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RELATION BETWEEN BODY MASS AND HOME RANGE SIZE OF SMALL MAMMALS

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ABSTRACT. Relation between body mass and home range size (HRS) was studied in two small mammals' species *Clethryonomys glareolus* and *Apodemus sylvsticus* inhabiting the same habitat. The relation between HRS and the body mass of individuals of both species is thought to be regression expressed in the following way: $\log y = a + b * \log x$. The regression equations for both sexes and different age groups during the period of investigation were worked out. Analysis of equation coefficients revealed indirectly the influence of *Apodemus flavicollis* on territorial behavior of *Clethrionomys glareolus*.

KEY WORDS. body mass, home range size, Apodemus flavicollis, Clethrionomys glareolus

INTRODUCTION

Home range is the area normally traversed by an individual animal or group of animals during activities associated with feeding, resting, reproduction and shelter-seeking (Burt, 1943). The home range size (HRS) in mammals depends not only on sex, age, habitat productivity, type of food eaten but on body mass of an individual animal, i.e. on its energetic requirements (McNab, 1963; Korn, 1986; Harestad, Bunnell, 1979; Kelt, Van Vuren, 2001; Schmidt *et al.*, 2002).

McNab (1963) demonstrated the relation between the HRS and animals body mass in 36 mammals' species. According to the type of the food and the way of feeding he divided the mammals into two groups: „croppers" (grazers or browsers, which don't need to hunt for its food) and „hunters" (granivorous, frugivorous, insectivorous, or carnivorous species, which have to hunt for its food). The „hunters" have HRS four times larger than the „croppers" with the same body mass. Voles are usually „croppers" and mice are „hunters".

Home range size (A) varied as a power of body mass (w) which did not differ statistically from the relationship between animal's' body mass and basal metabolic rate (McNab, 1963; Attuquayefio *et al.*, 1986)

$$A=a*w^b$$

Energetic requirements as well as the way of life of small mammals vary through different seasons and the home range size changes too. Another factor determining HRS of individuals of single species could be the presence of another species inhabiting the same biotope (Atanassov, Koshev, 2004).

The objective of the present study is to find the type of relation between body mass and home range size in two small mammals' species (*Clethryonomys glareolus* and *Apodemus sylvsticus*) inhabiting the same biotope and the changes in this relationship with the season and individuals' age.

MATERIAL AND METODS

The investigations were carried out during the period of 1981 – 1983 (from April to October) in a „Beglika" reserve (Western Rhodopes). The study area was situated in a plant community of spruce and whortleberry *(Piceetum myrtillosum)*. The Davis (1956) CMR method was used. The live traps were situated in 10 lines (10 traps in each line at intervals of 15 m) and formed a grid (150 – 150 m) with a total area 2,25 ha. The total number of caught animals was 243 belonging to the dominant species: 149 bank vole (*Clethrionomys glareolus* Schr.) individuals and 94 yellow-necked mouse (*Apodemus flavicollis* Melch.) individuals. The species, sex, weight (with maximum standard deviation of 0.1g) and the breeding activity of each individual were determined and the animals were divided into two age groups: mature breeding adults and non-breeding subadultus. The statistical analysis of the data collected during the field investigations and the computing of home range size (HRS) and spatial distributions are processed by means of original software (Atanassov, Koshev, 2004). The minimal method was used for computing the HRS (Nikitina, 1965).

Several types of regression functions describing the relation between HRS and animal's body mass were analyzed. The best correspondence between empirical and theoretical data showed the function

$$\log y = a + b*\log x$$

where y (dependent variable) is the HRS in m^2 and x (independent variable) is the animal's body mass in g.

The equations were calculated separately for the both age groups of males and females of each species in each season. Differences between the regression equations were tested by F-test of the coefficient b (curve slope). The curve slope is an important parameter in the regression analysis although being very difficult to interpret from biological point of view (Sokal, Rolf, 1969).

RESULTS AND DISCUSSION

Parameters and statistical indices of the regression equations for the different age groups in the three years of study are presented in Tables 1 and 2. The coefficients *a* and *b* depend on species, sex, etc., and are strictly specific. The values of coefficient of determination (r^2) show that there is positive correlation between the individual's mass and their HRS in all groups. Variation analysis of the regression model reveals high level of significance in the biggest part of the groups. Almost all values of F are higher than critical ones showing that grate and statistically significant part of variance of *y* (HRS) could be explained through regression on *x* (individual's body mass).

Comparison between the regression equations in *Clethrionomys glareolus* revealed significant differences in the pattern of relation between HRS and body mass in adult males in summer of 1981 and summer of 1982 (F=33.53, df=1,8) and in summer of 1981 and summer of 1983 (F=31.65, df=1,9). The slope of the curve for the summer of 1981 was much steeper than the slopes of the other two curves (1982 and 1983) and reflected the more intensive using of territory by males (fig. 1). In 1981 the population of *Clethrionomys glareolus* increased its numbers (Atanassov, Koshev, 2004) and individuals with smaller body mass could occupy larger home ranges. In 1982 both the population numbers of bank vole reached peak values and the second dominant species (yellow-necked wood mouse) appeared influencing the possibilities for using the territory inhabited together. The equation describing the relation between HRS and body mass had slighter slope (*b*=3.55) indicating that there were smaller differences between HRS of individuals with different body masses.

In 1983 although the second dominant species (*Apodemus flavicollis*) withdrew, bank vole population didn't reach the level of territory using observed in 1981. The slope of the curve (*b*=2.65) was the slightest for the whole period of investigation and reflected the relation between the HRS and body mass in the period of high drop in numbers.

Significant differences were found while comparing the regression coefficients in subadult males in summer of 1982 and summer of 1983 (F=21.7; df=1,5), the slope of the curve for 1983 being steeper (fig. 2). This age group participates actively in population dispersal. When the yellow-necked wood mouse withdrew in 1983, subadult and younger bank vole males became in position to occupy easily favorable patches and increase in HRS of individuals with smaller body mass was observed.

In *Apodemus flavicollis* significant differences between the compared regression equations were found only in subadult females in summer and autumn of 1982 (F=9.47; df=1,6), the slope of the curve being steeper in autumn (fig. 3).

This feature reflects the fact that subadult females use more intensively the available territorial resources in autumn thus providing successful wintering. The role they play in reproductive process is extremely important in the beginning of the next vegetation period and so their survival during the winter is essential to the population.

In order to compare the strategy of both studied species (*Clethrionomys glareolus* and *Apodemus flavicollis*) in getting possession of the territory, the regression equations of separate age groups were compared by seasons in 1982, when both species inhabit together the plot. The difference in the curve slopes found between bank vole and yellow-necked wood mouse subadult males in the summer proves that *Apodemus flavicollis* occupy the territory more intensively than *Clethrionomys glareolus* (fig. 4). This reflects the biological features of granivorous species (mice) in the process of movement of population. The drawing shows that when entering in large numbers into the plot, *Apodemus flavicollis* influences the territorial behavior of the cropper *Clethrionomys glareolus*.

CONCLUSIONS

The type of the equation describing the regression relationship between HRS and animal's body mass in both species *Apodemus flavicollis* and *Clethrionomys glareolus* was found ($\log y = a + b*\log x$). Separate regression equations for each sex and different age groups in years with different population density were worked out. Analysis of the differences in the coefficients of the deduced regression equations revealed that it indirectly reflects the influence of *Apodemus flavicollis* on the territorial behavior of *Clethrionomys glareolus*.

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Table 1. Parameters (*a, b*) of the regression equation log*y*=*a*+*b**log*x*, coefficient of determination (r^2) and residual sum of squares (d^2xy) in *Clethrionomys glareolus*. M – male, F – female, Ad – adultus, Sad – subadultus

Year	Group	a	b	d^2xy	r^2	F
1981	M Ad summer	-6.954	7.476	0.023	0.962	125.9*
1982	M Ad summer	-2.442	3.549	0.006	0.986	207.9*
	M Sad summer	0.826	1.362	0.0004	0.968	59.6*
	F Sad summer	-3.490	4.560	0.003	0.972	34.6
	F Sad autumn	-10.414	10.032	0.0003	0.992	124.9
	F Ad autumn	0.890	1.204	0.0026	0.768	6.63
1983	M Ad summer	-0.623	2.651	0.037	0.933	55.8*
	M Ad autumn	0.423	1.792	0.005	0.791	15.1*
	F Ad summer	-0.665	2.534	0.031	0.637	5.27
	F Ad autumn	-12.502	10.849	0.001	0.971	68.3*
	M Sad summer	-1.749	3.442	0.010	0.927	25.5*

F-values marked with asterisk are significant at p>0.05 and corresponding degrees of freedom.

Table 2. Parameters (*a, b*) of the regression equation log*y*=*a*+*b**log*x*, coefficient of determination (r^2) and residual sum of squares (d^2xy) in *Apodemus flavicollis*. M – male, F – female, Ad – adultus, Sad – subadultus

Year	Group	a	b	d^2xy	r^2	F
1982	M Ad summer	-5.65	5.70	0.233	0.5937	14.6*
	M Ad autumn	-2.76	3.68	0.086	0.606	10.8*
	M Sad summer	-16.17	13.64	0.096	0.616	4.8
	F Ad summer	-9.024	7.93	0.076	0.729	13.5*
	F Ad autumn	0.21	2.24	0.067	0.618	3.24
	F Sad summer	-8.87	8.148	0.015	0.846	16.5*
	F Sad autumn	-24.10	19.16	0.026	0.93	39.4*

F-values marked with asterisk are significant at p>0.05 and corresponding degrees of freedom.

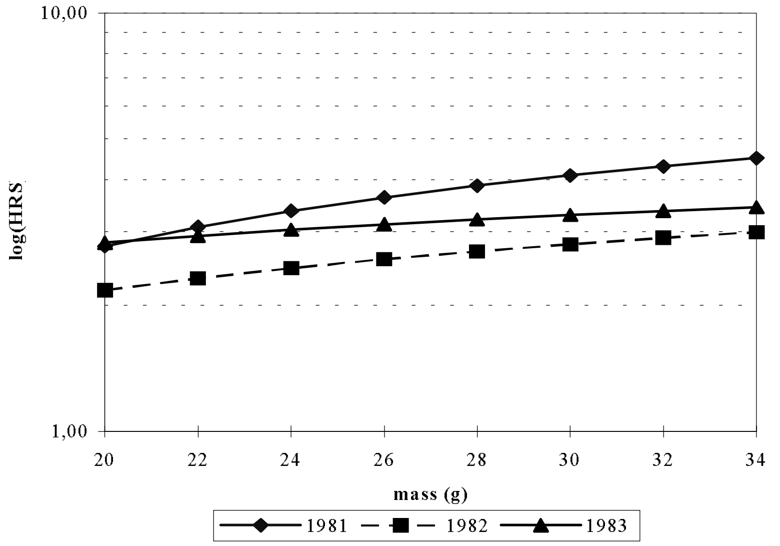

Fig. 1. *Regression curves of HRS on body mass of adult males of Clethrionomys glareolus in 1981, 1982 and 1983*

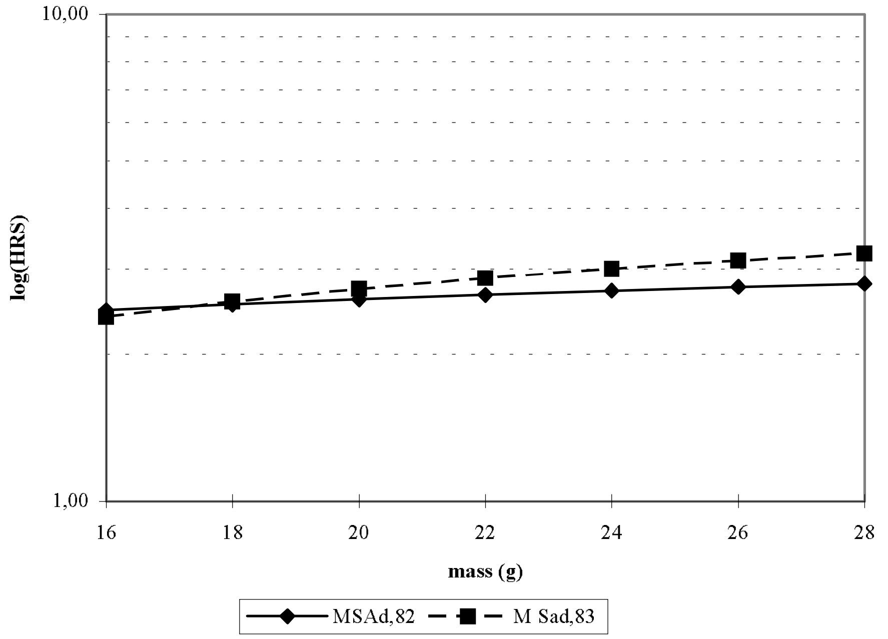

Fig. 2. *Regression curves of HRS on body mass of subadult males of Clethrionomys glareolus in summer of 1982 and summer of 1983*

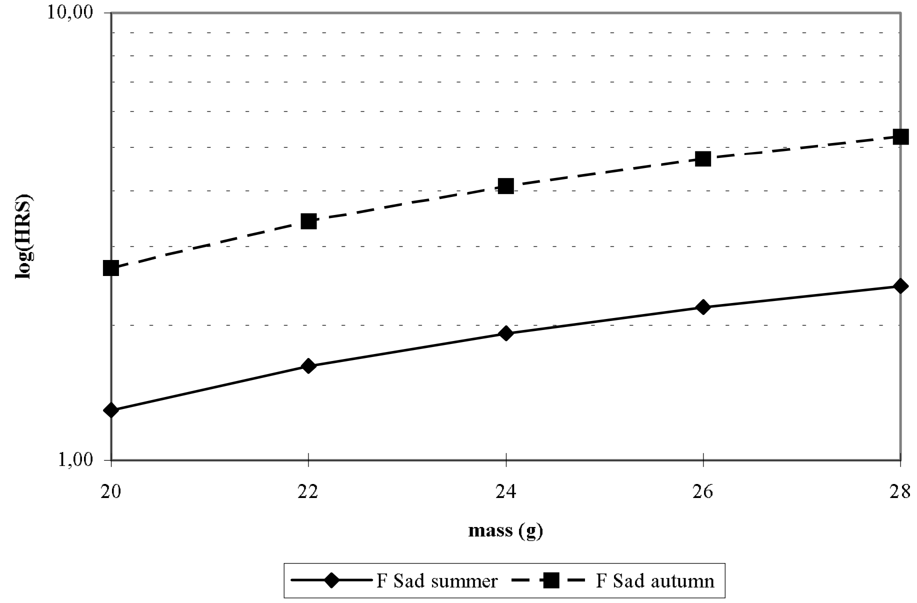

Fig. 3. *Regression curves of HRS on body mass of subadult females Apodemus flavicollis in summer and autumn of 1982*

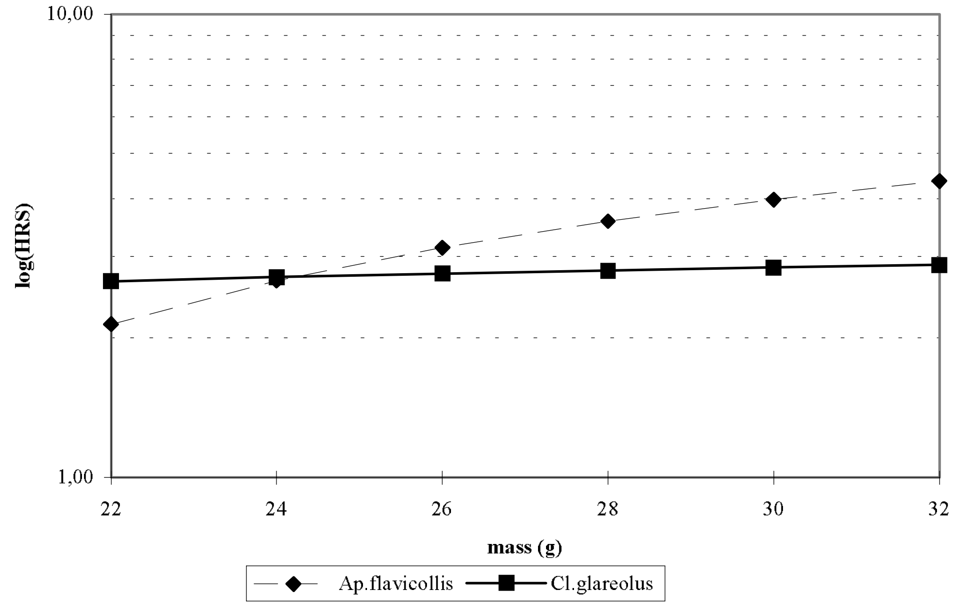

Fig. 4. *Regression curves of HRS on body mass of subadult males of Apodemus flavicollis and Clethrionomys glareolus*