

ALEXEY V. SUROV, PAVEL L. BOGOMOLOV, Moscow/Russia

## **The fauna of small mammals under changing of urban environment**

Key words: urbanization, Russia, synanthropy, abundance, species composition

### **Introduction**

The age of cities is not comparable with the age of most mammalian species. The first human settlements were too small to affect significantly the environment, but with their growth, the natural complexes were subjected to notable changes. It applies equally to Moscow, one of the largest cities in the world, which, judged by its population, remained practically unchanged during eight centuries, up to the 1860s, when the serfdom was abolished and peasants could move to cities. The second rise of urban population was connected with industrial development and resulted in the growth of the city area and changes of its infrastructure.

After radical expansion of the Moscow area made in 1960, all the suburbs within the Moscow encircling beltway were included into the territory of the city. Within these borders significant urbanization took place during following 50 years caused by intensive growth of population (with the average increase about 1 million per 10 years), mass residential building, and industrial and transportation construction. All agricultural lands and villages within new city borders were substituted by housing districts and industrial areas. The next wave of urbanization is expected at New Moscow are-

as outside the outer beltway. Similar processes of population upsurge and area expansion took place in other cities and settlement but with lower intensity. It is obvious that these processes affected species composition and abundance of wild mammals.

The aim of this study was to analyze changes in composition and species abundance of small mammals in Moscow and other cities and settlements of Central Russia during last 50 years and reveal more prosperous species.

### **Material and methods**

Standard methods of population survey for small mammals were used in this study. Snap-traps were set in various habitats within the city: in parks, gardens, cemeteries, boulevards, on swards, waysides, etc. Survey lines of 50 traps spaced 5 meters apart were inspected during three successive nights in spring and autumn in every locality. In all, from 1955 to 2005 the staff of the Institute of Ecology and Evolution and Moscow Sanitary Inspection realized about 1 million of day-traps, 68 397 rodents and insectivores have been caught. The data on other human settlements are available in manuscript (TIKHONOVA et al. 2012).

## Results

It is shown that the number of species of small mammals inhabiting vacant territories in Moscow constantly decreased during 50 years from 23 species in the 1960s to 13 species in the 2000s. One would think that the abundance of small mammals under the influence of transformations characteristic for urbanization should also decrease. Indeed, in 1960s it was 10 animals per 100 day-traps, and in 1970s this number decreased to 6 individuals. This decrease continued during 1980s to 5 animals per 100 day-traps. But in 1990s the tendency to some increase has been noted and their abundance reached the level of 1970s, and in 2000s it was 8 animals per 100 day-traps (fig. 1).

What was the reason determining the increase of the abundance of small mammals in Moscow during 1990s and 2000s? Every caught species was attributed to one of three groups according to the degree of its synanthropy: noncommensal (*Microtus arvalis*, *Sylvaeus uralensis*, *Clethrionomys glareolus*), semicomensal (*Microtus levis*, *Apodemus agrarius*), true commensal

(*Mus musculus*, *Rattus norvegicus*). Then changes in abundance of members of every group were analyzed. During the survey period non-commensal revealed decrease in the number of species, abundance, and its portion within small mammals. Semicommensal maintained their species diversity but their abundance slightly decreased in 1970s with subsequent growth in 1980s, 1990s and 2000s. True commensal represented by only two species, house mouse and Norway rat, demonstrated the same changes in abundance as did semicomensal (fig. 2). It was these two groups which ensured the increase in population density of small mammals in Moscow during last decades.

But is this process unique for Moscow or it takes place also in other cities? To answer this question the comparison of city fauna of small mammals was made for several cities of variable size and smaller settlements including villages in the same geographical zone of Central Russia. The objects for study were specially selected to reflect different stages of anthropogenic transformations of the environment. This degree of such transformations was believed to depend

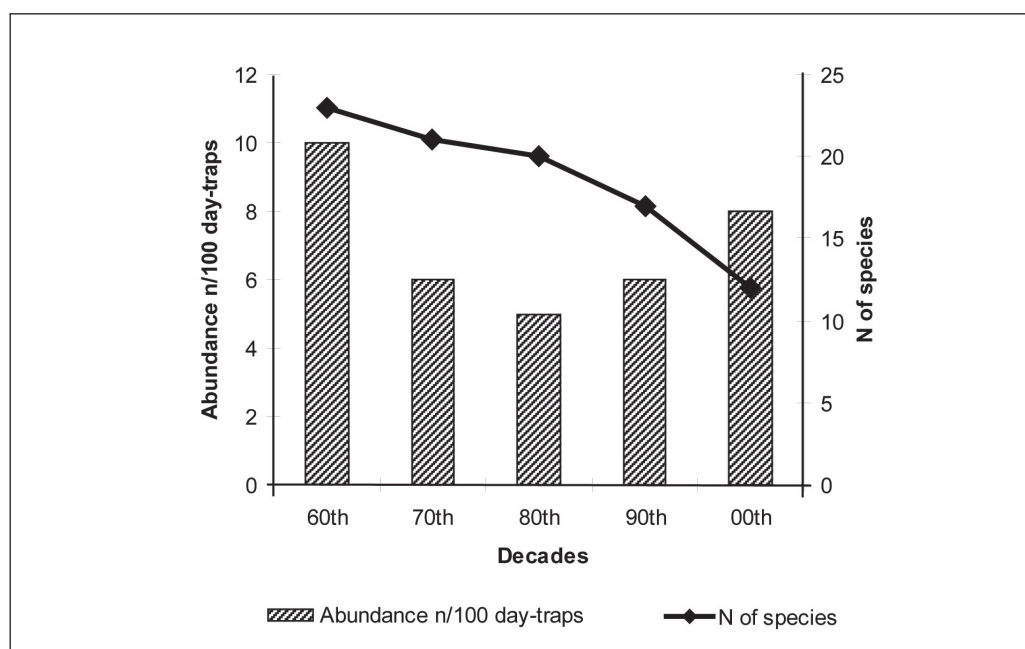


Fig. 1 Population dynamics and the number of species of small mammals in Moscow for the last 50 years. Abscissa – decades; ordinate: on the left – catches per 100 day-traps, on the right – number of species.

on the human population of the settlement, so several groups of settlements were selected by their population (Russian cities ..., 1994). The succession that was obtained demonstrated the same pattern as in Moscow, i.e. the increase of the urbanization pressure initiated the decrease in the proportion of noncommensal species and increase in the abundance of semicomensal and commensal ones. It should be noted that in this "evolutionary succession" from small settlements to the larger ones a prominent leap is observed in the share of synanthropic species and sharp decrease in the share of noncommensal ones when the rural settlements are transformed into towns. It supports the view that assignment to a settlement the status of town (which is made in accordance with administrative decision) generally reflects their qualitative differences. Observed difference in abundance and proportion of species with different disposition to synanthropy in small mammals of different cities may be explained in considerable extent by the presence of variable habitats within the city landscapes. In earlier publication (TIKHONOVA et al. 2012) we mentioned that the

differences in landscapes between the downtown and outskirts in Moscow and other cities are obvious. So we separated areas of studied cities into concentric zones with obvious differences in landscape features and tried to find out whether some common features exist in distribution of small mammals according to this zonation. In peripheral regions of cities high abundance and proportion of noncommensal species are always observed. Frequently they are insignificantly less than the same parameters of semicomensal species. Closer to the city center the proportion of noncommensal species decreases, and abundance of semicomensal increases almost twice.

It results in seemingly paradoxical appearance – the number of small mammals increases close to the city center. We have already described this phenomenon found during the analysis of abundance of small mammals in Moscow during 50 years – after the initial decrease of abundance its growth was observed being initiated by semicomensal and commensal species. It may be interpreted as the presence of a special stage during the process of urbanization

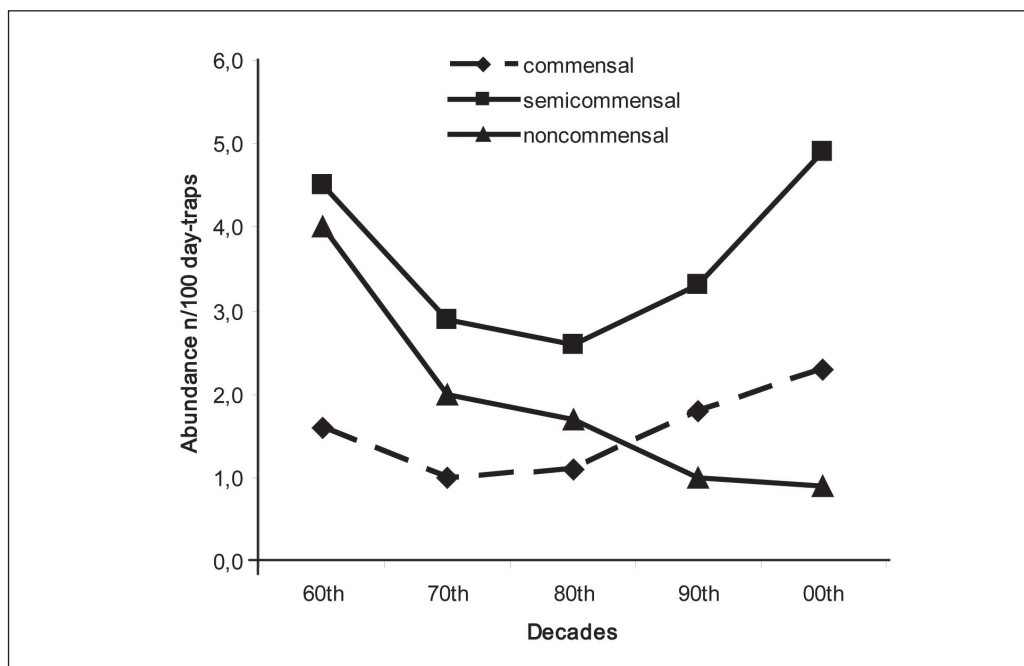


Fig. 2 Population dynamics of three ecological groups of small mammals in Moscow for the last 50 years. Abscissa – decades; ordinate – catches per 100 day-traps.

at which some crisis takes place due to destruction of natural and quasi-natural habitats (such as agricultural lands, meadows etc.) affecting native species. But at a later date a new city environment is formed together with corresponding fauna specific for cities which permits to some native species (semicommmensal ones) to increase their abundance. But in other zones closer to the Moscow center disappearance of noncommensal and then also semicommmensal species is observed. As a result, transformation of the city environment reached the stage at which native species (semicommmensal and noncommensal ones) disappeared entirely, and the city center is inhabited by only commensals. Very similar picture is observed in other large city – Yaroslavl with the only distinction determined by the fact that the city center does not reach the final stage of environmental changes observed in Moscow. In a small city (Chernogolovka) a similar structure of the fauna in different zones is observed but it is natural that the proportion of noncommensal species is higher in this city.

## Conclusion

This study of population dynamics of small mammals in Moscow and other cities and settlements of different size revealed common patterns in fauna formation depending on the degree of anthropogenic transformation of the environment. During initial steps of urbanization a transitional stage of transformation of natural habitats and agricultural areas is observed. For this stage a decrease in abundance of all native species is typical and small growth of commensal species abundance does not compensate the overall decrease in abundance of small mammals. During the next stage a new urban environment is formed with numerous habitats typical for cities but favorable primarily for semicommmensal species. They reach high number and successfully compete with both noncommensal and commensal species. As opposed to true commensal species semicommmensal rarely colonize houses and utility structures. During following stages of urbanization some habitats vanish or are transformed in others, which are not suitable for small mammals, due to more dense building. As a result the general

decrease in abundance of semicommmensal and commensal species takes place together with the increase of the number of commensals species. Now the vacant territories is the reservoir for true commensal species. At final stages initially noncommensal and then semicommmensal species completely disappear. To determine the direction and intensity of changes in animal population of human settlements numerous parameters should be taken into account including types of buildings, infrastructure development, size and distribution of green areas, etc. In addition, the ability of different species to adapt themselves to unusual conditions should be considered as well. That is what we tried to perform in this study.

## Summary

Archival and personal data on the fauna of small mammals inhabiting vacant territories of Moscow and some other cities of Russia during last 50 years have been analyzed. It is shown that species number of small mammals in Moscow decreased two times during this period. General abundance of animals decreased in 1970s, but restored practically up to previous level by the beginning of XXI century at the expense of some commensal and semicommmensal species. Similar processes are observed in other studied cities. The data obtained may testify to the formation of specific urban environment suitable for commensal and semicommmensal species, while noncommensal ones retreat to city borders and beyond.

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## *Anschrift der Verfasser:*

Dr. ALEXEY V. SUROV, PAVEL L. BOGOMOLOV  
Severtsov Institute of Ecology and Evolution,  
Russian Academy of Sciences  
Moscow, 119071, Leninsky prosp. 33  
E-Mail: surov@sevin.ru

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Autor(en)/Author(s): Surov Alexey V., Bogomolov Pavel L.

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