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Population ecology of *Eligmodontia morgani* (Rodentia, Cricetidae, Sigmodontinae) in northwestern Patagonia

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ABSTRACT. *Eligmodontia morgani* is one of the most abundant endemic species of arid Patagonian steppe. Most previous studies have focused on systematics and taxonomy and ecological information on this species is scarce. The objectives of this study were to estimate population parameters for *E. morgani* in the Patagonian steppe ecoregion and to compare them to parameters available for this species in another environment. Data were collected from February 2003 through October 2004. Abundances ranged from 12±1.85 to 71±6.67, with residents comprising 39% of the population. The sex ratio was female biased and age classes resulted in juveniles body mass ≤11 g, subadults between 13-15 g, and adults ≥17 g. The breeding season lasted from August to March. The home range sizes were 659.72±90.55 m^2 for females and 439.58±114.54 m^2 for males. The comparison of present results with those obtained in the Subandean district within the Patagonian steppe ecoregion showed similar home range sizes and residency but a different proportion of *E. morgani* in the total number of rodent captures, trap success, and sex ratio. The ability of this species to occupy diverse arid environments of Patagonia may evidence a significant ecological niche breadth.

[Palabras clave: estepa patagónica, ambientes áridos, laucha sedosa, ecología de roedores, parámetros poblacionales]

RESUMEN. Ecología poblacional de *Eligmodontia morgani* (Rodentia, Cricetidae, Sigmodontinae) en Patagonia noroeste: *Eligmodontia morgani* es uno de los roedores endémicos más abundantes de los ecosistemas áridos patagónicos. Sin embargo, la mayoría de los estudios previos se han concentrado en la sistemática y taxonomía por lo que se dispone de escasa información ecológica sobre esta especie. Los objetivos de este estudio fueron estimar parámetros poblacionales para *E. morgani* en la ecoregión de la estepa patagónica y compararlos con los disponibles para esta especie en otro ambiente. Los datos fueron recolectados entre febrero 2003 y octubre 2004. Las abundancias poblacionales oscilaron entre 12±1.85 y 71±6.67, con 39% de individuos residentes. La proporción de sexos estuvo sesgada hacia las hembras y las masas corporales por clase etaria resultaron ≥11 g en juveniles, entre 13-15 g en subadultos y ≥17 g en individuos adultos. La época reproductiva se verificó entre agosto y marzo. Las áreas de acción fueron de 659.72±90.55 m^2 en las hembras y de 439.58±114.54 m^2 en los machos. La comparación de estos resultados con los obtenidos en el Distrito Patagónico Subandino revelaron tamaños similares del área de acción y de proporción de individuos residentes, y diferencias en la abundancia relativa de esta especie con respecto a otros roedores y en la proporción de sexos. La capacidad de esta especie de sobrevivir en diferentes ambientes de la Patagonia árida sugiere su gran amplitud de nicho ecológico.

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[Keywords: Patagonian steppe ecoregion, arid environments, silky desert mouse, rodent ecology, population parameters]

INTRODUCTION

Eligmodontia morgani (Allen 1901) inhabits Chile and southern Argentina, where it occurs along a narrow western fringe of the provinces from western Mendoza to Santa Cruz Province in Patagonia (Lanzone & Ojeda 2005; Mares et al. 2008). It is a small (~8.2 cm in length), nocturnal rodent found in open environments with bare ground and low vegetative cover. It is well adapted for arid or xeric conditions (Pearson 1995), and is associated with mesic habitats within the Patagonian steppe (Hillyard et al. 1997; Mares et al. 2008) and with transitional areas within the Subantarctic forest (Lozada et al. 2000).

E. morgani ecology and natural history in the Patagonian steppe is not well described and little information is available. Thus, the main goals of this study were to provide novel information on its population ecology in the Occidental district of that ecoregion, and to compare the results with data documented for the same species in another type of habitat within Patagonia steppe ecoregion (Guthmann et al. 1997; Lozada et al. 2000; Lozada et al. 2001).

METHODS

The study area was located at Paraje San Cabao of Neuquén Province, Argentina (39º54′ S; 71º07′ W; 814 m.a.s.l.) in the Occidental district of the Patagonian steppe ecoregion (Cabrera & Willink 1980). The landscape is comprised of tablelands and valleys and the climate is dry with cold temperatures and prevailing westerly winds. Dominant vegetation includes shrubs such as *Mulinum spinosum* and bunchgrasses such as *Festuca* sp. and *Stipa* sp. (Cabrera & Willink 1980).

We conducted a 21 month-capture-mark-recapture study between February 2003 and October 2004. We set a 10x10 trapping grid consisting of 100 Sherman live-traps spaced at 10 m intervals. Traps were set monthly for three consecutive nights and were baited with rolled oats, bovine fat, and vanilla extract. Rodents were released at the site of capture. External morphologic characteristics were recorded, and each rodent was ear-tagged with individually numbered metal tags.

Abundance was estimated using the 2CAPTURE software (White et al. 1982).

Table 1. Percentage of adult and in breeding condition *E. morgani* in the Occidental district of the Patagonian steppe ecoregion (Neuquén province) between February 2003 and October 2004. Seasonal sample sizes are also detailed between brackets.

Tabla 1. Porcentaje de *E. morgani* adultos y en condición reproductiva en el Distrito Occidental de la ecoregión de la estepa patagónica (Provincia de Neuquén) entre febrero 2003 y octubre 2004. También se detallan entre paréntesis los tamaños muestrales estacionales.

Season (n)	Adults %	Seasonal average of % adults	% in breeding condition	Seasonal average of % in breeding condition
Winter 03 (64)	51.5	71.2	65.1	51.1
Winter 04 (44)	90.9		37.2	
Fall 03 (150)	48.0	60.1	53.4	42.9
Fall 04 (133)	72.2		32.3	
Spring 03 (75)	86.7	93.3	90.3	91.1
Spring 04 (25)	100.0		92.0	
Summer 03 (22)	63.6	60.5	68.2	72.3
Summer 04 (127)	57.5		76.4	

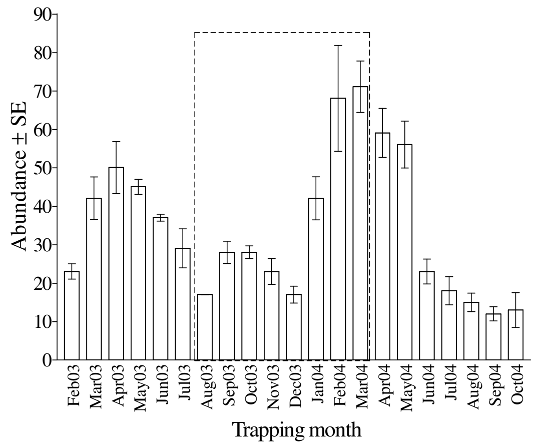

Figure 1. *Eligmodontia morgani* abundance (N±SE) trends in the Occidental district of the Patagonian steppe ecoregion (Neuquén Province) between February 2003 and October 2004. Pointed rectangle indicates breeding season.

Figura 1. Tendencias de la abundancia (N±SE) de *E. morgani* en el Distrito Occidental de la ecoregión de la estepa patagónica (Provincia de Neuquén) entre febrero 2003 y octubre 2004. El rectángulo punteado indica la estación reproductiva.

Home ranges were estimated using the Minimum Convex Polygon method for adult rodents trapped at least five times during the study (Mohr 1947; Southwood 1966; Corbalán & Ojeda 2005). Mean home range sizes were compared between sexes and seasons by a two-way ANOVA (Doncaster & Davey 2007). Animals were classified as juvenile, subadult and adult, based on the combination of reproductive condition, body size, and body mass at first capture. We performed Kruskal-Wallis analyses for testing differences in body mass values among age classes for each sex, and Mann-Whitney tests for assessing differences in body mass values between sexes for each age class (Ayres et al. 2004). Hierarchical log-linear analyses were conducted to assess the effect of season and sex on the proportion of adult individuals, and reproductive individuals. Overall analyses were evaluated by likelihood-ratio chi-square (Agresti 2002). Values of $P<0.05$ were considered statistically significant in all analyses.

RESULTS

A total of 332 individual *E. morgani* were captured 964 times (632 recaptures) in 6300 trap-nights. The average trap success was 5.3 individuals/100 trap-nights. *Akodon iniscatus* (n=30), *Reithrodon auritus* (n=18), *Abrothrix longipilis* (n=1), *Chelemys macronyx* (n=3), and *Ctenomys* sp. (n=1) were also captured. *Eligmodontia morgani* was the most frequently trapped species comprising over 53% of all rodents captured each month.

The sex ratio was bias towards females except during February, March and June 2004, when males outnumbered females, and during October 2003, July 2004 and August 2004, when the number of males equaled that of females. Sex ratios varied between 0.69 and 0.43 males/females.

The proportion of adult individuals varied with sex ($X^2_{(2)}=8.51$, $P=0.014$) and season ($X^2_{(6)}=50.02$, $P<0.001$). The proportion of adults was higher in spring than in the other seasons for both sexes (Table 1). Reproductive activity was higher in spring and summer for both sexes ($X^2_{(3)}=96.77$, $P<0.001$) (Table 1), and the proportion of reproductive individuals was higher for females than males (females=0.64 vs. males=0.56, $X^2_{(1)}=8.33$, $P=0.003$) during the whole study. An overall breeding season for both sexes was estimated from August to March. Pregnant females appeared in late summer/early fall 2003 (March to April) and during summer 2004 (January to March).

Abundance for *E. morgani* fluctuated both seasonally and annually with peaks occurring from the end of summer to winter (March to July 2003) and during summer to fall (February to May 2004). The highest abundance (71 individuals) occurred during March 2004, and the lowest abundance occurred from winter to early summer (July to December in both years) with a minimum value of 12 individuals during September 2004 (Figure 1).

Adult females were heavier than adult males (18.86±0.42; n=97 vs. 17.01±0.32; n=71, Z(U)=25.12, $P<0.01$). No differences in body

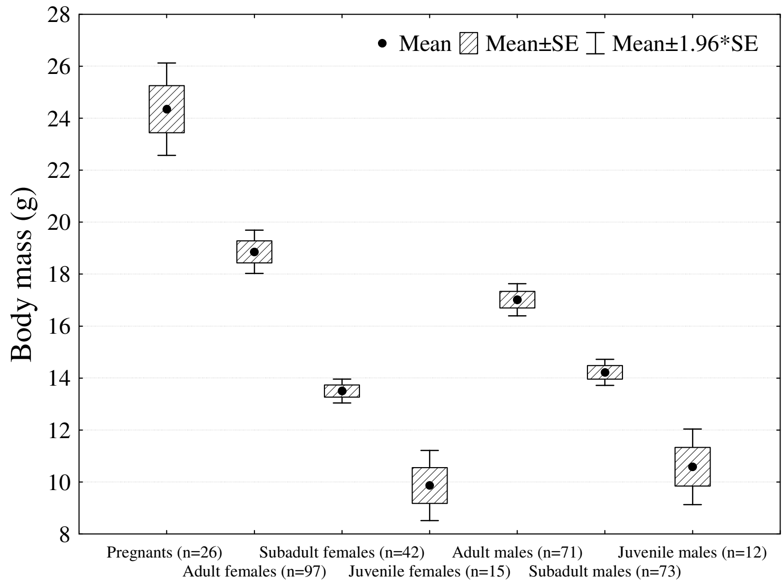

Figure 2. Average body mass (at first capture) for *E. morgani* females and males in the Occidental district of the Patagonian steppe ecoregion (Neuquén Province) between February 2003 and October 2004. Sample sizes are indicated between brackets.

Figura 2. Masa corporal promedio (en primera captura) para hembras y machos de *E. morgani* en el Distrito Occidental de la ecoregión de la estepa patagónica (Provincia de Neuquén) entre febrero 2003 y octubre 2004. Los tamaños muestrales están indicados entre paréntesis.

mass occurred between sexes for the other two age classes (Figure 2).

Assuming resident rodents were those captured during at least two months, residents comprised 38.8% of the population and there were no differences between sexes. The average residency time±SE was approximately three months (females=3.0±0.2 months, n=136, males=2.6±0.2 months, n=160). The maximum number of months between the first and last capture was 12 months for males and 9 months for females. *E. morgani* females had significantly larger homes ranges than males (females: 659.72±90.55 m^2, n=20; males: 439.58±114.54 m^2, n=14, $F_{(1)}$=4.25, P=0.040) but we did not detect seasonal effect on mean home ranges for each sex.

The comparison of present results with those obtained in the Subandean district within the Patagonian steppe ecoregion showed similar home range sizes and residency but different proportion of *E. morgani* in the total number of rodent captures, trap success, and sex ratio (Table 2).

DISCUSSION

This study contributes novel ecological data for *E. morgani* in the Occidental district of the Patagonian steppe ecoregion. We propose some possible mechanisms to explain differences between our study and previous ones in the Subandean district. It is important to note that all these studies (including ours) have been conducted in isolated sites without replicates and in different sample periods, so caution should be taken in order not to over generalize our conclusions.

E. morgani strongly dominated the rodent assemblage in our sampling site, while *A. xanthorhinus* was the most abundant rodent in the Subandean district with *E. morgani* representing less than 25% of the total number of rodent captures (Guthmann et al. 1997; Lozada et al. 2001). In the same way, our overall trap success was between 1.7 to 4.5 times higher than the trap success reported in the Subandean district. Thus, assuming a direct relationship between both parameters,

Table 2. Summary of comparable data between *E. morgani* populations of Occidental district and Subandean district within the Patagonian steppe ecoregion.

Tabla 2. Resumen de la información comparable entre poblaciones de *E. morgani* del Distrito Occidental y el subandino en la ecoregión de la estepa patagónica.

	Present study	Other studies
Sample period	2003-2004	1991-1994 (1) (2) (3)
Sample district	Occidental	Subandean (1) (2) (3)
Community dominant species	*E. morgani*	*A. xanthorhinus* (1) (2)
% in the total number of rodent captures	86.2	22.9 (1) 20.4 (2)
Trap success	5.30	1.16 (1)
(ind/100 trap-nights)		3.03 (2)
Sex ratio	f>m	f<m (1)
Reproductive season	August-March	September-May (1)
% of residents	39	48 (1)
Average residency time	3.0 months	4.1 months (1)
Longest residency time	12 months	11 months (1)
Home ranges (m^2)	f: 659.72±90.55; n=20	f: ~620 (3)
	m: 439.58±114.54; n=14	m: ~474 (3)

(1) in Guthmann et al. (1997); (2) in Lozada et al. (2000); (3) in Lozada et al. (2001). f=female, m=male.

E. morgani seems to be more abundant in the Occident district than in the Subandean one. *E. morgani* may become numerically dominant as environmental conditions become more arid (Subandean district to Occidental district), suggesting a higher competitive efficiency in the Occidental district.

In spite of the large number of recaptures within each month, few rodents were recaptured in subsequent months. This is reflected in the relatively low percentage of resident animals and the short average residency time. Although our maximum residency time (about 1 year) was similar to that reported in Subandean district, the *E. morgani* population showed a higher percentage of residents and a longer average residency time in that district (Guthmann et al. 1997). A possible explanation could be that a low relative reproductive success of *E. morgani* in the Subandean district would result in lower abundance but with a maximization of residents remaining longer in their habitats.

The estimated breeding season appears to have started and ended earlier (August to March) than in the Subandean district (September to May) (Guthmann et al. 1997). This difference could be due to weather variation among study areas. Although our home range values were similar to those in the Subandean district (Lozada et al. 2001), our study detected significantly larger female home ranges. This could be explained by the presence of fewer resources in our more arid area. Parental care activities of female would require larger areas for resource collection to feed growing juveniles (Frank & Heske 1992). In general agreement with this, Ostfeld et al. (1985) proposed that if the proportion of reproductive individuals is lower for males than females with males having lower average body mass (as in this study), male spacing behavior is strongly influenced by mate search, whereas in females, food distribution and abundance are most important.

The sex ratio was female biased; however, in the Subandean district there was a higher proportion of males (Guthmann et al. 1997). We also found sexual dimorphism with adult *E. morgani* females weighing significantly more than males. Perhaps, the sexual dimorphism in rodents with females being larger can be explained by the fecundity advantage afforded to large females (Andersson 1994).

Intraspecific variation in population parameters has been postulated as the basis on which evolution operates to optimize a population response to environmental fluctuations (Stoddart 1979). The observed differences in population parameters between study areas probably result from environmental differences between study areas. The ability of *E. morgani* to occur in these diverse environments may evidence a significant ecological niche breadth.

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