

## *Peromyscus guardia* (Rodentia: Cricetidae)

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**Abstract:** *Peromyscus guardia* Townsend, 1912 is a small, gray-brown cricetid commonly called the La Guarda deermouse. It is a Mexican endemic rodent from Angel de la Guarda Island and 2 islets off the northern tip of Angel de la Guarda in the Gulf of California. Populations of *P. guardia* were common up until the mid-1960s but have since declined. This species is currently listed as “Critically Endangered” by the International Union for Conservation of Nature and Natural Resources.

**Key words:** Angel de la Guarda, Baja California, cricetid, critically endangered species, deermouse, endemic species, insular species, Mexico

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### *Peromyscus guardia* Townsend, 1912 La Guarda Deermouse

*Peromyscus guardia* Townsend, 1912:126. Type locality “Angel de la Guarda Island.”

CONTEXT AND CONTENT. Order Rodentia, suborder Myomorpha, superfamily Muroidea, family Cricetidae, subfamily Neotominae, tribe Reithrodontomyini, genus *Peromyscus* (Musser and Carleton 2005), subgenus *Haplomyomys*, species-group *eremicus*. Currently, 3 subspecies are recognized (Carleton 1989):

*P. g. guardia* Townsend, 1912:126. See above.

*P. g. harbisoni* Banks, 1967:215. Type locality “Isla Granite [Granito], 29°33'N, 113°34'W, Gulf of California, Baja California, Mexico.”

*P. g. mejiae* Burt, 1932:174. Type locality “Mejía Island (29°33'N, 113°35'W), Gulf of California, Lower California, Mexico.”

NOMENCLATURE NOTES. *Peromyscus interparietalis* was included as a subspecies of *P. guardia* (Burt 1932), but Banks (1967) considered it a separate species. Support for species status came also from demonstrated differences in morphologic and electrophoretic characteristics (Brand and Ryckman 1969). It has been suggested (Lawlor 1971) that phallic, dental, and chromosomal characteristics played a role in the evolution of *P. guardia* and *P. interparietalis*. *P. interparietalis* is considered a species by Musser and Carleton (2005); however, on the basis of mitochondrial sequence data, *P. interparietalis* is considered a subspecies of *P. eremicus* by Hafner et al. (2001).

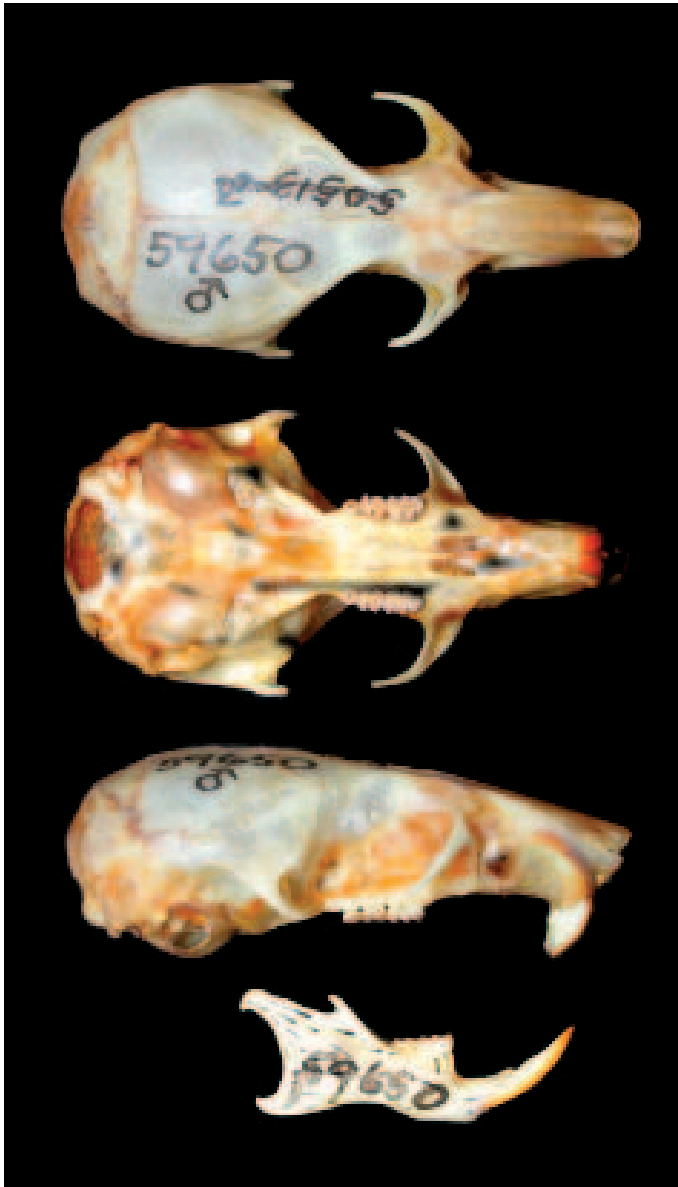
The name *guardia* is a reference to Angel de la Guarda Island, the subspecies name *mejiae* is in reference to Mejía Island, and *harbisoni* honors Charles F. Harbison, who collected the original series of this subspecies (Banks 1967). *Peromyscus* is derived from a combination of 3 Greek words: *pera* = small, *mys* = mouse, and *iskos*, a diminutive suffix (Álvarez-Castañeda and Álvarez 1997).

### DIAGNOSIS

Townsend (1912) described *Peromyscus guardia* (Fig. 1) as being larger in overall size than *P. eremicus* (cactus deermouse) as well as being as least as pale in coloration. It is possible that all (or some) of the specimens of *eremicus*



**Fig. 1.**—*Peromyscus guardia* from Estanque Island. This is probably the last known specimen. Photograph by Gerardo Ceballos used with permission.



**Fig. 2.**—Dorsal, ventral, and lateral views of skull and lateral view of mandible of *Peromyscus guardia* (adult male, MVZ 59650) from E side of Angel de la Guarda Island, elevation 30 feet, Gulf of California, Baja California, Mexico. Greatest length of skull is 26.82 mm. Photograph taken by STÁ-C.

used for comparison were *P. fraterculus* (Northern Baja deer mouse as defined by Riddle et al. 2000). General skull features of *P. guardia* (see Banks 1967, fig. 3 and Lawlor 1971, figs. 8 and 9 for drawings of skull comparisons) are similar to those of *P. eremicus* (included *P. fraterculus*—Hafner et al. 2001), but the upper outline of the skull in *P. guardia* is less arched dorsally, with a longer rostrum and broader interpterygoid fossae; the zygomatic arch is more compressed anteriorly, and the auditory bullae larger than those of *P. eremicus* (Townsend 1912; Fig. 2). Individuals of *P. guardia* differ from those of *P. interparietalis* (San

Lorenzo deer mouse) by the nearly complete absence of mesostyles and entostyles on M1 (Lawlor 1971). *P. guardia* is different from other *eremicus*-like forms in characteristics that are relatively invariable within species, such as the presence of band C for hemoglobin, a triangular interparietal bone, and characteristics of the phallus (Lawlor 1971). *P. guardia* can be distinguished from other closely related species such as *P. merriami* (Merriam's deer mouse) on the basis of geographic distribution (Hall 1981).

*Peromyscus guardia* from Angel de la Guarda Island is distinguishable from the other species found on the island (*Chaetodipus spinatus guardiae*—Angel de la Guarda pocket mouse, *Neotoma lepida*—desert woodrat [described as *Neotoma insularis*—Angel Island wood rat by Townsend 1912], and the 2 introduced species, *Mus musculus*—house mouse and *Rattus rattus*—roof rat) chiefly by the prominent lateral bony extensions of the interparietal (Lawlor 1971; fig. 9b). *P. g. harbisoni* specimens have a shorter tail ( $\chi = 104.0$  mm in *P. g. harbisoni*,  $\chi = 112.9$  mm in *P. g. guardia*, and  $\chi = 115.8$  mm in *P. g. mejiae*), are slightly paler dorsally and more white ventrally than *P. g. guardia*, and have a tail that is less hairy than in *P. g. guardia* and *P. g. mejiae*. *P. g. mejiae* can be differentiated from *P. g. guardia* by its larger body length ( $\chi = 210.0$  mm rather than 206.3 mm—Banks 1967).

## GENERAL CHARACTERS

*Peromyscus guardia* is a small mouse with gray-brown coloration; dorsum is pale, ventral whitish, ears are large and nearly naked, and feet are white (López-Forment et al. 1996). The posterior edges of the nasals of *P. guardia* are rounded or pointed (Banks 1967). The incisive foramina are short and do not reach the anterior plane of M1 (Townsend 1912). Among species of *Peromyscus* on the northern islands in the Gulf of California, *P. guardia* is the most divergent in morphology of the *eremicus*-like forms and on the basis of 27 karyologic, morphologic, osteologic, and serologic characters it is closest to *P. merriami* (Lawlor 1971).

Means  $\pm$  SE and ranges (in parentheses) of selected measurements (mm) of 15 specimens from the Angel de la Guarda Island, Gulf of California, Baja California (Banks 1967) were: total length,  $206.2 \pm 2.51$  (189–223); length of tail,  $111 \pm 1.95$  (93–123); length of head and body  $93.4 \pm 1.76$  (81–102); length of skull,  $26.4 \pm 0.12$  (25.5–26.9); width of interparietal,  $8.02 \pm 0.14$  (7.2–8.8); length of palate,  $4.4 \pm 0.03$  (4.2–4.6); length of nasals,  $9.49 \pm 0.07$  (9.0–9.8).

## DISTRIBUTION

*Peromyscus guardia* is endemic to Angel de la Guarda Island, in the northern Gulf of California, Baja California, Mexico and to 2 small islets off the northern tip of the

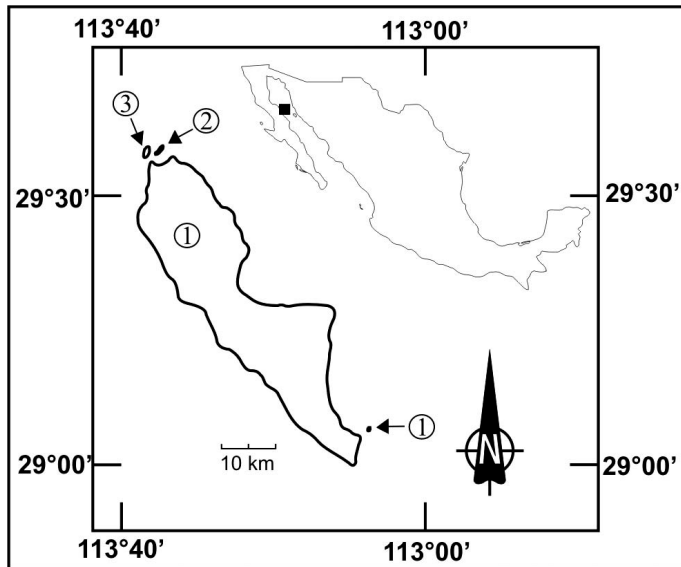


Fig. 3.—Distribution of *Peromyscus guardia* in the Angel de la Guarda archipelago, Gulf of California, Mexico, modified from Álvarez-Castañeda and Cortés-Calva (1999). Subspecies are: 1, *P. g. guardia*; 2, *P. g. harbisoni*; 3, *P. g. mejiae*.

island, Mejía, and Granito islands (Fig. 3; Banks 1967; Burt 1932; Townsend 1912). *P. guardia* has been reported on Estanque Island (Lindsay, 1966), an islet off the southern tip of Angel de la Guarda Island, but it remains unknown as to how it arrived on the island and whether or not it is an undescribed subspecies (Mellink et al. 2002). No fossils are known for *P. guardia*.

### FORM AND FUNCTION

On the basis of morphology and genetics, *Peromyscus guardia* apparently had its origin from *eremicus* (= *fraterculus* sensu Riddle et al. 2000) stock on the mainland (Avisé et al. 1974; Banks 1967; Lawlor 1971). In a biochemical dendrogram, on the basis of polymorphism of allozymes of species in subgenus *Haplomylomys*, forms of *eremicus*, *guardia*, *interparietalis*, *dickeyi*, and *merriami* comprise a complex whose members show relatively little genetic differentiation (Avisé et al. 1974).

Offspring of a mating between *P. guardia* (females) and *P. interparietalis* (males) were obtained in the laboratory, but the fertility of the F<sub>1</sub> generation is unknown (Brand and Ryckman 1969). Lawlor (1971) presents limited information on additional attempts to hybridize *P. guardia* with other insular and mainland species in a laboratory setting. A protein electrophoresis (cellulose acetate strip) analysis of blood serum revealed that there is differentiation between these taxa as well as with *P. eremicus* (compared individuals were intergrades between *eremicus* and *fraterculus*—Brand and Ryckman 1969). The protein patterns indicated consistent differences between populations of *P. guardia*,

*P. interparietalis*, and *P. eremicus*. From protein analysis, the same hemoglobin variants occur in *P. guardia* and *P. eremicus* (= *fraterculus* sensu Riddle et al. 2000) of the Baja California Peninsula and may reflect a close affinity between these populations (Lawlor 1971).

Male *P. guardia* mice exhibit phalli that are morphologically intermediate between simple and complex types; a protrusible tip, although poorly developed, 2 small dorsal lappets on each side of the very small median cleft, and small cartilaginous tips also are present (Lawlor 1971). Females have 2 pairs of mammary glands; pectoral teats are absent (Lawlor 1971).

### ONTOGENY AND REPRODUCTION

Apparently, the peak breeding period for *Peromyscus guardia* occurs in early spring (Banks 1967). Several gray-pelage juveniles and a female containing 2 embryos 15 mm in length were obtained in March (Banks 1967). Two of 13 females captured on Angel de la Guarda in June were pregnant; however, no pregnant females ( $n = 3$ ) were collected at Mejía Island (Brand and Ryckman 1968). Males trapped in March had testes averaging 10.6 by 6.3 mm (Banks 1967).

### ECOLOGY

*Peromyscus guardia* is endemic to the islands of the Angel de la Guarda group. These islets are very rocky with sparse arid vegetation of desert scrub (Álvarez-Castañeda et al. 2008; Banks 1967). Angel de la Guarda Island is the largest and has the highest elevation of the northern islands in the Gulf of California; however, it has very little habitat diversity (Banks 1967). Individuals of *P. guardia* have been collected on rocky beaches (Brand and Ryckman 1968), on a brushy sand flat (Granito), in a dense thicket of iodinebush, *Allenrolfea occidentalis*, and at the edge of the beach (Angel de la Guarda—Banks 1967). Brand and Ryckman (1968) reported 2.1% catch success in rocky canyons and brushy sand flats as compared with 29.0% catch success along rocky beaches. By the late 1960s, the species was apparently confined to sandy beaches (Mellink et al. 2002).

*Peromyscus guardia* was previously considered an abundant species (Banks 1967). In November 1997, one of us (STÁ-C) set > 2,500 Sherman live-traps (H. B. Sherman Traps, Inc., Tallahassee, Florida) in 9 different areas of Angel de la Guarda Island near the beach and no specimens of *P. g. guardia* were collected. Also, no specimens were obtained in surveys conducted in 1999 and 2001 (Mellink et al. 2002), and between 2004 and 2008 by A. Zavala (in litt.) in different surveys.

*Peromyscus g. harbisoni* and *P. g. mejiae* on Granito and Mejía islands, respectively, were considered very common at the beginning and end of the 1960s (Banks 1967; Lawlor

1971). However, Mellink (1992) and Álvarez-Castañeda and Cortés-Calva (1999) tried to collect *P. guardia*, but only the house mouse was collected on both islands and the roof rat at Granito Island (Mellink et al. 2002, Álvarez-Castañeda and Ortega-Rubio 2003). *P. g. harbisoni* and *P. g. mejiae* have been reported as extinct (Álvarez-Castañeda and Cortés-Calva 1999; Álvarez-Castañeda and Ortega-Rubio 2003; Mellink 1992).

Granito Island is an important nesting ground for sea birds, particularly gulls (*Larus*), cormorants (*Phalacrocorax*), and brown pelican (*Pelecanus occidentalis*) and guano mining occurs there in some years. Also there is a semipermanent fishing camp on the island that is used throughout the year (Álvarez-Castañeda and Ortega-Rubio 2003); these conditions set up an optimal habitat for the house mouse and roof rat, which in turn replaced *P. g. harbisoni*.

The Belvedere Expedition (Lindsay 1962) stopped at Isla Pond (= Estanque Island) on 17 March 1962, and did not find any mammals, collecting only lizards, scorpions, and insects in pitfall traps that were set in rocky habitats. However, Lindsay (1966:351, 353) reported the collection of 1 *P. guardia* by R. C. Banks on 23 April 1966. The population of *P. guardia* on Estanque Island is now regarded as extinct, allegedly caused by a single domestic cat (*Felis catus*) introduced to the island (Vázquez-Domínguez et al. 2004).

*Peromyscus guardia* is considered a species with an aggressive temperament; individuals bite readily when disturbed (Brand and Ryckman 1968). The geographic range of *P. guardia* overlaps with the desert woodrat on Angel de la Guarda and the Angel de la Guarda pocket mouse on all islands except for Granito Island (Banks 1967).

## GENETICS

As do all species of *Peromyscus*, *P. guardia* has a diploid number (2n) of 48 chromosomes (Committee for Standardization of Chromosomes of *Peromyscus* 1977). The fundamental number for *P. guardia* is 90. It has 1 pair of small acrocentrics and the other chromosomes are submetacentrics or subtelocentrics (Lawlor 1971). The sex chromosomes have unequal arms. The X chromosome has a small subtelocentric form, but in individuals from Mejía Island, it has a large subtelocentric form. The Y chromosome is a medium-sized acrocentric (Lawlor 1971). Allozyme data from 25 loci indicated that *P. guardia* and *P. interparietalis* (= *P. eremicus* sensu Hafner et al. 2001) were more similar to each other than either were to *P. eremicus*, *P. merriami*, *P. caniceps* (Montserrat Island deer mouse), *P. dickeyi* (Dickey's deer mouse), *P. eva* (southern Baja deer mouse), or *P. californicus* (California deer mouse—Avisé et al. 1974). The genetic evidence suggests that *P. guardia* and *P. interparietalis* developed from remnants of a single stock on the ridges of a mountain range that became isolated into islands with rising sea levels at the end of the Pleistocene (Avisé

et al. 1974). The genetic diversity of *P. guardia*, on the basis of allozyme analysis of 4 individuals from Estanque Island, is very low, with a heterozygosity value of 0.01 (Vázquez-Domínguez et al. 2004).

## CONSERVATION STATUS

Populations of *Peromyscus guardia* were common until the mid-1960s (Banks 1967) but have since declined (Mellink et al. 2002). Population declines were most likely a consequence of the introduction of exotic species (roof rat, house mouse, and domestic cat) that are associated with the fishing camps on the islands (Álvarez-Castañeda and Cortés-Calva 1999; Vázquez-Domínguez et al. 2004).

The 3 subspecies of *P. guardia* are under special protection by the Mexican Government (Norma Oficial Mexicana 2002). *P. guardia* is listed by the International Union for Conservation of Nature and Natural Resources as “Critically Endangered” (possibly extinct candidate) because there is no known location for the species at present, but the species may persist in small numbers on Angel de la Guarda Island (Álvarez-Castañeda et al. 2008). However, Mellink (1992), Álvarez-Castañeda and Cortés-Calva (1999), and Álvarez-Castañeda and Ortega-Rubio (2003) consider *P. g. harbisoni* and *P. g. mejiae* as extinct, and Mellink et al. (2002) consider the population at Estanque Island to be extirpated as well. If the species still occurs on Angel de la Guarda Island, its area of occupancy will be very small; in a single location, less than 10 km<sup>2</sup>, with a continuing decline in the number of mature individuals due to introduced predators and competitors (Álvarez-Castañeda et al. 2008). Surveys are urgently needed to confirm if it is currently extant.

Major threats to *P. guardia* include predation by feral or domestic cats, competition with introduced rodents, and intrinsic factors due to its limited distribution and small population size (Álvarez-Castañeda et al. 2008). There is a risk that more human activity will result from the Mexican government's plans to make the Gulf of California a major tourist destination, which will substantially increase the chances of detrimental introduction of nonnative species (Álvarez-Castañeda et al. 2006).

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