

Nota



## MICROHABITAT USE BY SIGMODONTINE RODENTS IN CROP-FIELD BORDERS OF PAMPEAN AGROECOSYSTEMS

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**ABSTRACT.** The aims of this work were to assess the relevance of some variables in the use of microhabitats by two rodent species, and to contribute to models predicting their presence in agroecosystems in the south of Córdoba province, Argentina. Rodent sampling was conducted in crop-field borders seasonally from spring 2013 to winter 2014. Floristic composition, litter cover and bare soil percentage were determined at each trap site. Variables influencing the use and not-use of trapping stations by each species were identified with a logistic regression. We suggest a differential microhabitat use by both species.

**RESUMEN.** Uso de microhábitat de roedores sigmodontinos en bordes de cultivo de agroecosistemas pampeanos. Los objetivos de este trabajo fueron determinar la relevancia de algunas variables en el uso del microhábitat por dos especies de roedores, y contribuir a modelos que predigan su presencia en agroecosistemas del sur de la provincia de Córdoba, Argentina. El muestreo de roedores fue realizado estacionalmente en bordes de campos desde primavera de 2013 hasta invierno 2014. En cada sitio de trampeo se determinó la composición florística y el porcentaje de mantillo y de suelo desnudo. Las influencias de las variables en el uso o no uso de los sitios de trampeo por cada especie fueron identificadas con regresión logística. Se puede sugerir un uso diferencial de los microhábitats para ambas especies.

**Key words:** *Akodon azarae*, *Calomys musculinus*, vegetation cover.

**Palabras claves:** *Akodon azarae*, *Calomys musculinus*, cobertura de vegetación.

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The use of a current habitat by organisms at a given time is influenced by factors including quantity, quality, and distribution of resources (Wiens 1986). Seasonal variation of resources causes some variables to have more or less importance as explanatory variables for the presence and abundance of a species (Lambert & Adler 2000). The relationships between species and habitat variables also change according to the reproductive activity and the study scale (Lima et al. 2002).

Microhabitat can be assessed from quantifying physical and chemical variables, which influence the allocation of time and energy by an individual within its home range (Morris 1987). Numerous studies on microhabitat use have established positive or negative relationships between the presence or abundance of rodent species and variables indicating microhabitat structure, such as the percentage of bare soil (Barnum et al. 1992), the exposed rock surface (Bertolino 2007), the soil organic matter (Dueser & Shugart 1978), and the vegetation cover (Lambert & Adler 2000; Bakker 2006). This affects the abundance and composition of the fauna inhabiting that site since it provides refuge, food, and opportunities for nesting, as well as protection against predators (Birney et al. 1976; Jacob & Brown 2000). In Argentina, the relationship between wild rodents and habitat variables has been studied for macrohabitats in desert environments (Corbalán 2006; Corbalán & Debandi 2006), in protected areas (Gómez-Villafañe et al. 2012, Vadell et al., 2017) and in agroecosystems (Ellis et al. 1997; Andreo et al. 2009, Cavia et al. 2005, Gomez et al. 2015; Gomez et al. 2018).

Pampean agroecosystems can be defined as mosaics, which are temporally and spatially heterogeneous at different scales (Merriam 1988). They are characterized by monoculture fields, surrounded by a network of linear habitats, which some authors have termed "borders" (Bennett 1990). Border habitats are less disturbed than fields which are subject to agricultural practices, and usually present a relatively high vegetation cover throughout the year (Simone 2010), and they may contain potential resources (food and shelter) for reproduction and survival in the long term of

the rodent species which inhabit them (Ellis et al. 1997). The quality and quantity of resources vary seasonally in agroecosystems due to environmental changes, which are mainly the result of weather seasonality and agricultural practices (Crespo 1966; Kravetz & Polop 1983, Sommaro et al. 2010; Gomez et al. 2011).

*Akodon azarae* (Fisher 1829) and *Calomys musculus* (Thomas 1894) are the two most abundant rodent species, which inhabit agroecosystems of the Córdoba province (Andreo et al. 2009; Simone et al. 2012; Gomez et al. 2015). *Akodon azarae* is usually found in habitats with little disturbance and with high levels of vegetation cover (Ellis et al. 1997; Hodara et al. 2000; Andreo et al. 2009; Gomez et al. 2015) such as crop field borders, roadsides and areas of native vegetation (Bilenca & Kravetz 1998; Gomez et al. 2011). *Calomys musculus* is considered the most opportunistic and generalist species of the rodent assemblage that lives in agroecosystems, since it inhabits crop-field borders preferably, but it can also be found in cultivated fields (Busch et al. 2000; Sommaro et al. 2010). The relationship between rodent species and environmental variables at microhabitat scale (trap site) has only been studied for reproductive *A. azarae* (Bilenca & Kravetz 1998; Escudero et al. 2012).

Our aims were to assess the relevance of some variables in the use of habitat by *A. azarae* and *C. musculus* at microhabitat scale, and to contribute to models predicting their presence in the field borders of agroecosystems in the rural area of Chucul, department of Río Cuarto, province of Córdoba, Argentina (32° 55' 06" S and 64° 10' 09" W). Phytogeographically the area belongs to the Neotropical Region, Chacoan Dominion, Pampean Province (Martinez et al. 2016), and has been characterized according to its physiognomic type as a Grass Steppe (Bianco et al. 1987).

Rodent sampling was conducted seasonally in 16 borders (crop-field borders) during four trapping sessions (December 2013, February, May and August 2014). A trap line was located in each border (separated by at least 100 m from one another). A total of 20 live traps of Sherman type (baited with a mixture of bovine fat and peanut butter) were set in each line at

a distance of 6 m among them. Capture, mark and release (CMR) samplings were carried out during 4 consecutive nights. During trapping sessions, traps were checked each morning and the captured rodents were marked with caravans. Capture and manipulation of rodents were performed following the standards of the American Society of Mammalogists for the use of wild mammals in research (Sikes et al. 2011) and the Center for Disease Control and Prevention (CDC) (Mills et al. 1995).

In each border, vegetation measurements were made using a quadrant of 1 m<sup>2</sup> (modified from Dueser & Shugart 1978) centered on each trap site. A flora census was conducted and the species present were determined according to their morphological characteristics. In addition, the litter cover percentage and the bare soil percentage were determined through direct visual estimation. Each site containing a trap was considered a replica, and only those plant species covering more than 5% and which were present in at least 10% of the trap sites were taken into account.

Logistic regression analyses were applied to establish the relationship between the microhabitat variables and the occurrence of individuals in each trap site. Model selection followed a forward stepwise procedure, using the Akaike information criterion (AIC) for each model, including the null model. Models with the lowest AIC and  $p < 0.05$  values were selected to draw inferences. All statistical analyses were performed using the R version 3.0.3 library

(nlme) (R Development Core Team 2009, www.r-project.org).

With a capture effort of 5120 traps/nights, 144 captures were obtained, 93 corresponding to individuals of *A. azarae* and 81 to individuals of *C. musculus*. In spring 2013, only *Bidens subalternans*, *Bromus catharticus*, *Clematis montevidensis*, *Cynodon dactylon*, and *Sorghum halepense* were present in at least 10% of the registered sites. The average of mulch at the trapping sites was  $13.26 \pm 22.61$  and that of bare soil was  $5.61 \pm 11$ . In summer 2014, eight plant species were present in 10% of the census: *B. pilosa*, *B. catharticus*, *Conyza bonariensis*, *C. dactylon*, *Digitaria sanguinalis*, *Gomphrena perennis*, *S. halepense*, and *Verbena litoralis*. The average values of mulch and bare soil were  $1.76 \pm 2.31$  and  $1.4 \pm 2.73$ , respectively. During autumn 2014, *B. subalternans*, *B. catharticus*, *C. dactylon*, *Sonchus asper*, *S. halepense*, and *V. litoralis* were present in 10% of the vegetation censuses. In this season, an average of  $6.17 \pm 13.8$  of mulch and  $4.57 \pm 10.54$  of bare soil was registered. In winter 2014, only *C. dactylon* and *S. halepense* were registered in 10% of the trap sites, and the average of mulch was  $1.15 \pm 0.99$ , while that of bare soil was  $1.91 \pm 6.37$ .

The best model for *A. azarae* in autumn included five variables (Table 1). The Odds ratio obtained indicated that the probability that *A. azarae* is present in the trap is 3, almost 2 and 3.5 times higher when *B. subalternans* (ODDS = 3.19; C.I. 95% [1.72– 5.95]),

**Table 1**

Best logistic regression model for *Akodon azarae*'s presence in autumn 2014 in crop-field borders of the rural area of Chucul, Córdoba province. AIC: Akaike Information Criterion.

	Variable	Estimated Value	Standard Error	Z Value	p
Model	<i>Bidens subalternans</i>	1.0556	0.3358	3.144	0.00167
	<i>Bromus catharticus</i>	0.6063	0.2827	2.145	0.03197
	<i>Cynodon dactylon</i>	1.0320	0.4707	2.193	0.02833
	<i>Sonchus asper</i>	-0.9511	0.6346	-1.499	0.13395
	<i>Sorghum halepense</i>	0.5849	0.2846	2.055	0.03988
AIC: 335.35					

*B. catharticus* (ODDS = 1.79; C.I. 95% [1.06-3.03]) and *C. dactylon* (ODDS = 3.41; C.I. 95% [1.41-8.24]) are present, respectively. For winter, the best model (Table 2) only included *C. dactylon*. When this plant species is present, the probability (ODDS = 2.53; C.I. 95% [1.04-6.17]) that *A. azarae* is also present in the trap is 2.5 times higher. In the logistic regression analysis for spring, none of the microhabitat variables included was statistically significant. In summer, the insufficient amount of available data for this season did not allow for any statistical analyzes.

Regarding *C. musculus*, in spring the best model (Table 3) included the *S. halepense* presence. According to the Odds ratio (ODDS = 17.68; C.I. 95% [2.35-132.84]), when this plant species is present, the probability that *C. musculus* is also present is 17 times higher. None of the variables considered in the logistic regression analysis was statistically significant for summer, autumn and winter.

The physiognomy and vegetation composition of habitats in agroecosystems are not the same throughout the year and during the same season (Simone et al. 2012). It is from those differences that rodents would select resources. In autumn, the plant species related with *A. azarae* have morphological characteristics that are

very different, contributing differentially to the cover and vertical structure of the microhabitat. *Cynodon dactylon* provides cover in the low-intermediate stratum, whereas *S. halepense*, *B. subalternans*, and *B. catharticus* would make up an intermediate-high vertical stratum. In this way, the presence of these plant species would generate high-quality microhabitats for the protection against predators. Besides, most of these species are available throughout the year, which would reinforce the “quality” of the microhabitat in terms of shelter. In other studies, *A. azarae* had already been identified as cover-dependent to avoid principally aerial predation (Bilenca et al. 1992; Ellis et al. 1998). In agroecosystems of the Buenos Aires province, at a macrohabitat scale, there was a relationship between *A. azarae* captures and *Stipa* cover and vertical development of vegetation (Bonaventura et al. 1989), grass cover (Ellis et al. 1997) and *Baccharis* cover (Busch et al. 2001). In most cases, that relationship was interpreted because of the vegetation contribution to the vertical structure and to the protection against predators (Bilenca et al. 1992; Ellis et al. 1998). At microhabitat scale, Escudero et al. (2012) and Bilenca & Kravetz (1998), have found a strong relationship between vegetation cover and the reproductive condition of *A. azarae*

**Table 2**

Best logistic regression model for *Akodon azarae*'s presence in winter 2014 in borders of the rural area of Chucul, Córdoba province. AIC: Akaike Information Criterion.

	Variable	Estimated Value	Standard Error	Z Value	p
Model	<i>Cynodon dactylon</i>	1.21	0.50	2.40	0.016277
	AIC: 311.57				

**Table 3**

Best logistic regression model for *Calomys musculus*' presence in spring 2013 in borders of the rural area of Chucul, Province of Córdoba. AIC: Akaike Information Criterion.

	Variable	Estimated Value	Standard Error	Z Value	p
Model	<i>Sorghum halepense</i>	2.872	1.029	2.79	0.00524
	AIC: 152.03				

females, stating that cover could be an important resource in the reproductive performance for shelter instead of feeding. From the results obtained in this study, it can be suggested that *A. azarae* use the microhabitat differentially based on the vegetation that would provide structure and cover as protection against potential predators, this in relation to those plants would have no relevance for consumption (Castellarini et al. 2003). For *C. musculinus*, the lack of relationship between plant species and its presence could be expected, since this species is considered the most generalist and opportunistic species of agroecosystems (Busch et al. 2000; Sommaro et al. 2010). The relationship between *C. musculinus* and *S. halepense* at microhabitat scale found in this study could be because the cover offered by this grass in borders provides shelter for protection against predation and for reproduction, which is not offered by plot fields in spring, agreeing with findings by Simone (2010) at the macrohabitat scale. This author registered many vegetation variables as predictors of the presence of *C. musculinus* in borders of the rural area of Chucul, and established relationships with individual plant species that varied according to season. However, *C. musculinus* would seek coverage regardless of the plant species providing it. The habitat structural characteristics and the vegetation cover as shelter would be more important than the limitations for food resources for this rodent species. Since, according to Castellarini et al. (2003), plant species related to the presence of rodents in this study would not constitute food resource, we could infer that they would be acting as a refuge, without being able to discriminate if they are used as protection against predators or nesting sites, or both. On the other hand, the fact that the small number of captures could be a limitation for model fitting in some seasons for both species cannot be ruled out.

Future studies that reinforce or complement this study are necessary to explain in accurate way microhabitat use by *C. musculinus* in order to include relevant variables in the management and control programs, given its zoonotic importance.

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