

## MULTIANNUAL DYNAMICS OF SHREW (MAMMALIA, SORICOMORPHA, SORICIDAE) COMMUNITIES IN THE REPUBLIC OF MOLDOVA

NISTREANU Victoria

**Abstract.** The paper is based on the existing bibliographical data, on the collection of vertebrate animals of the Institute of Zoology of AȘM and on personal studies performed in the last years on the whole territory of Moldova. During the last 50 years considerable modification of shrew communities in various types of ecosystems on the whole territory of Moldova were registered. The most well adapted species is the common shrew, being dominant in the majority of the studied periods. The bicolor shrew, which was a rare, endangered species, introduced in the Red Book of Moldova, 2<sup>nd</sup> edition, became one of the most common among shrews in the last few years, while the Mediterranean water shrew that was one of the most abundant in the past century, at present became very rare, because of the pollution and transformation of wet and water habitats. The pygmy shrew is wide spread in various types of ecosystems, but its abundance is always below 25%. The lesser shrew is the most synanthropic species among shrews, its frequency in urban and rural area reaching 80%. The shrew species are good ecological indicators. Further measures on the protection of natural and water habitats must be taken.

**Keywords:** shrew, dynamics, natural and anthropogenic ecosystems.

**Rezumat. Dinamica multianuală a comunităților de chițcani (Mammalia, Soricomorpha, Soricidae) în Republica Moldova.** Articolul are la bază datele bibliografice existente, colecția de vertebrate terestre a Institutului de Zooogie al AȘM și cercetările personale ale autorului efectuate pe tot teritoriul Moldovei în ultimii ani. Pe parcursul a 50 ani s-au înregistrat modificări considerabile ale comunităților de soricide în diverse tipuri de ecosisteme de pe tot teritoriul republicii. Cel mai bine adaptat este chițcanul comun, care e dominant în majoritatea perioadelor studiate. Chițcanul de câmp, care era o specie rară, periclitată și introdusă în Cartea Roșie a Moldovei, ediția a 2-a, în ultimii ani, iar chițcanul de mlaștină, care era una din speciile cele mai abundente în secolul trecut, actualmente este foarte rară din cauză poluării și transformării habitatelor acvatice. Chițcanul mic este larg răspândit în diverse tipuri de biotopuri, însă abundența acestuia nu depășește 25%. Chițcanul de grădină este cea mai sinantropă specie de chițcani, frecvența ei în zonele urbane și rurale atingând 80%. Speciile de chițcani sunt buni indicatori ecologici și sunt necesare măsuri de protecție și conservare a habitatelor naturale și umede.

**Cuvinte cheie:** chițcani, dinamică, ecosisteme naturale și antropogene.

### INTRODUCTION

Although the shrews are the smallest mammals of the world fauna, they have an important role in natural environment and in human economy, being an important link within the animal trophic chain. Five shrew species inhabit in Moldova: common shrew (*Sorex araneus*), pygmy shrew (*S. minutus*), bicolored white-toothed shrew (*Crocidura leucodon*), lesser shrew (*C. suaveolens*) and Mediterranean water shrew (*Neomys anomalus*). The water shrew (*N. fodiens*) was mentioned for the territory of Moldova by several researchers, but the detailed studies accomplished in the past century (AVERIN, 1969; CUCIUK, 1969; LOZAN, 1975, 1979) did not reveal the presence of this species. The presence of the species was mentioned in pellets of some predatory birds (GANEA & ZUBCOV, 1975; ZUBCOV, 1983).

In 60's – 70's of the past century the shrews were rather well studied. The most serious papers concerning the insectivore species in Moldova were published by LOZAN (1975, 1979), where it can be found data on morphology, ecology, palaeontology and spreading of shrews on the territory of Moldova. Also, some data concerning shrews can be found in other papers, where shrew species are mentioned (AVERIN, 1969a, 1969b, 1975; CUCIUK, 1969; LOZAN, 1969; ANISIMOV & COJUHARI, 1978; AVERIN et al., 1984; MUNTEANU & SAVIN, 1990; MIHAILENCO, 1996; MUNTEANU, 2005). After the 80's, the studies concerning this group of mammals were sporadic and incomplete, therefore their status in this period was uncertain. After 2000 shrew species were studied more completely from morphological, zoogeographical and ecological point of view (NISTREANU, 2007, 2008, 2009; NISTREANU et al., 2008, 2009; 2010). Also, in several papers shrew species are mentioned as components of small mammal communities in various types of ecosystems (TIKHONOV et al., 2009a, 2009b, 2010; TIKHONOVA et al., 2009; SAVIN et al., 2010). The paper contains information on multiannual dynamics of shrew communities in the last several decades on the territory of Moldova.

### MATERIAL AND METHODS

The paper is based on the existing bibliographical data, on the collection of vertebrate animals of the Institute of Zoology of ASM and on personal studies performed in the last years on the whole territory of Moldova.

Shrews were caught with snap traps and fall traps in various types of ecosystems in the northern, central and southern parts of the republic. The individuals were determined, measured, weighed, sex, age, physiological and reproductive state were registered, the skulls were preserved for further morphological studies.

To characterize the biotopic distribution of the species the following indexes were considered: trappability  $C_e = 100n/C$ , where  $n$  – number of individuals,  $C$  – number of traps; the frequency  $F = 100p/P$ , where  $P$  – number of samples,  $p$  – samples where the species is present, and the species abundance  $A_i = 100n/N$ , where  $n$  – number of individuals of the species  $i$  in the sample,  $N$  – total individual number. To emphasize the position of certain species in a habitat the ecological significance was calculated ( $W_A$ ) using the formula  $W_a = F_a \cdot A_a / 100$ , where  $F_a$  is frequency of the species and  $A_a$  – abundance index. The species with the significance lower than 1% in the studied biocoenoses are considered accidental; 1.1-5 % - accessory; 5.1-10% – characteristic and  $W > 10\%$  - constant for the given biocoenosis.

**RESULTS AND DISCUSSIONS**

During the last 50 years considerable modifications of shrew communities in various types of ecosystems on the whole territory of Moldova were registered. In the 1960's the dominant species among shrews in natural ecosystems of the republic was *S. araneus*, followed by *N. anomalus* that was very abundant in wet habitats (up to 25-30% in lower course of the Prut river). We have to mention that in 50's-60's of the past century the lower Prut area occupied large surfaces with many floating reed islet, covered with dense herbaceous vegetation and abundant litter. Here, the shrew species, especially the most hygrophilous ones (*S. araneus*, *S. minutus*, *N. anomalus*) could find favourable trophic and shelter conditions, therefore they were the dominant mammals in these biotopes (NISTREANU, 2007). The pigmy and lesser shrews were rather spread all over the studied territory, but their abundance was lower (Fig. 1). The bicolor shrew was rather rare and together with *C. suaveolens* was recorded in more arid biotopes, such as fields, pastures, abandoned lands, slopes with herbaceous or bush vegetation. The common, pigmy and Mediterranean water shrews have been recorded in various types of forest ecosystems, as well as in paludous and riparian biotopes (AVERIN, 1969; CUCIUK, 1969) with characteristic frequency. Shrew species were also recorded in pellets of predatory birds, but in very low quantity: *S. araneus* – between 0.6% and 2.4% from all the vertebrate prey, *S. minutus* – between 0 and 1.6%, *C. leucodon* – between 0.02% and 1.6%, *C. suaveolens* – between 0.3% and 1.9%. *N. anomalus* was not found in pellets, although its abundance among the small mammals was of 2.3% (ANISIMOV, 1969a, 1969b; LOZAN, 1969).

In the 1970's the most abundant species remained *S. araneus*, followed by *N. anomalus*. The proportion of common shrew among other shrew species was the highest in most of the ecosystems: forest (insular forests in the northern part, central forest, forest shelter belts), in meadows of the Nistru and the Prut rivers, in wet biotopes near woods. In insular woods of the northern part of the country, the common shrew constituted about 9-15% from all the small mammals, in wet oak forests with well-developed shrub and herbaceous vegetation its abundance reached 20%, while in the lower Prut marshes this species constituted up to 55% from all the small mammals (LOZAN, 1975, 1979). In the southern part of the republic, in the steppe zone, this species was very rare. In agricultural ecosystems, such as old orchards, forest shelter belts the density of the common shrew was rather low (3-4 individuals per 100 traps). The trappability index of the species was between 3% and 12% depending on the biotope (LOZAN, 1975).

The pigmy and lesser shrews were rather spread on the republic territory, but had low abundance, while *C. leucodon* was registered only in few natural ecosystems with very low abundance (fig. 1). The common shrew, both species of the genus *Crocidura* and *N. anomalus* were recorded as fauna components of cities and towns of Moldova (ANISIMOV & COUHARI, 1978). The Mediterranean water shrew was also rather spread, but mostly in wet biotopes, near various water sources. Its abundance in such biotopes reached about 30% from all the shrews. Together with the common shrew it constituted about 80% from the shrew population of the republic. The white-toothed shrew was represented only by few individuals recorded in "Codri" forest reserve. Its abundance did not overpass 2% from the shrew population. The pigmy and lesser white-toothed shrews had approximately the same frequency and constituted about 20% from the whole shrew population.

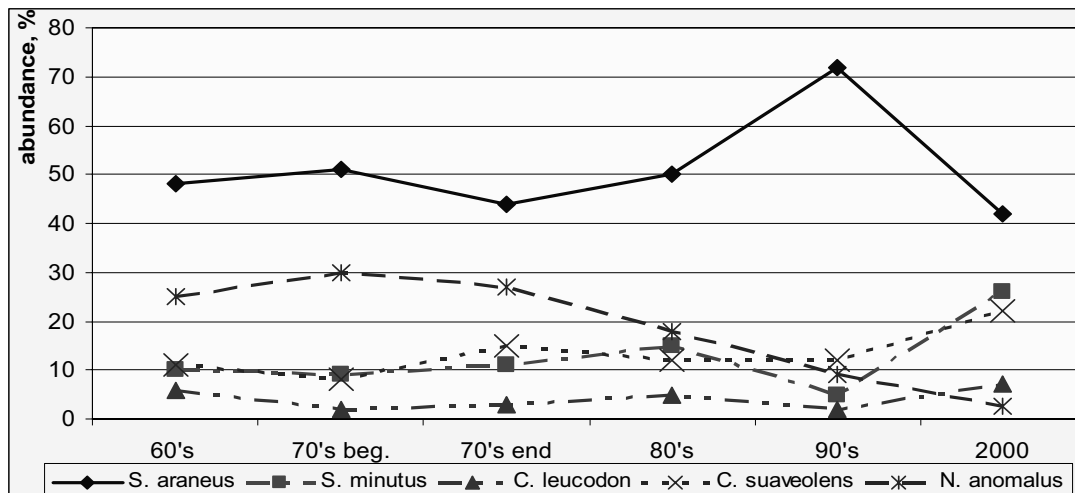


Figure 1. Dynamics of shrew community structure before 2000. / Figura 1. Dinamica comunităților de chițcani până în 2000.

In the pellets of owls the proportion of identified shrew remains among all the trophic resources constituted 0.31%-0.67% of *S. araneus*; 0.31% of *N. anomalus*, up to 1.14% of *C. suaveolens* (GANEA & ZUBCOV, 1975).

In the 1980's the abundance of common shrew was maintaining at high level and the species constituted more than half of the shrew population (Fig. 1). It was the only species among shrews that was recorded in forest shelter belts (MUNTEANU & SAVIN, 1990). In opposite, the Mediterranean water shrew dominance decreased below 20%, this species being common only in natural reserves in biotopes near water sources, while in the other ecosystems it became very rare. The abundance of pigmy shrew increased by about 10%, especially in "Codri" forest reserve in wet biotopes (AVERIN et al., 1984), but it still was rare on the republic territory. The abundance of white toothed shrews was very low, below 10% each species.

In 70's – beginning of 80's the trophic spectrum of predatory birds and owls was intensely studied (ZUBCOV, 1983). Thus, in the diet of *Buteo buteo* the frequency of shrew species related to the total prey species was the following: *N. fodiens* (0.4%-0.7%), *C. suaveolens* (0.7%); in *Falco tinnunculus* diet - *C. suaveolens* (0.4%-1.4%); in *Buteo lagopus* diet - *C. suaveolens* (1.4%-2.1%); in *Accipiter gentilis* diet - *S. araneus* (1.6%); in *A. nisus* diet - *Crociodura* sp. (1.4%); in *Asio otus* diet - *S. araneus* (0.1%-0.3%), *S. minutus* (0.1%-0.3%), *N. anomalus* (0.01%-0.02%), *C. suaveolens* (0.1%-0.8%), *C. leucodon* (0.1%-0.7%); in *Athene noctua* diet - *S. araneus* (0.1%-0.8%), *S. minutus* (0.1%-0.2%), *N. fodiens* (0.1%-0.4%), *N. anomalus* (0.1%), *C. suaveolens* (0.4%-0.9%); in *Strix aluco* diet - *S. araneus* (1.3%-4.8%), *S. minutus* (0.2%-0.7%), *N. anomalus* (1.2%-4.1%) and *C. suaveolens* (0.4%-0.9%).

In 1990's the changes of social and economic conditions led to the changes of ecosystem structure and to the modification of whole landscape of the Republic of Moldova. Vast single-crop agricultural fields from the agrarian complex of 70-80's that occupied large territories were divided in parcels cultivated with various annual, biannual and perennial cultures. Many lands were abandoned and uncultivated, the mosaicity of the territory increased. The process of natural habitat destruction (forest cutting, increasing of recreational activity, waste deposited outside localities, water habitat pollution etc.) was rather intense. In such stressful conditions the shrew species density decreased drastically compared with other mammal groups. In this period the common shrew showed high degree of adaptability and the largest limits of ecological valence. Thus, it had the highest abundance among sorcid mammals and constituted almost 80% of the shrew population, being a constant species in many types of natural and anthropized ecosystems (MIHAILENCO, 1996). *S. minutus* and *N. anomalus* were characteristic in wet habitats and near water basins in natural reserves and protected areas, while in other habitats they were accidental or accessorial species. Their total abundance was rather low: the pigmy shrew constituted 5%, the Mediterranean water shrew – about 9%, the lesser white-toothed shrew – about 12%, while the white toothed shrew – only 1-2% (Fig. 1). The last species was very rare in the past century and since the 80's its number decreased more, so it was included in the Red Book of Moldova, 2<sup>nd</sup> edition as critically endangered. It can be also observed the strong decrease of the Mediterranean water shrew by more than three times in comparison with the 70's, conditioned by intense drying of the lower Prut and the Nistru swamp ecosystems in the 80's and by intense pollution of surface waters in 90's.

At the beginning of the new century many abandoned lands reverted to their more or less natural state as natural biotopes, such as pastures, meadows, grazing lands etc. At the same time, the processes of anthropization, urbanization and degradation of the natural ecosystems occur all over the territory of the republic. In this context the modification of the shrew community's structure continued. The common shrew remain the dominant species in the population, but its abundance decreased (to 43%) compared with the previous period. It is more tolerant to the environment conditions and to anthropogenic activity in comparison to other shrew species. The pigmy shrew had the abundance of above 30%. The density of bicolor white-toothed shrew increased up to 8%, while the abundance of *N. anomalus* decreased drastically to only 3% (Fig. 1).

Starting with 2003 regular and detailed studies of shrew communities were performed. The common shrew is the dominant species and was recorded in the majority of the studied natural and anthropogenic biotopes (F = 94%). The frequency of pigmy shrew was also rather high – 88%, but it is rarer. The density of bicolor white-toothed shrew increased and its frequency was rather high with the value of 9.7%, while in its preferred habitats the frequency of the species reaches 40%. The density of bicolor white-toothed shrew increased up to 8.8% and its frequency was rather high with the value of 9.7% while in its preferred habitats the frequency of the species reaches 42% (NISTREANU et al., 2008). The lesser shrew was more frequent (17.8%) and abundant. The Mediterranean water shrew was the rarest shrew among other species after 2000. Its frequency was very low (below 5%), being registered only near aquatic basins of natural reserves, and the maximum abundance of 7.8% (Fig. 2).

In the last years of study the structure of shrew communities on the territory of Moldova show significant changes (Fig. 2). In the majority of the study periods *S. araneus* is the dominant species, except 2004 and 2008, when its abundance is below 30%. The abundance of pigmy shrew is the highest in 2004 (more than 45%), than it maintains between 20% and 25% and decreases to 10% in 2009. The evolution of *C. leucodon* is very interesting: from rare species and 15% abundance it increases to 36% in 2009, being together with the common shrew the dominant species in the studied ecosystems. The lesser white-toothed shrew abundance also increased to 2008, when it was the dominant species. Its frequency constituted 40% in natural ecosystems and more than 85% in urban environment. *N. anomalus* abundance decreased during the last years; in 2008 it was not recorded at all and in 2009 it constituted only about 7% from all the shrews. The Mediterranean water shrew was registered as rare, accidental species. Its abundance in the

republic ecosystems decreased drastically in the last 20 years and it becomes a very rare and critically endangered species. This fact is caused by the degradation of wet habitats and by water basins pollution.

We have to mention the high abundance of bicolour white-toothed shrew in the last several years. It was recorded not only in natural and wet biotopes, but also in more arid ones and in agrocoenoses. In abandoned lands the species was even more abundant than the common shrew and its trappability index constituted 10% from all the small mammals.

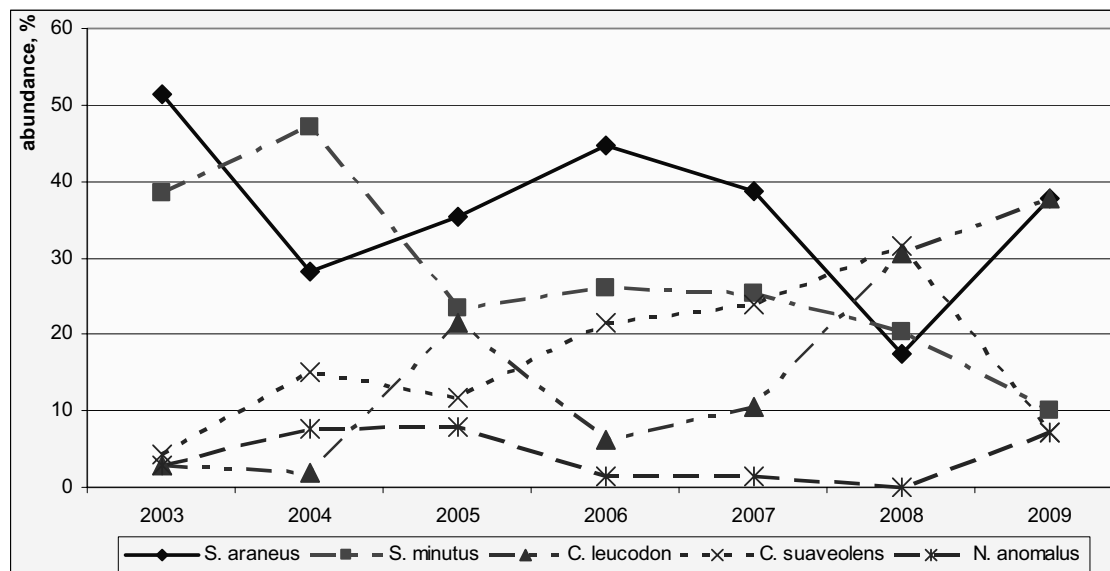


Figure 2. Multiannual dynamics of shrew communities in the last years of study. / Figura 2. Dinamica multianuală a comunităților de chițcani în ultimii ani de studiu.

## CONCLUSIONS

The structure of shrew community showed significant changes during the last decades. The most well adapted species is the common shrew, being dominant in the majority of the studied periods. The bicolour white-toothed shrew, which was a rare endangered species, introduced in the red Book of Moldova, became one of the most common among shrews in the last years. The Mediterranean water shrew that was one of the most abundant in the past century, at present became very rare, because of the pollution and transformation of wet and water habitats. The pygmy shrew is wide spread in various types of ecosystems, but its abundance is always below 25%. The lesser shrew is the most synanthropic species among shrews, its frequency in urban and rural area reaching 80%.

## REFERENCES

- ANISIMOV E. P. 1969a. *Materialy po letnemu pitaniyu ceroi neiasyti v Moldavii*. In Voprosy ecologii i prakticheskogo znacheniya ptits i mlekopitaiyushchikh. **3**: 30-35. [In Russian].
- ANISIMOV E. P. 1969b. *Factory opredeliayushchie dbychu ushastoi soby zimoi*. In Voprosy ecologii i prakticheskogo znacheniya ptits i mlekopitaiyushchikh. **3**: 36-40. [In Russian]
- ANISIMOV E. & COJUHARI A. A. 1978. *Fauna gorodov I ee ohrana*. Cartea Moldovenească. Chișinău. 56 pp. [In Russian].
- AVERIN I.U.V. 1969a. *Osnovnye komplekсы covremennykh biotopov ptits i mlekopitaiyushchikh Moldavii*. In Voprosy ecologii i prakticheskogo znacheniya ptits i mlekopitaiyushchikh. **4**: 3-14. [In Russian].
- AVERIN I.U. V. 1969b. *O pitanii obychnovvennoi pustelgi v Moldavii*. In Voprosy ecologii i prakticheskogo znacheniya ptits i mlekopitaiyushchikh. **4**: 21-25. [In Russian].
- AVERIN I.U. V. 1975. *Ptitsy i mlekopitaiyushchie zapovednica "Codri"*. Ecologia ptits i mlekopitaiyushchikh Moldavii. Știința. Chișinău: 73-81. [In Russian].
- AVERIN I.U. V., MUNTEANU A. I., CHEGORCA P. T., GAVRILENCO V. S., LUNCASHU M. I., SAVIN A. I. 1984. *Mlekopitaiushchie. Priroda zapovednica "Codri"*. Știința. Chișinău: 57-64. [In Russian].
- CUCIUK A.V. 1969. *Mlekopitaiushchie plavnei nizoviev Pruta*. In Voprosy ecologii i prakticheskogo znacheniya ptits i mlekopitaiyushchikh. **4**: 63-68. [In Russian].
- GANEA I. M. & ZUBCOV N. I. 1975. *Pitanie domovogo sycha (Athene noctua Scop.) v srednei chasti Moldavii*. Ecologia ptits i mlekopitaiyushchikh Moldavii. Știința. Chișinău: 63-72. [In Russian].
- LOZAN M. N. 1975. *Nasekomoyadnye mlekopitayushchie Moldavii (Insectivora, Mammalia)*. In Ecologia ptits i mlekopitaiyushchikh Moldavii. Știința. Chișinău: 96-118. [In Russian].

- LOZAN M. N. 1979. *Nasekomoyadnye. Mlecopitayushchie*. In Jivotnyi mir Moldavii. Știința. Chișinău: 25-40. [In Russian].
- LOZAN M. N. 1969. *Osobennosti zimovki mlekopitayushchikh Dnestrovsco-Prutscogo mejdurechia*. Voprosy ecologii I practicheskogo znachenia ptits I mlekopitayushchikh. 3: 61-79. [In Russian].
- MUNTEANU A. I. & SAVIN A. I. 1990. *Mlecopitayushchie*. In Fauna biotsenoticheskikh oazisov I ee practicheskoe znachenie. Știința. Chișinău: 179-202. [In Russian].
- MIHAILENCO A. 1996. *Gryzuny I nasekomoiadnye zapovednicov Moldovy*. Simpozion jubiliar “Rezervația naturală Codrii” – 25 ani. Realizări, probleme, perspective: 40-41. [In Russian].
- MUNTEANU A. 2005. *Mamifere. Natura Rezervației „Plaiul Fagului”*. Chișinău: 244-265.
- NISTREANU VICTORIA. 2007. *Soricidele (Soricidae, Insectivora) din colecția muzeului Laboratorului Vertebrate Terestre al Institutului de zoologie al A.S.M.* VI Conf. of Zoologists of Moldova, Chișinău, Știința: 43-44.
- NISTREANU VICTORIA. 2008. *Spreading of insectivore species (Erinaceidae, Talpidae, Soricidae, Insectivora) in Nistru river basin*. Transboundary Dniester river basin management and the EU Water Framework Directive. Proceedings of International Conference: 213-217.
- NISTREANU VICTORIA, MUNTEANU A., SAVIN A., CARAMAN NATALIA, BENEȘ O., GHEORGHÎȚĂ STELA, BURLACU VICTORIA, USPENSKAIA I. 2008. *Date preliminare privind răspândirea soricidelor (Soricidae, Insectivora) pe teritoriul Republicii Moldova*. Simpozion Internațional consacrat jubileului de 60 de ani al academicianului Ion Toderaș. Chișinău: 68-70.
- NISTREANU VICTORIA. 2009. *Spreading of shrews from genus Sorex on the territory of Republic of Moldova*. Annual Zoological Congress of “Grigore Antipa” Museum. Bucharest. Romania: 50.
- NISTREANU VICTORIA, BURLACU VICTORIA, CARAMAN NATALIA. 2009. *Rasprostranenie belozuboc (Soricidae, Insectivora) na teritorii Moldovy*. Actual problems of zoo and phylogeography of mammals. Penza: 60. [In Russian].
- NISTREANU VICTORIA, SAVIN A., LARION ALINA, CORCIMARU N., BULRACU VICTORIA, CARAMAN NATALIA. 2010. *Evolution of shrew (Mammalia, Soricomorpha, Soricidae) communities in Republic of Moldova in the last decades*. Dniester river basin: ecological problems and management of transboundary natural resources: 148-150.
- SAVIN A., NISTREANU VICTORIA, CORCIMARU N., LARION ALINA. 2010. *Diversity of mammal communities in the ecosystems from the central zone of the Republic of Moldova*. *Oltenia. Studii și comunicări. Științele Naturii*. Muzeul Olteniei Craiova. **26**: 259-262.
- TIKHONOV I. A., KOTENKOVA E. V., YSPENSKAIA I. G., CONOVALOV I. N., BURLACU V. I., BENEȘ O. A., GHEORGHÎȚĂ C. D., CARAMAN NATALIA, TIKHONOVA G. N., KHRYSSTIN V. A., NISTREANU VICTORIA, MUNTEANU A. I. 2009. *Gryzuny I nasekomoyadnye nezastroennyh territorii g. Chisineva*. Proceedings of 4<sup>th</sup> International Scientific-Practical Conference “Urboecosystems: problems and Prospects of Development”, Ishim: 310-315. [In Russian].
- TIKHONOV I. A., MUNTEANU A. I., YSPENSKAIA I. G., CONOVALOV I. N., BURLACU VICTORIA. I., BENEȘ O. A., GHEORGHÎȚĂ C. D., CARAMAN NATALIA C., TIKHONOVA G. N., KHRYSSTIN V. A., NISTREANU VICTORIA, KOTENKOVA E. V. 2009. *Vidovoe raznoobrazie melkih mlecopitayushchikh na primere g. Chișinău*. Geocological and biocological problems of northern Black Sea basin. Proceedings of IIIrd international conference. Tiraspol: 200-203. [In Russian].
- TIKHONOVA G. N., TIKHONOV I. A., KOTENKOVA E. V., YSPENSKAIA I. G., CONOVALOV I. N., BURLACU VICTORIA I., NISTREANU VICTORIA, BENEȘ O. A., GHEORGHÎȚĂ C. D., CARAMAN NATALIA C., KHRYSSTIN V. A., MUNTEANU A. I. 2009. *Sravnitelnyi analiz naseleniya melkih mlecopitayushchikh nezastroennyh territorii dvuh Ebropeiskih gorodov (Moskvy I Chișinău)*. Diversitatea, valorificarea rațională și protecția lumii animale. Simpozion internațional consacrat celei de-a 70-a aniversări din ziua nașterii profesorului universitar Andrei Munteanu. Chișinău. Știința. Moldova: 117-120. [In Russian].
- TIKHONOV I. A., MUNTEANU A. I., YSPENSKAIA I. G., CONOVALOV I. N., BURLACU VICTORIA, CARAMAN NATALIA, NISTREANU VICTORIA, TIKHONOVA G. N. 2010. *Biotopicheskoe raspredelenie, structura populiatsii i necotorye osobennosti razmnijenja melkih mlecopitayushchikh g. Kishineva*. Povoljskii ekologicheskii jurnal. 4: 404-415. [In Russian].
- ZUBCOV N. 1983. *Hishchnye ptitsy I sovy Moldavii*. Thesis of doctor of biology. Chișinău. 224 pp. (In Russian).

Nistreanu Victoria  
Institute of Zoology of ASM  
Str. Academiei, No.1, Chișinău, Moldova  
E-mail: vicnistreanu@gmail.com

Received: March 29, 2011  
Accepted: July 22, 2011