MAMMALIAN SPECIES 43(885):172–176

Peromyscus guardia (Rodentia: Cricetidae)

EVELYN RIOS AND SERGIO TICUL ÁLVAREZ-CASTAÑEDA

Centro de Investigaciones Biológicas del Noroeste, Mar Bermejo 195, Apartado Postal 128, La Paz, Baja California Sur, 23000, Mexico; everios04@cibnor.mx (ER); sticul@cibnor.mx (STÁ-C)

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

Synonymy completed 1 January 2010
DOI: 10.1644/885.1
www.mammalogy.org

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 *Haplomylomys*, 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."

NOMENCLATURAL 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.

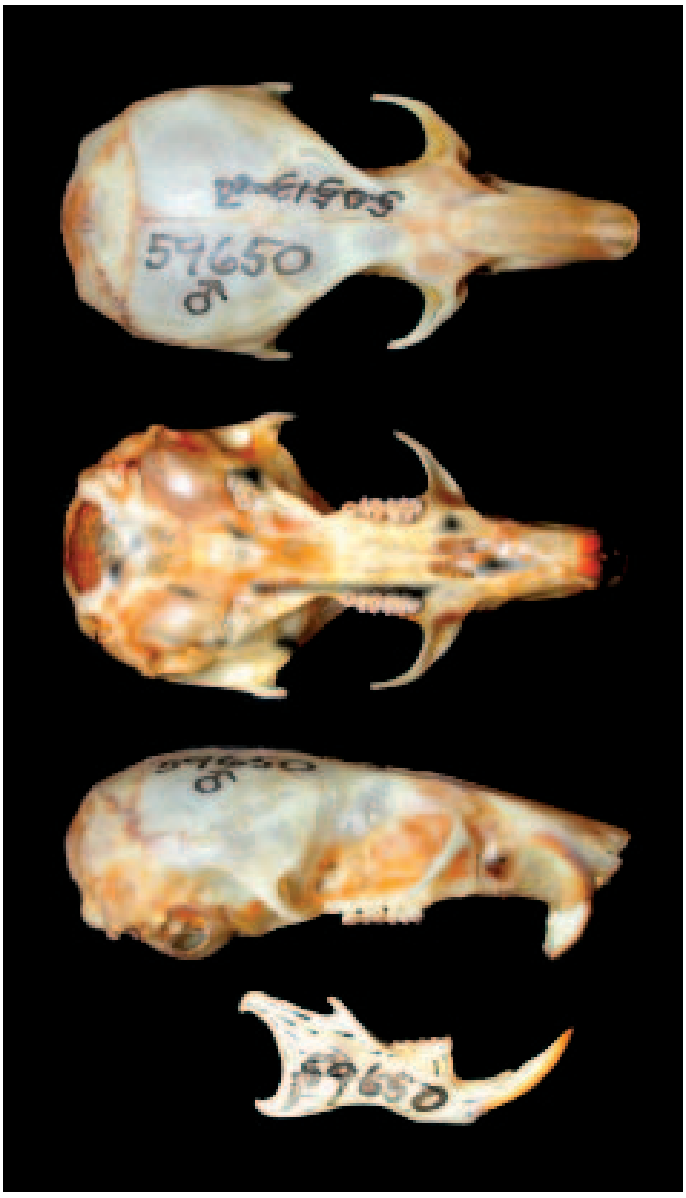

Fig. 2.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of *Peromyscus guardia* (adult male, MVZ 59650) from E side of Angel de la Guarda Island, elevation 30 feet, Gulf of California, Baja California, Mexico. Greatest length of skull is 26.82 mm. Photograph taken by STÁ-C.

used for comparison were *P. fraterculus* (Northern Baja deermouse 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 deermouse) 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 deermouse) 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 (χ = 104.0 mm in *P. g. harbisoni*, χ = 112.9 mm in *P. g. guardia*, and χ = 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 (χ = 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 ± *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 ± 2.51 (189–223); length of tail, 111 ± 1.95 (93–123); length of head and body 93.4 ± 1.76 (81–102); length of skull, 26.4 ± 0.12 (25.5–26.9); width of interparietal, 8.02 ± 0.14 (7.2–8.8); length of palate, 4.4 ± 0.03 (4.2–4.6); length of nasals, 9.49 ± 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

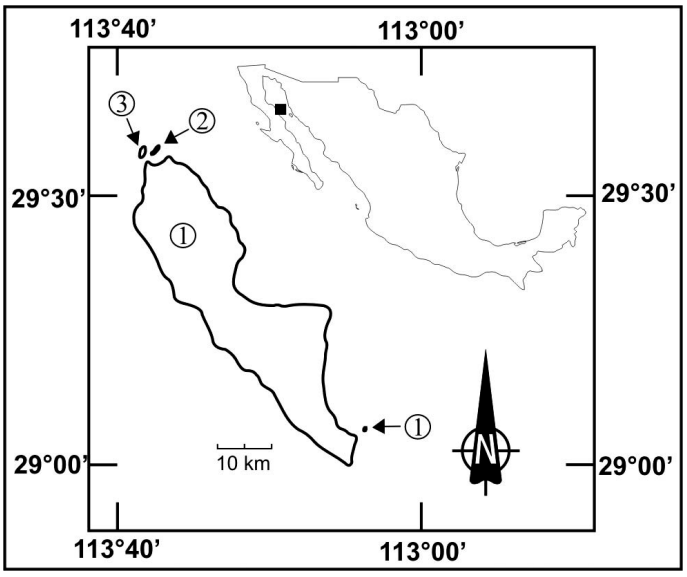

Fig. 3.—Distribution of *Peromyscus guardia* in the Angel de la Guarda archipelago, Gulf of California, Mexico, modified from Álvarez-Castañeda and Cortés-Calva (1999). Subspecies are: 1, *P. g. guardia*; 2, *P. g. harbisoni*; 3, *P. g. mejiae*.

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 (Avise 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 (Avise 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_1 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 deermouse), *P. dickeyi* (Dickey's deermouse), *P. eva* (southern Baja deermouse), or *P. californicus* (California deermouse—Avise 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 (Avise 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 (Alvarez-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^2, 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).

ACKNOWLEDGMENTS

The editor at Centro de Investigaciones Biológicas del Noroeste improved the English text. Financial support was provided by Consejo Nacional de Ciencia y Tecnología (CONACYT grant 39467Q and fellowship No. 158497 to ER), and by Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP2002-COL-019).

LITERATURE CITED

Álvarez-Castañeda, S. T., and T. Álvarez. 1997. Etimologías de los géneros de mamíferos Mexicanos. Ciencia 47:39–49.

Álvarez-Castañeda, S. T., I. Castro-Arellano, T. Lacher, and E. Vázquez. 2008. *Peromyscus guardia*. International Union for Conservation of Nature and Natural Resources Red list of threatened species. www.iucnredlist.org, accessed 21 May 2011.

Álvarez-Castañeda, S. T., and P. Cortés-Calva. 1999. Familia Muridae. Pp. 445–568 in Mamíferos del noroeste de México (S. T. Álvarez-Castañeda and J. L. Patton, eds.), Centro de Investigaciones Biológicas del Noroeste. La Paz, Baja California Sur, México.

Álvarez-Castañeda, S. T., P. Cortés-Calva, L. Méndez, and A. Ortega-Rubio. 2006. Development in the Sea of Cortés calls for mitigation. BioScience 56:825–829.

Álvarez-Castañeda, S. T., and A. Ortega-Rubio. 2003. Current status of rodents on islands in the Gulf of California. Biological Conservation 109:157–163.

Avise, J. C., M. H. Smith, R. K. Selander, T. E. Lawlor, and P. R. Ramsey. 1974. Biochemical polymorphism and systematics in the genus *Peromyscus*: V. Insular and mainland species of the subgenus *Haplomylomys*. Systematic Zoology 23:226–238.

Banks, R. C. 1967. The *Peromyscus guardia–interparietalis* complex. Journal of Mammalogy 48:210–218.

Brand, L. R., and R. E. Ryckman. 1968. Laboratory life histories of *Peromyscus eremicus* and *Peromyscus interparietalis*. Journal of Mammalogy 49:495–501.

Brand, L. R., and R. E. Ryckman. 1969. Biosystematics of *Peromyscus eremicus*, *P. guardia*, and *P. interparietalis*. Journal of Mammalogy 50:501–513.

Burt, W. H. 1932. Descriptions of heretofore unknown mammals from islands in the Gulf of California, Mexico. Transactions of the San Diego Society of Natural History 7:161–182.

Carleton, M. D. 1989. Systematics and evolution. Pp. 7–141 in Advances in the study of *Peromyscus* (Rodentia) (G. L. Kirkland, Jr. and J. N. Layne, eds.). Texas Tech University Press, Lubbock.

Committee for Standardization of Chromosomes of *Peromyscus*. 1977. Standardized karyotype of deermice, *Peromyscus* (Rodentia). Cytogenetics and Cell Genetics 19:38–43.

Hafner, D., B. Riddle, and S. T. Álvarez-Castañeda. 2001. Evolutionary relationships of white-footed mice (*Peromyscus*) on islands in the Sea of Cortéz, Mexico. Journal of Mammalogy 82: 775–790.

Hall, E. R. 1981. The mammals of North America. 2nd ed. John Wiley & Sons, Inc., New York.

Lawlor, T. E. 1971. Evolution of *Peromyscus* on northern islands in the Gulf of California, Mexico. Transactions of the San Diego Society of Natural History 16:91–124.

Lindsay, G. E. 1962. The Belvedere Expedition to the Gulf of California. Transactions of the San Diego Society of Natural History 13:1–44.

Lindsay, G. E. 1966. The Gulf Islands Expedition of 1966. Proceedings of the California Academy of Sciences 30:309–359.

López-Forment, W., I. E. Lira, and C. Mündespacher. 1996. Mamíferos: Su biodiversidad en las islas mexicanas. AGT Editores, México Distrito Federal.

Mellink, E. 1992. Status de los heterómidos y cricétidos endémicos del estado de Baja California. Comunicaciones Académicas. CICESE, Ensenada, Baja California, Mexico.

Mellink, E., G. Ceballos, and J. Luevano. 2002. Population demise and extinction threat of the Angel de la Guarda deer mouse (*Peromyscus guardia*). Biological Conservation 108:107–111.

Musser, G. G., and M. D. Carleton. 2005. Superfamily Muroidea. Pp. 894–1531 in Mammal species of the world, a taxonomic and geographic reference, 3rd ed. (D. E. Wilson and D. M. Reeder, eds.). Johns Hopkins University Press, Baltimore Maryland.

Norma Oficial Mexicana. NOM-059-ECOL-2001. 2002. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Diario Oficial de la Federación.6 de marzo de 2002.

Riddle, B. R., D. J. Hafner, and L. F. Alexander. 2000. Phylogeography and systematics of the *Peromyscus eremicus* species group and the historical biogeography of the North American warm regional deserts. Molecular Phylogenetics and Evolution 17:145–160.

Townsend, C. H. 1912. Mammals collected by the "Albatross" expedition in Lower California in 1911, with descriptions of new species. Bulletin of the American Museum of Natural History 31: 117–130.

Vázquez-Domínguez, E., G. Ceballos, and J. Cruzado. 2004. Extirpation of an insular subspecies by a single introduced cat: the case of the endemic deer mouse, *Peromyscus guardia* on Estanque Island, Mexico. Oryx 38:347–350.

Kristofer M. Helgen reviewed the synonymy. Editors were Meredith J. Hamilton and Virginia Hayssen.