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# Dormice in small mammal assemblages in a mixed southern European forest

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**Abstract**

We studied an assemblage of terrestrial small mammals in a mixed fir and beech forest at 920–1225 m elevation on Mt. Snežnik, southwestern Slovenia. The community consisted of three species of dormice (*Glis glis, Dryomys nitedula, Muscardinus avellanarius*), one mouse (*Apodemus flavicollis*), one vole (*Clethrionomys glareolus*) and three shrews (*Sorex araneus, Sorex alpinus, Sorex minutus*). With 67.7% of all small mammals trapped, mice and voles were more abundant than dormice (9.5% of individuals), but the discrepancy was much less in total biomass (kg): 16.7 in muroids versus 9.4 in dormice. The majority of dormice (93%) were trapped on trees and most of the voles and mice (97%) were captured on the ground. *Glis glis*, which was the largest species in this small mammal community, contributed nearly 33% to the total biomass. We conclude that this dormouse is an important component in a mixed southern European forest and should be taken into consideration in studies of ecology of small mammal communities.

**Keywords:** *Glis glis, Dryomys nitedula, Muscardinus avellanarius*, muroid rodents, shrews

## 1. Introduction

Dormice (family Gliridae) are one of the oldest extant rodent families and the only one of European origin. Their diversification and relative abundance in fossil assemblages culminated towards the end of the Early Miocene but started to decline afterwards, a situation that has continued until the present (Daams & de Bruijn 1995). Although extant glirids still occupy large areas in the Palaearctic and Ethiopian regions, they are merely relics of a diverse Paleogene fauna. The family comprises only nine genera with 28 species, i.e. 1.9% of modern rodent genera and 1.2% of species. Similarly, dormice are not regarded as a significant component of extant rodent assemblages in Europe. Of 50 species of small rodents (body mass < 1 kg) native to Europe, only 5 (= 10%) are dormice (data from Mitchell-Jones et al. 1999). Besides, dormice are rare in many parts of their native range (e.g. Bright & Morris 1996) and their assemblages are regarded to be less abundant than that of small terrestrial mammals (e.g. Gaisler et al. 1977). Also the sampling protocols employed for primarily terrestrial rodents, are not effective for dormice, which are mainly active above ground level. Field tools used in ornithology, nest-boxes in particular, are long known to be effective also for dormice (e.g. Vietinghoff-Riesch 1960, Koppmann-Rumpf et al. 2003, Juškaitis 2006, Adamík & Král 2008). Dormice are therefore mainly studied separately from mice and voles, which are believed to be the major small mammal consumers in European deciduous forest ecosystems. Moreover, small mammal community research is highly focussed on shrews, mice and voles (Gurnell 1985, Schröpfer 1990).

In this paper, the focus will be on dormice as a component of the small mammal assemblage in a southern European mixed forest. We note that there are valid arguments against referring to taxonomic aggregations as ecological assemblages/communities (Hallett 1991).

## 2. Material and methods

Study area: We conducted our study on Mt. Snežnik (peak at 1796 m) which sits within the Dinaric Alps (about latitude 45°36’ N, 45°38’ N and longitude 14°22’ E, 14°27’ E) in south-western Slovenia. The bedrock is karstified limestone with no surface water. The region represents a transition between the Mediterranean climate along the coast and the continental climate further inland. Fir-beech forest (*Omphalodo-Fagetum*) is predominant throughout the study area. For further details on the area and its small mammal fauna see Kryštufek et al. (2011).

Sampling methodology: Small mammals were sampled on 40 sampling plots in mature silver fir-beech forest stands at elevations between 920 and 1225 m a.s.l. A minimal distance of 200 m between plots was supposed to overcome pseudo-replication and autocorrelation (Morris 1989). Small plots (15 × 15 m) enabled sampling in a relatively homogenous patches of a closed canopy forest. Small mammals were trapped in spring and autumn 2008 and 2009, and in spring 2010 (Tab. 1). Each sampling plot was equipped with eight snap traps, four Ugglan mesh traps (24 × 6 × 9 cm) and four Sherman folding traps (23 × 8 × 9 cm). Sherman traps were set on branches > 2 m high and the remaining traps were set on the ground. Live traps were provided with bedding material and baited with rolled oats mixed with sunflower oil and a piece of apple, snap traps were baited with pieces of wick soaked in a mixture of salted fat. Following field protocols for sampling small mammals (Sullivan et al. 2009) and dormice (Berg & Berg 1999), we set traps for three nights (= 48 trap nights per sampling unit) and checked them twice daily. Trap success (%) is the number of small mammals captured per 100 trap nights, and the term ‘trap night’ (TN) is used to describe a trap that was set for a 24-h period. Captured animals were measured, marked by fur clipping and released. Dead animals were preserved in ethanol and deposited in the Slovenian Museum of Nature History, Ljubljana. The methods used followed guidelines approved by the American Society of Mammalogists (Sikes et al. 2011). Taxonomy and nomenclature were followed according to Wilson & Reeder (2005), except for *Clethrionomys* which we use instead of *Myodes* (see Tesakov et al. 2010).

## 3. Results

In total we collected 911 individuals in 9600 TN (= 9.5 specimens per 100 TN), 484 individuals (= 53.1 %) were captured in snap traps and the remaining 427 specimens (= 46.9 %) were obtained by live traps. In all subsequent analyses we ignored recaptures. These were classified into eight species, three shrews (*Sorex araneus*, *S. minutus*, *S. alpinus*), two muroide rodents (*Clethrionomys glareolus* and *Apodemus flavicollis*) and three dormice (*Glis glis, Dryomys nitedula, Muscardinus avellanarius*) (Tab. 1). Our sampling was not suitable for recording a red squirrel (*Sciurus vulgaris*), which was observed during sampling sessions.

In terms of relative abundance, dormice were the most rare with 87 individuals captured (= 9.5 % of the total). The muroide rodents were the most abundant (617 individuals; 67.7 %), and shrews were represented by an intermediate number of individuals (207; 22.7 %). The most numerous were both muroide rodents, *Clethrionomys glareolus* (366 individuals; 40.2 % of all small mammals) and *Apodemus flavicollis* (251 individuals; 27.6 %), followed by the common

**Tab. 1** Summary of trapping results in fir-beech forest (*Omphalodo-Fagetum*) on Mt. Snežnik, south-western Slovenia, according to seasons. Sampling effort per session was constant (1920 TN). A – abundance (number of individuals); BM – biomass (in grams).

| | **Spring 2008 13.–30.05.** | | **Autumn 2008 17.09–02.10.** | | **Spring 2009 09.–25.05.** | | **Autumn 2009 08.–24.09.** | | **Spring 2010 29.04.–23.05.** | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | BM | A | BM | A | BM | A | BM | A | BM | A | BM |
| ***Glis glis*** | 1 | 123 | - | - | 17 | 2098 | 11 | 1357 | 45 | 5553 | 74 | 9131 |
| ***Dryomys nitedula*** | 5 | 114 | - | - | 1 | 19 | 4 | 91 | 1 | 23 | 11 | 247 |
| ***Muscardinus avellanarius*** | - | - | 2 | 53 | - | - | - | - | - | - | 2 | 53 |
| ***Clethrionomys glareolus*** | 131 | 3426 | 189 | 4638 | 4 | 101 | 23 | 670 | 19 | 560 | 366 | 9395 |
| ***Apodemus flavicollis*** | 198 | 5550 | 18 | 434 | - | - | 3 | 98 | 32 | 1222 | 251 | 7304 |
| ***Sorex araneus*** | 23 | 293 | 62 | 523 | 12 | 129 | 63 | 498 | 16 | 175 | 176 | 1618 |
| ***Sorex minutus*** | 1 | 5 | 2 | 7 | - | - | - | - | 2 | 10 | 5 | 22 |
| ***Sorex alpinus*** | 4 | 45 | 7 | 59 | 2 | 18 | 9 | 73 | 4 | 42 | 26 | 237 |
| **Small mammals** | **363** | **9556** | **280** | **5714** | **36** | **2366** | **113** | **2787** | **119** | **7584** | **911** | **28007** |

shrew (176 individuals; 19.3 %) and the edible dormouse (74 individuals; 8.1 %). The rarest small mammals were the common dormouse (2 individuals; 0.2 %) and the pygmy shrew (5 individuals; 0.5 %). Relative abundance of shrews may be underestimated because traps we used were more suitable for sampling rodents (e.g. Kirkland & Sheppard 1994).

The total biomass of 911 small mammals was 28,007 grams, the lowest proportion of which consisted of shrews (1,877 g; 6.7 %), followed by dormice (9,431 g; 33.7 %) and by muroides (16,699 g; 59.6 %). Three rodents accounted for 92.2 % of total biomass: the bank vole (9,395 g; 33.5 %), the edible dormouse (9,131 g; 32.6 %), and the yellow-necked mouse (7,304 g; 26.1 %). The edible dormouse is much larger (body mass [in grams] in a sample from Mt. Snežnik is 124.9 ± 14.42, N = 34) than the bank vole (25.5 ± 3.17, N = 167), or the yellow-necked mouse (33.1 ± 6.61, N = 147), therefore it forms a high total biomass despite its low abundance.

All species and taxonomic groups showed significant variations in abundance across seasons. Trapping success was lowest in spring 2009 (2.0 per 100 TN) and the highest in spring 2008 (18.9 per 100 TN), about a 10-fold difference. Shrews were more abundant in the autumn than in spring in both 2008 and 2009. Comparisons between the two seasons within the same year pointed to higher spring densities for muroides in 2008 and for glirids in 2008 and 2009.

Small mammals showed highly significant preferences in respect of the habitat layer (Tab. 2). The edible dormouse was mainly captured > 2 m above the ground, while shrews and muroide rodents were largely collected at ground level.

**Tab. 2** Trapping results for traps set at the ground level and on trees (> 2 m high) in fir-beech forest on Mt. Snežnik. A – abundance (number of individuals). Proportions were tested by $\chi^2$-test; significance level: $^{n.s.}$ – not significant ($p > 0.05$); * $p << 0.00001$.

| | Ground level 7200 TN | | Trees 2400 TN | | $\chi^2$-test |
|---|---|---|---|---|---|
| | A | % | A | % | |
| ***Glis glis*** | 1 | 1.4 | 73 | 98.6 | 70.06* |
| ***Dryomys nitedula*** | 5 | 45.5 | 6 | 54.5 | $0.09^{n.s.}$ |
| ***Muscardinus avellanarius*** | 0 | 0.0 | 2 | 100.0 | |
| ***Clethrionomys glareolus*** | 363 | 99.2 | 3 | 0.8 | 354.10* |
| ***Apodemus flavicollis*** | 235 | 93.6 | 16 | 6.4 | 191.08* |
| ***Sorex spp.*** | 207 | 100.0 | 0 | 0.0 | 207.00* |

## 4. Discussion

Small mammal communities are structured, and the combination of coexisting species in a habitat shows a certain pattern. In temperate zones up to three species that are phylogenetically and ecologically far apart, form the predominant number of individuals (> 70 %): an insectivorous shrew, a herbivorous vole, and a granivorous/omnivorous mouse (Schröpfer 1990). On Mt. Snežnik, as elsewhere in Europe, these three species were the common shrew, the bank vole and the yellow-necked mouse. However, our results provide evidence that the edible dormouse is probably also an important component in a small mammal community in a southern European mixed forest, at least as much as is any of the above 'principal species' ('Hauptarten'; sensu Schröpfer 1990).

We captured three species of dormice, as compared to only two species of muroide rodents on Mt. Snežnik. The altitudinal belt 800–1200 m a.s.l., where our sampling plots were located, is occupied by further three voles (*Chionomys nivalis, Microtus liechtensteini, Arvicola scherman*) and one mouse (*Apodemus sylvaticus*) (Kryštufek et al. 2011) which we did not record in our study. This failure is not surprising considering that these species are mainly associated with early successional stages, gaps in a canopy, forest edge and rocky outcrops, and are rarely encountered in a closed canopy forest. The muroide diversity was therefore low within the forest where it was exceeded by dormice. Niche overlap between the predominantly arboreal dormice on the one hand and terrestrial muroides on the other, is most probably minimised by microhabitat partitioning.

Many studies imply that muroide rodents are a significant ecological factor due to their consumption within various ecosystems while dormice were excluded from such assessments (e.g. Grodziński & French 1983). In our results, about one third of the total biomass of small mammals was due to the edible dormouse which points to its significant ecological role in a mixed/deciduous forest. The entire picture, however, is not straightforward. Small mammal hibernators tend to be K-selected (Kirkland & Kirkland 1979), which implies lower amplitudes in population fluctuations as opposed to predominantly r-selected muroides. Our results do not accord with this, since relative abundance of the edible dormouse varied widely between samplings. Besides, we captured many more dormice in spring than in autumn. Since the edible dormouse has its only litter in late summer (Kryštufek 2010), one would expect high abundance in the autumn resulting from new recruits. This, however was not the case in our study for several reasons. First, the edible dormouse responds to year-to-year fluctuations in food availability by skipping reproduction in years with a lack of seed crops (Kryštufek 2010). Our unpublished observations show that *Glis glis* remained reproductively inactive all over the Dinaric Alps in Slovenia during both consecutive years of our study, i.e. 2008 and 2009. Therefore, there were probably no recruits in the autumn of these two years. Next, dormice start hibernating earlier in non-reproductive years than in years with reproduction (Kryštufek et al. 2003). Both these factors explain low autumn abundance in our study and if *Glis glis* had bred abundantly in either year (or both), the relative importance of dormice in the community would have been even greater.

The daily energy requirement in the period of active life of dormice is similar to that of non-hibernating rodents, their annual budget however is markedly different. Gębczyński et al. (1972) estimated that in the half-year hibernation period, dormice consume less than 10 % of their total annual energy budget. Recent observations show that torpidity in *Glis glis* is not restricted to hibernation but may lasts up to 10 months. Namely, a significant proportion of edible dormice may stay torpid even during the summer season if no food is available (Morris & Morris 2010).

Voles and mice at the average density of their population consume 0.17 % of total primary net productivity and 3.94 % of their potential food supply in a temperate mixed forest (Grodziński et al. 1970). This proportion is certainly much lower for the edible dormouse because of hibernation and extended periods of dormancy during the summer. Despite this, its high biomass means the edible dormouse represents a noteworthy link between primary producers and secondary consumers, being an important prey component for the lynx (Krofel et al. 2011) and several owl species (Kryštufek 2010). As an important component in a European forest they should be taken into consideration in studies of energy flow (cf. Gębczyński et al. 1972).

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