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Comparison of populations of small mammals in a climax spruce forest and in an acidophilic beech forest in Kľačianska Magura NNR (Malá Fatra NP)

A. MATEČEK[1] and L. HLÔŠKA[2]
[1]*Institute of the High Mountain Biology, University of Žilina, Tatranská Javorina 7, 05956-SR, Slovak Republic,*
[2] *Považské múzeum v Žiline, Topoľová 1, 010 03-SR Žilina, Slovak Republic, e-mail: hloska@pmza.sk*

Abstract. Paper analyses habitat preferences of small mammals (*A. flavicollis* and *M. glareolus*) on the level of age group in two types of climax forest. In general, it compares the fitness extent of populations of small mammals species in individual habitats and analyzes fitness of individual age brackets, their mutual interactions as well as interactions with the environment. Aim of this work was to provide an overwiev about population density and its annual change, pattern of distribution in space. Small mammals were captured by the quantitative quadrate method. We determined their main ecological characteristics, which depend on their population density. Competition pressure was growing during the gradation cycle and individual species were expelling lower age groups to the peripheries of generally prefered areas. In season 2008, we have discovered inverse changes in weight and number of both species in both habitats.

Key words: small mammals, habitat variables, ecological niche, population dynamics, density

Introduction

Small terrestrial mammals are highly adaptable animals and we can find them in practically every habitat from polar regions to the tropics (Hayward and Phillipson 1979).

Quantitative research on vertebrates in Slovakia was conducted, for example, by Turček (1960). Hanzák and Rosický (1950) and Gaisler *et al.* (1967), for example, studied the cenology and population ecology of small terrestrial mammals. Dudich and Štollmann (1980) studied the qualitative and quantitative structure of small mammals communities. The age and sex structure, abundance, biomass and distribution of small mammals at the species level in Slovak conditions were studied by, for example, Dudich (1970, 1988, 1992, 1994), Darola and Obuch (1980), Darola and Štollmann (1981), Boďová and Dudich (2000), Dudich and Pavlíková (2000), Baláž (2002, 2006), Baláž and Ambros (2005a,b,c).

Tkadlec and Zejda (1998) studied population dynamics and their cyclical nature in small terrestrial mammals. Stenseth and Ims (1993), Meserve *et al.* (1995), Korpimäki and Krebs (1996), Leirs *et al.* (1996), Lima and Jaksic (1999), Krebs (2002) contributed substantially to the understanding of population cycles of small mammals.

The aim of the present work was to analyse the population structure of *Apodemus flavicollis* and *Myodes glareolus* in two types of climax forest.

Material and Methods

Capture method

The research was conducted in Malá Fatra National Park (49° 08´ N, 18° 50´ E). Monitoring of small terrestrial mammals was conducted in 2007–2008 at various times of year. The capture method was done using the standard quadrate method (e.g. Miklós and Žiak 2002, Hlôška and Saniga 2005). Two trial quadrates measuring 75x75m, representing standardised measurements for forest geobiocoenoses, were laid out, within each of which 36 capture points were regularly arranged in 15m squares and at every point 1 live trap was placed (Pelikán 1971). The reason for using live traps was the opportunity to use the CMR method (capture – mark – recapture) by marking captured individuals and then releasing them in anticipation of capturing them again. Brass ear tags with a numerical code for identifying individuals were used for marking. If the tag was lost it was still possible to identify a previously captured individual on the basis of the char-acteristic healing of the notch on the ear to which the tag was attached.

Whenever possible, when delineating trial plots in the field, homogenous phytocoenosis was taken into account so that the trial plot lay in the centre. Capture was done during 3 days and 3 days and traps were checked twice daily.

Processing trapped animals

Following the capture of small mammals standard taxonometric methods were used to process the following morphometric and population ecological characteristics: sex, age category, weight, pregnancy (females), sexual activity, species, marked and recaptured individuals, pres-ence/absence. Sex, sexual activity, species and age category of individuals were determined on the basis of visual determination of typical morphological and taxono-

metric marks. Sexual maturity and sexual activity in males of small rodents was determined macroscopically on the basis of scrotal position of the testes (Hlôška 2004). The criterion for sexual activity in females was the presence of embryos in pregnant females determined by gentle palpitation in the abdominal region and the evident presence of functioning milk glands in lactating females (Hlôška 2004).

Statistical analysis of data

All data were processed using standard statistical methods and procedures used in practice in evaluating ecological data of a similar character, as used for example in the work of Wolff (1999). To calculate gross density per hectare from quantitative data the 2nd edition of the Ecological methodology 6.1.1. program was used, with the use of the Schnabel-Schumacher method (Krebs 1999). Density in a plot with a standard size of 0.56 ha was converted to 1 ha.

To determine differences in weight and fitness between species in the two habitats with regard to their age categories and sex a One-Way ANOVA was used. We used the Ecological methodology 6.1.1 program to test niche overlap of *A. flavicollis* and *M. glareolus* using the Niche Overlap method (Krebs 1999). In case of insufficient sample size or data not normally distributed, a Kruskal-Wallis test was used for multiple comparison of Z values.

The Ms Access database program was used to enter source data into a spreadsheet for sta-tistical testing and multiple analysis procedures. Analyses, calculations and graphs were prepared and evaluated using the Ms Excel XP spreadsheet and the NCSS 2004 statistical program (Hintze 2001).

Results

Overview of trapped animals

From 2005 to 2009 two species of small mammals of the order Rodentia were trapped in the acidophilic beech forest environment; representatives of the order Eulipotyphla were absent. In the 2005 and 2009 seasons no small mammals were captured in the acidophilic beech forest environment (latent phase of the population cycle). Two trapping series were completed in spruce-rowan forest, in June and September 2008 and 2009, during which there was a capture result of zero in the 2009 season. During the whole study period, 93 individuals of *A. flavicollis* and 120 individuals of *M. glareolus* were captured in acidophilic beech forest. In the case of the spruce-rowan forest, the numbers were 38 individuals of *A. flavicollis* and 73 individuals of *M. glareolus*. Table 1. contains data on the number of captured individual during separate capture series.

The overall summary of individuals of all age categories, with a view to sexual activity of both species, showed an upward trend. In the 2006 season density showed the lowest measurable value and its gradient grew until the 2008 season, when it reached its maximum value.

Dispersal

Dispersal of individuals within the study area was established using Morisita's Index. The value for dispersal of *A. flavicollis* individuals in September 2008 indicated a clustered type. For the other trapping series dispersal was equal to unequal. The precision of the measured values could have been negatively influenced by an insufficient number of sequential captures during individual years over the period of study. It could also have been affected by the size of the study area.

Average weight of zoomass

In the context of increasing numbers of both species in plot units, an increase in mass of the biological material weighed was also recorded. This peaked in September 2007, when the highest average value reached a value of 31.01g for *M. glareolus* and 23.28g for *A. flavicollis*.

Weight structure of A. flavicollis in spruce-rowan forest

During the 2008 study period it was found that adults reached an average weight of 34.78g. The average weight of adult females was 37.00g; in the case of adult males it was 33.12g. Juveniles reached an overall average of 17.68g. Females in this age category had an average weight of 16.66g, males 17.81g. The average weight of subadults was 22.25g. Females in this age category had an average weight of 24g. The average weight of subadult males was 22.09g.

The overall average weight of females during the entire trapping period was 26.42g. For males an average weight of 20.74g was recorded. Sexually active individuals reached an average weight of 33.00g. The average weight of sexually inactive individuals was 19.85g. The presence of pregnant females was not recorded.

Weight structure of A. flavicollis in acidophilic beech forest

The average weight of adults was 32.54g, with the average for females reaching 33.23g and for males 31.88g. The average weight of juveniles was 15.81g. Female juveniles reached an average weight of 14.14g and males 15.96g. The overall average weight of subadults was 23.63g. Female subadults reached an average weight of 21.87g. For males the average weight was 24.90g.

The overall average weight of all females was 28.44g, males 24.18g. The average weight of all sexually active individuals was 32.54g, sexually active 18.77g. The average weight of pregnant females was 38.66g.

	Month/year of trapping					
	Aug./ 2006	**June/ 2007**	**June/ 2008**	**Sep./ 2008**	**Total**	**%**
A. flavicollis	19	42	99	10	170	44.97
M. glareolus	13	32	112	51	208	55.03
Total	32	74	211	61	378	100.00

Table 1. Sample size (n) of micromammals obtained in separate trapping seasons and their percentage composition of the cumulative sample expressed as a percentage (Kľačianska Magura NNR, August 2006 - September 2008).

Weight structure of M. glareolus in spruce-rowan forest

In the 2008 vegetation season the average weight of adults was 20.66g; females in this age category averaged 19.5g. The average weight of adult males was 21.00g. Juveniles showed an aver-age weight of 17.06g, with females averaging 16.33g and males 17.55g. The overall average of subadults was 17.85g. Female subadults had an average weight of 18.66g, males 17.42g.

The average weight of all female individuals was 18.00g, males 18.64g. One pregnant female was identified during the trapping period with a weight of 17.00g.

Weight structure of M. glareolus in acidophilic beech forest

The average weight of all adults in this habitat was 25.98g. Females in this age category reached an average weight of 26.67g, males 24.12g. The over-all average weight of juveniles was 14.67g. Juvenile females reached an average weight of 13.25g, males 15.54g. Subadults reached an over-all average weight of 18.69g: females 17.45g and males 19.17g.

Dynamics of zoomass

Gradation of abundance and average weight in an acidophilic beech forest in three years

M. glareolus reached its inter-annual maximum weight in 2007 with an average value of 23.29g, while its abundance peaked in the 2008 season (82 individuals). *A. flavicollis* reached its highest average weight of 31.01g in the 2007 season and the abundance of this species peaked in the 2008 season (56 individuals).

Fig. 1 shows the growth of population density in a time interval of 3 years and encapsulates changes from the latent period up to the peak period in the 2008 season.

Abundance and average weight of small mammals in a spruce-rowan forest during the first capture season

M. glareolus reached its highest abundance during summer with a value of 32 individuals. The highest weight, with a value of 19.61g, was reached in autumn. For *A. flavicollis*, the maximum abundance was reached in autumn (43 individuals). Its highest average weight had a value of 31.17g and was measured in summer.

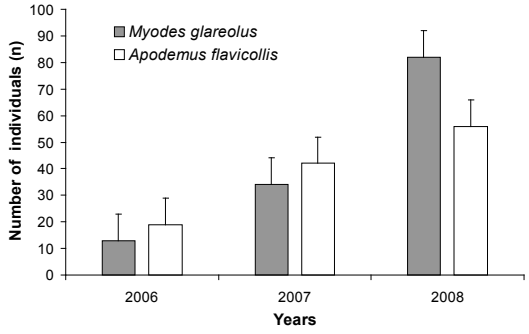

Fig. 1. Changes in the abundance of *A. flavicollis* and *M. glareolus* in an acidophilic beech forest (n = 378) recorded during the years 2006-2009.

Niche overlap of A. flavicollis and M. glareolus

The niche overlap of sympatric species showed high values in both habitats. In spruce-rowan forest conditions (plot 76) it reached 73.198%, in acidophilic beech forest (plot 73) it had a value of 70.457%.

Discussion

During the 2005–2009 vegetation seasons forest dwelling species of rodents (Rodentia) were captured in the environmental conditions of climax forest communities of an acidophilic beech for-est. The species spectrum during this period was represented by two species of small mammals, *A. flavicollis* and *M. glareolus*. Insectivorous species were not represented in any capture series. During trapping seasons we detected part of the gradation cycle in both species of small mammals. In the 2005 and 2009 seasons there were no captures, which was connected with the latent phase of the gradation cycle. In spruce-rowan forest conditions we detected a decline in abun-dance between two capture series conducted in July and September 2008; the 2009 season capture series showed a zero value for density.

Fluctuations in *M. glareolus* and *A. flavicollis* in central Europe are regarded in Carpathian forest conditions as true population cycles (Hansson and Henttonen 1988). Gradation cycles of forest dwelling species of small mammals run in 3 to 4 year intervals, when regularly repeated high population density occurs (Stašiov 2003). In July 2008 the populations of both species peaked, while in September 2008 we already detected a marked decline in density, retrogradation, which preceded a sudden population crash. This steep decline did not show a clear connection with one-year population fluctuations (oscillation). Then, the population grows exponentially (natality exceeds mortality) up to the winter period, when the ratio of natality and mortality changes. In regards to the amount of seasonal food sources in the summer and autumn periods of the 2008 season and the favourable environment conditions, which after statistical evaluation of the whole study period showed a significant influence in evaluating preference and presence of small mammals, when evaluating the decline over the period June 2008 - September 2008 we can rule out time synchronisation with the vegetation period, shown mainly by oscillations. Stašiov (2003) showed that population density is low after gradation (latent), after which abundance gradually begins to increase again (progradation) and goes into steep, unlimited exponential growth (progression) and thus forms a new gradation peak (culmination).

Interannual values of dispersal suggested a slight change in the spatial structure of the population. Dispersal values showed a random (unequal) to even (equal) type of spatial distribution of individuals. Equal (even) dispersal could be the result of the influence of competition at high population density. Stašiov (2003) showed that an equal type of dispersal occurs only rarely in animals and is conditional on strong competition for resources,

which obliges individuals to isolate themselves from each other. According to Begon *et al.* (1997) we speak about uniform distribution when individuals which are too close to others die or leave the population completely. A marked homogeneity of dispersal correlated with a high population density in individ-ual periods, but could be slightly influenced by an insufficient number of sequential captures, as well as by the size of the study plots. The type of distribution of organisms depends on the spatial scale, so on the size of the area in which we observe the organisms (Begon *et al.* 1997).

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