MAMMALIAN SPECIES 44(892):26–32

Myotis simus (Chiroptera: Vespertilionidae)

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Abstract: *Myotis simus* Thomas, 1901, is a vespertilionid bat commonly called the velvety myotis. A small to medium-sized bat with the plagiopatagium attached at ankles and short (≤5 mm), woolly fur, it is 1 of about 100 species of *Myotis* worldwide and 1 of 15 South American species of *Myotis*. It is endemic to South America, occurring from Colombia and northern Brazil southward to Paraguay and northeastern Argentina in both terra firme and floodplain areas in lowland forest and savanna at elevations from 28 to 600 m. It is not of special conservation concern.

Key words: bat, insectivorous bat, murciélago vespertino aterciopelado, Myotinae, South America, velvety myotis

Synonymy completed 24 September 2011
DOI: 10.1644/892.1
www.mammalogy.org

Myotis simus O. Thomas, 1901
Velvety Myotis

Myotis simus O. Thomas, 1901:541. Type locality "Sarayacu, Peru."

Myotis guaycuru Proença, 1943:313. Type locality "Salobra, rio Miranda, Mato Grosso [do Sul], Brasil" (see "Nomenclatural Notes").

Myotis (*Leuconoe*) *simus*: Koopman, 1993:215. Name combination (see "Nomenclatural Notes").

[*Myotis*] *sima* Woodman, 1993:545. Unjustified emendation of *Myotis simus* O. Thomas, 1901 (see "Nomenclatural Notes").

CONTEXT AND CONTENT. Order Chiroptera, suborder Microchiroptera, family Vespertilionidae, subfamily Myotinae, genus *Myotis*. Previously included in the cosmopolitan subgenus *Leuconoe* (Koopman 1993, 1994), but that was determined to be polyphyletic (Hoofer and Van Den Bussche 2003; Ruedi and Mayer 2001; Stadelmann et al. 2007). Currently, *M. simus* is included in an unnamed New World subgenus (Stadelmann et al. 2007). The genus *Myotis* includes more than 100 species (Simmons 2005). *M. simus* is monotypic (Koopman 1994; LaVal 1973; Moratelli et al. 2011a; Simmons 2005; Wilson 2008).

NOMENCLATURAL NOTES. LaVal (1973) provided a more precise description (Río Ucayali, Loreto) of the type locality for *M. simus*, and Carter and Dollan (1978) provided specific geographic coordinates (06°44′S, 75°06′W). Woodman (1993) argued that the correct gender of the name *Myotis* is feminine, which would require a nomenclatural change in the spelling of the epithet *simus* to *sima*. However, in 1958 the International Commission on Zoological Nomenclature fixed the gender of the name *Myotis* as masculine and placed the name as such on the *Official List of Generic Names in Zoology* (International Commission on Zoological Nomenclature 1958). The monotypic subgenus *Hesperomyotis* was proposed by Cabrera (1958:103) for *M. simus* because of its remarkable distinction from the remaining species, but *Hesperomyotis* was not supported by subsequent authors. Based on morphological features, Findley (1972) proposed 3

Fig. 1.—An adult *Myotis simus* from El Refugio, near Parque Nacional Noel Kempff, Bolivia. Used with permission of the photographer Marco Tshapka (University of Ulm, Germany).

subgenera to accommodate the diversity of *Myotis* (*Myotis*, *Leuconoe*, and *Selysius*). Although *M. simus* was not included in Findley's (1972) analyses, the species subsequently was allocated to the cosmopolitan subgenus *Leuconoe* (Koopman 1993). Later, molecular phylogenies (Hoofer and Van Den Bussche 2003; Ruedi and Mayer 2001; Stadelmann et al. 2007) and ecomorphological analyses (Fenton and Bogdanowicz 2002) provided convincing evidence to reject the 3 subgenera. *M. simus* has been clustered in a New World subgenus (Stadelmann et al. 2007), tentatively named as *Aeorestes* (Hoofer and Van Den Bussche 2003). However, this name is not available for *Myotis* (Wilson 2008).

Based on Article 27 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature 1999), the diacritic mark used in the original spelling of *Myotis guaycurú* [sic] Proença, 1943, must not be used. *M. guaycuru* was tentatively suggested to be the oldest name for *Myotis riparius* (LaVal 1973), but later was regarded as a junior synonym of *M. simus* (López-González 2005; López-González et al. 2001; Moratelli et al. 2011b). *Myotis simus riparius* was raised to specific rank by LaVal (1973). The generic name *Myotis* means eared mouse (*my* [mouse] + *ot* [ear{ed}] + *is* [Latin 3rd declension ending]—Gardner 2005). The epithet *simus* is a Latin adjectival form in gender agreement with the generic name, referring to its velvety pelage.

DIAGNOSIS

Myotis simus is the most distinctive New World species of *Myotis* (Cabrera 1958; Miller and Allen 1928; Thomas 1901). It differs from all other South American myotine bats by having the plagiopatagium attached at the level of the toes by a narrow band of membrane (≤ 1.5 mm; e.g., American Museum of Natural History [AMNH] 91473) or at ankles (q.v., López-González et al. 2001:141, figure 1), by the extremely short (≤ 5 mm) and woolly fur, by the absence of a fringe of hairs along the trailing edge of the uropatagium, and by the longer and narrower baculum (length 0.80 mm, depth 0.24 mm, and width 0.30 mm) with lateral knobs slightly projected (Baud and Menu 1993; LaVal 1973; López-González 2005; López-González et al. 2001; Miller and Allen 1928; Moratelli et al. 2011b; Thomas 1901; Vicente et al. 2005; Wilson 2008), although the baculum is *riparius*-like in a few specimens (LaVal 1973).

The plagiopatagium attachment was 1st used as a diagnostic character to distinguish *M. simus* from all other American species of *Myotis* (Miller and Allen 1928; Thomas 1901). Subsequently, it was considered an artifact of preparation (Handley 1960; LaVal 1973). An analysis of the structure in living specimens ratified its validity in distinguishing *M. simus* from other species (Baud and Menu 1993), which was later confirmed (q.v., López-González 2005; López-González et al. 2001; Moratelli et al. 2011b; Vicente et al. 2005).

GENERAL CHARACTERS

Myotis simus (Fig. 1) is a medium-sized species (forearm length 35.4–40.7 mm; mass 5–11 g) when compared with other South American *Myotis*. The ears are short (11–13 mm), extending forward halfway from eye to nostril; antitragal notch is barely evident; tragus is pointed, slightly curving outward above and convex below, with a small triangular lobule at the outer base, somewhat similar to that of the black myotis, *M. nigricans*. Ventral hairs are generally slightly bicolored, whereas dorsal hairs are monocolored, without contrast between bases and tips (López-González et al. 2001; Moratelli et al. 2011b). Coloration and length of fur apparently are variable seasonally (Handley 1960). Ecuadorian specimens collected in February and March had short, monocolored, orange-brown fur, whereas specimens collected in October and December had longer, chocolate-brown fur, with slightly burnished tips (Handley 1960). One Bolivian specimen (United States National Museum [USNM] 584502) had dorsal and ventral pelage ochraceous orange, whereas central and western Amazonian specimens (USNM 364482, AMNH 76252, AMNH 91414) had dorsal pelage that was Tawny, Russet or Cinnamon-Brown, and ventral pelage that was Ochraceous-tawny or Buckthorn-brown (Moratelli et al. 2011b).

Changes in coloration of dry museum specimens due to time in storage and variation in storage conditions require further study. One live specimen was bright orange when collected in Paraguay but became ochraceous brown after 1 year of storage as a dry skin, resembling Amazonian specimens (López-González et al. 2001). On the other hand, dark, cinnamon-red individuals (e.g., Texas Tech University [TTU] 46348) from Peru retained the same red coloration after 15 years of storage (López-González et al. 2001). No geographic pattern of color variation has been detected in *M. simus* (López-González et al. 2001; Moratelli et al. 2011b), and therefore this variation is most likely related to the changes in color of skins across storage time (López-González et al. 2001) and under different storage conditions.

Ears and membranes are blackish. The uropatagium is naked dorsally and a fringe of hairs along the trailing edge is absent. Few scattered hairs are present on the basal portion of the uropatagium. Calcar usually with a small keel present. The skull (Fig. 2) is moderate in total length (greatest length of skull—13.57–15.05 mm), with a broad and well-marked interorbital constriction (in dorsal view) and short rostrum. In lateral view, the parietal is generally inclined forward, and the supraoccipital region is flattened. A sagittal crest is generally present, and occipital crests are always present. Both sagittal and occipital crests range from very low to high. Canines are generally larger than those of other South

Fig. 2.—Dorsal, ventral, and lateral views of the skull and lateral view of mandible of an adult female *Myotis simus* (The Natural History Museum [BNHM] 85.5.12.2) from Río Ucayali, Loreto, Peru. Total length of skull, excluding incisors, is 14.1 mm (LaVal 1973). The jugal and squamosal processes of the zygomatic arches are broken. Used with permission of the photographer Roberto Portela Miguez (The Natural History Museum, United Kingdom).

American species (Baud and Menu 1993; LaVal 1973; López-González 2005; López-González et al. 2001; Miller and Allen 1928; Moratelli et al. 2011b; Myers and Wetzel 1979; Thomas 1901; Wilson 2008). The tendency of P3 to be crowded to the lingual side and obscured by the cingulum of the P4 in labial view was reported as diagnostic by most authors. However, in a series of 100 specimens analyzed, the P3 is in toothrow and not visible in labial view in 66 specimens; displaced to the lingual side and not visible in 7 specimens; and in toothrow and visible in lateral view in 12 specimens (Moratelli et al. 2011b).

Means (ranges; *n*) of external and skull measurements (mm) and masses (g) of adult females from Bolivia, northern Brazil, and Peru were (data collected by RM): total length, 89 (83–92; 11); length of tail, 38 (33–40; 11); length of foot, 9 (7–10; 12); length of ear, 12 (11–13; 12); forearm length, 38.6 (35.5–40.7; 38); thumb length, 6.0 (4.7–6.6; 44); length of 3rd metacarpal, 35.2 (33.1–37.9; 44); length of dorsal hairs, 4.2 (3.1–5.5; 41); length of ventral hairs, 3.5 (2.8–5.3; 41); greatest length of skull, including incisors, 14.32 (13.57–14.99; 47); condylocanine length, 12.66 (11.87–13.31; 45); condyloincisive length, 13.56 (12.75–14.23; 46); basal length, including incisors, 12.11 (11.18–12.69; 45); zygomatic breadth, 9.68 (8.83–10.23; 15); mastoid breadth, 7.87 (7.26–8.46; 43); braincase breadth, 7.14 (6.67–7.66; 45); interorbital breadth, 4.89 (4.57–5.28; 47); postorbital breadth, 3.93 (3.63–4.34; 47); breadth across canines, 4.12 (3.67–4.41; 45); breadth across molars, 5.87 (5.28–6.35; 47); length of maxillary toothrow, 5.21 (4.86–5.58; 46); length of upper molariform toothrow, 3.07 (2.72–3.32; 47); mandibular length, excluding incisors, 10.64 (9.45–11.83; 24); length of mandibular toothrow, 5.58 (5.16–5.97; 44); and body mass, 9.5 (5.0–10.8; 17).

Means (ranges; *n*) of external and skull measurements (mm) of adult males from Bolivia, northern Brazil, Ecuador, and Peru were (data collected by RM): forearm length, 37.6 (35.4–39.5; 8); thumb length, 5.9 (5.1–6.6; 16); length of 3rd metacarpal, 34.7 (32.5–36.7; 16); length of dorsal hairs, 4.3 (3.3–5.6; 12); length of ventral hairs, 3.7 (3.0–4.8; 12); greatest length of skull, including incisors, 14.25 (13.67–15.05; 14); condylocanine length, 12.50 (11.91–13.38; 14); condyloincisive length, 13.38 (12.73–14.24; 14); basal length, including incisors, 11.95 (11.47–12.71; 13); zygomatic breadth, 9.55 (9.34–9.98; 5); mastoid breadth, 7.54 (6.93–8.27; 9); braincase breadth, 6.87 (6.60–7.42; 12); interorbital breadth, 4.81 (4.54–5.22; 15); postorbital breadth, 3.82 (3.67–4.07; 15); breadth across canines, 4.29 (4.16–4.51; 15); breadth across molars, 5.78 (5.61–6.06; 15); length of maxillary toothrow, 5.10 (4.87–5.52; 15); length of upper molariform toothrow, 2.95 (2.84–3.22; 15); mandibular length, excluding incisors, 10.33 (9.47–11.88; 6); and length of mandibular toothrow, 5.53 (5.37–5.84; 15).

Skull measurements of Bolivian samples are consistently larger than measurements of Amazonian and Paraguayan

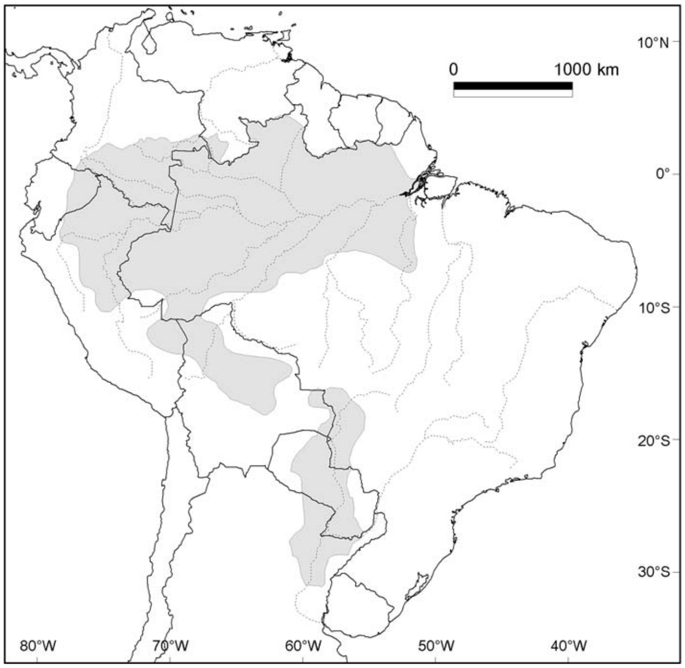

Fig. 3.—Geographic distribution of *Myotis simus*. Map redrawn from Moratelli et al. (2011a) with modifications.

samples (López-González et al. 2001; Moratelli et al. 2011b). In addition, Bolivian specimens have, on average, more laterally projected mastoid processes (Moratelli et al. 2011b). This evidence supports the hypothesis that the Bolivian population may constitute a distinct species. However, more comprehensive morphological samples from outside the Amazon Basin, mainly from midwestern Brazil, Paraguay, and Argentina, are necessary for a more precise conclusion. Also, molecular studies addressing the genetic variation of population samples should help in evaluating this hypothesis (Moratelli et al. 2011b). Because of morphological similarities, *M. simus*, *M. riparius* (riparian myotis), and *M. ruber* (red myotis) were placed in the *ruber* group by Koopman (1994).

DISTRIBUTION

Myotis simus is endemic to South America (LaVal 1973; Moratelli et al. 2011a; Simmons 2005; Wilson 2008; Fig. 3). Confirmed records report the species in Colombia, Ecuador, Peru, Bolivia, northern and midwestern Brazil, Paraguay, and northeastern Argentina (Barquez et al. 1999; Fornes 1972; López-González 2005; Moratelli et al. 2011a; Myers and Wetzel 1979, 1983; Simmons 2005; Wilson 2008). Previous records for southern Brazil (e.g., Bianconi and Pedro 2007; Peracchi et al. 2006; Tavares et al. 2008; Wallauer et al. 2000) are apparently based on misidentifications (Cherem et al. 2004; Moratelli et al. 2011a). Elevation data range from 28 m in Itacoatiara, Amazonas, Brazil, to 600 m in Huánuco, Peru (LaVal 1973; Moratelli et al. 2011a). The potential distribution map proposed by Moratelli et al. (2011a) revealed higher probability values of occurrence in the Amazon River basin (including northern Brazil, southern Venezuela, and the lowlands east of the Andes in Colombia, Ecuador, Peru, and northern Bolivia) and Paraná River basin (including midwestern Brazil, Paraguay, and northeastern Argentina). These areas are connected by a bottleneck of low and intermediate probability values in southeastern Bolivia. The Andean slopes, the Guyana, Paraná, and central Brazil plateaus, and the dry Chaco, in northwestern Paraguay and southeastern Bolivia, were identified as natural barriers, delimiting the distribution of *M. simus* (Moratelli et al. 2011a). The model proposed does not reject the hypothesis of a disjunctive distribution provided by Wilson (2008). No fossils are known.

FORM AND FUNCTION

Like other species of *Myotis*, the dental formula is i 2/3, c 1/1, p 3/3, m 3/3, total 38 (Miller and Allen 1928). Compared with other New World myotine bats, *M. simus* has larger upper canines in length and basal section, and a shorter distance between C and P4, the latter implying a lingual displacement of P2 and especially of P3 (Baud and Menu 1993:605, figure 6; Miller and Allen 1928). In several specimens P3 is displaced to the lingual side, in a way that P2 seems to be in contact with P4. The distal border of P4 has a conspicuous indentation, forming a striking inner lobe. The anterolingual singular cuspid is missing (Baud and Menu 1993). P4 is classified as type B (sensu Menu 1985), whereas upper molars (M1–M3) belong to type A. M1 and M2 show a strong metalophe, directed toward the interior of the protofossa. The metacone of M3 is voluminous, and its base represents the distal projection of the tooth (Baud and Menu 1993). The mandibular toothrow is classified as *Leuconoe*-type (sensu Menu 1985).

ONTOGENY AND REPRODUCTION

One subadult female was caught in April in Argentina (Barquez et al. 1999). Subadults deposited at the American Museum of Natural History were caught in January ($n = 1$), October ($n = 2$), and December ($n = 1$) in Brazil, February ($n = 2$) and March ($n = 5$) in Ecuador, and April ($n = 8$) in Peru. Pregnant females were caught in September ($n = 10$) in Bolivia (Anderson 1997), October ($n = 2$) in Paraguay (Myers and Wetzel 1979), and February–March ($n = 1$) in Peru (Ascorra et al. 1996), all of them with single embryos. One male specimen from Balta, Peru, had spermatozoa production with all stages of spermatogenesis in the tubules, and swollen epididymides packed with spermatozoa. The testes were relatively larger and with much less interstitial tissue compared with specimens of *M. nigricans* (Wilson and Findley 1971).

ECOLOGY

Myotis simus has been classified as a water bat, foraging over water (Findley 1993; Myers and Wetzel 1983). Confirmed records report the species for different formations, indicating both terra firme and floodplain areas in lowland forest and savanna (López-González 2004; Moratelli et al. 2011a; Muñoz-Arango 2001). According to the labels of 21 specimens (AMNH) captured in hollow trees in Amazonas, Brazil, 7 were caught near rivers, and 14 in floodplain areas. Northern Brazilian specimens were found in banana leaves and hollow trees, cohabiting in the latter with the lesser bulldog bat, *Noctilio albiventris* (Patterson 1992). In Bolivia, specimens have been captured in hollow trees, holes in the ground, and thatched roofs of houses. In the latter 2 roosts, specimens were recorded cohabiting with the Argentinean brown bat, *Eptesicus furinalis* (Aguirre 1994, not seen, cited in Espinoza 2007:327). Paraguayan specimens were recorded roosting with the lesser bulldog bat in hollow quebracho trees (*Aspidospermum* [Apocynaceae]—Myers and Wetzel 1979). *M. simus* has been caught only in ground-level mist nets (Ascorra et al. 1996; Handley 1967).

The batflies *Paradyschiria parvula* (Streblidae: Trichobiinae), *Trichobius parasiticus* (Streblidae: Trichobiinae), and *Basilia manu* (Streblidae: Nicteribiidae) were reported from *M. simus* (Autino et al. 2011; Graciolli 2001; Graciolli et al. 2008; Guerrero 1996). *Paradyschiria* has been regarded as a specific parasite of noctilionid bats (Guerrero 1998), infecting members of other families accidentally or transitorily (Wenzel 1976). The finding of *P. parvula* in *M. simus* was the 1st record of the genus in a vespertilionid bat (Autino et al. 2011). Contrary to the opinion of the authors, it may be another case of accidental or transitory infection due to the cohabitation with the lesser bulldog bat. *Basilia ferrisi* and *B. anceps* were reported, respectively, from Venezuelan (Guimarães 1966) and Panamanian individuals of *M. simus* (Guimarães 1977); however, there are no confirmed collection records of *M. simus* taken from these countries.

In Bolivia, *M. simus* has been reported eating Orthoptera (Grillidae), Hemiptera (Corixidae), Homoptera (at least 2 families), Coleoptera (at least 5 families), Lepdoptera, and Diptera (Nematocera). Nine of 10 prey items found in stomachs of Bolivian specimens of *M. simus* measured less than 10 mm in length (Aguirre 1994, not seen, cited in Espinoza 2007:327).

GENETICS

One specimen collected near Leticia, Bolivia, had a diploid number (2n) of 44 and a fundamental number (FN) of 50 (Baker and Jordan 1970). The autosomal complement is composed of 3 large pairs and 1 small pair of metacentric chromosomes and a graded series of 17 pairs of acrocentric chromosomes, ranging in size from medium to small. The X chromosome is a medium submetacentric, and the Y chromosome is a small acrocentric (Baker and Jordan 1970).

Molecular phylogenies using mitochondrial cytochrome-*b* (1,140 base pairs [bp]) and nuclear Rag 2 (1,148 bp) genes have clustered *M. simus* and its New World congeners in a well-supported clade that includes 2 Palearctic species (Stadelmann et al. 2007:38, figure 2). These molecular phylogenies reveal the close relationship of *M. simus*, *M. riparius*, *M. elegans* (elegant myotis), and *M. ruber* (Stadelmann et al. 2007).

CONSERVATION

Myotis simus was classified as "Data Deficient" in the 2008 *International Union for Conservation of Nature and Natural Resources Red List of Threatened Species* because of the absence of recent information on its distribution, threats, status, and ecological requirements (Barquez and Díaz 2008). The species was considered almost threatened in Bolivia (Aguirre et al. 2007).

ACKNOWLEDGMENTS

I am grateful to D. E. Wilson (National Museum of Natural History) for reviewing a draft of the manuscript; J. L. P. Cordeiro (Oswaldo Cruz Foundation, Brazil) for support in preparing the map; and M. Tshapka (University of Ulm, Germany) for providing the photograph of the live animal.

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Associate editor and Editor of this account was Meredith J. Hamilton.