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Small Mammals of the Southeast Tver Oblast. Communication 1. The Fauna and Biotopic Distribution

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Abstract—The authors analyze the data of a 12-year monitoring of small mammal populations with live-catch cage traps, snap traps, and pitfall traps. Eighteen species were trapped. Biotopical distributions of the species are outlined. The study shows that snap-trapping and pitfall-trapping results are not in complete agreement. Capture-mark-recapture live-trapping results are consistent with averaged results obtained with snap traps and pitfalls, standardized to a unit of distance.

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Key words: biodiversity, small mammals, fauna, Tver oblast, pitfalls, snap traps, live traps

The interest in such a 'trivial' subject as faunistic analysis of the region is propelled by the lack of faunistic data for central parts of Russia. Therefore, we cannot analyze the dynamics of small mammal communities under changing qualitative and quantitative human influence. Yet in the late 1990s a unique phenomenon occurred in Central Russia—forest natural regeneration began in the farmlands of the region.

Due to their size, small mammals have similarly small home ranges, 0.2 to 0.5 ha, and areas occupied by their local assemblages are close to those of plant communities. Small mammals can be easily monitored, so it will not take too long to collect data. Being warm-blooded, small mammals have high metabolism. They make a considerable contribution to the ecosystem dynamics and are grossly dependent on physical and biotic conditions of the habitat.

The above reasons stimulated us to summarize the data of a 12-year monitoring of a small mammal community in the southeast Tver oblast and analyze their diversity in a variety of habitats. Thus we had to answer the following questions: (1) Which of the trapping methods used yield the most representative data? (2) How variable is the structure of the community in different habitats and locations of the same region? (3) How do environmental fluctuations and man affect community structure?

MATERIAL AND METHODS

The permanent study area is located between the Staritskii and Zubtsovskii raions (56°18′N, 34°52′E) on the right-hand bank of the Volga River within the Smolensk–Moscow Province [1], at the contact of southern-taiga and mixed forests [2]. All forests in the Russian Plain are assumed to have been disturbed by man, with the greatest disturbance caused to the broad-leaved-spruce forests that had been growing on the most fertile soils and cleared for tilling [3, 4]. As all forests have been affected in some way, Rysin distinguishes a number of modified natural types [5]. The primary and modified natural forests in the region are various spruce and pine stands [6]. The study was conducted in a bilberry- and a wood-sorrel-pine forest. On watersheds the primary type is a dwarf-shrub–sphagnum-pine forest. Second growth patches of a yellow-archangel-spruce forest occur. There are solitary oak saplings up to 20 years of age. The second growth that forms on clearings and abandoned farmlands is composed of hygrophilous-forbs–birch forests, some of them dominated by the speckled alder. The second growth on old-burned sites is a bilberry-spruce-pine forest. A similar one forms on the edges of dwarf-shrub–sphagnum-spruce forests on watershed plateaus. All the forests have been logged to various extents. The most intact spruce forest is on the bedrock bank of the Volga River (VSF). As the forest is in the water protection zone, it appears to have not been logged. The forest is highly mosaic; a transect established there may cross bilberry–green-moss, bilberry–wood-sorrel, yellow-archangel–wood-sorrel, and bilberry–haircap-moss patches. There is an adjacent logged area where a dying deciduous forest, consisting mostly of alder, (AF) is being replaced by a young spruce stand. The spruce forest near the Zaborovo Village (ZSF), a former kolkhoz forest, has been frequently logged. It consists of mainly the overmature birch and some grass-forbs-covered glades. Other characteristics of the stand are the same as in the above mentioned one. There is a bracken-fern–bilberry-pine stand with bilberry–haircap-moss patches on an old-burned site within a spruce forest by the Volga River (VPF). The bilberry–haircap-moss pine forest (ZPF) is adjacent to the Zaborovo spruce forest on the fringe of a raised bog.

A characteristic trait of the study area is that 20% of the land is covered with meadows, tillage, and fallow lands of various ages. The meadow (M) under study formed under grazing pressure and has thick sod cover with much dead grass. The stand consists of sparse birch and pine saplings. However, herbaceous plants are the most diverse here. Tree stands on farmlands began regenerating immediately after the lands were abandoned. There is active regeneration of the pine and the birch on the tilled land (TL) under study, resulting in a 9-year-old birch-pine forest. The grass cover consists of forbs, but the cover is not uniformly continuous; there are dead patches under thick tree clumps. The second growth forest (SGF) appeared on the grazing lands and tillages about 70 years ago. Now the tree stand consists of the dying speckled alder with spruce undergrowth. The herbaceous cover consists of the nettle and in moister habitats of the dropwort and ferns. Random trappings were conducted in houses and barns in the neighboring villages, Krutitsy and Bokanovo.

The main body of material was collected on transects with live traps efficient in catching insectivores [7] and rodents [8]. The traps were set at 7.5 m intervals in lines. Trap lines are six times more efficient than grids, trapping effort being equal [9]. An accounting unit was a 375 m trap line of 50 traps [10]. During this study, the traps were checked more frequently than usual and were operative for only 3 hours. We checked the traps twice every 1.5 hours and then closed them, so that animals could move freely for most of the day. With this approach, animal mortality, especially that of shrews, was <0.1% per >20 000 recaptures. The traps were baited with oats mixed with unrefined sunflower oil. The comparison of rodent and insectivore trappability showed that trap efficiency is similar for different species [11].

When watching red-toothed shrews, we found that pitfalls trapped mainly nonresident animals [12]. This fact has been known of since the method was adopted [13]. A standard use of such traps involves a 50 m ditch with 5 pitfalls [13, 14]. We compared the efficiency of a standard 50 m ditch, a 50 m fence with 5 pitfalls, and five 10 m fences with 1 pitfall per fence. No differences were revealed [15]. Each trapping session for every method lasted 14 days. Live-catch cage traps with standard bait were used at a different site after pitfall- and capture-mark-recapture live-trapping the animals. The abundance measure is the number of animals trapped per 100 trap-days. For live traps we calculated the number of individuals captured in 100 traps per day on the average.

RESULTS AND DISCUSSION

Of 24 small mammal species expected to be trapped according to the data on their distribution [16], only 18 were captured (Table 1). The European mole (*Talpa europaea* L., 1758) and the weasel (*Mustela nivalis* L., 1766) were captured accidentally and were omitted from analysis. The following expected species were not trapped: the least shrew (*Sorex minutissimus* Zimmermann, 1780), the northern red-backed vole (*Clethrionomys rutilus* Pall., 1779), the pine vole (*Microtus subterraneus* Selys-Longchamps, 1838), *Microtus rossiaemeridionalis* Ognev, 1924, the house mouse (*Mus musculus* L., 1758), and the black rat (*Rattus rattus* L., 1758). The common rat (*Rattus norvegicus* Berkenhout, 1769) was trapped only when the farm in the Krutitsy Village was functioning (closed in 1999). Now it occurs in barns and adjacent farmlands only in the villages where farmers keep poultry or cattle. The species was not trapped on the transects.

While the decreased and sporadic range of the *Rattus rattus* can be explained by different type of farm buildings, the absence of the house mouse and common rat indicates that rural population and its farming activities decreased significantly. Interestingly, the species were partly replaced by the yellow-necked mouse (*Sylvaemus flavicollis* Melchior, 1834) in the attics, and the bank vole (*Myodes glareolus* Schreber, 1780), in the basements. The absence of the northern red-backed vole is probably due to the edge effect of the range. The nearest location the species is known from is the Central Forest Reserve. The absence of the pine vole in the trapping data appears to confirm the situation. The species is readily trappable with the traps that we use, easily detectable even at low numbers, and was found 160 km northwest. That *Microtus rossiaemeridionalis* was not trapped does not imply it is absent in the study area. Most likely, we encountered monospecific populations of the common vole (*Microtus arvalis* Pallas, 1778). We randomly karyotyped 9 individuals from different localities and all of them proved to be *M. arvalis arvalis* ($2n = 46$, $NFa = 80$). The least shrew occurs sporadically throughout the range. Of the common shrew (*Sorex araneus* L., 1758), the Moscow chromosome race with a characteristic karyotype occurs [17]. The closest chromosome race, Seliger, forms a hybrid zone with Moscow 160 km northeast [18]. The northern extremity of the range of the lesser white-toothed shrew (*Crocidura suaveolens* Pall., 1811) overlaps the study area. It usually occurs in houses and spreads with man beyond continuous populations of the species [19]. We did not find any such populations as not all villages neighboring the study area were studied: one lesser white-toothed shrew individual was trapped in the forest and one in the field.

Different traps show different population structure. The most inconsistent results were found between pitfall- and snap-trapping samples. Both methods are standard, but their efficiency is known to vary with species.

Table 1. Composition and relative abundance of small mammals captured with different traps

Species	Live trap			Snap traps		Pitfalls	
	Number of individuals	Number of captures	Per 100 trap-days	Number of individuals	Per 100 trap-days	Number of individuals	Per 100 trap-days
Talpa europaea	1	1	0	6	0.4	0	0
Crocidura suaveolens	0	0	0	1	0.07	1	0.03
Sorex minutus	690	4022	2.51	1	0.07	218	5.74
Sorex caecutiens	928	16 235	10.14	2	0.13	296	7.8
Sorex isodon	123	918	0.57	0	0	14	0.37
S. araneus	1222	14 103	8.81	41	2.73	405	10.67
Neomys fodiens	20	26	0.02	1	0.07	8	0.21
Mustella nivalis	6	6	0	0	0	0	0
Sicista betulina	3	3	0	0	0	56	1.48
Myodes glareolus	1545	20 980	13.11	159	10.6	29	0.76
Arvicola terrestris	2	2	0	0	0	2	0.05
Microtus oeconomus	80	173	0.11	13	0.87	11	0.29
M. arvalis	25	132	0.08	11	0.73	57	1.5
M. agrestis	15	119	0.07	5	0.33	10	0.26
M. sp.	19	35	0.02	1	0.07	8	0.21
Micromys minutus	30	38	0.02	0	0	25	0.66
Apodemus agrarius	5	28	0.02	0	0	0	0.08
Sylvaemus uralensis	48	62	0.04	9	0.6	1	0.03
S. flavicollis	12	20	0.01	3	0.2	0	0
Total	4774	56 903	35.55	253	16.87	1141	30.14

Numbers of the common vole and shrews tend to be overestimated with pitfalls and underestimated with snap traps. To reduce the disproportions, we pooled the data from both types of traps. Data can be pooled in two ways, by standardizing the data to either the trapping effort or to the unit of distance. In the former case, relative abundance is an average day catch per 100 traps or per 100 pitfall-days. In the latter case, the catch is standardized to the transect length. A transect of 100 traps set at 5 m intervals totals 500 m, while pitfalls are used with 10 m fences, therefore relative abundance of species is calculated as an average day catch per 100 traps and per 50 pitfall-days.

Species abundance estimates are not absolute values and they may not indicate true numbers of animals in the habitat. However, species relative rank is quite a reliable characteristic. We compared the samples with Spearman's rank test (Rs). The most similar were the live trap sample and the pooled pitfall–snap-trap sample standardized to the unit of distance (Table 2). Snap-trap and pitfall samples are dissimilar and show different percentages of species. The live-trap sample is similar to both the snap-trap and pitfall samples, as well as to the pooled sample. The results suggest that live-trapping estimates can be used as the most versatile data for estimating biodiversity.

Figure 1 shows the structure of the fauna in the trapped habitats. The bank vole, the common shrew, the Laxxman's shrew (*Sorex caecutiens* Laxxman, 1788), and the lesser shrew (*Sorex minutus* Linnaeus, 1766) form 90% of the total abundance of small mammals. The abundance indices (percentage of the total abundance) of the bank vole and the common shrew were 0.28 and 0.27, respectively. The third most abundant species was the Laxxman's shrew with the abundance index 0.20. The fourth most abundant species was the lesser shrew with the abundance index 0.15. In other species the abundance index is about ten times lower and is 0.022 for the even-toothed shrew (*Sorex isodon* Turov, 1924), 0.017 for the root vole (*Microtus oeconomus* Pallas, 1776), and 0.015 for the common vole. However, the even-toothed shrew is abundant in riparian forest biotopes where it can be the third abundant species, following the bank vole and the lesser shrew, with abundance index 0.17. The northern birch mouse (*Sicista betulina* Pallas, 1779), the wood mouse (*Sylvaemus uralensis* Pallas, 1811), and the harvest mouse (*Micromys minutus* Pallas, 1771) had an abundance index of 0.01. Less abundant were the field vole

Table 2. Similarities (Spearman's rank test Rs for species' frequencies of occurrence) of small mammal populations estimated with live traps, snap traps, and pitfalls

Trap type	Snap traps		Pitfalls		Snap traps and pitfalls			
					Average		Standardized to distance	
	Rs	p	Rs	p	Rs	p	Rs	P
Snap traps	—	—	0.21	0.432	0.57	0.019	0.69	0.0028
Live traps	0.55	0.024	0.71	0.002	0.79	0.0002	0.81	0.0001

(*Microtus agrestis* Linnaeus, 1761), the field mouse (*Apodemus agrarius* Pallas, 1771), and the water shrew (*Neomys fodiens* Pennant, 1771) who had an abundance index of ca 0.005. The least abundant were the yellow-necked mouse with an abundance index of 0.003, the water vole (*Arvicola terrestris* Linnaeus, 1758), 0.0007, and the lesser white-toothed shrew, 0.0003.

According to a preferred habitat, the species can be divided into three groups: forest, meadow, and eurytopic (Fig. 2). In different forests the most abundant are the bank vole, the common shrew, and the lesser shrew; open habitats are dominated by the common shrew with the lesser shrew and the common vole as codominants.

Biota of the local ecosystems is represented by existing complexes with a specific structure and compensatory capabilities [20, 21]. It is common knowledge that activity of ecosystems in a specific locality "smoothes out" environmental conditions by affecting such variables as climate, soil fertility, etc. [21]. It is apparent that monitoring dynamics of natural ecosystems proves to be essential. One traditionally monitored object is small mammals that fill various ecological niches and specialize in food resources of an ecosystem: green mass, seeds, or invertebrates [22, 23]. As a result, the structure of small mammal communities is interwoven with a variety of microhabitats, and changes in that structure reflect all changes occurring in the interacting species at large.

To analyze fauna and biodiversity correctly, appropriate methods of acquiring primary data are needed. Neither snap-trapping nor ditch-trapping yield comprehensive data on diversity and structure of small mammal communities. To reveal complete faunistic composition and its structural quantitative characteristics, one must use both trapping methods and standardize the resultant samples. We consider that the most representative samples are those standardized to a unit

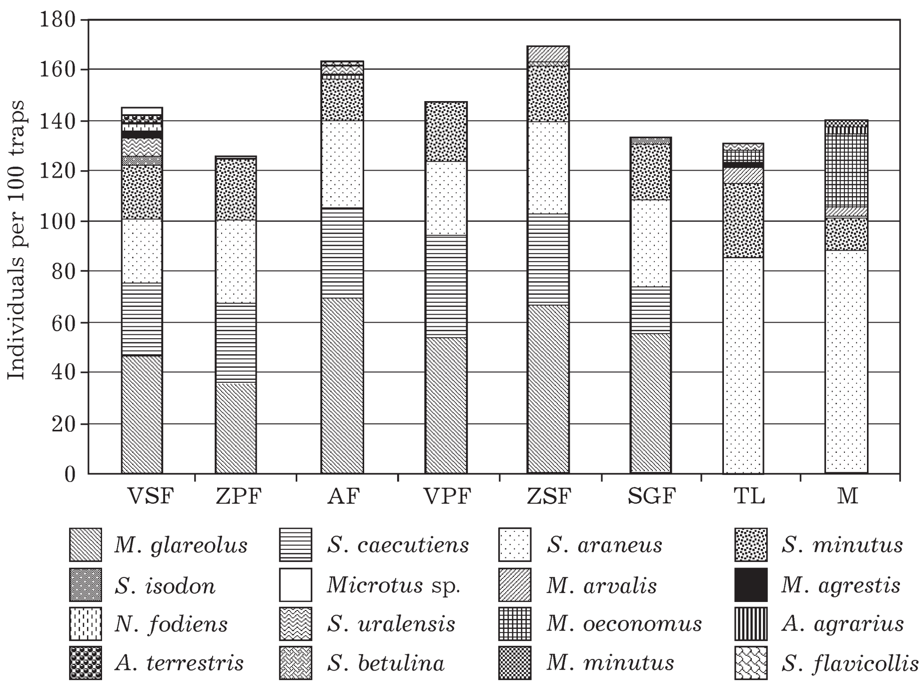

Fig. 1. Relative abundance of small mammals in August (average long-term live-trapped catch per trapping session). Habitat abbreviations see in the text.

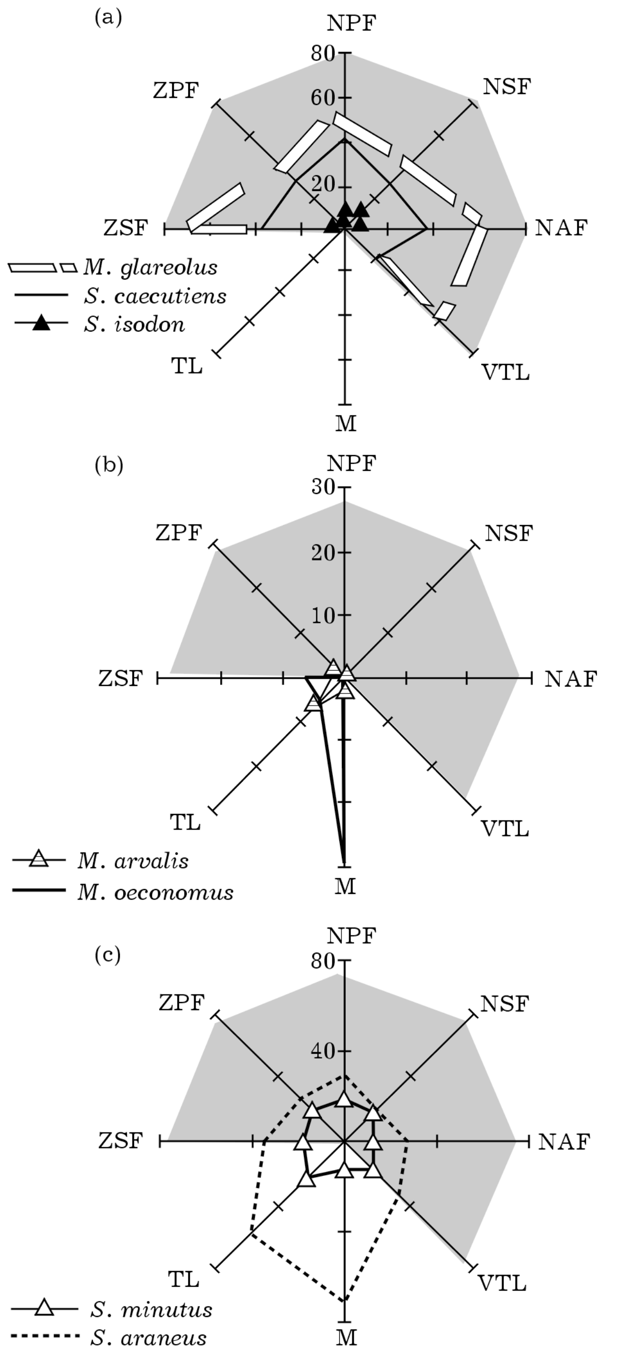

Fig. 2. Relative abundances of forest (a), meadow (b), and eurytopic (c) species in various habitats. The axes represent average long-term trappability in live traps in August. Forest habitats are shown in gray.

of distance. Samples obtained with standard ditches with 5 pitfalls can be standardized to 100 trap-days and to 10 ditch-days. The method we use on the transects can be used instead of both methods and yield representative data on biodiversity over a fairly short trapping session—a sample representative of a year can be obtained over a two-week trapping session in August.

Although faunistic compositions of the regions are known, confirmed presence or absence of a species in a locality is of special interest in contemporary circumstances. The environment has been grossly transformed by man, and some previously continuous ranges may prove to be disrupted. This may be quite an issue at range edges where there may be populations separated from their main distribution. Previously abundant species may disappear in the fragmented habitats and their populations lose the regenerative capacity.

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