGOES. Using data and measurements computed from the positions of the landmarks, we compared several morphometric techniques to determine how well they separate the two species. We also analyzed the shape of the outline of the mandibles for possible differences between the two species. Using mandibles from owl pellets as unknowns, we tested our previous predictions of the reliability of each particular method. Using the most powerful method to distinguish between the two species, we allocated 444 mandibles from owl pellets and mapped the distribution of the two species in Hungary.

We found that there are detectable differences in the shape of the mandible between the two species. Traditional morphometric methods can be useful in separation of the species, but geometric morphometric methods resulted in better allocation. The outlines of the mandibles were described and analyzed by elliptic Fourier harmonic components. The Fourier analysis performed surprisingly well, indicating pronounced differences in the shape of the mandible. This method has the advantage that data acquisition is completely

automated by the employed software and quickly carried out by the computer. On the other hand, the method is very sensitive to missing or broken parts of the mandible. This problem can be overcome by separately processing intact and broken mandibles. The analysis of shape coordinates has slightly weaker discriminatory power, but it helped describe the features of shape differences.

We detected character displacement among the syntopic populations of the two species. The less abundant *Neomys fodiens* avoided competition with the co-existing *Neomys anomalus* by being larger, and by shifting the shape of the mandible. Allopatric populations of the two species in the same geographic area are more similar morphometrically. As regards geographic distribution, our study helped to depict a more detailed picture of the distribution of the two species in Hungary. It seems that the southern edge of the range of *N. fodiens* goes through the country. Analyzing this boundary might help to understand what environmental factors limit the distribution of this water shrew species.