

**Factors affecting home range size and overlap in  
*Akodon azarae* (Muridae: Sigmodontinae)  
in natural pasture of Argentina**

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Differences in home range size in relation to sex, age, breeding and non-breeding periods were studied. Home range size and overlap were examined at different densities values in populations of *Akodon azarae* (Fischer, 1829) on railway banks in southern Córdoba Province (Argentina). The sampling was carried out between October 1994, and February 1997, using the capture-mark-recapture method. Home range size in *A. azarae* was determined by sex and breeding period, and it was independent of the observed density values. Home range size of males was always larger than that of females. Increase of population density during the breeding period affected the degree of intersexual overlap of home range.

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**Introduction**

Home range size can vary within a species due to differences in the quality of habitat, distribution and abundance of food, or population density (Hixon 1980, Ostfeld 1985, Wolff 1985). For example, home range in *Peromyscus leucopus* and *Peromyscus maniculatus* was smaller in bushy, favorable habitats than in more open, less favorable habitats (Metzgar 1971, Van Horne 1982). Access to additional food supply resulted in a significant reduction of home range size in *Microtus townsendii* (Taitt and Krebs 1981) and in *Peromyscus maniculatus* (Taitt 1981). On the other hand, the effect of density on home range size is less clear. In some cases, high densities caused a reduction in home range size and/or an increase in the degree of overlap of home range (Getz 1961, Taitt 1981, Ostfeld *et al.* 1985, Ostfeld 1986, Erlinge *et al.* 1990); in other cases, home range size was independent of population density (Batzli 1968, Bondrup-Nielsen 1986). Home range size is also affected by sex, age and social condition (Mazurkiewicz 1971, Maza *et al.* 1973, Webster and Brooks 1981). In rodents, movement is likely to be limited by

breeding activity (Ostfeld 1985, Erlinge *et al.* 1990). So, in polygynous mating systems, males show larger home ranges than females because they are subjected to sexual selection favoring mating with a greater number of females (Madison 1978, 1980, Ostfeld 1985). On the other hand, social condition plays a significant role in space use because the presence of dominant animals affects the subordinate ones, inhibiting their movements or stimulating their emigration (Bujalska 1973, Myton 1974).

In this study, we provide information about spacing behaviour of *Akodon azarae* (Fischer, 1829), one of the most abundant species living in the agroecosystems of southern Córdoba Province (Argentina) (Priotto and Polop 1997), and discuss: (1) the differences in home range size, in relation to sexes, ages, breeding and non-breeding periods; and (2) home range size and overlap according to sexes, breeding and non-breeding periods in relation to population densities.

### Material and methods

The study was carried out in Chucul (64°20'09"W, 32°21'06"S), Río Cuarto Department, Córdoba Province, Argentina. Phytogeographically, this region corresponds to "Provincia del Espinal" "Distrito del Algarrobo" (Cabrera 1953), which is a plain at a low elevation (600–900 m) with vegetation dominated by algarrobo (*Prosopis alba*, *P. nigra*), accompanied by quebracho blanco (*Aspidosperma quebracho blanco*), mistol (*Zizyphus mistol*) and itin (*Portulaca kuntzie*). The vegetation of the study site, however, has undergone marked alterations as a result of agriculture and cattle farming. At present, the landscape consists mainly of individual cropfields, surrounded by wire fences with borders dominated by weedy species. In the area, the railway banks are an environment where some rodent populations reach high densities. This plant community is characterised by pasture interspersed with bushes, and was selected for sampling. Despite the influence of nearby crop fields, it bears some resemblance to indigenous vegetation. This community, with a homogeneous plant cover of about 85% throughout the year, is composed mainly of *Diploaxis tenuifolia*, *Sorghum halepense*, *Iresine difusa*, *Conium maculatum*, *Setaria geniculata* and *Lippia turbinata*, and has a high availability of seeds in soil (A. Previtali pers. comm.).

Rodents were caught in October 1994 through February 1997, in traps arranged in a grid of 6 × 10 traps (37.5 m × 67.5 m) with an interstation interval of 7.5 m. One Sherman live trap, placed at each station, was baited with a mixture of peanut butter and cow fat. Monthly censuses (trapping sessions) were taken in periods of 10 successive days. Traps were checked daily in the morning.

Trapped animals were weighed and marked with a numerical code in the ears. Sex and reproductive state (males: scrotal or abdominal testicles, females: perforated or imperforated vagina, nipples visible or not) were also recorded. Each captured animal was assigned to the category of juvenile or adult according to Crespo *et al.* (1970). Individuals weighting 12–21 g were considered "Juvenile" and individuals with body weights between 22–31 g were considered "Adult".

Data were analysed by considering separately the non-breeding period (May to August) and the breeding period (September to April). This division was based on the fact that between May and August 100% of the males and females did not present breeding activity (abdominal testicles and imperforated vagina respectively), whereas, between September and April, a large proportion of males (96.56%) and females (86.21%) became reproductive (scrotal testicles and perforated vagina, nipples visible and evidence of pregnancy respectively).

Population size was estimated by computing the minimum number of animals known alive (MNKA) (Krebs 1966). For the analysis of home range size in relation to different values of population

density, these were divided into low-density (MNKA < 10 and MNKA < 20 for breeding and non-breeding periods respectively) and high-density (MNKA > 10 and MNKA > 20 for breeding and non-breeding periods respectively). This division of low- and high-density was based on values of abundance of *A. azarae* observed by Priotto and Polop (1997), from April 1990 throughout February 1995, at the same location of this study.

Monthly home range size configuration was obtained by means of the Boundary Strip Method (Stickel 1954), and area was determined by the method suggested by Calhoun and Casby (1958). The number of captures for each home range estimate varied from 5 to 8.

Home range overlap was estimated for each animal in each trapping session. We calculated proportional overlap by measuring the area in each home range (the target animal) that was shared by all other animals of the same sex (intrasexual overlap) or all other animals of the opposite sex (intersexual overlap) and dividing by the area of the target animals home range. The authors assume, as suggested by Batzli and Henttonen (1993), that home range overlap that is significantly lower than would be expected by random placement indicates that individuals are avoiding one another, and consider this evidence of territorial behaviour.

To analyze home range size in relation to sex, breeding period and population density, a three-factor ANOVA was made. The relationship between home range size and age (adults and juveniles) was also studied during the breeding period employing a one-factor ANOVA. In all cases, normality assumption was tested by the Kolmogorov-Smirnov test, and variance homogeneity was tested by the Bartlett's test.

## Results

From October 1994 to February 1997, a total of 270 *A. azarae* individuals (736 captures) were obtained during 12,000 night traps. In our population, mean abundances were minimal at the beginning of the breeding period, and maximum at the beginning of the non-breeding period, with variation within each period among the sampling years.

During the sampled years, 83 home ranges were estimated; 50 during the breeding period (20 and 30 home ranges of males and females respectively) and 33 during the nonbreeding period (17 and 16 home ranges of males and females respectively). Males showed a minimal home range size of 98 m<sup>2</sup> and a maximum home range size of 857.5 m<sup>2</sup>; meanwhile, minimum and maximum home range size for females were 98 m<sup>2</sup> and 441 m<sup>2</sup> respectively. This wide scattering of home range sizes generated non-homogeneous variances ( $p < 0.05$ ), with a normal distribution of data ( $p > 0.05$ ). In order to accomplish the assumption of variance homogeneity of ANOVA, it was necessary to employ a logarithmic transformation of the response variables (home range size). All animals which established home range during the breeding period were sexually mature.

The number of observations ( $n$ ), average values and their standard deviations of home range size by sex, sampling period and population density are shown in Table 1. Home range size of males was larger than that of females ( $F = 18.20$ ,  $df = 1, 75$ ,  $p < 0.05$ ), either in the breeding period or the non-breeding period, and at high or low densities. Home range size also varied between sampling periods, and it was larger in the breeding period ( $F = 4.02$ ,  $df = 1, 75$ ,  $p < 0.05$ ). This was mainly observed in males, since home range size of females was almost constant

Table 1. Average values of home range size in *Akodon azarae* according to sex, sampling period and population density on railway banks (Río Cuarto, Córdoba, Argentina).

Density	Home range size (m <sup>2</sup> )			
	Males		Females	
	<i>n</i>	$\bar{x} \pm SD$	<i>n</i>	$\bar{x} \pm SD$
	Breeding period			
High	9	428 ± 165	18	284 ± 78
Low	11	497 ± 202	12	251 ± 82
	Non-breeding period			
High	12	402 ± 176	5	225 ± 94
Low	5	300 ± 65	11	278 ± 99

throughout the study (Table 1). No significant differences in home range size were observed between high and low population densities ( $F = 0.001$ ,  $df = 1, 75$ ,  $p > 0.05$ ). First-order and second-order interactions were not statistically significant ( $p > 0.05$ ) and indicated independence between the studied factors (sex, breeding period and population density).

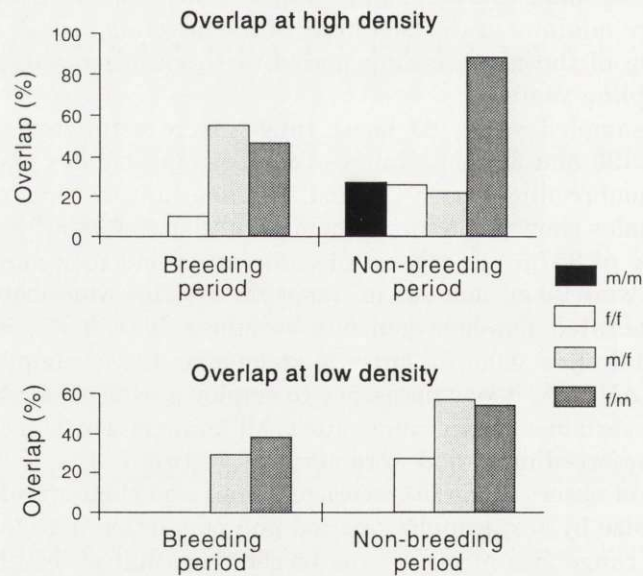


Fig. 1. Percentages of home range overlap in *Akodon azarae* at high and low population densities during the breeding period and the non-breeding period on railway banks (Río Cuarto, Córdoba, Argentina). Intrasexual overlap: m/m and f/f. Intersexual overlap: m/f and f/m. (m – males, f – females).

The study of age in relation to home range size was made only in the breeding period because both juvenile and adult animals were present. Adults showed an average home range size ( $\pm$  SD) of  $450.67 \pm 168.27 \text{ m}^2$  and  $261.13 \pm 83.68 \text{ m}^2$  for males and females respectively; whereas for juveniles, home range size was  $488.13 \pm 218 \text{ m}^2$  for males and  $287.94 \pm 73.40 \text{ m}^2$  for females. To make the ANOVA, a logarithmic transformation of the data was needed. Home range size did not vary significantly between the two categories of studied ages ( $F = 0.83$ ,  $df = 1$ ,  $48$ ,  $p > 0.05$ ).

Average values for the percentage of home range overlap in each sampling period, at different density values are shown in Fig. 1. Overlap between males was only observed in the non-breeding period at high density values; whereas overlap between females was dependent on breeding period and independent of the observed abundance values. Breeding females overlapped slightly at high densities (10%) but not at all when densities were low. The highest overlap values observed were intersexual (m/f, f/m), recording similar values (home range utilization between males and females) both in the breeding period (at different density values) and the non-breeding period (at low density). However, in the non-breeding period and at high density, females utilized a significant percentage of male home range (87%), whereas males used only 22% of the female home range.

## Discussion

According to our results, home range size in *A. azarae* was determined by sex and breeding period, and was independent of population abundance. Even though home range size of males was always larger than that of females, this was more evident in the breeding period. Female home ranges in the breeding period represented 58% of the home range area of males; whereas, in the non-breeding period, home range size of females represented 72% of the male area. These sexual differences in home range size are considered a typical feature of rodent species with a promiscuous/polygynous mating system (Gaulin and FitzGerald 1988). In males spacing behaviour is strongly influenced by mate search; whereas in females food distribution and abundance are most important (Emlen and Oring 1977, Ostfeld 1985, 1986, Ostfeld *et al.* 1985). This mating system in *A. azarae* was suggested by Zuleta and Bilenca (1992).

At high densities, in numerous rodent species, a reduction of home range size in both sexes (Getz 1961, Ostfeld 1986, Erlinge *et al.* 1990) or in one of them (Bondrup-Nielsen 1986, Urayama 1995) has been observed. In *A. azarae*, as was reported by Batzli (1968) for *Microtus californicus*, density did not affect home range size of males or females. Nevertheless, intersexual overlap did increase at high densities. In the breeding period, when males showed territorial behaviour, the degree of overlap in home ranges with that of females was nearly doubled (Fig. 1). Considering that home range overlap of females with males did not change,

male behaviour could be due to the fact that an increase of density would result in an enlarged number of contacts with reproductive females, ie, the resource of interest would increase. This, in an environment with available reproductive spaces (Heske and Bondrup-Nielsen 1990). In this study, at high densities, the environment allowed the establishment of six new breeding spaces (reproductive females) (Table 1). In the non-breeding period, differences observed in the intersexual overlap in relation to density could not be explained in terms of the spacing behaviour. This is because in that period, as recorded by Ostfeld (1985) and Erlinge *et al.* (1990) in other rodent populations, a loss of male and female territoriality was observed. This allows an analysis of intersexual overlap as a whole, with no distinction between home range overlap of males over females vs. females over males.

Unlike that observed by Mikesic and Drickamer (1992) in *Mus musculus domesticus* and that suggested by Brown (1953), we did not find any differences in home range size between adult and juvenile individuals of *A. azarae*. This could be due to the fact that in our study, animals which established home ranges were reproductively active, in spite of being classified as juveniles by their weights.

We conclude that differences in home range size in *A. azarae* are determined by sex and breeding period, and that increase of population density does not influence home range size, but it does affect the degree of intersexual overlap in the breeding period.

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