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UDC 574

SUCCESSION OF BIOCENOTIC GROUPS OF SMALL MAMMALS AFTER LOGGING THE PINE FORESTS IN EASTERN FENNOSCANDIA

SUMMARY. Fennoscandia is one of the most developed taiga regions in Eurasia. The most widespread and intense form of anthropogenic transformation of taiga forests is forestry (including forest exploitation). This article analyzes the trends of secondary succession of small mammal communities after logging, from the time of pine forests cutting to the stage of mature tree stand formation (120-year period). We found that, in most cases, when green-moss pine forest types are cut, the dominant small rodent in those areas is Microtus (Dark Vole or Root Vole), while in the control group of coniferous forests the dominant rodent is Clethrionomys (Bank Vole).

KEY WORDS. Biocenotic groups, small mammals, logging, succession.

Introduction. Fennoscandia is one of the most developed taiga regions in Eurasia. The most widespread and intense form of anthropogenic transformation of taiga forests is forestry. In order to understand the trends in small mammal communities species diversity and structure, and to make long-term forecasts for taiga biome clear cutting, researchers need detailed and thorough analysis of succession process, not only in phytocenosis, but also in zoocenosis, including the species diversity and structure of small rodent communities.

Material and methods: We used the method that we had called "serial" before (1). It involves estimation of species composition and a number of animals in the series of biocenotic areas, indicating the main stages of secondary succession (2; 3; 4, 5, 6; 7, 8; and other). Since 1980, stationary research has been established in mid-taiga of the Karelia region. The main studied area is 17000 hectares, and is situated 40 km to the north of Petrozavodsk (62° north, 34° east). Within its boundaries we have allocated the control (mature coniferous forest) and a series of experimental sectors (20, including several open-type cuttings). The choice of the experimental sectors was based on strict following of preliminarily formulated principles: identical

allocation in relation to the landscape; natural reservoir proximity, etc); also, the area should have been big enough (at least 5 hectares).

The control areas were pine-tree green-moss forests, mostly blueberry and herbal types. The control sectors' area was about 30 hectares (large massive, low fragmentation) and 6 hectares (fragmented sector). Besides that, among constantly monitored bank sectors were pine seed clumps (about 1 hectare, with the initial structure similar to the control sector) and several coniferous undercuts. The experimental sectors are in fact a "series" of ecosystems of green-moss pine-tree stand at different stages of secondary succession after logging. All the 15 experimental sectors (biotopes transformed by logging) are divided into several groups according to the stages of biogeocenotic succession based on the structure of animal habitats. These are (1) – open cuttings (cut 4-5 years ago, several different cutting types); (2) – young forests of 6-20 years old (mostly pine and pine-hardwood forest of different composition and density); (3) – high-density wood stands, 20-40 years old; (4) – secondary hardwood and mixed forests, emerged after clearcuts. At the stationary sectors we followed the principles of *synchronicity* and *sample-size identity* at all the control and experimental sectors. Forest type and cuttings definition was based on geobotanical and forestry classification adjusted for Karelian conditions (9; 10 and 11). We also consulted specialists (S.S. Zyabchenko, A.D. Volkov, A.N. Gromtsev, A.M. Shelekhov) for choosing the sectors. The small mammals' number record was held using two techniques, all year round and in all the compared biotopes simultaneously: 1) using Gero traps on standard paths (12); and 2) using trap-cones with five meter long guide tracks (7). Total amount: over 70 thousand trap/day and 1500 cone/day. More than 5000 small animals of 17 species were caught and registered in the standard way.

Discussion of results: In order to compare the early succession stages of species groups it is first necessary to characterize the control sectors – the sectors that had not been affected by logging and that are "genetically predecessors" of the cut areas. Unfortunately, there are very few areas that had not been affected by logging, even in Russian part of Fennoscandia. Nevertheless, to characterize the old coniferous forests (almost unaffected by logging) animal species diversity, it is useful to show the results of unique research of small mammals in the far east of Fennoscandia, on the border of the Karelia and the Arkhangelsk regions, that was made in the late 90-s in those coniferous forests that are now cut. This data prove that there is great small mammal species diversity in old pine and spruce stands. For instance, to the north of Kolodozero village (Pudozhsky district, east of Karelia, Russia), in a virgin wood stand of green-moss pine-tree and larch during one day we caught 112 small animals of 8 species (including bank voles and shrews) using safe traps. In the virgin spruce stands of Andoma Uplands (the border of the Karelia and the Vologda regions of Russia, wood-stand age is over 200 years) with high quality of caught animals (18 animals per 100 trap/day) among the shrews there were *Sorex caecutiens* and *Sorex isodon* that are quite rare in Fennoscandia. Among the small rodents was the bank vole. Those three species, more than others, match the prinicple "Species indicating virgin taiga forests of Europe".

The most radical are the changes in biocenotic groups during the first years of cutting.

Compared with mature pine-tree stands, the quantity of caught small mammals decreases dramatically during the first year after logging.

The biggest changes in species diversity during the first years after logging are registebank for murine rodents (figure 1, 2), among them – the main groups: *Clethrionomys* and *Microtus*, especially dark voles (13).

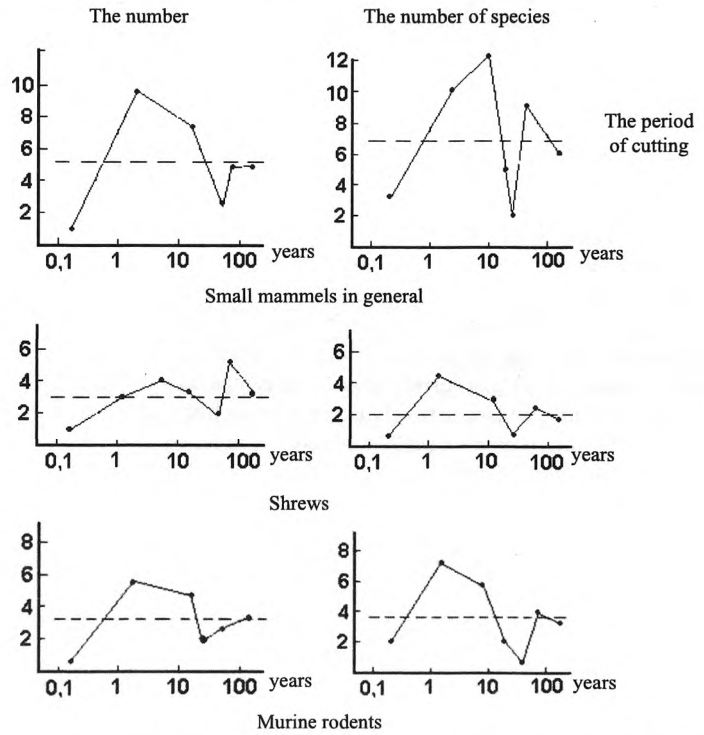

Figure 1. The changes in number (on the left, animals per 100 trap/day) and species diversity (on the right, number of different species) of small mammals (above), as well as murine rodents during the forest ecosystem recovery after pine-tree stands cutting. The dotted line shows the average values for all biotopes. Species diversity is presented for all the trap types, total. Cutting remoteness is presented on decimal logarithms scale

We can conclude that, although the old (over 100 year old) pine tree green-moss stands (control groups) have species diversity and number indicators similar to the average numbers for all the biotopes, those numbers are lower than those of the recently cut trees (cut from 1 to 10-15 years ago). That difference between mature coniferous forests and previously cut ones are especially noticeable for murine rodents

(figure 1, bottom). Particularly large difference (30 times) between the control group and previously cut forests are registered for *Microtus* (figure 2). Based on that data alone (figure 2) we can distinguish clear signs of species change (succession) of murine rodents, mostly noticeable during the first 15-20 years of secondary succession in previously cut trees ecosystems.

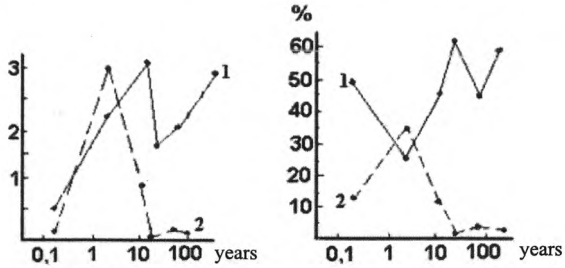

Figure 2. Changes in number (on the left) and dominance index (on the right) of *Clethrionomydae* (1) and *Microtinae* (2) during forest ecosystem recovery after pine tree stands cutting. Horisontal scale represents cutting remoteness (years, decimal logarithm scale)

Conclusion. We have found that during the first 7-8 years after Eastern Fennoscandia pine tree forests clear cutting, the main inhabitants of grass-type cut forests are *Sorex araneus* and *Microtus agrestis*. The ration difference in species inhabiting pine tree stands and cuts are particularly evident for *Sorex caecutiens*, *Clethrionomys glareolus* and *Microtus agrestis*. For the latter two species, the abundance ratio in the compared biotopes is exactly opposite: bank vole demonstrates tenfold numerical superiority in pine tree woods (compared with previously cut forests), while the situation with field vole is opposite. Bank vole dominates among murine rodents in pine-tree stands (88 %), field vole dominates in cut forest (97 %). Besides theoretical knowledge, that fact makes forecasts possible: knowing characteristics of a certain area (indigenous formation, dominant original biogeocenotic type, swampiness, landscape, soil properties, mosaic structure of habitats), we can create a highly reliable forecast for the changes in biogeocenotic group structure, small mammals predators number after caniferous forests loging. Considering an important role that field vole in cut forests of Eastern Fennoscandia plays for forestry (14), the ability to make such forecasts has a great practical importance.

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