A New Species of the Didelphid Marsupial Genus Monodelphis from Eastern Bolivia

Authors: Voss, Robert S., Pine, Ronald H., and Solari, Sergio

Source: American Museum Novitates, 2012(3740) : 1-14

Published By: American Museum of Natural History

URL: https://doi.org/10.1206/3740.2

AMERICAN MUSEUM NOVITATES

Number 3740, 14 pp. April 18, 2012

A New Species of the Didelphid Marsupial Genus *Monodelphis* from Eastern Bolivia

ROBERT S. VOSS,[1] RONALD H. PINE,[2] AND SERGIO SOLARI[3]

ABSTRACT

A new species of the didelphid marsupial genus *Monodelphis* is described from the eastern Bolivian province of Santa Cruz. The new species, currently known from a single specimen, belongs to the *M. brevicaudata* group but differs from other taxa within that clade (*M. brevicaudata, M. domestica, M. glirina, M. maraxina,* and *M. palliolata*) in size, qualitative morphological characters, and cytochrome-*b* gene sequences.

INTRODUCTION

Members of the didelphid marsupial genus *Monodelphis* are small terrestrial opossums that occur in many tropical and subtropical habitats from eastern Panama to northern Argentina. One species, *M. domestica,* has become an important model organism for biomedical and genome research (VandeBerg and Robinson, 1997; Macrini, 2004; Mikkelsen et al., 2007; Keyte and Smith, 2008), but little is known about other congeneric forms, and the species-level taxonomy of the genus is unrevised. Although 22 species were recognized by Voss and Jansa (2009), some of the taxa that they recognized have subsequently been synonymized (e.g., by Vilela et al., 2010) and several new species remain to be described (Pine and Handley, 2007). One of the latter is the topic of this report.

[1] Division of Vertebrate Zoology (Mammalogy), American Museum of Natural History.
[2] Natural History Museum and Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, KS 66045-7561.
[3] Instituto de Biología, Universidad de Antioquia, Medellín, Colombia.

ISSN 0003-0082

Among the 36,900 specimens of Bolivian mammals examined by Anderson (1997) was a single example of an undescribed species of *Monodelphis* collected at Santa Rosa de la Roca, a small town in the eastern lowlands of Santa Cruz department. Anderson (1997: 161) referred to this specimen as "*Monodelphis* sp. A," noting that it externally resembled *M. domestica* but was much smaller. The Santa Rosa specimen was not mentioned again in the literature until Pine and Handley (2007: 107) listed it as "*Monodelphis* [species B]" and noted the apparent absence of any distinguishing traits beyond those mentioned by Anderson. A partial cytochrome-*b* gene sequence from this specimen was recently analyzed by Solari (2010), who recovered it as the sister taxon of *M. glirina* in a robustly supported clade that also included *M. domestica* and *M. brevicaudata*. Close examination of the Santa Rosa specimen subsequently revealed morphological traits that serve to diagnose it from these species, and from all other previously described forms of *Monodelphis*.

MATERIALS AND METHODS

Specimens that we examined for this report are in the American Museum of Natural History, New York (AMNH); the Natural History Museum, London (BMNH); the Field Museum, Chicago (FMNH); the Museum of Southwestern Biology, University of New Mexico, Albuquerque (MSB); the University of Michigan Museum of Zoology, Ann Arbor (UMMZ); and the National Museum of Natural History, Washington, DC (USNM).

Our descriptive terminology for didelphid external and craniodental morphology follows Voss and Jansa (2009), and we use capitalized color names from Ridgway (1912). We transcribed total length (nose to fleshy tail-tip, TL), length of tail (basal flexure to fleshy tip, LT), length of hind foot (heel to tip of longest claw, HF), and length of ear (from notch, Ear), from specimen labels or field notes, and we computed head-and-body length (HBL) by subtracting LT from TL. Additionally, we remeasured HF to check the accuracy of values recorded by the collector, and we used our values whenever large discrepancies were found. All external measurements are reported to the nearest millimeter (mm).

Craniodental measurements were taken with digital calipers as skulls were viewed under low (6–12×) magnification; although measurement values were recorded to the nearest 0.01 mm, those reported herein are rounded to the nearest 0.1 mm. The following dimensions were measured as illustrated by Giarla et al. (2010): condylo-basal length (CBL), measured from the occipital condyles to the anteriormost point of the premaxillae. Nasal breadth (NB), measured across the triple-point sutures of the nasal, frontal, and maxillary bones on each side. "Least interorbital breadth" (LIB), measured at the narrowest point across the frontals, either between or behind the orbits.[4] Zygomatic breadth (ZB), measured at the widest point across both

---

[4] The least distance across the frontals is either interorbital or postorbital in *Monodelphis*. In some young adult females measured for this study the frontals are narrowest between the orbits and there is no measurable postorbital constriction, but in older adult females and in all measured adult males the frontals are narrowest behind the orbits (between the right and left temporal fossae) and there is no measurable interorbital constriction. In effect, there is only a single constriction between the orbitotemporal fossae in all of the specimens we measured, despite individual positional variation.

zygomatic arches. Palatal length (PL), measured from the anteriormost point of the premaxillae to the postpalatine torus, including the postpalatine spine (if present). Palatal breadth (PB), measured across the labial margins of the upper fourth molar (M4) crowns, at or near the stylar A position. Maxillary toothrow length (MTR), measured from the anterior margin of the upper canine (C1) to the posterior margin of ipsilateral M4. Length of molars (LM), measured from the anteriormost labial margin of M1 to the posteriormost point on ipsilateral M4. Length of M1–M3 (M1–M3), measured from the anteriormost labial margin of M1 to the posteriormost point on ipsilateral M3. Width of M3 (WM3), measured from the labial margin of the crown at or near the stylar A position to the lingual apex of the protocone.

RESULTS

We have examined representative material of all currently recognized species of *Monodelphis* over the last several decades of our revisionary work on this genus (e.g., Pine and Handley, 1984, 2008; Pine et al., 1985; Voss et al., 2001; Solari, 2004, 2007), and we directly compared the Santa Rosa specimen with material representing other members of the *Monodelphis brevicaudata* group (sensu Solari, 2010). Based on data collected for this report and for previous revisionary studies, we determined that the Santa Rosa specimen differs from all currently recognized species in multiple traits and clearly merits taxonomic recognition. Except as noted otherwise, the Santa Rosa specimen conforms in all respects to the diagnosis of *Monodelphis* provided by Voss and Jansa (2009: 105–107), so only characters that are known to vary within the genus are mentioned in the following description.

Monodelphis sanctaerosae, new species

Holotype: The holotype consists of the skin, skull, and postcranial skeleton of a young adult female (AMNH 263548, original number RHP 15068) collected on 29 June 1990 at Santa Rosa de la Roca (15°50′S, 61°27′W, 250 m above sea level) in the Bolivian department of Santa Cruz; a frozen tissue sample and a suspension of bone-marrow cells in Carnoy's fixative (both with field preparation number NK 21048) are preserved in the Division of Genomic Resources at the Museum of Southwestern Biology. A partial (801 bp) cytochrome-*b* gene sequence from the holotype was deposited in GenBank with accession number HM998596 by Solari (2010).

Distribution: Known only from the type locality.

Description: Dorsal pelage uniformly grizzled brownish gray (near Buffy Brown) from crown to rump, indistinctly paler along the flanks than middorsally, but without distinct stripes or other sharp pigment discontinuities (fig. 1). Fur on sides of head and surrounding ear pale reddish (near Cinnamon-Buff). Pinnae macroscopically naked, with pigmented skin (probably brownish gray in life). Ventral fur grayish basally but heavily washed with pale beige (near Light Buff). Hands and feet covered dorsally with short pale hairs, without any darker markings. Manual plantar epithelium unpigmented (probably pinkish in life); pedal plantar epithelium lightly pigmented (probably pale gray in life). Mammary formula unknown (teats are not visible in the single examined female specimen). Tail furred for about 10 mm at base (to about

FIGURE 1. Dorsal, ventral, and lateral views of the holotype skin of *Monodelphis sanctaerosae* (AMNH 263548). All views about ×0.9.

the same extent dorsally as ventrally), the unfurred remainder distinctly bicolored (dark dorsally and abruptly paler ventrally).

Skull unremarkable in general aspect, neither unusually long and narrow nor remarkably short and broad in dorsal view (fig. 2) and not conspicuously flattened in lateral profile (fig. 3). Lacrimal foramina laterally exposed anterior to orbit; infraorbital foramen dorsal to

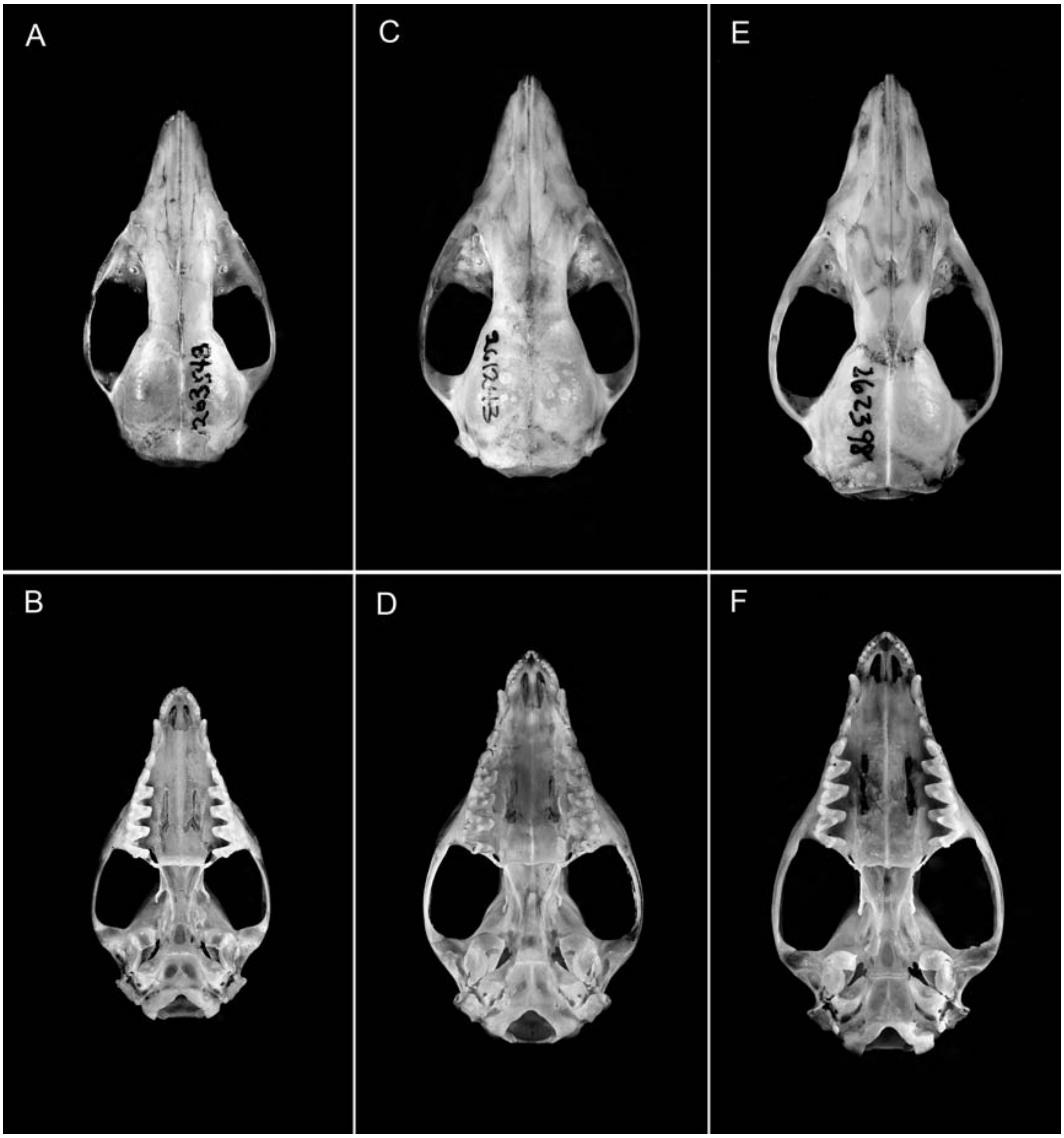

FIGURE 2. Dorsal and ventral cranial views of female *Monodelphis sanctaerosae* (**A**, **B**; AMNH 263548), *M. domestica* (**C**, **D**; AMNH 261243), and *M. glirina* (**E**, **F**; AMNH 262398). All views about ×2.

P3; sagittal crest present but inconspicuous, extending from occiput to fronto-parietal sutures. Maxillopalatine fenestrae long, extending from level of P3/M1 commissure to level of M3 protocone on each side; palatine fenestrae absent; posterolateral palatal foramina very long, extending anteriorly beyond M4 protocones (fig. 4). Alisphenoid tympanic process small and uninflated (not extending posteriorly to the level of the basioccipital/basisphenoid suture, leaving the hypotympanic sinus roof exposed in ventral view); secondary foramen ovale absent;

rostral tympanic process of petrosal narrow and acutely pointed, widely separated from caudal tympanic process (fenestra cochleae laterally exposed); stapes perforate and subtriangular (bicrurate, with a large foramen). Crowns of I2, I3, I4, and I5 increasing in width from front to back (such that I2 is visibly smaller than I5); upper and lower canines simple, without accessory cusps; p2 slightly taller than p3 (contra Voss and Jansa, 2009: 107).

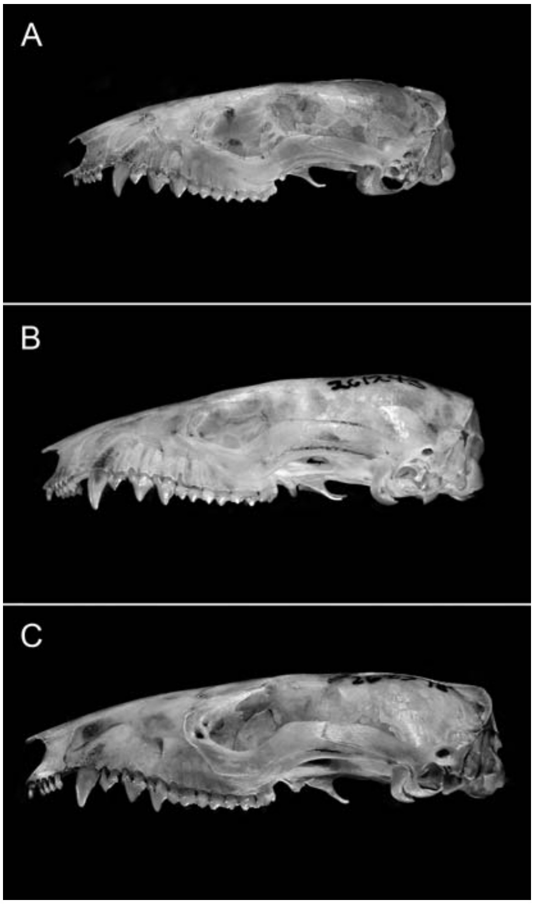

FIGURE 3. Lateral cranial views of female *Monodelphis sanctaerosae* (**A**, AMNH 263548), *M. domestica* (**B**, AMNH 261243), and *M. glirina* (**C**, AMNH 262398). All views about ×2.

Comparisons: Members of the *Monodelphis brevicaudata* species group (sensu Solari, 2010)—including *M. brevicaudata, M. domestica, M. glirina, M. maraxina, M. palliolata,* and *M. sanctaerosae*—differ from other congeneric species by (1) lacking distinct longitudinal stripes in the dorsal pelage (versus stripes present, e.g., as in *M. iheringi*); (2) having the infraorbital foramen positioned dorsal to P3 or to the P3/M1 commissure (versus dorsal to M1, e.g., as in *M. scalops*); (3) by having long maxillopalatine fenestrae (versus short fenestrae, e.g., as in *M. dimidiata*); (4) by having small alisphenoid bullae that do not extend posteriorly behind the basisphenoid-basioccipital suture (versus larger bullae that extend well behind the suture, e.g., as in *M. emiliae*), (5) by lacking a secondary foramen ovale (versus secondary foramen ovale present, e.g., as in *M. americana*), (6) by having a triangular or subtriangular stapes with a large obturator foramen (versus stapes columelliform and imperforate or microperforate, e.g., as in *M. adusta*), and (7) by having the crowns of I2–5 increasing in width from front to back, such that the crown of I5 is visibly much broader than the crown of I2 (versus I2–5 crowns subequal in width, e.g., as in *M. kunsi*).

Monodelphis sanctaerosae differs from all other members of the *Monodelphis brevicaudata* species group by its small size (e.g., LM < 7 mm; table 1) and long posterolateral palatal foramina. The latter perforations, which occupy the maxillary-palatine sutures, extend anteriorly beyond the protocone of M4 on each side (fig. 4). This trait appears to be unique in the genus, resembling the condition otherwise seen among didelphids only in *Thylamys* and *Lestodelphys* (Voss and Jansa, 2009: fig. 14).

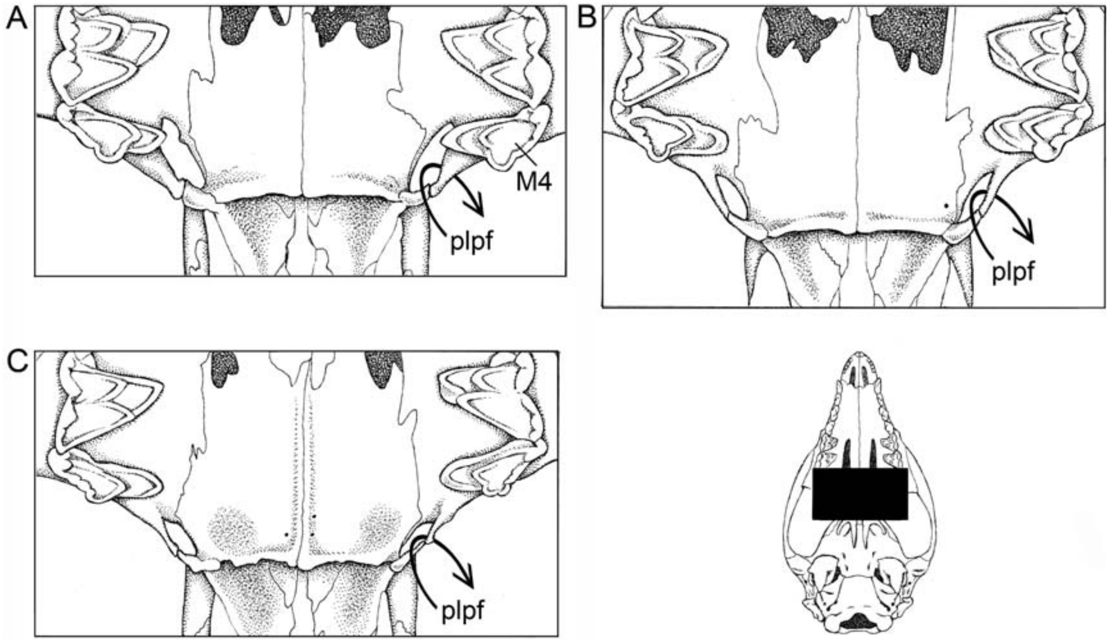

FIGURE 4. Ventral view of posterior palate in *Monodelphis sanctaerosae* (**A**, AMNH 263548), *M. domestica* (**B**, MSB 63278), and *M. glirina* (**C**, AMNH 262398) illustrating the position of the posterolateral palatal foramen (**plpf**) in relation to the fourth molar (**M4**).

Closer comparisons are warranted with two members of the *Monodelphis brevicaudata* group that also occur in Bolivia, and which appear to be closely related to M. *sanctaerosae* based on phylogenetic analyses of cytochrome-*b* sequence data (Solari, 2010). As previously noted by Anderson (1997), *Monodelphis sanctaerosae* ("*Monodelphis* sp. A") externally resembles *M. domestica,* both species having uniformly grizzled-grayish dorsal pelage. In side-by-side comparisons, however, the overall color of the dorsal pelage of *M. sanctaerosae* is distinctly browner (close to Ridgway's Buffy Brown) whereas that of *M. domestica* is yellower in tone (closer to Citrine Drab or Deep Olive). Additionally, the fur of the cheeks and that surrounding the base of the ear is pale reddish in *M. sanctaerosae,* whereas the facial fur of *M. domestica* is grizzled grayish like the rest of the head, nape, and back. The holotype of *M. sanctaerosae* is smaller than any adult Bolivian *M. domestica* that we measured in head-and-body length and length of the hind foot (table 1), but immature *M. domestica* probably have external measurements that overlap with those of adult *M. sanctaerosae.* Therefore, given the rather subtle pigmental differences between these species and the absence of other qualitative external differences, field identifications of small *domestica*-like animals are potentially problematic. Fortunately, our examination of a syntype of *domestica* (BMNH 87.10.25.1, an adult female collected by Johann Natterer at Cuiabá, Mato Grosso, Brazil) unequivocally associates this name with the larger of these two superficially similar species.

TABLE 1. Measurements (mm) and Weights (g) of Bolivian Species of the *Monodelphis brevicaudata* Group

	M. domestica		*M. glirina*					*M. sanctae-rosae*
	Females[a]	Males[b]	AMNH 262398♀	UMMZ 126683♀	AMNH 262399♂	MSB 57005♂	UMMZ 126682♂	AMNH 263548♀[c]
HBL	138 ± 19 (115–176) 11	148 ± 12 (130–171) 13	148	130	156	162	138	108
LT	75 ± 9 (60–88) 11	81 ± 6 (72–96) 13	73	83	88	87	78	60
HF	20 ± 1 (18–21) 11	21 ± 2 (18–25) 13	19	20	18	21	18	15
Ear	21 ± 2 (19–25) 11	23 ± 2 (20–28) 14	20	23	20	21	21	19
CBL	35.7 ± 2.4 (33.2–40.6) 11	38.8 ± 2.1 (35.9–42.7) 13	37.0	35.7	40.2	40.8	36.1	29.7
NL	16.5 ± 1.2 (15.5–18.9) 11	18.4 ± 1.0 (16.4–20.3) 12	18.0	16.5	19.8	20.6	16.8	13.7
NB	5.0 ± 0.4 (4.3–5.8) 11	5.4 ± 0.5 (4.7–6.4) 14	5.6	5.4	6.4	6.3	5.1	4.1
"LIB"	6.0 ± 0.2 (5.8–6.3) 10	6.0 ± 0.2 (5.6–6.5) 14	5.7	5.8	6.1	5.9	5.9	5.2
ZB	19.6 ± 1.4 (18.2–22.1) 10	21.0 ± 1.6 (18.9–23.6) 14	20.4	18.9	21.9	22.4	19.1	16.2
PL	20.3 ± 1.3 (19.1–22.8) 10	21.6 ± 1.1 (19.9–23.6) 14	21.0	19.7	22.0	22.3	20.2	16.2
PB	12.3 ± 0.6 (11.6–13.7) 10	12.9 ± 0.6 (12.1–14.3) 14	12.8	11.7	13.2	12.9	12.0	10.0
MTR	15.1 ± 0.7 (14.0–16.2) 11	15.8 ± 0.6 (14.9–16.9) 14	15.5	15.0	16.0	15.5	15.2	12.6
LM	8.0 ± 0.3 (7.4–8.2) 11	8.1 ± 0.1 (7.9–8.3) 14	8.2	8.0	8.1	8.2	8.1	6.8
M1–3	6.8 ± 0.2 (6.6–7.1) 10	6.9 ± 0.1 (6.6–7.1) 14	7.0	6.7	6.9	7.0	7.0	5.7
WM3	2.8 ± 0.1 (2.5–2.9) 11	2.9 ± 0.1 (2.7–3.0) 14	3.0	2.7	2.8	2.8	2.9	2.4
Weight	50 ± 14 (33–73) 9	70 ± 22 (44–110) 12	55	49	83	89	53	23

[a] The mean plus or minus one standard deviation, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 261232, 261234, 261235, 261240, 261243, 263547; MSB 55849, 55852; USNM 390566, 460728, 461347.

[b] The mean plus or minus one standard deviation, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 260024, 261231, 261233, 261236, 261241; FMNH 44857; MSB 55072, 55847, 55850, 55853, 63278, 67022, 67023; USNM 390567.

[c] Holotype.

Although *Monodelphis sanctaerosae* ("*Monodelphis* species B") and *M. glirina* were recovered as sister taxa in Solari's (2010) analysis of cytochrome-*b* sequence data, these species are externally dissimilar. *Monodelphis glirina* is larger in all external dimensions (table 1), and it is an altogether gaudier species, with sharply contrasting pelage colors. Like some geographic forms of the Guianan species *M. brevidaudata* (see Voss et al., 2001: fig. 31), *M. glirina* is grizzled grayish middorsally from the crown of the head to the rump, whereas the sides of the head, legs, flanks, hips and tail base are clear reddish (near Orange Rufous); ventrally, the reddish color of the flanks grades imperceptibly to gray-based yellowish (near Pale Yellow-Orange). Because this distinctive color pattern is present even in immature specimens of *M. glirina,* confusion with *M. sanctaerosae* seems unlikely.

Other Specimens Examined: *Monodelphis domestica*: **Bolivia**—*Beni,* La Granja (USNM 461347), San Joaquín (FMNH 114651; USNM 364714, 364715, 460728–460731); *Chuquisaca,* 4.6 km E by road Carandaytí (AMNH 261234), Porvenir (AMNH 261231–261235, 261236, 261240–261243; MSB 55847, 55849, 55850, 55852, 55853), Río Limón (AMNH 263547, MSB 63278); *Santa Cruz,* Basilio (USNM 390568), 3.4 km S Basilio (USNM 390566, 390567), Montegrande (FMNH 44857), Río Quiser (FMNH 44856), San Ignacio de Velazco (USNM 390015), 27 km S Santa Cruz (MSB 67022, 67023), 4 km N [&] 1 km W Santiago de Chiquitos (MSB 55072), Tihumayu (USNM 290898), Tita (AMNH 260024); *Tarija,* Estancia Bolívar (AMNH 278252, 278253).

Monodelphis glirina: **Bolivia**—*La Paz,* 4 km by road NW Alcoche (UMMZ 126682, 127783), Guanay (AMNH 72570), 5 km SE Guanay (UMMZ 126684, 126685); *Pando,* Independencia (AMNH 262397), Santa Rosa (AMNH 262398, 262399; MSB 57005).

DISCUSSION

Species of the *Monodelphis brevicaudata* group are apparently restricted to lowland habitats; none is known to occur above 1500 m, where they seem to be replaced (in the Andes and the Guiana highlands, for example) by members of other species groups. In Bolivia, *M. glirina* and *M. domestica* have nonoverlapping ecogeographic distributions (fig. 5). Specimens that we examined and others reported by Anderson (1997)—who referred to this species as *M. brevicaudata*—document the occurrence of *M. glirina* in the rainforested lowlands of Pando and La Paz departments; it also occurs in similar habitats (lowland rainforest) in the adjacent Peruvian department of Madre de Dios, and in the Brazilian states of Acre and Amazonas (Pine and Handley, 2007: map 42). By contrast, *M. domestica* occurs in the drier habitats (thornscrub and savannas) of eastern Bolivia, with known collection localities in the departments of Beni, Chuquisaca, Santa Cruz, and Tarija. Elsewhere, *M. domestica* is found in open vegetation formations (Caatinga, Cerrado, and Chaco) from eastern Brazil to Paraguay and northwestern Argentina (Pine and Handley, 2007: map 40). Given the extensive geographic distributions of these closely related species, the single known collection locality for *Monodelphis sanctaerosae* seems anomalous. Is this species narrowly endemic to some special habitat near Santa Rosa de la Roca, or could it reasonably be expected to occur elsewhere?

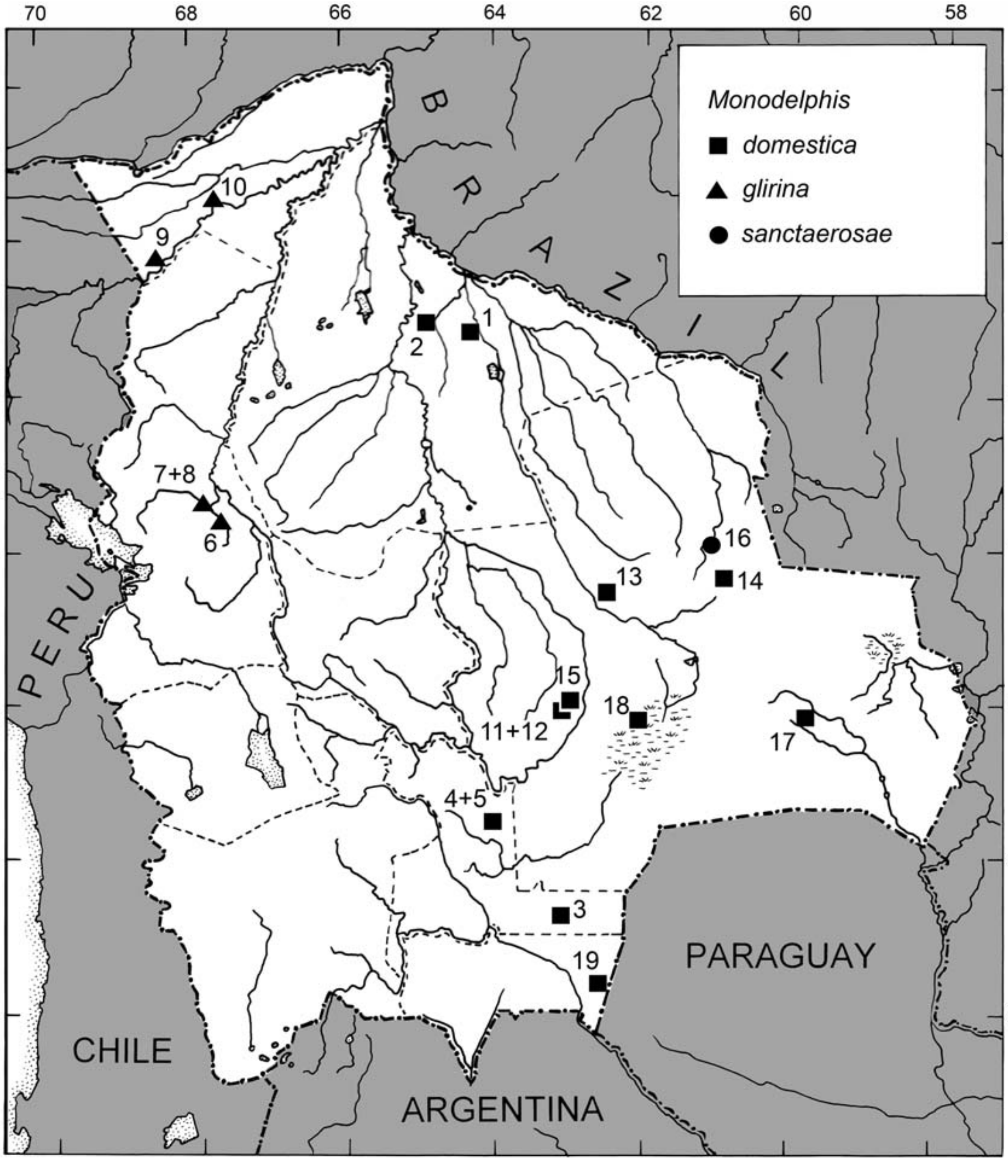

FIGURE 5. Collecting localities for examined Bolivian specimens of the *Monodelphis brevicaudata* group (sensu Solari, 2010; including *M. domestica, M. glirina,* and *M. sanctaerosae*). Numbers are keyed to gazetteer entries (see appendix). Broken lines indicate Bolivian departmental borders. Degrees of south latitude and west longitude are shown along the righthand and top margins, respectively.

The holotype of *Monodelphis sanctaerosae* was collected by personnel of a joint AMNH/MSB expedition that was temporarily stranded at Santa Rosa de la Roca by the breakdown of their field vehicle. Three expedition members (Jorge A. Salazar-Bravo, Rosa Leny Cuéllar, and José Carlos Herrera) set a line of Sherman traps on the evening of 28 June 1990 near a wet place bordered by savanna and forest.[5] Three rodents (*Calomys tener, Cerradomys scotti, Oligoryzomys microtis*) and the holotype of *M. sanctaerosae* were found in these traps the next morning. The specimens were transported alive to Santa Cruz de la Sierra on 30 June, where they were prepared as specimens on 1 July by other expedition members (including Pine, whose initials prefix the field number originally assigned to AMNH 263548).

As described and photographed by members of the 1990 AMNH/MSB expedition, and as indicated by aerial photographs today, the natural vegetation surrounding Santa Rosa de la Roca is a mosaic of upland savanna with scattered trees (resembling the "campo sujo" of typical Cerrado landscapes; Eiten, 1972), closed-canopy dry forest ("campo cerrado"), and seasonally flooded grassland. All three formations are typical of the Chiquitanía region of eastern Santa Cruz (Killeen et al., 1990, 1998), but without additional fieldwork it is impossible to know whether *Monodelphis sanctaerosae* is typically associated with such environments or with some other local habitat adjacent to the capture site but unremarked by the collectors.

Small mammals of the Chiquitanía include some with very wide distributions and others that appear to be regional endemics. Examples of the former include two cricetid rodents collected at Santa Rosa de la Roca—*Calomys tener* and *Cerradomys scotti*—which are also known to occur throughout much of the Brazilian Cerrado (Almeida et al., 2007: fig. 4; Percequillo et al., 2008: fig. 1). Examples of the latter include several other cricetids, recently described from nearby Parque Nacional Noël Kempff Mercado, that are currently known to occur only in northeastern Bolivia (Emmons, 1999; Emmons and Patton, 2005; Carleton et al., 2009). Without future collecting or the discovery of additional specimens (perhaps currently misidentified as *Monodelphis domestica*) in museum collections, the distribution of *M. sanctaerosae* will remain a zoogeographic enigma.

ACKNOWLEDGMENTS

We are grateful to Phil Myers and Steve Hinshaw (at UMMZ) and to Joe Cook and Jon Dunnum (at MSB) for specimen loans, and to Roberto Portela for hosting a visit to the Natural History Museum in London. Patricia J. Wynne produced the art in figures 4 and 5, and Peter Goldberg took the photographs in figures 1–3. Louise Emmons provided useful information about the vegetation surrounding Santa Rosa de la Roca, and Jorge Salazar-Bravo helped us understand colloquial Bolivian habitat descriptors. Most of the specimens we examined were

---

[5] Jorge Salazar-Bravo's field notes for 29 June 1990 (archived at the AMNH and MSB) describe the capture site as "cerca a un curiche rodeado de un poco de savana y un poco de bosque." The term *curiche* (or *curichi*) is a Bolivianism more or less corresponding to *lodazal* in international Spanish. In the department of Santa Cruz it is often used to refer to seasonally flooded grassy areas, several of which are visible in aerial photos of the landscape surrounding Santa Rosa de la Roca.

collected on expeditions partially funded by National Science Foundation grants to the American Museum of Natural History and the University of New Mexico from 1985 to 1993.

REFERENCES

Almeida, F.C., C.R. Bonvicino, and P. Cordeiro-Estrela. 2007. Phylogeny and temporal diversification of *Calomys* (Rodentia, Sigmodontinae): implications for the biogeography of an endemic genus of the open/dry biomes of South America. Molecular Phylogenetics and Evolution 42: 449–466.

Anderson, S. 1997. Mammals of Bolivia, taxonomy and distribution. Bulletin of the American Museum of Natural History 231: 1–652.

Carleton, M.D., L.H. Emmons, and G.G. Musser. 2009. A new species of the rodent genus *Oecomys* (Cricetidae: Sigmodontinae: Oryzomyini) from eastern Bolivia, with emended definitions of *O. concolor* (Wagner) and *O. mamorae* (Thomas). American Museum Novitates 3661: 1–32.

Eiten, G. 1972. The Cerrado vegetation of Brazil. Botanical Review 38: 201–341.

Emmons, L.H. 1999. Two new species of *Juscelinomys* (Rodentia: Muridae) from Bolivia. American Museum Novitates 3280: 1–15.

Emmons, L.H., and J.L. Patton. 2005. A new species of *Oryzomys* (Rodentia: Muridae) from eastern Bolivia. American Museum Novitates 3478: 1–26.

Giarla, T.C., R.S. Voss, and S.A. Jansa. 2010. Species limits and phylogenetic relationships in the didelphid marsupial genus *Thylamys* based on mitochondrial DNA sequences and morphology. Bulletin of the American Museum of Natural History 346: 1–67.

Keyte, A.L., and K.K. Smith. 2008. Opossum (*Monodelphis domestica*): a marsupial developmental model. Cold Spring Harbor Protocols 2008 [doi:10.1101/pdb.emo104]

Killeen, T.J., B.T. Louman, and T. Grimwood. 1990. La ecología paisajística de la región de Concepción y Lomerío en la provincia de Ñuflo de Chávez, Santa Cruz, Bolivia. Ecología en Bolivia 16: 1–46.

Killeen, T.J., A. Jardim, F. Mamani, and N. Rojas. 1998. Diversity, composition and structure of a tropical semideciduous forest in the Chiquitanía region of Santa Cruz, Bolivia. Journal of Tropical Ecology 14: 803–827.

Macrini, T.E. 2004. *Monodelphis domestica.* Mammalian Species 760: 1–8.

Mikkelsen, T.S. et al. [61 coauthors]. 2007. Genome of the marsupial *Monodelphis domestica* reveals innovation in non-coding sequences. Nature 447: 167–178.

Percequillo, A.R., E. Hingst-Zaher, and C.R. Bonvicino. 2008. Systematic review of genus *Cerradomys* Weksler, Percequillo and Voss, 2006 (Rodentia: Cricetidae: Sigmodontini: Oryzomyini), with description of two new species from eastern Brazil. American Museum Novitates 3622: 1–46.

Pine, R.H., and C.O. Handley, Jr. 1984. A review of the Amazonian short-tailed opossum *Monodelphis emiliae* (Thomas). Mammalia 48: 239–245.

Pine, R.H., and C.O. Handley, Jr. 2008 ("2007"). Genus *Monodelphis* Burnett, 1830. *In* A.L. Gardner (editor), Mammals of South America, vol. 1. (Marsupialia, Insectivora, Edentata, Chiroptera): 82–107. Chicago: University of Chicago Press.

Pine, R.H., P.L. Dalby, and J.O. Matson. 1985. Ecology, postnatal development, morphometrics, and taxonomic status of the short-tailed opossum, *Monodelphis dimidiata,* an apparently semelparous annual marsupial. Annals of Carnegie Museum 54: 195–231.

Ridgway, R. 1912. Color standards and color nomenclature. Washington, DC: published by the author.

Solari, S. 2004. A new species of *Monodelphis* (Didelphimorphia: Didelphidae) from southeastern Peru. Mammalian Biology 69: 145–152.

Solari, S. 2007. New species of *Monodelphis* (Didelphimorphia: Didelphidae) from Peru, with notes on *M. adusta.* Journal of Mammalogy 88: 319–329.

Solari, S. 2010. A molecular perspective on the diversification of short-tailed opossums (*Monodelphis*: Didelphidae). Mastozoología Neotropical 17 (2): 317–333.

VandeBerg, J.L., and E.S. Robinson. 1997. The laboratory opossum (*Monodelphis domestica*) in biomedical research. *In* N. Saunders and L. Hinds (editors), Marsupial biology. Recent research, new perspectives: 238–253. Sydney: University of New South Wales Press.

Vilela, J.F., C.A.M. Russo, and J.A. de Oliveira. 2010. An assessment of morphometric and molecular variation in *Monodelphis dimidiata* (Wagner, 1847) (Didelphimorphia: Didelphidae). Zootaxa 2646: 26–42.

Voss, R.S., and S.A. Jansa. 2009. Phylogenetic relationships and classification of didelphid marsupials, an extant radiation of New World metatherian mammals. Bulletin of the American Museum of Natural History 322: 1–177.

Voss, R.S., D.P. Lunde, and N.B. Simmons. 2001. The mammals of Paracou, French Guiana: a Neotropical lowland rainforest fauna. Part 2. Nonvolant species. Bulletin of the American Museum of Natural History 263: 1–236.

APPENDIX

BOLIVIAN GAZETTEER

This gazetteer includes all localities from which we personally examined Bolivian specimens of the *Monodelphis brevicaudata* species group. Names of departments are italicized, and collection localities as they appear in the text of this report are in boldface. Unless recorded by the collector, geographic coordinates and elevation above sea level are provided in square brackets with a cited secondary source for these data. The species name, name(s) of the collector(s), and date(s) of collection are separated from each locality entry by a colon. Numbered localities are plotted in figure 5.

1. *Beni,* **La Granja** [13°18′S, 64°09′W; Anderson, 1997], 4 km N Magdalena: *Monodelphis domestica* (M.L. Kuns, 20 December 1970).
2. *Beni,* **San Joaquín** [13°04′S, 64°49′W; Anderson, 1997]: *Monodelphis domestica* (M.L. Kuns, 22 March 1963–4 January 1970).

3a. *Chuquisaca,* **Porvenir** (20°45′S, 63°13′W), 675 m: *Monodelphis domestica* (S. Anderson and B.R. Riddle, 6–15 July 1985).

3b. *Chuquisaca,* **4.6 km E by road Carandaytí** (20°46′S, 63°02′W), 460 m: *Monodelphis domestica* (S. Anderson, 9 July 1985).

4. *Chuquisaca,* **Río Limón** (19°33′S, 64°08′W), 1300 m: *Monodelphis domestica* (R.L. Cuellar and E. Palma, 3 August 1990).
5. *Chuquisaca,* **Tihumayu** [= Tihumayo at 19°34′S, 64°08′W; Anderson, 1997], 1500 m: *Monodelphis domestica* (M. Marzana, 25 April 1949).
6. *La Paz,* **4 km by road NW Alcoche** [15°40′S, 67°42′W; Anderson, 1997]: *Monodelphis glirina* (G.K. Creighton, 10–11 May 1978).

7. *La Paz,* **Guanay** [15°28′S, 67°52′W; Anderson, 1997], 1700 m: *Monodelphis glirina* (G.H.H. Tate, 15 April 1926).
8. *La Paz,* Río Challana, **5 km SE Guanay** [15°30′S, 67°50′W; Anderson, 1997]: *Monodelphis glirina* (G.K. Creighton, 23–24 June 1978).
9. *Pando,* **Independencia** [11°26′S, 67°34′W; Anderson, 1997], 170 m: *Monodelphis glirina* (L.A. Ruedas, 5 August 1986).
10. *Pando,* **Santa Rosa** [12°13′S, 68°24′W; Anderson, 1997]: *Monodelphis glirina* (C.K. Malcolm and L.A. Ruedas, 1 August 1986).
11. *Santa Cruz,* **Basilio** [18°08′S, 63°12′W; Anderson, 1997]: *Monodelphis domestica* (W.K. Kern, 2 October 1965).
12. *Santa Cruz,* **3.4 km S Basilio** [18°10′S, 63°12′W; Anderson, 1997]: *Monodelphis domestica* (M. Acasigue, 1 October 1965).

–. *Santa Cruz,* **Montegrande**, Cafeces, 600 m [not located]: *Monodelphis domestica* (J. Steinbach, 20 June 1918).

13. *Santa Cruz,* **Río Quiser** [= Río Quizer at 16°37′S, 62°46′W; Anderson, 1997], 800 m: *Monodelphis domestica* (J. Steinbach, 13 June 1918).
14. *Santa Cruz,* **San Ignacio de Velazco** [16°23′S, 60°59′W; Anderson, 1997]: *Monodelphis domestica* (M.L. Kuns, 27 June 1965).
15. *Santa Cruz,* **27 km S Santa Cruz** [17°58′S, 63°03′W; Anderson, 1997], 3 km E & 1 km S Brecha Tres: *Monodelphis domestica* (M.L. Campbell and J.L. Dunnum, 20 June 1991).
16. *Santa Cruz,* **Santa Rosa de la Roca** [15°50′S, 61°27′W; Anderson, 1997], 250 m: *Monodelphis sanctaerosae* (J.A. Salazar-Bravo, R.L. Cuéllar, and J.C. Herrera, 29 June 1990).
17. *Santa Cruz,* **4 km N [&] 1 km W Santiago de Chiquitos** (18°18′S, 59°36′W), 700 m: *Monodelphis domestica* (J.A. Cook, 2 October 1984).
18. *Santa Cruz,* **Tita** (18°25′S, 62°10′W), 300 m: *Monodelphis domestica* (S. Anderson, 19 October 1984).
19. *Tarija,* **Estancia Bolívar** (21°38′S, 62°34′W), 400 m: *Monodelphis domestica* (S. García H, 18 August 1991).

Complete lists of all issues of *Novitates* and *Bulletin* are available on the web (http://digitallibrary.amnh.org/dspace). Order printed copies on the web from http://www.amnhshop.com or via standard mail from:

American Museum of Natural History—Scientific Publications
Central Park West at 79th Street
New York, NY 10024