Short Note

Discovery of desert-adapted *Tympanoctomys barrerae* in Central Patagonia, Argentina

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The red vizcacha rat (*Tympanoctomys barrerae*) is an octodontid which has adapted to the aridity of the Monte desert biome of Argentina (Ojeda et al. 1996, 1999, Mares et al. 1997). Known from only 11 disjunct populations, its present distributional range extends from Ischigualasto National Park (La Rioja province, 30°05′ S, 67°56′ W) to the Añelo salt flat (Neuquén province, 38°10′ S, 68°53′ W; Ojeda et al. 2007). Animals live in border areas of salt flats and saline basins and their main food items are halophytic chenopods, such as *Atriplex*, *Heterostachys*, and *Soueda* (Torres-Mura et al. 1989, Ojeda et al. 1996). Several adaptations have made possible the colonization of these extreme environments by the red vizcacha rat (Mares et al. 1997, Giannoni et al. 2000). For instance, the vibrations of the rigid bundle of hairs behind the animal's upper incisors helps to shave off the salty epidermis of chenopods, thus decreasing the salt content (Berman 2003). The animal's highly specialized kidney is a key adaptation for conserving metabolic water. In fact, the red vizcacha rat excretes urine as concentrated (7080 mosm/l) similar to North American and Australian desert rodents (Díaz and Ojeda 1999, Díaz et al. 2000). Moreover, animal nocturnal activity and the construction of multi-leveled burrow systems for which portal orientation is correlated with wind and solar direction helps to avoid predators and excessive solar heat (Torres et al. 2003).

Here, we document the first recording locality for *Tympanoctomys barrerae* in Central Patagonia, Argentina. Two males and one female were collected from their burrows using Oneida-Victor traps in Estancia La Porfía (43°13′51.6″ S, 68°38′49.1″ W, 517 masl, on 17–20 March 2008; Figure 1). Animals were sacrificed in the field by head dislocation, prepared as museum specimens, and deposited at the Mammal Collection of Centro Nacional Patagónico. The collecting locality is approximately 20 km NE of Los Adobes, on provincial route 58. It is a pouch of sandy soils within a large basin that belongs to the *Chuquiraga avellanedae* steppe, Central District of the Patagónica Phytogeographic Province (León et al. 1998). Mean annual temperature ranges between 8°C and 9°C and mean annual precipitation is around 150 mm (Beeskow et al. 1987). The general landscape is dominated by badlands and sandy areas with scarce plant cover consisting of *Chuquiraga avellanedae*, *Prosopis* sp., *Prosopidastrum* sp., and *Schinus jonhstoni*. Unlike northern salt flats (i.e., Añelo or Nihuil) where the sagebrush *Atriplex lampa* and *Suaeda divaricata* are dominant (Ojeda et al. 2007), *Atriplex* is not the main shrub in Central Patagonia. Nevertheless, it is most abundant in sandy pouches where the red vizcacha rat was trapped. Nearby places containing similar soils but no sagebrushes (or with *Atriplex* growing on stony ground) showed no evidence of present or past occupancy. Scarce signs of past burrowing activity were observed in overgrazed areas with compacted, disturbed sandy soils. Other small mammals found together with *T. barrerae* are the sigmodontine rodents *Akodon iniscatus*, *Eligmodontia* sp., *Euneomys chinchilloides*, *Graomys griseoflavus*, *Reithrodon auritus*, the marmosine marsupial *Lestodelphys halli*, and the caviomorphs *Microcavia australis* and *Ctenomys* sp.

Body size and external features of Patagonian *Tympanoctomys barrerae* fit the description of the species (Díaz et al. 2000), although a more grayish coloration compared to northern specimens was recognized. The biarmed, 102-chromosome karyotype of *T. barrerae* from Patagonia (not shown) emphasizes the karyotypic stability of the species and its similarity to karyotypes reported from northern populations (Gallardo et al. 2004, 2006). The sperms have the characteristic paddle-like, truncated head (Figure 2B) and exceedingly large dimensions described elsewhere (Gallardo et al. 1999, 2002, 2004). Mean head length, mean head width, and mean tail length are 11.76 ± 1.8 µm, 9.56 ± 0.72 µm, and 55.49 ± 1.78 µm, respectively. These estimates are smaller than previous records (Gallardo et al. 2002) but do not differ significantly, except for the tail length ($p \leq 0.0005$; Figure 2A). The ridge separating the nucleous from the acrosomal tip of the head (measured from tail implantation) is at 28–32% of the head length in northern populations. Nevertheless, it is only at 18–22% in the animals reported here, probably reflecting inter-populational differences (Figure 2A,B).

Figure 1 Distribution map of *Tympanoctomys barrerae* in Argentina, shady points depict recorded localities for the species. 1: New sampling locality of *T. barrerae* in central Chubut province, Argentina; 2–5: fossil localities of *T. barrerae* in Chubut province, Argentina.

The initial diversification of the octodontids is estimated to have occurred 7.8 Ma bp, coinciding with landscape changes and habitat fragmentation derived from the Andean orogenesis in South America (Mares 1985, Contreras et al. 1987, Mares et al. 2000, Honeycutt et al. 2003). Before this report, the nearest record of *T. barrerae* was approximately 550 km to the north, in the Añelo salt flat (38°10′ S, 68°53′ W; Neuquén province). Floristically, this locality is within the Monte Phytogeographic Province, whereas Estancia La Porfía belongs to the Patagónica Phytogeographic Province (León et al. 1998).

The coincidental presence of *Atriplex* sagebushes and red vizcacha rats in different localities suggests that this plant is a floristic indicator, providing the existence of suitable sandy soils for burrow construction. Accordingly, food resources and edaphic conditions seem to have been more important than phytosociological differences for the colonization success of the red vizcacha rat.

Although the fossil record of the octodontids is scarce and peculiar, cytogenetic data analysis and the variation pattern for the penial morphology together with the northern distribution of its closely related taxa (abromomids and chinchillids) suggest a northern origin for the group (Spotorno et al. 1995), Genera *Abalosia* and *Pithanotomys*, ancestral to living *Octomys* and *Aconaemys*,
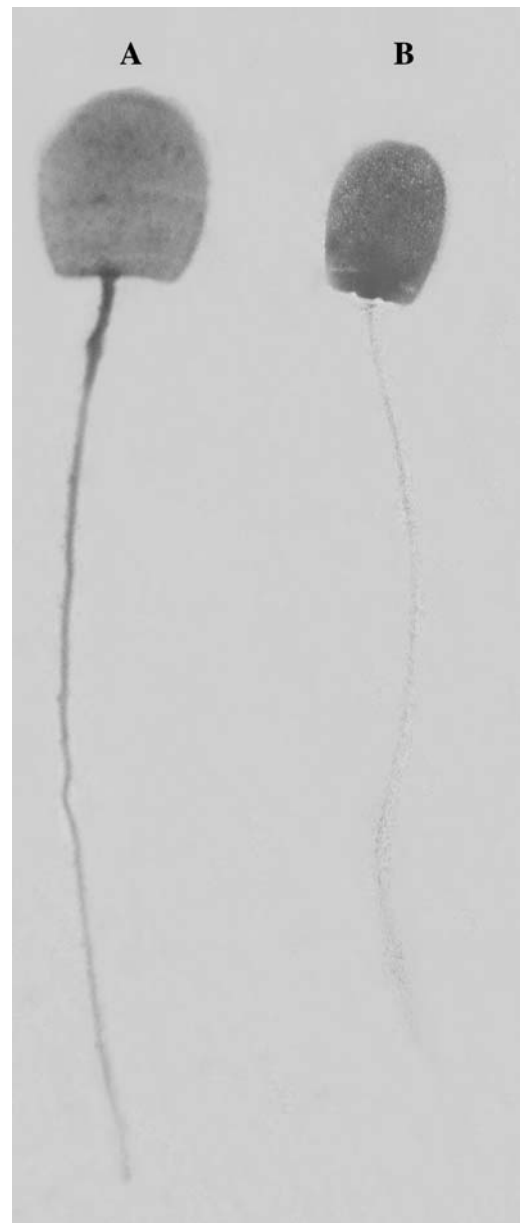
Figure 2 General morphology of Giemsa-stained sperms of *Tympanoctomys barrerae*. (A) Sperm from the northern population of Nihuil. (B) Sperm from Estancia La Porfía, Chubut province, Argentina. Sperms were obtained from testes and caudae epididymes of one live adult male. Semen was extruded, placed in Hanks solution, air-dried, fixed, and stained following Gallardo et al. (2002). Spermatozoa were measured under a light microscope, using an ocular micrometer at 1250×. Linear dimensions of tail length, head length, and greatest width of the head were recorded in 53 gametes chosen at random from different slides.

respectively, have been found in the San Andrés Formation, in western Buenos Aires province. The presence of these pre-Andean genera in the arid Atlantic coast represents a faunistic turnover derived from the Late Pliocene global cooling near 2.5 Ma (Verzi and Quintana 2005). The fossil record of *Tympanoctomys barrerae* is also scarce and its remains are hard to distinguish from living animals. *Tympanoctomys cordubensis*, a presumptive fossil species, has been reported from Pleistocene deposits (0.9–0.78 Ma) of the Atlantic coast and Central

Argentina where it does not occur anymore (Verzi et al. 2002). The displacement of rodents to the west seems to reflect an adaptive response to avoid increasingly inhospitable conditions generated by Quaternary glaciations (Pardiñas 2004). Indeed, climatic changes during the Cenozoic of Patagonia culminated with multiple glaciations (Rabassa and Clapperton 1990, Coronato et al. 2004). During the glacial-interglacial cycles, the increasing climatic continentality resulted in extreme temperatures and precipitation diminution. Thus, when the climate was wetter and warmer, the Brazilian fauna advanced over the Argentinean pampas. Patagonian mammals did the opposite when the climate was dryer and colder. Simultaneously, wind effects led to the formation of salt lakes, basins and dune fields in northern Patagonia and Buenos Aires province (Rabassa et al. 2005). These climatic cycles elicited floral turnover and concerted changes in the regional plant composition (Wolkheimer 1971). This, in turn, triggered an isomorphic tracking response by the herbivores (e.g., Tonni et al. 1999, Pardiñas 2001, 2004).

Fossil remains attributable to *Tympanoctomys barrerae* have been uncovered recently from three Late Holocene localities (<3 kya, Figure 1) along the course of the Chubut River (Udrizar Sauthier et al. 2008). The local extinction of the red vizcacha rat from this area seems to be very recent (<100 years); indeed, not a single specimen has been trapped or recovered from owl pellets, despite 3 years of field work along the Chubut River. Apparently, the extirpation of *Tympanoctomys* from this valley resulted from overgrazing by sheep, introduced to Patagonia at the beginning of the 20th century (Aguado 2005). But on suitable, restricted patches similar to the one reported here, remnant populations can still persist. Since there are numerous and large salt flats yet to be surveyed in Northern Patagonia (i.e., Río Negro province), it is theoretically possible to find additional isolated rodent populations in that area.

Acknowledgements

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