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N. S. Korytin, V. N. Bolshakov, A. M. Goskov, Ekaterinburg/Russland

A comparative analysis of the population density dynamics of some carnivorous mammal species in Europe and in the Urals

Introduction

Population dynamics is the result of a large set of abiotic and biotic factors which influence is refracted through the intrapopulation reaction. Among the biotic factors, stocks and the availability of food objects as well as the competitive relationship between consumers of common food resource can play a leading role in the formation of a certain level of population density. The purpose of this work is to assess the role of certain interactions in this area and their impact on the population density of certain predatory mammal species.

Materials and Methods

We used data from the winter route census of stoat *Mustela erminea*, Siberian weasel *Mustela sibirica*, pine marten *Martes martes* and red fox *Vulpes vulpes* on the Eastern macroslope of the Middle Urals for the period from 1970 to 2006. It is the territory of Transural Flatland Provinces, which is the transition zone from southern taiga to forest-steppe. The obtained results were compared with European materials published in a number of works, including H. Nyenhuis (2000), in which the author analyzed the relationships of the red fox, stone marten, stoat, weasel and polecat in Germany (region of the state of North-Rhine Westphalia district Steinfurt). We used data of changes in the numbers of red fox, stoat, stone marten in Germany and pine marten in the Middle Urals. In the Urals there was selected area relatively similar to the main types of habitats in the Steinfurt district. For estimates of the predatory mammal species population size in the Steinfurt District the author used annual hunting bag information. It should be noted here that the special verification of different methods using comparison with independent criterion revealed that data on the hunting bag of animals approximates the actual population size (Korytin 2003).
Overall Steinfurt district is characterized by a greater proportion of open habitats and lower proportion of forests as compared to selected area in the Urals.

Results and Discussion

The dynamics of population density of species included in the analysis in the Urals is shown in Figures 1–4. From 1970 to 1991, the population density of the red fox fluctuated at approximately one, relatively low level. After a strong decline in 1992, the density began to increase sharply. In subsequent years (after 2006), the density of the fox in the Sverdlovsk region continued to grow in a whole (Korytin 2011).
The population density of the marten population changed in a similar way to the density of

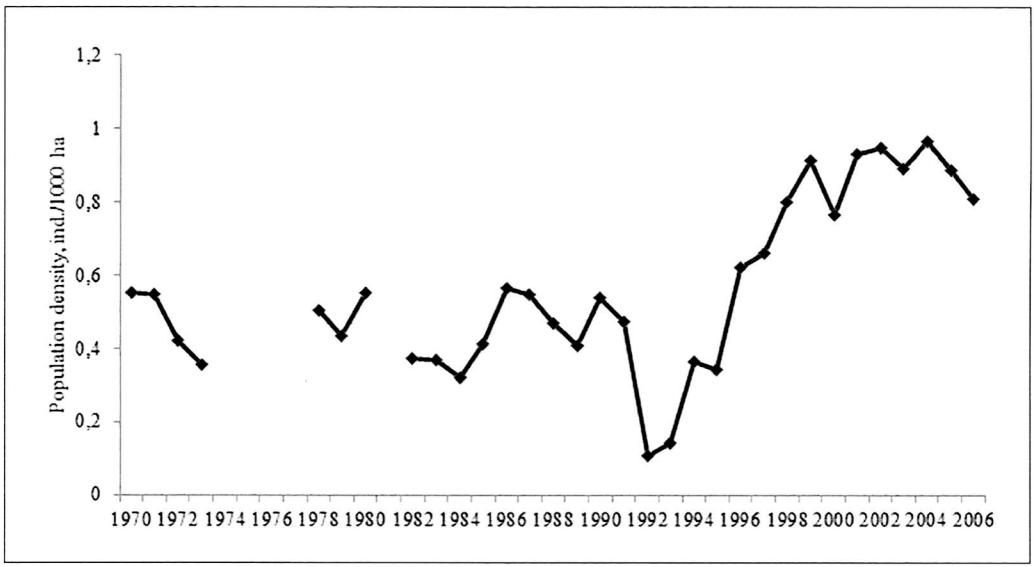

Fig. 1: Density dynamics of the red fox in the Urals

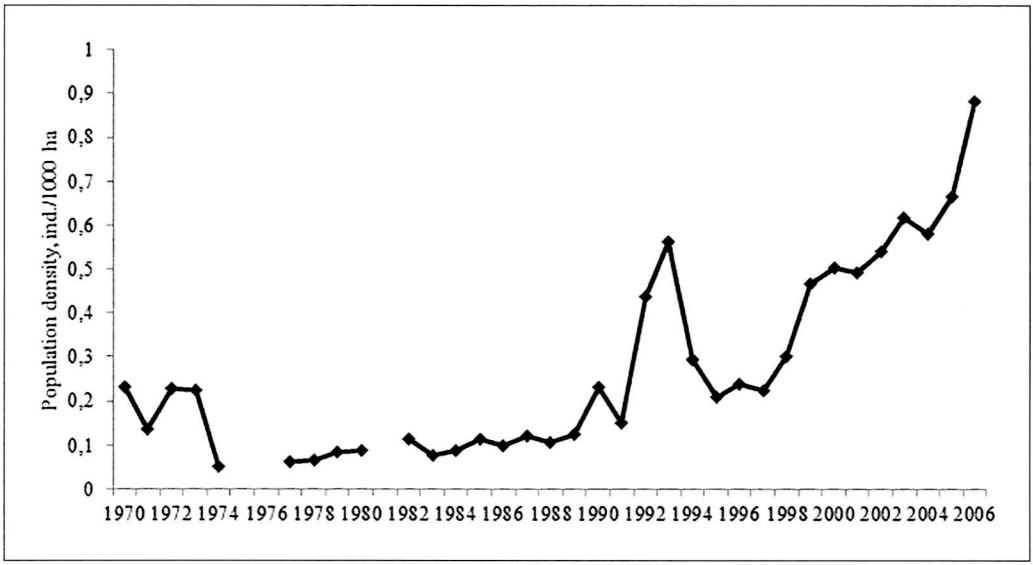

Fig. 2: Density dynamics of the pine marten in the Urals

the fox. From 1970 to the early 1990s, the density of the marten remained at a very low level, then a sharp rise began. This behavior of the abundance curves was explained by the powerful pressure of the hunting in the period before the early 1990s (Korytin 2011). The population density of stoat fluctuated in a rather stochastic manner from 1970 to 1990s. Then sharp jumps of density with the general tendency to growth began. The peak density was achieved in 1997, after which a strong decline of the population size began, which continues to the present.

The pattern of changes in the population density of the polecat essentially resembles that of the

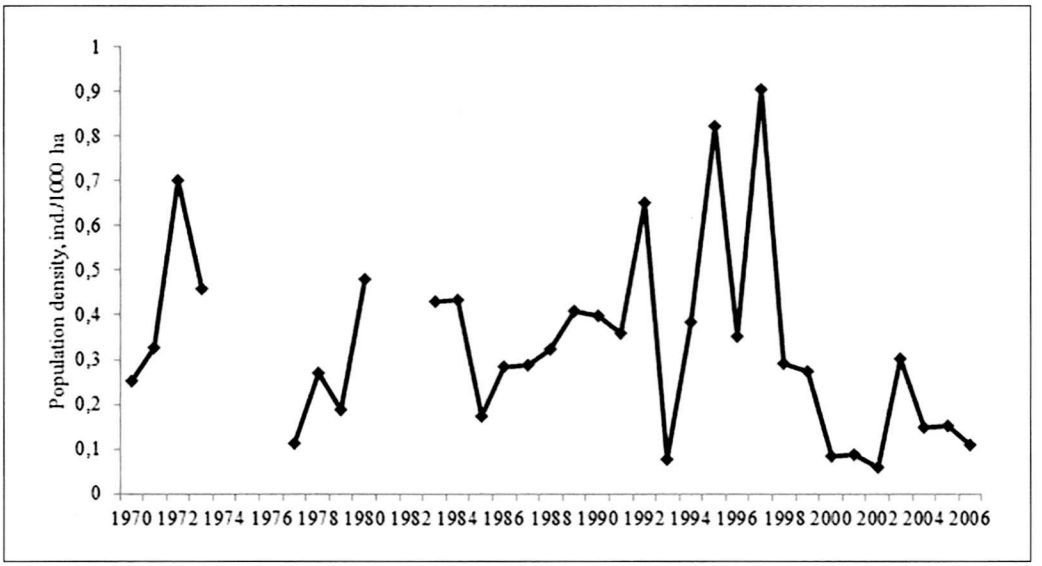

Fig. 3: Density dynamics of the stoat in the Urals

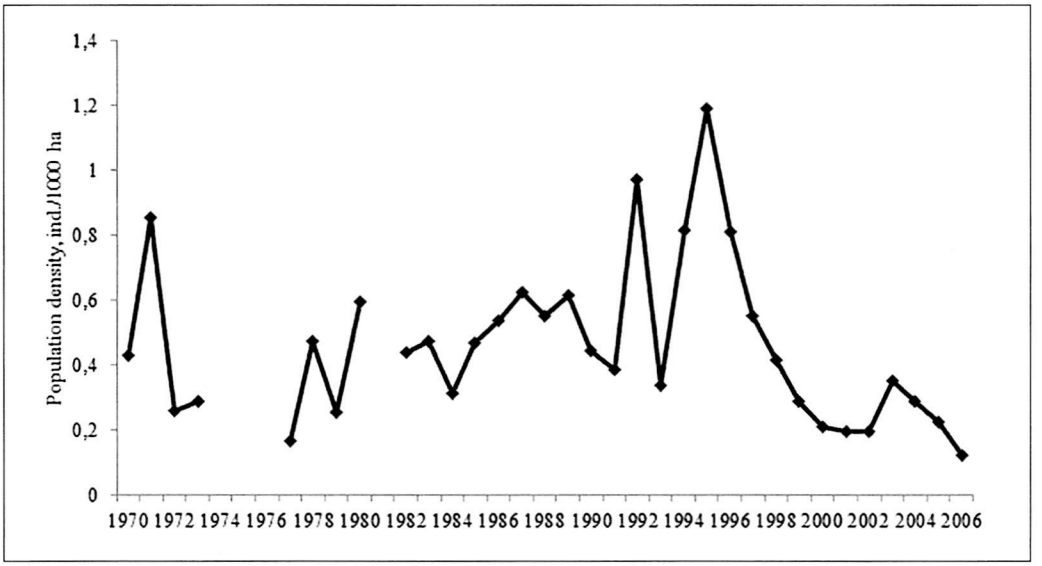

Fig. 4: Density dynamics of the Siberian weasel in the Urals

stoat. It can be assumed that in the period from 1970 to the early 1990s, there was a powerful additional factor of mortality in the form of hunting, which suppressed the influence of any kind of interspecies relationship.

In the early 1990s, the fur harvesting practically ceased due to the sharply reduced cost of the pelts. It would seem that in this situation we should expect a similar reaction to the cessation of harvesting in all analyzed species – increasing population size and density. Nevertheless, this pattern was peculiar only to the fox and marten. The population density of the stoat and the polecat began to decline sharply. It should

be noted that a further decline occurred in the following years. The increase in the abundance of red fox and the simultaneous decrease in the abundance of stoat has also been noted for the Steinfurt district (Nyenhuis 2000).

The diet of the red fox, stoat, polecat and pine marten is largely similar and is based on the consumption of field and forest voles, that is, it is potentially possible to assume the presence of competitive relations for a common food resource, which can be expressed in the curves of the change in the species population density inhabiting one territory. The share of consumption of one or another type of food depends on the set of habitats on the individual home range and, accordingly, on the ratio of the biomass of the preferred feed. The fox can be attributed to a large extent to euryphages, the ermine – to stenophages. The marten and the polecat are likely to occupy an intermediate position.

In Hungary, studies of trophic niches of foxes and stoat showed that they overlap largely. The degree of overlap varies by season. The minimum overlap of 0,55 was observed in winter, and the maximum was 0,64 in autumn. In the diet of both species, small mammals predominate in proportion to 49.7% in foxes and up to 77.3% in stoat. A decrease in the consumption of gray voles to 4.3% by foxes in summer was observed when the food spectrum is the widest. The proportion of the forest voles of the genus *Clethrionomys* in summer was also 4.3%, and the forest mice *Apodemus* 2.2%. In the remaining seasons, the voles of the genus *Microtus* predominate in the diet. The foxes ate half the forest voles and the mice average 4 times less. Stoat mostly consumed *Apodemus* forest mice in winter – 40.9%, and in the remaining seasons predominantly *Microtus* vole 14.6% – 28.6%. Forest voles in the feed of the ermine were only met in spring and summer – 6.5% and 2.4%, respectively (Lanszki et al. 1999).

In the Białowieża National Park, eastern Poland, food niche overlap between red fox and stoat was 0,43, between red fox and pine marten – 0,59, between pine marten and stoat 0,89. In the diet of the ermine, forest rodents were found prevalent and swamp and shrub *M. oeconomus, M. agrestis, Micromys minutus* were also present. In the pine marten diet, forest rodents also prevailed. In the diet of the red fox, a significant proportion of the diet consisted of both forest swamp and shrub rodents, but field rodents *M. arvalis* and *A. agrarius* dominated (Jędrzejewski, Jędrzejewska, Szymura 1989).

In those habitats where the water vole is numerous, the population size of the ermine depends to a large extent on the fluctuations in its abundance (Debrot 1983; Erlinge 1983; Weber et al. 2002). The number of water voles is low in the studied area in the Urals.

In Europe, the prevalence of *Microtus* voles in the fox feed is more than 50% (Dell'Arte et al. 2007). The pine marten prefers forest rodents, so the basis of the diet is the forest vole *Clethrionomys*. But with a significant decrease in the number of foxes, the number of martens increased sharply, presumably due to a decrease in competition with the fox in open habitats (Russell, Storch 2004; Storch, Lindström, Jounge 1990).

In the Lapland Reserve (north-west of Russia) among all small rodents, the proportion of *Clethrionomys* vole in the fox's diet is 28.6%, in marten's diet – 52.2%, in stoat's diet – 71.2%, and the proportion of *Microtus* voles in fox's diet – 52.4%, in marten's diet – 26.3%, in stoat's diet – 28.8% (Kataev, Okulova 2007).In the north of Italy, the trophic niches of martens and foxes were compared. It was found that they overlap largely. In the summer, the spectra are much wider, and the proportion of rodents is no more than 20%, while in winter it increases to 47.8% in marten's diet and up to 52.6% in fox's diet (Remonti et al. 2012).

In the studied area in the Urals, the proportion of forest habitats is 42% of the total area. Marten preferring forest biotopes probably does not enter into a significant competitive relationship with the fox, which prefers open and semi-open habitats. We can assume that due to the difference in the preferred biotopes and, correspondingly, the reduction of competitive pressure, we observe an increase in population density both in foxes and martens. However, both these species can have a competitive effect on the ermine and probably on the polecat. This is evidenced by literary data on the degree of overlapping food niches in pairs of foxes – ermine and marten – stoat.

Conclusions

Observed in quite distant areas (Germany and the Urals), similar changes in the population density of foxes and stoat can indicate a competitive relationship between these species. Taking into consideration the fact that the preferred habitats, in regions where a significant area is occupied by agricultural land, the stoat inhabits mainly field woodland between open habitats and wetland shrubs. The fox also most often chooses similar biotopes for equipping burrows and hunting. Therefore, along with trophic competition, there can also be direct competition, get worse with increasing fox population density. Fox as a larger predator can displace and even attack the stoat. In the case of martens, if there is a significant overlap of trophic niches, competition with the fox has less impact on abundance. Although for different regions, the number of martens increases during the years of the fox's decrease.

Resume

Comparison of the population density dynamics of the fox, the marten, the stoat in Germany and in the Urals has revealed similar processes. The population density of the red fox and marten grows, and the density of the stoat decreases. The fox and marten, due to the wider trophic niches, supplant the small mustelids with a narrower trophic niche. Most likely there is not only competition for food resources, but also the direct displacement of small predators by larger ones.

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Anschrift der Verfasser:

Korytin N.S., Bolshakov V.N., Goskov A.M.
Institute of plant and animal ecology UB RAS,
Ekaterinburg, Russia
E-Mail: nsk@ipae.uran.ru