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TERRESTRIAL SMALL MAMMAL COMMUNITIES FROM HÂRTIBACIU PLATEAU (ROMANIA)

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Abstract. Small mammal communities were studied by live trapping during August-September 2010 and June-September 2011 in three localities from Hârtibaciu Plateau, in southern Transylvania. The area is situated between 420 and 550 m a.s.l., and represents a mosaic of small patches of different land use. 200 traps were set in lines for three consecutive nights, in 80 different habitats representing 12 habitat types, both cultivated and semi-natural. 1235 small mammals belonging to 15 species (four soricomorphs and 11 rodents) were captured. Abundance of small mammals was expressed by means of capture index (number of individuals caught per 100 active trap-nights). The community structure was strongly shaped by habitat type, even in case of small land patches. *Microtus arvalis* prevailed in the investigated area, being the dominant species in open fields with high grassy vegetation. The density of this species increased strongly from the beginning of summer to autumn, when the traps were occasionally saturated with field voles.

Résumé. Les communautés de petits mammifères ont été étudiées en utilisant des pièges pour la capture des animaux vivants, pendant Août-Septembre 2010 et Juin-Septembre 2011 dans trois localités du Plateau Hârtibaciu, dans le sud de la Transylvanie. La zone est située entre 420 et 550 m altitude et représente une mosaïque de petites parcelles de différentes utilisations. 200 pièges ont été installés dans les transects linéaires pour trois nuits consécutives, dans 80 habitats différents représentant 12 types d'habitats, cultivés et semi-naturels. 1235 petits mammifères, appartenant à 15 espèces (quatre musaraignes et 11 rongeurs) ont été capturés. L'abondance des petits mammifères a été exprimée par l'index de capture (nombre d'individus capturés par 100 pièges-nuits actifs). La structure de la communauté de petits mammifères a été fortement influencée par le type d'habitat, même en cas de petites parcelles. *Microtus arvalis* a prévalu dans la zone étudiée, étant l'espèce dominante dans les champs ouverts avec végétation herbeuse haute. La densité de cette espèce a augmenté à partir du début de l'été jusqu'automne, lorsque les pièges ont été occasionnellement saturés avec campagnols agrestes.

Key words: rodents, shrews, live trapping, community structure, habitat preferences.

INTRODUCTION

Hârtibaciu Plateau is an area of great conservation importance in Romania, being part of the Site of Community Importance ROSCI0132 Oltul Mijociu-Cibin-Hârtibaciu. It is a mosaic of habitats in an almost natural state, which shelters a high biodiversity. Several studies were made on different groups, mainly plants and birds, but information on the mammal fauna is scarce. The only published research (Benedek, 2007) presents the data obtained by live-trapping in September 2003 from four study sites (Retiș, Brădeni, Stejărișu and Dealu Frumos localities) in the upper part of Hârtibaciu River Basin.

The aim of the present study is to widen the knowledge on small mammal communities from different localities in relation to the habitat types and to highlight the seasonal changes in these communities.

STUDY AREA AND METHODS

Between 2010 and 2011, a survey of small mammal communities from different habitat types was carried out in the Hârtibaciu Plateau. In autumn 2010 a field campaign took place in two localities from Hârtibaciu Plateau, namely Beneşti (named Beneşti I) and Iacobeni. In 2011 the survey was accomplished during two campaigns, one in summer and the other in autumn (beginning with late August), in Alţâna and Beneşti, in another area than during the previous year (named Beneşti II). The survey was carried out by means of CMR (capture-mark-release) method, using plastic handmade box traps (18x8x6 cm) set in lines in different habitats. Each transect included 33 or 34 traps, placed at intervals of 10 m. Six (in 2010) or five (in 2011) trap lines were set at the same time, and traps were checked for three consecutive nights, at dawn and in the evening. In all, 80 transects were established in 12 habitat types: pastures, hayfields, unused lands with low vegetation - margins of roads and railroads - and high vegetation - river and canal banks, corn, wheat and alfalfa fields, abandoned cultures, pastures with sparse shrubs, shrubby pastures with extensive woody vegetation cover, forest edges and hornbeam (*Carpinus betulus*) forests. The position of sampling localities is indicated in fig. 1. The number of transects in each habitat type was proportional to its ratio in the area, so that the results give a sound image of the structure and abundance of small mammal communities from the investigated zones.

The traps were baited with sunflower seeds and apple slices. No prebaiting was done. No bedding material was provided, but the traps were set in shady places or when not possible, hay cover was provided in order to avoid overheating of captured animals. The captured specimens were identified to species based on morphological characters (Murariu, 2000; Popescu & Murariu, 2001), marked by fur clipping on

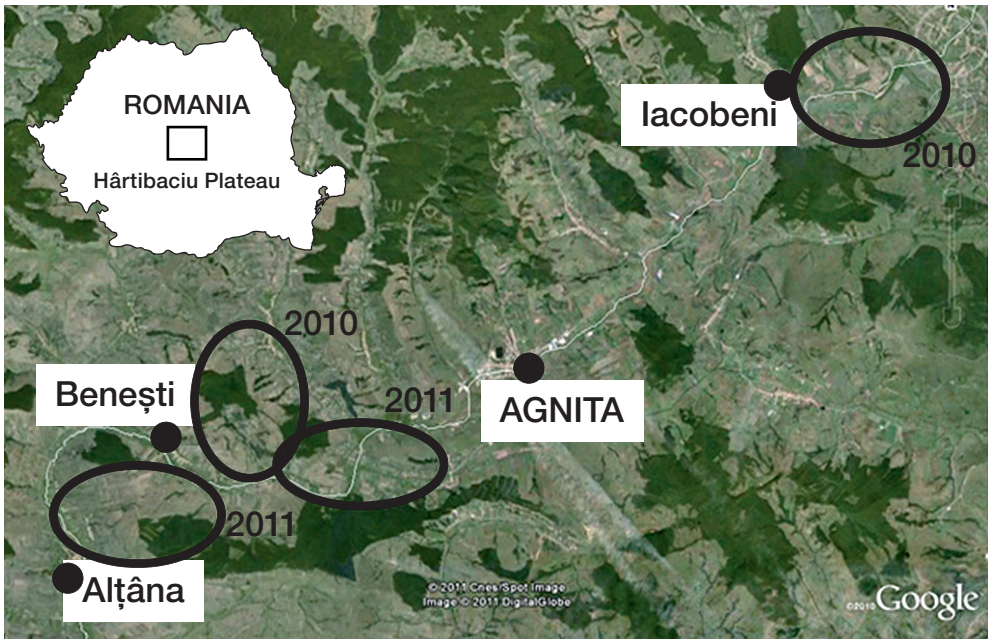

Fig. 1 - Study area in Hârtibaciu Plateau with sampling localities and the year of sampling.

the rear part of the back, and released. In case of mice belonging to *Apodemus* genus (*A. flavicollis, A. sylvaticus, A. uralensis*) we considered the presence and shape of the collar, the colour of the back and belly, the length of hind foot and the ratio between the lengths of tail and body.

Relative abundance was expressed as the ratio of the species (in percentages) within a sample. Frequency was calculated as the ratio (in percentages) between the trap lines where the species was captured and the total number of trap lines. Abundance, as a measure of population density, was expressed as capture index, meaning the number of captured individuals per 100 active trap-nights (TN). Many traps were disturbed by animals (especially shepherd dogs), rain or wind, destroyed by tractors or cattle, or even stolen, thus of the intended 8010 TN (80 lines with 33-34 traps for 3 consecutive nights) only 5571 TN (69.6%) were effective.

Mystat 12 software was used for data analysis. The significance of correlation between the abundance and frequency of the captured species and between the number of captured species and capture index in different habitat types was tested and its strength expressed by Pearson correlation coefficient. The Pearson χ^2 test of independence was used to test the influence of the locality on the species' ratio (McDonald, 2009). The association between the prevailing species was tested using t test, and its strength was expressed both in qualitative - by means of Fager index (Southwood, 1966) and quantitative terms - proportion of individuals occurring together - we used the modified Whittaker and Fairbanks equation (Southwood & Henderson, 2000), with the range of 0 to 1.

RESULTS

A total number of 1235 individuals were captured, belonging to 15 species, four shrews and 11 rodents. Further three species were identified based on direct or indirect visual observations. The number of specimens captured during the research period, the species' frequency (F%), the trapping effort and the capture index for each site are presented in tab. 1.

The terrestrial small mammal species known to inhabit Hârtibaciu Plateau, based on the data collected during the field campaigns and the previous study carried out in September 2003 (Benedek, 2007), are presented below. Systematics is given according to Wilson & Reeder (2005).

Order Erinaceomorpha
Family Erinaceidae

1. *Erinaceus roumanicus* Barret-Hamilton, 1900 (Eastern hedgehog) – a specimen was found crossing a dirt road in Alțâna in August 2011.

Order Soricomorpha
Family Soricidae

2. *Sorex araneus* Linnaeus, 1758 (Common shrew) – the most abundant and frequent shrew species during this study, but also in September 2003, captured in a great variety of habitat types.

3. *Sorex minutus* Linnaeus, 1766 (Pygmy shrew) – two specimens were captured in one of the research areas (Benești) in August and September 2011. In the 2003 study, this shrew species was captured at the forest edge from Brădeni and Retiș.

Table 1

Terrestrial small mammals captured in the localities from Hârtibaciu Plateau, in 2010 and 2011 (F% stands for frequency).

Species	2010		2011		Total	F%
	Benești	Iacobeni	Alțâna	Benești		
S. araneus	0	4	11	1	16	12.50
S. minutus	0	0	0	2	2	1.25
C. suaveolens	0	1	0	1	2	2.50
C. leucodon	0	1	0	0	1	1.25
M. glareolus	2	0	0	2	4	2.50
A. sherman	1	0	0	5	6	7.50
M. arvalis	55	277	178	108	618	73.75
M. subterraneus	0	0	27	4	31	7.50
M. minutus	0	0	4	0	4	2.50
A. agrarius	29	169	87	55	340	47.50
A. flavicollis	50	12	14	4	80	31.25
A. sylvaticus	0	24	37	6	67	25.00
A. uralensis	0	0	28	2	30	16.25
M. musculus	1	4	28	0	33	10.00
R. norvegicus	0	0	0	1	1	1.25
Total	138	492	414	191	1235	
Trapping effort	763	1010	2121	1677	5571	
Capture index	18.08	48.71	19.51	11.38	22.16	

4. *Neomys fodiens* (Pennant, 1771) (Water shrew) – one specimen captured in the riverside willow thicket at Stejărișu in September 2003.

5. *Crocidura leucodon* (Hermann, 1780) (Bicoloured white-toothed shrew) – was found during both studies, in 2003 in the shrubs from Stejărișu, and in 2010 in the pasture with sparse shrubs from Iacobeni.

6. *Crocidura suaveolens* (Pallas, 1811) (Lesser white-toothed shrew) – two specimens were captured, one in the pasture with sparse shrubs from Iacobeni in September 2010 and the other under a bush in a hayfield from Benești, in September 2011.

Family Talpidae

7. *Talpa europaea* Linnaeus, 1758 (European mole) – was widely spread in the area, its presence being indicated by the numerous mole hills from different habitats. One specimen was found dead in a hayfield in Alțâna in July 2011.

Order Rodentia

Family Castoridae

8. *Castor fiber* Linnaeus, 1758 (Beaver) – probably went extinct in Romania during the first decades of the 19th century, although in 1850 Bielz mentioned the possibility of its presence in Transylvania. In 1998 ICAS (The Institute for Forest Research and Management) Brașov initiated a program of reintroduction on three

rivers from Romania, namely Olt, Mureș and Ialomița, which lasted until 2003. 182 specimens brought from Bavaria were released and they established stable populations, which are now in process of expansion (www.beaver.icaswildlife.ro). From the upper sector of the Olt River, the reintroduced beavers colonised its middle course and some of tributaries, including Hârtibaciu (via Cibin River). Local people claim that the beaver is found along the most part of the river. During our study several burrow entrances and footprints were observed downstream Alțâna and more recently fallen and gnawed willow trunks and branches were found downstream Cașolț, near the confluence with Cibin River and in the upper sector, upstream Netuș.

Family Gliridae

9. *Glis glis* (Linnaeus, 1866) (Fat dormouse) – was captured in the mixed broadleaf forest from Retiș and at the forest edge from Brădeni in 2003.

10. *Muscardinus avellanarius* (Linnaeus, 1758) (Hazel dormouse) – three specimens were captured in September 2003 at Dealu Frumos, in the hornbeam and oak forest, the forest clearing and in the ditch along a dirt road.

Family Cricetidae

11. *Arvicola sherman* (Shaw, 1801) (Montane water vole) – was captured only at Benești, both in 2010 and 2011, in hayfields, unused lands with high vegetation and pastures with sparse shrubs.

12. *Myodes* (syn. *Clethrionomys*) *glareolus* (Schreber, 1780) (Bank vole) – was found in 2003 in the forests and at the forest edges from Dealu Frumos, Brădeni and Retiș, in 2010 at the forest edge from Benești and in 2011 in the unused land with high vegetation bordering the willow riparian forest on the banks of Hârtibaciu River at Benești.

13. *Microtus arvalis* (Pallas, 1778) (Common vole) – captured in 2003 only at Dealu Frumos and Brădeni, in several open habitats, was the most abundant and frequent species during the present study, found in most types of habitat, in all the research areas, both in 2010 and 2011.

14. *Microtus subterraneus* (de Selys-Longchamps, 1836) (Common pine vole) – was found only in 2011, both in Alțâna and Benești, in different moist habitats with high and rich vegetation.

Family Muridae

15. *Micromys minutus* (Pallas, 1771) (Harvest mouse) – was captured only at Alțâna, in a hayfield and an unused field with high vegetation, in August 2011.

16. *Apodemus agrarius* (Pallas, 1771) (Striped field mouse) – although not the prevailing species, it was very abundant and frequent both in 2003 and 2010-2011, being present in all the habitat types except for the forest.

17. *Apodemus flavicollis* (Melchior, 1834) (Yellow-necked mouse) – the prevailing species in 2003, was captured during the present study in all the research areas, mainly in forests and at forest edges, but also in other habitats with wooded vegetation or near the forest.

18. *Apodemus sylvaticus* (Linnaeus, 1758) (Wood mouse) – in 2003, was captured at Dealu Frumos (dominant in the clearing), Brădeni (dominant in the reed bed) and at Retiș and during the present study in all the three localities (at Benești only in 2011), in cultivated fields and semi-natural habitats with moderate cover of woody vegetation (it was absent both in the hayfields and forests).

19. *Apodemus uralensis* (Pallas, 1811) (Pygmy field mouse) – in 2003, was found only at Dealu Frumos in the cornfield and the adjacent shrubby ditch, during the present study it was found only in 2011, in both areas, in the same habitat types as *A. sylvaticus*.

20. *Mus musculus* Linnaeus, 1758 (House mouse) – was found in all three localities (at Benești only in 2010), mainly in cultivated (corn and wheat) fields, being most numerous in the maize culture near the abandoned farm from Alțâna.

21. *Rattus norvegicus* (Berkenhout, 1769) (Brown rat) – one juvenile was captured in July 2011 in an abandoned cornfield from Benești.

Among the captured small mammals rodents were dominant, and among them the vole *M. arvalis* (50%) and the mice species belonging to *Apodemus* genus (Fig. 2). *M. arvalis* also recorded the highest frequency, being captured in 73.75% of the trap lines. It was followed by *A. agrarius*, both in what relative abundance (27.5%) and frequency (47.5%) are concerned. A significant association was found between these two species ($p<0.001$; $t = 3.979$; $df = 95$), both preferring open habitats with high vegetation, and being widely distributed in the research area. The affinity between these species was slightly stronger when abundance was considered (the proportion of the individuals occuring together was 0.75, while the Fager affinity index was 0.68).

A. flavicollis and *A. sylvaticus* had similar ratios, the first being slightly more abundant and more frequent, found mainly in forests and at forest edges, as well as in habitats with woody vegetation. All the other small mammals presented low ratios and frequencies. Among the shrews *S. araneus* prevailed, with 16 captured specimens (1.3%).

There was a very significant ($p<0.001$), positive and strong ($r = 0.950$) correlation between the relative abundance and frequency calculated for the captured small mammals.

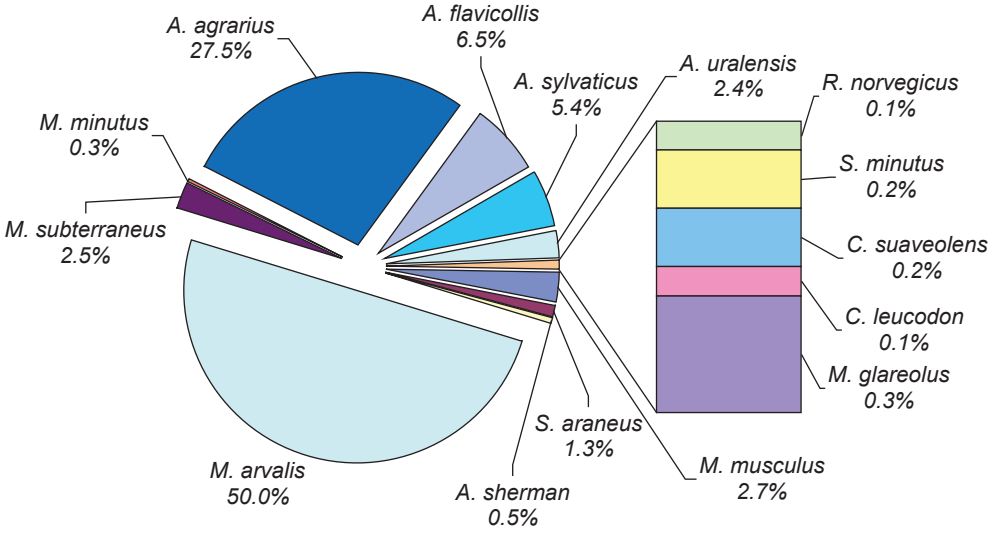

Fig. 2 - Relative abundance of terrestrial small mammal species captured in Hârtibaciu Plateau during the research.

Considering separately the four investigation areas, the Pearson chi-square test for independence showed a very significant ($p<0.001$, $\chi^2 = 233.737$, df = 9) dependence of the relative abundance of the most abundant species (*M. arvalis, A. agrarius, A. flavicollis* and *A. sylvaticus*) on the locality, the most distinctive being Benești I. Here *A. flavicollis* had a high ratio, outnumbering *A. agrarius*, being second only to *M. arvalis*. However, if we consider only the two prevailing species in the four areas, *M. arvalis* and *A. agrarius*, their abundance did not differ significantly ($p>0.05$, $\chi^2 = 2.195$, df = 3), indicating a homogeneity of the small mammal communities in this type of patchy landscape from southern Transylvania.

In 2011, each transect was set twice, first time in mid-summer and then in late summer and early autumn, enabling us to observe the changes occurred in the small mammal populations as a consequence of the breeding season. There were some similarities but also differences between the patterns of seasonal changes in the two localities. In both cases there was a significant increase of the total capture index. The increase was stronger in Benești, where the capture index rose from 3.3 ind./100 TN in summer to 19.3 in autumn (Fig. 3). At Alțâna the increase was given mainly by *A. agrarius* and at a lesser extent by *A. sylvaticus* and *M. subterraneus*, while *M. arvalis* presented a similar abundance (8.1 ind./100 TN in summer and 8.6 in autumn). *A. flavicollis* was the only species with a lower capture index in autumn (0.4 compared with 0.9 ind./100 TN in summer), indicating that it was present along the trap lines only temporarily, coming from the neighbouring forest. At Benești the strong growth of the community density was given by *A. agrarius* and especially *M. arvalis*, the latter with an increase in the capture index more than tenfold (from 0.9 to 12 ind./100 TN).

In autumn, although the total capture index for *M. arvalis* was around 10 ind./100 TN in both localities, in suitable habitats (e.g. some unmown hayfields) the traps were saturated with field voles, the capture index being occasionally higher than 100 ind./100 TN (due to day-time captures and multiple catches).

The density and diversity of small mammal communities varied greatly among the researched habitat types (Fig. 4). Although the correlation between the species number and capture index is not really significant ($p = 0.06$), if we leave out the forests and consider only the more or less open habitats, the correlation becomes highly significant and strong ($p = 0.003$, $r = 0.805$). The highest capture index (51.1 ind./100 TN) and also species richness (11 species) were recorded for the unused

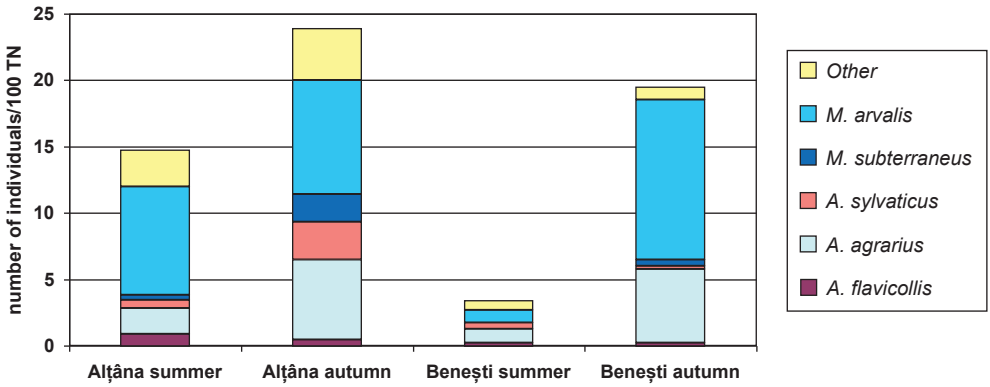

Fig. 3 - The abundance of small mammals from the two localities sampled in summer and autumn 2011.

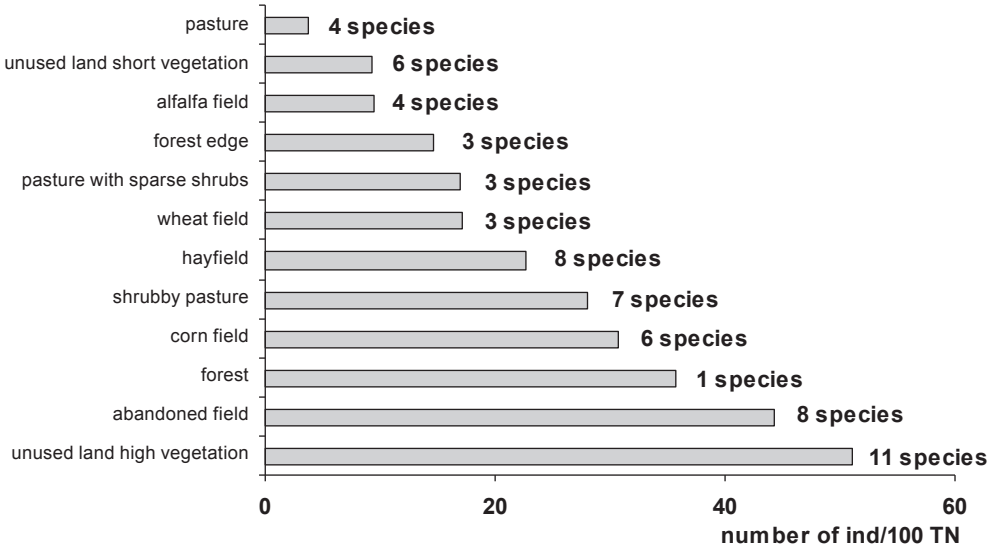

Fig. 4 - Abundance and species richness of small mammal communities in the investigated habitat types (captures from all trap lines in the same habitat type are pooled together).

lands with high vegetation, most of them situated along the willow riparian forest on the bank of Hârtibaciu River and along the canals separating the cultivated fields. Abundant and diverse assemblages were sheltered also by abandoned fields, where 8 species were found, with a total of 44.2 ind./100 TN. Both had a good ground cover by high and diverse vegetation and presented a low human disturbance.

In forests the relatively high density was given by the yellow-necked mouse, the sole species captured in this habitat. The other typical forest species (e.g. dormice, bank vole), well represented in the previous survey, are more exacting in what the habitat conditions are concerned. Thus, they were absent from the two forests due to the lack or poor development of undergrowth (Benești I) or to the disturbance from grazing sheep (Altâna).

Among the cultivated terrains the richest small mammal assemblages were sheltered by cornfields, due to the high vegetation and food availability, their structure being influenced by the presence and density of weeds. In plots where intensive agricultural works were carried out, leaving behind an extremely neat and tidy maize culture, with no other plants among the corn stems, small mammals were poorly represented, with the house mouse among the prevailing species. In contrast, in plots with a rich cover of weeds, where no herbicides were sprayed and no hoeing was done, communities were more abundant and diverse. Several other species of rodents were also abundant in these habitats: the striped field mouse, the wood mouse, the pygmy field mouse and the common vole, the latter being the prevailing species in the wheat and alfalfa fields. However, the presence of rodents in different cultures is usually temporary, depending on the food and shelter resources and the disturbing effect of agricultural works (Hamar & Șutova, 1965, 1968; Theiss, 1962).

The species number and capture index values decreased with the reduction of land cover, vegetation height and human pressure. The poorest habitats in what density is concerned, were the pastures. The same conclusion was drawn also in the Făgăraș Piedmont (Lazăr et al., 2012). In pastures only 3.8 ind./100 TN were

captured, although in all 4 species were identified. The reasons for the scarcity of small mammals in pastures are the frequent disturbance by grazing sheep (or cattle) and the shephard dogs, the compacted soil, and especially the short vegetation and the lack of cover.

DISCUSSION

The large extent of open habitats in Hârtibaciu Plateau shapes the structure of the small mammal community, favouring the common vole and the striped field mouse. The two species prevail in all the research sites, finding favourable conditions in several habitat types, where they build up populations increasing in density from summer to autumn.

The results of this study show several similarities with those from another plateau area, the Făgăraş Piedmont (Lazăr et al., 2012). However, the shares of the dominant species are reversed in the two research areas. Compared to Hârtibaciu Plateau, the Făgăraş Piedmont is moister, due to the numerous streams and rivers crossing it, the proximity of the mountains and the montane forest belt. The higher humidity favours the striped field mouse, while the numerical development of the common vole populations is limited. The proximity of the mountain forest belt determines also a relatively high capture index for the yellow-necked mouse. The reduced abundance of this species in autumn compared to summer was observed in both areas, indicating a retreat from the open habitats (including cultivated fields), inhabited or more frequently visited during summer, to the forest.

Although the soricomorphs had a low relative abundance, the common shrew had a relatively high frequency, being captured in a large variety of habitat types. This result confirmed that it is an euryoecious species, inhabiting both open and forested habitats in lowlands and mountain areas (Istrate, 1998; Murariu, 2003; Benedek & Sîrbu, 2009). The scarcity of shrews among the captured small mammals was due mainly to the high density of rodents and the large proportion of open lands among the researched habitats, but might be also the result of sampling bias. The relative abundance of soricomorphs was significantly lower than in 2003 (Benedek, 2007) or in some mountain areas, especially when rodent population densities are low (Benedek, 2006; Benedek & Drugă, 2005), but close to their ratio in the Făgăraş Piedmont (Lazăr et al., 2012), where similar habitat types were surveyed.

Conclusions

During the research period a total number of 1235 individuals were captured, belonging to 15 species (four species of shrews and 11 of rodents). *Microtus arvalis* was the prevailing species, followed by the mice from *Apodemus* genus (*A. agrarius*, *A. flavicollis,* and *A. sylvaticus*). They recorded also the highest frequencies. The population densities increased from summer to autumn, as a result of the breeding season, later in the common vole and earlier in other open habitat species. The number of species and the capture index values decreased with the reduction of land cover, vegetation height and increase in the human pressure. The most abundant and diverse assemblages were sheltered by unused lands with high vegetation and abandoned fields, while the poorest communities were found in pastures. Among the cultivated fields the richest small mammal assemblages were sheltered by maize cultures, their structure being influenced by the presence and density of weeds.

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COMUNITĂȚI DE MAMIFERE MICI TERESTRE DIN PODIȘUL HÂRTIBACIU (ROMÂNIA)

REZUMAT

Comunitățile de mamifere mici au fost studiate prin utilizarea capcanelor tip cutie în perioada august-septembrie 2010 și iunie-septembrie 2011, în trei localități din Podișul Hârtibaciu, în sudul Transilvaniei. Zona este situată între 420 și 550 m alt. și reprezintă un mozaic de mici parcele cu diferite folosințe ale terenurilor. 200 de capcane au fost amplasate în transecte liniare timp de trei nopți consecutive, în 80 de habitate diferite reprezentând 12 tipuri de habitate, atât cultivate cât și semi-naturale. 1235 exemplare aparținând la 15 specii (4 soricomorfe și 11 rozătoare) au fost capturate. Structura comunităților de mamifere mici a fost puternic influențată de tipul de habitat, chiar și în cazul parcelelor mici de teren. *Microtus arvalis* a predominat în zona cercetată, fiind specia dominantă în terenuri deschise cu vegetație ierboasă înaltă, densitatea ei crescând puternic de la începutul verii până toamna.

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