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Peromyscus schmidlyi (Rodentia: Cricetidae)

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Abstract: *Peromycus schmidlyi* Bradley et al., 2004, is a Reithrodontomyine (formally Peromyscini) rodent commonly called Schmidly's deermouse. It is endemic to Mexico, known only from Durango, Sinaloa, and Sonora at elevations greater than 2,000 m. It inhabits rocky hillsides in the pine-oak forest regions of the northern and central portions of the Sierra Madre Occidental. *P. schmidlyi* is a member of the *P. boylii* species group and is closely related to *P. beatae* and *P. levipes*. At this time, it is not considered to be a species deserving special conservation concern.

Key words: cricetid, Mexico, rodent, Schmidly's deermouse

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Peromyscus schmidlyi Bradley et al., 2004
Schmidly's Deermouse

Peromyscus schmidlyi Bradley et al., 2004:1190. Type locality "Mexico: Durango; 3.8 miles (6.1 km) W Coyotes (Hacienda Coyotes)."

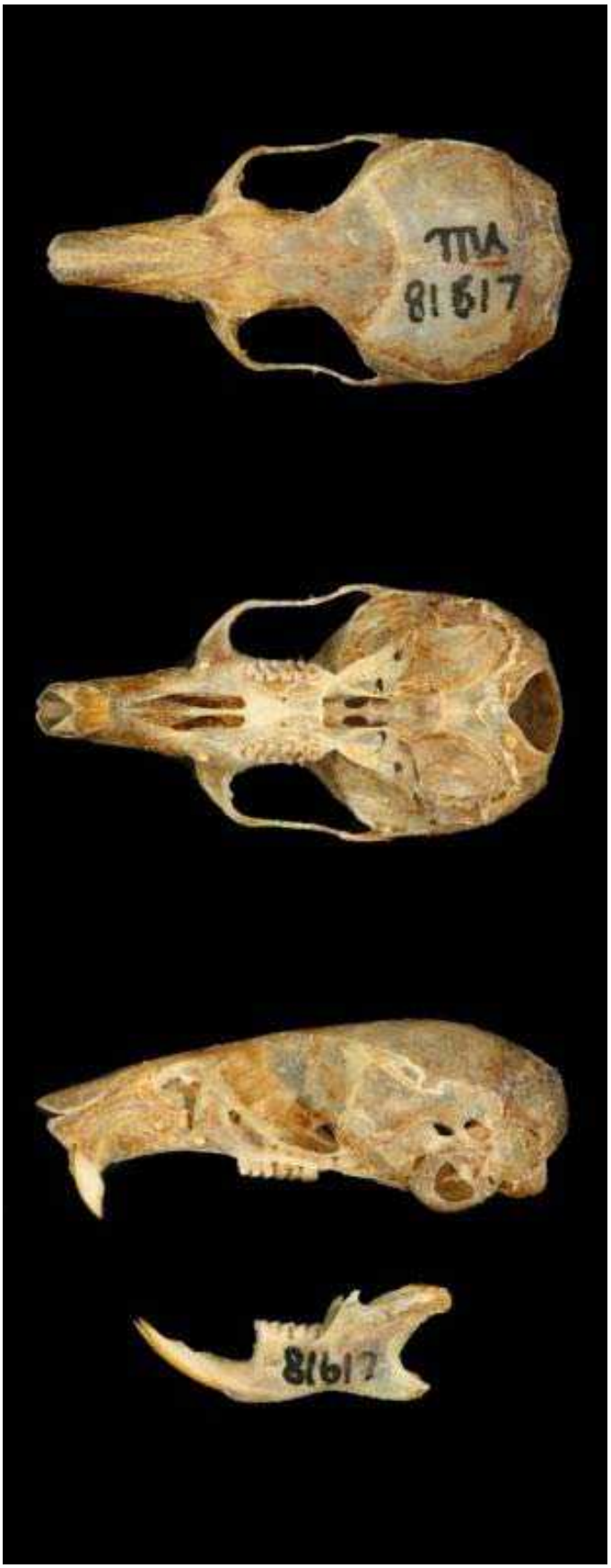
CONTEXT AND CONTENT. Order Rodentia, suborder Myomorpha, superfamily Muroidea, family Cricetidae, subfamily Neotominae, tribe Reithrodontomyini (formally Peromyscini), subgenus *Peromyscus* (Musser and Carleton 2005), *boylii* species group (Bradley et al. 2004).

NOMENCLATURAL NOTES. The phylogenetic relationships and systematic status of the *Peromyscus boylii* species group inhabiting western Mexico has been complex since Hooper (1968) 1st summarized the species group. Studies related to this Mexican region began in the 1960s with specimens currently recognized as *P. schmidlyi* being referred to *P. boylii rowleyi*, *P. b. levipes*, or *P. b. spicilegus* (Baker and Greer 1962; Carleton 1977, 1989; Carleton et al. 1982; Lee et al. 1972; Schmidly and Schroeter 1974). At the center of this conundrum was the fact that 3 subspecies of *P. boylii* (*rowleyi*, *simulus*, and *spicilegus*) occupied the Mexican state of Durango and surrounding areas. Across this region of southern Durango, *P. boylii* varied in color and size from east to west along the slopes of the Sierra Madre Occidental (Baker and Greer 1962). Subsequently, several studies indicated that the specimens from central Durango represented an undescribed subspecies, or perhaps, an undescribed species (Bradley et al. 1996, 2000; Carleton 1977, 1989; Houseal et al. 1987; Tiemann-Boege et al. 2000). Bradley et al. (2004) elevated this taxon to species level based on chromosomal and molecular sequence data and suggested that this species occupied the pine–oak forest of the Sierra Madre Occidental in Durango, Sinaloa, and possibly Sonora. The distribution of *P. schmidlyi* in Sonora was recently confirmed by Cabrera et al. (2007).

DIAGNOSIS

As part of the *Peromyscus boylii* species group (Bradley et al. 2004), *P. schmidlyi* (Fig. 1) resembles other members of the group, including the nimble-footed deermouse (*P. levipes*) with which it is similar in size and coloration.

Fig. 1.—An adult *Peromyscus schmidlyi* from 6.1 km west of Coyotes, Hacienda Coyotes, Durango, Mexico. Photographed by Robert D. Bradley, August 2004.



However, *P. schmidlyi* is larger and darker compared to the brush deermouse (*P. b. rowleyi*—Bradley et al. 2004). The orbital region is hourglass-shaped (Fig. 2) and not angular as compared to that of the gleaning deermouse (*P. spicilegus*). However, at this time there are not sufficient diagnostic morphological differences to separate *P. schmidlyi* from other species of the *P. boylii* species group occurring in western Mexico (Cabrera et al. 2007) and accurate diagnosis requires DNA analyses. In terms of size, specimens from Sonora appear to be smaller than those from the type locality (Coyotes, Durango) with the exception of lengths of rostrum and molar toothrow (Cabrera et al. 2007; see "General Characters").

GENERAL CHARACTERS

Peromyscus schmidlyi is a Reithrodontomyine rodent (Fig. 1) characterized by a combination of traits (Bradley et al 2004): tail coarsely haired to the tip and bicolored, Blackish-Brown (Ridgway's color standards—Ridgway 1912) above and White below, scantily haired at base and tufted at tip; tail usually longer than head and body; hind feet principally whitish and <23 mm in length. Molar toothrow > 4 mm; baculum, one-half length of hind foot with a small knob-shaped tip capped by a minute cone of cartilage as in other members of the *P. boylii* species group (Bradley and Schmidly 1987). Surface between orbital region and nasals convex in lateral view; postorbital constriction hourglass-shaped in dorsal view (Fig. 2). Dorsal pelage is Mummy Brown at tips and Plumbeous-Black at base; sides Cinnamon-Rufous; ventral pelage White at tips and Plumbeous-Black at base; feet possess an Iron Gray stripe extending slightly past ankle; toes White; ears Dark Neutral Gray; and vibrissae Black (Bradley et al. 2004). External measurements of holotype (mm) are: total length, 186.0; length of tail vertebrae, 84.0; length of hind foot, 20.0; and length of ear from notch 20.0 (Bradley et al. 2004). Craniodental measurements (mm; taken with dial calipers) on same specimen are: greatest length of skull, 26.65; zygomatic breadth, 13.10; breadth of braincase, 12.50; depth of cranium, 9.90; interorbital breadth, 4.30; breadth of rostrum, 4.40; length of rostrum, 10.30; length of palate, 4.70; length of molar toothrow, 4.10; length of incisive foramen, 5.55; breadth of zygomatic plate, 2.05; and breadth of mesopterygoid fossa, 3.65 (Bradley et al. 2004). External

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Fig. 2.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of type specimen of *Peromyscus schmidlyi.* Adult female from 6.1 km west of Coyotes, Hacienda Coyotes, Durango, Mexico (Museum of Texas Tech University [TTU 81617]). Greatest length of skull is 26.65 mm. Photograph by Bill Mueller, February 2009, used with permission.

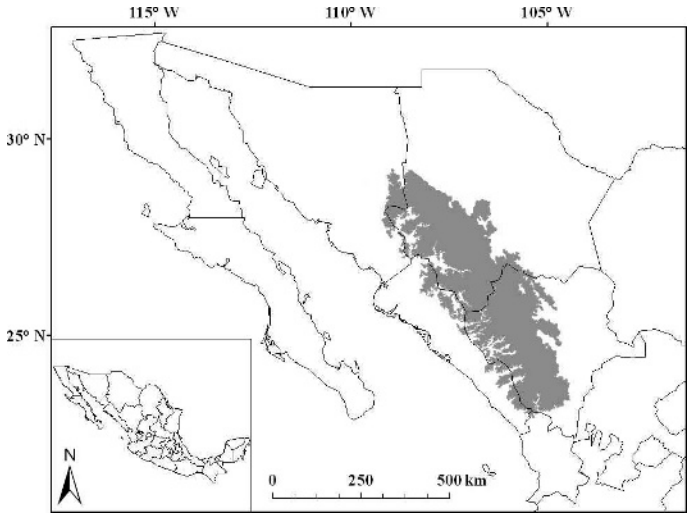

Fig. 3.—Geographic distribution of *Peromyscus schmidlyi*.

and cranial measurements (mm; mean ± *SD*; $n = 8$; ranges in parentheses) of specimens from Sonora are: total length, 179.5 ± 14.76 (175–205); length of tail, 86.0 ± 8.57 (72–102); length of hind foot, 19.4 ± 1.06 (19–21); length of ear, 19.5 ± 0.93 (18–21); length of skull, 26.2 ± 1.22 (24.2–28.8); zygomatic breadth, 12.9 ± 0.43 (12.4–13.6); breadth of braincase, 12.1 ± 0.30 (11.6–12.5); depth of cranium, 9.4 ± 0.27 (9.0–9.7); interorbital breadth, 4.2 ± 0.15 (4.1–4.4); breadth of rostrum, 4.2 ± 0.20 (3.9–4.5); length of rostrum, 10.4 ± 0.62 (9.3–11.2); length of palate, 4.0 ± 0.33 (3.7–4.6); length of molar toothrow, 4.2 ± 0.19 (4.0–4.6); length of incisive foramen, 4.9 ± 0.38 (4.6–5.3); and breadth of zygomatic plate, 1.9 ± 0.32 (1.2–2.2).

DISTRIBUTION

Peromyscus schmidlyi is endemic to Mexico, known only from Durango, Sinaloa (Bradley et al. 2004), and Sonora (Cabrera et al. 2007), at elevations greater than 2,000 m (Fig. 3; Bradley et al. 2004). The record from Sonora (Cabrera et al. 2007) indicates that the geographical distribution extends northward throughout the Sierra Madre Occidental, and may continue to the western part of Chihuahua, northeastern Nayarit, northwestern Zacatecas, and northern Jalisco. In 2008, additional specimens collected in Yecora, Sonora, were identified as *P. schmidlyi* based on DNA sequence analysis (R. D. Bradley, in litt.). The earliest fossil of the Reithrodontomyines occurred during the Pliocene (5–10 million years ago—Hibbard 1968); for *P. schmidlyi* there are no available data.

FORM AND FUNCTION

Dental formula is i 1/1, c 0/0, p 0/0, m 3/3, total 16. Upper incisors are not grooved. Molars are bunodont and typical of other species of *Peromyscus*. Phallus elongate in shape, glans about one-half length of hind foot and 6 times longer than wide; measurements of glans and baculum, except for the distance from the urinary meatus to the distal tip of the glans, larger than other taxa in *P. boylii* group (see *P. boylii rowleyi*—Bradley and Schmidly 1987). Glans and baculum narrow relative to length; surface of glans covered with triangular spines of equal height and width, with asymmetrical distribution; slight fluting evident on dorsal and ventral surfaces of glans (see *P. boylii rowleyi*—Bradley and Schmidly 1987).

ECOLOGY

Space use.—*Peromyscus schmidlyi* inhabits the central highlands of the Sierra Madre Occidental in Mexico, a mountain range bounded by the Mesa Central to the east and the Tropical Deciduous forest to the west (Bradley et al. 2004). *P. schmidlyi* inhabits mountain regions that are dissected by numerous deep gullies or canyons. These gullies often are bordered by steep-sided walls of massive rock (Webb and Baker 1962). The type locality and other areas where *P. schmidlyi* has been collected are hillsides covered principally with pines having drooping needles (pino triste [*Pinus lumbholtzii*]) and distinctive oaks of a broadleaf species (*Quercus viminea*); rocky hillsides with fallen logs, rocks, boulders, and old rock walls are reported for areas around the type locality. Forests dominated by pines, oaks, madroño, and manzanita cover most of the plateau that forms the crest of the Sierra Madre Occidental (Webb and Baker 1962). Specimens from Sonora have been collected in pine–oak forest, including one-seeded juniper (*Juniperus monosperma*), Apache pine (*Pinus engelmani*), Ponderosa pine (*Pinus ponderosa*), Yécora pine (*Pinus yecorensis*), Arizona white oak (*Quercus arizonica*), Sípuri (*Quercus durifolia*), silverleaf oak (*Quercus hypoleucoides*), and kittle lemonhead (*Coreocarpus arizonicus*—Cabrera et al. 2007).

Diseases and parasites.—Members of the *Peromsycus boylii* species group are host for viruses (Monroe et al. 1999) and bacteria (Schwan et al. 2009) that cause several diseases. Although no parasites have been reported specifically for *P. schmidlyi*, herein is a list of the principal parasites and related diseases for species related to *P. schmidlyi* (i.e., *P. boylii*—Whitaker 1968).

In the southwestern United States, the rodent species important in maintaining enzootic transmission of bubonic plague include mice of the genus *Peromyscus* (Davis et al. 2002). *Peromyscus* serves as a vector of plague by maintaining fleas and *Yersinia pestis*, the bacterium causing this disease (Davis et al. 2002). There is a report for 1 member of the *P. boylii* species group with positive serology for *Y. pestis* (Davis et al. 2002; Nieto et al. 2007) in California.

Species of *Peromyscus* are host for Limestone Canyon hantavirus, and there is at least 1 report for a member of the *P. boylii* species group that is host of this virus (Kuenzi et al. 2007). Also, there are reports of *P. boylii* as a reservoir of hantavirus (Abbott et al. 1999; Mantooth et al. 2001), including Sin Nombre virus (Kuenzi et al. 1999). Recently, the tick *Ixodes spinipalpis* was found to be a competent Lyme disease vector in enzootic cycles involving mice of the genus *Peromyscus* (Fritz and Kjemtrup 2003). Other species of ticks reported for *Peromyscus* are *Ixodes angustus* and *I. scapularis* (Wilder and Meikle 2004). Also, a bacterial agent of Lyme disease, *Borrelia burgdorferi*, has been isolated from some cricetids including some members of the *P. boylii* species group (Burkot et al. 1999). Cestodes (tapeworms) are reported for at least 1 species of the *P. boylii* species group. These include *Hymenolepis horrid*, *Mesocestoides kirbyi*, and *M. variabilis* (Whitaker 1968). Nematodes reported from intestinal tracts of members of the *P. boylii* species group are *Gongylomena peromysci* and a species of *Heligmosomum* (Whitaker 1968). Mites generally are the most abundant parasite on mice of the genus *Peromyscus*. Species reported as most abundant in the *P. boylii* species group are *Eubrachylaelaps circulari* and *Androlaelaps fahrenholzi*. Other reported species are *Androlaelaps casalis*, *Brevisterna uthaensis*, *Bryobia praetiosa*, *Dermanyssus becki*, *Eubrachylaelaps debilis*, *Hemogamasus nidi*, *H. ppontiger*, *Hirstionyssus affinis*, and *H. occidentalis* (Whitaker 1968).

Larval forms of mites or chiggers from the family Trombiculidae are usual parasites of *P. boylii* species group, including *Chatia ochotona*, *Euschoengastia criceticola*, *E. lacerta*, *E. peromysci*, *E. pomerantzi*, *E. randfordi*, *Neotrombicula dinehartae*, *N. jewetti*, *Odontacarus hirsutus* (Whitaker 1968), and *O. villosus* (Goff and Loomis 1973). Fleas are very common on *Peromyscus*, often several being found on a single individual; they could be of the same or different species. Various species of *Peromyscus* are the type host for at least 19 species of fleas. For species of the *P. boylii* group the list includes: *Atyphloceras echis*, *A. felix*, *A. multidentatus*, *Catallagia decipiens*, *C. mathesoni*, *Coropsylla kohlsi*, *Epitedia standfordi*, *Hystrichopsylla dippieri*, *H. gigas*, *Hoplopsyllus anomalus*, *Malaraeus sinomus*, *M. telchinum*, *Megarthroglossus procus*, *Monopsyllus eumolpi*, *M. wagneri*, *Opisodasys keeni*, *Orchopeas howardi*, *O. leucopus*, *O. sexdetatus*, *Peromyscopsylla ebrighti*, *P. hemisphaerium*, *P. heperomys*, *P. adelpha*, *Pleochaetis sibynus*, *Rhadinopsylla sectilis* (Whitaker 1968), *Stenoponia ponera* (Tipton and Mendez 1968), *S. americana*, and *Hoplopsyllus affinis* (Medina et al. 2006). For members of the *P. boylii* species group 2 species of sucking louse have been reported: *Hoplopleura ferrisi* and *Polyplax auricularis* (Whitaker 1968). A relatively large amount of information has accumulated concerning parasitism on *Peromyscus* by botfly larvae, *Cuterebra*; however, there are only 2 reports for the *P. boylii* species group carrying botflies (Brown 1965; Seaman and Nash 1976).

Interspecific interactions.—*Peromyscus schmidlyi* has been collected with the following species: *P. spicilegus*, black-eared deermouse (*P. melanotis*), southern rock deermouse (*P. difficilis*), Mexican woodrat (*Neotoma mexicana*), Mexican harvest mouse (*Reithrodontomys zacatecae*), yellow-nosed cotton rat (*Sigmodon ochrognathus*), white-eared cotton rat (*S. leucotis*), Mexican vole (*Microtus mexicanus*), and Durango chipmunk (*Tamias durangae*).

Miscellaneous.—Specimens of *Peromycus schmidlyi* collected at the type locality and the northern locality in Sonora during June and July were adults or subadults, and some of the females were lactating or had embryos (based on field notes archived with voucher specimens in the Museum at Texas Tech University). Three males collected in October in Sonora exhibited scrotal testes and 3 females had 2 embryos each (Cabrera et al. 2007).

GENETICS

Cytogenetics.—All species of *Peromyscus* have a diploid number (2n) of 48. Karyotypes exhibit fundamental numbers (FN) ranging from 54 to 56 with polymorphisms observed in FN = 54 and FN = 55 karyotypes (Bradley et al. 2004). Specimens evaluated from Durango and the surrounding areas by Bradley et al. (2004) possessed a biarmed condition for chromosomes 1, 22, and 23, with the condition for chromosomes 2 and 9 polymorphic, producing the range seen in the fundamental number. Bradley et al. (2004) also reported 5 different karyotypes among 48 specimens of *P. schmidlyi* from Durango. The standard pattern for the FN = 54 karyotype involved an acrocentric chromosome 2 and a biarmed chromosome 9, and 1 karyotype with FN = 54 was heteromorphic for chromosomes 2 and 9. One hypothesis that has been proposed to explain the origin of the FN = 54–56 karyotype is that it represents an introgression between an unnamed FN = 56 form and the FN = 52 form of *P. b. rowleyi* (Kilpatrick and Zimmerman 1975; Schmidly and Schroeter 1974). This hypothesis was supported by Kilpatrick and Zimmerman (1975). However, neither Schmidly and Schroeter (1974) nor Kilpatrick and Zimmerman (1975) were able to demonstrate that the variation attributed to introgression or hybridization was not polymorphism within a reproductively isolated population.

Bradley et al. (2004) suggested that the FN = 54–56 karyotype is unique to *P. schmidlyi* and probably is not a result of hybridization. To support this position, Bradley et al. (2004) proposed the following, 1st, the unnamed form presumably involved in this hybridization event would have to be monomorphic for the FN = 56 karyotype. The FN = 52 form would have to hybridize with the FN = 56 form to produce the FN = 54–56 polymorphism; however, no

population that is monomorphic for the FN = 56 karyotype has been recorded in the region. Additionally, if an FN = 52 form was involved in hybridization, FN = 53 forms would be expected to be generated in backcross individuals and these have not been reported. Second, the condition of chromosomes 2 (acrocentric) and 9 (biarmed) are unique compared to other members of the *P. boylii* species group that possess the FN = 54 karyotype. Third, the geographic distribution of the karyotypes shows that the FN = 54–56 forms occupy a specific habitat in southern Durango and eastern Sinaloa, Mexico. Bradley et al. (2004) gave other possible explanations for the origin of the FN = 54–56 karyotype, suggesting that the FN = 54–56 karyotype could involve either a hybridization event or isolation and subsequent differentiation of a former widespread polymorphic population.

The FN = 56 karyotype is identical to the FN = 56 karyotype of *P. levipes* from Michoacán and Jalisco (Bradley et al. 2004; Houseal et al. 1987). If the FN = 56 karyotype of *P. levipes* represents an ancestral population once distributed in Durango or nearby areas, it might have been involved in past hybridization events (with FN = 52 karyotype forms) that led to the FN = 54–56 karyotype forms. Alternatively, a widely distributed FN = 54–60 karyotype might have became isolated and differentiated into the FN = 54–56 karyotype form (Bradley et al. 2004).

Molecular genetics.—Specimens of *Peromyscus schmidlyi* have been analyzed phylogenetically, and compared with other members of the *P. boylii* group (Bradley et al. 2004). Sequences of the mitochondrial genome corresponding to the cytochrome-*b* gene indicate that *P. schmidlyi* is a sister taxon to *P. levipes* (parsimony analysis) or sister to a clade that contains the Orizaba deermouse (*P. beatae*) and *P. levipes* (maximum likelihood and Bayesian analysis). The sequence divergence distances between *P. schmidlyi* and members of the *P. boylii* species group (*P. beatae*, *P. boylii*, *P. levipes*, Tres Marías deermouse [*P. madrensis*], Sinaloan deermouse [*P. simulus*], San Esteban deermouse [*P. stephani*], and an undescribed species of *Peromyscus* from Nayarit and Michoacán, Mexico) are, respectively, 5.63%, 7.94%, 3.25%, 6.97%, 7.35%, 8.08%, 3.37%, and 3.34% (Bradley et al. 2004), indicating levels of genetic divergence compatible with the Genetic Species Concept as discussed by Baker and Bradley (2006).

CONSERVATION

Peromyscus schmidlyi is listed as a species of "Least Concern" by the International Union for Conservation of Nature and Natural Resources (2010) with population trends listed as unknown. Populations in Durango appear to be robust in that several individuals were collected at various localities across the Sierra Madre Occidental. Specimens have been collected more or less continually from the 1960s to as recently as 2008. However, as with many other species that occur in the old-growth pine–oak forest, logging and other human-related activities are a concern for the long-term survival of the species.

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