

## Space Use in Two Rodent Species (*Abrothrix xanthorhinus* and *Eligmodontia morgani*) in North-Western Patagonia

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### ABSTRACT

The home range of two rodent species inhabiting the ecotonal steppe in North-Western Patagonia was studied. Significant differences were found between home range size and overlap of *Abrothrix xanthorhinus* males and females, according to their reproductive condition. These results suggest that *Abrothrix xanthorhinus* might be polygynous or promiscuous. In contrast, in *Eligmodontia morgani*, no difference was found between the home range size of males and females, irrespective of their reproductive condition. Differential space use may occur in both sigmodontine rodents which may be important as sigmodontine species are Hantavirus reservoirs in the Patagonian steppe.

*Key Words:* Home range, Semi-arid steppe, Patagonia, Hantavirus, Sigmodontine rodents, Argentina.

### INTRODUCTION

The home range of two typical steppe rodent species: *Abrothrix xanthorhinus* and *Eligmodontia morgani* has been studied in North-Western Patagonia, Argentina. Home range reflects the movements of an individual during its normal activities of food gathering, mating, and caring for the young (Burt 1943). The manner in which individuals react to their habitat and to each other, strongly influences home range characteristics. Several authors, who have discussed home range size in vertebrates, have reported differences between adults and juveniles, males and females, as well as seasonal's (Mares et al. 1980, 1982). In addition to home range size, overlap among home ranges is important, both of which could be related to reproductive adaptation (Swihart and Slade 1989). Gaulin and Fitzgerald (1986, 1988) have hypothesised that, in populations characterised by promiscuous or polygynous mating systems, home ranges of males are typically larger than those of females. On the other hand, in monogamous species home range size of both sexes is usually similar and strongly overlapping during the breeding season. The above mentioned authors have suggested that, if divergent reproductive adaptations lead to differences in patterns of movements by the two sexes, home range size could be used as a first approach to knowing the mating system of a species.

In North-Western Patagonia, a semi-arid steppe

lies between the Andean forest and the eastern desert. Several rodent species co-exist in this habitat, where *Abrothrix xanthorhinus* and *Eligmodontia morgani* (Muridae sp) are among the most abundant (Guthmann et al. 1997, Lozada and Guthmann, 1998). *Abrothrix xanthorhinus* is a small (15-20 g) omnivorous semi-diurnal rodent and *Eligmodontia morgani* is granivorous and nocturnal (17-20 g). The life span of both species is less than one year (Guthmann et al. 1997).

Most of the previous ecological studies of *Abrothrix xanthorhinus* and *Eligmodontia morgani* have concentrated on descriptions of their natural history, usually as part of a larger study of mammalian communities in the region (Pearson et al. 1987, Lozada et al. 1996, Kelt 1994, 1996, Guthmann et al. 1997). Home range has not been studied in *Eligmodontia morgani* and preliminary estimates of home range in *Abrothrix xanthorhinus* were based on few data (Heinemann et al. 1995).

Hantavirus Pulmonary Syndrome, transmitted by sigmodontine rodents, has been detected recently in this region (Guthmann et al. 1997, Cantoni et al. 1997). The results of the present study might become useful in understanding how these two potential Hantavirus vectors utilise the NW Patagonian habitat.

Our study describes the intraspecific variation in both rodent species along with their home range size, overlapping pattern, and home range dynamics in relation to reproductive season. It also compares home range size of *Abrothrix xanthorhinus* and *Eligmodontia*

*morgani*. The obtained results might enable us to suggest the mating system and territorial behaviour, which are still unknown for both species. This work is based on a long term live-trapping study conducted over a period of 4 years.

## MATERIALS AND METHODS

### Study Area

The study site is a semi-arid steppe located in a flat area, 8 km east of Bariloche, Patagonia, Argentina (41°S, 71°W). The vegetation consists of patches of xerophyllous cushion plants (*Acaena splendens*), low grass (*Stipa speciosa*), and scarce bushes (Ghermandi 1997). The region receives strong westerly winds and has a mean annual temperature of 8.0°C, a mean maximum temperature of 14.1°C, and a mean minimum temperature of 2.4°C. The mean annual precipitation is 800 mm and it is concentrated in autumn and winter (March to September) (Bariloche Airport Meteorological Service). The combined increase in temperature and decrease in rainfall during spring and summer (October to February) cause a moderate hydric stress (Barros and Mattio 1977). The grid was located in an enclosure of one hectare of this region.

### Capture Methods

Rodents were sampled monthly from March 1991 to November 1994 on a 10 × 10 Sherman trap grid with a 10 m inter-station distance. In each trapping session, traps were set on four consecutive days, were baited with rolled oats and checked each morning. Species were determined following Monjeau et al. (1994). Captured individuals were released near the trap after being marked (by toe clipping). We recorded capture-trap coordinates, species, sex and sexual condition, distinguishing three sexual categories: subadults, reproductive adults, and non-reproductive adults.

Individuals that weighed less than 12 g for *Abrothrix xanthorhinus* and less than 16 g for *Eligmodontia morgani* were considered subadults. However, larger sexually immature individuals captured during the breeding season were also recorded as subadults. Non-reproductive adults were non-subadults captured during the non-breeding period (June to August). We consider reproductive adults as those rodents captured during the breeding season (September to May).

### Estimation of Home Range Area

The data used to estimate home range size correspond to eight sampling days distributed in two four-day periods twenty days apart. This type of sampling

method, as shown in previous studies, (e.g.: O'Farrell 1980, Erlinge et al. 1990) is used to obtain representative data of an entire month. Home range was studied in voles caught in at least two different trap stations, with at least three different captures, in two consecutive trapping months (Hayne 1949, Getz 1961, Desy et al. 1989, Urayama 1995).

Home range was estimated by means of Areography 2.0 software (Guasp et al. 1997). This program builds bi-dimensional maps based on the field data, applying the minimum convex polygon method (Southwood 1966) as a modification of the minimum area method. (Stickel 1954, Jennrich et al. 1969). This method is relatively simple and broadly used in these kind of studies (e.g., Mares et al. 1980, Bergstrom 1988). The activity radius was set at 5 meters, half the distance between trap-sites.

Each home range overlap was estimated for two individuals captured in the same month, to ensure comparisons within this time frame. We calculated home range, inter- and intra-sexual overlap under the same reproductive conditions. Comparisons among home range mean areas and overlapping areas were obtained by means of the t-test for independent samples and, when the sample sizes were too small the non-parametric statistic Mann-Whitney U-test was used, given that the data could not be transformed to meet the requirements of a normal distribution.

## RESULTS

### Home Range Area

For *Abrothrix xanthorhinus*, home range comparisons indicated that significant differences existed among male home ranges for all reproductive stages, i.e., reproductive males had larger home ranges than the non-reproductives ( $t = 2.89, p < 0.0049$ ) and subadults ( $t = 3.61, p < 0.0005$ ), while non-reproductive's males home ranges were larger than those of subadults ( $t = 2.69, p < 0.01$ ). However, comparisons among female home ranges showed that the only significant differences were found between reproductive and subadult females ( $t = 2.86, p < 0.005$ ). Intersexual comparisons showed that home ranges were of similar size for non-reproductive and subadult individuals, whereas reproductive males had larger home ranges than reproductive females ( $t = 4.14, p < 0.0001$ ) (Table 1).

For *Eligmodontia morgani*, home range comparisons indicated that non-significant differences were found between home ranges of reproductive males and non-reproductives males ( $z = -0.70, p = 0.48$ ), and between reproductive and subadult males ( $z = -1.27, p = 0.20$ ). Non-reproductive male home ranges were no different to those of subadults ( $z = -0.78, p = 0.43$ ). Moreover,

Table 1. *Abrothrix xanthorhinus* and *Eligmodontia morgani* mean home range areas and its standard error (SE) for each reproductive condition. Mean area values are expressed in square meters. SA indicates subadult individuals, NR non-reproductives and R reproductives. N indicates the number of individuals.

		<i>Abrothrix xanthorhinus</i>		<i>Eligmodontia morgani</i>	
		Mean ± SE	N	Mean ± SE (m <sup>2</sup> )	N
Females	SA	438 ± 35	44	437 ± 127	6
	NR	586 ± 79	19	636 ± 53	10
	R	616 ± 44	68	603 ± 54	12
Males	SA	423 ± 39	20	558 ± 106	5
	NR	600 ± 54	26	521 ± 64	15
	R	1061 ± 105	56	426 ± 82	6

comparisons among female home ranges showed that only non-significant differences were found among home ranges of the reproductive and the non-reproductive ( $z = -0.66, p = 0.508$ ), and between reproductive and subadult females ( $z = -1.78, p = 0.07$ ). Non-reproductive female home ranges were no different to those of subadults ( $z = -1.51, p = 0.13$ ). Intersexual comparisons showed that home ranges were not significantly different among the non-reproductive individuals ( $z = -1.66, p = 0.09$ ), among subadults ( $z = -0.82, p = 0.41$ ), and among reproductive individuals ( $z = -1.78, p = 0.07$ ) (Table 1).

When comparing *Abrothrix xanthorhinus* and *Eligmodontia morgani* home ranges, non-significant differences were found between subadult females ( $z = -0.34, p = 0.73$ ), subadult males ( $z = -1.68, p = 0.09$ ), non-reproductive females ( $z = -0.83, p = 0.41$ ), males ( $z =$

$-0.99, p = 0.32$ ) and reproductive females ( $z = -0.52, p = 0.60$ ). However, the home range area of *Abrothrix xanthorhinus* reproductive males was significantly larger than that of the corresponding *Eligmodontia morgani* ( $z = -2.55, p = 0.01$ ).

### Home Range Overlap

Comparisons of non-reproductive individuals of *Abrothrix xanthorhinus* indicate that home range overlap among males (M-M) was significantly larger than among females (F-F) ( $t = 3.55, p < 0.004$ ). During the breeding season, M-M home range overlap was significantly higher than between sexes (F-M) ( $t = 4.59, p < 0.00001$ ) and, in addition, this intersexual home range overlap was larger than among females (F-F) ( $t = 3.85, p < 0.006$ ). Finally, reproductive conditions indi-

Table 2. Mean home range overlap and its standard error (SE) of *Abrothrix xanthorhinus* for each pairwise interaction among sexes within reproductive and non-reproductive conditions, where: F-F stands for female-female interaction, F-M for female-male interaction and M-M for male-male interaction. N indicates the number of overlap cases. The column before the last shows the relative size overlap (absolute size of overlap/home range size). (F) indicates the relative overlap size referred to mean female home range size, whereas (M) indicates the relative overlap size referred to the mean male home range size.

Sexual Condition	Pairwise Comparison	Mean Overlap (±SE m <sup>2</sup> )	Relative Overlap (%)	N (Pairs)
Reproductives	F-F	152 ± 11	24.7	85
	F-M	234 ± 20	38.0 (F) 22.1 (M)	131
	M-M	369 ± 33	34.8	123
Non-Reproductives	F-F	243 ± 28	41.5	6
	F-M	192 ± 41	32.8 (F) 32.0 (M)	19
	M-M	102 ± 39	17.0	8

cate that reproductive females had a significantly smaller overlap than non-reproductives. In contrast, the

home range overlap of reproductive males was at least three times larger than that of non-reproductives ( $t = 2.23$ ,  $p < 0.027$ ) (Table 2).

Mean home range overlap in *Eligmodontia morgani* was estimated for reproductive and non-reproductive males and females. The mean home range overlap for females was 16 m<sup>2</sup> and 25 m<sup>2</sup>, for reproductive and non-reproductive respectively. For males, mean home range overlap was 5 m<sup>2</sup> and 45 m<sup>2</sup> for reproductive and non-reproductive respectively. The low number of overlapping cases in this species did not allow for statistical comparison.

## DISCUSSION

A differential space use pattern can be described for both steppe species *Abrothrix xanthorhinus* and *Eligmodontia morgani* as previously observed in microhabitat selection studies in North-Western Patagonia (Lozada et al. 2000). These tendencies might suggest differential reproductive adaptation, although further studies using more precise sampling methods such as radiotelemetry are needed to confirm this prediction.

Home ranges of adult males of *Abrothrix xanthorhinus* were significantly larger during the breeding season than during the non-reproductive season, whereas home ranges of adult females were of similar size throughout the year. Although male home ranges were almost twice as large as those of females during the reproductive season, home range areas of males and females were not significantly different during the non-reproductive period. These findings could be related to the hypothesis that larger male home range areas during the breeding season are primarily the result of reproductive behaviour which tends to maximise the number of contacts with potential mates. On the other hand, female home range size might be relatively unresponsive to transient reproductive events during the breeding season because females generally will be either producing offspring or gathering the necessary storage of resources to do so (Frank and Heske 1992).

Home ranges of male *Abrothrix xanthorhinus* during the breeding season showed extensive overlap with both adult females and neighbouring males. Given that the inter-sexual home range overlap was calculated for pairs, the degree of home range overlap could have been higher. In contrast, breeding females exhibited little intra-sexual home range overlap. These results suggest that *Abrothrix xanthorhinus* might be a polygynous possibly promiscuous, a social system common in small mammals (e.g., Ostfeld 1986, Gipps et al. 1985). Comparisons among home range overlap between groups of *Abrothrix xanthorhinus* under different reproductive conditions showed that female home range overlap decreases with sexual activity, suggesting

territorial behaviour during the breeding season. In contrast, home ranges of male *Abrothrix xanthorhinus* increased in size, as did the amount of home range overlap, during the reproductive season.

If the magnitude of the differences in home range size between sexes is proportional to the extent of effective polygyny, these sexual differences should disappear outside the breeding season. In our study, this happened as a result of a marked decrease in the size of male ranges. This is in accordance with the interpretation that this spacing behaviour is a reflection of male reproductive behaviour in non-monogamous microtines (Gaulin and Fitzgerald 1988). The seasonal changes in space-use patterns reported here for *Abrothrix xanthorhinus* are similar to those reported for polygynous or promiscuous species of other small mammals such as *Microtus pennsylvanicus* (Madison 1985).

In contrast, home range in *Eligmodontia morgani* did not vary with reproductive condition for either sex, or same-sex home range overlap seemed to be very small in this species. However, no absolute conclusions can be drawn given that *Eligmodontia morgani*'s population density during the sampling period was relatively low, and the number of possible male-female overlap cases was scarce. Although this information might suggest a monogamous reproductive strategy, future long term radiotelemetry studies should be undertaken in order to confirm this hypothesis.

It should be noted that these assessments involve some assumptions. We have assumed that environmental factors such as food supply, spatial heterogeneity and human disturbance were not limiting factors. In addition, data obtained from a grid always imply an underestimation of real home range sizes, because individuals trapped near borders may extend their home ranges outside the study area.

Due to the fact that Hantavirus Pulmonary Syndrome (HPS) is severely affecting this North-Western Patagonian region and sigmodontine rodents are its vector (Cantoni et al. 1997), space use studies might contribute to elucidate mechanisms for rodent control and thereby help diminish the spread of this disease.

In conclusion, this study describes home range characteristics of *Abrothrix xanthorhinus* and *Eligmodontia morgani*, providing new information on these two sigmodontine rodents in North-Western Patagonia.

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## REFERENCES

- Barros, V.R. and Mattio, H. 1977. Tendencias y fluctuaciones en la precipitación de la región patagónica. *Meteorológica* 8: 237-248.
- Burt, W.H. 1943. Territoriality and home range concepts as applied to mammals. *Journal of Mammalogy* 24: 346-352.
- Cantoni, G., Lázaro, M., Resa, A., Arellano, O., Amestoy, A., de Bunder, S., Herrero, E., Pérez, A. and Larrieu, E. 1997. Hantavirus pulmonary syndrome in the province of Río Negro, Argentina. *Revista Instituto Medicina Tropical, Sao Paulo* 394: 191-196.
- Desy, E.A., Batzli, G.O. and Jike, L. 1989. Comparison of vole movements assessed by live trapping and radio-tracking. *Journal of Mammalogy* 70: 652-656.
- Frank, D.H. and Heske, E.J. 1992. Seasonal changes in space use patterns in the southern grasshopper mouse, *Onychomys torridus*. *Journal of Mammalogy* 73: 292-298.
- Gaulin, J.C. and Fitzgerald, R.W. 1986. Sex differences in spatial ability: an evolutionary hypothesis and test. *American Naturalist* 127: 74-88.
- Gaulin, J.C. and Fitzgerald, R.W. 1988. Home range size as a predictor of mating systems in *Microtus*. *Journal of Mammalogy* 69: 311-319.
- Getz, L.L. 1961. Home ranges, territoriality, and movements of meadow vole. *Journal of Mammalogy* 42: 24-36.
- Ghermandi, L. 1997. Seasonal patterns in the seed bank of grassland in North-Western Patagonia. *Journal of Arid Environments* 35: 215-224.
- Gipps, J.H., Flynn, M.P., Gurnell, J. and Healing, T.D. 1985. The spring decline in populations of the bank vole, *Clethrionomys glareolus*, and the role of female density. *Journal of Animal Ecology* 54: 351-358.
- Guasp, A.C., de Torres Curth, M.I. and González, D.E. 1997. AREOGRAPHY 2.0. A program to delimit distributional areas of species. *Environmental Software*. 114 pages.
- Guthmann, N., Lozada, M., Monjeau, A. and Heinemann, K. 1997. Population dynamics of five sigmodontine rodents in an assembly of North-Western Patagonia. *Acta Theriologica* 42: 143-152.
- Hayne, D.W., 1949. Calculations of home range. *Journal of Mammalogy* 30: 1-18.
- Heinemann, K.M., Guthmann, N., Lozada, M. and Monjeau, J.A. 1995. Home range of *Abrothrix xanthorhinus* Muridae, Sigmodontinae and the implications on its mating strategy. *Mastozoología Neotropical* 2:23-30.
- Ims, R.A. 1987. Responses in spatial organization and behavior to manipulation of the food resources in the vole *Clethrionomys rufocanus*. *Journal of Animal Ecology* 56: 585-596.
- Jennrich, R.I. and Turner, F.B. 1969. Measurements of non-circular home range. *Journal of Theoretical Biology* 22: 227-237.
- Kelt, D.A. 1994. The natural history of small mammals from Aisén Region, southern Chile. *Revista Chilena de Historia Natural* 67: 183-207.
- Kelt, D.A. 1996. Ecology of small mammals across a strong environmental gradient in southern South America. *Journal of Mammalogy* 77: 205-219.
- Lozada, M. and Guthmann, N. 1998. Microhabitat selection under experimental condition of three sigmodontine rodents. *Ecoscience* 51: 51-55.
- Lozada, M., Guthmann, N. and Baccala, N. 2000. Microhabitat selection in five rodent species of North-Western Patagonia. *Environmental Studies on Neotropical Fauna* 35(2).
- Lozada, M., Monjeau, J.A., Heinemann, K.M., Guthmann, N. and Birney, E. 1996. *Abrothrix xanthorhinus*. *Mammalian Species* 540: 1-6.
- Madison, D.I. 1980. Space use and social structure in meadow voles, *Microtus pennsylvanicus*. *Behavioural Ecology and Sociobiology* 7: 65-71.
- Madison, D.I. 1985. Activity rhythms and spacing. pages 373-419, In: Tamarin, R.H. (Editor) *Biology of new world Microtus*. The American Society of Mammalogists, Special Publication, N° 8.
- Mares, M.A., Willig, M.R. and Bitar, N.A. 1980. Home range size in eastern chipmunk *Tamias striatus* as function of number of captures: statistical biases of inadequate sampling. *Journal of Mammalogy* 61: 661-669.
- Mares, M.A., Lacher, T.E. Jr., Willig, M.R., Bitar, N.A., Adams, R., Klinger, A. and Tazik, D. 1982. An experimental analysis of social spacing in *Tamias striatus*. *Ecology* 63: 267-273.
- Monjeau, J.A. 1989. Ecología y distribución geográfica de los pequeños mamíferos del Parque Nacional Nahuel Huapi. Tesis Doctoral, Universidad Nacional de La Plata, La Plata, Argentina. 253 pages.
- Monjeau, J.A., Bonino, N. and Saba, S.L. 1994. Annotated checklist of the living land mammals in Patagonia, Argentina. *Mastozoología Neotropical* 1: 143-156
- Ostfeld, R.S. 1986. Territoriality and mating system of California voles. *Journal of Animal Ecology* 55: 691-706.
- Ostfeld, R.S., Pugh, S.R., Seamon, J.O. and Tamarin, R.H. 1988. Space use and reproductive success in a population of meadow voles. *Journal of Animal Ecology* 57: 385-394.
- Pearson, O., Martin, S. and Bellati, J. 1987. Demography and reproduction of the silky desert mouse *Eliomodontia* in Argentina. pages. 433-446, In: Patterson, B.D. and Timm, R.M. (Editors) *Studies in Neotropical Mammalogy: Essays in Honour of Philip Hershkovitz*. Fieldiana: Zoology, N° 39.
- Rapoport, E.H. 1982. Areography, Geographical Strategies of Species. Pergamon Press, Oxford. 269 pages.
- Southwood, T.R.E. 1966. *Ecological Methods*. Methuen and Co. Ltd. London. 391 pages.
- Stickel, L.F. 1954. A comparison of certain methods of measuring ranges of small mammals. *Journal of Mammalogy* 35: 1-15.
- Swihart, R.K. and Slade, N.A. 1989. Differences in home range size between sexes of *Microtus ochrogaster*. *Journal of Mammalogy* 70: 816-820.
- Urayama, K. 1995. Size and overlap of home range in a high density population of the Japanese field vole *Microtus montebelli*. *Acta Theriologica* 403: 249-256.