



Species Composition and Population Structure of Rodent Communities in Different Habitats in the Lozenska Mountain, Bulgaria

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Abstract: The aim of this study is to assess the rodent community as a key component of agricultural and semi-natural ecosystems. Small mammals were caught on the territory of the Lozenska Mountain, western Bulgaria, in various natural and agricultural habitats. For this purpose, natural areas such as xerothermic oak forests, hygromesophytic secondary grasslands and their border areas as well as corn and alfalfa fields were examined. Species composition varied across the habitats, with a total catch of four rodent species. Population number, sex and age structure of the house mouse (*Mus musculus*), wood mouse (*Apodemus* sp.), bank vole (*Myodes glareolus*) and common vole (*Microtus arvalis*) were studied. Only two species (*M. glareolus* and *Apodemus* sp.) were found in the oak forest. The secondary grasslands also contained two rodent species (*Apodemus* sp. and *Microtus arvalis*). The agricultural habitats contained each a rodent community of three species (*Apodemus* sp., *Microtus arvalis* and *Mus musculus*) but the former two represented with low estimated population numbers, possibly due to animals visiting these fields for feeding and originating from neighbouring habitats. The populations of the four rodent species had balanced sex and age structure.

Key words: small mammals, habitats, vegetation structure

Introduction

MACARTHUR & MACARTHUR (1961) developed the habitat-heterogeneity hypothesis proposing that the increase in the number of habitats types could lead to an increase in species diversity (see also SIMPSON 1949, MACARTHUR & WILSON 1967, LACK 1969). This hypothesis has become one of the keystones of ecology. It assumes that structurally-complex habitats may provide more niches and diverse ways of exploiting the environmental resources and, thus, resulting into an increase of the species diversity (BAZZAZ 1975). In the majority of habitat types, the

diversity of plant communities determines the physical structure of the environment and, therefore, has a considerable influence on the distributions and interactions of animal species (MCCOY & BELL 1991). Positive relationships between vegetation-shaped habitat heterogeneity and animal species diversity have been well documented at both local and regional scales (DAVIDOWITZ & ROSENZWEIG 1998). Moreover, effects of habitat heterogeneity may vary considerably depending on characteristics of the preferred habitats of a certain group studied; furthermore, structural attributes of the vegetation that constitute habitat heterogeneity for one group may

be perceived as habitat fragmentation for another taxonomic group (ØKLAND 1996).

The Lozenska Mountain is located near Sofia and is considered as an element of the natural capital of the city. The diversity of forests, grasslands and wetlands creates suitable conditions for the richness of plant and animal species. The diversity of plant communities and animals' species composition is a function of the diversity of environmental factors determining living conditions. The relatively small territory of the mountain contains more than 30 habitats of mountainous and grassland type, representing c. 10% of all habitat types recorded in Bulgaria (SOPOTLIEVA et al. 2019).

The aim of the present study is to explore how the presence of different habitats affects species composition of rodent communities in natural and semi-natural habitats as well as in agricultural ecosystems. No data exist about the rodent communities and their habitat preferences in the studied region until now. Rodents are considered as an important part in the diet of various predators and this defines their basic position in the trophic chains as well as determines their important role for the ecosystem stability at the level of consumers.

Materials and Methods

The mountain ridge of the Lozenska Mountain is relatively flattened and located at an altitude of about 1000–1100 m a.s.l. It is composed of various rocks such as gneisses, marls, limestones, sandstones, conglomerates, andesite, tuffs and rhyodacites. The field studies were carried out during the summer of 2019 in four habitats: forest habitat on the north slope (42°35'02.32"N; 23°30'58.81"E; altitude c. 990 m a.s.l.), grassland area (42°35'08.50"N; 23°31'11.71"E; altitude c. 1062 m a.s.l.), alfalfa field *Medicago sativa* (42°35'50.29"N; 23°29'24.69"E; altitude c. 737 m a.s.l.) and corn field *Zea mays* (42°35'47.79"N; 23°29'24.79"E; altitude 748 m a.s.l.). The former two habitats belonged to the mountain zone, while the latter two habitats were at lower altitudes in the agricultural area. Two types of natural habitats were chosen for the purpose of this study: mountain meadows dominated by herbaceous species of the family Poaceae and forest area with deciduous forest where the plant community (xerothermic oak forest) is dominated by *Quercus frainetto*.

Patterns of the composition of plant species and vegetation in the chosen location varied across the habitat types. The xerothermic oak forest was dominated by *Quercus frainetto*, with homogenous for-

est stands and well-expressed undergrowth. Treeless habitats were formed by shrub and grass vegetation (SOPOTLIEVA et al. 2019); the majority of them were of secondary origin, evolving in places of forests destroyed in the past. They were mainly xeromesophytic, with dominant plants such as *Brachypodium pinnatum* and *Danthonia alpina*. In both studied crop habitats, a large percentage of weeds were observed. For alfalfa, this can be explained by its age, while the high contamination of the corn was most probably due to poor agricultural practices. The dominant tree species in the forest were *Q. frainetto*, *Q. pubescens*, *Sorbus domestica*, *S. torminalis* and *Malus sylvestris*; the undergrowth was formed by *Fraxinus ornus*, *Cornus mas*, *Crataegus monogyna* and *Prunus spinosa*. Grasslands were composed mainly by *Festuca valesiaca*, *Chrysopogon gryllus*, *Brachypodium pinnatum* and *Danthonia alpina*. Most common weeds in the two explored crop fields were *Sorghum halepense*, *Cynodon dactylon* and *Setaria viridis*.

Rodent trapping was conducted at the beginning (June) and at the end of the summer (August and September) of 2019, periods defined by the phenology of the plant communities (COLBERT 1986) and the time of maximum plant development and reproduction. The animals were collected using live and snap traps with specific bait for each trap type. A total of 472 trap-nights were included in the study. The population number of each species in each habitat was established following the method of PIELOU (1966) on the basis of trap-night calculations. This approach provided an accurate estimate of ecological density, i.e. a quantitative assessment of the space per individual that is used for ecological activities such as foraging, reproduction and social interactions. The assumption is that populations were confined to each site during a certain trapping season and that no new individuals were added through births and immigration or subtracted through deaths and emigration.

Results

Totally, the following rodent species were captured: wood mouse *Apodemus* sp. (n=34), bank vole *Myodes glareolus* (n=16), common vole *Microtus arvalis* (n=34) and house mouse *Mus musculus* (n=15). The structure of the rodent community varied across the studied habitats (Table 1, Fig. 1). *Apodemus* sp. was recorded in all the habitats studies, being the species with the highest population number. Among the different types of habitats, the highest species diversity of rodents was observed in the two agri-

Table 1. Rodent communities in the examined habitats of the Lozenska Mountain: species composition, number of captured animals (n), population number (estimated per 100 trap-nights separately for males, females and for the entire population), sex and age population structure (recorded numbers and proportions).

| Habitat | Species | n | Population number | | Sex structure | | Age structure | |
|---------------------------|---------------------|----|-------------------------|--------|---------------|--------|---------------|----|
| | | | male | female | male | female | sad | ad |
| Xerothermic oak forest | <i>Apodemus</i> sp. | 18 | 6.3 | 4.7 | 11 | 7 | 2 | 16 |
| | | | 10.3 | | 1.6 : 1 | | 1 : 8 | |
| | | | <i>Myodes glareolus</i> | 16 | 5.1 | 1.7 | 9 | 3 |
| | 6.9 | | | | 3 : 1 | | 1 : 11 | |
| Xeromesophytic grasslands | <i>Apodemus</i> sp. | 6 | 1.8 | 0.9 | 4 | 2 | 3 | 3 |
| | | | 2.7 | | 2 : 1 | | 1 : 1 | |
| | | | <i>Microtus arvalis</i> | 12 | 3.6 | 1.8 | 8 | 4 |
| | 5.4 | | | | 1 : 2 | | 0 : 12 | |
| Alfalfa field | <i>Apodemus</i> sp. | 2 | 0.2 | 0 | 2 | 0 | 0 | 2 |
| | | | 0.2 | | 2:0 | | 0:2 | |
| | | | <i>Microtus arvalis</i> | 16 | 3.0 | 3.0 | 8 | 8 |
| | 6.0 | | | | 1:1 | | 1:3 | |
| | <i>Mus musculus</i> | 7 | | | 1.6 | 1.9 | 3 | 4 |
| | | | 3.5 | | 1:1.2 | | 1:2.5 | |
| Corn field | <i>Apodemus</i> sp. | 8 | 2.6 | 1.3 | 6 | 2 | 2 | 6 |
| | | | 3.9 | | 3:1 | | 1:3 | |
| | | | <i>Microtus arvalis</i> | 6 | 1.5 | 1.5 | 3 | 3 |
| | 3.0 | | | | 1:1 | | 1:2 | |
| | <i>Mus musculus</i> | 9 | | | 2.8 | 2.5 | 5 | 4 |
| | | | 5.3 | | 1.3:1 | | 1:3.5 | |

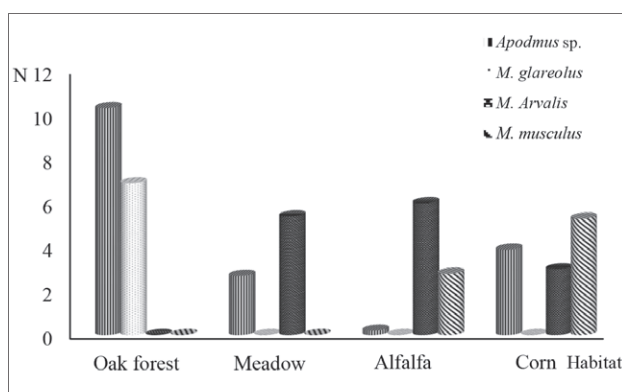


Fig. 1. Species composition and abundance of rodents in the studied habitats (N -population number).

cultural habitats studies. The populations of the four recorded rodent species exhibited a relatively balanced sex and age structure (Table 1).

Discussion

The rodent population structure from the four studied habitat type of the Lozenska Mountain is relatively stable. The obtained results for the population numbers are relatively stable, with the species composition being closely related to the altitude and the habitat preferences of the recorded species.

The omnivorous wood mouse *Apodemus* sp. was found in all studied habitats. Its presence in wood-

lands is expected, and its occurrence in the meadow and the alfalfa field is most probably a result of migration from the surrounding deciduous forests. The relatively low number of females recorded in the present study is probably a result of the breeding season, when many females are pregnant or taking care for their offspring, thus having lower locomotor activity. In the oak forest, where the higher population density of *Apodemus* sp. has been established, 28% of females are found pregnant. For the grassland, this percentage is approximately the same (25%) as well as for the corn field (21%). The young individuals comprise from 12.5% up to 50% from the total number of the caught specimens. Because of the relatively low number of caught animals, it is not correct to consider that the increase of the population numbers is due to the higher obtained percentage of young individuals in the grassland. The probable explanation is the high abundance of seeds of different cereals that provide a rich food basis for omnivorous species.

The bank vole *Myodes glareolus* is a typical inhabitant of woodlands and hedgerows. In the present study, the species have been found only in the forest area and its population number is c. 30% lower than that of the wood mouse. The bank vole is herbivorous and feeding competition between it and the wood mouse occurs mostly on territories with specific characteristics. The population number of the common vole *Microtus arvalis*, which is also a herbivorous analogue of the bank vole in meadows at lower altitudes, is comparable with that of the latter species. The two vole species, being both herbivorous, are spatially separated (*Myodes glareolus* and *Microtus arvalis* occur in forest (or shrub) habitats and grasslands, respectively. The sex structure of the two vole species, similarly to that of the wood mouse, is well balanced, with small dominance of more active male individuals in our captures. The percentage of the caught pregnant animals is 12% for the bank vole to 17% for the common vole.

The house mouse *Mus musculus* has been found only in the two investigated crop fields. The relatively higher population number of the species is due to its highly specific biology and ecology, e.g. inhabiting places closely situated to human settlements. The wide ecological plasticity of the wood mouse as well as its omnivorous preferences likely lead to a strong competition between *M. musculus* and *Apodemus* sp., which also occurs by approximately equal population number in alfalfa and corn fields.

The obtained higher species diversity in agricultural habitats is due to the presence of the semi-

synanthropic house mouse as well as to the richer feeding conditions there. Due to its age phase and lack of crop rotation, alfalfa provides permanent shelter for an extended time period. For this reason, the population of small rodents there is higher and more stable than in the maize field.

Habitat associations of rodents have been studied extensively in deserts (HESKE et al. 1994, KOTLER & BROWN 1988) and grassland ecosystems (KAUFMAN & FLEHARTY 1974, LACHER & ALHO 1989, MOULTON et al. 1981, SNYDER & BEST 1988). Many studies have examined the direct responses of one species to the removal of a competitor (BOWERS et al. 1987, HESKE et al. 1994, PRICE 1978, REBAR & CONLEY 1983) in order to assess whether competition plays a role in determination of habitat associations. Few studies directly assess the effects of habitat heterogeneity on species diversity (GRANT & BIRNEY 1979, HALL & WILLIG 1994) while others examine the structure of the rodent community on the basis of demographic and behavioural responses of a few common species (BROWN 1989, BROWN et al. 1994, KOTLER 1984, KOTLER & BROWN 1988, ROSENZWEIG 1973, ROSENZWEIG & ABRAMSKY 1997). The present study provides further evidence that the examination of rodent communities in various closely-situated habitats is a useful approach to determine how different species respond to environmental heterogeneity. As MARTIN (1998) has mentioned, the habitat selection has an adaptive basis and it is reasonable to assume that individuals demonstrating preferences to high-quality habitats have an advantage in their reproduction over conspecifics living in lower-quality habitats. This ultimately would lead to particular species being more abundant in some habitats than in others.

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