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A New Species of *Monodelphis* (Didelphimorphia: Didelphidae) from the Brazilian Amazon

SILVIA E. PAVAN,^{1,2} ANA C. MENDES-OLIVEIRA,³ AND
ROBERT S. VOSS¹

ABSTRACT

We describe a new species of the didelphid marsupial genus *Monodelphis* from Brazil, where it appears to be widely distributed in the states of Pará, Mato Grosso, Rondônia, and Acre. *Monodelphis saci*, new species, belongs to the subgenus *Mygalodelphys*, and analyses of DNA sequence data suggest that it is most closely related to *M. handleyi*, *M. osgoodi*, and *M. peruviana*. Diagnostic morphological traits include pelage coloration, qualitative aspects of craniodental morphology, and a distinctive range of morphometric variation. The new species has sometimes been misidentified in the literature as *M. kunsi*, a distinct but apparently allopatric taxon. *Monodelphis saci* occurs sympatrically with *M. emiliae*, *M. glirina*, and *M. touan* in the rainforested lowlands south of the Amazon River.

INTRODUCTION

American marsupials of the genus *Monodelphis* Burnett, 1830, are widespread in South America, ranging from high elevations in the Andes across Amazonia to the Atlantic Forest in southeastern Brazil and the temperate grasslands of northern Argentina (Pine and Handley,

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TABLE 1. Mean uncorrected cytochrome-*b* distances (scaled as percent sequence divergence) among species of *Monodelphis*, subgenus *Mygalodelphys*. The diagonal elements (in parentheses) correspond to mean pairwise distances among conspecific sequences. See Pavan et al. (2014) for analytical methods, GenBank accession numbers, and other information about sequenced material.

	<i>adusta</i>	<i>handleyi</i>	<i>kunsi</i>	<i>osgoodi</i>	<i>peruviana</i>	<i>pinocchio</i>	<i>reigi</i>	“species 2”
<i>adusta</i> (N = 7)	(0.6)							
<i>handleyi</i> (N = 6)	12.8	(0.5)						
<i>kunsi</i> (N = 22)	13.2	15.1	(3.6)					
<i>osgoodi</i> (N = 6)	11.0	9.3	14.2	(1.9)				
<i>peruviana</i> (N = 17)	11.0	9.5	13.9	8.4	(3.8)			
<i>pinocchio</i> (N = 3)	14.5	15.0	11.1	14.3	13.9	(1.0)		
<i>reigi</i> (N = 2)	9.2	9.8	14.2	9.2	9.4	13.3	(0.4)	
“species 2” (N = 3)	9.7	9.2	13.6	8.1	8.9	14.0	9.4	(2.7)

2008; Pavan et al., 2016). Twenty-two named species in five subgenera are currently recognized as valid (Pavan and Voss, 2016), but several new species remain to be described (Pavan et al., 2014, 2016; Vilela et al., 2015).

This report concerns the Brazilian form that Pavan et al. (2014, 2016) called *Monodelphis* “species 2.” Their analyses of DNA sequence data indicated that this informally recognized taxon—represented by several specimens from Pará and Rondônia—belongs to a monophyletic group with *M. adusta* (Thomas, 1897) and six other congeneric species comprising the “Adusta Group” (fig. 1). Consistently large genetic distances among members of this complex (>8%, uncorrected, at the cytochrome-*b* locus; table 1) suggested that each is an evolutionarily independent lineage, but this inference was not explicitly tested with either multilocus data or phenotypic traits in Pavan et al.’s (2014, 2016) reports. Subsequently, Pavan and Voss (2016) referred “species 2” to the subgenus *Mygalodelphys* based on these molecular results.

Close examination of sequenced specimens corresponding to *Monodelphis* “species 2” indicates that this form can be distinguished from all other congeneric taxa by a distinctive suite of external and craniodental features. These traits provide a sufficient basis for referring unsequenced material (including recently collected specimens from Acre and Mato Grosso) to a new species, which we formally describe and name below.

MATERIAL AND METHODS

Specimens listed in this report are deposited in the following collections (in the United States except as noted otherwise): AMNH (American Museum of Natural History, New York), ANSP (Academy of Natural Sciences, Philadelphia), BMNH (Natural History Museum, London, UK), CM (Carnegie Museum of Natural History, Pittsburgh), FMNH (Field Museum, Chicago), KU (Biodiversity Research Center and Natural History Museum, University of Kansas, Lawrence), LMUSP (Coleção do Laboratório de Mamíferos da Escola Superior de Agricultura “Luiz de Queiroz,” Universidade de São Paulo, São Paulo, Brazil), MACN-Ma (Colección de Mamíferos del Museo Argentino de Ciencias Naturales “Ber-

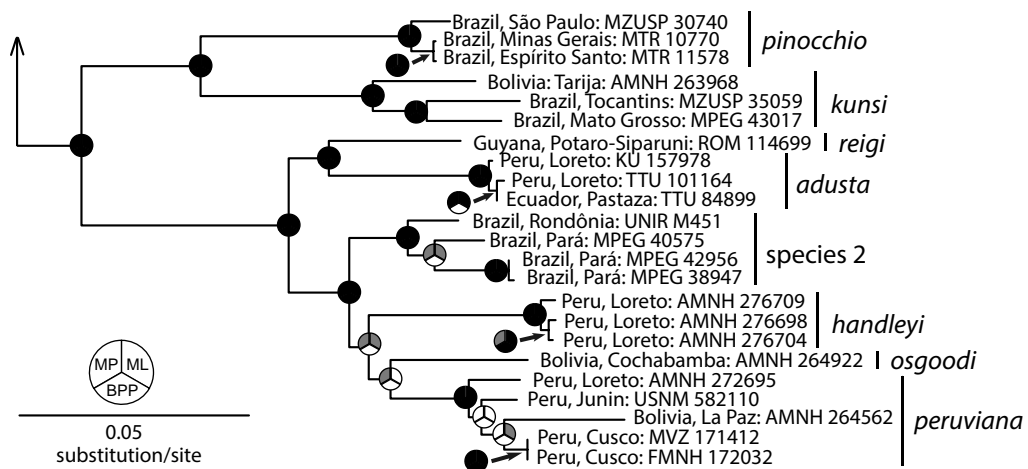


FIG. 1. Phylogenetic relationships of species of the subgenus *Mygalodelphis* based on a maximum-likelihood analysis of DNA sequence data from one mitochondrial and four nuclear genes (4983 aligned sites; after Pavan et al., 2014). Support statistics from maximum-parsimony (MP) and maximum-likelihood (ML) bootstrap analyses are indicated at each resolved node along with Bayesian posterior probabilities (BPP). White wedges indicate MP and ML bootstrap frequencies ≤50%, gray indicates bootstrap frequencies between 50% and 75%, and black indicates bootstrap frequencies ≥75%. For Bayesian statistics, white indicates BPP <0.95, whereas black indicates BPP ≥0.95.

nardino Rivadavia,” Buenos Aires, Argentina), MCN-M (Coleção de Mamíferos, Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil), MN (Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil), MNHN (Muséum National d’Histoire Naturelle, Paris, France), MPEG (Museu Paraense Emílio Goeldi, Belém, Brazil), MSU (Michigan State University, Michigan), MUSM (Museo de Historia Natural de la Universidad Nacional Mayor de San Marcos, Lima, Peru), MVZ (Museum of Vertebrate Zoology, University of California, Berkeley), MZUSP (Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil), OMNH (Sam Noble Oklahoma Museum of Natural History, Oklahoma), ROM (Royal Ontario Museum, Toronto, Canada), TTU (Museum of Texas Tech University, Lubbock), UFMG (Universidade Federal de Minas Gerais, Belo Horizonte, Brazil), UFMT (Coleção Zológica do Instituto de Biociências da Universidade Federal de Mato Grosso, Mato Grosso, Brazil), UFPA (Universidade Federal do Pará, Belém, Brazil), UFSC (Universidade Federal de Santa Catarina, Florianópolis, Brazil), UNIR (Fundação Universidade Federal de Rondônia, Porto Velho, Brazil), and USNM (National Museum of Natural History, Smithsonian Institution, Washington DC).

Our descriptive terminology for external and craniodental morphology follows Wible (2003) and Voss and Jansa (2009); capitalized color nomenclature follows Ridgway (1912). External measurements (typically recorded to the nearest millimeter, mm) and weight (in grams, g) for each examined specimen were transcribed from specimen labels or field notes. External measurements included total length (nose to tail tip, TL), length of tail (basal flexure to tip, LT), length of hind foot (heel to tip of longest claw, HF), and length of ear (from notch, Ear). Head-and-body length (HBL) was computed by subtracting LT from TL.

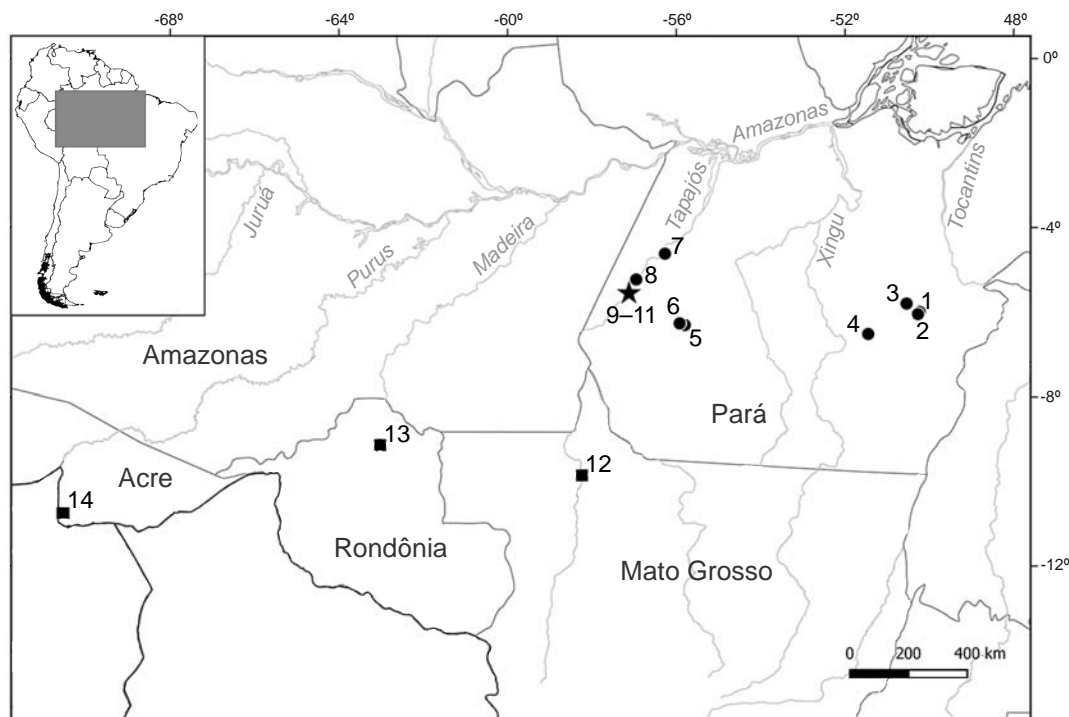


FIG. 2. Collecting localities of *Monodelphis saci*. Localities for which we did not examine specimens are represented by squares. Numbers are keyed to localities mentioned in the text.

Craniodental measurements were determined to the nearest 0.01 mm using digital calipers as specimens were viewed under a stereomicroscope (at 6–25 \times), but craniodental measurement values and sample means are rounded to the nearest 0.1 mm in our tables and text. The following dimensions were recorded: condylo-basal length (CBL), measured from the occipital condyles to the anteriormost point of the premaxillae; nasal length (NL), the greatest anteroposterior dimension of either bone; nasal breadth (NB), measured between the triple-point sutures of the nasal, frontal, and maxillary bones on each side; 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 tooththrow length (MTR), measured from the anterior margin of the upper canine (C1) to the posterior margin of M4; length of molars (LM), measured from the anteriormost labial margin of M1 to the posteriormost point on M4; length of M1–M3 (M1–3), measured from the anteriormost labial margin of the upper first molar (M1) to the posteriormost point on upper third molar (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; length of maxillopalatine fenestra (LMPF), the greatest anteroposterior dimension of one maxillopalatine fenestra; least interorbital breadth (LIB), measured at the narrowest point across the frontals between the orbits, even when the postorbital constriction (between the temporal fossae) is narrower; postorbital constriction (POC), measured at the narrowest point across the frontals

between the temporal fossae; breadth of braincase (BBC), measured immediately above the zygomatic process of the squamosal on each side; zygomatic breadth (ZB), measured at the widest point across both zygomatic arches.

RESULTS

Monodelphis (Mygalodelphys) saci, new species

Figures 4–8

HOLOTYPE: The holotype consists of the skin, skull, postcranial skeleton, and preserved tissues of an adult male (UFPA 1422, original number JD 05) from Bom Jardim, Tapajós, Itaituba, Pará, Brazil (5.61° S, 57.12° W; fig. 2: locality 9), collected on 11 January 2013 by A.C. Mendes-Oliveira.

PARATYPES: We refer 17 other examined specimens from the Brazilian state of Pará to *Monodelphis saci*, including: the skull, postcranial skeleton, and preserved tissues of a young adult animal of unknown sex (MPEG 38947 [original number IAVRD 1135]) from Barragem da Pêra, Serra dos Carajás, Marabá (6.00° S, 50.21° W; fig. 2: locality 1) collected on 22 February 2005 by personnel from the Vale do Rio Doce Environmental Institute; the skins, skulls, and postcranial skeletons of three adult males (MCN-M 2301, MN 73872, MN 74003 [original numbers BM 72, FMH 127, FMH 420]), one juvenile male (MCN-M 1962 [original number ELP 007]), and one juvenile female (MN 74002 [original number FMH 356]) from Floresta Nacional de Carajás, Parauapebas (6.05° S, 50.25° W; fig. 2: locality 2)⁴; the skin, skull, and postcranial skeleton of an adult female (MN 75511 [original number FMH 827]) from Floresta Nacional de Tapirapé-Aquiri, Marabá (5.80° S, 50.52° W; fig. 2: locality 3) collected on 24 February 2010 by D. Gettinger; the skin and preserved tissues of an adult male (MPEG 40575 [original number CT 05]) from Rio das Tropas, Floresta Nacional do Crepori, Itaituba (6.52° S, 51.43° W; fig. 2: locality 4) collected on 29 April 2008 by S. Morato and L. Phov; a skin with skull in alcohol and preserved tissues of an adult female (MPEG 42956) from Mina do Palito, Itaituba (6.31° S, 55.78° W; fig. 2: locality 5), collected on 21 March 2012 by A.O. Maciel and J.O. Gomes; the skin of an apparently juvenile male (MPEG 41820 [original number CAC 308]) from Jardim do Ouro, Itaituba (ca. 6.27° S, 55.90° W; fig. 2: locality 6) collected on 4 April 2011 by C. Braga; the skin and skull of an adult male (MZUSP 12207 [original number B-M-1]) from Uruá, Parque Nacional da Amazonia, Transamazon Km 65 (4.62° S, 56.25° W; fig. 2: locality 7) collected on 22 August 1978 by L.C. Branch; the skins, skulls, postcranial skeletons, and preserved tissues of two adult males (UFPA 1394, 1395 [original numbers JB 09, JB 10]) from Boca do Rato, Tapajós, Itaituba (5.23° S, 56.93° W; fig. 2: locality 8) collected on 19 January 2013 by A.C. Mendes-Oliveira; the skin, skull, and postcranial skeleton of an adult male (UFPA 1260 [original number JMID 27]) and the skin and preserved tissues of an adult female

⁴ Of these, MCN-M 2301 was collected on 18 December 2008 by R. Carvalho; MCN-M 1962 was collected on 16 January 2009 by E.L. Paschoalini; and MN 73872, 74002, and 74003 were collected respectively on 14 February 2009, 25 July 2009, and 25 February 2010, by D. Gettinger.



FIG. 3. Forest vegetation along the middle Tapajós, Pará, Brazil, illustrating capture sites of *Monodelphis saci*. A–B, terra firme forest (Bom Jardim and Penedo); C, igapó forest (Boca do Rato).

(UFPA 1738 [original number JD 33]) from Penedo, Tapajós, Itaituba (with two sets of coordinates [5.59° S, 57.12° W and 5.57° S, 56.13° W]; fig. 2: localities 10, 11) collected on 15 October 2012 and 17 June 2013 by A.C. Mendes-Oliveira; the skin, skull, and carcass in alcohol of an adult male (UFSC 5210 [original number JC 3409]) from Marabá (specific locality unknown) collected on 25 January 2013 by G. Mette; and the skin of an apparently juvenile female (MPEG 42601 [original number L079]) from São Félix do Xingu, (specific locality unknown) collected on 27 October 2011 by L.H. Diniz and T.R. Diniz.

OTHER SPECIMENS: Four additional Brazilian specimens, apparently representing this species, have been reported in the literature, but we were not able to examine them for the present study. Among these, Semedo et al. (2011) reported one specimen (UFMT 1355) from Fazenda São Nicolau, Mato Grosso (9.85° S, 58.22° W; fig. 2: locality 12), collected in December 2009. Additionally, Pavan et al. (2014) analyzed DNA sequences from one specimen (UNIR M451) from Madeflona, Floresta Nacional do Jamari, Rondônia (9.14° S, 63.00° W; fig. 2: locality 13), collected in February 2012 by R. Mendonça and M.R. Messias. Lastly, Abreu-Júnior et al. (2016) reported two specimens (LMUSP 279, 280) from Estação Ecológica do Rio Acre, Acre (10.75° S, 70.52° W; fig. 2: locality 14) collected in April 2015 and February 2016.

ASSOCIATED SEQUENCE DATA: DNA sequences from one mitochondrial gene (cytochrome *b*), two autosomal exons (IRBP exon 1, BRCA1 exon 11), one autosomal intron (SLC38 intron

7), and one X-linked intron (OGT intron 14) obtained from MPEG 40575 and MPEG 42956 were included in the phylogenetic analyses of Pavan et al. (2014) and are deposited in GenBank with accession numbers KM071402, KM071124, KM071035, KM071316, and KM071221 (corresponding to sequences obtained from MPEG 40575), and KM071403, KM071123, KM071034, KM071315, and KM071220 (corresponding to sequences obtained from MPEG 42956). DNA sequences from cytochrome *b*, BRCA1 exon 11, and OGT intron 14 loci of MPEG 38942 were also included in the phylogenetic analyses of Pavan et al. (2014) and are deposited in GenBank with accession numbers KM071404, KM071036, and KM071317.

DISTRIBUTION: *Monodelphis saci* is currently known from at least 14 localities scattered along the south bank of the Amazon in the Brazilian states of Pará, Mato Grosso, Rondônia, and Acre (fig. 2).

DESCRIPTION: Dorsal pelage superficially brownish from behind ears to rump (varying from near Clove Brown to Olive Brown, slightly darker on the rump than over the shoulders), without distinct stripes or other sharp pigmental discontinuities, but head conspicuously reddish (near Sepia); middorsal fur 4–5 mm long and grayish basally. Ventral pelage gray-based and usually brownish on most of chin, throat, groin, and flanks, but abruptly self-whitish midventrally on chest and abdomen.⁵ Pinnae macroscopically naked, but densely covered internally and externally with short, brown hairs. Mystacial and supraorbital vibrissae mostly dark, with longest mystacial hairs extending behind eyes when laid flat against cheek but not reaching pinnae. There are two supraorbital vibrissae on each side (but only one is present on the right side on MPEG 42601 and UFPA 1422). Genal vibrissae lighter colored than the remaining facial vibrissae, usually reaching the pinnae but rarely extending behind their posterior border. Gular gland (indicated by an area of yellowish fur on the throat) present in all mature males and, apparently, in one out of three mature females examined. Hands and feet covered dorsally with short, mostly light-brown hairs. Ungual tufts very short (restricted to the bases of the manual claws and reaching only the middle of the pedal claws). Thenar and first interdigital pad of pes separate (not fused). Hypothenar pad of pes present (e.g., on MCN-M 2301) or absent (e.g., on MPEG 42956). Scrotal skin light brownish to cream, covered with pale (near Tilleul-Buff) hairs. Mammary formula apparently 3–0–3 = 6 (MPEG 42956), all abdominal-inguinal. Tail about half as long as combined length of head and body (mean LT/HBL = 0.51 in 8 males, 0.46 in three females; tables 2, 3), dark brown dorsally but mottled ventrally with pale blotches in mature specimens. Body pelage extends onto tail farther ventrally than dorsally. Caudal scales (discernible mostly on the distal portion of the tail) arranged in predominantly spiral series.

Skull unremarkable in general aspect (not conspicuously flattened; rostrum neither greatly elongated nor unusually short). Infraorbital foramen dorsal to anterior root of M1; anterior margin of lacrimal dorsal to M2 or to M1/M2 commissure; two lacrimal foramina usually present on anterior orbital margin. Interorbital region hourglass shaped, with rounded supra-orbital margins, and lacking distinct processes, but supraorbital surface of frontals with

⁵ The ventral pelage of MPEG 40575, MZUSP 12207, and UFSC 5210 is dirty cream in general aspect, such that this marking is absent or indistinct.



FIG. 4. Adult female of *Monodelphis saci* (MPEG 42956), from Mina do Palito, Itaituba, Pará, Brazil. Photos: A.O. Maciel.

V-shaped temporal scars in large males (e.g., UFPA 1395, UFSC 5210, MZUSP 12207); sagittal crest absent even in largest adult males examined; nuchal (occipital) crest present, restricted to dorsolateral margin of the skull (interrupted middorsally); no parietal-mastoid contact on posterior braincase (interparietal extends laterally to contact squamosal, except on left side of MZUSP 12207); zygomatic arches laterally expanded, with anterior connection to skull marked by shallow but distinct inflection in all examined mature specimens; frontal process of jugal absent or indistinct.

Incisive foramina extending from level of third upper incisors to between upper canines (never behind C1s); maxillopalatine fenestrae extending from M1 to posterior margin of M2 or middle of M3; anterior margin of maxillopalatine fenestrae usually posterior to infraorbital foramen in mature specimens (but ventral to the foramen on UFPA 1394); palatine fenestrae present (e.g., in MPEG 38947; MN 73872, 75511) or absent (e.g., MZUSP 12207; UFPA 1260,

1395); posterolateral palatal foramina small (not extending anteriorly between M4s) and complete (with an entire posterior bony margin); basisphenoid concealed by alisphenoid in lateral view (not exposed through sphenorbital fissure in posteromedial orbit); infratemporal crest of alisphenoid usually distinct; tympanic wing of alisphenoid small, uninflated, and widely separated from rostral tympanic process of petrosal; rostral tympanic process narrow, triangular, and widely separated from caudal tympanic process (fenestra cochleae exposed); anterior process of malleus exposed between ectotympanic annulus and tympanic wing of alisphenoid; extracranial course of mandibular nerve not enclosed by bone (secondary foramen ovale absent); stapes columelliform and imperforate; subsquamosal foramen large (substantially wider than the squamosal strut which separates this opening from the postglenoid foramen); paroccipital process elongated, dorsoventrally directed.

Crowns of I2–I5 increasing in width from front to back (such that the crown of I5 is distinctly wider than the crown of I2); upper canines usually simple, without distinct accessory cusps (but tiny accessory cusps are sometimes present in juveniles and young adults; e.g., in MN 74002, 74003, 75511); postcanine diastemata very small or absent in upper dentition; P2 and P3 usually subequal in width, or P3 slightly wider than P2 (e.g., on UFPA 1260 and 1422).

Lower dentition also without distinct postcanine diastemata; p2 and p3 subequal in height; anterior cingulid of lower molars narrow (on m2 and m3 these shelves are unambiguously lingual to the hypoconids of m1 and m2, respectively); lower milk premolar (dp3) narrow, with an incomplete (bicuspid) trigonid and a minimally differentiated anterior cingulid (MN 74002); entoconids of m1–m3 small or indistinct.

COMPARISONS: *Monodelphis saci* shares the diagnostic external and craniodental traits of the subgenus *Mygalodelphys* and therefore differs from species in other subgenera by having body fur that extends onto the tail farther ventrally than dorsally, lacking a distinct frontal process of the jugal, lacking parietal-mastoid contact on the lateral braincase, having a small sphenorbital fissure through which the basisphenoid is not exposed laterally, having narrow anterior cingulids on m2 and m3, and having indistinct entoconids on m1–m3 (Pavan and Voss, 2016). Additionally, *M. saci* can be distinguished externally from sympatric congeners by its much smaller size and by its lack of conspicuously patterned dorsal pelage: whereas *M. saci* is uniformly brownish with reddish highlights only on the head, *M. glirina* (Wagner, 1842) and *M. touan* (Shaw, 1800) have reddish flanks, and *M. emiliae* (Thomas, 1912) has a grayish mid-body contrasting with its reddish head and rump.

Monodelphis saci can be distinguished from other species of the subgenus *Mygalodelphys* by a distinctive range of morphometric variation (tables 2, 3)⁶ as well as qualitative external and craniodental traits. Among the latter, no other species of *Mygalodelphys* has a distinctly reddish head, nor does any other congener have pale mottling on the underside of the base of the tail. Other relevant comparisons with species of *Mygalodelphys* are summarized below.

Monodelphis saci can be readily distinguished from *M. handleyi* Solari, 2007, and *M. ronaldi* Solari, 2004, by its much smaller size (most external and all craniodental dimensions of

⁶ For comparative measurements of *M. handleyi*, *M. ronaldi*, *M. reigi*, *M. osgoodi*, *M. pinocchio*, and *M. kunsii* see Pavan (2015: table 1).



FIG. 5. Dorsal (A), lateral (B), and ventral (C) views of the holotype skin of *Monodelphis saci* (UFPA 1422). Scale bar = 50 mm.

M. saci exhibit nonoverlapping variation with our samples of *M. handleyi* and *M. ronaldi*). In addition, *M. saci* lacks several traits exhibited by *M. handleyi* and *M. ronaldi*, including an extremely flattened skull, a prominent sagittal crest, and a nuchal crest that is continuous across the dorsal midline of the occiput.

On average *Monodelphis saci* is smaller than *M. reigi* Lew and Peréz-Hernández, 2004, in all measured external and craniodental dimensions, and is consistently smaller in four dimensions (HBL, TL, CBL, PL) that exhibit nonoverlapping variation in these species. In addition to the aforementioned differences in pelage color (*M. reigi* is uniformly dark brown), *M. saci* lacks the conspicuously elongated rostrum and the distinct postcanine diastemata of *M. reigi*.

By comparison with *Monodelphis osgoodi* (Doutt, 1938) and *M. pinocchio* Pavan, 2015, *M. saci* can be distinguished, among other features, by a much broader and less elongated rostrum (measurements of PB exhibit nonoverlapping variation in pairwise comparisons of *M. saci* with either species), by the absence of distinct postcanine diastemata in the upper and lower dentition, and by shorter maxillopalatine fenestrae that extend anteriorly only to M1 (maxillopalatine fenestrae extend anteriorly to P3 or to the P3/M1 commissure in *M. osgoodi* and *M. pinocchio*).

Monodelphis saci is substantially larger than *M. kunsi* Pine, 1975, in all measured external and craniodental dimensions (e.g., males of these species exhibit no overlap in HBL, CBL, PL, PB, and LM). In addition to its reddish head and pale-mottled caudal undersurface, *M. saci* also differs from *M. kunsi* by its longer dorsal pelage (4–5 mm versus 3 mm in *M. kunsi*), tail scales in predominantly spiral series (annular series predominate in *M. kunsi*), a more elongated rostrum (best appreciated in side-by-side cranial comparisons), distinct lateral inflections where the zygomatic arches join the rostrum (absent in *M. kunsi*), a reduced facial exposure of the lacrimal (not extending anteriorly beyond the M1/M2 commissure, versus dorsal to M1 or extending to the P3/M1 commissure in *M. kunsi*), and upper incisor crowns that increase in width from I2 to I5 (versus I2–I5 crowns subequal in *M. kunsi*).

Monodelphis saci is similar to *M. adusta* and *M. peruviana* (Osgood, 1913) in most external and craniodental dimensions, but differs in qualitative traits. In addition to its reddish head and pale-mottled caudal undersurface, *M. saci* exhibits distinct lateral inflections at the anterior roots of the zygomatic arches (absent in *M. adusta* and *M. peruviana*) and shorter maxillopalatine fenestrae, with the anterior margin of these openings usually posterior to the infraorbital foramen (the anterior margin of the maxillopalatine fenestrae are usually anterior to the infraorbital foramen in *M. adusta* and *M. peruviana*). Additionally, we observed V-shaped temporal scars on the supraorbital surface of the frontals in most large male specimens of *M. saci* but not in any examined material of *M. adusta* or *M. peruviana*.

HABITATS AND SYMPATRY: At Bom Jardim, Penedo, and Boca do Rato, *Monodelphis saci* was found in both primary and disturbed forest (logged areas and secondary vegetation) on both banks of the Rio Tapajós. Capture sites at these localities included terra firme forest characterized by a relatively low canopy (10–15 m) with numerous lianas (fig. 3A–B), as well as seasonally flooded riparian forest characterized by clayey soil, abundant epiphytes, palm trees, and herbaceous vegetation (fig. 3C).



FIG. 6. Dorsal view of skins of adult specimens of *Monodelphis saci* (A, left to right: UFPA 1422, 1394, 1395, 1738, 1260), and *M. peruviana* (B, left to right: FMNH 169811, 172032; MVZ 173928; AMNH 264562, 272695; USNM 588019). Note the distinctly reddish head of *M. saci*.

Monodelphis saci probably occurs sympatrically with *M. emiliae* and *M. glirina* throughout its known geographic range, and it occurs sympatrically with *M. touan* between the Xingu and Tocantins rivers. Sympatry among *M. saci*, *M. glirina*, and *M. touan* has previously been reported from Floresta Nacional de Carajás (Martins et al., 2012), whereas sympatry among *M. saci*, *M. glirina*, and *M. emiliae* was recently reported from the upper Rio Acre (Abreu-Júnior et al., 2016). *Monodelphis saci* and *M. glirina* occur syntopically along the middle Tapajós (where both species were caught in three lines of pitfall traps by the second author), and it occurs syntopically with *M. emiliae* at Mina do Palito (where the two species were caught in the same line of pitfall traps by A.O. Maciel and J.O. Gomes; personal commun.).

REMARKS: Several specimens deposited at the Museu Nacional (MN 73872, 74002, 74003) that we refer to *Monodelphis saci* were previously identified as *M. kungsi* by Gettinger et al. (2011).

ETYMOLOGY: The specific epithet is a noun in apposition and refers to the Brazilian folkloric character Saci, a one-legged gnome with a red cap. Saci is allegedly derived from the Yaci Yaterê of Tupi-Guarani mythology, to which elements of African and European folklore have been added over the last several centuries (Cascudo, 1947).

OTHER SPECIMENS EXAMINED: ***Monodelphis adusta*** ($N = 24$)—COLOMBIA, *Boyacá*, Guaicaramo (AMNH 75232); *Cundinamarca*, Paime (MNHN 1929-672), Susumuco (BMNH 21.5.2.6), “W. Cundinamarca” (BMNH 97.7.2.1 [holotype of *adusta*]); *Magdalena*, Colonia Agrícola de Caracolicito (USNM 280894); *Meta*, Villavicencio (AMNH 136158, 139227, 202650), 7 km NE Villavicencio (AMNH 207765); *Tolima*, Mariquita (BMNH 12.4.2.10, 12.9.8.3). ECUADOR, *Napo*, Lumbaqui (USNM 534286), San Jose Abajo (AMNH 68136); *Pastaza*, Mera (AMNH 67274), Safari Hostería Park (TTU 84865, 84899); *Tunguragua*, Palmera (AMNH 67275); *Zamora-Chinchipe*, Zamora (AMNH 47189). PANAMA, *Darien*, Cana (USNM 179609 [holotype of *melanops*]), Guayabo (ANSP 19676), Tacarcuna Village Camp (USNM 309263). PERU, *Loreto*, 1.5 km N Teniente Lopez (KU 157978), Estación Biológica Allpahuayo (TTU 98923, 101164).

Monodelphis handleyi ($N = 6$)—PERU, *Loreto*, Jenaro Herrera (AMNH 276698, 276704, 276709; MUSM 23808–23810).

Monodelphis kungsi ($N = 36$)—ARGENTINA, *Salta*, Finca Falcón (MACN-Ma 23783, 23784). BOLIVIA, *El Beni*, La Granja (USNM 461348 [holotype of *kungsi*]); *Santa Cruz*, El Refugio (USNM LHE 1692); *Tarija*, Río Lipeo (ANSP 18191), Tapehua (AMNH 263968). BRAZIL, *Distrito Federal*, Fazenda Agua Limpa (OMNH 22265–22266); *Goiás*, Silvânia (MN A 191); *Mato Grosso*, Fazenda Tanguro (MPEG 43016–43017), Reserva do Patrimônio Particular Natural SESC Pantanal (MN 64323, 64411, 64424); *Mato Grosso do Sul*, margem direita Córrego Urucum (UFMG LFS 202), Mineração Rio Tinto (UFMG RM 318–319, 324, 340); *Minas Gerais*, Aiuruoca (MCN-M 1570, 1607), Betim (MCN-M 1470, 1531), Divinópolis (MCN-M 1256), Palmital (MCN-M 2964), Parque Nacional da Serra do Cipó (MZUSP MTR 20361, MCN-M 1465), Pompéu (MCN-M 1420, 1421), Rio Manso (MCN-M 2273), Serra do Salitre (MCN-M 2304), Unidade Ambiental Jacob (UFMG 1965); *São Paulo*, Nadiu Figueredo (MN 46571); *Tocantins*, Peixe (MZUSP 35059). PARAGUAY, *Canendeyú*, Reserva de Biosfera del

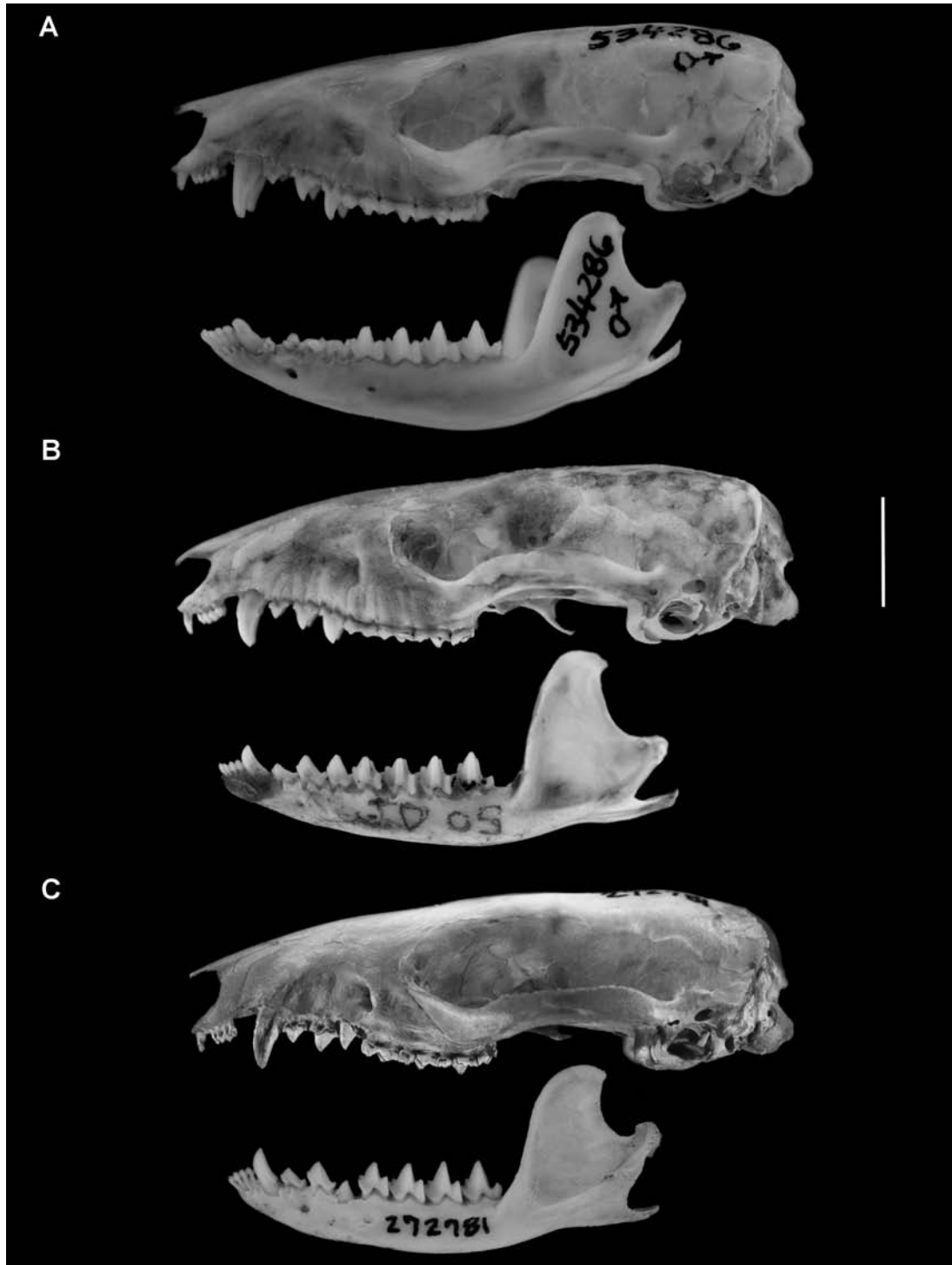


FIG. 7. Lateral cranial and mandibular views of adult male *Monodelphis adusta* (A, USNM 534286), *M. saci* (B, UFPA 1422), and *M. peruviana* (C, AMNH 272781). Scale bar = 5 mm.



FIG. 8. Dorsal and ventral cranial views of adult male *Monodelphis adusta* (A, USNM 534286), *M. saci* (B, UFPA 1422), and *M. peruviana* (C, AMNH 272781). Arrows indicate the diagnostic lateral concavity on the anterior root of the zygomatic arch in *M. saci*. Scale bar = 5 mm.

TABLE 2. Measurements (mm) and weights (g) of adult male specimens of *Monodelphis adusta*, *M. peruviana*, and *M. saci*.

	<i>M. adusta</i> ^a	<i>M. peruviana</i> ^b	<i>M. saci</i> ^c
HBL	109 (89–125) 11	101 (85–118) 9	102 (93–117) 8
LT	56 (40–66) 11	55 (47–62) 9	52 (41–59) 8
HF	16 (15–17) 11	16 (12–19) 9	14 (12–15) 9
Ear	12 (10–14) 8	12 (10–16) 7	12 (9–13) 5
Weight	27 (17–35) 6	20 (15–33) 6	23 (17–29) 7
CBL	28.3 (25.7–30.9) 10	26.2 (24.3–28.9) 7	27.1 (25.4–29.4) 9
NL	14.0 (12.5–15.1) 9	13.1 (11.7–14.7) 7	12.6 (11.8–13.6) 6
NB	4.2 (3.9–4.6) 12	3.7 (3.2–4.2) 9	3.9 (3.1–4.7) 8
PL	15.3 (14–16.6) 12	14.5 (13.2–16.5) 9	14.5 (13.7–16.2) 9
PB	9.3 (8.8–10.0) 12	8.7 (7.5–9.9) 7	8.6 (8.3–9.4) 9
MTR	11.4 (10.5–12.0) 12	10.7 (10.1–11.7) 8	10.7 (10.1–11.8) 9
LM	6.1 (5.6–6.3) 12	5.8 (5.3–6.1) 8	5.8 (5.6–6.2) 9
M1–3	5.2 (4.9–5.4) 12	5.0 (4.6–5.4) 8	5.0 (4.9–5.4) 9
WM3	2.1 (1.9–2.2) 12	2.0 (1.7–2.2) 8	1.9 (1.8–2.1) 9
LMPF	3.8 (3.0–4.3) 12	3.7 (3.3–3.9) 8	3.2 (2.4–3.6) 9
LIB	5.6 (5.1–5.9) 10	5.5 (5.0–6.2) 8	5.2 (4.8–6.5) 9
POC	5.4 (4.9–5.8) 10	5.2 (4.8–5.5) 8	5.1 (4.7–5.6) 9
BBC	10.5 (10.1–11) 9	9.8 (9.2–10.7) 6	10.2 (9.6–10.9) 9
ZB	15.2 (13.2–16.6) 10	13.7 (11.8–16.0) 8	14.4 (13.3–15.5) 9

^a The mean, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 47189, 67274, 68136, 75232, 136158, 207765; KU 157978, 157978; TTU 101164, 84865, 98923; USNM 179609, 280894, 534286.

^b The mean, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 272781; FMNH 169811, 172032, 19362; MUSM 7157, 15318; MVZ 173928; USNM 259433, 582782.

^c The mean, the observed range (in parentheses), and the sample size for measurements of the following series: MCN-M 2301; MN 73872, 74003; MZUSP 12207; UFPA 1260, 1422, 1394, 1395; UFSC 5210.

Bosque Mbaracayú (TTU 116526); *Presidente Hayes*, Trans-Chaco Highway, Km 412 (FMNH 164094). Locality unknown (MN 73381).

Monodelphis osgoodi ($N = 3$)—BOLIVIA, *Cochabamba*, 4.4 km N Tablas Monte (AMNH 264922), Incachaca (CM 5242 [holotype of *osgoodi*]). PERU, *Cusco*, Ocobamba Valley (USNM 194379).

Monodelphis peruviana ($N = 13$)—BOLIVIA, *La Paz*, Serranía Bella Vista (AMNH 264562). PERU, *Cusco*, 2 km SW Tangoshiari (USNM 588019), 3 km E Amaybamba (MVZ 173928), Cashiriari (USNM 582782), Pillahuata (FMNH 172032), Suecia (FMNH 189811); *Huánuco*, Hacienda San Antonio (USNM 259433); *Junín*, Cordillera Vilcabamba (USNM 582110); *Loreto*, Nuevo San Juan (AMNH 272695, 272781; MUSM 13297, 15318); *Madre de Dios*, Reserva Cusco Amazónico (MUSM 7157).

Monodelphis pinocchio ($N = 7$)—BRAZIL, *Espírito Santo*, Serra do Caparaó (MZUSP MTR 15815); *Rio de Janeiro*, Alto do Itatiaia (AMNH 61547), Serra de Macaé (MZUSP 2793);

TABLE 3. Measurements (mm) and weights (g) of adult female specimens of *Monodelphis adusta*, *M. peruviana*, and *M. saci*.

	<i>M. adusta</i> ^a	<i>M. peruviana</i> ^b	<i>M. saci</i> ^c
HBL	99 (97–100) 4	101 (85–112) 5	100 (98–101) 3
LT	52 (50–53) 4	56 (46–64) 5	46 (42–49) 3
HF	15 (14–15) 4	14 (12–17) 5	15 (14–15) 2
Ear	13 (12–13) 2	11 (10–13) 5	12 (11–12) 2
Weight	–	22 (14–28) 5	18 (16–19) 2
CBL	26.7 (25.0–27.9) 5	26.4 (23.8–28.3) 5	26.1
NL	13.0 (12.1–13.6) 4	12.6 (11.2–13.5) 4	12.5
NB	4.3 (4.0–4.5) 4	3.3 (2.9–3.7) 5	3.8
PL	14.9 (14.6–15) 4	14.1 (13.2–15.1) 5	13.8
PB	8.7 (8.2–9.0) 3	8.6 (7.8–9.4) 5	8.6
MTR	10.8 (10.3–11.1) 4	10.6 (10.0–11.1) 5	10.3
LM	5.9 (5.5–6.3) 5	5.6 (5.4–5.9) 5	5.6
M1–3	5.2 (4.7–5.4) 4	4.9 (4.6–5.2) 5	4.9
WM3	2.1 (1.8–2.2) 3	1.9 (1.8–2.1) 5	1.9
LMPF	4.0 (3.8–4.1) 3	4.2 (4.1–4.3) 5	2.1
LIB	5.6 (5.4–6.0) 4	5.1 (4.8–5.2) 5	5.0
POC	5.5 (5.2–5.8) 4	5.0 (4.9–5.2) 5	4.9
BBC	10.4 (10.0–11.0) 4	9.9 (9.4–10.2) 5	9.9
ZB	14.2 (13.5–14.6) 3	13.7 (11.6–15.1) 5	13.5

^a The mean, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 67275, 139227, 202650; ANSP 19676; BMNH 97.7.2.1.

^b The mean, the observed range (in parentheses), and the sample size for measurements of the following series: AMNH 264562, 272695; MUSM 13297; USNM 582110, 588019.

^c The mean, the observed range (in parentheses), and the sample size for measurements of the following series: MN 75511, MPEG 42956, UPPA 1738 (craniodental measurements from MN 75511 only).

São Paulo, Reserva Florestal do Morro Grande (MN 78651, 78680 [holotype of *pinocchio*]), Riacho Grande (MZUSP 30740). Locality unknown (MZUSP 33878).

Monodelphis reigi ($N = 2$)—GUYANA, Potaro-Siparuni, Mount Ayanganna (ROM 114699, 114864).

Monodelphis ronaldi ($N = 1$)—PERU, Madre de Dios, Pakitza (MUSM 17027).

DISCUSSION

Monodelphis saci is the only species in the subgenus *Mygalodelphys* currently known to occur in the rainforested lowlands along the right (south) bank of the Amazon River in Brazil. Apparently, its geographic range does not overlap those of its closest relatives—*M. handleyi*, *M. osgoodi*, and *M. peruviana*, which occur in Amazonian Peru—nor is the geographic range of *M. saci* known to overlap that of *M. kunsii*, a more distantly related species that occurs in

savannas and other open habitats along the southern margins of Amazonia. In effect, *M. saci* occupies a unique portion of the enormous ecogeographic range of *Mygalodelphys*, which broadly overlaps the distributions of other subgenera of *Monodelphis* (Pavan and Voss, 2016). Extensive sympatry, and a few reports of syntopy, between *M. saci* and members of other subgenera (*M. emiliae*, *M. glirina*, and *M. touan*) suggest that the new species occupies a distinctive ecological niche in opossum communities along the south bank of the Amazon, but no dietary or behavioral studies are available to support or refute this inference.

Considering that *Monodelphis saci* is widespread and occurs in both primary forest and secondary vegetation, its recent discovery and current rarity in museums seems noteworthy. Of the specimens examined for the present study, almost all (95%) were collected in just the last two decades. This remarkable fact is plausibly explained by the now-routine use of pitfall traps by mammalogical collectors. As noted by several authors (e.g., Voss et al., 2001; Pardini and Umetsu, 2006; Umetsu et al., 2006) pitfall traps seem to be more effective than conventional traps for collecting many species of small mammals. Information on capture method is available for 13 specimens of *M. saci*, all of which were taken in pitfalls. The continued use of this trapping method seems likely to result in improved distributional data for many species once considered rare and might yet produce new discoveries, even in areas that have been intensively sampled by conventional trapping for many years.

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