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POPULATIONS OF *CLETHRIONOMYS GLAREOLUS* IN THREE ISOLATED FOREST COMPLEXES IN RURAL SOUTHERN MORAVIA (CZECH REPUBLIC)

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ABSTRACT In rural landscapes, the dynamics of bank vole (*Clethrionomys glareolus*) populations were studied from 2002 to 2005 in three large isolated forest complexes which differed in tree composition and food supply. Populations fluctuated markedly during the four years of research. Extra seed crop in 2003 and probable niche vacation - the density of the dominant *Apodemus flavicollis* lowered in 2004 -, determined two years (2004-05) of higher bank vole population densities. The relative abundance of *C. glareolus* was higher in the most variable biotope (RB), consisting of an intensive pheasantry. Also the body mass of adult individuals, particularly females, was higher in RB. The influence of seed crop on the weight of individuals was statistically significant. During winter 2004/2005 a strong impact on the forest regeneration in tree plantings was reported. We argue that vole abundance prediction by periodical monitoring is needed to prevent damage.

Key words: bank vole, *Clethrionomys glareolus*, rural landscape, population dynamic, food supply.

RIASSUNTO – ***Popolazioni di* Clethrionomys glareolus *in tre complessi forestali di un'area agricola della Moravia meridionale (Repubblica Ceca).*** La dinamica di popolazione di *C. glareolus* è stata indagata in tre complessi forestali relitti in ambiente rurale, differenti sia per aspetti vegetazionali sia riguardo la disponibilità di risorse alimentari. L'abbondanza relativa (rA) dell'arvicola rossastra ha mostrato ampie oscillazioni nei tre siti, in parte da ricollegare a una produzione eccezionale di ghiande nell'autunno 2003 e a un decremento di *A. flavicollis* (specie dominante) nel 2004, che hanno determinato due anni consecutivi (2004-05) di rA elevate per *C. glareolus*. Nel complesso, i valori di rA sono risultati maggiori nel biotopo più diversificato, così come anche la massa corporea degli adulti, in particolare delle femmine. La produzione di semi del 2003 ha anche influito significativamente sul peso degli individui dell'anno successivo. Nell'inverno 2004-05 è stato registrato un forte impatto dell'arvicola nelle aree di riforestazione. La stima predittiva dell'abbondanza della specie basata su monitoraggi periodici può rappresentare un'azione efficace di prevenzione.

Parole chiave: arvicola rossastra, *Clethrionomys glareolus*, ambiente rurale, dinamica di popolazione, disponibilità trofica.

INTRODUCTION

Populations of widely distributed species living in different environments can exhibit different demographic parameters in relation to the ecological characteristics of habitats. The bank vole *Clethrionomys glareolus* uses a variety of habitats and faces different environmental conditions throughout its geographical range (Zejda, 1973, 1976; Montgomery, 1979; Dudich and Štollman, 1983; Petrusewicz, 1983; Alibhai and Gipps, 1985; Gurnell, 1985; Májsky, 1985; Flowerdew, 1987; Gliwicz, 1988; Mazurkiewicz and Rajska–Jurgiel, 1989; Mazurkiewicz, 1991; Pucek *et al*., 1993; Krištofík, 1999). The species is found in all forest habitats, preferring ground plant cover (Petrusewicz, 1983). Bank vole populations exhibit annual cycles. The lowest population level is usually shown in spring, then the reproduction period starts and populations grow through summer, reaching their highest level in autumn with the appearance of tree seeds. In years when oaks or other trees shed masses of seeds in autumn and winter, the extra food improves winter survival of rodents and can even cause winter breeding (Zejda, 1962; Andrzejewski, 1975). During the following spring and summer, rodents make use of both stored seeds and fresh vegetation and populations increase in numbers. As a result, high densities are recorded in autumn, the year after a large seed fall (Holišová, 1971; Flowerdew, 1973; Flowerdew and Gardner, 1978; Jensen, 1982; Jedrzejewska *et al.,* 2004). In the present study we compare some demographic parameters (abundance, sex ratio, breeding activity and body mass) between three populations of *C. glareolus* inhabiting different forest habitats which differ in food supply.

STUDY AREA AND METHODS

The material was obtained in the years 2002 to 2005 from three study sites, consisting of large forest complexes, isolated within the intensively managed landscape of South Moravia (Czech Republic). The sites are characterized by different degrees of intensity to which they are exploited by people, and by different forest types. Horní les“ (HL) site (120 ha) is an old seminatural forest with dominance of oak. Hájek“ (HJ) site (60 ha) is a typical production broad leaved forest with prevalence of oak and black locust. Rumunská“ (RB) site (280 ha) is used as an intensive pheasantry and is characterized by several forest plots of various tree species of different age with permanent supplementary food for pheasants and roe deer. In each site food availability was assessed two times per year in September and November evaluating the mean crop of acorns (g/m^2) on ten 0.5 m^2 plots. Traditional line trapping was applied (Pelikán, 1976). Snap traps were baited with a wick fried in flour and fat. Animals were trapped five times a year for three consecutive trap-nights. Traps were evenly spaced in lines (20 traps in 100 m). In HL and HJ, 5 lines were laid, whilst in RB, 8 lines were placed. The relative abundance of *C. glareolus* (rA) was expressed as number of individuals trapped per number of trap-nights. All the trapped small mammals were classified according to the species, body size, sex, and sex condition. Vole abundance in different sites and years was compared by ANOVA test. Body mass variation was compared by the t-test, considering only adults showing sexual activity. The same test was used for

comparing the abundance of acorns among the sites.

RESULTS AND DISCUSSION

During 20 trapping periods (20150 trap nights), 442 bank voles out of 2112 small mammals (20.9%) were recorded Trapped individuals included also *Apodemus flavicollis* (N = 1107), *A. sylvaticus* (N = 376), *A. microps* (N = 5), *Microtus arvalis* (N = 140), *M. subterraneus* (N = 5), *Mus musculus* (N = 3), *Sorex araneus* (N = 7), *Crocidura leucodon* (N = 3) and *C. suaveolens* (N = 1).

In HL site the amount of acorns (208 g/m^2, SD = 78.00) was higher than that recorded in the other sites (HJ: 100 g/m^2, SD = 10.99, t = 4.29, P = 0.002 RB: 69 g/m^2, SD = 18.93, t = 4.95, P = 0.0008). In addition, the availability of acorns differed between RB and HJ sites (t = 3.69, P = 0.005).

Bank vole abundance fluctuated markedly in number during the four years of study and in 2003 seemed to be influenced by a great acorn harvest (Fig. 1).

The mean annual relative abundance of bank voles for the RB site (rA_{RB} = 2.58 ± 2.97), where supplementary food for game was also available, was higher than that recorded in the other sites (rA_{HL} = 2.21 ± 2.37, F = 7.363, P = 0.003; rA_{HJ} = 1.64 ± 2.65, F = 5.48, P = 0.009). The same result was found comparing the rA between HL site and HJ site (F = 4.71, P = 0.018).

According to Watts (1970) and Flowerdew (1973), food quality seems to influence the amplitude of rodent fluctuations in numbers but not their decline. Also inter-specific relations (i.e. the influence of dominant small mammal species) can limit the population size. This occurred in the RB site, where the high variety of microhabitats and extra food seemed to

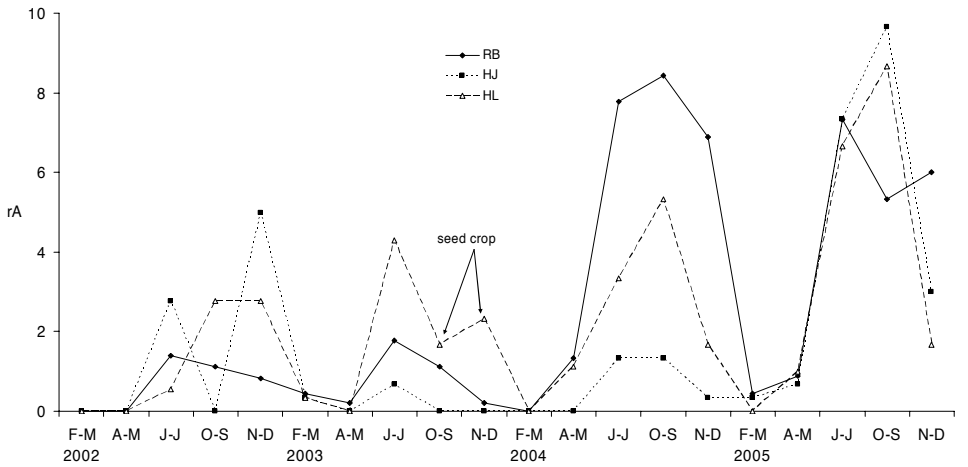

Figure 1 - Variation of the relative abundance (rA) of bank voles in three isolated forest complexes from 2002 to 2005.

limit the competition between the bank vole and *A. flavicollis*, the dominant species (Tamarin, 1983; Suchomel and Heroldová, 2006). Bank vole abundance was lower in the HL site, a lowland forest offering the highest biomass of herb stratum, which is the most suitable food supply for this species (Andrzejewski and Mazurkiewicz, 1976; Cole and Batzli, 1978; Flowerdew and Gardner, 1978; Petrusewicz, 1983). It was probably due to the presence of a high population density of *A. flavicollis* (rA = 5.33). The preference of bank voles for dicotyledonous herb species could have determined the lowest abundance of *C. glareolus* in the HJ site, a typical production forest with mostly grasses in the herb stratum.

Autumn prolonged breeding (progradation phase) in 2004, a consequence of extra seed crop in 2003, and probable niche vacation (*A. flavicollis* numbers lowered to rA = 1.38) were the reasons of a second year (gradation phase 2005) of high vole abundance (Fig. 1).

The number of sexually active females and body mass are thought to indicate habitat quality (Petrusewicz, 1983). Comparing bank vole sexual activity in the three sites, the highest value was at the HL site (57% of active females) and the lowest in the RB site (48%). These values were not significantly different ($t = 0.579$, $p = 0.566$). Sex ratio was almost balanced in RB and HL but slightly shifted to male dominance (59%) in HJ.

The mean body mass of adult individuals varied from 24.76 ± 3.53 g in the HJ site to 25.6 ± 4.11 g in the RB site and 25.77 ± 3.66 g in the HL site. Nevertheless no significant difference was found (HJ *vs* RB: $t = -1.07$, $P = 0.29$; HL *vs* RB: $t = 0.36$, $P = 0.72$; HL *vs* HJ: $t = 1.34$, $P = 0.18$). Comparing the mean weight between sexes (sexually active individuals only) for each site (RB: ♂ 24.6 ± 3.0 g, ♀ 26.7 ± 4.8 g; HJ: ♂ 23.8 ± 2.53 g, ♀ 25.4 ± 3.9 g; HL: ♂ 24.6 ± 2.63 g, ♀ 26.5 ± 3.99 g), only in the RB site were the females significantly heavier than males ($t = 2.83$, $P = 0.0054$). Comparing years before and after a large seed fall (2003-2004), difference in body weight was significant ($t = -2.487$; $P = 0.0138$).

A strong impact on forest regeneration was found in southern Moravian forests by bank voles gnawing the stems of young tree specimens. In controlled forests, 40% of young oak plantings were damaged to a certain extent after winter 2004/2005 but no impact was reported in winter 2005/2006. A sound prediction of population densities by species monitoring and early plantation protection (Hansson, 1988) seem to be the only effective prevention against damage.

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