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Distribution of Wood Mice Species (Muridae: Apodemus) in the Republic of Armenia

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ABSTRACT

West-Palaearctic wood mice species of the genus *Apodemus sensu lato* is widespread in Armenia. The current work considers the areal distribution of the wood mice species throughout all regions of the country. These rodents are actively involved in the circulation of zooanthroposes and can be pests for agricultural crops and forest plants. The results are validated upon the applied methods of genetic analyses.

Introduction

Wood mice of the genus *Apodemus* Kaup, 1829, have been the subject of many systematic and evolutionary studies in the last few decades (Mezhzherin, Zagorodnyuk, 1989, Filippucci, et al., 2002, Vorontsov, et al., 1992). Despite these numerous works, the taxonomic status, particularly, the biogeography of the genus *Apodemus sensu lato*, is not specified in Transcaucasia yet, especially, in the territory of the Republic of Armenia. The available information on the taxonomy and area of distribution of wood mice species in Armenia is rather fragmentary and scarce (Frynta, et al., 2001). So far, five existing species of the genus *Apodemus* have been reported from the territories adjacent to Armenia (Macholan, et al., 2001, Suzuki, et al., 2008, Bellinvia, et al., 2004, Vorontsov, et al., 1992): *A. uralensis* (*Pallas, 1811*), *A. witherbyi (Thomas, 1902)*, *A. flavicollis, A. hyrcanicus* (Vorontsov, et al., 1992) and *A. ponticus* (Mohammadi, et al., 2014). In this study, three species of wood mice inhabiting in the territory of the republic were clearly described and identified: *A. uralensis* (*Pallas, 1811*), *A. witherbyi* (*Thomas, 1902*) and *A. ponticus (Sviridenko, 1936)*, out of the previously declared 5 species, including: *A. sylvaticus (Linnaeus, 1758)* and *A. flavicollis (Melchior, 1834)* (Hayrapetyan, et al., 2014, Balasanyan, et al., 2018).

This article provides an overview of the distribution and species diversity of wood mice in all areas of the republic. The aim of the study is to collect and summarize the existing and newly collected data on the distribution of West Palaearctic wood mice species of the genus *Apodemus*.

Materials and methods

The subject of the study is to identify the distribution and frequency of occurrence of *Apodemus* species. Field

work was carried out during the expeditions conducted in the territory of selected monitoring stations including all regions of Armenia. During the field activities, data on the distribution and frequency of occurrence of animals were documented, the necessary information was obtained, and material was collected for further morphometric and genetic analyses. Data collection and analysis includes the relevant steps described in the standard fieldwork protocol (Heyer, et al., 2003).

To determine the species diversity and the number of wood mice, some trap models — live traps and crushers — were used. As bait, crusts of bread dipped in sunflower oil and cereal seeds were used. Traps were placed using the following method: *trap line method.* It is a fairly universal method widely used in various biotopes (Schnitnikov, 1929, Kalabukhov, Raevsky, 1933). Standard bait was used and traps were placed in lines. In our case, 20-40 traps were placed in a line. Each trap was filled with bait and placed in the area of the investigated biotope. The traps were placed in the evening at a distance of 5 meters from each other along the line. Trap sites were selected in accordance with the most probable places for animal trapping. Traps were checked several times during the night. Usually, this method was used for 2-3 days for each biotope under study.

The species of the captured samples was initially identified by the exterior indicators as the primary morphological analysis. Then, the identification of the species was carried out in laboratory using the method of sequencing the mtDNA gene.

The DNA was isolated from finger and tail tips preserved in absolute ethanol at -20 ^{0}C. The DNA was extracted using a DNeasy Blood and Tissue kit (Qiagen) following the manufacturer's protocol. PCR and direct sequencing of the cytochrome oxidase subunit 1 (COI) gene fragment was conducted using a BigDye Terminator Cycle Sequencing Kit v. 3.1 on an automated ABI 3500xL Genetic analyzer at the Laboratory of Molecular and Biometric Techniques, Museum and Institute of Zoology, PAS in Warsaw.

Results and discussions

As a result of research work throughout all regions of Armenia, the estimated data on the species diversity of representatives of the West Palaearctic wood mice belonging to genus *Apodemus* were obtained (Figure). Morphological and genetic studies have proved the occurrence of the mentioned species in certain regions of the republic.

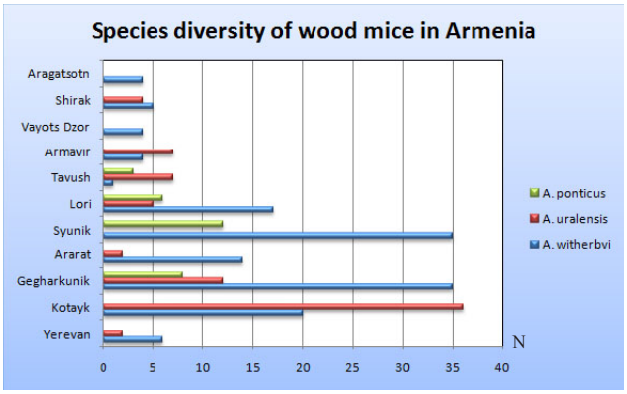


Figure. Species diversity of wood mice in Armenia (*composed by the author*).

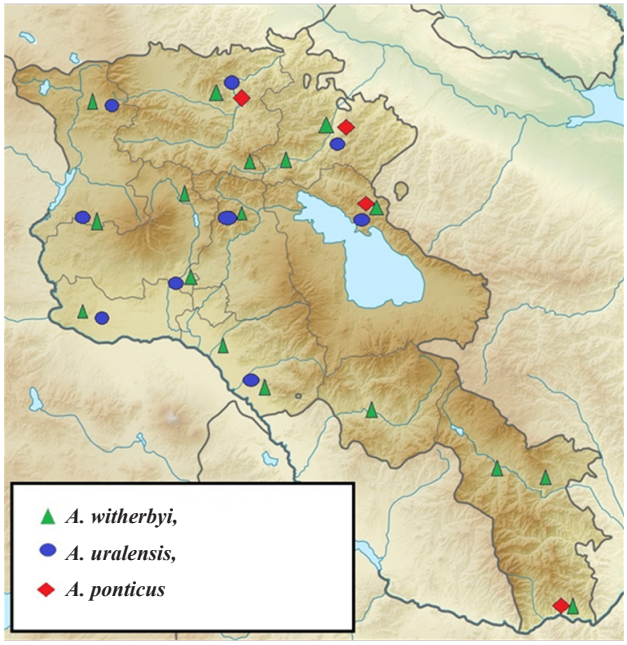
The Caucasian wood mouse *Apodemus ponticus (Sviridenko, 1936)* is the least widespread species in the fauna of Armenia. It is represented in four regions by relatively few populations. It is important to emphasize the "bipolar" distribution of representatives of this species in the territory of the Republic of Armenia, as in the course of our full-scale studies, samples were exclusively collected from the monitoring station of southern Meghri (Syunik) and from the northern regions (Lori, Tavush, Gegharkunik). This fragmented and maximally remote distribution area can be grounded by the history of penetration of this species into the territory of the Republic of Armenia. According to Bukhnikashvili and Kandaurov (2002), the Caucasian wood mouse is a fairly widespread species in Georgia with an exact distribution area to the south of the country bordering Armenia (Bukhnikashvili, Kandaurov, 2002). Mohammadi (2014) first mentioned in his work about the detection of *A. ponticus* in the territory of northwestern Iran (Mohammadi, et al., 2014).

The steppe wood mouse *Apodemus witherbyi (Thomas, 1902)* is ubiquitous in all regions of the Republic of Armenia - from south to north. The largest number of representatives of this species was caught from the territories having long-term monitoring stations in four regions of the republic. However, steppe mouse samplings and observations were conducted in other areas as well, where both periodic capture points and single capture points of animals were set up. Such a wide distribution of representatives of the mentioned species *A. witherbyi* can be explained by their preferences for various biotopes. They inhabit not only the steppes, but are also well adapted to the habitat in mature forest belts and in mountain steppes.

The Ural pygmy wood mouse *Apodemus uralensis (Pallas, 1811)* is found almost everywhere in Armenia - from the dry subtropical zones, semi-deserts and mountain steppes to the forest zones; it can penetrate even to the mountainous meadows and is found at the heights of 600-3200 m above the sea level. It lives in deciduous and mixed forests and has a preference for shrubbery. Their presence was also observed in treeless areas in conditions of steppe and mountain-steppe landscapes.

The results of our long-term observations showed that representatives of the species of Ural pygmy wood mouse inhabit mainly the central and northern regions of the Republic of Armenia (Kotayk, Gegharkunik, Lori, Tavush, Shirak), it is also found in Yerevan (strong evidence of syntropism). However, according to our study results it completely lacks in the southern regions of the republic (Vayots Dzor and Syunik).

Thus, it should be noted that the distribution of the wood mice genus *Apodemus* in the Republic of Armenia is almost ubiquitous (Picture). It is worth mentioning that unfortunately, many employees of sanitary-epidemiological services do not differentiate many rodents and cite them as super species.



Picture. Distribution of three *Apodemus* species in Armenia: *A. witherbyi, A. uralensis, A. ponticus*.

Conclusion

The data obtained enable to assess the quantitative distribution of representatives of the discussed genus in line with the biotopic allocation peculiar to each biotope species. So, Figure shows that almost half of the total number of the wood mice is concentrated in the central part of the republic, besides, they are almost equally spread in two regions of the republic: in the south part (Syunik) and in the north part (Lori). Most likely, such a quantitative prevalence of forest mouse species can be accounted for their main ecological indicators and biotope choice. The identification of the species in the abovementioned areas depends on the landscape and climatic conditions of the terrain. For example, it is well known that the pygmy wood mouse *Apodemus uralensis* prefers woodlands (Kotayk, Gegharkunik, Lori), forming an adjacent sympatric population with representatives of the steppe mouse *Apodemus witherbyi*, which are widespread not only in the woodlands but also in the territories with distinct steppe, mountain-steppe and mountain landscapes (Syunik, Vayots Dzor, Ararat).

Summarizing the results of our work, we can assume that *A. ponticus* is a sympatric species for the steppe field mouse *A.witherbyi* mainly spread in the steppe and rocky terrains, and *A.uralensis* lives in woodlands and can form an adjacent sympatric population with the steppe field mice. Also, the resulted distribution pattern of *Apodemus* species may testify on the existence of some parapatria in the populations.

Thus, apart from the relevance of monitoring and controlling the dynamics of number and distribution areas of the forest mice in the fauna of Armenia, these findings are also vital for identifying and preventing zoonotic diseases.

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