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## DYNAMICS OF SMALL MAMMALS' COMMUNITIES (INSECTIVORA AND RODENTIA) FROM RETEZAT MOUNTAINS NATIONAL PARK (ROMANIA)

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Abstract. The Retezat National Park shelters a rich fauna of small mammals. Up to the present 22 species are known from here, among them 9 insectivores and 13 rodents. Between 2000 and 2005 a series of investigations was carried out using live trapping, aiming to reveal the spatial and temporal dynamics of small mammals' communities. The diversity and abundance of these communities decrease on altitude. Dominants are *Clethrionomys glareolus* and *Apodemus flavicollis*, and in years with low densities of the latter, *S. araneus*. The multiannual dynamics of *A. flavicollis* and *S. araneus* are negatively correlated. *C. glareolus* is a constant presence in the area, both in space and time, but with a relatively low abundance.

Résumé. Le Parc National Retezat abrite une riche faune des petits mammifères. Jusqu'au présent 22 espèces sont connues d'ici, 9 insectivores et 13 rongeurs. Entre les années 2000 et 2005 nous avons entrepris une série des investigations visant la dynamique spatiale et temporelle des communautés des petits mammifères. La diversité et l'abondance de ces communautés baissent avec l'altitude. Elles sont dominées dans la plupart des habitats par *Clethrionomys glareolus* et *Apodemus flavicollis*, et durant les années de déclin du dernier, par *S. araneus*. Les dynamiques multi annuelles de *A. flavicollis* et *S. araneus* sont négativement corrélées. *C. glareolus* est une présence constante dans toutes les forêts durant l'entière période de recherches.

Key words: insectivores, rodents, communities' ecology, altitudinal distribution, multiannual dynamics.

Like in any mountain region from Romania, only few studies were carried out in the Retezat Mountains on the small mammals communities. The first study on the flora and fauna was published by J. von Csató in 1866. These data were taken over by E. A. Bielz (1888) and R. Călinescu (1931). Other original data were published by M. Hamar (1958), O. Wagner (1974), V. Simionescu and D. Munteanu (1988). However, most of these data are faunistical. In the few cases where the number of captured individuals is given, no information on the capture effort is available.

The present study, carried on between 2000 and 2005, aimed to reveal the dynamics of the small mammals' communities, both in space and time.

### STUDY AREA AND METHODS

Investigations were carried out by live-trapping of small mammals using Longworth-like wooden box traps. 20 stations and about 40 habitats were researched at different heights and in different habitat types, in several areas of the park (Fig. 1). The research area stretches between the following extreme points: in North - Cărnic Chalet (45°25'49.90'' N, 22°53'42.40'' E), in South Cheile Buții (45°18'08.56'' N, 22°58'18.65'' E), in East Câmpușel Forest Range (45°15'43.25'' N, 22°52'14.49'' E) and in West Gura Apei Lake shore (45°18'56.86'' N, 22°40'25.60'' E).

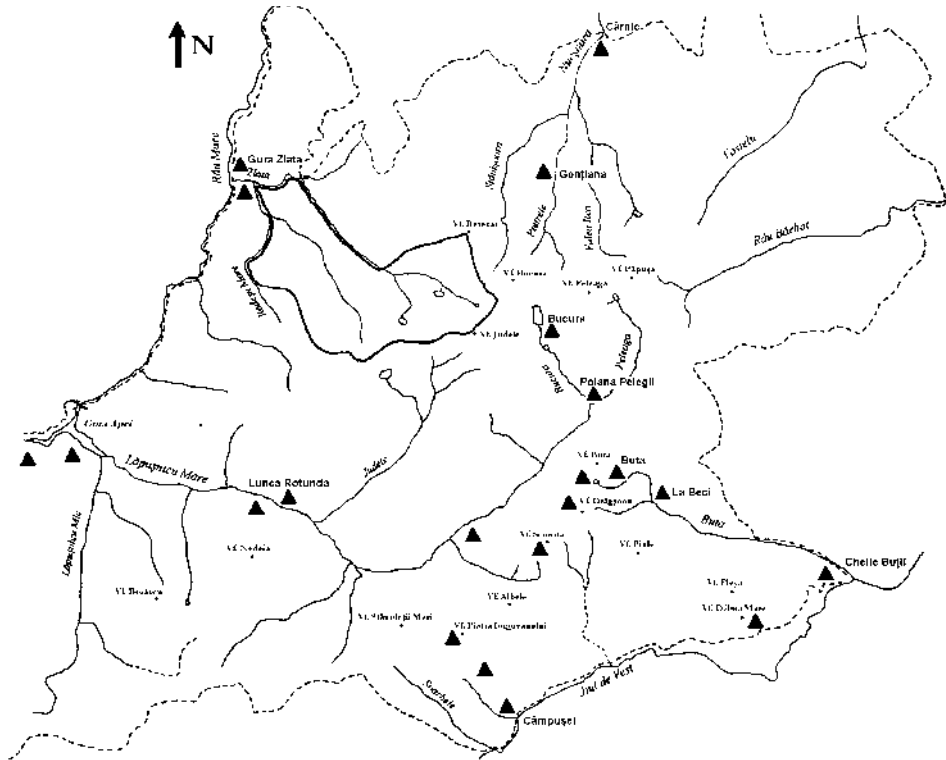


Fig. 1 – Position of the research stations in the Retezat National Park.

Studies were accomplished during 10 to 30 days field campaigns in August 2000, July, August and September 2002, September 2003, June and September 2004, June and September 2005.

The traps were set either in a rectangular net (in forests) or in transect (along river banks), at 10 m distance one from another. They were checked twice a day, in the night and at dawn. Captured animals were identified according to Pucek (1981), Murariu (2000) and Popescu and Murariu (2001), based on external morphological features. They were marked by cutting their fur in different parts of the body, and then released.

Multiannual dynamics was expressed using both the relative abundance and the capture index values. The capture index was calculated according to the formula:

$$Ic_i = \frac{n_i}{c \times n - C_n} \times 100$$

where:  $Ic_i$  = standardised capture/night index (standardised frequency);  
 $n_i$  = number of captured individuals belonging to species  $i$  (individuals are counted only the first time they are captured during a sampling session);  
 $c$  = total number of checked traps' checkings;  
 $C_n$  = number of not functional checked traps (escapes, blocked traps, etc.).

## RESULTS AND DISCUSSIONS

Up to the present 22 species of small mammals are known from Retezat Mountains, among them 9 insectivores (all the species known from Romania) and 13 rodents. For a few species there are only vague spatial references in the literature, so that we can not know if they were found within the present park's borders, or beyond them.

## Ordo Insectivora Bowdich, 1821

Family Erinaceidae Bonaparte, 1838

1. *Erinaceus concolor* Martin, 1838

Family Talpidae Gray, 1825

2. *Talpa europaea* Linnaeus, 1758

Family Soricidae Gray, 1821

3. *Sorex araneus* Linnaeus, 1758
4. *Sorex minutus* Linnaeus, 1766
5. *Sorex alpinus* Schinz, 1837
6. *Neomys fodiens* (Pennant, 1771)
7. *Neomys anomalus* Cabrera, 1907
8. *Crocidura leucodon* (Hermann, 1780)
9. *Crocidura suaveolens* (Pallas, 1811)

## Ordo Rodentia Gray, 1821

Family Sciuridae Gray, 1821

10. *Sciurus vulgaris* Linnaeus, 1758
11. *Marmota marmota* Linnaeus, 1758

Family Gliridae Thomas, 1897

12. *Eliomys quercinus* (Linnaeus, 1758)
13. *Myoxus glis* (Linnaeus, 1766)
14. *Muscardinus avellanarius* (Linnaeus, 1758)

Family Arvicolidae Gray, 1821

15. *Clethrionomys glareolus* (Schreber, 1780)
16. *Pitymys subterraneus* (de Selys - Longchamps, 1836)
17. *Microtus agrestis* (Linnaeus, 1761)
18. *Chionomys nivalis* Martins, 1842

Family Muridae Gray, 1821

19. *Apodemus sylvaticus* (Linnaeus, 1758)
20. *Apodemus flavicollis* (Melchior, 1834)
21. *Apodemus agrarius* (Pallas, 1771)
22. *Mus musculus* Linnaeus, 1766

The specific diversity and abundance of small mammals communities decrease on altitude. The same rule was recorded also by other authors (Simionescu, 1968). The highest number of species (captured or cited in the literature), 15, is found in the lower areas, in the beech forests zone, while in the alpine level, above

the upper limit of the subalpine shrubs, only 5 species were recorded. The impoverishment of small mammals communities at higher altitudes is recorded both in years with low and high populational densities. Table 1 contains the number of animals and species captured in September 2003 (a year of low populational densities), in the 7 investigated stations.

Table 1

The number of small mammals captured in September 2003.

Station Species	900 m Ch.Buții	1000 m Cârnic	1350 m La Beci	1550 m Buta	1650 m P.Pelegii	1750 m Gențiana	2100 m Bucura
<i>S. araneus</i>	6	8	7	3	4	1	1
<i>C. glareolus</i>	2	1	3	1	2	0	0
<i>A. flavicollis</i>	2	3	0	0	0	0	0
<i>S. minutus</i>	2	1	0	0	0	0	0
<i>S. alpinus</i>	0	0	0	2	0	0	0
<i>N. fodiens</i>	2	0	0	0	1	0	0
<i>M. agrestis</i>	0	0	1	0	0	0	0
<i>M. avellanarius</i>	0	0	1	0	0	0	0
No. of individuals	14	13	12	6	7	1	1
No. of species	5	4	4	3	3	1	1

*S. araneus* was present in every station, *C. glareolus* was not found in the subalpine zone, *A. flavicollis* and *S. minutus* were captured only at low altitudes, while *S. alpinus* is characteristic for spruce forests. *N. fodiens* is the only species that does not seem to be altitude-, but habitat-related. The maximum number of species (5) and individuals (14) were found in the lowest station (900 m altitude), in the beech forest vegetation level. The most sudden decrease is recorded at the upper limit of the spruce forest. Thus, at Gențiana Chalet and Bucura Lake only one *S. araneus* specimen was captured.

Considering the relative abundance of the small mammals from Retezat National Park in the research years (Fig. 2), their communities record a significant dynamics.

In 2000, the small mammals fauna was clearly dominated by rodents, namely the two typical forest species, *C. glareolus* (with a higher relative abundance) and *A. flavicollis*, the only captured rodent species. Among insectivores only *S. araneus* was found by one specimen captured in the beech forest at Gura Zlata. In 2002, *A. flavicollis* recorded an increase in relative abundance, representing 66% of the captured animals, while the abundance of *C. glareolus* dropped to 30%. The diversity of captured rodents was higher than in 2000, four other species being found, namely *M. agrestis*, *Ch. nivalis*, *P. subterraneus* and *M. glis*, but no more than two specimens each. Insectivores were, like in 2000, very scarce, besides *S. araneus* only *S. minutus* was captured.

The next year, 2003, is characterized by a series of significant changes compared with the situation recorded in 2000 and 2002. Among these, the increase of populational densities of insectivores, especially *S. araneus*, which dominated the small mammals communities and the drastic relative abundance decrease of *A. flavicollis*, which was not encountered above 1000 m are most important. From faunistical point of view, the appearance of *S. alpinus*, a species considered rare by most authors is remarkable. These changes, occurred during 2003 in the small mammals communities from Retezat National Park, did not have a local character,

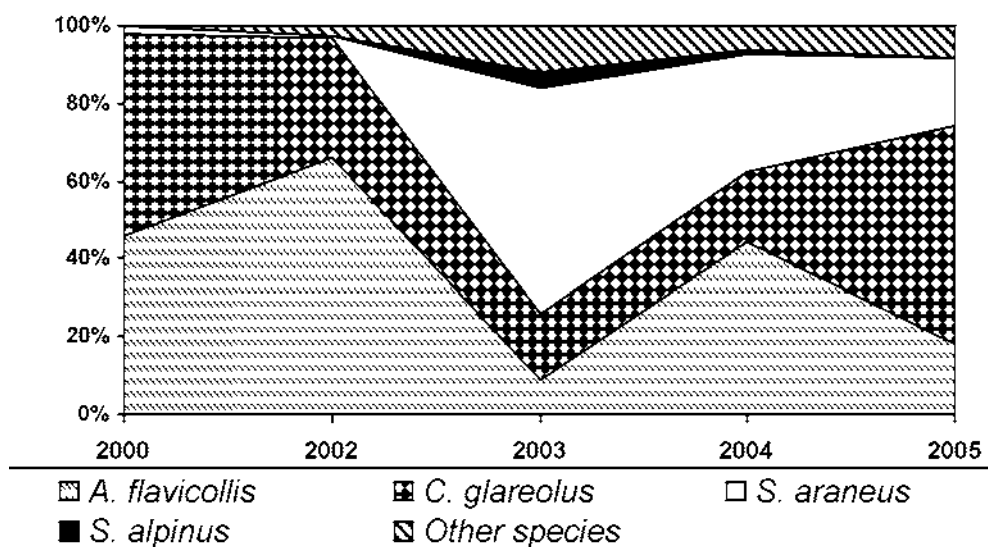


Fig. 2 – The multiannual dynamics of small mammals' relative abundances, between 2000-2005, in Retezat National Park.

similar situations being recorded also in some other mountain areas, namely in Țarcu-Godeanu Mts. (Râu Șes River Basin) (Benedek & Drugă, 2005) and Lotru Mts. (Lotrioara River Basin) (Benedek, unpubl. data). In 2004 a numerical balancing of dominant species was registered. The rodents prevailed (relative abundance 65% - value recorded by insectivores previous year), *A. flavicollis* presenting the highest densities. Among insectivores, a high relative abundance was recorded only for *S. araneus*. The other species (*Ch. nivalis*, *S. minutus*, *S. alpinus*, *C. leucodon*) represented less than 3% of the total number of captured animals. The next year, 2005, against a background of communities' total density decrease, the rodents recorded an increase of their relative abundance (80%). *C. glareolus* was dominant, captured in each station excepting those in the subalpine zone. The population densities of *A. flavicollis* decreased again, presenting low abundances in broadleaf forests and being absent in the captures from higher altitudes. Among insectivores *S. araneus* prevails once more, found in small numbers in most of the stations.

Table 2

Number of small mammals belonging to less abundant species, captured during research years.

Year	Species										
	<i>S. minutus</i>	<i>S. alpinus</i>	<i>N. fodiens</i>	<i>N. anomalus</i>	<i>C. leucodon</i>	<i>M. avellanarius</i>	<i>M. glis</i>	<i>Ch. nivalis</i>	<i>P. subterraneus</i>	<i>M. agresti</i>	Total
2002	1	-	-	-	-	-	1	2	1	2	7
2003	2	2	-	-	-	1	-	-	-	1	8
2004	2	3	-	-	1	-	-	3	-	-	9
2005	1	-	-	1	-	-	-	1	1	4	8

\* Obs. In 2000 no other species was captured.

Considering these changes as a whole, we can draw some conclusions on the dynamics of small mammals fauna from mountain regions. First, the relative abundances of *A. flavicollis* and *S. araneus* are negatively correlated; the insectivore becomes dominant against the background of the rodents' numerical decline. The variations of the third species, *C. glareolus*, presented lower ranges, especially in 2002-2004 period (varying slightly around 20%). The other species present low densities and consequently, small relative abundances. Table 2 presents the number of specimens belonging to these species captured during the research years.

In the mentioned period their maximum relative abundance was recorded in 2003, a year of significant decline of the dominant rodents. The dynamics of these species does not seem to present a high amplitude. Their absence in some years or in some suitable habitats is due to their low densities that makes capturing them a stochastic event. Some hypothesis can be advanced on the dynamics of one of these species, namely *S. alpinus*. It was first captured during our study in the year 2003 (two specimens at Buta), when, as mentioned before, the rodents (and especially *A. flavicollis*) registered a significant numerical decline. In the same year, between August, and November, *S. alpinus* was captured in several mountain areas - Țarcu, Godeanu, Retezat, Lotru Mountains (Murariu & Benedek, 2005), these being our first recordings of the species since 2000. The next year, 2004, after a decline in spring (that caused its absence among the animals captured during June) it recovered during summer, without reaching, however, the densities from 2003 (in September was captured maximum one specimen per station - Lăpușnicul Mare Valley, Buta). In 2004 *S. alpinus* was captured also in Făgăraș Mountains (idem). During 2005, *S. alpinus* was not found, although the rodents' populational densities were again very low. These facts lead to the conclusion that the numerical development of *S. alpinus* populations can occur only in the absence of competition pressure exerted by rodent species, especially *A. flavicollis* (no competition seems to exist between *S. alpinus* and *S. araneus*). But even if the competition pressure is held out at low values, the populational density of *S. alpinus* decreases after a certain period, possible (also) due to unfavourable climatic conditions (the summer of 2005 was extremely rainy, with relatively low temperatures).

For the illustration of quantitative changes in the small mammals communities from Retezat National Park during 2002-2005 period the Buta station was chosen (Fig. 3), as from here the most complete series of data is available.

The most conspicuous characteristics of the communities' quantitative dynamics are also given by the two species, *A. flavicollis* and *S. araneus*. Considering the global image of dynamics, these species are constantly present together (with the mentioned fluctuations) in the park, while at Buta they were never found both in the same period. In this station an almost complete replacement of fauna can be observed, the single species present during all the investigation periods, with a relative constant populational density is *C. glareolus*.

In the summer of 2002 the community was very abundant. It was clearly dominated by rodents, none insectivore being found. Among the rodents *A. flavicollis* recorded the highest value of capture index. During the investigation period three major moments can be distinguished in the small mammal community dynamics from the spruce forests. The spring of 2003 is the first, when the populational density of *A. flavicollis* dropped to the point where no individual was captured in September. This species was replaced by *S. araneus*, with much lower densities. Meantime also *S. alpinus* appears, presenting a similar value of the

capture index. In this new structure of community, rodents are dominated by insectivores and are represented only by *C. glareolus*, which records a decrease of populational density. The second significant moment in the temporal dynamics of the small mammal community is the spring of 2004, when it reverts to the structure from 2002, with the clear dominance of rodents, and among them, *A. flavicollis*. Quantitatively however, it can be observed a significant difference, concerning the populational densities, as the capture index values recorded in June 2004 are reduced to half (in case of *A. flavicollis*) compared to those recorded in August 2002. Although this is partly due to the fact that June is still a breeding season, the absence of *A. flavicollis* in 2003 from higher altitudes (or its very low densities) is an important cause of its low abundances. The last change in the community's structure, occurred in the summer of 2004, is very interesting, when during two months only (July-August) *A. flavicollis* disappeared again, the dominance being taken over by *S. araneus*. The total abundance of the small mammal community is very high, almost similar to that recorded in August 2002. The complete absence of *A. flavicollis* among the captured specimens at the beginning of autumn is unlikely to be caused by the death of animals, or to be a sampling effect, because the differences are too big. A more probable explanation is that *A. flavicollis* individuals migrate at lower altitudes during winter. This fact is suggested also by the results obtained during researches in other mountain regions. In the Lotrioara River Basin (Lotru Mountains), at 900 m high, this species is absent during each winter (Benedek et al., 2002). More surprising and difficult to explain is the sudden appearance of the insectivore *S. araneus* with the highest capture index value from the whole investigation period. There are two possible causes: either a massive breeding as a result of *A. flavicollis*'s withdrawal, or an immigration from other areas. Beginning with September 2004 the small mammals' community structure is maintained relatively constant, against a background of the total abundance decrease (due to the unfavourable weather conditions during summer of 2005).

Due to their scarce presence among the trapped animals, no conclusions can be yet drawn regarding the multiannual dynamics of the species *S. araneus* and *M. agrestis*. *Ch. nivalis* was captured in September 2004 and June 2005 - the same

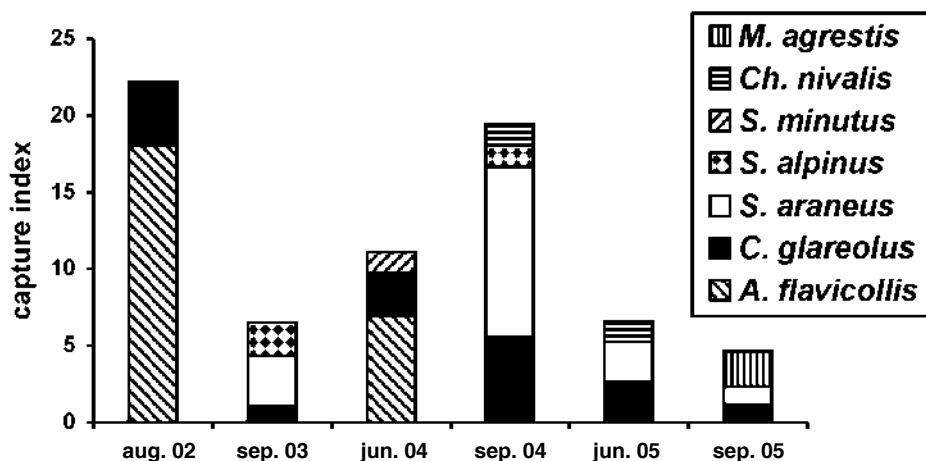


Fig. 3 – The dynamics of capture index values in 2002-2005 period, at Buta.

individual, an adult female, in the same trap, situated under a rock in the hygrophylous spruce forest. It is very likely that the same female was present also in September 2005, as in the mentioned trap an escape was recorded. Although the results of other studies (for instance, in Lotrioara River Basin at 900 m altitude, it was captured from autumn till spring or only in spring, but never during summer - Benedek, unpubl. data) suggest the hypothesis of altitudinal migration of this species, it is possible that at Buta (at a higher altitude) its presence is constant during the whole year, at least in some years with unfavourable meteorological conditions (as 2005).

### Conclusions

From the Retezat National Park, 22 species of small mammals are known up to the present, among them 9 insectivores and 13 rodents. The diversity and abundance of small mammals' communities decrease on altitude, being the highest in the broad leaf forests. *C. glareolus* and *A. flavicollis* are dominant, and in the years with low densities of the latter, *S. araneus*. The multiannual dynamics of *A. flavicollis* and *S. araneus* are negatively correlated. The absence of *A. flavicollis* from high altitudes in some years (2003, 2005) is probably due to its altitudinal migration. *C. glareolus* is a constant presence in the area, both in space and time, but with a relatively low abundance. *S. alpinus* appeared against the background of *A. flavicollis*'s absence from spruce forests, but it was found only in two years. *Ch. nivalis* might be present in years with unfavourable weather conditions in suitable habitats at 1500 m during the whole year.

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### DINAMICA COMUNITĂȚILOR DE MAMIFERE MICI (INSECTIVORA ȘI RODENTIA) DIN PARCUL NAȚIONAL RETEZAT (ROMÂNIA)

#### REZUMAT

Parcul Național Retezat adăpostește o faună bogată de mamifere mici, până în prezent fiind cunoscute 22 de specii, dintre care 9 insectivore și 13 rozătoare. Între anii 2000-2005 am întreprins o serie de investigații utilizând capcane tip cutie, urmărind dinamica spațială și temporală a acestor comunități. Diversitatea și abundența comunităților scad pe altitudine. Dominante sunt *Clethrionomys glareolus* și *Apodemus flavicollis*, iar în anii cu densități scăzute ale acestuia din urmă, *Sorex araneus*. Dinamicile populațiilor de *A. flavicollis* și *S. araneus* sunt corelate negativ. *C. glareolus* a avut în perioada de studiu o prezență continuă în etajele montane, cu variații relativ reduse ale densității.

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