Species-habitat Association of the Spiny Rat, *Proechimys roberti* (Rodentia: Echimyidae), in the National Park of Brasília, DF, Brazil

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Abstract

Habitat association of the spiny rat, *Proechimys roberti* (Rodentia: Echimyidae), was studied in the National Park of Brasília from October 1998 to June 1999. Thirty-three captures and 25 individuals were recorded with an effort of 1907 trap-nights. Stepwise logistic regression revealed a significant positive association between the presence of babaçu palms and the probability of occurrence for *P. roberti* (*p* = 0.0006, df = 1). Stepwise multiple linear regression identified mean gallery forest width between sampling areas as a marginally significant variable in predicting capture success for this species (*p* = 0.056, df = 1). The results of this study suggest that *P. roberti* selects for specific microhabitats within the heterogeneous gallery forest environment.

Keywords: *Proechimys roberti*, gallery forests, Cerrado, habitat association, babaçu.

Introduction

Spiny rats (genus *Proechimys*) are often the most abundant terrestrial mammals in neotropical forests (Emmons, 1978; Gastal, 1997; Da Silva & Patton, 1993). They feed on fruits, seeds, fungi, and palm nuts, which they may also disperse (Forget, 1990; Adler, 1995; Hoch & Adler, 1997). Among the rodents of the Brazilian Cerrado (see Eiten, 1972), the spiny rat, *Proechimys roberti* Thomas 1901 (Rodentia: Echimyidae), is found to occur exclusively in gallery forests (Alho, 1981; Alho et al., 1986; Gastal, 1997; Marinho-Filho et al., 1998), often in high local abundance (Alho, 1981; Gastal, 1997). In the Federal District of Brazil several studies have provided some information regarding the reproduction (Mares et al., 1989) and habitat association (Alho, 1981; Gastal, 1997) of *P. roberti*. However, the factors that influence the distribution and abundance of this species in the Cerrado remain poorly understood.

Gallery forests are evergreen formations that occur in areas of greater water availability (Eiten, 1972; Resck & Da Silva, 1998), primarily along small streams and rivers. These forests represent less than 10% of the total area of the Cerrado (Redford & Fonseca, 1986), yet provide the principal habitat for many mammal species of this biome (Johnson et al., 1999), and several authors have suggested that these riparian formations may serve as dispersal corridors between the Atlantic and Amazonian rainforests (Bishop, 1974; Fonseca & Redford, 1985; Redford & Fonseca, 1986; Nitikman & Mares, 1987).

A variety of factors, such as width, continuity and matrix quality, may characterize a particular corridor as adequate, or not, for a certain species (Ruefenacht & Knight, 1995; Tischendorf & Wissel, 1997). Furthermore, habitat specialists tend to experience difficulties when migrating through matrix from one habitat patch to another (Tiebout & Anderson, 1996; Downes et al., 1997). The Cerrado gallery forests...
represent heterogeneous environments (Oliveira-Filho et al., 1990; Da Silva Jr. et al., 1998), and there is evidence that some mammal species select particular microhabitats within these forests (Alho et al., 1986; Nitikman & Mares, 1987; Gastal, 1997).

This study aims to provide information on the importance of gallery forests as habitat and dispersal corridors for an endemic species of the Cerrado, *P. roberti*. Regression analysis is used to model patterns of occurrence of this species in relation to landscape features and microhabitat variables found in the National Park of Brasilia, Brazil.

**Materials and methods**

**Study area**

This study was conducted within the Rio Torto Basin of the National Park of Brasilia (NPB), Brazil, located in the northwestern region of the Federal District (15°35′–15°45′S, 48°05′–48°53′W). The NPB covers an area of approximately 28,000 ha, and encompasses the watersheds that drain into the Santa Maria Reservoir, which supplies water to the city of Brasilia. The construction of this reservoir resulted in the fragmentation of the gallery forest network associated with the streams of the Rio Torto Basin (Fig. 1).

**Data collection**

Small mammals were collected from 30 live-trap grids at 22 locations within the NPB, from October 1998 until June 1999. In some instances, adjacent grids were considered to be of the same location due to their proximity. Sixteen of the 30 trapping grids were used in the collection of microhabitat data, while the remaining 14 trapping grids were used only in the macrohabitat analysis. In either case, each grid consisted of four rows of Sherman, Tomahawk and Young live-traps spaced 10 m apart and baited with a mixture of peanut butter, cassava flour, apple and banana. The number of traps used in each of the four rows varied according to the width of the gallery forest and other field conditions, but in most cases consisted of 3–5 traps. Three to four nights of trapping were carried out on each of the 30 trapping grids,
for a total effort of 1907 trap-nights. Capture success on each grid did not correlate with trapping effort (data not shown). Captured individuals were lightly anaesthetized with 70% ether, marked with numbered ear tags, and their sex was recorded.

On the 16 grids used in the microhabitat analysis the following variables were measured and recorded for each trap site: percent canopy cover, tree density, mean tree circumference at breast height, distance to the nearest water, distance to the edge of the forest, vegetation type and the percent ground cover of fallen logs for that grid. A convex mirror densiometer was used to calculate the mean percent canopy cover at each trap site. The density of trees registering a circumference greater than 10 cm was calculated through the point-centered-quadrant method (Bonham, 1989), using the trap as the center of each quadrant. Mean tree circumference was obtained as the mean breast-height circumference of the four trees considered in the calculation of tree density. The vegetation at each trap site was classified as grassland, dry gallery forest or wet gallery forest. The presence of the palm *Euterpe edulis* and/or fern trees (*Cyathea* spp., *Cyatheaceae*) were used as indicators of wet gallery forest.

Four transects, each perpendicular to the stream course and crossing a distance of 80 m or to the border of the forest, were established for each grid. The diameter of all fallen tree trunks measuring over 20 cm were recorded, summed and then divided by the total distance covered by the four transects to provide an estimate for percent ground cover of fallen logs. The presence or absence of the babaçu palm (*Attalea speciosa*) within a distance of 10 m was recorded for each trap site.

To investigate the role of forest corridor macro characteristics in determining *Proechimys* occurrence in habitat patches throughout the park, 14 trapping grids were added to the 16 used in the microhabitat analysis, and trapping was conducted as described for the investigation of microhabitat association.

### Statistical analyses of habitat association and distribution

A probability of resource selection function (Manly et al., 1993) was used to detect microhabitat associations of *P. roberti*. Stepwise logistic regression (SAS Institute Inc., 1989) was used to construct models for the probability of occurrence of *P. roberti* in relation to the recorded microhabitat variables, with $\alpha = 0.01$ to enter and maintain a variable in the model.

To estimate the probability of occurrence for *P. roberti* in relation to the combination of habitat variables included in the regression model, a logit function of selection probability was used:

$$\omega^*(x) = \frac{\exp(\beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p)}{1 + \exp(\beta_0 + \beta_1 X_1 + \ldots + \beta_p X_p)},$$

where $\omega^*(x)$ is the probability of occurrence for the species during the three capture nights, $\beta$ is the coefficient related to each variable in the model and $X$ is a value observed in the field for the variable considered (Manly et al., 1993). Using the program SYSTAT (Wilkinson et al., 1992), the logit functions were then used to construct graphs simulating the probability of occurrence of *P. roberti* in relation to the habitat variables included in the regression model. Arbitrary values for the habitat variables were used in the construction of the graphs, obeying the limits observed in the field, so as to avoid extrapolation (Ramsey & Schafer, 1997).

To investigate the pattern of occurrence of *P. roberti* with relation to landscape characteristics of the NPB, the capture success data (number of individuals captured per trap night) in each trapping location were tested for association with several macro characteristic variables related to the gallery forests. The location that recorded the greatest trapping success was here considered as the ‘source population.’ From this ‘source population’, the distance, mean width of the gallery forest and degree of connectivity to all other trapping locations were calculated with the aid of a 1:50,000 satellite image map. The mean widths of the gallery forest were calculated using measurements corresponding to intervals of every 250 m along the forest. Stretches of river lacking gallery forest were not considered in the calculation of mean forest width. Gallery forest connectivity was calculated as the percentage of the total distance along the stream between the ‘source population’ and each study area that lacked gallery forest on both banks.

The width, distance and connectivity variables were tested for association with capture success through multiple stepwise linear regression using SYSTAT (Wilkinson et al., 1992). An $\alpha$ value of 0.05 was used to enter a variable into the model, with a value of $\alpha = 0.06$ to remove variables.

### Results

#### Captures

Through a total capture effort of 1907 trap nights, 33 captures of 25 individuals were recorded, resulting in an overall capture success of 1.31%. Fourteen males, ten females and one unsexed juvenile were captured. The highest capture success in the NPB (4.50%) was recorded within the largest area of dry gallery forest containing babaçu palms, hereafter referred to as the ‘source population’.

#### Habitat association

Of the 233 trap sites used in the microhabitat analysis, 62 were located in wet gallery forest, 11 in grassland and 156 in dry gallery forest, with babaçu at 27 sites of the latter category. On these grids, 10 captures of nine individuals were recorded, all in dry gallery forest. On average, dry gallery forest had a more closed canopy than wet gallery forest ($F = 7.77; p = 0.006; df = 1$), but did not significantly differ in...
Corridors and connectivity

The capture success of *P. roberti* was positively associated with the mean width of the gallery forest between the ‘source population’ and all other areas considered (*F* = 4.16, *p* = 0.056, df = 1), resulting in the following model:

\[ C = -0.807 + 0.007f, \]

Where \( C \) = capture success of an area and \( f \) = mean gallery forest width, in meters, from that area to the ‘source population’.

The capture success at sampling areas throughout the park was not associated with the distance from the ‘source population’ (*F* = 0.16, *p* = 0.691, df = 1) nor to the degree of fragmentation of the gallery forest leading to that population (*F* = 1.17, *p* = 0.295, df = 1) from the ‘source population.’
who reported a strong positive association between the abundance of *P. roberti* and the density of trees 22.5 to 37.5 cm in diameter, but not with smaller trees. Gastal (1997) likewise recorded a greater number of *P. roberti* captures in an area that had the highest values for tree diameter.

Several authors have noted that spiny rats use fallen tree trunks as runways (Passamani, 1995; Malcolm, 1997), and numerous captures atop fallen trunks (Gastal, 1997; this study) indicate that *P. roberti* may do just that. In fact, during this study, one *P. roberti* individual was observed crossing a 4 m wide creek bed by means of a narrow, fallen tree, which had signs of frequent use. However, we did not find a significant association between the occurrence of *P. roberti* and the availability of fallen trees. It is most likely that the absence of this habitat element does not characterize an area as unsuitable for the species.

**Corridors and connectivity**

Over a larger spatial scale, the capture success of *P. roberti* was positively associated with the mean width of the forest corridor between any particular area considered and the area of the ‘source population.’ The importance of corridor width for terrestrial species has been demonstrated by both simulation models (Tischendorf & Wissel, 1997) and field studies (Ruefenacht & Knight, 1995). The narrow width of the Três Barras forest may explain for the absence of *P. roberti* in otherwise favorable habitat patches along this stream. Even though the logistic regression model indicated a strong association between the probability of occurrence of *P. roberti* and the presence of babaçu, *P. roberti* was not captured in a forest patch of the Três Barras stream system that was dominated by babaçu palms, but effectively isolated from the rest of the Três Barras gallery forest by an area of open grassland. Additionally, no signs of palm seed predation by *Proechimys* were observed in this forest patch.

If the distribution pattern of *P. roberti* is indeed influenced by metapopulation dynamics, as proposed by Gastal (1997), characteristics such as width and continuity of the gallery forests between subpopulations would certainly have a strong influence on the local persistence of the species (Anderson & Danielson, 1997; Paradis, 1997; Ruxton et al., 1997).

Habitat specialists tend to be more vulnerable to habitat fragmentation, principally when their resources are distributed unevenly over the landscape (Meffe & Carroll, 1997). In this respect, species such as *P. roberti*, which are associated with specific microhabitats within the heterogeneous environment of the Cerrado gallery forests, may suffer considerable losses with the degradation and/or fragmentation of these forests.

**Acknowledgements**

We would like to extend our sincere thanks to the people and organizations who participated in the realization of this study. Valuable comments on earlier versions of the manuscript were provided by Raimundo P. B. Henriques, José R. A. Moreira and Maria Luiza Gastal. James L. Patton provided helpful information regarding *Proechimys* species identification. Special thanks are due to Mauricio Sacramento, Kleber Almeida and Alexandre Palma for their help in the fieldwork. MAJ received a CAPEs graduate research fellowship throughout the course of the study. JMF received financial support from CNPq (Proc. 300591/86-1).

**References**


