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A new hyladelphine marsupial (Didelphimorphia, Didelphidae) from cave deposits of northern Brazil

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Abstract

Based on very small upper and lower molars recovered from the Quaternary limestone caves in the State of Tocantins, northern Brazil, we describe a new genus and species of a didelphimorphian marsupial. A phylogenetic analysis based on morphological + karyotypic data set recovered the new genus and species as the sister taxon to the living didelphid, *Hyladelphys kalinowskii* Voss, Lunde & Simons. The new taxon differs from the latter in having a slightly larger size, more inflated and blunt cusps, greater reduction in number and size of the stylar cusps, in the absence of an anterior cingulum, a deeper ectoflexus in M2, paracone and metacone subequal in M2, and narrower and eccentric protocones. The new marsupial probably weighed no more than 40 g and its molar morphology is suggestive of mixed, insectivorous-frugivorous feeding habits. Although we regard the fauna of Gruta dos Mouras cave as Pleistocene, we do not negate the possibility that a temporal mixing ("time-averaging") of Pleistocene and Holocene specimens existed and that the newly described taxon is a living marsupial in the study area.

Key words: cave, karst, systematics, *Hyladelphys*, Pleistocene, South America

Introduction

Recent field work in the cave deposits of the southern State of Tocantins, Brazil, have produced a large sample of Quaternary micro- and large mammals, which include numeral remains of marsupials, rodents, cingulates, among others (Avilla *et al*. 2010). A preliminary analysis of the marsupial fauna indicated that none of the studied specimens can be assigned confidently to any known living species cited for the State of Tocantins (see Bezerra *et al*. 2009, Rocha *et al*. 2011). One of the marsupials from the cave deposit of Aurora de Tocantins is of general interest because of its very distinct dental structure in relation to cited living genera for the study area. No comparative dental structure to the marsupial herein described is also observed in the relevant Quaternary cave marsupial faunas described for Brazil, such as Lagoa Santa, State of Minas Gerais and São Raimundo Nonato, State of Piauí (Winge 1893, Guérin *et al*. 1993). Below we describe this marsupial and assign it to the Order Didelphimorphia.

Although the living and late Cenozoic radiations of New World marsupials are of great interest, few studies dealing with materials from caves or other Cenozoic deposits have been conducted in Brazil. Records of late Cenozoic marsupials are very fragmentary and date back to latest Miocene (Huayquerian SALMA). Czaplewski (1996) described the remains of indeterminate didelphids from the late Miocene in the Acre region, while Cozzuol *et al*. (2006) described a new species of *Didelphis* Linnaeus from this same age and region. Abundant late Pleistocene (Lujanian SALMA) marsupial remains have been collected from the limestone caves of Lagoa Santa, State of Minas Gerais (Winge 1893). Other records include the remains of *Didelphis albiventris* Lund, *Monodelphis domestica* Wagner and *Marmosa* Gray from the late Pleistocene of the State of Piauí (Guérin *et al*. 1993), and of *Gracilinanus microtarsus* Wagner, *G. agilis* Burmeister, *Monodelphis americana* Müller, *Thylamys velutinus* Wagner,

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Thylamys cf. *T. velutinus*, *Philander opossum* Linnaeus, and *Didelphis* Linnaeus from the Holocene of Rio Grande do Sul (Hadler *et al*. 2009).

Several phylogenetic studies performed in the last decades on New World marsupials have revealed the existence of an unexpected diversity in the living Didelphimorphia radiation, as represented by didelphines, caluromyines, hyladelphines, and glironiines (Kirsch & Palma 1995, Reig *et al*. 1987, Hershkovitz 1992, Goin 1997, Jansa & Voss 2005, Voss & Jansa 2009). Despite the recent diversity of the order, no fossil representatives of caluromynes, hyladelphines and glironiines have ever been described (but see Goin *et al*. 2007).

Here we report the discovery of a new didelphimorphian marsupial in the Quaternary limestone caves of Gruta dos Mouras, State of Tocantins, northern Brazil, which we show to be a representative of the Hyladelphinae, a clade of very small marsupials recently proposed by Voss & Jansa (2009). The objective of this paper is to describe this new genus and species of marsupial, compare it with other fossil and living South American forms, and to discuss its affinities on the basis on a parsimony analysis involving living didelphimorphians.

Material and methods

Abbreviations: Institutions: DGEO-UFPE, Departamento de Geologia, Universidade Federal de Pernambuco, Recife, Brazil. Dental terminology: M1, M2, M3, M4, upper molars; StA, StB, StC, StD, StE: stylar cusps A, B, C, D, E respectively. Molar cusp and crest nomenclature follow Goin & Candela (2004). L is length (anteroposterior length) and W is width (labiolingual width). All measurements are in millimeters.

Biochronology: SALMA, South American Land Mammal Age.

Geological setting of the specimen: Material was derived from a limestone cave in Aurora de Tocantins, State of Tocantins in Northern Brazil (Fig. 1). The study area is geologically poorly understood. Online notes of CPMR (Companhia de Pesquisa de Recursos Minerais) on the geology of the municipality of Aurora de Tocantins reports carbonate and terrigenous deposits of the Bambui Group, which is Neoproterozoic in age (CPRM 2006). The carbonatic rocks in the region of Aurora do Tocantins are part of the Speleological Province of the Bambui Group, which contains the limestones that are home to the largest number of caves in Brazil (Zampaulo & Ferreira 2009).

Phylogenetic analysis: We employed a morphological matrix composed of 129 morphological characters published in Voss & Jansa (2009) plus eight new dental characters, listed below. We employed the same outgroups of Voss & Jansa (2009): *Dromiciops* Thomas, *Perameles* É. Geoffroy, *Murexia* Tate & Archbold, *Sminthopsis* Thomas, *Echymipera* Lesson, as representatives of the Australidelphia and the Paucituberculata *Caenolestes* Thomas and *Rhyncolestes* Osgood. Descriptions, illustrations, scorings, and comments regarding characters 1 to 129 are discussed by Voss & Jansa (2003, 2009). The following characters were added to the matrix:

Character 130. Development of stylar cusps (modified from Reig *et al*. 1987): (0) cusps reduced in number and size, (1) four to five well developed cusps, (2) two well-developed cusps and the other small. *Dromiciops*, *Hyladelphys* and the new taxon are representative of the state 0. This character was coded as state 1 for most didelphimorphian and Australian taxa, and coded as state 2 for paucituberculatans, *Didelphis*, and *Philander* Brisson.

Character 131. Stylar shelf width in relation to talon in M2-M3 (modified from Cifelli 1993 and Goin *et al*. 2006): (0) narrow, (1) moderate to wider. State 0 is observed in *Dromiciops*, *Perameles*, caluromyines, and caenolestids. Remaining taxa exhibits state 1.

Character 132. Metaconule presence (modified from Goin *et al*. 2006): (0) present, (1) absent. The metaconule is present in *Caluromys* J. A. Allen, caenolestids and in Australian taxa. We follow Wroe *et al*. (2000) regarding the presence of metaconule in Australian taxa. The presence of metaconule in recent didelphimorphians is contentious (Voss & Jansa, 2009), but we interpreted that the second and third upper molars of *Caluromys* bear a metaconule, which is not restricted to postprotocrista but extends vertically along the labial face of the protocone.

Character 133. Shape of the labial face of paracone and metacone (Rougier *et al*. 1998): (0) conical, convex, (1) not conical, flat to concave. State 0 was scored only for *Dromiciops*, caluromyines and for the new taxon.

Character 134. Size of paracone and metacone in relation to paracone in M3 (modified from Reig *et al*. 1987): (0) subequal to slightly larger, (1) substantially larger. State 0 was coded for *Dromiciops*, caluromyines, *Hyladelphys* and new taxon. We follow Wroe *et al*. (2000) regarding the presence of state 1 in Australian taxa.

Character 135. Protocone position on M1 and M2 in relation to transverse mid-line of tooth: (0) central, (1) eccentric. An eccentric protocone is autapomorphic for the new taxon described in this paper. In the remaining marsupials, the protocone is transversely aligned to the mid-line of the tooth.

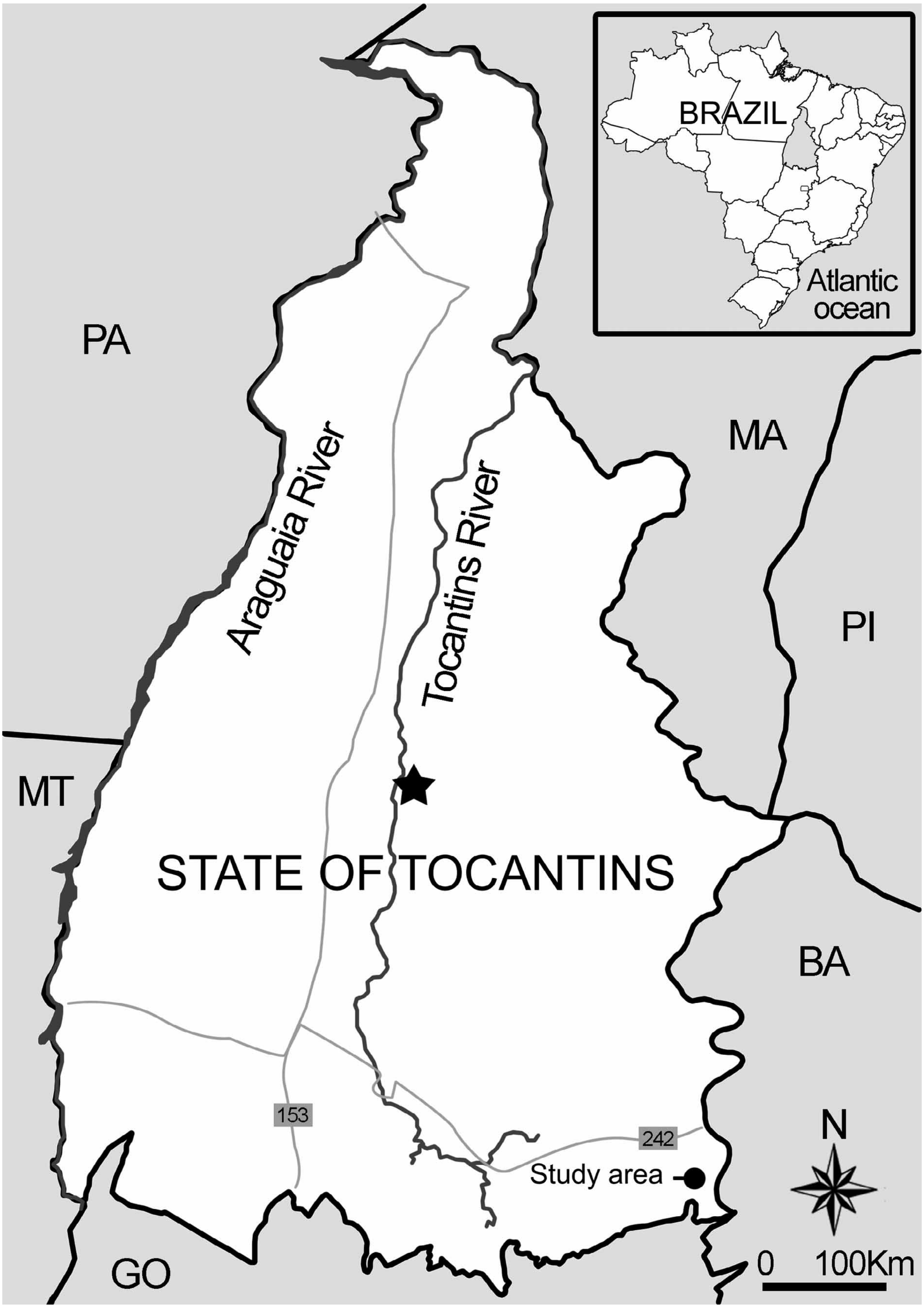

FIGURE 1. Map showing the municipality of Aurora dos Tocantins, State of Tocantins, Brazil, where the fossil locality is situated.

Character 136. M2 length in relation to M3: (0) M2 clearly smaller than M3, (1) M2 subequal to larger than M3. A M2 subequal or larger than M3 is observed in *Dromiciops*, *Caluromys*, caenolestids, *Hyladelphys*, and in the new taxon. Remaining taxa have M2 smaller than M3.

Character 137. Cristid oblique (Archer 1976). Position in relation to posterior face of trigonid: (0) ending lingually, close to postprotocristid notch (1) ending at middle point or well labially to the postprotocristid notch. Most of didelphimorphians were coded as state 1, except caluromyines. The Australian *Perameles*, *Echymipera*, *Sminthopsis* were coded as state 0 (Wroe *et al*. 2000).

Character 138. Prefossid. (0) poor developed (1) well-developed. Reig *et al*. (1987) used this character in their dental description but not in their phylogenetic analysis. The character is related to the presence of a well-developed basin on the trigonid, similar to the presence of a talonid basin (postfossid). In *Hyladelphys* and in the new taxon this character is related to the anterolabial displacement of the paraconid.

Parsimony analysis of the matrix was carried out using the heuristic search algorithm of PAUP* 4.0b 10 (Swofford 2003) with an initial search of 1000 replications. We enforced a topological constraint in order to obtain the monophyly of Didelphimorphia. Bootstrap nodal support values (Felsenstein 1985) were calculated using 1000 bootstrap replicates: bootstrap nreps=1000 conlevel=50 keepall=yes cutoffpct=50/ start=stepwise constraints=didelph enforce=yes nreps=1000 savereps=yes nchuck=100 chuckscore=10 dstatus=none. Decay indices (Bremer 1994) were calculated using the commands hsearch keep=[number of steps] timelimit=60 limitperrep=yes nreps=1000.

Results

Systematics

Supercohort Marsupialia Illiger, 1811

Order Didelphimorphia Gill, 1872

[*nom. transl*. Aplin & Archer, 1987]

Superfamily Didelphoidea Gray, 1821

Family Didelphidae Gray, 1821

Subfamily Hyladelphinae Voss & Jansa, 2009

Sairadelphys gen. nov.

Etymology. *saíra* is a word from Tupi language meaning tiny or slender + *delphys*, a Greek suffix used for New World marsupials.

Type species. *Sairadelphys tocantinensis* **sp. nov.**

Diagnosis. Very small didelphid, with slightly larger size than *Hyladelphys*. Relatively low crowned molars. M3 with similarly sized paracone and metacone. Stylar cusps are reduced in number and size. Paracone and metacone have convex labial faces. Upper molars not strongly carnassialized (i.e. postmetacristae are only slightly longer than postprotocristae) and postprotocrista are without a carnassial notch. M2 subequal to slightly larger than M3. First lower molar with well-developed prefossid. Differs from *Hyladelphys* in having a slightly larger size, more inflate and sharpless teeth, deeper ectoflexus in M2, no size difference between paracone and metacone in M2-3, protocone eccentric and very low, absence of anterior cingulum, stronger reduction in number and size of stylar cusps and smaller M4.

Description. M2 is the largest known molar tooth (M1 is unknown); M2>M3>M4. The ectoflexus is very deep and symmetrical so that the parastylar and metastylar areas are very conspicuous. The trigon cusps are low and bunodont. The stylar shelf is much higher than the trigon basin and is transversely wider at both paracone and metacone in relation to the talon. There are no traces of stylar cusps StA, STB, StC and StE; only a hint of StD is present in M2. In general, the stylar shelf surface is smooth, with a rounded labial edge. The preparacrista is poorly developed, low and ends at the anterolabial corner of the tooth. The postmetacrista is slightly longer than the preparacrista, and extends relatively transversely to the dental axis. The paracone and metacone are subequal in height, and their labial faces are convex. The lingual edges of the paracone and the metacone are not vertical but instead gently slope medially. In occlusal view, the paracone is slightly larger than the metacone. A distinct ovate wear facet is observed at the apices of the paracone and metacone. The centrocrista is low, poorly developed and linear. Smooth lingual crests descend from the apex to the base of the paracone and the metacone. There are no traces of anterior or posterior cingulum; para- and metaconules are absent. The protocone is reduced and anteriorly displaced (eccentric). The protocone is round, low and the trigon basin is small.

M3 differs from M2 in having a more developed metastylar area, the postmetacrista extends slightly less transversely to the dental axis. Furthermore, the anterolingual face of the paracone is mostly rectilinear and the protocone is slightly more eccentric. M4 is very reduced in relation to M2–3 and bears only two cusps, the protocone and a large parastyle. The labial-most cusp is rounded and anterolabially displaced.

The only lower molar available is an isolated m1 (Fig. 3). It presents low and slightly inflated cusps. The trigonid is equivalent in length to the talonid. The protoconid is the tallest trigonid cusp. The metaconid is compressed labio-lingually and placed aligned transversally to protoconid. The paraconid is wide in its basis, with the apex not lingual but displaced labially. The trigonid presents a well-developed prefossid. The prefossid is anteriorly delimited by two short crests running from the apex of the paracone to the basis of the protoconid and of the metaconid. The talonid is wider than the trigonid. The entoconid is the tallest and largest cusp of the talonid, occupying much of the lingual margin of the talonid. The hypoconulid is small, twinned to the entoconid and slightly displaced labially in relation to it. The hypoconid is labially expanded and its basis is displaced posteriorly relative to the entoconid. The cristid obliqua ends anteriorly at a point labial to the posprotocristid notch. The anterior cingulid is narrow, and a short labial cingulid occurs in the postero-labial face of the protoconid.

Sairadelphys tocantinensis sp. nov.

Figs. 2–4

Etymology. *tocantinensis* after the State of Tocantins, where the paleontological site is located.

Type. DGEO-UFPE 6745, incomplete left maxilla with complete M2–4.

Hypodygm. The type and DGEO-UFPE 6746, an isolated left m1.

Locality and age. Municipality of Aurora de Tocantins, cave of Gruta dos Mouras, Sate of Tocantins, Brazil (12º42´47´´S and 46º24´28´´W); Pleistocene.

Diagnosis and description. Same as for the genus.

Comments. The lower molar assigned to *Sairadelphys tocantinensis* is similar in morphology to that of *Hyladelphys* and *Marmosa* (e.g. *M. murina* Linnaeus). However, in comparison with *Marmosa* we noted that in DGEO-UFPE 6746 the crests are less developed and the cristid oblique is most labially placed in relation to the postprotocristid notch; therefore, the cristid oblique in the new taxon runs less obliquely in relation to the anteroposterior dental axis, a feature that is compatible with the linear centrocrista described for upper molars of *Sairadelphys*. Another complementary occlusal relationship between the holotype and the assigned lower molar is related to the low protocone in *Sairadelphys*, which is compatible with lower molars with high entoconid as seen in DGEO-UFPE 6746.

Measurements (mm). DGEO-UFPE 6745: M2 L =1.38, M2 W=1.77; M3 L=1.42, M3 W=1.50; M4 L= 0.73, M4 W=0.97; DEGEO-UFPE 6746: m1 L = 1.68, m1 W=0.93.

Comparisons. Several features of this new marsupial confidently place it in the Didelphimorphia (see below). However, the presence of plesiomorphic features in *Sairadelphys tocantinensis*, as exemplified by the presence of a linear centrocrista, and subequal paracone and metacone, constitute characters absent in most living didelphimorphians and, therefore, warrants comparisons with fossil and generalized forms such as Caluromyinae, Sparassocynidae, Peradectidae, *Wirunodon* Goin & Candela, and Microbiotheriidae. A relationship to the latter can be rejected on the basis of several characters: the trigon basin is reduced in *Sairadelphys* (very wide in Microbiotheriidae), the protocone is narrow (it is wide in Microbiotheriidae), and the stylar shelf is wide in relation to the talon (very reduced in Microbiotheriidae). *Sairadelphys tocantinensis* differs from the Peradectidae in the absence of cingula, para- and metaconule and StC, and in the preparacrista ending at the anterolabial angle of the tooth (stylar cusp A region). Furthermore, peradectids are significatively older than *Sairadelphys*, which was found on Pleistocene sediments (see below). The enigmatic marsupial *Wirunodon*, from the late Paleogene of Santa Rosa, Peru (Goin & Candela 2004) resembles *Sairadelphys*, with some characters such as the reduction of stylar cusps and of the protocone. However, *Sairadelphys* differs from *Wirunodon* in having subequal paracone and metacone, absence of anterior cingulum, and much less developed stylar cusps. Sparassocynid affinities of *Sairadelphys* can be ruled out on the basis of its absence of cingula and conules (except *Hesperocynus* Forasiepi, Goin & Martinelli), deep ectoflexus (mainly in M3), absence of cutting crests, reduced postmetacrista, and in that the paracone and the metacone are similar in size.

Although *Sairadelphys* shows an unusual morphology, a combination of derived features are consistent with its assignment to the Didelphimorphia, among which a transversely well-developed stylar shelf in relation to the talon, and absences of paraconule, anterior cingulum and posterior cingulid. Most of the living didelphimorphians have an incomplete anterior cingulum in the upper molars and do not have a posterior cingulid in the lower molars (Voss & Jansa 2009). However, most didelphimorphians have a V-shaped centrocrista, (albeit with variations; Goin 1997), and show a clear difference in height and volume between the paracone and the metacone (as seen in *Sairadelphys*, the paracone and the metacone are subequal in height and volume).

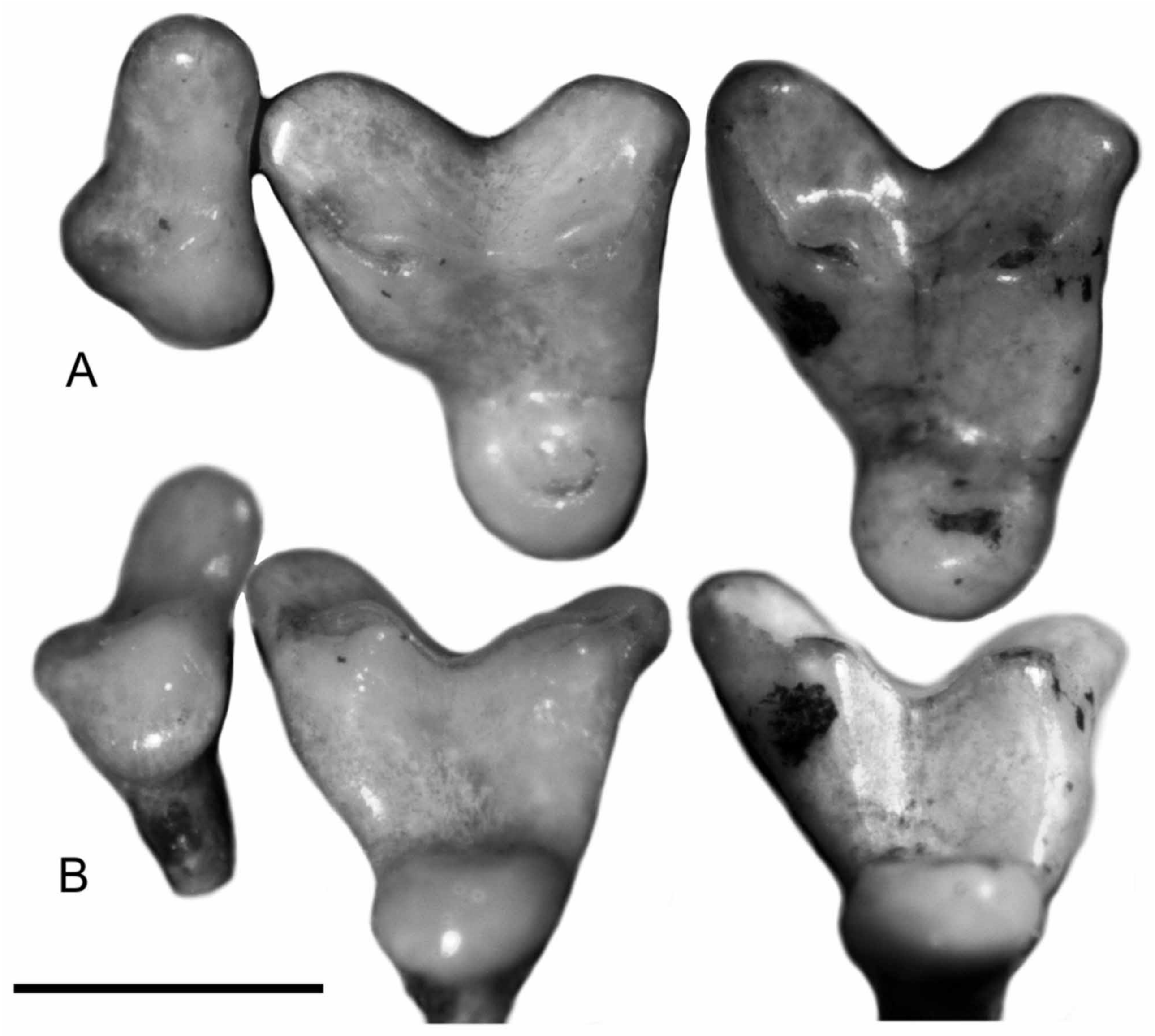

FIGURE 2. *Sairadelphys tocantinensis* **gen. et sp. nov.**, DGEO-UFPE 6745, type. A, M2–4 in occlusal view; B, M2–4 in linguo-occlusal view. Scale = 1 mm.

FIGURE 3. Lower molar of *Sairadelphys tocantinensis* **gen. et sp. nov.**, DGEO-UFPE 6746. A, mesial view, B, posterior view. Scale bar = 1mm.

Below we describe some characters (including three synapomorphies) that suggest a close relationship between *Sairadelphys tocantinensis* and the living Didelphimorphian *Hyladelphys kalinowskii*, described from the amazon region in French Guiana, Peru, and Brazil (Hershkovitz 1992, Voss *et al*. 2001, Jansa & Voss 2005, Astúa 2006). When compared to *Hyladelphys*, *Sairadelphys* is differs in having more inflate cusps, strongly reduced stylar cusps, and in lacking cingula.

Cladistics . The phylogenetic analysis resulted in 1093 parsimonious trees of 372 steps [consistency index (CI) = 0.4731, retention index (RI) = 0.7768]. The consensus tree resulting from parsimony analysis of morphological + karyotypic data set is identical to that which has been previously published (Voss & Jansa 2009: fig. 27), except for the inclusion of *Sairadelphys* as the sister taxon of *Hyladelphys* (Fig. 5). This last clade (Hyladelphinae) composes a monophyletic group together with *Glironia* and caluromyines. The genus *Tlacuatzin* and the *Marmosa* group were recovered as a polytomy within the clade reuning hyladelphines +glironiines+caluromyines. Regarding the results of Voss & Jansa (2009) it is interesting to note that the trees resulting from a mixed-model Bayesian analysis of a combined (nonmolecular + molecular) data set recovered glyroniines+caluromyines and *Hyladelphys* as successive sister groups to remaining didelphids.

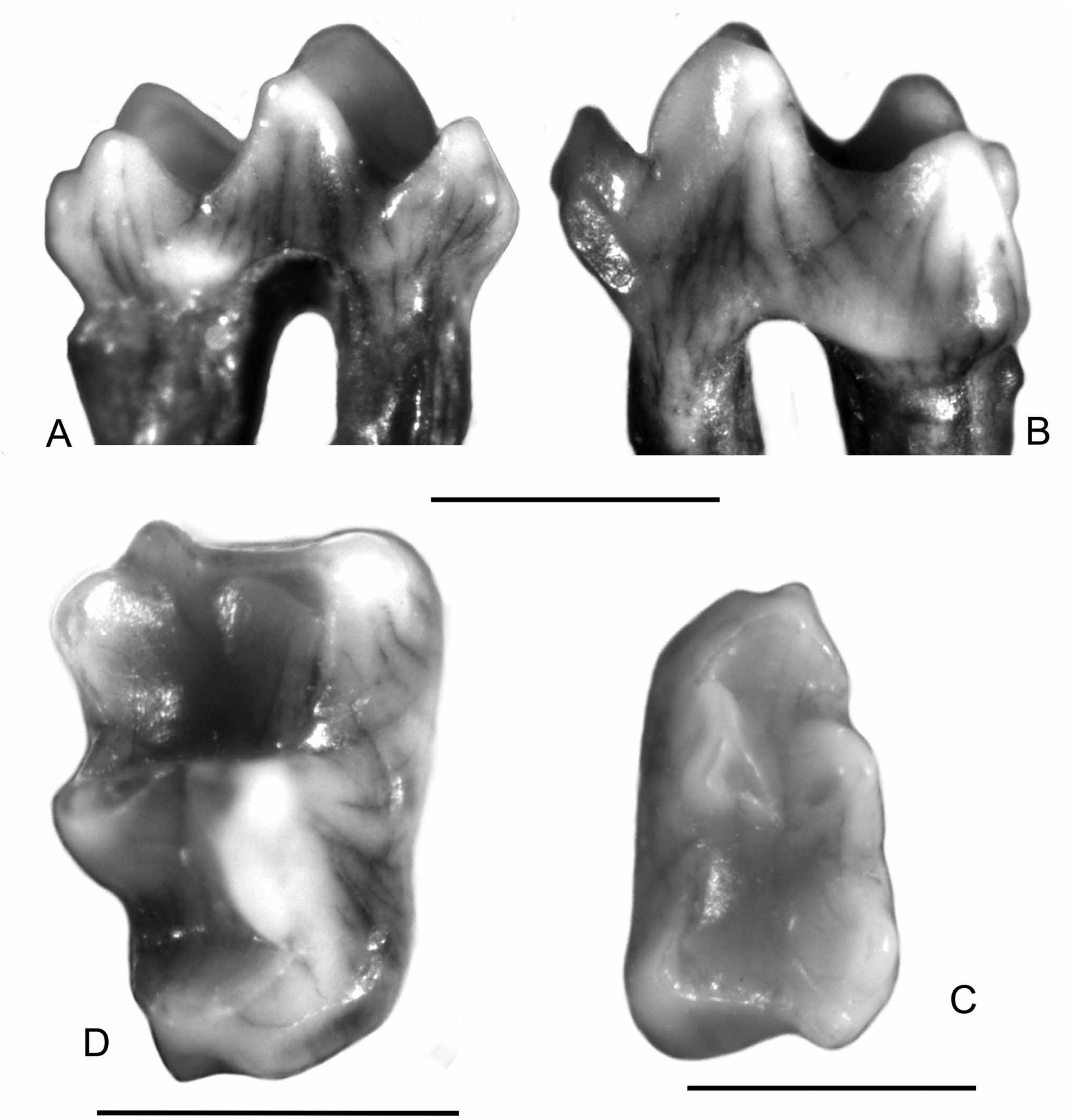

FIGURE 4. Lower molar of *Sairadelphys tocantinensis* **gen. et sp. nov.**, DGEO-UFPE 6746. A, lingual view; B, labial view; C, occlusal view; D, labio-occlusal view. Scale bar = 1 mm.

The sister taxon relationship between *Sairadelphys* and *Hyladelphys* (bootstrap=67%) is supported by three synapomorphies: development of stylar cusps reduced in number and size (character 130, state 0; CI 0.067), M2 subequal to slightly larger than M3 (character 136, state 1; CI 0.333), and presence of well-developed prefossid (character 138, state1; CI 1.000). With regards to *Hyladelphys*, Jansa & Voss (2005) performed a phylogenetic analysis based on nuclear genes and morphology concluding that this Amazonian marsupial is a didelphid that occupies an internal branch separating the traditionally recognized subfamilies, Caluromyinae and Didelphinae. Later, Voss & Jansa (2009) diagnosed the subfamily Hyladelphinae by their vestigial milk dentition (dP3/dp3 are large, more or less molariform teeth in other opossums) and indicated six characters listed in Jansa & Voss (2005, table 5), which according these authors, support an intermediate position of *Hyladelphys* between caluromyines and didelphines. Similarly, considering the postcranial morphology in a combined analyses, *Hyladelphys* was recovered as the sister taxon to didelphines, with *Glironia* and calurmonyines occupying a most basal position (Flores 2009). Besides the synapomorphies listed above, we found additional dental characters supporting the clade Hyladelphinae, including relatively low crowned molars, similarly sized paracone and metacone in M3, reduction of stylar cusps in number and size, convex labial faces of paracone and metacone, upper molars not strongly carnassialized (i.e. postmetacristae are only slightly longer than postprotocristae) and postprotocrista are without a carnassial notch.

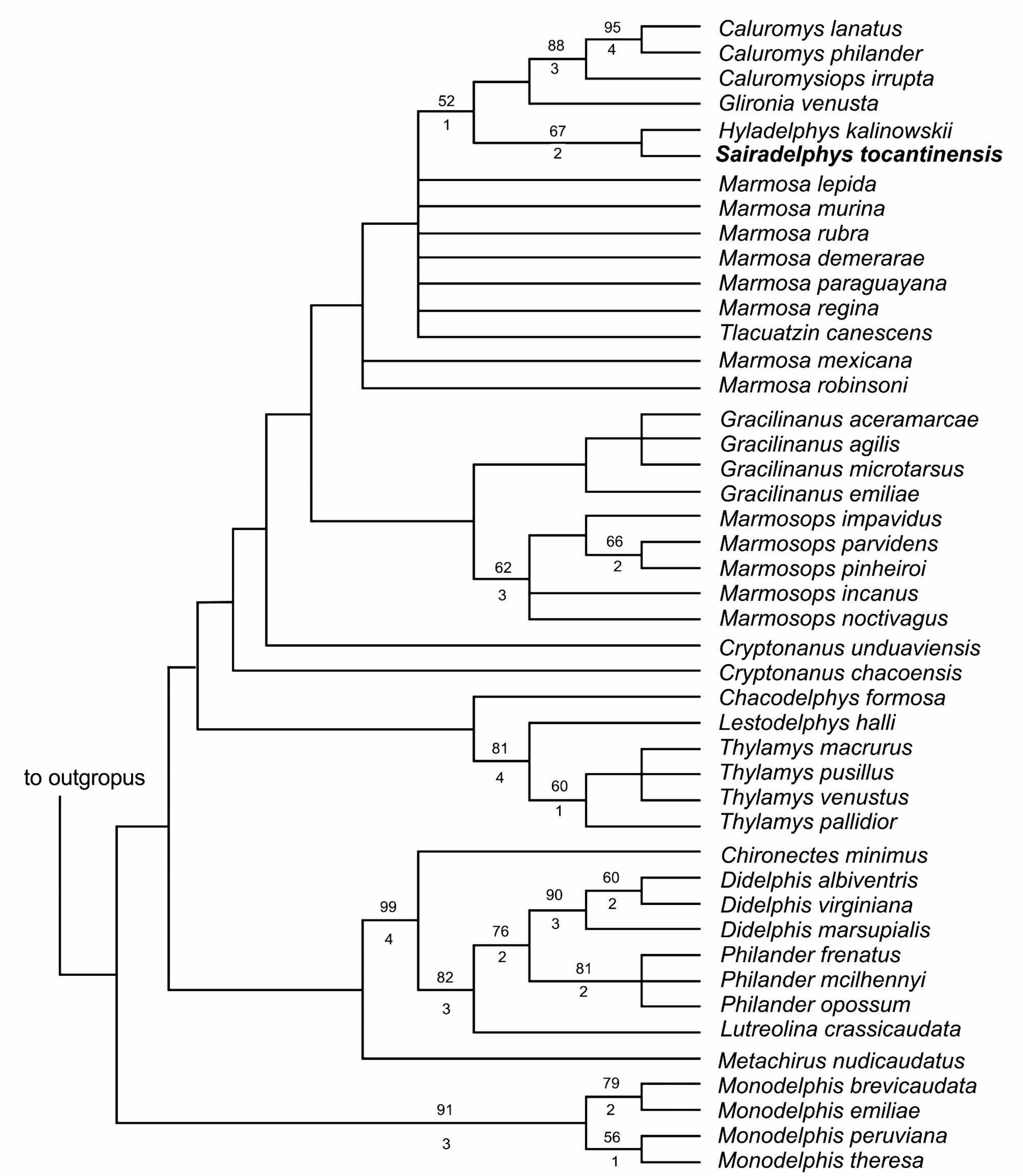

FIGURE 5. Strict consensus tree of 1093 equally most parsimonious trees. The numbers above branches indicating bootstrap support values (>50% only; 1000 replicates); numbers below branches represent decay indices.

Size and inferred feeding habits. *Sairadelphys tocantinensis* was a very small marsupial comparable in dental dimensions to some of the smallest living didelphimorphians such as *Hyladelphys* and *Gracilinanus* Gardner & Craighton. Adult *Hyladelphys* weigh between 13 and 18 g (Voss *et al*. 2001), but *Sairadelphys* is slightly larger than *Hyladelphys* in terms of dental dimensions. Using upper and lower molars, Gordon (2003) published an estimate of body mass in fossil and living marsupials. In all length and width molar measurements of Didelphidae analyzed in the Gordon (2003) study, *Gracilinanus agilis* Burmeister and *Thylamys elegans* Waterhouse are those better comparable to *Sairadelphys*, with an average weight of approximately 27 g. The body mass for these species using length and area of first molars was estimated between 28 to 37 g for *Thylamys elegans* and from 30 to 40 g for *Gracilinanus agilis*. Thus it is probable that *Sairadelphys* weighed no more than 40 g.

The upper molar morphology of *Sairadelphys* includes relatively low crowns, reduced M4, absence of shearing cristae and reduction of protocones. These features are suggestive of insectivorous-frugivorous feeding habits. *Hyladelphys* has more developed posmetacristae than *Sairadelphys*, which is suggestive of a more insectivorous diet.

Age of material. In absence of radiometric dating for the mammal-bearing deposit, the age of the Aurora de Tocantins fauna is discussed on the basis of the marsupials and associated taxa such as the tayassuid *Catagonus* Ameghino, the xenarthran dasypodid *Propraopus* Ameghino and the glyptodontid *Pachyarmatherium* Downing & White (unpublished data). Although some of these taxa (e.g. *Propraopus*, *Pachyarmatherium*) are frequently found in late Pleistocene deposits in Brazil, other taxa do not permit a very accurate age (SALMA or epoch) assignment. For example, the *Catagonus* and *Pachyarmatherium* genera range from the late Pliocene to late Pleistocene of South and South/North America, respectively (Porpino *et al*. 2009, Gasparini *et al*. 2009). However, the genus *Propraopus* suggests a Pleistocene age because it ranges from the Ensenadan to Lujanian SALMAs (early to late Pleistocene) (Cione & Tonni 1999). The marsupial fauna include numeral isolated teeth, incomplete maxillaries and dentaries. In addition to the new taxa described here, the preliminary analysis of the remaining marsupials also suggests the presence of a probable new species of *Monodelphis* Burnertt. Given that none of the studied marsupial specimens can be assigned confidently to any known living species cited for in Brazil (Gardner 2008), the marsupial fauna is inconclusive in terms of age. Other mammals recovered from the same cave include numerous undescribed remains of rodents, bats, and indeterminate microvertebrates, currently under study (Avilla *et al*. 2010).

Although we regard the fauna of Gruta dos Mouras cave as Pleistocene, we do not rule out the possibility of temporal mixing ("time-averaging") of Pleistocene and Holocene specimens, and thus there is a chance that the newly described taxon is still a living marsupial in the study area. More field work is necessary for corroboration of this exciting possibility.

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APPENDIX. Coding of the morphological characters (130 to 138) added to the original matrix of Voss & Jansa (2009) and characters coding for *Sairadelphys tocantinensis*.

Dromiciops gliroides	001000010
Perameles gunnii	100110000
Murexia longicaudata	110?10010
Echymipera kalubu	110?10000
Sminthopsis crassicaudata	110?10000
Caenolestes fuliginosus	201-10110
Rhyncholestes raphanurus	201-10110
Caluromys lanatus	100000100
Caluromys philander	100000100
Caluromysiops irrupta	111000000
Chacodelphys formosa	111110010
Chironectes minimus	111110010
Cryptonanus chacoensis	111110010
Cryptonanus unduaviensis	111110010
Didelphis albiventris	211110010
Didelphis marsupialis	211110010
Didelphis virginiana	211110010
Glironia venusta	111110010
Gracilinanus aceramarcae	111110010
Gracilinanus agilis	111110010
Gracilinanus emiliae	111110010
Gracilinanus microtarsus	111110010
Hyladelphys kalinowskii	011100111
Lestodelphys halli	111110010
Lutreolina crassicaudata	111110010
Marmosa (Marmosa) lepida	111110010
Marmosa (Marmosa) mexicana	111110010
Marmosa (Marmosa) murina	111110010
Marmosa (Marmosa) robinsoni	111110010
Marmosa (Marmosa) rubra	111110010
Marmosa (Micoureus) demerarae	111110010
Marmosa (Micoureus) paraguayana	111110010
Marmosa (Micoureus) regina	111110010
Marmosops impavidus	111110010
Marmosops incanus	111110010
Marmosops noctivagus	111110010
Marmosops parvidens	111110010
Marmosops pinheiroi	111110010
Metachirus nudicaudatus	111110010
Monodelphis brevicaudata	111110010
Monodelphis emiliae	111110010
Monodelphis peruviana	111110010
Monodelphis theresa	111110010
Philander frenatus	211110010
Philander mcilhennyi	211110010
Philander opossum	211110010
Thylamys macrurus	111110010
Thylamys pallidior	111110010
Thylamys pusillus	111110010
Thylamys venustus	111110010
Tlacuatzin canescens	111110010
Sairadelphys tocantinensis	?? ??????????????????????0011?0100????????0000001001????011001111