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SHORT COMMUNICATIONS

The Phenomenon of Multiyear Synchronization of High Population Number of Rodents in Remote Regions of the Urals

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Detailed studies of the dynamics of population parameters in many rodent species revealed the possibility of realizing a wide spectrum of temporal regimes of population functioning. For example, regular fluctuations in population numbers of model small mammal species ranging from 1–2 to 3–4 years were found in natural conditions (Bobretsov, 2009; Cheprakov, 2011; Zhigal'skii, 2011, 2014; Luk'yanova, 2013), as well as fluctuations with the 5—6-year period (Kataev, 2012; Krebs, 2013; Ivanter et al., 2015). In addition, possibility of realization of the 8–9-year variation in rodent population numbers (Evdokimov, 2011; Litvinov et al., 2013), as well as 12-year fluctuations of animal abundance (Maksimov, 1984) were determined in natural conditions. Along with these variants, in recent years a change in dynamic regimes of functioning of individual species populations was demonstrated, as well as possibility of a significant change in chronological parameters of stabilization of animal population number level (Chernyavskii and Lazutkin, 2004; Kataev and Okulova, 2010; Ivanter et al., 2013; Frisman et al., 2015 Ims et al., 2008; Kausrud et al., 2008).

Thus, even a brief analysis of a small sample of published works evidences for the urgency of searching new ways and approaches to solution of the complex problem of the rodent species population dynamics and animal population dynamics as an important and integral population parameter.

Within the framework of the problem above, data obtained during long-term uninterrupted studies in biological stations of the best known model species, the bank vole (*Clethrionomys* (*Myodes*) *glareolus* Shreber, 1780) are of great interest. Value of such works is significantly increased if the studies have been conducted in the same years and seasons with the use of universal standardized methods, in animal settlements in remote geographic regions completely "separated by distance" from the others. However, especially important may be comparative analysis of results of such works in those cases when it is possible to fix a uniform synchronization of parameters in the population dynamics of a model species. Just this phenomenon was recorded in independent studies on the Southern and the Middle Urals, which allowed us starting with determination of general regularities in the formation of population dynamics in the model species independently on weather and climate, biogeocenotic surrounding, and habitat attribution of bank vole settlements remote from each other. This composed the aim of this study.

Materials were collected form Ilmen State Reserve of the South Urals (Olenev and Grogorkina, 2014) and 50 km from the Southwestern border of Visimskiy State Nature Reserve in Shalinskii district of Sverdlovskaya oblast (Dobrinskii, 2010). Standard and commonly accepted universal methods of relative population census, catching live animals, and permanent marking of rodents on standard transects and plots of individual marking were used. The author's databases include data on more than 9,000 bank voles from the territories of the South Urals and more than 5,600 individuals of this species from regions of the Middle Urals. Materials on the autumn population number of rodents are used in this work for comparative analysis of data from different regions.

As a result of uninterrupted 32 years of practical use of strictly standardized protocols of main types of forest rodent censuses in the conditions of the Middle Urals, it was found that usage of the following criteria is reasonable to determine the levels of relative and absolute (total or general) population number: depression – 0–2 specimens per 100 trap–days, or 0–9 specimens per hectare; low number – 3–5 specimens per 100 trap–days, or 10–20 specimens per hectare; not high number – 6–10 specimens per 100 trap–days, or 20–40 specimens per hectare; average number – 11–15 specimens per 100 trap–days, or 40–60 specimens per hectare; high number – 16–19 specimens per 100 trap–

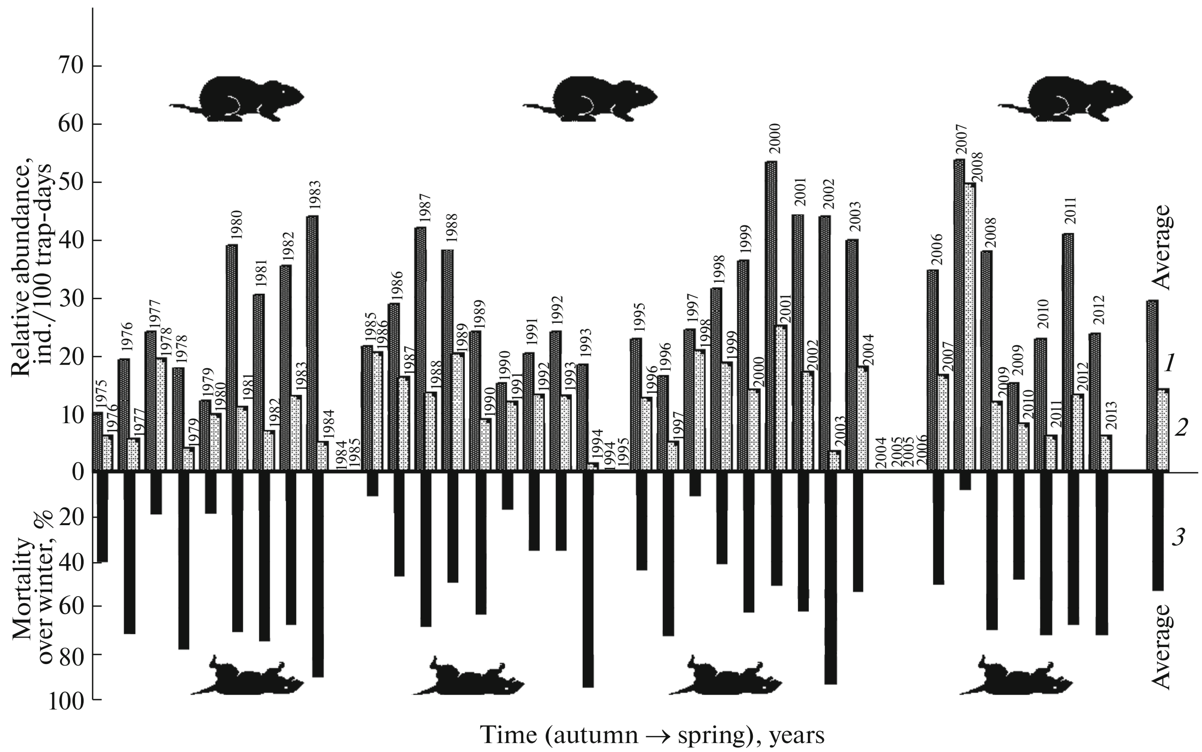

Fig. 1. Dynamics of interyear differences in survival and mortality in bank voles of the 2nd type of ontogenesis in winter period (by Olenev and Grogorkina, 2014). (*1*) September; (*2*) May; (*3*) number of voles died in winter period.

days, or 60–80 specimens per hectare; peak number – 20–25 specimens per 100 trap–days, or 80–100 specimens per hectare and more.

As can be seen from the above list of criteria, the reduction coefficient for calculation of the general (absolute or total) number of animals per hectare will be four, according to data from relative census with the use of standard census lines of traps. According to Bernshtein et al. (1995), the reduction coefficient for bank voles at their highest absolute population number, 113–227 individuals per hectare, may be 2.6–3.5, at an average of 3.05. We believe that the method of absolute (total or general) census of forest rodents on nonfenced marking plots of 1.5–3.2 hectares, used by these authors, allowed them the possibility of significant downward bias of the census data and, correspondingly, underestimation of the number of animals living on a given territory. Nevertheless, as a compromise for using the reduction coefficient, it is possible to use the arithmetic mean from the sum of 3.05 and 4, i.e., 3.5.

The duration of stationary uninterrupted monitoring studies on the South Urals was 40 years, from 1975 to 2015 (Olenev and Grigorkina, 2014). According to these authors, the number of model rodent species has increased significantly every time after exceeding a certain level (25 specimens per 100 trap–days, which corresponded to the peak level of 87 specimens per hectare), and then retained extremely high values from three to seven years consecutively (Fig. 1). The first period of long retention of extremely high population number was recorded for four years since 1980 to 1983, the second took three years from 1986 to 1988, the third took seven years from 1997 to 2003, and the fourth from 2006 to 2008, i.e., three years. In the middles of the seven-year period and the extreme three-year period, averaged by seasons, population number for the region was 55 specimens per 100 trap–days, which corresponds to 192 specimens per hectare. It should be noted that the 40-year row of uninterrupted stationary observations, rare by its duration, was divided in four practically equal parts by three deep falls in the level of the vole population number. In the years of falls, starting spring rodent number has declined each time towards autumn to the minimum, and the third period of extremely low autumn number of animals took two years consecutively.

The duration of uninterrupted monitoring studies on the Middle Urals was 32 full years, from 1983 to 2015 inclusively. During that time, only one period of the deep depression (to zero) in the number of all rodent species was registered in 1984. From 1985 to 1993, the number of bank voles fluctuated in different directions around the middle level of 50 specimens per hectare, and the peak level was attained twice in this period, in 1989 and 1992, with the values of 112 and 160 specimens per hectare, correspondingly (Fig. 2). Then the number of model rodent species reached its

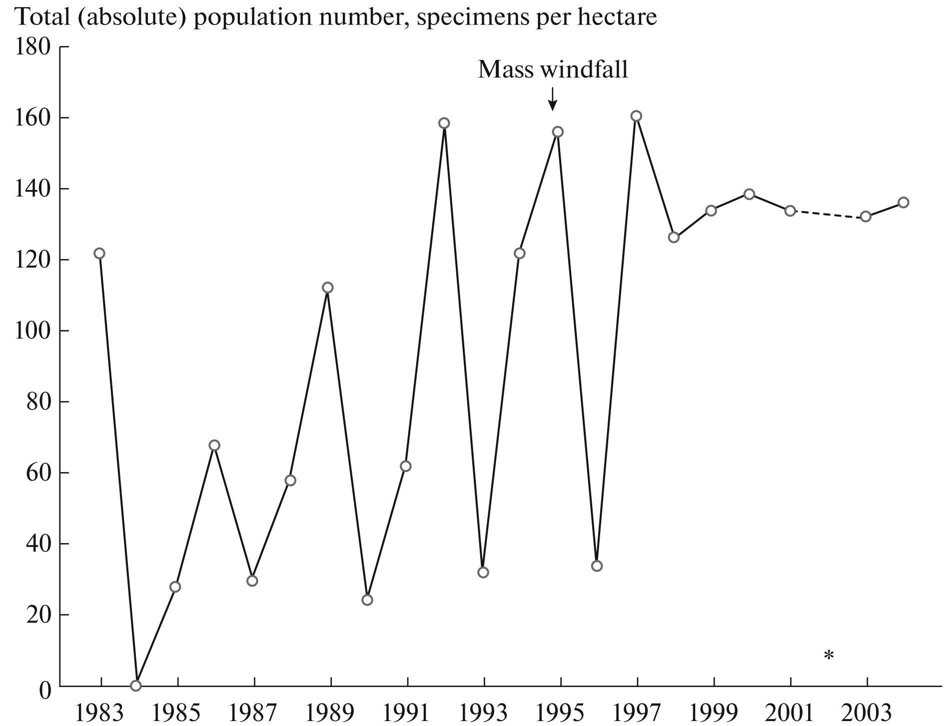

Fig. 2. Population number dynamics of forest voles by results of autumn catches on a stationary marking plot in an area of the Middle Urals.
Asterisk means that data on the year 2002 were not provided due to late collecting (in October).

peak during two consecutive years, 1994 and 1995. A catastrophic windfall has taken place in the Middle Urals in spring period in the second year of the extremely high population number, 156 specimens per hectare. It was caused by squally wind. In the next 1996 year the number of bank voles naturally decreased to 34 specimens per hectare. It should be noted that one year after the mass windfall, at the background of cardinal improvement of protective conditions of environment, the food resources of the rodent were not improved due to significant disturbance of forest vegetation, including herbaceous layer. However, in 1997 grass-forb vegetation started to develop intensively on clarified territories affected by the windfall. As a result, in 1997, the population number of the model species attained its maximum level of 162 specimens per hectare. Later, from 1998 to 2004, the resulting autumnal number of voles regularly attained peak levels each year.

It should be noted that the values of total (general or absolute) population number in this period were untypically aligned and fell in the interval to 63–69 specimens on the 0.5 ha, which would be 126–138 specimens per hectare. At that time, mean general (absolute) population number of the bank vole for six years was 66.7 ± 0.8 specimens per 0.5 hectares, i.e., it was stable on almost the same level for six consecutive years. It should be added that, after the year 2005, population number of the model rodent species in the end of reproductive seasons in 10 consecutive years up to 2015 inclusively attained its peak levels for the Middle Urals. This phenomenon resulted from synergetic effect of two leading ecological factors, the trophic factor and the factor of protective conditions of the rodents' environment after the appearance of vast forest windfalls, when grass-forb vegetation started to dominate, resulting from habitat clarification and processes of succession. In these conditions on sites of numerous windfalls, as a result of natural processes of self-organization of populations, fairly large, from one hectare and more, stationary units of the vole settlements with unusually high population number have been formed. Finally, long-term and stable network structure consisting of dense and vital rodent settlements was formed on the territories of the mass windfall. This structure constantly influenced habitats around the windfall sites.

Therefore, comparative analysis of data from the South and the Middle Urals revealed that high ecological capacity of natural ecosystems in snowless period on the territories of both regions may serve as a necessary base for maintenance on regular basis of extremely high population number of bank voles on temporal sections from 3–4 to 7–19 years with possibility of synchronization to seven consecutive years. Apparently, this was conditioned by a high spring "starting" number of rodents, i.e., regular realization of the possibility of successful hibernation. In the conditions of undisturbed typical habitats of the South Urals, it was ensured by a sufficient amount of food resources combined with necessary amount of refuge suitable for rodents, at the background of comparatively more favorable weather and climatic conditions. Maintenance of the maximum population number of wintering cohorts of small mammals on the regular basis in the Middle Urals during many years may be ensured only at cardinal improvement of protective and trophic conditions of the animal environment on broad areas. It was found that such opportunity was realized after catastrophic windfall disturbances of the structure of pristine forest biogeocenoses typical for the region.

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