

**DISTRIBUTION AND HABITAT ASSOCIATION
OF FIELD MOUSE (*APODEMUS AGRARIUS* PALLAS, 1771)
IN NATIONAL PARK „STRANDJA“**

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SUMMARY. The structure of the landscape and its heterogeneity, the species' specific nutrition, reproductivity, and adaptations abilities determine the species' spatial distribution. For evaluating the ecological characteristics and for determining the common traits in the distribution and habitat preferences of the field mouse in NP „Strandja“, the suggested by Pesenko(1982) indexes were used: *participation of the separate habitats in the distribution of the species' populations, relative habitat association, and degree of relative attachment to a certain habitat.* The distribution of the field mouse specimens in the investigated biotopes is uneven. The examination of the field mouse's distribution shows its presence in two of the four investigated habitats in NP „Strandja“: moist habitats and mixed forests with artificial coniferous plantations. Therefore, a direct casual dependence between the regime of humidity and the habitat association of the species is present. The high humidity creates pleasant conditions for the development of various vegetation communities, which allow for high productivity of the moist biotopes and good food resources for the species.

KEY WORDS. *Apodemus agrarius, habitat preferences, distribution of field mouse*

INTRODUCTION

The species' spatial distribution has great biological importance for the normal vital activity of its populations. It defines the more effective using of the environmental resources, furthers the maintenance of species' maximal biological

activities, and raises the probability of their sustainable existence (Shilov, 1977). The species' habitat preferences depend on the complex action of a sequence of factors: topographical and edaphical, climatical and biological – predatoriness, parasitism or competition.

The type of territorium utilized, the structure of the landscape, and its heterogeneity also play an important role. The species' specific nutrition, reproductivity, and adaptations abilities are important when the species' typical character of the territorium utilized is being formed

The spatial distribution changes with the different seasons and years, and can significantly vary in accordance to the dynamics of the vegetations biomass, the distribution of food resources, climatic changes, etc. The complex action of all these environmental factors determines the population parameters and the spatial distribution of the species' populations.

The investigation of the species' distribution and habitat preferences is a key element of the detailed zoo monitoring, zoological, and biological investigations of specific territories. They expand the degree of comprehensiveness of the fauna and determine the reservation of biological diversity in protected areas.

The field mouse (*Apodemus agrarius* Pallas, 1771) is a relatively rare species in Bulgaria with small numbered populations. Its spreading is determined by the biological characteristics and ecological adaptations. In Bulgaria, the species inhabits mainly the moist river valleys, where mosaic distribution is present. In the high mountainous parts, it is completely absent (Popov, 2004).

Strandja mountain is characterized with specific geological, climatic, and biogeographical factors. This leads to the forming of typical ecosystems with a wide biological diversity – presence of endemical and relict species. 31 species of small mammals inhabit in Strandja; this makes the mountain the most representative region for the faunal diversity of small mammals in Bulgaria (Popov, 1993).

The investigations of the stacial, zonal, and vertical distribution of the field mouse's populations in NP „Strandja“ have a certain theoretical and practical importance. They will raise the degree of comprehensiveness of the species in Bulgaria and will contribute to the complex assessment of biodiversity in this protected area.

The aim of the present investigation is to evaluate the ecological characteristics and to determine the common traits in the distribution and habitat preferences of the field mouse in NP „Strandja“.

MATERIAL AND METHODS

Investigation area. The material was collected from 8 habitats, united in the following biotopes:

Biotope I – moist habitats. The canopy is half exposed, composed of small tree groups by the river. An understory of bushes and lianas is present. Close to the river's mouth is the moist forest floor with hydrophilic and hygrophilic vegetations.

Biotope II – deciduous forests. Here the dominating species are oak and beech with a weakly developed understory of bushes.

Biotope III – mixed forests (with artificial coniferous plantations). The species' palette is not rich, with a predominant presence of black pine. The grass floor in the denser and more shadowy areas is weakly developed and is presented by only a few species. However, in the rare and lightened parts and on the periphery, the number of species drastically increases.

Biotope IV – cultivated areas. The biotope includes arable vine massifs, as well as older, deserted agricultural lands.

Material

The catching of animals is done through the using of the trap line method with live and/or killing traps. Every specimen caught has its sex and species determined. The specimens of sibling species – *Apodemus sylvaticus* / *Apodemus flavicolis* and *Microtus arvalis*/*Microtus rosiemeridionalis*, are determined only by genus because of the impossibility of their synonymous species' classification due to external indications.

The investigations span is a sixth year period (1998 – 2004 г.).

Methods

The dominancy of the species in the investigated habitats, as well as on the territory of NP „Strandja“, is assessed on the basis of the percentage of every species from the whole catch (n_i/N , where n_i is the number of specimens from a certain species in a certain habitat, and N is the total number of specimens caught from all species in the same habitat). The relative number is determined as number of specimens per 100 trap days, where its qualitative assessment is accomplished on the Kuziakin scale (1986).

For evaluating the biotopic distribution of species, the suggested by Pesenko indexes were used (1982): *participation of the separate habitats in the distribution of the species' populations, relative biotopic attachment, and degree of relative attachment to a certain habitat.*

Relative habitat association of a certain species is the species' preference to a certain habitat, expressed in comparison with the other species, inhabiting this habitat. This index does not give an account of the species' density in different habitats, but its partial participation in the respective excerpts. To determine the kinds of habitats the species i prefers and avoids one should compare its partial participation in the excerpts of every habitat (j) with its participation in all excerpts of all habitats.

$$d_p = p_{ij} - p_i,$$

where $p_{ij} = n_{ij}/N_j$ (n_{ij} is the number of specimens of the species i in habitat j ; N_j is the number of specimens of all species, inhabiting habitat j); $p_i = n_i/N$ (n_i is the number of all specimens of the species in all habitats i ; N is the volume of the whole excerpt).

The significance of the difference d_p is determined by the Student's criterion. If the value of d_p is significantly larger than zero, than the species prefers habitat j ; if its smaller than zero, the species avoids it (in comparison with the other investigated species). In the case of insignificance of d_p , it can be said that the species shows „indifference“ toward the certain kind of habitat.

Degree of relative attachment – the index is interpreted as a ratio of the differences between partial participation of the species I in the excerpts of habitat j and its partial participation in all other investigated habitats.

$$F_{ij} = (n_{ij}N - n_iN_j)/(n_{ij}N + n_iN_j - 2n_{ij}N_j)$$

$$-1 \leq F_{ij} \leq +1$$

The values of F_{ij} in the interval between -1 and 0 are interpreted as negative, whereas from 0 to 1 – as positive relative attachment towards the certain habitat. If $F_{ij} = 0$, the species is „indifferent“ towards the habitat. If $F_{ij} = 1$, the species densely inhabits the habitat. In the case of $F_{ij} = -1$, the species completely avoids the habitat.

Participation of the separate habitats in the distribution of the species' populations

$$q_{ij} = n_{ij}/\sum n_{ij} \quad 0 \leq q_{ij} \leq 1$$

This index expresses the degree of participation of habitat j in the distribution of species i . The confidential interval of q_{ij} is determined by the average mistake and table value of the Student criterion in the respective degrees of freedom and level of confidentiality.

The width of the ecological niche is calculated by the Levin index using the following formula:

$$B_A = B - 1/N - 1$$

B_A – standard Levin index for the width of the ecological niche

B – Levin index for the width of the ecological niche, which is calculated by the formula:

$$B = 1/\sum p_i$$

p_i – partial participation of the species' in the separate habitats.

RESULTS

During the investigated period (1998 – 2004) in the four investigated biotopes of NP „Strandja“, the following species were determined (table 1): 3 species of order *Insectivora* (*Neomis fodiens*, *Crocidura leucodon* and *Crocidura sauveolens*) and 6 species of order *Rodentia* (family *Gliridae* – *Dryomys nitedula*, family *Muridae* – *Apodemus agrarius*, *Apodemus species*, *Rattus rattus*, *Rattus norvegicus* and *Mus musculus*, family *Arvicolidae* – *Microtus arvalis* and *Microtus guentheri*).

Dominancy and relative populational numbers of the field mouse in NP „Strandja“.

The examination of the field mouse's distribution shows its presence in two of the four investigated habitats in NP „Strandja“: moist habitats and mixed forests with artificial coniferous plantations. During the investigation period (1998 – 2004) in the investigated biotopes for 25 630 trap days, 45 specimens belonging to species *A. agrarius* were caught. The field mouse forms 6.5 % of the whole catch of small mammals. According to the Kuziakin scale (1962) it can be determined as a normal species for the regions. In the habitats, where it is found, the mouse is the second most abundant species after the forest mouse, with relative number of 1.76 specimens per 100 t.n. (fig.2).

The distribution of the field mouse specimens in the investigated biotopes is uneven ($\chi^2 = 12.1$ when $df = 3$, $P = 0.01$). The mouse can be found only in two of the investigated biotopes: moist habitats and mixed forests. The influence of these biotopes on the distribution of the species in the investigated area is assessed through the index q (table 2). In moist territories, it is almost 3 times as large as that in the mixed forests and, therefore, has a more significant meaning on the determining of the spatial distribution of the species.

Assessment of the relative habitat association of the field mice in the investigated region. The habitat association of the species towards the investigated biotopes is determined through the indexes dp and F (table 3). The values of the index dp show that the field mouse prefers moist habitats and avoids deciduous forests, as well as deserted cultivated areas. In mixed forests, the index dp does not statistically differ from 0. Perhaps the species inhabits this biotope accidentally and is not biotopically attached to it. The field mice's degree of biotopic attachment is highest to moist habitats. It can be determined as positive and high according to the Pesenko classification (1982). To mixed forests, the species shows low, negative values of the degree of attachment. This confirms the conclusion that the mouse accidentally inhabits the habitat.

DISCUSSION

The investigations of the habitat association of the species *Apodemus agrarius* in NP „Strandja“ showed that the species inhabits 2 of the 4 investigated biotopes – moist habitats and mixed forests. This is in unison with the description of the ecological requirements of the species (Corbet and Hill, 1992).

The largest relative number of the species is found in the moist habitats and the least number – in biotopes 2 and 4. Therefore, a direct casual dependence between the regime of humidity and the habitat association of the species is present. The high humidity creates pleasant conditions for the development of various vegetation communities, which allow for high productivity of the moist biotopes and good food resources for the species.

The preferences toward a certain biotope are also determined by the food resources and preferences of the species. In the period when seeds are absent, the field mouse, which feeds on seeds, inhabits primarily lawns and river-banks, not showing preferences towards a certain type of plant cover. However, when there is an abundance of seeds on the forest ground, the distribution of the species shows a positive correlation with the tree forest vegetation and a negative one toward the bushes and grasslands (Castien & Gosalbez, 1994).

Another important factor, which determines the distribution of the species, is the competition between species. In the moist habitats, the field mouse exists in conditions of syntopia with other representatives of small mammals. However, the most significant influence on its distribution has the wood mice, which are dominating species for the region. Probably the species can coexist in syntopia conditions under relatively high overlapping of ecological niches due to the presence

of different, shifted in time, mechanisms, conditioning the dynamics of their populations. This allows them to inhabit a certain biotope together. These are the different deadlines for reaching reproductive activity, as well as their different participation in the preparation of the populations for overcoming of unpleasant climatic, food, and other conditions (Montgomery, 1981).

Last but not least, the differences in behavior of both species, which are related to their spatial structure by inhabiting the biotope in syntopia, also play an important role (Hoffmeyer, 1973). The larger percentage participation of wood mice in the catches in the investigated area may be explained with the more active investigation behavior of these species: they are less dependent on the vegetation and more active than *A. agrarius* during the conditioning of new territories. The wood mice „suppress“ passively the field mouse, which avoids direct contacts in the habitats, where wood mice dominate (Dojchev et al., 1983; Hoffmeyer, 1973).

REFERENCES

- ДОЙЧЕВ, Р., Е. МОЛЛЕ, Н. АТАНАСОВ, 1983. Изследователската активност и емоционално поведение на гризачи в теста „открито поле“. I. Жълтогърла горска мишка (*Apodemus flavicollis* Melch.). Екология, БАН, С., 11, 67-74.
- ПЕСЕНКО, Ю. А., 1982. Принципы и методы количественного анализа в фаунистических исследованиях. М., Наука, с. 286.
- ПЕШЕВ, Ц., Д. ПЕШЕВ, В. ПОПОВ, 2004. Фауна на България. София, 632 стр.
- ПОПОВ, В., 1993. Дребни бозайници (Insectivora, Lagomorpha, Rodentia). В: „Национална стратегия за опазване на биологичното разнообразие“, т.1, 615-630.
- ШИЛОВ, И. А., 1977. Эколого-физиологические основы популяционных отношений у животных. М., Изд. МГУ, с. 261.
- CASTIEN, E., J. GOSALBEZ, 1994. Habitat selection of *Apodemus flavicollis* in *Fagus sylvatica* forest in the Western Pyrenees. *Folia zool.*, 43, 3, 219-224.
- CORBET, G.B. and J.E. HILL. 1992. Mammals of the Indomalayan Region. Oxford University Press.
- HOFFMEYER, I., 1973. Interaction and habitat selection in mice *Apodemus flavicollis* and *A. sylvaticus*. *Oikos*, 24, 108-116.
- KREBS, C.J., 1989. Ecological Methodology. Harper & Row, Publ., New York, NY, U.S.A., 381p
- MONTGOMERY, W. I., 1981. A removal experiment with sympatric populations of *Apodemus sylvaticus* (L.) and *A. flavicollis* (Melchior) (Rodentia, Muridae). *Oecologia* (Berlin), 51, 123-132.
- PIANKA, E.R. 1973. The structure of lizard communities. *A. Rev. Ecol. Syst.* 4:53-74.

Table 1. Small mammals species in the NP „Strandja,, (sign „+“ show the presence of the species in certain habitat)

Species	BiotopI	BiotopII	BiotopIII	BiotopIV
Apodemus sp.	+	+	+	+
Apodemus agrarius	+		+	
Rattus rattus	+	+		
Rattus norvegicus	+			
Mus musculus	+			
Microtus arvalis	+			+
Microtus guentheri	+			
Crocidura leucodon	+			
Crocidura sauveolens	+			
Dryomys nitedula	+			

Table 2. Participation of the different habitats in the territorial distribution (q) of *Apodemus agrarius*' individuals in the NP „Strandja“

Видове	Биотоп 1	Биотоп 2	Биотоп 3	Биотоп 4
Apodemus sp.	0.490	0.029	0.284	0.087
Apodemus agrarius	0.045	0	0.0164	0
Rattus rattus	0.008	0.004	0	0
Rattus norvegicus	0.001	0	0	0.014
Mus musculus	0.001	0	0	0
Microtus arvalis	0.001	0	0	0.014
Microtus guentheri	0.011	0	0	0
Crocidura leucodon	0.001	0	0	0
Crocidura sauveolens	0.001	0	0	0
Dryomys nitedula	0.001	0	0	0

Table 3. Relative part of the *Apodemus agrarius*' individuals in the investigated habitats (dp) and degree of the relative habitat associations (*F*)

Species	Biotop1		Biotop 2		Biotop 3		Biotop 4	
	F	dp	F	dp	F	dp	F	dp
Apodemus sp.	-0.030	-0.024	-0.009	-0.016	0.043	0.055	-0.016	-0.026
Apodemus agrarius	0.357	0.018	-1.000	-0.061	-0.083	-0.007	-1.000	-0.061
Rattus rattus	0.211	0.002	0.873	0.112	-1.000	-0.012	-1.000	-0.012
Rattus norvegicus	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001
Mus musculus	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001
Microtus arvalis	-0.857	-0.013	-1.000	-0.015	-1.000	-0.015	0.978	0.120
Microtus guentheri	1.000	0.008	-1.000	-0.011	-1.000	-0.011	-1.000	-0.011
Crocidura leucodon	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001
Crocidura sauveolens	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001
Dryomys nitedula	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001
Neomis fodiens	1.000	0.001	-1.000	-0.001	-1.000	-0.001	-1.000	-0.001

Table 4. Indices of ecological niches' overlapping by the small mammals in the investigated habitats

ВИДОВЕ	Apodemus sp.	Apodemus norvegicus	Rattus rattus	Rattus norvegicus	Mus musculus	Microtus arvalis	Microtus guentheri	Crocidura leucodon	Crocidura sauveolens	Dryomys nitedula	Neomis fodiens
Apodemus sp.	1.0	0.68	0.40	0.37	0.16	0.16	0.58	0.16	0.16	0.16	0.16
Apodemus agrarius		1.0	0.79	0.55	0.23	0.23	0.62	0.23	0.23	0.23	0.23

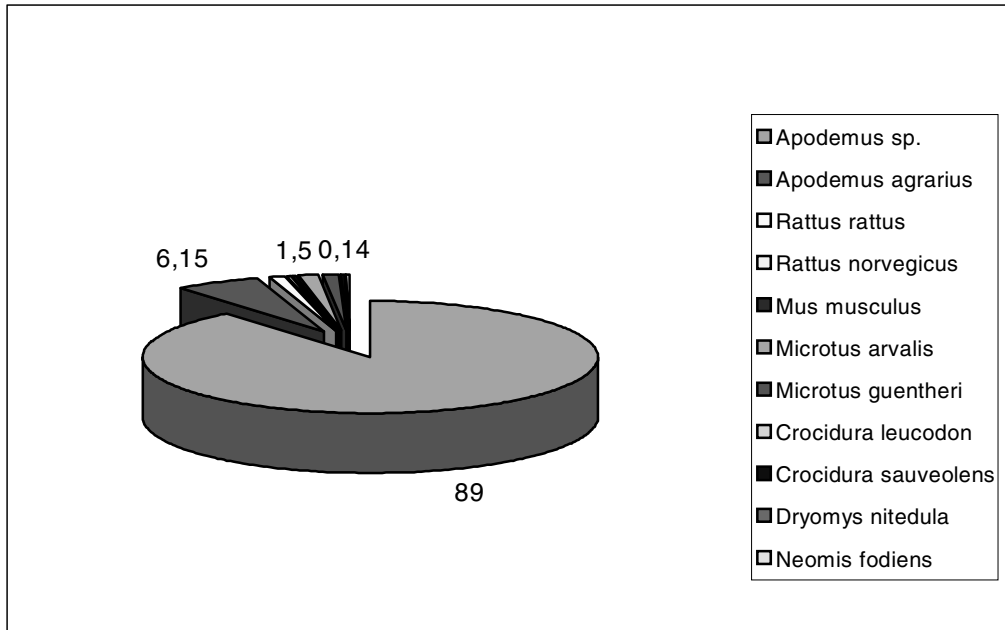


Fig.1. Dominance index (in %) of the field mouse (*Apodemus agrarius*) in the are of NP „Strandja“

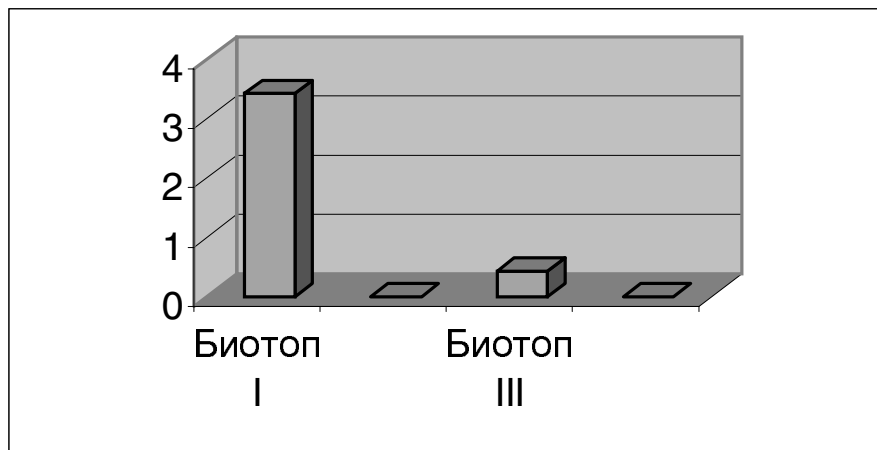


Fig.2. Relative number of the *Apodemus agrarius* individuals in the investigated habitats in the NP „Strandja“