



Tamiasciurus mearnsi (Rodentia: Sciuridae)

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Abstract: *Tamiasciurus mearnsi* (Townsend, 1897) is a small-sized tree squirrel commonly called Mearns’s squirrel. One of 3 species that comprise the genus *Tamiasciurus*, *T. mearnsi*, is endemic to the Sierra de San Pedro Mártir in Baja California, Mexico; it is considered rare and occurs only at low densities. *T. mearnsi* is federally listed as “Threatened” in Mexico and is also included in the International Union for the Conservation of Nature and Natural Resources *Red List of Threatened Species* as “Endangered.” The introduction of the eastern gray squirrel (*Sciurus carolinensis*) may be a serious threat to this relict species.

Key words: ardilla roja, Baja California, endemic species, Mearns’s squirrel, Mexico, Sierra de San Pedro Mártir, tree squirrel

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Tamiasciurus mearnsi (Townsend, 1897)

Mearns’s Squirrel

Sciurus hudsonius mearnsi Townsend, 1897:146. Type locality “San Pedro Martir Mountains, Lower California (altitude about 7,000 feet).”

Sciurus mearnsi Allen, 1898:286. Elevation to specific status.

Sciurus douglasii mearnsi Elliot, 1903:210. Replacement name for *Sciurus hudsonius mearnsi* Townsend, 1897.

Tamiasciurus douglasii mearnsi Hayman and Holt in Ellerman, 1940:348. Replacement name for *Sciurus hudsonius mearnsi* Townsend, 1897 (= *Sciurus douglasii mearnsi* Elliot, 1903).

Tamiasciurus mearnsi: Lindsay, 1981:680. Elevation to specific status; first use of current name combination.

CONTENT AND CONTEXT. Order Rodentia, suborder Sciuromorpha, family Sciuridae, subfamily Sciurinae, tribe Sciurini, genus *Tamiasciurus*. *Tamiasciurus mearnsi* is monotypic (Wilson and Reeder 2005).

NOMENCLATURE NOTES. Lindsay (1981) recommended that *Tamiasciurus mearnsi* be elevated to species status based on the comparison of skull characteristics (of 32 specimens) with similar samples of *T. douglasii albolimbatus* (Douglas’s squirrel) from south central California and *T. hudsonicus mogollonensis*

(red squirrel) from Arizona and New Mexico. Both univariate (12 of 17 cranial features) and multivariate statistics separated



Fig. 1.—An adult female *Tamiasciurus mearnsi* from the Sierra de San Pedro Mártir, Baja California, Mexico. Photograph taken at Vallecitos on 10 August 2005 by N. Ramos-Lara.

the 3 species equally (Lindsay 1981). The specific epithet is in honor of Dr. Edgar A. Mearns, Naturalist of the United States-Mexican Boundary Commission of 1892–1894 (Townsend 1897). The common name of Mearns's squirrel is used as recommended by Wilson and Cole (2000). Other common names are Mearns squirrel, ardilla roja, Mearns Chickaree (Mearns 1907), and Sierra San Pedro Martir Chickaree (Minnich et al. 1997).

DIAGNOSIS

No native populations of sympatric species of arboreal squirrels exist within the range of *Tamiasciurus mearnsi* (Yensen and Valdés-Alarcón 1999; Thorington et al. 2012). However, in 1946, 2 populations of eastern gray squirrels (*Sciurus carolinensis*) were introduced separately in the same mountains where *T. mearnsi* occurs (Huey 1964). Eastern gray squirrels have a slate to steel gray dorsum (not pale gray to brown as in *T. mearnsi*) occasionally suffused with buff or brown (not reddish-yellow to peach); venter is white and tail is gray (not black) frosted with white to buff (Koprowski 1994); eastern gray squirrels lack the distinctive lateral stripe present in *T. mearnsi* (Yensen and Valdés-Alarcón 1999). Eastern gray squirrels (550 g) are about twice the body size of *T. mearnsi* (271.6 g—Koprowski 1994; Ramos-Lara 2012). The dental formula of *T. mearnsi* is $i\ 1/1, c\ 0/0, p\ 1/1, m\ 3/3$, total 20 (Yensen and Valdés-Alarcón 1999 and that of the eastern gray squirrel is $i\ 1/1, c\ 0/0, p\ 2/1, m\ 3/3$, total 22, with the first upper premolar peg-like and usually present (Koprowski 1994).

Tamiasciurus mearnsi differs from *T. h. mogollonensis* and *T. d. albolimbatu*s in being paler gray dorsally and having a dorsal band of reddish-yellow. *T. d. albolimbatu*s is darker gray to almost black dorsally, more yellow on the venter, and has a less distinct lateral stripe. The tail is more red dorsally with some white ventrally; ears are slightly tufted. *T. h. mogollonensis* is a uniform reddish-brown dorsally without a central band, white venter, less distinct lateral stripe; legs more reddish-brown than yellow, white beneath; tail reddish toward base; ears not tufted (Lindsay 1981). *T. mearnsi* is also on average heavier than *T. hudsonicus* (male = 194.0 g, female = 213.0 g) and *T. douglasii* (male = 206.9 g, female = 199.3 g—Ramos-Lara 2012; Thorington et al. 2012).

GENERAL CHARACTERS

Tamiasciurus mearnsi is a diurnal tree squirrel of small size (Fig. 1). Pelage is soft and dense with thick long underfur beneath lengthy guard hairs. The body is dorsally pale gray-brown with reddish-yellow middorsal band; venter is white with some scattered yellow spots, hairs are gray at base; a distinct black lateral stripe separates the dorsal and ventral pelage. The forelegs are reddish-yellow to peach above and whitish beneath; hind legs are gray-brown above, and yellowish on sides and underside. The tail is black, short, and bushy with slight outer white fringe and dorsal yellow fringe toward base. Top of head is light gray.

Ears are blackish and yellowish toward base, with slight tuft. Nose and mouth area are light yellowish with gray-brown above nose. Ring around the eye is whitish (Townsend 1897; Nelson 1899; Lindsay 1981; Thorington et al. 2012).

Mean measurements ($\pm SD$ mm) for 32 adults (Lindsay 1981) were: head and body length, 201.00 ± 13.22 ; hind foot length, 51.39 ± 5.15 ; greatest length of skull, 49.17 ± 0.84 ; greatest height of skull, 17.23 ± 0.33 ; zygomatic width, 27.65 ± 0.56 ; nasal length, 13.18 ± 0.34 ; interorbital breadth, 15.00 ± 0.49 ; braincase breadth, 20.49 ± 0.30 ; length of maxillary toothrow, 8.17 ± 0.17 ; temporal fossa diagonal, 16.97 ± 0.33 ; diastema length, 12.91 ± 0.37 ; 2nd molar width, 2.59 ± 0.06 ; premolar width, 2.11 ± 0.06 ; breadth at 3rd molars, 6.27 ± 0.21 ; pterygoid width, 4.02 ± 0.15 ; foramen magnum height, 6.31 ± 0.15 ; foramen magnum width, 7.30 ± 0.18 ; nasal width, 7.86 ± 0.30 ; and infraorbital foramen breadth, 6.93 ± 0.42 (Fig. 2). Mean body mass ($\pm SD$ g; range) for 20 males and 18 females, respectively, were: $271.6 (\pm 18.1; 220\text{--}300)$ and $271.7 (\pm 31.1; 220\text{--}360)$, with females weighing slightly more than males (Ramos-Lara 2012). However, Lindsay (1981) did not find sexual dimorphism in cranial and skin characters.



Fig. 2.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of an adult female *Tamiasciurus mearnsi* (The Field Museum of Natural History [FMNH] #10576) from Vallecitos, Sierra de San Pedro Mártir, Baja California, Mexico. Photographs taken by B. Patterson used with permission. Greatest length of skull is 51.1 mm.

DISTRIBUTION

Tamiasciurus mearnsi is endemic to the Sierra de San Pedro Mártir in Baja California, Mexico (Lindsay 1981; Mellink-Bijtel 1991; Fig. 3). *T. mearnsi* is separated from the nearest population of its congener *T. douglasii* by about 560 km of mostly nonforested lowlands (Taylor 1999; Yensen and Valdés-Alarcón 1999). Anecdotal accounts of its presence in the Sierra de la Laguna, to the south of Sierra de San Pedro Mártir, in Baja California Sur, Mexico (Leopold 1959) and northward into the Cuyamaca and Laguna Mountains of southern California, United States (Mearns 1907), have never been substantiated; it is believed endemic to a single montane island (Yensen and Valdés-Alarcón 1999; Thorington et al. 2012). Within the Sierra de San Pedro Mártir, *T. mearnsi* is known from only 3 sites < 10 km apart: La Grulla (30°53'N, 115°28'W—Minnich and Vizcaino 1998), Vallecitos (31°00'N, 115°31'W—Minnich and Vizcaino 1998), and 6.3 km west of Vallecitos by road (Yensen and Valdés-Alarcón 1999). To the east of the Sierra de San Pedro Mártir, the San Felipe desert provides a formidable barrier between *T. mearnsi* and *T. hudsonicus*. To the north and west of the Sierra de San Pedro Mártir, Californian chaparral is a barrier between *T. mearnsi* and *T. douglasii* in the Sierra Nevada (Yensen and Valdés-Alarcón 1999).

FOSSIL RECORD

No occurrence of *Tamiasciurus mearnsi* in the fossil record is known. Lindsay (1981) and Arbogast et al. (2001) suggest that much of the geographic variation in *Tamiasciurus*, including that of *T. mearnsi*, likely resulted from periodic isolation during

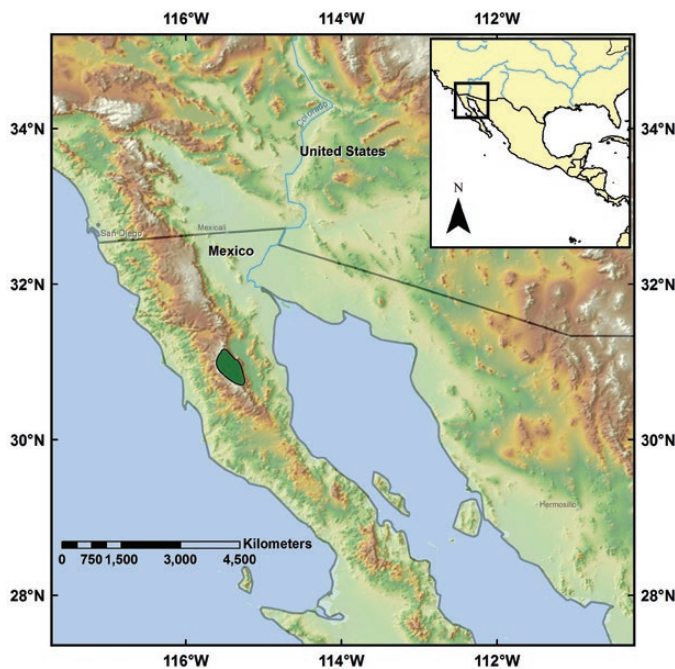


Fig. 3.—Geographic distribution of *Tamiasciurus mearnsi*. Created by M. J. Merrick.

the Pleistocene. Ancestors of *T. mearnsi* could have invaded the Peninsula of Baja California during 1 or more mesic cycles, perhaps as early as 700,000 years ago (Hafner and Riddle 1997). Yensen and Valdés-Alarcón (1999) believed that Mearns's squirrel was present in the Sierra de Juárez Mountains of Baja California during the Wisconsin glaciation of more northerly portions of North America.

FORM AND FUNCTION

One of 4 individuals collected in April and May had initiated molt into summer pelage (Allen 1893; Townsend 1897; Mearns 1907). During the summer rains, *Tamiasciurus mearnsi* may consume water from temporary creeks (Ramos-Lara 2012). Communal nesting occurs among adult individuals during the summer months; however, the physiological significance is still unknown (Ramos-Lara and Koprowski 2012).

ONTOGENY AND REPRODUCTION

Tamiasciurus mearnsi may reach sexual maturity between 10 and 12 months of age when ≥ 240 g (Ramos-Lara 2012). An estrous female with an enlarged pink vulva was reported in May during a mating chase involving 2–3 males (Koprowski et al. 2006). Males may possess scrotal testes during 5–7 months, with mating season starting in February or March and ending in July or August. Pregnant females have been recorded in April and May. Litter size ranges from 2 to 5 young/litter (Ramos-Lara 2012; Fig. 4). Female *T. mearnsi* may produce 1 or 2 litters/year with weather and food supply apparently influencing reproduction (Ramos-Lara 2012).



Fig. 4.—A litter of 5 *Tamiasciurus mearnsi* placed on the ground by their mother during a move to a new cavity nest in the Sierra de San Pedro Mártir, Baja California, Mexico. Photograph taken at Vallecitos on 25 May 2006 by N. Ramos-Lara.

ECOLOGY

Little ecological information on *Tamiasciurus mearnsi* exists and only 42 museum specimens are known (Yensen and Valdés-Alarcón 1999; Koprowski 2005). *T. mearnsi* is known from high elevation forests at 3 localities within the Sierra de San Pedro Mártir. *T. mearnsi* is considered to be a pluvial montane coniferous forest relict of the Peninsular fauna (Hafner and Riddle 1997) likely isolated during 1 or more of the glacial advances during the Pleistocene (Lindsay 1981; Yensen and Valdés-Alarcón 1999; Arbogast et al. 2001). *T. mearnsi* is considered to be diagnostic of the Baja California province of Mexico (Marrone and Escalante 2002; Escalante et al. 2003).

Tamiasciurus mearnsi is reported from boreal (Mearns 1907), pine (Nelson 1899), and transition forests (Nelson 1899) in the Sierra de San Pedro Mártir. Minnich et al. (1997) classified *T. mearnsi* as a characteristic mammal of the mixed-conifer forest zone in the Sierra de San Pedro Mártir. The 3 sites from which *T. mearnsi* is known are located at elevations between 2,100 and 2,750 m in forests composed principally of Jeffrey Pine (*Pinus jeffreyi*) with sugar pine (*P. lambertiana*), lodgepole pine (*P. contorta*), 2-leaved pine (*P. murrayana*), white fir (*Abies concolor*), canyon live oaks (*Quercus chrysolepis*), gray oak (*Q. grisea*), quaking aspen (*Populus tremuloides*), and incense cedar (*Calocedrus decurrens*) comprising the remainder of tree diversity (Elliot 1903; Vilella and Gerez 1994; Yensen and Valdés-Alarcón 1999; Felger et al. 2001; Ramos-Lara 2012). Lindsay (1981) reports the lower elevation records for *T. mearnsi* to be closer to 2,040 m.

The mixed-conifer forests potentially inhabited by *T. mearnsi* are estimated to be 40,655 ha and are located within the Sierra de San Pedro Mártir National Park established in 1947 (Minnich et al. 2000; Bojórquez-Tapia et al. 2004). Forests in the Sierra de San Pedro Mártir are open with forest cover ranging between 25% and 45% and stem densities of 65–145 trees/ha (Minnich et al. 2000; Ramos-Lara 2012; Fig. 5). The mixed-conifer forests are maintained by highly seasonal precipitation with as much as 700 mm occurring at the highest elevations (Minnich et al. 1993); however, mean annual precipitation during a 3-year period ranged between 9.0 and 22.8 mm (Ramos-Lara 2012). These forests experience burns infrequently at 15- to 82-year intervals (Minnich et al. 1993; Minnich et al. 2000; Stephens et al. 2003) over small areas of < 1,000 ha (Minnich 1989; Minnich et al. 2000) likely due to low fuel levels and lightning strikes at rates of about 2.3/1,000 h (Minnich et al. 1993). The coniferous forests of the Sierra de San Pedro Mártir have not been logged nor has fire suppression been practiced (Minnich et al. 2000; Stephens et al. 2003). This ecosystem has been used heavily as summer grazing range since the early Spanish missions of the 1700s (Minnich et al. 1997; Minnich and Vizcaino 1998).

Original biological assessments of the Sierra de San Pedro Mártir described *T. mearnsi* as very common (Nelson 1921). Leopold (1959) stated that *T. mearnsi* populations were usually small. Huey (1964) reported *T. mearnsi* to be rare in the higher



Fig. 5.—Open conifer-dominated forest habitat of *Tamiasciurus mearnsi* in the Sierra de San Pedro Mártir, Baja California, Mexico. Photograph taken at Vallecitos on 9 May 2008 by N. Ramos-Lara.

coniferous forests within its distribution. Densities of *T. mearnsi* are related to abundance of food. Survival of males and females during a radiotelemetric study was comparable. Maximum number of years alive post-collaring was 1.9 years for males and 1.2 years for females. Sex ratio (male:female) reported for adult *T. mearnsi* was 1.25:1 (Ramos-Lara 2012).

In contrast to other *Tamiasciurus*, home-range dynamics of *T. mearnsi* are more similar to the pattern observed in tree squirrels of the genus *Sciurus*, apparently due to their nonterritorial behavior (Ramos-Lara and Koprowski 2012, 2015). Estimates of adult home ranges (mean \pm SD) for males (3.91 ± 3.60 ha) were larger than those for females (1.58 ± 1.14 ha) using 95% fixed kernels; no difference was observed between mating and nonmating seasons. Adult males may travel greater distances from their nests during their daily activities compared to females. Similarly, juvenile males may travel distances 7.8 times greater than those of females before settling in other areas of the forest. Maximum distance traveled by a juvenile male was 1,800 m (Ramos-Lara 2012).

In stark contrast to its 2 congeners (*Tamiasciurus hudsonicus* and *T. douglasii*—Steele 1998, 1999), *T. mearnsi* does not larderhoard cones in middens nor do it build leaf nests (i.e., dreys) in the canopy; instead, it relies on tree cavities for nests (Koprowski et al. 2006; Ramos-Lara et al. 2013). More than 2 individuals may nest in different cavities of the same tree (Ramos-Lara and Koprowski 2012). *T. mearnsi* is known to nest in cavities of live and dead Jeffrey pine, lodgepole pine, and white fir. White firs, dead trees, large trees, and canopy cover are important habitat characteristics for nesting. Females seem to use primarily live trees, whereas males use primarily dead trees. An individual *T. mearnsi* was reported to nest underground occasionally (Ramos-Lara et al. 2013).

Tamiasciurus mearnsi feeds mainly on fir (*Abies*) and pine (*Pinus*) seeds of the current year (Fig. 6), and other food items such as pollen, twigs, branch tips, bones, deer antlers, and the basidiomycete fungi, veiled polypores (*Cryptoporus volvatus*),



Fig. 6.—A subadult *Tamiasciurus mearnsi* feeding on a Jeffrey pine (*Pinus jeffreyi*) cone in the Sierra de San Pedro Mártir, Baja California, Mexico. Photograph taken at Vallecitos on 15 July 2005 by N. Ramos-Lara.

found on the upper trunk of white firs (Ramos-Lara 2012). Interspecific interactions are poorly known. A red-tailed hawk (*Buteo jamaicensis*) chased a *T. mearnsi* through the canopy and western bluebirds (*Sialia mexicana*) mobbed a solitary adult female *T. mearnsi* (Koprowski et al. 2006). A shift to a mild alert posture by a resting *T. mearnsi* was detected in response to a coyote (*Canis latrans*—Koprowski et al. 2006). Despite the numerous protozoans, nematodes, cestodes, and ectoparasites reported from *Tamiasciurus*, only 1 parasite, a coccidian protozoan (*Eimeria tamiasciuri*), is reported from 3 of 5 specimens of *T. mearnsi* (Hill and Duszynski 1986; Seville et al. 2005).

BEHAVIOR

In contrast to *Tamiasciurus hudsonicus* and *T. douglasii* that defend exclusive territories against conspecifics in coniferous forests throughout most of their home ranges (Steele 1998, 1999), *T. mearnsi* does not display territorial behavior apparently due to the absence of middens (Ramos-Lara 2012; Ramos-Lara and Koprowski 2012). Because of their strong reliance on tree cavities for nesting, *T. mearnsi* conspecifics may compete for access to these resources (Ramos-Lara et al. 2013). Copulations may last < 30s and occur on the ground, under rock piles, inside hollow logs, and in the branches of trees (Ramos-Lara 2012). Three vocalizations are known (Koprowski et al. 2006), a call similar to the territorial “rattle” of *T. hudsonicus* and *T. douglasii* (Smith 1978) but of seemingly higher pitch, a “chirp” call (Smith 1978) when aggravated, and a woofing bark or “buzz” call (Smith 1978) when startled or mildly aggravated. *T. mearnsi* spent most of its time feeding, searching for food, and resting during a radiotelemetry study (Ramos-Lara 2012). No information exists on the

biology and behavior of *T. mearnsi* during the winter months (Ramos-Lara 2012).

GENETICS

The diploid number and chromosome morphology of *Tamiasciurus mearnsi* are unknown. Results from starch gel electrophoretic examinations of isozymes from 2 studies provide slightly different pictures of genetic variation in *T. mearnsi*. It was monomorphic for isozymes at the 8 loci examined for 5 individuals (Sullivan and Yates 1995); however, an examination of 8 other loci for 2 individuals found variation at 3 loci (EST-2, MDH-1, PDGH-1—Arbogast et al. 2001). In this comparison of the *Tamiasciurus*, 18 loci (Sullivan and Yates 1995) and 8 loci (Arbogast et al. 2001) were invariant for all 3 species. Based upon isozymes, *T. mearnsi* possessed a pairwise genetic similarity of 0.997 with *T. douglasii* and 0.250 to 0.306 with *T. hudsonicus* (Sullivan and Yates 1995). Examining 402 base pairs of the cytochrome-*b* gene yielded 14 mtDNA haplotypes with a single haplotype found in *T. mearnsi*; this haplotype nested within a clade that contained *T. douglasii* from California, Oregon, and British Columbia, Canada (Arbogast et al. 2001). The lack of observed genetic differentiation among the 3 currently recognized species of *Tamiasciurus*, including the Baja California populations currently recognized as *T. mearnsi*, suggests that these clades do not represent distinct species. Based upon isozymes and mtDNA haplotypes, Arbogast et al. (2001) suggest the recognition of a single, phenotypically variable species, *T. hudsonicus*, that is comprised of 3 subspecies, *T. h. hudsonicus* (an eastern clade), *T. h. douglasii* (a western clade, which includes *T. mearnsi*), and *T. h. mogollonensis* (a southwestern clade); Hope et al. (2016) also support a similar division. Pecnerova and Martinkova (2012) also noted a close relationship between all *Tamiasciurus* and used a multilocus phylogeny reconstruction to confirm *T. douglasii* as most closely related to *T. mearnsi*.

CONSERVATION

Tamiasciurus mearnsi is federally listed as threatened in Mexico (Ceballos and Navarro 1991; Ceballos and Rodríguez 1993; Ceballos et al. 2002; SEMARNAT 2010). It is also included in the International Union for Conservation of Nature and Natural Resources *Red List of Threatened Species* as “Endangered” (de Grammont and Cuarón 2008). The introduction of the eastern gray squirrel in 1946 may be a serious threat to this relict species (Huey 1964). Although a recent survey did not find this introduced species, its persistence in the Sierra de San Pedro Mártir remains unknown (Koprowski et al. 2006). The last records of the presence of eastern gray squirrels are from 1956 to 1958 (Yensen and Valdés-Alarcón 1999). Because of a reliance on tree cavities for nesting, large trees and snags that facilitate cavity formation are critical for the persistence of *T. mearnsi* (Ramos-Lara et al. 2013).

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