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# ECOLOGICAL OBSERVATIONS OF THE RED VIZCACHA RAT, *Tympanoctomys barrerae* IN DESERT HABITATS OF ARGENTINA

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**SUMMARY:** The red vizcacha rat *Tympanoctomys barrerae* is a rare octodontid rodent endemic to the dekkgsert ecosystem of central western Argentina. Our report is based on recent surveys of two isolated populations in the desert habitats of Mendoza province, Argentina. The red vizcacha rat lives in or near salt basins ("salares") (Arroyito site) and sand dunes (Trintrica site). This species lives in complex burrow systems built in sand mounds, with at least three different gallery levels, and several entrances. In Arroyito, halophytic chenopods such as *Heterostachys, Alternanthera* and *Suaeda* (Chenopodiaceae) represent more than 80% of its diet. In Trintrica the red vizcacha rat preferred *Atriplex* (Chenopodiaceae) and *Prosopis flexuosa* (Leguminosae). Our data on the natural history of *T. barrerae* expand the understanding of this poorly known and highly adapted desert rodent.

**ABSTRACT: Observaciones ecológicas de la rata vizcacha colorada, *Tympanoctomys barrerae* en hábitats de desiertos de Argentina.** La rata vizcacha colorada, *Tympanoctomys barrerae*, es un roedor octodóntido raro, endémico del ecosistema desértico central oeste de Argentina. Nuestro trabajo se basa en estudios recientes de dos poblaciones aisladas de hábitats desérticos de la provincia de Mendoza. La rata vizcacha colorada habita salares o sus alrededores (en Arroyito) y dunas (en Trintrica). Esta especie vive en sistemas de galerías complejos, de al menos tres niveles y con varias entradas, construidos en montículos de arena. En Arroyito, varias quenopodiáceas halofíticas tales como *Heterostachys, Alternanthera* y *Suaeda* (Chenopodiaceae) constituyen más del 80% de la dieta. En Trintrica, la rata vizcacha colorada prefiere *Atriplex* (Chenopodiaceae) y *Prosopis flexuosa* (Leguminosae). Nuestros datos acerca de la historia natural de *T. barrerae* amplían el conocimiento de esta especie pobremente estudiada y altamente adaptada a la vida en el desierto.

**Palabras clave:** roedores octodóntidos, *Tympanoctomys barrerae*, distribución, sistema de galerías, preferencias alimentarias, conservación.

**Key words:** Octodontid rodents; *Tympanoctomys barrerae*; distribution; burrow systems, diet preferences; conservation.

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## INTRODUCTION

Octodont rodents are found on both sides of the Andes, in Chile, Bolivia and Argentina, and represent one of the oldest rodent groups in South America (Mares and Ojeda, 1981; Patterson and Wood, 1982; Contreras et al., 1987; Reig et al., 1990). The 10 species of the family Octodontidae (Wilson and Reeder, 1993) have radiated into a wide variety of habitats and elevations, from the Puna highland desert (3500 m), and the lowland Monte desert (Argentina) to the temperate *Nothophagus* forest and the coastal mediterranean scrubland (Chile). They are diurnal or nocturnal herbivores (Reig, 1970; Mares and Ojeda, 1981; Contreras et al., 1987), and either burrower-fossorial *(Tympanoctomys, Spalacopus)* or saxicollous *(Octomys, Octodontomys)*, and are the most specialized Southamerican rodents in xeric habitats. Analysis of morphoecological traits (i.e. inflated bullae, tufted and long tail, among others) reveals a high degree of convergence with the North American members of the family Heteromyidae (i.e. kangaroo rats; Mares, 1975, 1976; Ojeda et al., in litt.).

The red vizcacha rat, *Tympanoctomys barrerae*, is endemic to the arid central-western region of Argentina. The red vizcacha rat is characterized by a small and patchy geographyc distribution restricted to salt basins ("salinas" or "salares") and sand dunes, low population density, specialized diet on halophytic vegetation, and several morphoecological adaptations to the desert (De la Barrera, 1940; Yepes, 1942; Justo et al., 1985; Ojeda et al., 1989; Torres Mura et al., 1989; Ojeda et al., 1996, in litt.). Here, we present data on the natural history of the elusive and poorly known red vizcacha rat, *T. barrerae,* particularly concerning its habitats, burrow systems and food habits. Observations are based on recent surveys of the Monte and Patagonian deserts of Mendoza province, Argentina.

## MATERIALS AND METHODS

Field work was conducted in the province of Mendoza, Argentina, on two different sites, during March and December of 1994. The first site, hereafter "Arroyito", is a salt flat located 40 km north of Desaguadero. The second site,

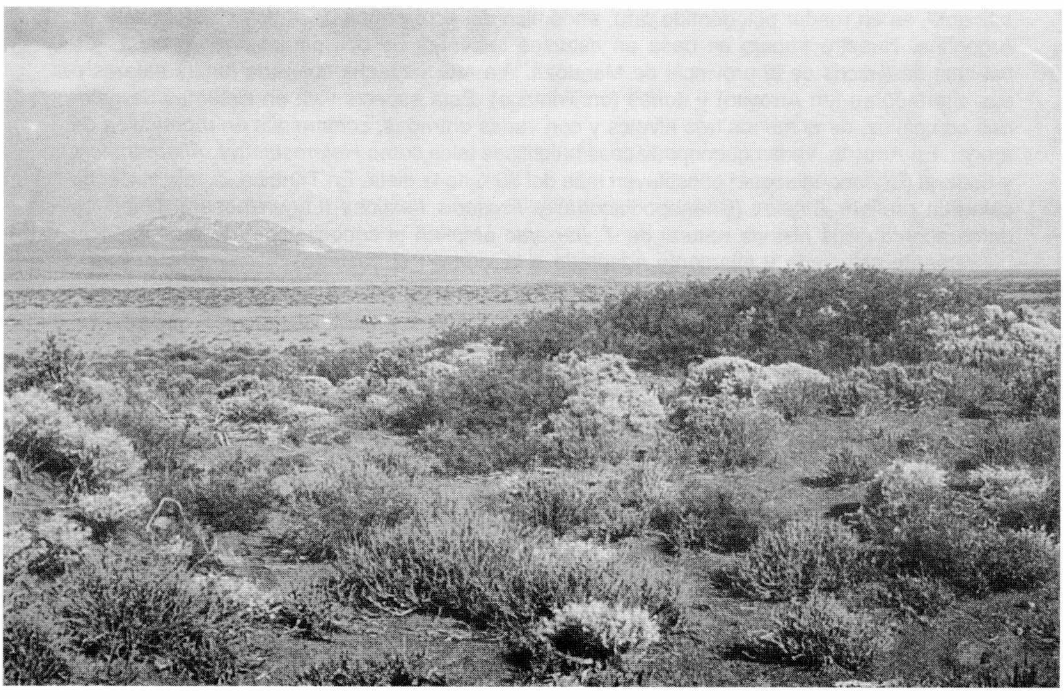

**Fig. 1.** A salt flat habitat (Trintrica site) in the desert of southern Mendoza Province. A mound of red vizvacha rat is visible. Dominant vegetation includes *Atriplex patagonica* and *Prosopis flexuosa*. Photograph by R.A. Ojeda.

hereafter "Trintrica", is a sandy habitat 30 km south of the town of El Nihuil and adjacent to a large salt flat (**Fig. 1**).

Arroyito belongs to the Monte desert phytogeographical province, while Trintrica is part of the Patagonian steppe botanical formation (Cabrera and Willink, 1980). Annual precipitation in Arroyito and Trintrica is 300 and 339 mm respectively. In Arroyito, trees such as *Prosopis*, and *Geoffroea*, and shrubs such as *Larrea*, *Lycium*, and *Atriplex* are the dominant vegetation along the elevations surrounding the salt flat (outer ring). The vegetation of the salt flat itself is dominated by shrubs (less than 50 cm high) like *Heterostachis ritteriana*, *Suaeda divaricata*, and *Atriplex* sp. (Chenopodiaceae). The center of the salt pan shows the sole presence of *Allenrolfea vaginata* (Chenopodiaceae), the only species capable of resisting these extreme soil conditions of clay accumulation and high salt concentrations. Trintrica is dominated by shrubby species like *Prosopis flexuosa* (Fabaceae) and *Atriplex* sp. (Chenopodiaceae).

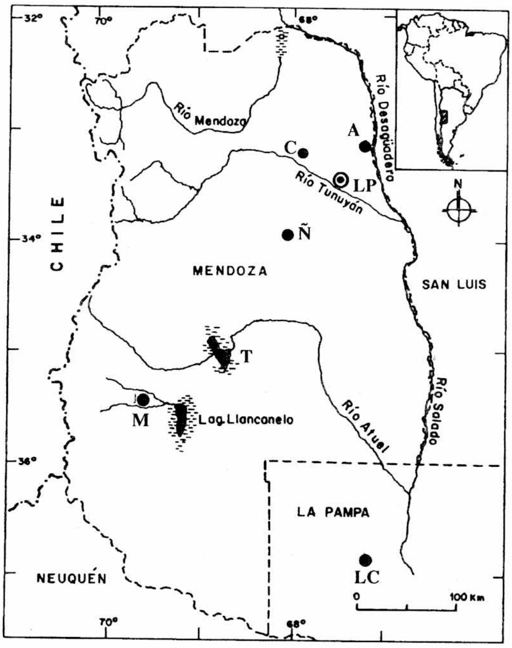


**Fig. 2.** Records of occurrence (dots) of *Tympanoctomys barrerae*. Abbreviations: Mendoza province: M, Malargue; T, Trintrica site; Ñ, Ñacuñán; C, Catitas; LP, La Paz, type locality; A, Arroyito site; La Pampa province: LC, Lihue-Calel.

The red vizcacha rat builds its burrow systems in sand mounds between one to three meters height. Habitat and food availability (plant species composition and cover) were determined along two transects (10 to 15 m) in each mound (5 in Arroyito and 4 in Trintrica) by the point-quadrat method (Goodall, 1952). The distance between active mounds was used to estimate density. Height, length, width, as well as active holes were recorded for each mound. In Arroyito we excavated and mapped one of these burrow systems.

Diet composition was obtained from feces collected in the field and analyzed through standard microhistological protocols (Dusi, 1949). From 15 to 18 feces per mound were collected in Arroyito, and five to 10 in Trintrica. The material from each mound was treated separately. After bleaching for about 10 minutes, the material was rinsed with tap water and sieved through two metal screens of 0.16 mm and 0.071 mm, respectively. We prepared two slides per sample mound of Arroyito and ten for each mound in Trintrica. Relative abundance of plant species was recorded for a total of 50 microscopic fields (400 x) per mound. Only those fields containing at least one identifiable species were considered. Fragments of epidermis were identified through reference slides from plants collected in the field. Difference between resource availability (plant species) and consumption was tested through Chi-square analysis ($p<0.05$), and Bonferroni's simultaneous confidence intervals (Neu et al., 1974; Byers et al., 1984). Usage of plant species was compared with their total abundance in all mounds by Kolmogorov-Smirnov test.

## RESULTS

### Habitats and mounds

The salt flats, and the sandy habitats inhabited by *T. barrerae* are characterized by a high proportion of bare soil, and sparse low vegetation dominated by halophytic genera such as *Heterostachys, Atriplex, Suaeda* (**Table 1**). The red vizcacha rat lives in burrows built in mounds of sandy and friable soils. These mounds average 13.59 m in length (n = 7; SD

**Table 1.** Habitat characteristics from the two study areas of *Tympanoctomys barrerae* in Mendoza province (Argentina). Plant cover (%), mean and standard deviation (SD).

| | **Arroyito Site** Cover (%) | | **Trintrica Site** Cover (%) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Shrub | | | | |
| Chenopodiacea | | | | |
| *Heterostachys ritteriana* | 40.16 | 13.73 | — | — |
| *Atriplex* sp. | 6.74 | 7.96 | 36.38 | 7.48 |
| *Suaeda divaricata* | 0.62 | 0.85 | — | — |
| Fabaceae | | | | |
| *Prosopis flexuosa* | — | — | 38.00 | 4.02 |
| Other | 7.36 | 13.36 | 12.50 | 12.70 |
| Herbaceous dicot | 5.86 | 3.81 | — | — |
| Grass | 3.82 | 5.43 | 2.00 | 1.92 |
| Bare soil | 48.84 | 12.34 | 34.25 | 7.97 |

= 8.7), 8.71 m in width (n = 7; SD = 4.08), and 1.25 m in height (SD = 0.31; n = 4). The average number of holes per mound was 22.7 in Arroyito (SD = 12.93; n = 9). Thus each burrow system is composed of several holes, food chamber, inactive tunnels, and up to three gallery levels (**Fig. 4**). The items found in the food chamber of the mound excavated in Arroyito were *Atriplex* sp. (2.09 g dry matter), *Heterostachys ritteriana* (4.25 g ), and *Alternanthera nodifera* (1.34 g). Signs of recent activity were seen in only five mounds in Arroyito. These burrows were distributed along a narrow band of about 6 meters wide by 3 km long between the outer belt of arboreal vegetation *(Prosopis* and *Geoffroea)*, and a central area dominated by the halophytic shrub *Allenrollfea vaginata.* The density (nearest neighbor; Byth and Ripley, 1980) of active mounds in Arroyito was 0.007 mound/ha, and the average distance between mounds was 470.4 m (n = 5; SD = 142.9). In Trintrica the density of active mounds was 7.31 mound/ha (n = 21; SD = 0.17). These mounds were more evenly distributed than in Arroyito. The average distance between mounds was 19.2 m (SD = 8.38).

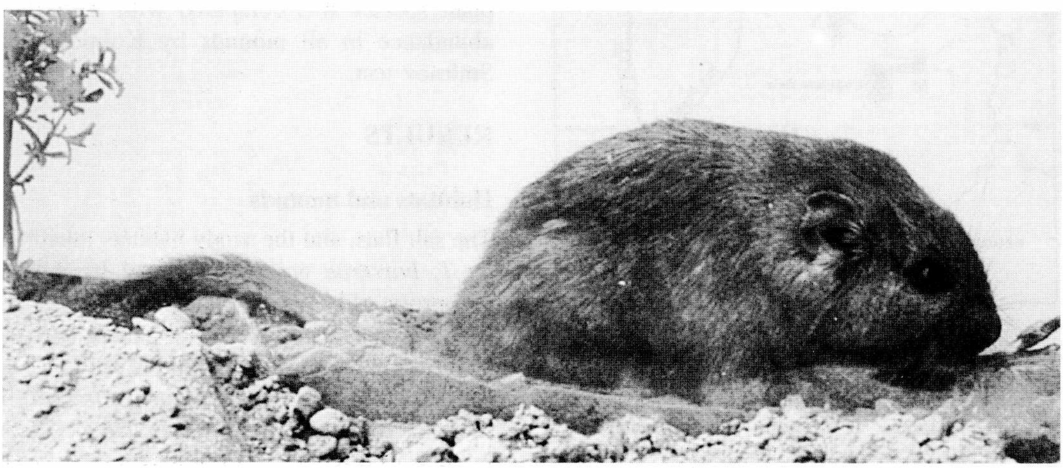

**Fig. 3.** Photo of *Tympanoctomys barrerae* captured in the salt basin of Trintrica, Mendoza. Photograph by R.A. Ojeda

## Dietary analysis

The red vizcacha rat *Tympanoctomys barrerae* was strictly herbivorous. Statistically significant differences were found between resource availability and consumption in both Arroyito and Trintrica ($\chi^2$; $p < 0.05$ for each mound). A significantly higher proportion of *Suaeda divaricata* (Chenopodiaceae) was found in the diet of *T. barrerae* in Arroyito (Kolmogorov-Smirnov test, D = -1; $p < 0.05$; $n_1 = 5$, $n_2 = 5$). The salt bush *Atriplex* sp. was preferred in Trintrica (Kolmogorov-Smirnov test, D = -1; $p < 0.05$; $n_1 = 4$, $n_2 = 4$).

In Arroyito *T. barrerae* feeds on at least 10 plant species (9 dicots and 1 monocot). The most abundant species in the diet of *T. barrerae* was *Heterostachys ritteriana* (55.8%), followed by *Alternanthera nodifera* (14.1%), *Suaeda divaricata* (13.7%), and *Atriplex* sp. (6.4%) (**Table 2**). Only one Gramineae species, *Tragus verteronianus*, could be indentified but we detected low proportions of Gramineae items in its diet (1.6%). *Alternantera nodifera* and *Suaeda divaricata* were preferred significantly by *T. barrerae* (in 2 and 3 of the 5 mounds respectively), as shown by Bonferroni simultaneous confidence intervals (**Table 2**). The chenopods *H. ritteriana* and *Atriplex* sp. were consumed in the same proportion as they were found in each mound. Gramineae items were eaten in lower proportions than available. Other plant species did not show a clear utilization-availability pattern. The red vizcacha rat feeds on at least seven species in Trintrica (6 dicots and 1 monocot) (**Table 3**). The saltbush *Atriplex* sp. was the most abundant plant in the diet (75.5%).

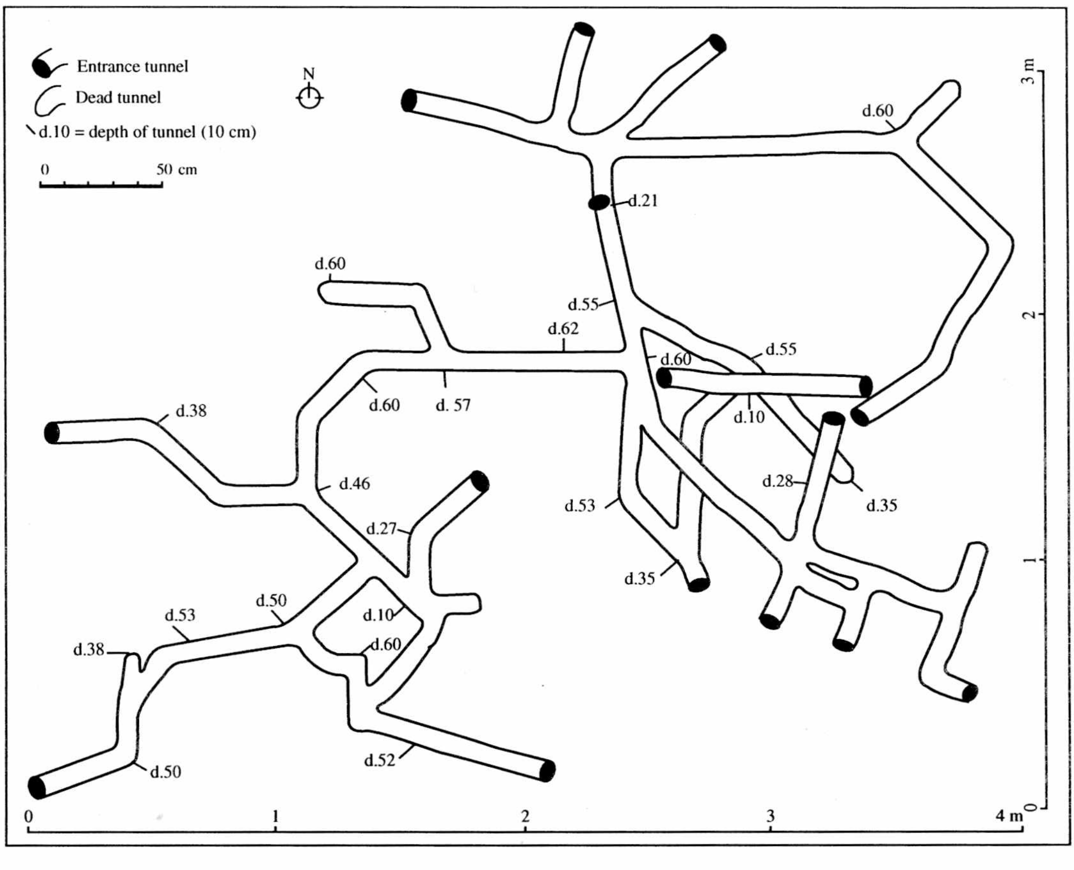


**Fig. 4.** Diagram of a burrow system of *Tympanoctomys barrerae*. Depths are indicated in centimeters. Entrances are marked with black.

**Table 2.** Plant relative frequency in the habitat and in the diet of *Tympanoctomys barrerae* in Arroyito (Mendoza province, Argentina). Associated probability (p) for Bonferroni's confidence simultaneous intervals carried out for the four more consumed plants; * = significant differences ($p < 0.05$); ns = not significant; (+) = preferred; (-) = less preferred

| Species | MOUND 1 | | | MOUND 2 | | | MOUND 3 | | | MOUND 4 | | | MOUND 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cover n=200 | Diet n=50 | p | Cover n=200 | Diet n=50 | p | Cover n=200 | Diet n=50 | p | Cover n=125 | Diet n=50 | p | Cover n=250 | Diet n=50 | p |
| **Chenopodiaceae** | | | | | | | | | | | | | | | |
| *Heterostachis ritteriana* | 0.42 | 0.30 | ns | 0.78 | 0.60 | ns | 0.70 | 0.74 | ns | 0.07 | 0.54 | ns | 0.64 | 0.60 | ns |
| *Atriplex* sp. | 0.30 | 0.18 | ns | 0.10 | 0.02 | ns | 0.06 | 0.04 | ns | 0.07 | 0.06 | ns | 0.00 | 0.02 | ns |
| *Suaeda divaricata* (+) | 0.00 | 0.04 | ns | 0.00 | 0.04 | ns | 0.02 | 0.16 | * | 0.00 | 0.12 | * | 0.01 | 0.32 | * |
| *Allenrolfea vaginata* | 0.00 | 0.02 | ns | | | | | | | | | | | | |
| **Portulacaceae** | | | | | | | | | | | | | | | |
| *Grahamia bracteata* (-) | 0.23 | 0.00 | * | 0.01 | 0.00 | * | | | | | | | | | |
| *Portulaca grandiflora* | 0.01 | 0.04 | ns | | | | | | | | | | | | |
| **Amarantaceae** | | | | | | | | | | | | | | | |
| *Alternanthera nodifera* (+) | 0.01 | 0.40 | * | 0.02 | 0.30 | * | | | | | | | | | |
| **Con volvulaceae** | | | | | | | | | | | | | | | |
| *Cressa nudicaulis* (-) | | | | 0.08 | 0.00 | * | 0.06 | 0.02 | ns | 0.19 | 0.18 | ns | | | |
| **Boraginaceae** | | | | | | | | | | | | | | | |
| *Cortesia cunneifolia* (-) | | | | | | | 0.04 | 0.00 | * | | | | 0.06 | 0.00 | * |
| **Solanaceae** | | | | | | | | | | | | | | | |
| *Lycium chilensis* (-) | | | | | | | 0.01 | 0.00 | * | | | | | | |
| *Solanum euacanthum* (-) | 0.02 | 0.00 | * | | | | | | | | | | | | |
| **Fabaceae** | | | | | | | | | | | | | | | |
| *Prosopis strombulifera* (-) | 0.00 | 0.02 | ns | 0.00 | 0.04 | ns | 0.02 | 0.00 | * | 0.00 | 0.04 | ns | 0.06 | 0.00 | * |
| **Compositae** | | | | | | | | | | | | | | | |
| *Cyclolepis genistoides* | 0.00 | 0.06 | ns | | | | | | | | | | | | |
| **Gramineae** | | | | | | | | | | | | | | | |
| Gramineas (-) | 0.08 | 0.02 | * | 0.00 | 0.06 | ns | 0.20 | 0.00 | * | | | | | | |

**Table 3.** Plant relative frequency in the habitat and in the diet of *Tympanoctomys barrerae* in Trintrica (Mendoza province, Argentina). Associated probability (p) for Bonferroni's confidence simultaneous intervals carried out for the three more consumed plants; * = significant differences ($p < 0.05$); ns = not significant.

| Species | Mound 1 | | | Mound 2 | | | Mound 3 | | | Mound 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Cover** n=200 | **Diet** n=510 | **p** | **Cover** n=200 | **Diet** n=506 | **p** | **Cover** n=200 | **Diet** n=503 | **p** | **Cover** n=125 | **Diet** n=503 | **p** |
| **Chenopodiaceae** | | | | | | | | | | | | |
| *Atriplex* sp.(+) | 0.510 | 0.640 | * | 0.450 | 0.720 | * | 0.440 | 0.970 | * | 0.330 | 0.690 | * |
| **Verbenaceae** | | | | | | | | | | | | |
| *Acantholippia seriphioides* (+) | 0.006 | 0.004 | ns | 0.005 | 0.023 | * | 0.001 | 0.002 | ns | — | — | |
| *Junellia seriphioides* (-) | 0.006 | 0.006 | ns | 0.017 | 0.006 | * | 0.043 | 0.000 | * | 0.090 | 0.002 | * |
| **Nictaginaceae** | | | | | | | | | | | | |
| *Bougainvillea spinosa* (+) | — | — | | — | — | | — | — | | 0.001 | 0.032 | * |
| **Solanaceae** | | | | | | | | | | | | |
| *Lycium chilensis* (-) | 0.006 | 0.000 | * | 0.023 | 0.000 | * | 0.012 | 0.000 | * | 0.050 | 0.000 | * |
| **Fabaceae** | | | | | | | | | | | | |
| *Prosopis f lexuosa* var. *depresa* (-) | 0.460 | 0.160 | * | 0.470 | 0.240 | * | 0.500 | 0.023 | * | 0.400 | 0.120 | * |
| Gramineae (+) | 0.006 | 0.190 | * | 0.030 | 0.004 | * | 0.006 | 0.002 | ns | 0.060 | 0.150 | * |

## DISCUSSION

Octodontids have a long evolutionary history in the arid landscapes of South America (Patterson and Pascual, 1972, Mares and Ojeda 1981). The salt flats or arid pockets where *T. barrerae* occurs might have acted as Pleistocene refugia during glaciations (Mares, 1973). The red vizcacha rat seems to be a solitary species according to our own observations and those of other coleagues (M. Mares, J. Braun and M. Gallardo, pers. comm.). This has been also reported for most heteromyids (Eisenberg, 1963).

Our results expand the plant spectrum known to compose the diet of *T. barrerae*, and reject the notion of its being a specialist on *Heterostachys ritteriana* (Chenopodiaceae) as proposed by Torres Mura et al. (1989). The specialized diet on halophytic vegetation with high salt content is one of the adaptations of the red vizcacha rat to these salt flats and sandy habitats. Earlier, casual observations of the dietary habits of *T. barrerae* were also mentioned by De la Barrera (1940). Our results showed that *H. ritteriana* was the most frequent item in the diet of Arroyito. However, preference analyses revealed *Suaeda divaricata* and *Althernanthera nodifera* (Chenopodiaceae) as the preferred plant species. Moreover in Trintrica where *H. ritteriana* was absent, we found more active mounds. In Trintrica *T. barrerae* preferred the saltbush *Atriplex* sp.

The red vizcacha rat *T. barrerae* shows various adaptive features shared with several other world desert rodents. Some of these traits include long tufted tail, hypertrophied bullae, herbivorous diet, construction of complex burrow systems, occurrence in patchy habitats of salt basins and sand dunes (Prakash and Ghosh, 1975, and references therein). Although the overall convergence between octodontids as *T. barrerae* and other world desert rodents has not been assessed, adaptations to a herbivorous diet of saline and succulent chenopodiaceous plants are found in several world desert rodents (Kenagy, 1972; Daly and Daly, 1973; Csuti, 1979, Mares et al., in prep.; Ojeda et al., in prep.).

The red vizcacha rat has been categorized as a threatened species (IUCN 1994; Reca et al., 1996). According to the classification of rarity proposed by Rabinowitz (1986), the red vizcacha rat occupies the extreme cell of the matrix, which is the most vulnerable category, involving species with restricted geographical distributions, habitat specialists (dunes and salt flats) and low population density. The area of geographic range of *T. barrerae* (encompassing all known sites) is approximately 450,000 $km^2$. Considering that the red vizcacha rat is restricted to salt basins and patchily distributed sand dunes, the area of occupancy is several orders of magnitude smaller. As pointed out by Rabinowitz (1986), natural selection can act in favor of attributes that offset the disadvantages of rarity (i.e. small local population size). Occurrence in extreme habitats such as salt flat pockets, specialized diet on stable food supply as evergreen halophityc shrubs, ability to regulate water balance, and hypertrophied tympanic bullae are some of the adaptive attributes of *T. barrerae* to overcome the disadvantages of rarity. From the perspective of conservation biology it is important to regard *T. barrerae* as a patch resource specialist in terms of habitat and food, with low population sizes. Vulnerability and risks of local extinction of the metapopulation due to natural or anthropogenic disturbances will be determined by the proportion of occupied patches, patch size, interpatch distances and the capacity for dispersal provided by the quality of the surrounding matrix among others factors (Wiens, 1985; Hanski, 1991).

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