

Studies on the genealogical relationships within the genus *Monodelphis* Burnett, 1830 (Didelphidae, Marsupialia) based on basicranial anatomy and external morphology

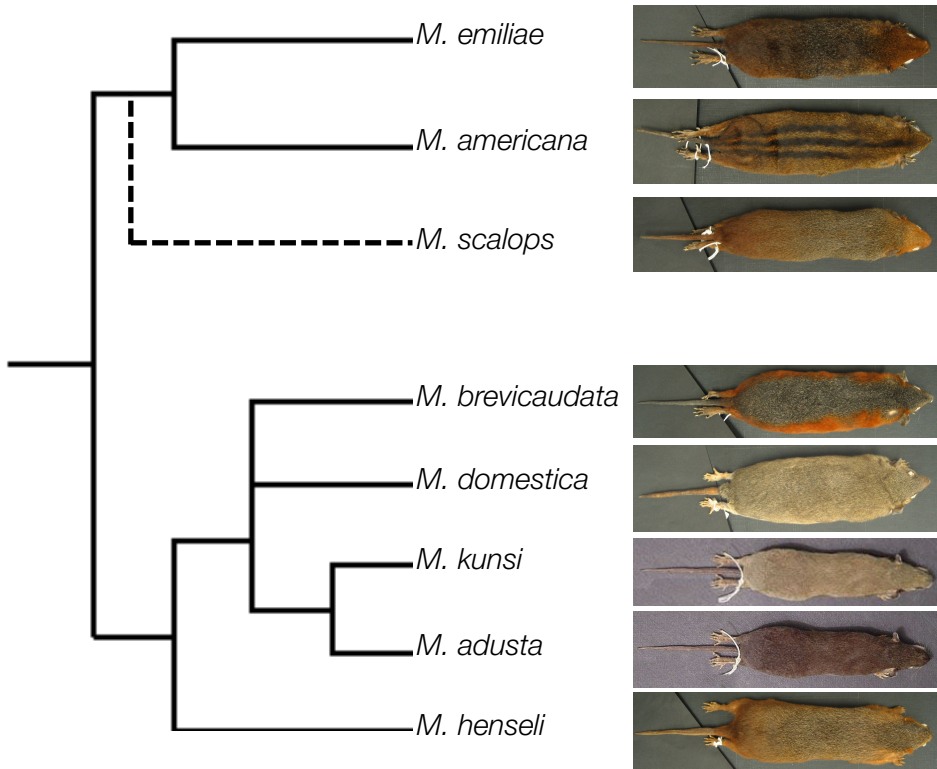
Vera Cristina Stegun Vidigal

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**STUDIES ON THE GENEALOGICAL RELATIONSHIPS
WITHIN THE GENUS *MONODELPHIS* BURNETT, 1830
(DIDELPHIDAE, MARSUPIALIA)
BASED ON BASICRANIAL ANATOMY AND
EXTERNAL MORPHOLOGY**



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**“Studies on the genealogical relationships within the
genus *Monodelphis* Burnett, 1830 (Didelphidae,
Marsupialia) based on basicranial anatomy and
external morphology”**

Memòria presentada per
Vera Cristina Stegun Vidigal
per optar al grau de
Doctora per la Universitat de Barcelona

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DEDICADA À

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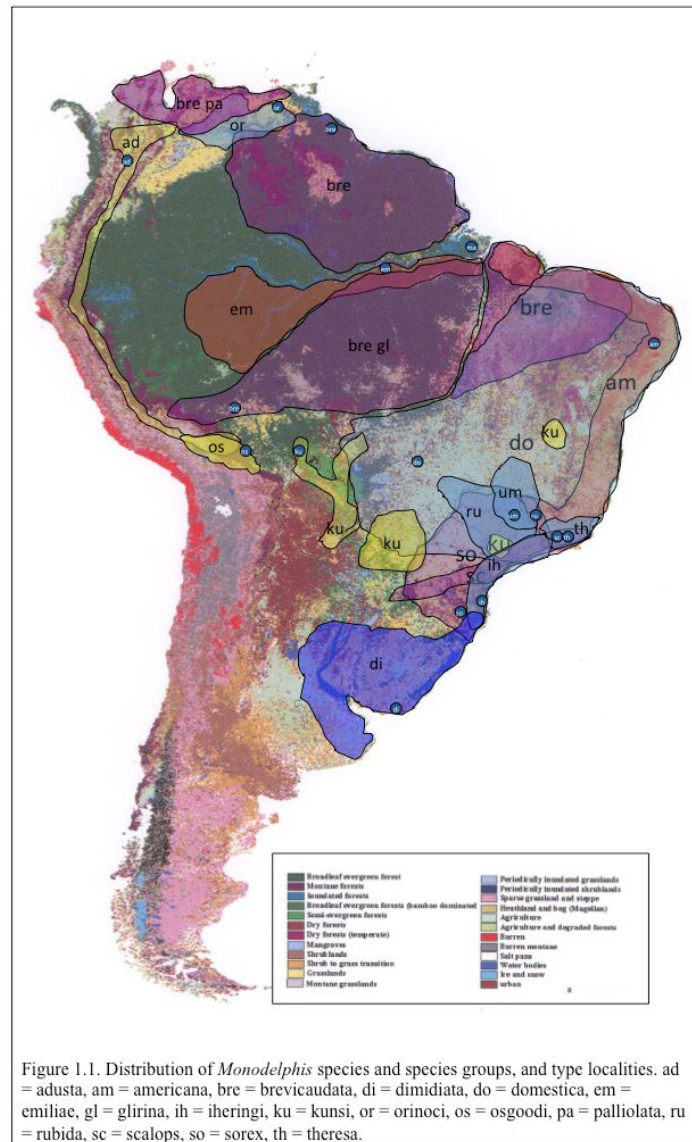
1. INTRODUCTION

1. INTRODUCTION

THE GENUS *MONDELPHIS*

The short-tailed opossums of the genus *Monodelphis* Burnett, 1830 are small-bodied marsupials which inhabit the Brazilian Atlantic, Amazonian, Andean, and Gallery forests, and the Pampas, Chaco, Pantanal, Cerrado, Caatinga, and Llanos habitats. Found at an altitudinal range of up to 2200 m, their distribution spans most of South America, from southwestern Panama to east Argentina (Figure 1.1). They are omnivorous, but mainly carnivorous and insectivorous, terrestrial and semi-fossorial, presenting diurnal to nocturnal habits (Anderson 1997; Aprile & Schneider 2008; Bergallo & Cerqueira 1994; Cabrera & Yepes 1940; Cuervo *et al.* 1986; Emmons 1997; González 1996; Lim *et al.* 2010; Linares 1998; O'Connell 1979; O'Connell 1989; Pérez-Hernández *et al.* 1994; Pine *et al.* 1985; Pine & Handley 2007; Redford & da Fonseca 1986; Redford & Eisenberg 1992a; Redford & Eisenberg 1992b; Robinson & Redford 1986; Salazar *et al.* 1994; Solari 2007; Streilein 1982; Vargas *M. et al.* 2003; among others). All karyotyped *Monodelphis* species have diploid counts of 18 chromosomes (Patton *et al.* 2000; Carvalho *et al.* 2002), as opposed to most didelphids which present either the most widespread $2n = 14$, or $2n = 22$ (Reigh & Bianchi 1969, Reig *et al.* 1977, Merry *et al.* 1983, Langguth & Lima 1988, Palma & Yates 1996, Carvalho *et al.* 2002). Of the twenty species listed in the IUCN Red List of Threatened Species, *M. unistriata* is classified into the Critically Endangered Status, *M. handleyi* into the Near Threatened Status, *M. reigi* and *M. umbristriata* into the Vulnerable Status, while the data is deficient for *M. iheringi*, *M. maraxina*, *M. rubida*, and *M. theresa*. Seven species are considered of decreasing population trend (i.e. *M. americana*, *M. iheringi*, *M. maraxina*, *M. rubida*, *M. scalops*, *M. theresa*, and *M. umbistriata*), while eight of population trend unknown (i.e. *M. brevicaudata*, *M. emiliae*, *M. glirina*, *M. handleyi*, *M. osgoodi*, *M. palliolata*, *M. reigi*, *M. unistriata*) (IUCN 2014). One species, *M. domestica*, has become a common laboratory research subject.

Despite the widespread South American distribution and the amplitude of habitats and microhabitats used by these short-tailed opossums and the attempts to understand the diversity within the genus, several species are not yet unequivocally defined and both the taxonomy and the evolutionary history of *Monodelphis* remain obscure.



TAXONOMY OF THE GENUS *MONODELPHIS*

Monodelphis is one of the most speciose genera of the family Didelphidae, with a diversity that ranges from 20 (Pine & Handley 2007) to over 30 species (Table 1.2) (Pine 1976; Pine *et al.* 1985; Gomes 1991; Redford & Eisenberg 1992a, 1992b; Lange & Jablonski 1998; Ventura *et al.* 1998; Ventura *et al.* 2005; Lemos *et al.* 2000; Voss *et al.* 2001; Lew & Pérez-Hernández 2004 ("2003"); Solari 2004; Solari 2007). In addition, Gomes (1991) proposed three undescribed species and Pine & Handley (2007) acknowledged five more. Most taxonomic reviews of the genus have been limited to one or a few species only (Pine 1976, 1977, 1979; Pine & Abaravaya 1978; Pine & Handley 1984; Pine *et al.* 1985; Ventura *et al.* 1998; Lemos *et al.* 2000; Voss *et al.* 2001, Solari 2004). Gomes (1991) carried out the most comprehensive morphologic study to date and a review of the genus, based primarily on morphometric data, but also including qualitative pelage and cranial comparisons. However his interpretations of species identifications have been considered very unusual to most other authors, and even discarded altogether (e.g. Pine & Handley 2007, Solari 2010). Pine & Handley (2007) provided the latest most comprehensive taxonomic, ecological and life history review of the genus at the species level. Solari (2010) proposed two alternative taxonomies for the genus: a conservative one in which *Monodelphis* (sensu lato) stands as the sole generic name with the eight species groups resulting from his DNA analysis (*adusta*, *americana*, *brevicaudata*, *dimidiata*, *emiliae*, *kunsi*, *theresa*, and one unnamed species group) remaining without formal taxon names, or each species group as a subgenus. Finally, a proper designation of voucher specimens for some type descriptions is in need, for example that of *M. americana* Müller 1776 (Thomas 1888b), and of the type species of the genus (Pine & Handley 2007).

Table 1.2. Taxonomy of *Monodelphis* species

	<i>Monodelphis</i> species	Description	Latest validation / proposition
1	<i>M. adusta</i>	Thomas, O., 1897.	Pine & Hendley (2007)
2	<i>M. amazonica</i>		Gomes (1991)
3	<i>M. americana</i>	Müller, 1776.	Pine & Hendley (2007)
4	<i>M. breviceaudata</i>	Erxleben, 1777.	Pine & Hendley (2007)
5	<i>M. breviceaudis</i>	Olfers, 1818.	Lange & Jablonski (1998) ^{1,2}
6	<i>M. dimidiata</i>	Wagner, J. A., 1847.	Pine & Hendley (2007)
7	<i>M. domestica</i>	Wagner, J. A., 1842.	Pine & Hendley (2007)
8	<i>M. emiliae</i>	Thomas, O., 1912.	Pine & Hendley (2007)
9	<i>M. fosteri</i>	Thomas, O., 1924.	Pine <i>et al.</i> (1985) ¹
10	<i>M. gardneri</i>	Solari <i>et al.</i> 2012	
11	<i>M. glirina</i>	Wagner, J. A., 1842.	Pine & Hendley (2007)
12	<i>M. handleyi</i>	Solari, S. 2007.	Solari (2010)
13	<i>M. henseli</i>	Thomas, O., 1888.	Redford & Eisenberg (1992b) ¹
14	<i>M. iheringi</i>	Thomas, O., 1888.	Pine & Hendley (2007)
15	<i>M. kungsi</i>	Pine, R.H., 1975.	Pine & Hendley (2007)
16	<i>M. macae</i>		Gomes (1991) ³
17	<i>M. maraxina</i>	Thomas, O., 1923.	Pine & Hendley (2007)
18	<i>M. melanops</i>	Goldman	Solari (2007) tentatively
19	<i>M. obscura</i>		Gomes (1991)
20	<i>M. orinoci</i>	Thomas, O., 1899.	Ventura <i>et al.</i> (2005) ¹
21	<i>M. osgoodi</i>	Doutt, 1938.	Pine & Hendley (2007)
22	<i>M. palliolata</i>	Osgood, 1914.	Pine & Hendley (2007)
23	<i>M. peruviana</i>	Osgood	Solari (2007)
24	<i>M. reigi</i>	Lew & Pérez-Hernández, 2004.	Pine & Hendley (2007)
25	<i>M. ronaldi</i>	Solari, S., 2004.	Pine & Hendley (2007)
26	<i>M. rubida</i>	Thomas, O., 1899.	Pine & Hendley (2007)
27	<i>M. scalops</i>	Thomas, O., 1888.	Pine & Hendley (2007)
28	<i>M. sorex</i>	Hensel, 1872.	Pine & Hendley (2007)
29	<i>M. species A</i>		Pine & Hendley (2007)
30	<i>M. species B</i>		Pine & Hendley (2007)
31	<i>M. species C</i>		Pine & Hendley (2007)
32	<i>M. species D</i>		Pine & Hendley (2007) ⁴
33	<i>M. species E</i>		Pine & Hendley (2007)
34	<i>M. theresa</i>	Thomas, O., 1921.	Pine & Hendley (2007)
35	<i>M. touan</i>	Shaw, G., 1800.	Redford & Eisenberg (1992b), Lim <i>et al.</i> (2010) tentatively ¹
36	<i>M. umbristriata</i>	Miranda-Ribeiro, A., 1936.	Pine & Hendley (2007)
37	<i>M. unistriata</i>	Wagner, J.A., 1842.	Pine <i>et al.</i> (2013)

1. Put into synonymy by Pine & Handley (2007).

2. *Nomen oblitum* (Hershkovitz, 1959)

3. *Nomen nudum* (Solari, 2010)

4. Put into synonymy by Solari (2010).

Monophyly

Monophyly of the genus *Monodelphis* is corroborated by cytochrome b sequences analyses (Lim *et al.* 2010), combined Irbp sequences and morphological character analysis (Jansa & Voss 2000, Voss & Jansa 2003), combined (Irpb + Dmp1 + morphologic) data analyses (Jansa & Voss 2005, Jansa *et al.* 2006), combined (Irpb + Dmp1 + RAG1 + BRCA1 + vWF + morphologic) analysis (Voss & Jansa 2009), and postcranial morphological character analysis (Flores 2009). However, results of the molecular phylogenetic analysis of mitochondrial cytochrome b sequence variation in Solari (2010) questioned the monophyly of *Monodelphis*. He used *Glironia*, *Didelphis*, *Philander*, *Tlacuatzin*, *Marmosa* and *Micoureus* as outgroups, and the latter two appeared nested within *Monodelphis*. Wible (2003) listed four osteological characters distinguishing *Monodelphis* specimens from the Carnegie Museum – CM from the didelphid *Didelphis albiventris*, the dasyurid *Dasyurus maculatus*, the early Paleocene metatherian *Pucadelphys andinus*, and the Late Cretaceous eutherian *Zalambdalestes lechei*, one of which pertaining to the basicranium (a small foramen in the posteroventral base of the orbitosphenoid (in 31 of 42 CM *Monodelphis*)).

Sister group

Many have been the attempts to uncover interspecific relationships as well as affinities between *Monodelphis* and other taxa. The first phylogenetic analysis of opossumlike marsupials (Reig *et al.* 1985) allowed the restriction of *Monodelphis* to the tribe Marmosini, proposing affinities with *Lestodelphis*, *Marmosa*, *Micoureus* and *Thylamys*, based on morphologic as well as cytogenetic and molecular data. *Gracilinanus*, *Thylamys*, and *Lestodelphys* appear as a sister clade to *Monodelphis* in Reig *et al.* (1987) based on morphology, serology, and karyotype, and the latter two taxa in Creighton (1984) based mainly on soft and hard anatomy. Without a

phylogenetic framework, Hershkovitz (1992) erected the monotypic subfamily Monodelphinae within the family Marmosidae, adding *Metachirus*, *Marmosops* and *Gracilinanus* to Reig *et al.* (1985)'s list of closely related taxa. Based on their research on DNA-DNA hybridization, Kirsch & Palma (1995) proposed the monotypic tribe Monodelphini within the subfamily Marmosinae, restricting the affinities of *Monodelphis* to *Marmosa* and *Micoureus*. *Marmosa* and *Micoureus* also resulted as the sister-clade to *Monodelphis* in analyses based on cytochrome b gene sequences and amino acid sequences of the cytochrome b gene (Patton *et al.* 1996). In the classification including fossil taxa put forward by McKenna & Bell (1997), the new subtribe Monodelphina of the tribe Monodelphini within the subfamily Didelphinae is composed of *Marmosa*, *Gracilinanus*, *Monodelphis*, *Thylamys*, *Lestodelphis*, *Micoureus* and the fossil *Thylatheridium*. Analysis of Irbp gene sequences (Jansa & Voss 2000) also yielded *Marmosa* and *Micoureus* as the sistergroups to *Monodelphis*. Though with weak support, parsimony analysis of the combining molecular sequence data of the Irbp and of the dentin matrix protein 1 gene (Dmp1) to morphologic data (Jansa & Voss 2005) resulted in *Tlacuatzin canescens* as the new sister taxon to *Monodelphis*, followed by a clade composed of *Micoureus* and *Marmosa*. Analysis based on Irbp only, however, placed *Monodelphis* in a polytomy. In Steiner *et al.* (2005), *Marmosa* and *Micoureus* resulted the sister groups of *Monodelphis* based on 12S rDNA, TTR, IRBP, and on the total evidence bayesian analysis. Cyt-b gene analysis, however, placed *M. brevicaudata* in a tricotomy with two clades, one of the large and another of the small didelphid marsupials. *Tlacuatzin* and *Chacodelphis* were not included in the analysis. In their latest Didelphid synthesis, Voss & Jansa's (2009) combined dataset of 5 nuclear gene and morphology yielded alternately *Marmosa* and *Tlacuatzin* as sister groups of *Monodelphis*. When including postcranial characters to previous nonmolecular hypotheses (Flores 2009), *Monodelphis* appears as sister to the large 2n = 22 opossums (i.e. *Metachirus*, *Chironectes*, *Lutreolina*, *Philander* and *Didelphis*), even though with low support.

Phylogenetic relationships

The genus has historically been subdivided into more than one genera, subgenera, tribe and species group (Burmeister 1856, Thomas 1888, Matschie 1916, Cabrera 1919 and 1958, Gilmore 1941, Pine 1976, Gomes 1991, Solari 2007 and 2010). Table 3 summarizes the species affinities proposed to date, with species groups composition presented, when possible, in the same order to facilitate comparisons among the *Monodelphis* species. Taxonomic rank is indicated when available. Thomas (1888) ranked *Monodelphis* as a subgenus of *Didelphis*. Matschie (1916) proposed the new subgenus *Monodelphiops* for a single species, *M. sorex*, distinct from the 18 *Monodelphis* species considered valid then; aside from restricting *M. americana*, *M. unistriata* and *M. iheringi* to the subgenus *Microdelphys* Burmeister 1856. Cabrera (1919) raised *Peramys* (synonym of *Monodelphis*) to the generic status with 12 species and proposed a new genus, *Minuania*, containing *M. dimidiata*, both within the family Didelphidae. Later, Cabrera (1958) changed the status of both *Minuania* and *Monodelphis* to subgenera of the genus *Monodelphis*. Gomes (1991) suggested several interspecific affinities based on morphologic and morphometric studies, but lacking a formal phylogenetic analysis. His allocations of species to species groups have been questioned, as well as his species identifications (Pine & Handley 2007, Solari 2010).

Hypotheses of phylogenetic relationships within the genus have been put forward only recently, based mainly on molecular data. The first molecular surveys, based both on mitochondrial DNA and nuclear Interphotoreceptor Retinoid Binding Protein (Irbp) gene sequences, included only a few species of *Monodelphis*, and did not yield any systematic resolution (Patton & Costa 2003; Voss & Jansa 2003; Jansa & Voss 2005; Jansa *et al.* 2006). In Vidigal's unpublished master thesis (2004), a cladistic analysis of basicranial and pelage characters, including 15 species, yielded two clades, one containing *M. adusta*, *M. osgoodi* and *M. kungsi* and the other uniting *M. scalops* and *M. emiliae* to the striped species of *Monodelphis*. Based on cytochrome b (cytb) sequences, Steiner & Catzeflis (2004) included 6 *Monodelphis* species in a phylogenetic analysis to assess genetic and geographical

structure of *M. brevicaudata* in the Guiana Region. Their results confirmed the distinction as well as close relationship between *M. brevicaudata* and *M. glirina*. Despite not commented by the authors, their maximum parsimony tree showed *M. adusta* and *M. scalops* as sister species. The molecular mitochondrial DNA survey presented in Solari (2007), supported the monophyly of the *M. adusta* species complex, based on a sample of 4 species. In another molecular phylogenetic analysis of mitochondrial cytochrome b sequence variation, Lim *et al.* (2010) studied the systematic relationships of *M. reigi* with 11 other species of *Monodelphis*. The systematics of the *M. adusta* species complex, including *M. reigi*, was resolved and well supported. A sister group relationship between three members of the *M. brevicaudata* complex and *M. domestica* was also well supported. Also using cytb sequences, Solari (2010) presented the broadest molecular systematic review of the genus, including 17 species. The consensus maximum parsimony tree recovered 8 major lineages (*brevicaudata* group, *adusta* group, *dimidiata* group, *theresa* group, *emiliae* group, *kunsi* group, *americana* group, and ‘species C’ group), though relationships among them are unresolved. After reviewing the taxonomy of *Monodelphis*, Solari (2010) proposed two alternative taxonomies for the genus: a conservative one in which *Monodelphis* (*sensu lato*) stands as the sole generic name with the eight species groups without formal taxon names, or each species group as a subgenus.

BASICRANIAL ANATOMY

The basicranium is the region of the skull against which the brain rests. It is particularly complex because it serves as passageway to a significant number of central nervous system and head vascular system outlets, houses the auditory system, and provides attachment areas for muscles and ligaments related to these systems and to the masticatory apparatus (Archer 1976; Wible 1987, 1990, 2003; Clark & Smith 1993; Smith 1994; Wible & Hopson 1995). Many aspects of these systems can be reconstructed based on the presence or absence of foramina, sulci,

and ridges; on impressions left on bone surfaces; and on the mosaic of shapes produced by the constituent basicranial bones (Rougier *et al.* 1992; Wible 1987, 1990; Wible & Hopson 1995).

The main bones which comprise the marsupial basicranium are: the alisphenoid, the basisphenoid, the basioccipital, the exoccipital, the squamosal, the petrosal, the ectotympanic, and the ear ossicles (the malleus, the incus, and the stapes) (Figure 1.3). Some of these bones are involved in very intricate functional processes. This is the case of those involved in hearing, which in Didelphimorphia are the alisphenoid, ectotympanic, and petrosal, forming a tripartite auditory bulla, and the ear ossicles (Reig *et al.* 1987; Wible 1990, 2003). The petrosal is a particularly complex compact bone. It houses the inner ear and provides attachment area for muscles and ligaments of the middle ear. The degree of development reached by the alisphenoid tympanic process, the rostral tympanic process of the petrosal, and the ectotympanic in adults determines the degree to which the floor of the tripartite bulla is ossified and inflated in marsupials (Reig *et al.* 1987; Wible 2003).

Wible (2003) provided one of the few detailed, well-illustrated treatments of the didelphid skull through a very comprehensive description of the basicranium of

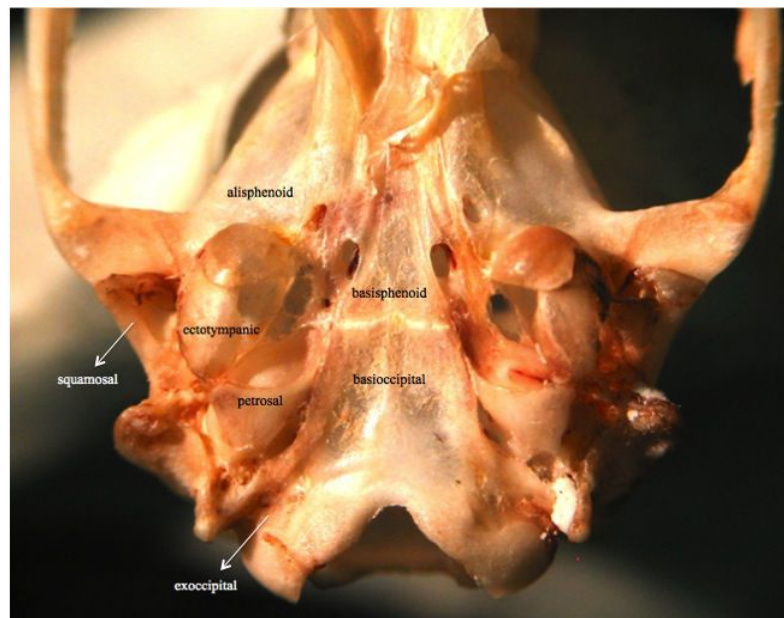


Figure 1.3. Main bones comprising the didelphid basicranium.

M. brevicaudata, a comparison to other *Monodelphis* species, a discussion of the major cranial foramina, their contents, and the variations encountered and a revision of anatomical terminology and proposal of standardization. His work is here used as an anatomic bone-by-bone reference.

BASICRANIAL ANATOMY IN SYSTEMATICS

The evolutionary history of mammals, including Metatheria, has been reconstructed, in part, based on a great number of basicranial characters (e.g. Mammalia: Novacek 1989; Wible 1991; Wible & Hopson 1993; Theria: Wible 1990; Eutheria: Gaudin *et al.* 1996; Monotremata: Macrini *et al.* 2006; Pholidota: Gaudin & Wible 1999; Primates and Insectivora: MacPhee 1981). The osteology of the basicranium and the auditory region has also been utilized to estimate the evolution of the vascular and neural systems based on shape, foramina, and surface impressions on bones (MacPhee *et al.* 1988; Rougier *et al.* 1992). Within Metatheria, basicranial morphology has been useful in determining phylogenetic relationships in Didelphimorphia (Reig *et al.* 1987, Voss & Jansa 2009), carnivorous marsupials (Archer 1976), and Phalangeriformes (Norris 1994).

Basicranial anatomy has not as often been surveyed comparatively at lower taxonomic levels. However, the basicranial complex has been shown to be informative at this level as well. For instance, Gardner & Emmons (1984) divided the genus *Proechimys* into four species groups based on bulla septae patterns. Salles (1992) found support for the monophyly of Felidae and diagnostic autapomorphies for felid species based on a 44 character matrix which included 11 basicranial transformation series. Norris (1994) uncovered 15 petrosal characters, yielding a cladogram for the Phalangeridae. Gaudin & Wible (1999) searched the auditory region of living and extinct *Pholidota* (*Manis* and *Patiomanis*) to understand the evolution of the entotympanic in this group, optimizing the distribution of this structure in a cladogram which included 15 basicranial transformation series of 67 cranial characters. Voss & Jansa (2009) revised and proposed a new classification for the new world marsupials based on their combined DNA and morphological

phylogenetic analysis, including 11 basicranial characters.

Systematic research on the genus *Monodelphis* has focused on external body and cranial morphology, yet the scope of the latter has been mainly limited to the overall shape of the skull (Thomas 1899, 1921; Doult 1938; Pine 1975, 1976, 1977; Anderson 1982; Pine & Handley 1984; Pine *et al.* 1985; Gomes 1991; Hershkovitz 1992; Ventura *et al.* 1998; Lemos *et al.* 2000). More detailed studies of basicranial anatomy concern a few species only (Voss & Jansa 2009; Solari 2007). In his systematic study of marsupicarnivores, Archer (1976) provided a revision of publications dating as early as the 1800s on mammalian basicranial anatomy and nomenclature and included his own identifications of homologous structures based on comparison with mammal-like reptiles and latex injection experiments. Included in his study is a detailed characterization of the basicranial anatomy of a specimen of *M. dimidiata*. Reig *et al.* (1987) used six basicranial and auditory region characters, in addition to 39 other morphologic and serologic traits, to estimate phylogenetic relationships of fossil and extant didelphimorphs. Their study included an intergeneric analysis within Didelphidae and the description of some aspects of the tripartite bulla in *M. domestica*. In his unpublished master's thesis, Gomes (1991) carried out the first detailed comparative morphological survey of the genus, in which he reported a few basicranial anatomical variations for the six *Monodelphis* species groups he proposed, including some interspecific comparisons. Hershkovitz (1992) described additional characteristics of the auditory bulla based on *M. domestica*, *M. palliolata* and *M. breviceaudata touan*. Gómez (1998) characterized aspects of the basicranial morphology in *M. breviceaudata*, *M. orinoci*, and *M. dimidiata*. Goin and Rey (1997) proposed the tribe Monodelphini as the sister group to Marmosini, including an ectotympanic character to distinguish both groups. Wible (2003) provided a thorough characterization of the basicranium of *M. breviceaudata*, with observations on *M. dimidiata*, *M. domestica*, and *M. osgoodi*, and a revision and standardization of marsupial basicranial nomenclature. Finally, the analysis of Voss & Jansa (2009) yielded a basicranial autapomorphy to *M. theresa*, and one to *M. emiliae*.

2. OBJECTIVES

2. OBJECTIVES

The present research is an expanded fine scale search for intraspecifically and interspecifically basicranial anatomy variation in representatives of 8 *Monodelphis* species groups and 21 species to fulfill the following objectives:

1. Contribute to the field of morphology by providing detailed characterizations of the basicranial anatomical variations found
2. Deepen the understanding of *Monodelphis*' anatomy by comparing and contrasting the basicranial variations reported to previous studies
3. Provide an insight into the evolutionary history of the genus by generating a systematic hypothesis based on a cladistic analysis of basicranial characters.

3. MATERIALS AND METHODS

3. MATERIALS AND METHODS

STUDY OF THE BASICRANIAL ANATOMY AND NOMENCLATURE

Identification of primary homology hypotheses, that is, those based on congruent topology (Rieppel 1988, de Pinna 1991), in basicranial structures relied on the detailed descriptions of topological relationships and reconstructions of the basicranial osteological, vascular and neurological anatomy of extant and extinct marsupials in Archer (1976), Wible (1987, 1990, 2003), and Wible & Hopson (1995), and on the ontogenetic characterizations on *M. domestica* of Maier (1987) and Clark & Smith (1993). Incus and malleus were not examined. Terminology used to describe morphological variation observed on basicranial structures followed Wible (2003), except that on stapes which followed Henson (1961).

IDENTIFICATION OF MUSEUM SPECIMENS AT HAND AND DELIMITATION OF SPECIES GROUPS

Searching for characteristics to identify the specimens of the genus *Monodelphis* at hand to species, I contrasted my own examination of several type specimens to diagnoses and definitions in type descriptions and additional descriptions in species revisions. The original type descriptions used as reference in specimen identification were: *M. brevicaudata* (Erxleben, 1777), *M. domestica* (Wagner, 1842), *M. henseli* (Thomas, 1888a), *M. iheringi* (Thomas, 1888a), *M. scalops* (Thomas, 1888a), *M. sorex* (Thomas, 1888b), *M. adusta* (Thomas, 1897), *M. brevicaudata orinoci* (Thomas, 1899), *M. rubida* (Thomas, 1899), *M. emiliae* (Thomas, 1912), *M. peruvianus* (Osgood, 1913), *M. theresa* (Thomas, 1921), *M. maraxina* (Thomas, 1923), *M. fosteri* (Thomas, 1924), *M. osgoodi* (Doutt, 1938), *M. kungsi* (Pine, 1975). The following species comparisons and interpretations were also used as guides in specimen identification: Emmons & Feer (1997) for *M. adusta*, Pine (1975) for *M. kungsi*, Thomas (1888b) and Voss *et al.* (2001) for *M. brevicaudata*, Voss *et al.* (2001) for *M. brevicaudata touan*, Ventura *et al.* (1998)

for *M. orinoci*, Thomas (1888b) for *M. americana* (Müller, 1776), *M. sorex* (Hensel, 1872), *M. henseli* and for *M. domestica*, Thomas (1888b), Pine (1979) and Pine *et al.* (1985) for *M. dimidiata* (Wagner, 1847), Pine (1976) and Lemos *et al.* (2000) for *M. umbristriata* (Miranda-Ribeiro, 1936), Pine (1977) for *M. iheringi*, Pine (1979) for *M. domestica* and *M. maraxina*; Pine & Abravaya (1978) for *M. scalops*; Pine & Handley (1984) for *M. emiliae*). Representatives of *M. reigi* Lew & Pérez-Hernández 2004 (“2003”) and *M. ronaldi* Solari 2004 were not studied. The type specimens examined in person for this survey are listed in the Specimens Examined section.

The majority of cranial characteristics in the literature pertained to general cranial morphology, and was useful to distinguish among major species groups within the genus, but not among the more problematic species within. I found considerable overlap among species definitions, thus specimens were assigned to a species only when this could be done unequivocally so, based on at least one exclusive pelage character. If this was not possible, specimens were allocated to what I hereon term ‘species group’, corresponding to the grouping of species with common major patterns of pelage coloration. Nevertheless, throughout the text, I notice when a specimen within a species group has been identified to a species by other authors or at museum collections, even though such identification may be in need of revision. A detailed revision of all the cranial and pelage characters described so far for *Monodelphis* and a taxonomic revision of the species complexes are beyond the scope of this report.

Three major patterns of pelage coloration are found among *Monodelphis* species. The longitudinal bicolor pelage pattern corresponds to specimens which have a uniform or quite uniform dorsal color in contrast to a different but also uniform ventral color. Within this pattern, there is a clear distinction among small and large body sized species. Specimens presenting the longitudinal tricolor pelage pattern have distinct dorsal, side and ventral coloration. Finally the transversal tricolor pelage pattern corresponds to specimens that present clearly contrasting anterior, mid-dorsal and rump coloration, aside from the ventral color. Within the latter pattern, there are species with tree longitudinal dorsal stripes. Table 3.1

illustrates these patterns and the species presenting each of them. (See also Appendix 1).

Table 3.1. Major patterns of pelage coloration found among *Monodelphis* species

Longitudinal Bicolor		Longitudinal Tricolor		Transversal Tricolor	
Small body size	Large body size	Northern South America	Southern South America	Without stripes	With stripes
<i>M. adusta</i>	(<i>M. brevicaudata</i> type) ²	(<i>M. brevicaudata s.l.</i>) ²	<i>M. henseli</i>	<i>M. scalops</i>	<i>M. americana</i>
<i>M. adusta peruviana</i>	<i>M. domestica</i>	<i>M. touan</i>	<i>M. sorex</i>	<i>M. emiliae</i>	<i>M. theresae</i>
<i>M. osgoodi</i> ¹	(<i>M. rubida</i>) ³	<i>M. orinoci</i>	<i>M. dimidiata</i>		<i>M. iheringi</i>
<i>M. kunsi</i>	<i>M. maraxina</i>	<i>M. glirina</i> <i>M. palliolata</i>			<i>M. umbristriata</i> (<i>M. rubida</i>) ³

Note: Species are listed in chronological order of original description. Species in parentheses appear simultaneously in two distinct columns, representing the group it has traditionally been interpreted to belong to in previous taxonomic reports, and the other allocation is where the group species belong to according to real pelage appearance.

1. The rump of some specimens identified as *M. osgoodi* is slightly darker than the rest of the body.
2. The pelage of the type of *M. brevicaudata* is longitudinally bicolor, but it has traditionally been treated with *M. brevicaudata sensu lato*.
3. Specimens of *M. rubida* are longitudinally bicolor, thus neither striped, nor transversal color-banded, yet have been traditionally treated with *M. americana sensu lato*.

On Table 3.2 I list the distinguishing characteristics based on which the identifications of specimens to species were done herein. Even if these identifications are equivocal, the anatomical descriptions of this report still hold, because characterizations and states were assigned individually to each real museum voucher specimen. Species not shown on Table 3.2 were treated under a species group as follows, although always noting specimen's museum identifications. Type specimens were treated as identified by original authors, except when noted otherwise. *M. adusta peruviana* and any longitudinally bicolor specimens of small size not fitting *M. adusta s.s.*, *M. osgoodi* or *M. kunsi*, but similar to *M. adusta* were treated as *M. adusta* species group. *M. maraxina* and any

longitudinally bicolor specimen of large size with pelage and distribution similar to *M. domestica* were assigned to *M. domestica* species group, to the exclusion of specimens fitting the descriptions and restriction to *M. breviceaudata s.s.* and *M. rubida*. Longitudinal tricolor specimens of Amazonian or Northern South American distribution and pelage similar to *M. breviceaudata*, including *M. glirina* and *M. palliolata*, were placed under *M. breviceaudata* species group when they did not match *M. breviceaudata s.s.* and *M. breviceaudata touan* as restricted by Voss *et al.* (2001) or *M. orinoci* as described by Thomas 1899 and restricted by Ventura *et al.* 1998. Longitudinal tricolor specimens of Southern South American distribution and pelage similar to *M. henseli* were sorted up to *M. henseli* species group. None of the specimens with the transversal tricolor pelage pattern with stripes I studied could be unequivocally placed under the names *M. iheringi* or *M. theresa*, presenting instead characteristics of both species as described in the literature and of *M. americana* simultaneously. Thus, the remaining striped animals were placed under *M. americana* group.

SPECIMEN SAMPLING: SELECTION OF SEMAPHORONTS WITH REPRESENTATION OF THE GREATEST DIVERSITY OF MORPHOTYPES AND GEOGRAPHIC LOCALITIES.

Specimens were selected as to represent the greatest diversity of morphotypes and geographic localities. Only adult individuals were included in character coding. Nevertheless, juveniles were also studied to ensure that character states were not due to ontogenetic development. Dental age determination criteria followed Vidigal (1996); thus specimens were classified as adults when all permanent dentition was fully developed.

Table 3.2. Distinguishing characteristics for assigning museum voucher specimens to *Monodelphis* species

Longitudinal Bicolor Pelage Pattern: small body size			
Species	Bibliography	Compared to	Characteristics
<i>M. adusta</i>	Emmons & Feer 1997	<i>M. peruvianus</i> and <i>M. osgoodi</i>	1) Dorsal coloration "completely dark brown, darker on rump than foreparts"
			2) Venter "gray or orange-gray, sometimes with a cream streak on midline"
<i>M. osgoodi</i> ¹	Doutt 1938		1) "rump not darker than rest of dorsal surface"
	Emmons and Feer 1997		2) "whitish underparts"
<i>M. kunsii</i>	Pine 1975	<i>M. adusta</i>	1) "paler dorsally"
			2) dorsal coloration "warm brown, more tawny on head, most dorsal hairs with dull pale gray at base succeeded by brown"
			3) ventral "from chin to tip of tail dirty white or buffy"
Longitudinal Bicolor Pelage Pattern: large body size			
Species	Bibliography	Compared to	Characteristics
<i>M. domestica</i>	Thomas (1888b)	<i>M. dimidiata</i>	1) "cheeks and sides with a paler or more yellowish tinge (but not the distinct orange-colour of [<i>M.</i>] <i>dimidiata</i>)"
			2) "whole of back uniform finely grizzled grey or mouse-colour"
			3) "face uniformly grey"
			4) "Chin, chest, and belly white or greyish white, sometimes with a tinge of yellow"
Longitudinal Tricolor Pelage Pattern: Amazonian or Northern distribution			
Species	Bibliography	Compared to	Characteristics
<i>M. breviceaudata</i> s.s.	Voss et al. (2001)	<i>M. breviceaudata</i> group	1) "extension of body fur onto the proximal one-third or more of the caudal dorsum; the ventral surface of the tail is just furred at the base"
<i>M. breviceaudata touan</i>	Voss et al. (2001)	<i>M. breviceaudata</i> group	1) "extension of body fur onto the proximal one-third or more of the caudal dorsum; the ventral surface of the tail is just furred at the base"
		<i>M. breviceaudata</i> s.s.	2) tricolored phenotype: a) "a broad middorsal stripe of grizzled-brownish, -grayish, or -blackish fur is sharply set off from the...flanks"; b) clear (ungrizzled) reddish flanks...separated by a similarly abrupt transition from the...ventral fur;" and c) cream, whitish or buffy venters.
<i>M. orinoci</i>	Ventura et al. 1998	<i>M. breviceaudata</i> group	1) smaller size (HB-110mm as opposed to HB-130-150mm in <i>M. breviceaudata</i> group)
		<i>M. breviceaudata</i> and <i>M. palliolata</i>	2) "not sexually dimorphic like [<i>M.</i>] <i>breviceaudata</i> & [<i>M.</i>] <i>palliolata</i> "
	Thomas 1899		3) "much paler..., coloured more nearly as in [<i>M.</i>] <i>dimidiata</i> "
Longitudinal Tricolor Pelage Pattern: Southern South America distribution			
Species	Bibliography	Compared to	Characteristics
<i>M. henseli</i>	Thomas (1888b)		1) "nape, and whole of the centre of the back uniform finely grizzled olive-grey;" and 2) sides "rufous."
<i>M. dimidiata</i>	Thomas (1888b)	<i>M. henseli</i>	1) dorsal coloration: "pale grizzled grey along the crown and upper side of back;" 2) sides "rich orange-yellow."
Transversal Tricolor Pelage Pattern: Without stripes			
Species	Bibliography	Compared to	Characteristics
<i>M. emiliae</i>	Thomas 1912	<i>M. scalops</i>	1) "belly-hairs...not plumbeous basally"
			2) rump rufous grizzled with deep brilliant orange hairs (personal observation)
<i>M. scalops</i>	Pine & Abravava (1978)	<i>M. emiliae</i>	"hairs over the entire body... gray-based"
Transversal Tricolor Pelage Pattern: With stripes			
Species	Bibliography	Compared to	Characteristics
<i>M. rubida</i>	Thomas (1899)		1) "colour uniformly chestnut-rufous all over above"
			2) "uniformly chestnut-rufous on the sides"
<i>M. umbristriata</i>	Pine (1976) and Lemos et al. (2000)	<i>M. americana</i> species group	1) "overall dorsal pelage reddish-brown," as opposed to the grizzled olive gray fore back in <i>M. americana</i>
			2) "with three faint darker, parallel stripes. Demarcation between dorsal stripes and the surrounding coloration unclear, especially posteriorly where the stripes blend into a darker background"
			3) greater size
			4) cranium large and robust

A comparative basicranial anatomy survey was done to fulfill the objective of providing detailed basicranial comparative descriptions and character construction. Character construction, as understood here, is the partitioning of phenotypes into discrete characters and the partitioning of variants into character states. Scoring is the ascribing of character states to a particular terminal (Harris *et al.* 2003), and this report's terminals were individual specimens.

Basicranial structures are only visible in well taxidermized and clean skulls. In depth basicraium cleaning under microscope magnification with the aid of the smallest and most delicate insulin syringes for children was necessary in most museum specimens. Very internal structures were examined only when portions of the skull were exposed by breakage or by the absence of constituent bones which usually keep these structures from view. No destructive sampling was applied. Not all taxa or specimens were scored for all characters because of differing states of preservation and preparation.

The basicranial complex was scrutinized for consistent discontinuous anatomical variation among specimens. I only discarded variation when a continuous gradient was found from one shape to another. Thus, even highly variable structures were characterized. Wiens' (2000) restriction of the term polymorphism to intraspecific variation, to the exclusion of sexual and ontogenetic variation, is adopted here. All instances of discontinuous polymorphism found among individuals of a species were reported in this study. Some characters describe the variation in the direction/inclination of a structure. In such cases, direction is classified according to the angle made with the anteroposterior axis (i.e. Anterior, slightly lateral is up to about 20° from the axis, anterolateral is between 30° and 60°).

Whenever there was no covariation, I adopted the reductive approach to character construction (Wilkinson 1995), where separate characters are used to describe variations in the different parts of a complex feature. Multistate characters

were accepted according to the following criteria. Variation of a structure such as presence/absence was dissociated from other descriptors of the same structure (i.e. size, shape, topology). The exception to this was when a character described the development of a structure (e.g. two bones are separate / in contact / fused). Vidigal (2004) found that most characters were symmetrical and normal, and the Wilcoxon test detected no directional asymmetry. Therefore, I assumed symmetry when left or right side bones were broken or missing.

A base matrix was constructed with each individual specimen coded for the character states found.

DELIMITING OF THE LEAST INCLUSIVE OTU: CONSOLIDATION OF INDIVIDUALS INTO GEOGRAPHIC POPULATIONS BASED ON WWF ECOREGIONS.

Because most *Monodelphis* species are in need of revision and *Monodelphis* species groups are so widespread geographically and show such a great variety of morphotypes, an OTU that was intermediate along this specimen-species-species group continuum was in need to reach a more equal base for intergeneric comparison. I called this intermediate OTU the least inclusive OTU, corresponding to a population composed of specimens aggregated by Ecoregion, as defined as follows. All specimens were grouped into populations based on locality coordinates and the correspondent World Wildlife Fund Neotropical Terrestrial Ecoregion. I recovered the coordinates of the collection locality from museums' databases and specimens' labels. When not provided with the specimen, I recovered coordinates based on locality information using Google Earth (<http://www.google.com/earth/index.html>), MapPlanet (<http://www.mapplanet.com/>), and FallingRain Global Gazetteer Version 2.2 (<http://www.fallingrain.com/world/index.html>, Copyright 1996-2010 by Falling Rain Genomics, Inc.). I then used the coordinates of each specimen to classify them into one of the World Wildlife Fund Terrestrial Ecoregions of the World (TEOW) (Olson, D. M. et al 2001). Membership to each Ecoregion population required unique pelage characteristics as described in the previous identification section and

collection at the correspondent WWW Terrestrial Ecoregion. Thus, specimens distinct from others by identification based on pelage and collected in the same Ecoregion that is united by morphology and geographic distribution, were aggregated to an Ecoregion population OTU. The OTU was obtained by compiling the character state codes of all correspondent member specimens.

REFERENCE GENERA SELECTION

Representatives of five didelphid genera were examined as reference taxa in the cladistic analysis: *Caluromys philander*, *Didelphis albiventris*, *Marmosa murina*, *Marmosops incanus* and *Lutreolina crassicaudata*. I used *Caluromys* as the rooting outgroup, because it appears consistently as the basal sister group to all other neotropical marsupials (Cardillo *et al.* 2004, Voss & Jansa 2009). It was followed by representative genera of the three major clades within Didelphinae (Cardillo *et al.* 2004, Voss & Jansa 2009): *Lutreolina* and *Didelphis* of Didelphini for the large sized didelphids (Hershkovitz 1992, Steiner *et al.* 2005, Voss & Jansa 2009), *Marmosops* of Thylamyini (Voss & Jansa 2009) and *Marmosa* of Marmosini (Reig *et al.* 1985, 1987, Hershkovitz 1992, Kirsch & Palma 1995, Patton *et al.* 1996, McKenna & Bell 1997, Jansa & Voss 2000 & 2005, Steiner *et al.* 2005, Voss & Jansa 2009) for the small sized didelphids most times resulting as direct sister groups to *Monodelphis*.

CLADISTIC ANALYSIS

To minimize missing data, a 50% minimum character coded cut was established for the least inclusive OTU cladistic analysis. Where there were signs of sexually dimorphism, potentially sexually dimorphic characters were scored for each sex separately.

The Software used for the cladistic analyses was TNT (Tree analysis using New Technology ver. 1.0, Goloboff 1999, Nixon 1999, Goloboff *et.al.* 2008) and WinClada (WinClada ver. 1.0, Nixon 2002) to reconstruct ancestral character states.

Characters were weighted equally. Multistate characters were treated as unordered. If more than one most parsimonious tree was found, implied weights (Goloboff 1993) was used as additional criteria to select among multiple most parsimonious trees. Node support was assessed by means of Bremer support (Bremer 1988) as implemented in TNT.

4. RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

SPECIMEN SAMPLING: SELECTION OF SEMAPHORONTS REPRESENTING MORPHOTYPE AND GEOGRAPHIC LOCALITY DIVERSITY.

Dental age determination was reported in Vidigal (2004). The lower third premolars - pm3 - are the last teeth to reach full development in *Monodelphis*. Within the adult age class, young adults are those presenting very little or no wear on third premolars and fourth molar, whereas adults are those with moderate wear on these teeth, and old adults are those with heavy wear on all teeth. Only adult individuals were included in this study.

A total of 165 specimens of *Monodelphis* and 31 specimens of outgroup species were examined and coded individually. All available specimen museum label information is presented with the complete basicranial anatomy data matrix in Appendix 2. Nineteen *Monodelphis* species were represented in the sample studied, including 10 type specimens of 8 species (*M. adusta*, *M. peruviana*, *M. osgoodi*, *M. rubida*, *M. umbristriata*, *M. theresa*, *M. brevicaudata*, and *M. maraxina*).

Of the *Monodelphis* specimens examined, 114 were males, 39 were females, and 12 specimens had no sex data. Eleven species were represented by individuals of both sexes, thus signs of sexual dimorphism could be assessed in these. Nevertheless, the sex ratio was equal in only three species sampled (*M. theresa*, *M. orinoci*, and *M. palliolata*), with the remainder of the sample been represented mainly by male specimens.

Specimens with complete locality information allowed an exact match to a WWF Terrestrial Ecoregion, yielding a total of 25 ecoregions (Table 4.1). When exact locality information was not available, I listed the possible ecoregions specimens were collected in. Thus, additional 16 ecoregions are estimated to be represented by the remaining sample studied. Table 4.1 lists all the ecoregions represented in this study. The greater number of ecoregions shown in Table 4.1 is due to a finer especification for some localities (e.g. Paraná-Paraíba Interior Forest SE versus Paraná-Paraíba Interior Forest). *Monodelphis* specimens were aggregated

into 58 ecoregion populations. Table 4.2 lists all *Monodelphis* Ecoregion Populations and Species Group OTUs, with their respective cladistic analysis label, percentage of characters coded and country and ecoregion of origin for reference. Some ecoregions are area of distribution to more than one species. The sharing of the same ecoregion by populations of different species either indicates sympatry or the presence of an even finer microhabitat subdivision among populations of different species.

Table 4.1.. World Wildlife Fund Terrestrial Ecoregions of the World (TEOW) containing localities where *Monodelphis* species were collected.

Exact Ecoregions	Ecoregion (Code Number)	Estimated ecoregions	Ecoregion (Code Number)
Araucaria moist forest	NT0101	Atlantic Coast Restingas	NT0102
Bahia Coastal Forests	NT0103	Atlantic Dry Forests	NT0202
Bahia Interior Forests	NT0104	Beni Savanna	NT0702
Caatinga	NT1304	Campos Rupestres montane savanna	NT0703
Central Andean Wet Puna	NT1003	Guayanan Highlands moist forests	NT0124
Cerrado	NT0704	Guianan Moist forests	NT0125
Chaco	NT0210	Humid Chaco	
Eastern Cordillera Real Montane Forests	NT0121	Iquitos Varzea	NT0128
Eastern Panamanian Montane Forest	NT0122	Llanos	NT0709
Guyanan Savanna	NT0707	Maracaibo Dry forests	NT0222
La Costa xeric shrublands	NT1309	Monte Alegre varzea	NT0141
Llanos W	NT0709	Paraná-Paraíba Interior Forest SE	NT0150
Madeira-Tapajós moist forest	NT0135	Pernambuco Coastal Forests	NT0151
Magdalena Valley Montane Forests	NT0136	Pernambuco Interior Forests	NT0152
Marajó Varzea	NT0138	Purus-Madeira Moist forests	NT0157
Mato Grosso Tropical Dry Forest	NT0140	Southwest Amazon Moist forests	NT0166
Negro-Branco Moist forests	NT0143	Venezuelan Andes Montane forests	NT0175
Paraná-Paraíba Interior Forest	NT0150	Ucayali Moist Forests	NT0174
Peruvian Yungas	NT0153		
Serra do Mar coastal forests	NT0160		
Tapajós-Xingu moist forests	NT0168		
Tapajós-Xingu Moist forests E	NT0168		
Tapajós-Xingu Moist forests W	NT0168		
Tocantins-Araguaia-Maranhão moist forests	NT0170		
Uatuma-Trombetas moist forests	NT0173		
Uatuma-Trombetas Moist forests E	NT0173		
Uatuma-Trombetas Moist forests W	NT0173		
Uruguayan savanna	NT0710		
Xingu-Tocantins-Araguaia Moist forests	NT0180		

Table 4.2. *Monodelphis* Ecoregion Populations and species OTUs.

Cladistic analysis label ²	Index OTU / N OTU	N specimens	Ecoregion Population ¹ / Species Group	Country	Ecoregion (when more than one listed, they are presented in order of probability)	% Coded Characters
adaaMaTY*	1	5	ad_aaTYMagdalenaValleyMontane	Colombia	Magdalena Valley Montane Forests - NT0136	51%
adbmeP*	2	1	ad_bmeEPanamanianMontane*	Panamá	Eastern Panamanian Montane Forest - NT0122	9%
adcpCR*	3	2	ad_cpeECordilleraRealMontane*	Ecuador	Eastern Cordillera Real Montane Forests - NT0121	20%
adpeTY*	4	3	ad_dpeTYPeruvianYungas*	Peru	Peruvian Yungas - NT0153	64%
adeosTY*	5	2	ad_eosTYCAndeanWetPuna*	Bolivia	Central Andean Wet Puna - NT1003	30%
adfbDP*	6	1	ad_f*	Peru	?	27%
ad_spGr*	6	14	adusta Species Group			77%
kuaMTTD*	7	2	ku_aMatoGrossoTropDry*	Brasil	Mato Grosso Tropical Dry Forest - NT0140	27%
kubCerr*	8	7	ku_bCerrado*	Brasil	Cerrado - NT0704	39%
kuPNPB*	9	1	ku_cParaná-ParaíbaInterior*	Brasil	Paraná-Paraíba Interior Forest - NT0150	45%
ku_spGr*	3	10	kunsi Species Group			56%
amaToAr*	10	5	am_aTocantins-Araguaia-MaranhãoMoist*	Brasil	Tocantins-Araguaia-Maranhão Moist forests - NT0170	53%
ambPE*	11	1	am_bPernambuco*	Brasil	Pernambuco Coastal Forests - NT0151 / Pernambuco Interior Forests - NT0152	15%
amcBACo*	12	1	am_cBahiaCoastal*	Brasil	Bahia Coastal Forests - NT0103	20%
amdruBa*	13	3	am_druBahiaInteriorN*	Brasil	Bahia Interior Forests N - NT0104	52%
ameumbTY*	14	2	am_eumbTYCerradoN*	Brasil	Cerrado N - NT0704	40%
amfCPNP*	15	3	am_fCerradoParaná-ParaíbaInteriorN*	Brasil	Cerrado - NT0704 / Paraná-Paraíba Interior forests N - NT0150	34%
amgBalN*	16	3	am_gBahiaInteriorS*	Brasil	Bahia Interior Forests S - NT0104	78%
amhumbC*	17	2	am_humbCerradoS*	Brasil	Cerrado S - NT0704	75%
amiPNPB*	18	2	am_iParaná-ParaíbaInteriorBahiaInteriorSerraMantiqueira*	Brasil	Paraná-Paraíba Interior forests - NT0150 / Serra da Mantiqueira	23%
amjtheTY*	19	4	am_jtheTYSerraMarRJCoastal*	Brasil	Serra do Mar Coastal forests - NT0160 / Coastal Rio de Janeiro	36%
amkihAr*	20	2	am_kihSerraMarCoastalAraucariaMoist*	Brasil	Serra do Mar Coastal forests - NT0160 / Araucaria Moist forests - NT0101	28%
amlihsP*	21	4	am_lihsSerraMarCoastalSP*	Brasil	Serra do Mar Coastal forests - NT0160 / Serra do Mar São Paulo	42%
ammCepN*	22	1	am_mCerradoParaná-ParaíbaInteriorS*	Brasil, SP	Cerrado - NT0704 / Paraná-Paraíba Interior forests S - NT0150	9%
am_spGr_sl*	13	33	americana Species Group			98%
scaBaIc*	23	2	sc_aBahiaInteriorCoastal*	Brasil	Bahia Interior forest - NT0104 / Bahia Coastal Forests - NT0103	12%
scbSMRJ*	24	2	sc_bSerraMarCoastalRJ*	Brasil	Serra do Mar Coastal forests - NT0160 / Coastal Rio de Janeiro.	20%
sccSMP*	25	1	sc_cSerraMarCoastalSP*	Brasil, SP	Serra do Mar Coastal forests - NT0160 / Serra do Mar, São Paulo	35%
scaArau*	26	2	sc_dAraucariaMoist*	Brasil	Araucaria Moist forest - NT0101	26%
sc_spGr*	4	7	scalops Species Group			48%
emaXTAM*	27	1	em_aXingu-Tocantins-AraguaiaMaranhãoMoist*	Brasil	Xingu-Tocantins-Araguaia Moist forests - NT0180 / Tocantins-Araguaia-Maranhão Moist forests - NT0170	16%
embMTX*	28	2	em_bMadeira-Tapajós-XinguMoist*	Brasil	Madeira-Tapajós Moist forest - NT0135 / Tapajós-Xingu Moist forests - NT0168	74%
emcMTcE*	29	4	em_cMadeira-TapajósMoistCerrado*	Brasil	Madeira-Tapajós Moist forest - NT0135 / Cerrado - NT0704	54%
emdAmIq*	30	5	em_dSWAmazonMoistIquitosVarzea*	Brasil, Peru	Southwest Amazon Moist forests - NT0166 / Iquitos Varzea - NT0128	45%
em_spGr*	4	12	emiliae Species Group			88%
headiUS*	31	4	he_adiUruguayanSavanna*	Brasil, Uruguay	Uruguayan Savanna - NT0710 / Paraná- Paraíba interior forests - NT0150 / Araucaria moist forests - NT0101	28%
hebbri*	32	15	he_bbrisParaná-ParaíbaInterior*	Brasil, Paraguay	Paraná-Paraíba Interior forest S - NT0150	37%
hecArau*	33	2	he_cAraucariaMoist*	Brasil	Araucaria Moist forest - NT0101	38%
hedSeMa*	34	2	he_dSerraMarCoastal*	Brasil	Serra do Mar Coastal forests - NT0160	22%
heesoPP*	35	2	he_esoParaná-ParaíbaInteriorSECerrado*	Brasil	Paraná-Paraíba Interior Forest - NT0150 / Cerrado - NT0704 / Serra do Mar coastal forests - NT0160	83%
he_spGr*	5	25	henseli Species Group			81%
breaMat*	36	5	bre_aMadeira-TapajósMoist*	Brasil	Madeira-Tapajós Moist forest - NT0135	30%
brebPMa*	37	8	bre_bPurus-Madeira-TapajósMoist*	Brasil	Madeira-Tapajós Moist forest - NT0135 / Purus-Madeira Moist forests - NT0157	42%
brecXTA*	38	2	bre_cXingu-Tocantins-AraguaiaMoist*	Brasil	Xingu-Tocantins-Araguaia Moist forests - NT0180 / Mato Grosso tropical dry forests - NT0140 / Tapajós-Xingu moist forests - NT0168	23%
bredTXW*	39	3	bre_dTapajós-XinguMoistW*	Brasil	Tapajós-Xingu Moist forests W - NT0168	74%
breetoTX*	40	2	bre_eTapajós-XinguMoistE*	Brasil	Tapajós-Xingu Moist forests E - NT0168	78%
breftoUT*	41	2	bre_ftoUatuma-TrombetasMoistE	Brasil	Uatuma-Trombetas Moist forests E - NT0173 / Guianan moist forests - NT0125	30%
bregUTW*	42	4	bre_gUatuma-TrombetasMoistW	Brasil	Uatuma-Trombetas Moist forests W - NT0173 / Monte Alegre varzea - NT0141	39%
brehNeB*	43	4	bre_hNegro-BrancoMoist*	Venezuela, Brasil	Negro-Branco Moist forests - NT0143 / Guayanan Highlands moist forests - NT0124	78%

Table 4.2. *Monodelphis* Ecoregion Populations and species OTUs. (cont.)

Cladistic analysis label ²	Index OTU / N	N specimens	Ecoregion Population ¹ / Species Group	Country	Ecoregion (when more than one listed, they are presented in order of probability)	% Coded Characters
breiGui*	44	3	bre_iGuiananMoistGuayananHighlandsMoist*	Venezuela	Guianan Moist forests - NT0125 / Guayanan Highlands Moist forests - NT0124	86%
brejGuy*	45	2	bre_jGuyananSavanna*	Venezuela, Brasil	Guyanan Savanna - NT0707	18%
brekorL*	46	2	bre_korLlanosW*	Venezuela	Llanos W - NT0709	33%
breIpaC*	47	3	bre_lpaLaCostaXericShrublands*	Venezuela	La Costa Xeric Shrublands - NT1309	85%
brempaM*	48	3	bre_mpaMaracaiboDryVenezuelanAndesMontane*	Venezuela	Maracaibo Dry forests - NT0222 / Venezuelan Andes Montane forests - NT0175	63%
brenTY*	49	1	brenTY*		?	26%
bre_spGr*	14	14	brevicaudata Species Group			98%
doamaTY*	50	1	do_amaTYMarajóVarzea*	Brasil	Marajó Varzea - NT0138	9%
dobXiTo*	51	1	do_bXingu-Tocantins-AraguaiaMoistMatoGrossoTropicalDry*	Brasil	Xingu-Tocantins-Araguaia Moist forests - NT0180 / Mato Grosso Tropical Dry forests - NT0140	9%
docCaa*	52	6	do_cCaatinga*	Brasil	Caatinga - NT1304 / Atlantic Coast Restingas - NT0102 / Pernambuco interior forests - NT0152	29%
dodCaAt*	53	1	do_dCaatingaAtlanticDry*	Brasil	Caatinga - NT1304 / Atlantic Dry forests - NT0202	20%
doeCeTY*	54	4	do_eTYCerrado*	Brasil	Cerrado - NT0704	41%
dofCePP*	55	3	do_fCerradoParaná-ParaibaInterior*	Brasil	Cerrado - NT0704 / Paraná-Paraiba Interior Forest - NT0150	36%
dogBeni*	56	1	do_gBeniSavannaSWAmazonMoist*	Bolivia	Beni Savanna - NT0702 / Southwest Amazon Moist forests - NT0166	45%
dohChac*	57	1	do_hChaco*	Bolivia	Chaco - NT0210	16%
doiChaP*	58	1	do_iHumidChacoParaná-ParaibaInterior*	Paraguay	Humid Chaco - NT0708 / Paraná-Paraiba Interior forests - NT0150 / Chaco - NT0210	57%
do_spGr*	9	19	domestica Species Group			87%

1. Ecoregion populations are coded as follows: abbreviation of *Monodelphis* species, followed by alphabetical population numbering for that species, followed by abbreviation 2. Highlighted cladistic analysis labels are populations included in the least inclusive OTU cladistic analysis.

CHARACTER LIST

The comparative basicranial anatomic survey yielded 102 characters, as summarized in Table 4.3 and described below. Characters are listed in an approximately anteroposterior topographic order of great complexes of basicranial bones (Figure 4.3A and Figure 4.3B). Each bone complex is explained following Wible (2003), and then the character and respective character states found are listed and discussed. There are more Matrix Characters – MC than Cladistic Basicranium Characters – CIB because Matrix Characters – MC count potentially sexual dimorphic characters separately for males and for females.

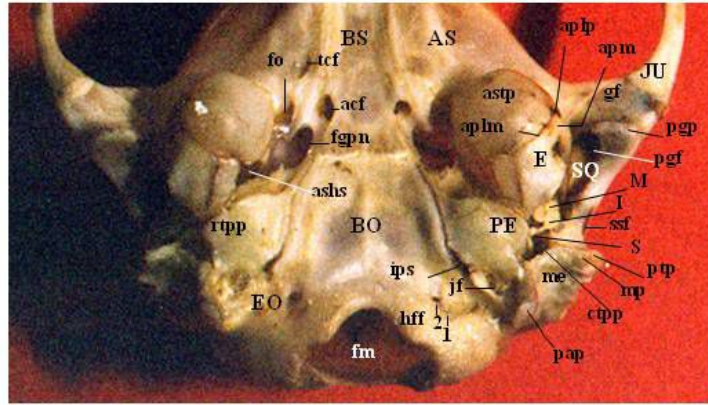


Figure 4.3.A. *Monodelphis emiliae* from Peru, illustrating basicranial osteology in ventral view. Abbreviations: **acf**, anterior carotid foramen; **aplm**, asp posterolateral margin; **aplp**, asp posterolateral process; **apm**, anterior process of the malleus; **AS**, alisphenoid; **ashs**, alisphenoid hypotympanic sinus; **astp**, alisphenoid tympanic process; **BO**, basioccipital; **BS**, basioccipital; **EO**, exoccipital; **E**, ectotympanic; **fgpn**, foramen for greater petrosal nerve; **fm**, foramen magnum; **fo**, foramen ovale; **gf**, glenoid fossa; **hff**, hypoglossal foramina 1, 2; **I**, incus; **ips**, foramen for the inferior petrosal sinus; **JU**, jugal; **jf**, jugular or posterior lacerate foramen; **M**, malleus; **me**, mastoid exposure; **mp**, mastoid process; **pap**, paracondylar process of the exoccipital; **PE**, petrosal; **pgf**, postglenoid foramen; **pgp**, postgenoid process; **ptp**, posttympanic process; **rtpp**, rostral tympanic process of petrosal; **S**, stapes; **SQ**, squamosal; **ssf**, subsquamosal foramen; **tcf**, transverse canal foramen.

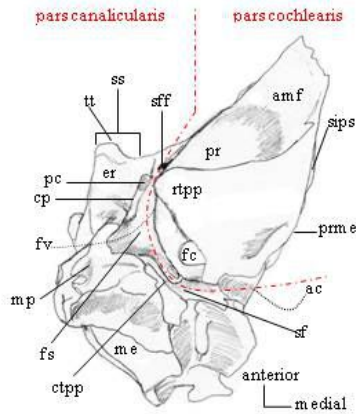


Figure 4.3.B. *Monodelphis domestica* MN32539, left petrosal in ventral view. Black dotted lines indicate location of structures hidden from view. Dot and space line separate the two regions of the petrosal. Abbreviations: **ac**, aqueductus cochleae; **cp**, crista parotica; **ctpp**, caudal tympanic process of petrosal; **er**, epitympanic recess; **fc**, fenestra cochleae; **fs**, facial sulcus; **fv**, fenestra vestibuli; **me**, mastoid exposure; **mp**, mastoid process; **pc**, prootic canal; **pr**, promontorium or periotic; **prme**, promontorium medial expansion; **rtpp**, rostral tympanic process of petrosal; **sf**, stapedius fossa; **sff**, secondary facial foramen; **sips**, sulcus for inferior petrosal sinus; **ss**, sphenoid septum; **tt**, tuberculum tympani.

Table 4.3. Index of cladistic characters (Cladistic basicranium characters – CIB, Matrix Character – MC).

INDEX	Anatomical Reference	Cladistic Character Numbers ('M' denotes male specimens in potentially Sexual Dimorphic characters, whether 'F' denotes female specimens)	N Clad Char = CIB102 (MC122 MF)
4.1.	BASISPHEOID – bs , PTERYGOID – pt, ORBITOSPHEOID – os, BASIOCCIPITAL – bo	Total N CLAD Char:	30 (37)
4.1.1.	Basisphenoid – bs		17 (23)
4.1.1.1.	Carotid foramen – cf	MC1, MC2, MC3M, MC4F, MC5, MC6, MC7	6 (7)
4.1.1.2.	Transverse canal foramen – tc	MC8, MC9, MC10M, MC11F, MC12, MC13M, MC14F, MC15M, MC16F, MC17, MC18M, MC19F, MC20M, MC21F, MC22, MC23	11 (16)
			4
4.1.2.1.	Pterygoid canal – ptc	MC24, MC25, MC26, MC27	4
4.1.3.	Orbitosphenoid – os or Sphenoid Complex		7 (8)
4.1.3.1.	Sphenorbital fissure – sof and foramen rotundum – fro	MC28, MC29, MC30, MC31, MC32M, MC33F, MC34	6 (7)
4.1.3.2.	Ethmoidal foramen – ef	MC35	1
4.1.4.	Basioccipital – bo	MC36, MC37	2
4.2.	ALISPHEOID – as	Total N CLAD Char:	25 (27)
4.2.1.	Foramen rotundum – fro	MC38, MC39, MC40	3
4.2.2.	Foramen ovale – fo and foramen for the greater petrosal nerve – fgpn	MC41, MC42, MC43, MC44, MC45, MC46, MC47	7
4.2.3.	Glenoid process of the alisphenoid – gas	MC48	1

INDEX	Anatomical Reference	Cladistic Character Numbers ('M' denotes male specimens in potentially Sexual Dimorphic characters, whether 'F' denotes female specimens)	N Clad Char = CIB102 (MC122 MF)
4.2.4.	ALISPHEOID TYMPANIC PROCESS – astp		12 (13)
4.2.4.1.	Alisphenoid tympanic process – astp, ventral view	MC49, MC50, MC51M, MC52F, MC53, MC54	5 (6)
4.2.4.2.	Alisphenoid tympanic process – astp, lateral view	MC55, MC56, MC57, MC58	4
4.2.4.3.	Alisphenoid tympanic process – astp, anteromedial strut	MC59, MC60	2
4.2.4.4.	Alisphenoid tympanic process – astp, glaserian fissure – glf	MC61	1
4.2.5.	Roof of the alisphenoid hypotympanic sinus – rashs	MC62, MC63M, MC64F	2 (3)
4.3.	ECTOTYMPANIC – ec		11 (14)
4.3.1.	Ectotympanic Expansion and Inflation	MC65, MC66, MC67M, MC68F, MC69, MC70, MC71, MC72, MC73M, MC74F	8 (10)
4.3.2.	Ectotympanic Shape	MC75M, MC76F, MC77, MC78	3 (4)
4.4.	PETROSAL – pe		20 (24)
4.4.1.	PARS COCHLEARIS		9 (10)
4.4.1.1.	Promontorium – pr		
4.4.1.1.1.	Rostral Tympanic Process of Petrosal – rtp		
4.4.1.1.1.1.	rtp Lateral Projection and Anteromedial Margin	MC79, MC80, MC81M, MC82F, MC83, MC84, MC85, MC86, MC87	8 (9)
4.4.1.1.1.2.	RTTP Posteromedial Margin	MC88	1

INDEX	Anatomical Reference	Cladistic Character Numbers ('M' denotes male specimens in potentially Sexual Dimorphic characters, whether 'F' denotes female specimens)	N Clad Char = CIB102 (MC122 MF)
4.4.2.	PARS CANALICULARIS		11 (14)
4.4.2.1.	Anteroventral portion of the PARS CANALICULARIS, lateral to the promontorium		
4.4.2.1.1.	Bony shelf lateral to the facial sulcus [old Epitympanic Recess]	MC89, MC90M, MC91F, MC92M, MC93F, MC94M, MC95F	4 (7)
4.4.2.1.2.	Crista Parotica – cp	MC96	1
4.4.2.1.3.	Prootic Canal – pc, tympanic opening [old Lateral Head Vein Canal]	MC97, MC98, MC99	3
4.4.2.2.	Medial View of the PARS CANALICULARIS		
4.4.2.2.1.	Cochlear canaliculus [old Aqueductus Cochleae]	MC100	1
4.4.2.3.	Occipital View		
4.4.2.3.1.	Mastoid Exposure – me	MC101, MC102	2
4.5.	CONTACT BETWEEN PETROSAL AND NEIGHBORING BONES		5 (6)
4.5.1.	Contact between pars cochlearis, pars canalicularis and exoccipital		
4.5.1.1.	Ventral contact	MC103	1
4.5.2.	Contact between Pars cochlearis – basioccipital exoccipital contact		
4.5.2.1.	Ventral contact	MC104M, MC105F, MC106, MC107	3 (4)
4.5.2.2.	Intracranial contact	MC108	1
4.6.	EXOCCIPITAL – eo		2
4.6.1.	Hypoglossal foramina	MC109, MC110	2
4.7.	MIDDLE EAR OSSICLES		4 (6)
4.7.1.	STAPES – s		4 (6)
4.7.1.1.	Stapedial Crura and foramen	MC111, MC112M, MC113F, MC114M, MC115F, MC116	4 (6)
4.8.	SQUAMOSAL – sq		5 (6)
4.8.1.	Subsquamosal foramen - ssf	MC117, MC118, MC119	3
4.8.2.	Postglenoid foramen – pgf	MC120, MC121M, MC122F	2 (3)

4.1. BASISPHENOID – bs, PTERYGOID – pt, ORBITOSPHEOID – os, BASIOCCIPITAL – bo

The basisphenoid and the basioccipital are midline elements in the skull base. Attached to the basisphenoid are the paired alisphenoid bones. The basisphenoid and alisphenoid are fused together by postnatal day 25. The landmarks that employed to demarcate the basisphenoid and alisphenoid in the adult skull are the foramen rotundum, which ontogenetically is entirely within the alisphenoid (Clark and Smith, 1993), and the transverse canal and carotid foramina, which ontogenetically are entirely within the basisphenoid (Wible, unpubl. observ.; Sánchez-Villagra, pers. commun.) (Wible 03, p. 149). The basisphenoid and the orbitosphenoid house internally the hypophyseal fossa and, laterally, the cavum epiptericum space, the space between the primary and secondary walls of the braincase in mammals (Kühn and Zeller, 1987; Novacek, 1993 in Macrini, 2007).

4.1.1. Basisphenoid – bs

4.1.1.1. Carotid foramen – cf

The carotid foramen is the posteriormost set of paired foramina in the basisphenoid. A well-defined, short vascular sulcus on the basisphenoid leads into each carotid foramen from behind. This sulcus is directed toward and in contact with the flat, expanded anteromedial flange of the petrosal (Wible 03, p. 152). Based on *M. domestica* (unpubl. observ. in Wible, 2003), the carotid foramen transmitted the internal carotid artery and accompanying vein and sympathetic nerve. In *M. brevicaudata* CM52729, the carotid foramen lies entirely within the basisphenoid (Wible, 2003), entering, as observed in *M. domestica*, the hypophyseal fossa (Macrini, 2007), following a straight and horizontally oriented cast of the internal carotid arteries. The hypophysis houses a portion of the pituitary gland.

The carotid foramen was categorized by Wible (2003) into the group of foramina bilaterally present in all specimens that exhibit no significant variation among the CM specimens. I found variation in shape, direction, and relative

position of the carotid foramina within the *Monodelphis* sample studied. The carotid foramen lies ventral to the hypophyseal fossa (Macrini, 2007).

MC1 / CIB001) Position of the anteroventral margin of the carotid foramen relative to the foramen ovale's anterior margin:

0 = anteroventral margin of the carotid foramen anterior to foramen ovale's anterior margin

1 = at approximately the same position

2 = posterior

Only the foramina *per se* are under consideration, as seen in ventral view, and not the sulci leading towards them. This is a more consistent criterion, even though it is hard to assess relative position when anterior carotid foramen and foramen ovale are separated by the alisphenoid tympanic process anteromedial extension.

Position characters should be checked for ontogenetic variation, given that Macrini (2007) found that the relative size of the fossa increases with age, and that the hypophyseal length increases at a faster rate than its width. In addition, the foramen ovale is incorporated in the cavum epipeteticum, which presented positive ontogenetic variation in relative size and individual variation in adults (Macrini 2007). Despite this ontogenetic variation, Macrini (2007) found no variation in the position of the aperture of canals transmitting the carotid arteries into the hypophysis within *Monodelphis*.

MC2 / CIB002) Confluence of the carotid foramen with the foramen ovale:

0 = confluent

1 = not confluent (carotid foramen anterior to foramen ovale)

Character state 1 was found only in *M. henseli*, *M. brevicaudata*, and *M. domestica*, in most cases unilaterally.

MC3M, MC4F / CIB003) Shape of the carotid foramen (Fig. 4.3.4):

0 = ovoid (Wible 2003)

1 = elipsoid

- 2 = round
- 3 = lens
- 4 = poligonal
- 5 = with the shape of a “limaçon”

Wible (2003) described the apertures of the carotid foramen as ovoid, however a greater variety of shapes was found within this sample.

Figure 4.3.4. MC3M,MC4F CIB003) Shape of the carotid foramen:



MC5 / CIB004) Presence of a process at the vertex of the carotid foramen’s ventrolateral parabolic margin:

- 0 = absent
- 1 = present

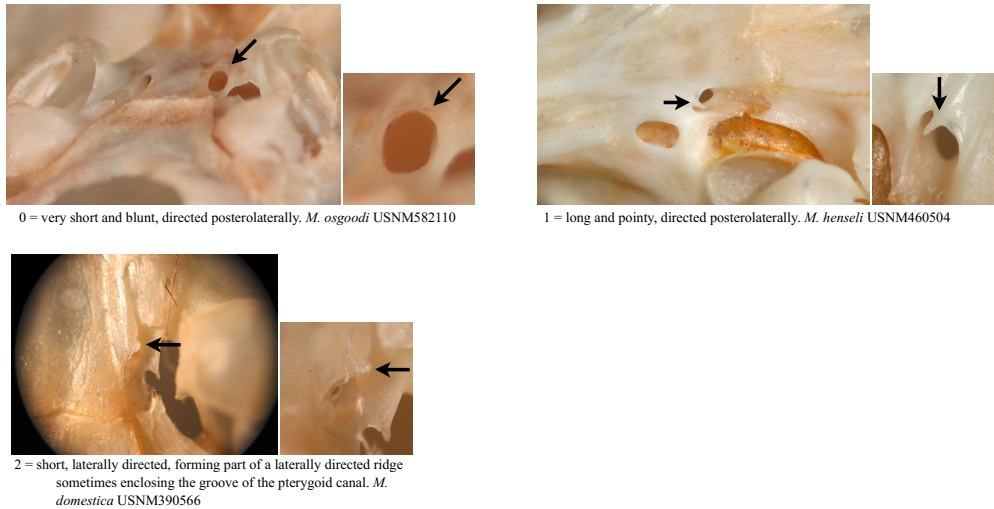
MC6 / CIB005) Shape of the process at the vertex of the carotid foramen’s ventrolateral parabolic margin (Fig. 4.3.5.):

- 0 = very short and blunt, directed posterolaterally
- 1 = long and pointy, directed posterolaterally

2 = short, laterally directed, forming part of a laterally directed ridge sometimes enclosing the groove of the pterygoid canal

The ridge was in all *M. scalops* specimens sampled and in *M. brevicaudata* from Itaituba and Tapajós River, from Ecoregion NT0168 (West Tapajós-Xingu Moist Forests). The ridge was recovered as *M. scalops*' single unequivocal autapomorphy in the most inclusive OTU cladistic analysis.

Figure 4.3.5. MC6/CIB005) Shape of the process at the vertex of the carotid foramen's ventrolateral parabolic margin:



MC7 / CIB006) Direction of the carotid foramen:

0 (Wible 2003) = the carotid foramen opens mainly posterolaterally and slightly ventrally

1 = opens mainly posteriorly, slightly ventrolaterally

2 = opens posteroventrolaterally

Wible (2003) described the apertures as directed posterolaterally and slightly ventrally. A series of skulls is necessary to assess this character states.

4.1.1.2. Transverse canal foramen – tc

The transverse canal foramen is the second pair of basisphenoid apertures, located near the posterior portion of the pterigoids. It transmits an extracranial vein

(Sánchez-Villagra & Wible 2002). The transverse canal foramen lies ventral to the cavum epiptericum (Macrini, 2007).

The transverse canal foramen in the CM sample was categorized by Wible (2003) into the group of foramina bilaterally present in all specimens that exhibit no significant variation. Within *Monodelphis*, I found variation in shape, direction, and relative position of the transverse canal foramen and in the depression postlateral to it.

MC8 / CIB007) Confluence of the transverse canal foramen with the carotid foramen:

0 (Sánchez-Villagra & Wible 2002) = “confluent with the carotid foramen or perforating the pterygoid fossa”

1 (Wible 2003) (Sánchez-Villagra & Wible 2002) = “anterior to the carotid foramen”

The results with the sample studied here corroborate the findings of Sánchez-Villagra and Wible (2002) and Wible (2003).

MC9 / CIB008) Position of the posterior margin of the transverse canal foramen relative to the carotid foramen:

0 = posterior margin at or just anterior to the carotid foramen, and posterior to the base of the alisphenoid tympanic process

1 = posterior margin at or just anterior to the carotid foramen and to the base of the alisphenoid tympanic process

2 = posterior margin much anterior to the carotid foramen (about equivalent to the length of one foramen) and at or just anterior to the base of the alisphenoid tympanic process

3 = posterior margin at or just anterior to the carotid foramen, and much anterior to the base of the alisphenoid tympanic process (about equivalent to the length of one foramen.)

4 = posterior margin much anterior to the carotid foramen and to the base of the alisphenoid tympanic process

Character states 0 and 3 were not represented in the *Monodelphis* sample, only in the outgroup specimens. This character describes the variation in the extent of the anterior position of the transverse canal foramen. It actually describes the distribution of the three structures (i.e. transverse canal foramen, carotid foramen, and alisphenoid tympanic process). Possibly, the three change in size and position within the basicranium interspecifically, possibly the whole basicranium varies its shape, thus moving these structures. It would be interesting to do a 3D or 2D morphometric map to evaluate this. Position of the transverse canal foramen should be checked for ontogenetic variation given that Macrini (2007) found that the relative size of the posterior half of the cavum epiptericum increases with ontogeny.

MC10M, MC11F / CIB009) Development and composition of a floor to the transverse canal foramen (Fig. 4.3.6.):

0 = no floor: transverse canal foramen not in contact with the alisphenoid tympanic process's anteromedial and without any process or ridge at its margins

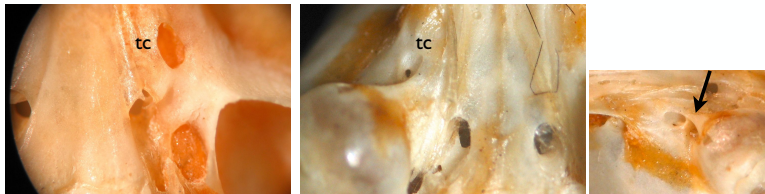
1 = floored by a ventromedial contribution of the alisphenoid tympanic process's anteromedial strut, but not forming a canal.

2 = floored medially in its entirety by the alisphenoid tympanic process's anteromedial strut, forming a canal

3 = floored by a ridge directed ventrolaterally from the transverse canal foramen towards the alisphenoid tympanic process's anteromedial strut, but not in contact with the alisphenoid tympanic process's anteromedial strut.

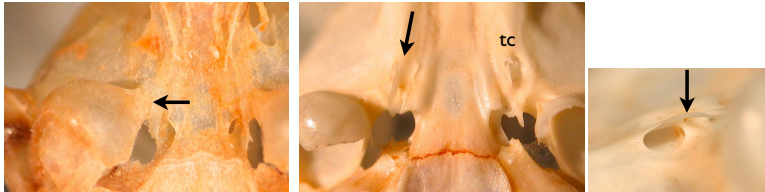
The configuration described by character state 3 was only observed in specimens of *M. domestica* and *M. brevicaudata*, and that described by character state 1 and 2 in *M. americana* and *M. emiliae*. The presence of state 3 is one of the three synapomorphies supporting the clade of node 30, which contains the *brevicaudata* species group, *M. domestica*, and the sister group composed of *M. kunsii* and the *adusta* species group. Even though neither the *adusta* species group nor *M. kunsii* were in fact coded for this character, as it can be checked in the resulting matrix, state 3 was coded uniquely for the *brevicaudata* species group and for *M. domestica*.

Figure 4.3.6. MC10M,MC11F/CIB009) Development and composition of a floor to the transverse canal foramen:



0 = no floor: transverse canal foramen not in contact with the alisphenoid tympanic process's anteromedial strut and without any process or ridge at its margins. *M. henseli* USNM484016.

1 = floored by a ventromedial contribution of the alisphenoid tympanic process's anteromedial strut, but not forming a canal. *americana* species group USNM304593



2 = floored medially in its entirety by the alisphenoid tympanic process's anteromedial strut, forming a canal. *M. americana* UnB170

3 = floored by a ridge directed ventrolaterally from the transverse canal foramen towards the alisphenoid tympanic process's anteromedial strut, but not in contact with the alisphenoid tympanic process's anteromedial strut. *M. domestica* USNM293130

Voss & Jansa's (2009) Character 73 includes aspects of development of both the transverse canal foramen and the alisphenoid tympanic process to address the different conditions of secondary nerve enclosure, considering the possibility that their states are nonhomologous. Their state 2 ("usually enclosed by posteromedial bullar lamina" from the transverse canal foramen) includes my state 2, though the qualifier "usually" is difficult to interpret in this context.

MC12 / CIB010) Shape of the transverse canal foramen:

0 = ellipsoid: "apertures of which are very flattened, almost cigar-shape" (Wible 2003)

1 = ovoid

2 = flat ventrally

MC13M, MC14F / CIB011) Direction of the transverse canal foramen (Fig. 4.3.7):

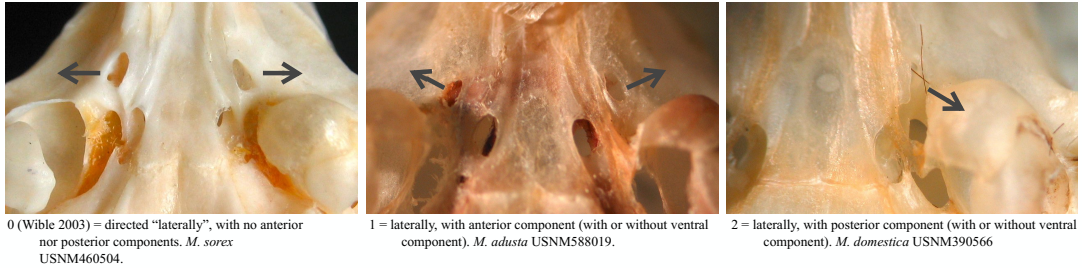
0 (Wible 2003) = directed "laterally", with no anterior nor posterior components

1 = laterally, with anterior component (with or without ventral component)

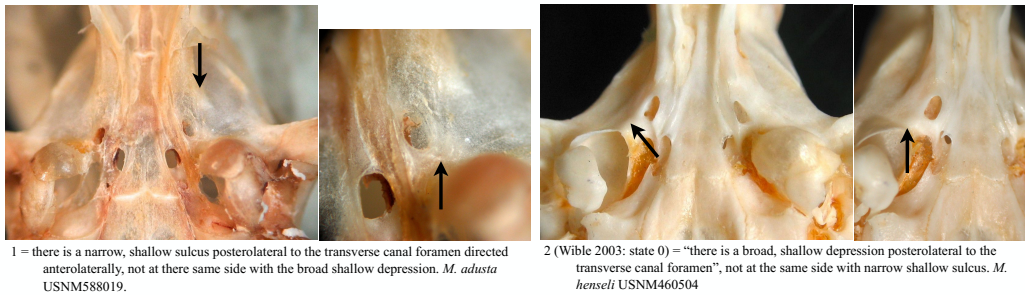
2 (Wible 2003) = laterally, with posterior component (with or without ventral component)

State 0 was recovered as an autapomorphy of the *M. emiliae* population embMTX from Pará based on USNM461884. Other specimens coded 0 for this character were *M. henseli* USNM460504 from São Paulo and *M. brevicaudata* USNM546207 also from Pará.

Figure 4.3.7. MC13M,MC14F/CIB011) Direction of the transverse canal foramen:



MC23/CIB017) Presence and configuration of a depression posterolateral to the transverse canal foramen:



MC15M, MC16F / CIB012) Presence of lateral foramina within the transverse canal foramen:

0 = absent

1 = present

MC17 / CIB013) Number of lateral foramina within the transverse canal foramen:

0 = one only

1 = >1

MC18M, MC19F / CIB014) Position of the lateral foramina within the transverse canal foramen:

0 = posterolaterally

1 = laterally

2 = anterolaterally

MC20M, MC21F / CIB015) Size of the lateral foramina within the transverse canal foramen:

0 = small, less than 1/6 the size of the transverse canal foramen

1 = large, approximately 1/4 to 1/3 the size of the transverse canal foramen

MC22 / CIB016) Presence and position of medial foramina or osseous subdivisions related to the transverse canal foramen:

0 = endocranial, within the transverse canal foramen

1 = basicranial, outside the transverse canal foramen

2 = absent

MC23 / CIB017) Presence and configuration of a depression posterolateral to the transverse canal foramen (Fig. 4.3.7.):

0 = inconspicuous

1 = there is a narrow, shallow sulcus posterolateral to the transverse canal foramen directed anterolaterally, not at the same side with the broad shallow depression

2 (Wible 2003: state 0) = “there is a broad, shallow depression posterolateral to the transverse canal foramen”, not at the same side with narrow shallow sulcus

3 = both “broad, shallow depression posterolateral to the transverse canal foramen or to the carotid foramen” and narrow, shallow sulcus posterolateral to the transverse canal foramen directed anterolaterally are present on both sides

The configuration described by character state 3 was only found in the outgroup sampled. Wible estimated that the broad, shallow depression posterolateral to the transverse canal foramen he observed in the CM sample likely accommodated the contents of the foramen. (2003 p. 152). Because the relative size of the posterior half of the cavum epiptericum increases with ontogeny (Macrini,

2007), which may affect the region around the transverse canal foramen, this character should also be checked for ontogenetic variation.

4.1.2. Pterygoid – pt

“The medial surfaces of the paired pterygoid bones form most of the roof and lateral walls of the nasopharyngeal passage.” (Wible 2003, p. 148) In ventral view, the posterior half of the pterygoid underlies the basisphenoid (Wible 2003).

4.1.2.1. Pterygoid canal – ptc

“In the dog (Evans, 1993), the pterygoid canal lies in the suture between the pterygoid and basisphenoid and transmits the nerve and artery of the pterygoid canal from the skull base to the posteroinferior floor of the orbit. According to Wible (1984), the metatherian pterygoid canal transmits nerves, but no artery.” (Wible 2003, p. 181)

The pterygoid canal was categorized in the group of foramina bilaterally present in all specimens that exhibit no significant variation by Wible (2003). I found variation in the position and shape of the posterior aperture of the pterygoid canal; in the ridges lateral to the basisphenoid, and in the sulcus lateral to the ridges.

The ontogenetic variation of both the hypophyseal fossa and the relative size of the posterior half of the cavum epiptericum (Macrini, 2007) possibly affect the characters presented here involving position and topological configuration.

MC24 / CIB018) Position of the posterior aperture of the pterygoid canal (Fig. 4.3.8.):

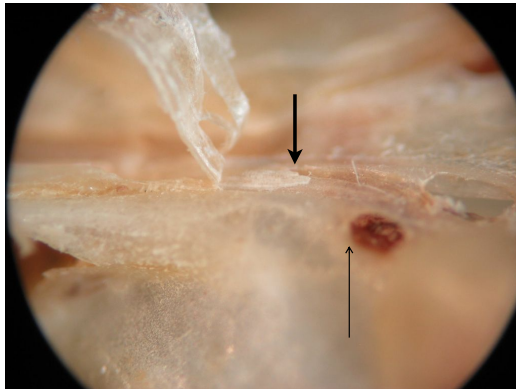
0 (Wible 03) = like Wible’s (2003) description below in state ‘1’, but just posterior to the level of the foramen rotundum”

1 (Wible 03) = “between the posterolateral border of the pterygoid and the overlying basisphenoid”, posterior to the foramen rotundum, “anterior to the” transverse canal and “carotid foramen and medial to the entopterygoid crest” (Wible 2003)

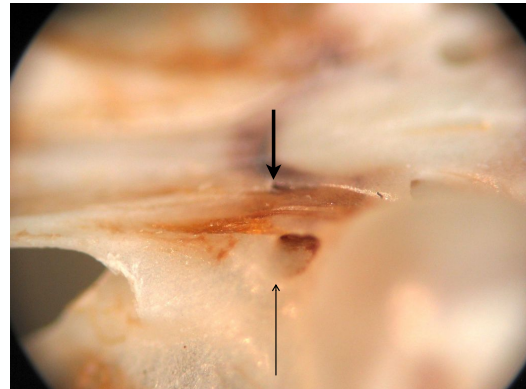
2 = like state '1', but approximately at level with the anterior margin of transverse canal

Figure 4.3.8.. MC24/CIB018) Position of the posterior aperture of the pterygoid canal:

0 (Wible 03) = like Wible's (2003) description below in state '1', but just posterior to the level of the foramen rotundum"



1 (Wible 03) = "between the posterolateral border of the pterygoid and the overlying basisphenoid", posterior to the foramen rotundum, "anterior to the" transverse canal and "carotid foramen and medial to the entopterygoid crest" (*M. Wible 03*).
M. adusta USNM588019



2 = like state '1', but approximately at level with the anterior margin of transverse canal.
M. americana USNM552402

MC25 / CIB019) Shape of the posterior aperture of the pterygoid canal:

0 (Wible 03) = "slit-like"

1 = arc-shaped (flat dorsally)

2 = lens-shaped (round dorsally and ventrally)

3 = triangular (flat ventrally and triangular groove dorsally)

State 1 was recovered as an autapomorphy of *M. brevicaudata* population brehNeB from Amazonas, based on specimen USNM385010.

MC26 / CIB020) Presence of a raised, rounded ridge extending anteriorly from the carotid foramen to the posterior extent of the pterygoid canal:

0 (Wible 03) = present

1 = absent or inconspicuous, flattend

While character state 1 appeared represent in several taxa, it was consistent in the *americana* species group.

MC27 / CIB021) Topological configuration of the narrow groove on the basisphenoid, running along the lateral aspect of the rounded ridge when present, leading to the posterior opening of the pterygoid canal (4.3.9.):

0 = lateral to the carotid foramen

1 = at the anterior margin of the foramen for the greater petrosal nerve, with a sulcus just slightly interrupted by a protuberance lateral to the carotid foramen

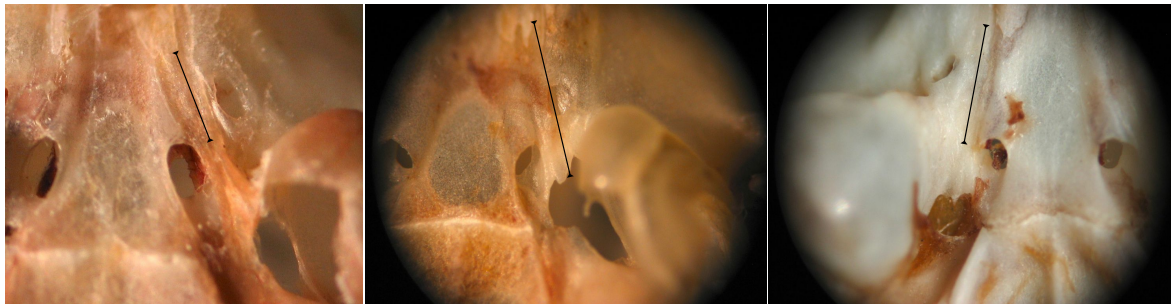
2 = at the anterior margin of the foramen ovale, medial to the anteromedial strut of the alisphenoid tympanic process

3 = confluent with the sulcus towards the transverse canal, both directed towards the foramen for the greater petrosal nerve

4 = closed ventrally by a medially directed bony ridge with origin on the groove's lateral margin

5 = directed towards the aperture between the anteromedial flange of the petrosal and the basisphenoid

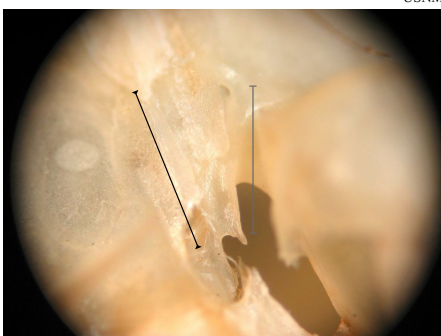
Figure 4.3.9. MC27/CIB021) Topological configuration of the narrow groove on the basisphenoid leading to the posterior opening of the pterygoid canal:



0 = lateral to the carotid foramen. *M. adusta* USNM588019

1 = at the anterior margin of the foramen for the greater petrosal nerve, with a sulcus just slightly interrupted by a protuberance lateral to the carotid foramen. *M. osgoodi* USNM582110

2 = at the anterior margin of the foramen ovale, medial to the anteromedial strut of the alisphenoid tympanic process. *M. americana* USNM552401



3 = confluent with the sulcus towards the transverse canal, both directed towards the foramen for the greater petrosal nerve. *M. domestica* USNM390566



4 = closed ventrally by a medially directed bony ridge with origin on the groove's lateral margin. *M. emiliae* USNM461884

4.1.3. Orbitosphenoid – os

The paired orbitosphenoid has a small exposure in the medial orbital wall anterodorsal to and continuous with the presphenoid. It contributes to the walls of the ethmoidal foramen anteriorly and the sphenorbital fissure posteriorly (Wible 2003, p. 151). Even though the ethmoidal foramen and the sphenorbital fissure were categorized in the group of foramina bilaterally present in all specimens that exhibit no significant variation by Wible (2003), I found the variation detailed below.

4.1.3.1. Sphenorbital fissure – sof and foramen rotundum – fro

In therians, the term sphenorbital fissure has been employed for the large gap in the medial wall of the orbit between the orbitosphenoid and alisphenoid that transmits nerves and vessels from the cavum epiptericum (Gregory, 1910; McDowell, 1958; Archer, 1976 in Wible 2003). Both the sphenorbital fissure and, posterior to it, the much smaller foramen rotundum are incorporated in the cavum epiptericum space (Kuhn and Zeller 1987 and Novacek 1993 in Macrini 2007; Wible 2003). The nervous and vascular contents of this opening vary dramatically among extant therians. In marsupials, the usual contents are the optic, oculomotor, trochlear, ophthalmic, and abducens nerves, and the ophthalmic artery and veins (Kuhn and Zeller, 1987; Wible and Rougier, 2000). In *Monodelphis brevicaudata* CM 52729 (Fig. 4) and the remainder of the CM sample, the large, ovoid, anterolaterally directed sphenorbital fissure is situated between the orbitosphenoid, alisphenoid, pterygoid, palatine, and presphenoid. As is usual in metatherians (Rougier *et al.*, 1998), *Monodelphis* lacks a separate optic foramen for the optic nerve in the orbitosphenoid (Wible 2003). The circular, anteriorly directed foramen rotundum are at the root of the anterior process of the alisphenoid and are mostly hidden in lateral view (Wible 2003, p. 153). The foramen rotundum is the exit of the maxillary branch of the trigeminal nerve (V2) (Macrini 2007).

MC28 / CIB022) Development of the dorsolateral wall of the foramen rotundum relative to the sphenorbital fissure (Fig. 4.3.10):

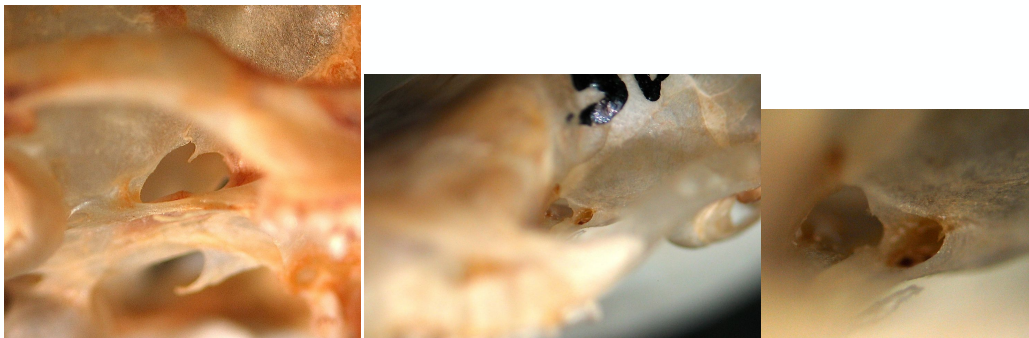
0 = rudimentary

1 = well developed, but does not or barely reaches lateral wall of sphenorbital fissure

2 = well developed, continuous with lateral wall of sphenorbital fissure

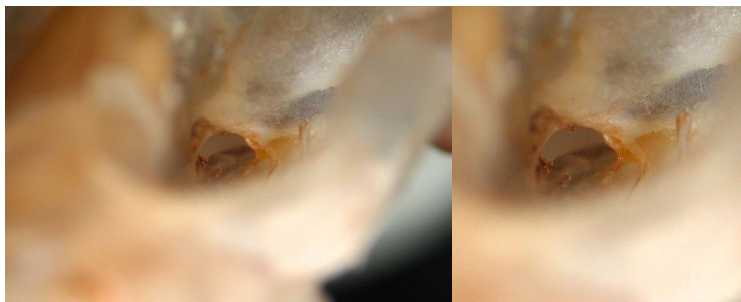
This character coincides in part with Voss & Jansa's (2009) Character 50. Their character deals with the exposition of the foramen rotundum laterally, where their state 0 (laterally exposed) should coincide with my state 0. However, it is difficult to say if both my characters 1 and 2 are equivalent to their character 1 (concealed, partly or wholly confluent with sphenorbital fissure), because even though I describe the degree of development of the foramen rotundum's dorsolateral wall towards the sphenorbital fissure, the exposition itself depends on the development and shape of the foramen rotundum's wall.

Fig. 4.3.10. MC28 / CIB022) Development of the dorsolateral wall of the foramen rotundum relative to the sphenorbital fissure:



0 = rudimentary. *M. americana* UnB70

1 = well developed, but does not or barely reaches lateral wall of sphenorbital fissure. *M. osgoodi* USNM582110



2 = well developed, continuous with lateral wall of sphenorbital fissures. *M. adusta* USNM588019.

MC29 / CIB023) Development of the suture formed by the orbitosphenoid and the alisphenoid at the level of the sphenorbital fissure:

0 = smooth

1 = raised but not to the point of forming a ridge

2 = raised with a larger contribution by the orbitosphenoid, such that the orbitosphenoid's contribution to the ridge overlies the alisphenoid midway posteriorly only, that is, not throughout suture

3 = ridge along orbitosphenoid and alisphenoid suture from dorsal limit until lateral margin's ridge

4 = raised with a larger contribution by the alisphenoid, such that the alisphenoid's contribution to the ridge overlies the orbitosphenoid midway posteriorly

MC30 / CIB024) Shape of the sphenorbital fissure given by the posterior limit of the suture formed by the orbitosphenoid and the alisphenoid:

0 = flat

1 = posteroventrally directed orbitosphenoid process present

2 = the orbitosphenoid interlocks with the alisphenoid posteriorly, alisphenoid makes posterior limit and is salient

3 = orbitosphenoid is salient

4 = ridge formed by the alisphenoid / orbitosphenoid suture is present

Wible (2003) characterized the sphenorbital fissure as ovoid in shape. My shape description for the sphenorbital fissure is not comparable because I found these other points of reference as shape descriptors.

MC31 / CIB025) Development of the dorsolateral margin of the sphenorbital fissure:

0 = simple dorsolateral margin

1 = developed into a roughly anteroposteriorly directed canal

The sphenorbital fissure presents either a simple lateral margin, which itself shapes the anteromedial margin of the foramen rotundum's medial wall, or a lateral

wall which extends posteriorly intracranially, in which case yielding a canal with two outlets, a extra and an intracranial one.

MC32M, MC33F / CIB026) Direction of the sphenorbital fissure:

0 = anterior, slightly laterally

1 = anterior, slightly ventrolaterally

2 = anteroventrolaterally

3 = anterolaterally

4 = anterior, slightly dorsally

5 = anterior

Potentially sexually dimorphic trait.

One can well characterize direction with a photograph. Lack of a tunnel or recession on sphenorbital fissure gives more space for direction interpretation, while recession makes direction classification more accurate. Wible (2003) found the sphenorbital fissure to be directed anterolaterally.

MC34 / CIB027) Visibility in ventral view of the posterolateral margin of the sphenorbital fissure:

0 = not visible

1 = visible

4.1.3.2. Ethmoidal foramen – ef

The ventrally directed ethmoidal foramen lies in the suture between the frontal and orbitosphenoid, with the anteroventral part of the orbitosphenoid forming the medial wall and the posterodorsal part the posterior and posterolateral walls. Running ventrally from the posterior half of the ethmoidal foramen onto the anteroventral part of the orbitosphenoid is a distinct sulcus that curves posteriorly (Wible 2003, p. 151).

MC35 / CIB028) Position of the ethmoidal foramen:

0 = right at juncture between, anteroposteriorly (frontal/ orbitosphenoid / alisphenoid), barely separated from the alisphenoid by very narrow protrusions of

frontal (directed posteroventrally) and, sometimes, of orbitosphenoid (directed anterodorsally)

1 = right at juncture between, anteroposteriorly (frontal/ orbitosphenoid / alisphenoid), barely separated from the alisphenoid by a very narrow slab of the orbitosphenoid directed anterodorsally

2 = the orbitosphenoid separates the ethmoidal foramen from the alisphenoid by a conspicuous anterodorsally directed slab

3 = at suture between the frontal and the orbitosphenoid, completely separated from the alisphenoid by the orbitosphenoid

4.1.4. Basioccipital – bo

“The basioccipital forms the skull base between the petrosals and the anteroventral border of the foramen magnum. It is roughly hexagonal with five straight sides ...and a posterior sixth side that is indented by the intercondyloid notch. ...The anterolateral side abuts the petrosal promontorium except at its posterior end where there is a gap between the petrosal, basioccipital, and exoccipital for the passage of the inferior petrosal sinus.” (Wible 2003, p. 166)

MC36 / CIB029) Development of the lateral margins of the basioccipital:

0 = project only slightly ventrolaterally

1 = Project abruptly ventrally, with a square edge (cliff like)

2 = project ventrally buldging conspicuously

This character addresses the development of a floor for the inferior petrosal sinus, provided medially by the basioccipital. Where it abuts the petrosal promontorium, in some *Monodelphis* species this border presents a good degree of inflation (*M. palliolata* (AMNH144834), *M. brevicaudata* from the Tapajós-Xingu Moist forests (AMNH94902), *M. dimidiata* (AMNH208970), *M. emiliae* from Peru (FMNH58955), *M. scalops* from Minas Gerais (MN32166).

MC37 / CIB030) Presence of anterolateral processes on the basioccipital:

0 = absent

1 = present, directed anteromedially overlying the basisphenoid

4.2. ALISPHENOID – as

“The paired alisphenoid bones are situated on either side of the basisphenoid and contribute to the side wall of the braincase, the skull base in front of the ear region, and the auditory bulla. The alisphenoids are fused seamlessly with the basisphenoid.” (Wible 2003, p. 152). The alisphenoid entirely encloses the foramen rotundum (Wible 2003, p. 153). The posterior section of the alisphenoid contributes greatly to the auditory bulla through the alisphenoid tympanic process.

4.2.1. Foramen rotundum – fro

MC38 / CIB031) Presence of an extracranial dorsal wall of the foramen rotundum (Fig. 4.3.11.):

0 = absent or rudimentary

1 = present, so canal conspicuous dorsally

State 1 of this character is one of the three synapomorphies giving support to the clade of node 30, containing *brevicaudata* species group, *M. domestica*, and the sister group *M. kunsi* and the *adusta* species group. However, *M. kunsi* could not be coded for this character.

Fig. 4.3.11. MC38 / CIB031) Presence of an extracranial dorsal wall of the foramen rotundum:



0 = absent or rudimentary. *M. adusta* USNM588019

1 = present, so canal conspicuous dorsally. *M. domestica* USNM390566

MC39 / CIB032) Direction of the foramen rotundum:

0 = anterior

1 = anterior, and slightly medial

2 = anteromedial

Wible (2003) described the foramen rotundum as being anteriorly directed, however these additional two states were detected in the sample at hand.

MC40 / CIB033) Visibility of posterolateral margin of the foramen rotundum in ventral view:

0 = not visible

1 = visible

I only considered visible when one can see it until posteriormost limit.

4.2.2. Foramen ovale – fo and foramen for the greater petrosal nerve – fgpn

Wible (2003) described *Monodelphis breviceaudata*'s foramen ovale, located between the alisphenoid and the lateral edge of the anteromedial flange of the promontorium of the petrosal. It is incorporated in the cavum epitericum space posterior to the sphenorbital fissure and the foramen rotundum (Macrini 2007). The didelphid foramen ovale transmits the mandibular division of the trigeminal nerve (Maier, 1987a; Wible, unpubl. observ.).

Medially, the foramen ovale is continuous with a smaller opening, the foramen for the greater petrosal nerve, between the anterior edge of the anteromedial flange and the basisphenoid. The foramen for the greater petrosal nerve (median lacerate foramen of Marshall and Muizon, 1995) transmits the greater petrosal nerve, a branch of the facial nerve, from the hiatus Fallopii to the posterior opening of the pterygoid canal (Wible 2003).

MC41 / CIB034) Posterior shape of the foramen ovale:

0 = posterolateral opening shaped by an incomplete juncture of the alisphenoid hypotympanic sinus with the anterolateral shelf of the anteromedial flange of the petrosal

1 = posterolateral opening shaped by a complete juncture between the alisphenoid hypotympanic sinus and the anterolateral shelf of the anteromedial flange of the petrosal

- = posterior margin of the foramen ovale not shaped by the alisphenoid hypotympanic sinus and the anteromedial flange of the petrosal, but by the anteromedial strut of the alisphenoid tympanic process.

MC42 / CIB035) Anterior shape of the foramen ovale:

0 = round

1 = pointy

2 = indented

MC43 / CIB036) Presence of sulci with origin in the foramen ovale:

0 (Wible 03) = "Leaving the anterior end of the foramen ovale and directed ventrolaterally is a sulcus, partly on the skull base and partly on the tympanic process" (*M. Wible 03*) and no other sulci leaves the foramen ovale

1 = like state "0" but with a 2nd sulcus leaving the anteromedial end of the foramen ovale that is directed towards the transverse canal foramen.

2 = like state "0" but with a 2nd sulcus from the transverse canal foramen, which is shared posteriorly with the foramen ovale laterally and with the foramen for the greater petrosal nerve medially, variably coinciding with the pterygoid canal sulcus

3 = like state "1" but with a 3rd sulcus that runs alongside the pterygoid

Three patterns can be observed when coding this character: 1) There are no other sulci directed towards the foramen ovale besides its own; 2) There are one or more sulci directed posteriorly towards the foramen ovale, but when they reach the foramen ovale's own sulcus, they disappear. I assume that the vessels then occupy the foramen ovale's own sulcus, but not positioned such that they leave an imprint

at the basicranial bone; and 3) there are one or more sulci directed posteriorly towards the foramen ovale, which leave a distinct imprint as additional sulci on the foramen ovale's own sulcus.

MC44 / CIB037) Development of the contact between the foramen ovale and the foramen for the greater petrosal nerve (Fig. 4.3.12):

0 (Wible 03) (Marshall and Muizon, 1995) = no contact separate

1 (Wible 03) = foramen ovale "continuous medially" with the foramen for the greater petrosal nerve, but "nearly closed off from the foramen ovale by prongs extending posteriorly from the sphenoid and anteriorly from the petrosal"

2 (Wible 03) = foramen ovale "continuous medially" with the foramen for the greater petrosal nerve, foramen for the greater petrosal nerve well distinguished from the foramen ovale

3 (Wible 03) = foramen ovale "continuous medially" with the fgpn, but "shallow foramen for the greater petrosal nerve that is barely recognizable as separate from the foramen ovale"

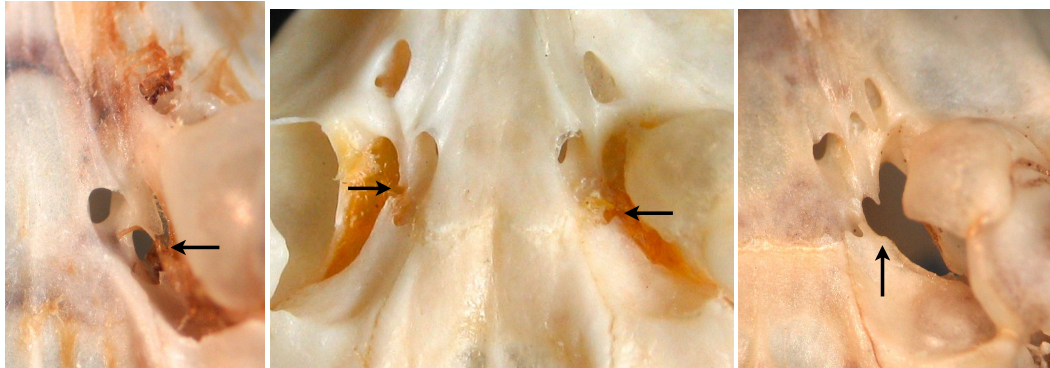
Wible (2003) reported that at one extreme are some *M. brevicaudata* (e.g., CM8019, CM80021) and *M. domestica* (e.g., CM63510) in which the foramen for the greater petrosal nerve is nearly closed off from the foramen ovale by prongs extending posteriorly from the sphenoid and anteriorly from the petrosal, and at the other extreme are the two *M. osgoodi* (CM5242, CM5248) with an extremely shallow foramen for the greater petrosal nerve that is barely recognizable as separate from the foramen ovale. (pg. 172, Wible 2003).

MC45 / CIB038) Presence of a sulcus leaving the foramen for the greater petrosal nerve:

0 = absent

1 = present

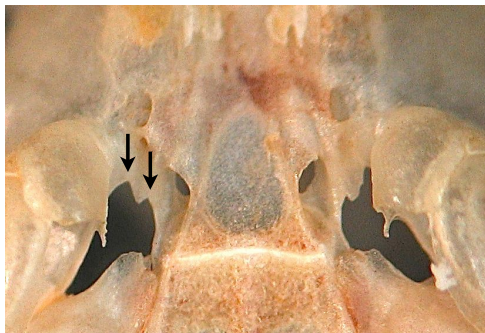
Fig. 4.3.12: MC44 / CIB037) Development of the contact between the foramen ovale and the foramen for the greater petrosal nerve:



0 (Wible 03) (Marshall and Muizon, 1995)
= no contact separate. *M. americana*
USNM552402

1 (Wible 03) = foramen ovale "continuous medially" with the foramen for the greater petrosal nerve, but "nearly closed off from the foramen ovale by prongs extending posteriorly from the sphenoid and anteriorly from the petrosal." *henseli* species group USNM460504

2 (Wible 03) = foramen ovale "continuous medially" with the foramen for the greater petrosal nerve, foramen for the greater petrosal nerve well distinguished from the foramen ovale. *M. brevicaudata* USNM385010



3 (Wible 03) = foramen ovale "continuous medially" with the fgpn, but "shallow foramen for the greater petrosal nerve that is barely recognizable as separate from the foramen ovale." *M. osgoodi* USNM582110

MC46 / CIB039) Morphological configuration of the sulcus leaving the foramen for the greater petrosal nerve:

0 = sulcus leaves the anterolateral end of the foramen for the greater petrosal nerve, directed towards the transverse canal foramen and the pterygoid canal

1 = sulcus leaves the anterior end of the foramen for the greater petrosal nerve, directed towards pterygoid canal only

2 = sulcus from the pterygoid canal is shared posteriorly between the secondary foramen ovale laterally and the foramen for the greater petrosal nerve medially

3 = sulcus leaves the anterolateral end of the foramen for the greater petrosal nerve, directed towards the transverse canal foramen only

4 = sulcus leaves the anterior end of the foramen for the greater petrosal nerve, directed anteroventromedially towards the carotid foramen.

MC47 / CIB040) Presence of the secondary foramen ovale (Fig. 4.3.13):

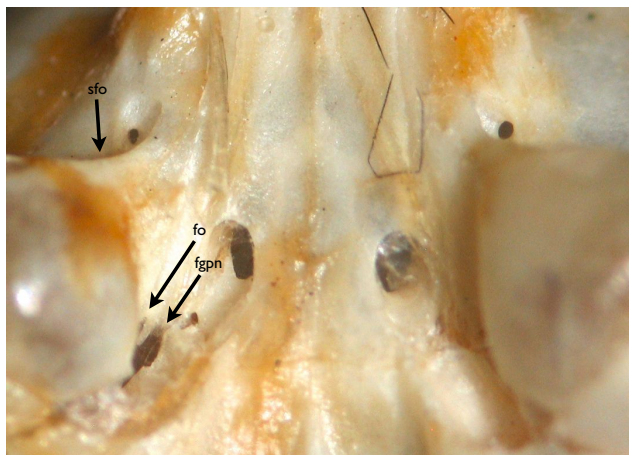
I here restrict the “secondary foramen ovale” to the opening extracranially separated from both the foramen ovale, by the alisphenoid tympanic process strut (as in Voss & Jansa 2009), and the foramen for the great petrosal nerve, by prongs of the basisphenoid and/or the anteromedial flange of the promontorium.

0 = absent (Wible 03)

1 = present

Fig. 4.3.13: MC47 / CIB040) Presence of the secondary foramen ovale:

I here propose the term “secondary foramen ovale” for the opening extracranially separated from both the foramen ovale (by the alisphenoid tympanic process strut) and the foramen for the great petrosal nerve (by prongs of the basisphenoid and/or the anteromedial flange of the promontorium).



4.2.3. Glenoid process of the alisphenoid – gpas

MC48 / CIB041) Contact between the glenoid process of the alisphenoid and the glenoid process of the jugal:

0 (Wible 03) = do not contact

1 = contact, such that the squamosal contribution to the glenoid fossa does not reach the latter's anterior margin

Wible's sample (2003 p. 147) allowed him to assert that “the glenoid process of the jugal approximates but does not touch the glenoid process of the

alisphenoid.” However, I found contact among the jugal and the alisphenoid contributions to the glenoid process in *M. americana* and in *M. brevicaudata*.

4.2.4. Alisphenoid tympanic process – astp

“All didelphids have an osteologically well-defined middle ear cavity or hypotympanic sinus” (van der Klaauw 1931 in Voss & Jansa 2009). The alisphenoid tympanic process projects ventrally from the posteroventral margin of the alisphenoid medial to the glenoid fossa, and curves posteriorly, cupping the ectotympanic bone and forming the anterior wall and floor of the auditory bulla. The posterolateral border of the tympanic process abuts the ectotympanic and anterior process of the malleus, while the posteromedial border has a distinct notch that marks the passage of the auditory or eustachian tube (Wible 03 p.153). The external acoustic meatus is partially open around 28-30 postnatal age (Reimer 1996 and Aitkin *et al.* 1997 in Macrini 2007).

Macrini (2007) found that the tympanic process of the alisphenoid is relatively larger in *M. domestica* in comparison to *D. virginiana* resulting in a relatively larger and more anteriorly expansive tympanic cavity in *M. domestica*. The relatively large tympanic cavity accounts for a broad indentation on the posterolateral surface of the cast of the piriform lobe of the cerebrum in *M. domestica*, absent on the endocast of *D. virginiana*. Voss & Jansa (2009) found that the alisphenoid tympanic process exhibits significant taxonomic variation in size at the family level. This was also true within the *Monodelphis* sample studied here.

4.2.4.1. Alisphenoid tympanic process – astp, ventral view

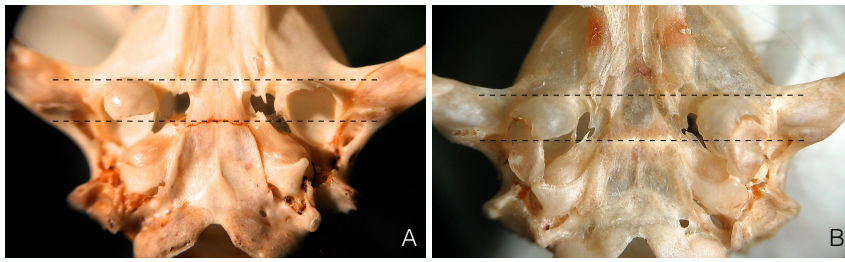
MC49 / CIB042) Length of the alisphenoid tympanic process (Fig. 4.3.14):

0 = short (anterior limit posterior to anterior limit of glenoid fossa; posterior limit anterior to or at basioccipital / basisphenoid suture)

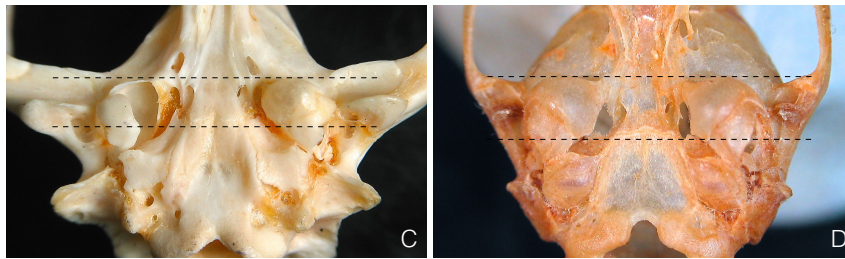
1 = medium (anterior limit posterior to anterior limit of glenoid fossa; posterior limit posterior to basioccipital/basisphenoid suture)

2 = long (anterior limit anterior to or at anterior limit of glenoid fossa; posterior limit posterior to basioccipital/basisphenoid suture)

Fig. 4.3.14. MC49 / CIB042) Length of the alisphenoid tympanic process.



0 = short (anterior limit posterior to anterior limit of glenoid fossa; posterior limit anterior to or at basioccipital / basisphenoid suture). Fig. 4D11 A: *M. domestica* USNM293130; Fig. 4D11 B: *M. brevicaudata* USNM546197.



1 = medium (anterior limit posterior to anterior limit of glenoid fossa; posterior limit posterior to basioccipital/basisphenoid suture). Fig. 4D11 C: *M. henseli* USNM460504.

2 = long (anterior limit anterior to or at anterior limit of glenoid fossa; posterior limit posterior to basioccipital/basisphenoid suture). Fig. 4D11 D: *M. americana* UnB170.

It is interesting to notice the variant *M. adusta* AMNH139227, with short alisphenoid tympanic process but anteriorly positioned, that is, with the anterior limit equivalent to the anterior limit of the glenoid fossa and the posterior limit anterior to the basioccipital/basisphenoid suture.

State 2 of this character is one of the three synapomorphies giving support to node 36, a group including *M. emiliae* and all the species of the *americana* group analysed. State 0 is a synapomorphy of the clade at node 30, containing *brevicaudata* species group, *M. domestica*, *M. kungsi* and *adusta* species group.

MC50 / CIB043) Presence of an apex line, which divides the alisphenoid tympanic process into two planes:

0 = absent

1 = present

The apex line is discernable in almost all taxa and specimens, except ones with very irregular-shaped or not cup-like alisphenoid tympanic process, like *Marmosops* UnB448.

MC51M, MC52F / CIB044) Shape, in occlusal view, of the alisphenoid tympanic process:

0 = compressed posterolaterally-anteromedially

1 = round

2 = compressed posteromedially-anterolaterally

3 = compressed antero-posteriorly

Potentially sexually dimorphic trait.

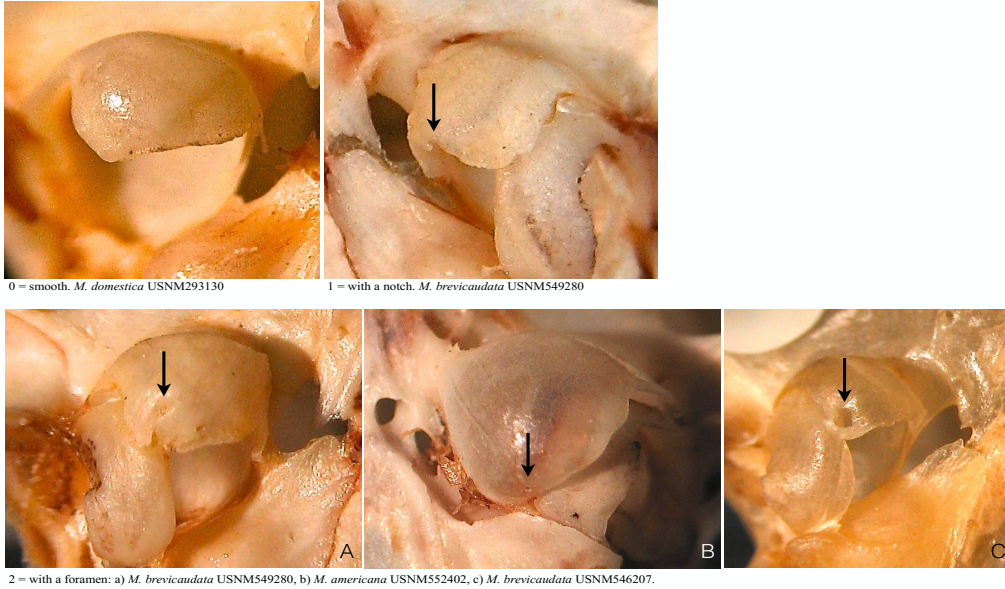
The presence of state 2 in the female *M. scalops* MZUSP1528, only representative of São Paulo with locality of collection closest to the male MN6419, both from the ecoregion NT0160 (Serra do Mar Coastal forests; Mustrangi & Patton Serra do Mar), was recovered as the single synapomorphy for the grouping of *M. scalops* to a clade containing the sister group *M. americana* and *M. emiliae*. State 1 is one of the four synapomorphies giving support to the sister group relationship among *Monodelphis* and *Marmosa*.

MC53 / CIB045) Shape, in ventral view of the alisphenoid tympanic process:

0 = with the shape of an incomplete cup (irregular posteromedial border does not reach apex line in its entirety, or it reaches it but does not extend beyond it posteriorly in its entirety)

1 = with the shape of a complete cup (posteromedial border approximately straight, and extends beyond apex line posteriorly)

Fig. 4.3.15: MC54 / CIB046) Ventromedial margin of the alisphenoid tympanic process:



MC54 / CIB046) Ventromedial margin of the alisphenoid tympanic process (Fig. 4D12 4.3.15):

0 = smooth

1 = with a notch

2 = with a foramen

Wible (2003, p. 184) called attention to a small opening in the ventromedial margin of the tympanic process in the left alisphenoid in *M. brevicaudata* CM 52729, with only a notch on the right side. He raised the possibility that “these are not true foramina, but merely unossified areas in the auditory bulla,” based on the seemingly erratic distribution of this anatomical feature: *M. brevicaudata* “CM 76732 has a small opening on the right side only, CM 4681 has three small openings on the left side only”. None of the specimens studied herein presented more than one foramen, when present. Of the 12 specimens of *M. brevicaudata* sampled for this character, 4 presented a notch or a foramen, and 2 presented them unilaterally. A foramen was also present in a *M. americana* specimen.

4.2.4.2. Alisphenoid tympanic process – astp, lateral view

MC55 / CIB047), Size, on lateral view, of the alisphenoid tympanic process relative to the ectotympanic ventral surface:

0 = little inflated, approximately level with the ectotympanic

1 = inflated, conspicuously more ventral than ectotympanic

MC56 / CIB048) Closure in lateral view perpendicular to apex line of the alisphenoid tympanic process:

0 = encapsulates

1 = opens posteroventrally

State 1 of this character is the synapomorphy that gives support for the clade at node 28 containing *M. kungsi* and the *adusta* species group.

MC57 / CIB049) Shape in lateral view perpendicular to apex line of the alisphenoid tympanic process:

0 = round

1 = pointy

2 = slightly squared

State 0 is one of the four synapomorphies giving support to the sister group relationship among *Monodelphis* and *Marmosa*.

MC58 / CIB050) Slant of anterior wall of the alisphenoid tympanic process, as estimated by the angle it makes with the horizontal plane, in lateral view:

0 = posterior, angle greater than 90°

1 = approximately perpendicular to horiz plane, projects straight ventrally

2 = anterior, angle below 90°

4.2.4.3. Alisphenoid tympanic process – astp, anteromedial strut

MC59 / CIB051) Presence of the anteromedial strut of the alisphenoid tympanic process:

0 = absent, or rudimentary at most (that is, just a small elevation that can be rounded like a mound or pointy, but not a process)

1 = present

MC60 / CIB052) Development of the anteromedial strut of the alisphenoid tympanic process:

0 = does not contact alisphenoid

1 = present, fuses completely with the alisphenoid, but not developed in width (does not extend posteriorly)

2 = present, fuses completely with the alisphenoid, and extends posteriorly continuous with almost the entire medial wall of the alisphenoid tympanic process, resulting in an almost full additional floor and medial wall to the foramen ovale.

The two previous characters represent a different perspective of the morphological variation of the alisphenoid tympanic process than that made by Voss & Jansa (2009, Fig. 16), who interpreted it in light of the secondary nerve enclosure condition. Their Character 73 state 0 is equivalent to MC59 state 0 above. Their state 1, however, is equivalent to both MC59 state 1 and MC60 states 1 and 2. Voss & Jansa's (2009) character 74 addressed the contact between the posterior extension of the alisphenoid tympanic process as described in the state 2 of my character 60 with the rostral tympanic process of the petrosal. Even though my observations agree with theirs in that a "distinct gap separates the alisphenoid tympanic process from the rostral tympanic process of the petrosal, such that at least part of the floor of the middle ear is membranous in *Monodelphis*, the extent of the posterior extension of the alisphenoid tympanic process presents a constant variation intergenerically as well.

4.2.4.4. Alisphenoid tympanic process – astp, glaserian fissure – glf

Wible (2003) described in the posteroventrolateral margin of the alisphenoid tympanic process a small opening of unknown function on the left side of *M. brevicaudata* CM52729 that is a notch on the right side. “Lateral to this notch on the right side, opposite the ventral end of the anterior process of the malleus is a faint notch leading to a short sulcus on the extratympanic surface of the tympanic process. The left side has no notch or sulcus, but only a gap. In other specimens (e.g. *M. domestica* CM80016), this notch is closed to a foramen.” He interpreted the gap, notch, and foramen as for the chorda tympani nerve, a branch of the facial nerve that exits the middle ear and enters the infratemporal fossa. “The gap, notch, or foramen for the chorda tympani is a glaserian fissure, which in placentals typically lies near the juncture of the petrosal, ectotympanic, squamosal, and alisphenoid (Klaauw, 1931 in Wible 2003). ...According to Klaauw (1931:p. 164), the fissura Glaseri develops first as an aperture in the anterior wall of the presumptive auditory bulla transmitting Meckel’s cartilage, which disappears later in development. Later on we find the chorda tympani nerve in it and often also the ramus inferior of the stapedia artery. As the components of the auditory bulla vary in mammals (Klaauw, 1931; Novacek, 1977), so do the components forming the glaserian fissure.” Wible (2003) identified the glaserian fissure in *M. brevicaudata* as a small notch or gap in the posteroventrolateral margin of the alisphenoid tympanic process, opposite the ventral end of the anterior process of the malleus. Given that the ramus inferior is not present in marsupials (Wible, 1987), the chorda tympani is the sole occupant of this notch (Wible 2003). “Rather than a notch or gap, some CM specimens have a small foramen distributed as follows. In *M. brevicaudata*, a foramen is absent bilaterally or present on one side only. In *M. domestica*, the foramen is absent bilaterally, present on one side only, or present bilaterally. In *M. dimidiata*, the foramen is absent bilaterally or present bilaterally. Finally, the foramen is absent in the one *M. osgoodi* (CM5242) that could be sampled.” (Wible 2003, p. 174) The glaserian fissure was clearly identified as Wible’s (2003) characterization in the *Monodelphis* sample studied here, presenting the following plausibly sequential pattern of development.

MC61 / CIB053) Configuration of the glaserian fissure at the posterolateral margin of the alisphenoid tympanic process:

0 = continuous, or in the shape of a gap, but uninterrupted by notch or a process, nor with a foramen immediately anteromedial to malleus.

1 = presenting a notch, the dorsolateral margin of which forms a lateral process that is directed posteroventrolaterally.

2 = presenting a notch and a lateral process, the latter is directed posteroventrally in a curve so that it overlies the posterolateral margin of the astp; sometimes fusing with it, yielding an aperture.

3 = continuous, but with a foramen immediately anteromedial to / opposite the malleus, the bone tissue around which showing no trace of bone fusion or overlap.

An increased degree of development of the glaserian fissure was neither observed in any specimen of the *adusta* species group nor in *M. kungsi*.

4.2.5. Roof of the alisphenoid hypotympanic sinus – rashes

The roof of the middle ear cavity in all Recent didelphids is almost exclusively formed by the alisphenoid, with the petrosal making only a small contribution (Voss & Jansa 2009). *Monodelphis* presents variation in the shape of the roof of the alisphenoid hypotympanic sinus as well as the angle it makes with the horizontal plane.

MC62 / CIB054) Shape of the roof of the alisphenoid hypotympanic sinus:

0 = strongly concave

1 = flattened, with a distinct posterior slant

MC63M, MC64F / CIB055) Slant of the roof of the alisphenoid hypotympanic sinus with reference to the horizontal plane:

0 = posteriorly deep: slant between 30° and 45° or more

1 = posteriorly shallow: up to 20° slant.

Potentially sexually dimorphic trait.

4.3. ECTOTYMPANIC – ec

The horse-shoe shaped ectotympanic is exposed in ventral view posterior to the alisphenoid tympanic process and anterior to the rostral tympanic process of the petrosal. Voss & Jansa (2009) pointed out that “in all didelphids with an indirect dorsal connection between the ectotympanic [anterior (dorsal) crus] and the skull, the tympanic annulus is more or less ringlike because the posterior (ventral) limb [crus] is not expanded to form part of the floor of the middle ear cavity. By contrast, in some taxa with direct ectotympanic suspension [attachment to the skull], the posterior limb tends to be dorsoventrally flattened and laterally expanded, forming part of the floor of the external ear canal to a greater or lesser extent.” Based on the CM sample, Wible (2003) described the anterodorsal leg or crus of the ectotympanic as narrow, with a broad contact with the squamosal, medial to the postglenoid foramen. “Anteroventral to the squamosal, the anterior crus has a narrow contact with the alisphenoid tympanic process. At the ventral base of the anterior crus, the anterior surface of the ectotympanic is covered by the anterior process of the malleus, which also contacts the alisphenoid tympanic process.”

Posterior to the alisphenoid tympanic process, the posterior leg or crus of the ectotympanic is broadened and abuts the rostral tympanic process of the petrosal distally. (Wible 03 p. 156)

All specimens of *Monodelphis* studied present a laterally expanded posterior crus of the ectotympanic, yet not all have a process at the lateral expansion. I take *Didelphis* as the standard for the absence of the lateral expansion. Its ectotympanic does widen a little approximately at the juncture of the anterior and the posterior crura, but this wider part is not conspicuous, neither as an expansion nor as a process. In *Caluromys*, there is no lateral surface which can be recognized as an expansion, but a lateral process is conspicuous.

The series of characters presented below illustrates the great extent of independent variation in lateral and medial expansion of the ectotympanic posteroventral crus, thus their contribution to the floor of the external ear canal. The greater the development of the lateral expansion of the ectotympanic posterior crus and depending of the angle of its development, the more the slight resemblance to a

tubelike morphology of the ear canal, which would be interesting to compare with that of Recent diprododontians (Aplin 1990 in Voss & Jansa 2009) and understand the function of such phenotype.

4.3.1. Contribution to the ossification of the bulla floor by the expansion and inflation of the ectotympanic – ec

MC65 / CIB056) Presence of a medial expansion of the ectotympanic posterior crus:

0 = absent

1 = present

MC66 / CIB057) Shape of the medial expansion of the ectotympanic posterior crus:

0 = rounded

1 = gradually widening posteriorly

2 = triangular with sharp edge anteriorly

3 = triangular obtuse with rounded edges

7 = triangular with round medial edge

4 = quadrangular with rounded edges

5 = sharp edged anteriorly, rounded posteriorly

6 = with three processes: anteromedial, medial, posteromedial

The state 2 of this character is one of three synapomorphies supporting node 36, a clade containing *M. emiliae* with all species of the *americana* group analysed.

MC67M, MC68F / CIB058) Size of the medial expansion of the ectotympanic posterior crus:

0 = extends the entire length of what is visible of the ectotympanic ventrally

1 = restricted to the posterior portion of the ectotympanic

Potentially sexually dimorphic trait.

MC69 / CIB059) Presence of a lateral expansion of the ectotympanic posterior crus:

0 = absent

1 = present

MC70 / CIB060) Presence of a lateral process at the lateral expansion of the ectotympanic posterior crus:

0 = with no lateral process

1 = with lateral process

MC71 / CIB061) Angle of the lateral expansion of the ectotympanic posterior crus with the ectotympanic's long axis:

0 = $< 30^\circ$

1 = $> 45^\circ$

Measurement was made on posteroventral view from the ectotympanic axis up towards the posterolateral end of the lateral expansion. Possibly also informative is the angle it makes anterior to the ectotympanic's lateral expansion posterior process. For example, in *M. brevicaudata*, the process makes a large angle (about 60°), but anterior to it the lateral expansion closes a lot. In the *americana* species group and the *henseli* species group, it seems that it's open posteriorly and anteriorly. It can actually be measured on ventral view with photographs, taking the apex line as axis. To code the *americana* species group for this character, the inside view of the ectotympanic is needed as reference for the identification of the axis. State 1 of this character is one of the three synapomorphies of node 32 that gives support for the monophyly of the genus *Monodelphis*.

MC72 / CIB062) Thickness of the ectotympanic posterior crus:

0 = thick, completely opaque

1 = thin, translucent

MC73M, MC74F / CIB063) Length of the lateral expansion of the ectotympanic posterior crus:

0 = extends the entire length of what is visible of the ectotympanic in place: from just ventral to contact with squamosal to extreme posterior limit of ectotympanic.

1 = restricted to the posterior portion of the ectotympanic

2 = extends from just ventral to contact with squamosal but does not reach extreme posterior limit of ectotympanic

Potentially sexually dimorphic trait.

4.3.2. Ectotympanic shape

MC75M, MC76F / CIB064) Ventral convex surface of the posterior crus of the ectotympanic:

0 = smooth and homogeneous

1 = with a median dark line that is not salient

2 = with a median ridge

Potentially sexually dimorphic trait.

The ventral line or ridge observed is equivalent topologically or just medial to the dorsal sulcus tympanicus, the groove channeling the inner circumference of the ectotympanic to which the tympanum, the tympanic membrane connecting with the malleus, attaches (Wible 2003 p. 156). Wible (2003) observed that the sulcus tympanicus lies on the extreme medial edge of the bone in the CM sample, and concluded that “the expansion of the posterior crus is lateral to the tympanum attachment and contributes to a floor for the external acoustic meatus.” In the *Monodelphis* sample studied here, expansions both medial and lateral to the sulcus tympanicus were present to several degrees of development.

MC77 / CIB065) Articulation of the posterior crus of the ectotympanic with the rostral tympanic process of the petrosal:

0 = does not articulate with it

1 = articulates with it.

MC78 / CIB066) Position of the articulation of the posterior crus of the ectotympanic with the rostral tympanic process of the petrosal:

0 = at ectotympanic's posterior process

1 = anteromedial to the ectotympanic posterior limit

Three patterns of articulation were observed. In the first, the articulation begins medially with process at the posterior-most end of the ectotympanic's (main point of articulation) and extends up to 1/3 of the ectotympanic's posteromedial margin, gradually being substituted by connective tissue, with the rostral tympanic process of the petrosal's lateral process overlapping (e.g. *M. henseli* brevicaudis CTX3358 and MHNCI1104). In the second pattern, having no process, the articulation is at the posteromedial portion of the ectotympanic's surface medial to the ectotympanic's medial line, articulating just a little more anteriorly of the rostral tympanic process of the petrosal's lateral process (e.g. *M. iheringi* MZUSP873). The last pattern is a wide surface of articulation, where half of the rostral tympanic process of the petrosal's anterior margin overlaps approximately 3/4 of the ectotympanic's posteromedial margin (e.g. *M. emiliae* INPA3040).

As mentioned by Voss & Jansa (2009), didelphids were described by van der Klaauw (1931: 26) as having a completely free ectotympanic. These authors recognized in Didelphidae two distinct patterns of ectotympanic attachment at its anterior crus. In their character 78, all *Monodelphis* species were coded with state 0 (anterior limb of ectotympanic directly attached to skull). Even though I did not address the anterior crus of the ectotympanic, an additional pattern of ectotympanic attachment was observed within *Monodelphis*, that of the posterior crus of the ectotympanic with the rostral tympanic process of the petrosal.

4.4. PETROSAL - pe

The petrosal is very informative in evolutionary biology. Because it is among the densest bones in the body, it is relatively very abundant in the fossil record and of the best preserved elements in specimens of the recent fauna (e.g. Wible 1990). In addition, the early developmental maturation of the mammalian ear region yields a

system with low ontogenetic confounding factor in systematic research (e.g. Ekdale 2010). “The paired petrosal bones enclose the organs of hearing and equilibration, provide attachment for the muscles and ligaments of the middle-ear ossicles, and include grooves, canals, and foramina for components of the cranial vascular and nervous systems.” The petrosal is divided into the pars cochlearis, housing the inner ear’s cochlear duct and saccule, and the pars canalicularis, housing the utricle and semicircular canals. In ventral view the pars cochlearis is represented by the promontorium and the flange projecting anteromedially from it, and the pars canalicularis by the remaining bone lateral and posterior to the promontorium (Wible 2003 p. 156). The petrosal grows via accretion of bone on its external surface (Ekdale 2010). Size and extracranial shape of the petrosal are not only revealing of the middle ear auditory functioning, but also of the inner ear cochlear morphology. Ekdale's (2010) results that the basic shape of the bony laberinth remains constant across the *M. domestica* ontogenetic series analyzed are significant in evaluating the petrosal anatomy as informative phylogenetically. Size and volume characters described here are all of adult specimens, and differences among young adults to old adults were check for. No significant correlation between age and the volume of the cochlea and the laberinth were found in *M. domestica* (Ekdale 2010).

4.4.1. PARS COCHLEARIS

4.4.1.1. Promontorium

“The bulbous shape of the promontorium reflects the enclosed coiled cochlear duct, which in adult *Didelphis virginiana* has two and one fourth turns (Larsell *et al.* 1935 in Wible 2003)”, while in adult *M. domestica* it has just under two turns (Ekdale 2010).

4.4.1.1.1. Rostral tympanic process of petrosal – rtp

Wible (2003) characterizes the rostral tympanic process of the petrosal as a finger-like process projecting ventroanterolaterally from the posteromedial surface of

the promontorium that abuts the posterior crus of the ectotympanic. The sample studied allowed for the detection of a great amount of anatomic variation.

4.4.1.1.1.1. Rostral tympanic process of the petrosal – rtp, lateral projection and anteromedial margin / ridge

There are ridges extending anteromedially and posterolaterally from the rostral tympanic process of the petrosal. Wible (2003) characterized them as follows: “the anteromedial ridge extends the length of the promontorium and contacts the basioccipital bone, distal to the basioccipital-basisphenoid suture. The shorter posteromedial ridge forms the dorsomedial lip of the cochlear fossula and fenestra cochleae”. I found some significant morphological variation in the development of these ridges.

MC79 / CIB067) Overall shape of the rostral tympanic process of the petrosal in ventral view:

0 = finger like or bulbous (3D), without neither anteriomedial nor posterior margins or very small.

1 = triangular

2 = poligonal

Even though they are both poligonal, I cannot consider the shape of the rostral tympanic process of the petrosal in the *henseli* species group equivalent to the shape observed in the *americana* species group. Even though both present a rostral tympanic process of the petrosal further developed into two lateral processes, they do not have the same shape (flat in *americana* versus, thick in *henseli*), nor the same position (anterior in *americana* versus lateral in *henseli*). In *henseli* it seems like a thick support for the ectotympanic to attach itself to, while in *americana*, the delicate anterior process can only serve as attachment to soft tissue, and actually seems to serve as a substitute for soft tissue, that is, to ossify the bulla.

MC80 / CIB068) Shape of the anterior margin of the rostral tympanic process of the petrosal with triangular shape:

- 0 = concave
- 1 = straight
- 2 = convex
- 3 = sectioned at extreme lateral tip

MC81M, MC82F / CIB069) Shape of the anterior margin of the rostral tympanic process of the petrosal with polygonal shape:

- 0 = sharp
- 1 = rounded

Potentially sexually dimorphic trait.

MC83 / CIB070) Shape, in ventral view, of the lateral tip of the rostral tympanic process of the petrosal:

- 0 = rounded
- 1 = rounded anterolaterally, sharp laterally
- 2 = sharp

MC84 / CIB071) Development of the anteromedial margin of the rostral tympanic process of the petrosal (Figure 4.3.16):

- 0 = does not expand significantly anteriorly overlying promontorium, or only near lateral tip
- 1 = expands anteriorly, forming a ridge that overlies the promontorium

State 1 of this character is the synapomorphy uniting the population amgBaIn of *M. americana* and population amhumbC of *M. umbristriata* from Minas Gerais.

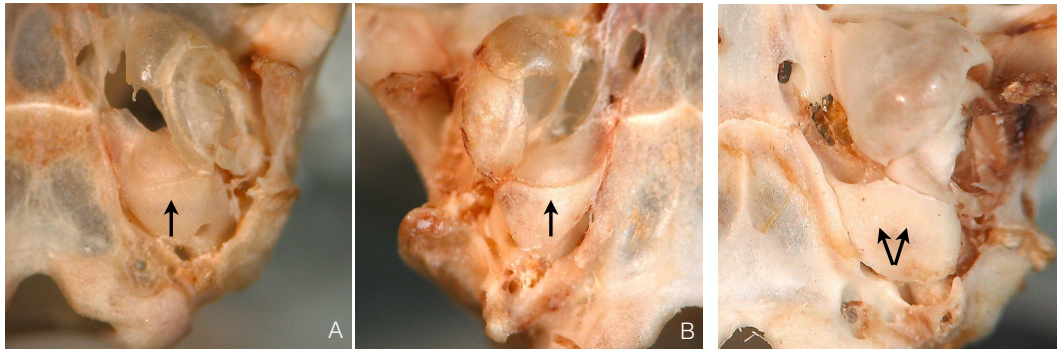
MC85 / CIB072) Shape, in lateral view, of the anteromedial margin of the rostral tympanic process of the petrosal (Figure 4.3.16):

- 0 = blunt edged
- 1 = sharp edged

State 0 of this character is one of the two synapomorphies supporting the clade of node 31 uniting the henseli species group to a group containing the *brevicaudata*

species group, *M. palliolata*, *M. domestica*, and a clade of the sister group composed of *M. kungsi* and *M. adusta*.

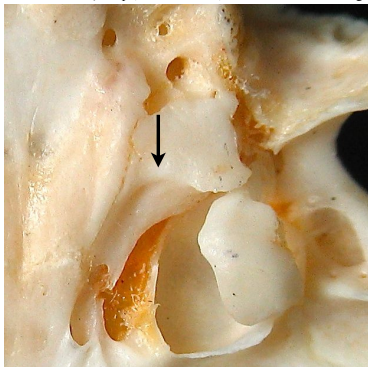
Figure 4.3.16. MC84 / CIB071) Development of the anteromedial margin of the rostral tympanic process of the petrosal:



0 = does not expand significantly anteriorly overlying promontorium, or only near lateral tip. A. *M. osgoodi* USNM582110, B. *M. adusta* USNM588019

1 = expands anteriorly, forming a ridge that overlies promontorium. *americana* group USNM552401

MC85 / CIB072) Shape, in lateral view, of the anteromedial margin of the rostral tympanic process of the petrosal:



0 = blunt edged

MC86 / CIB073) Depth, in lateral view, of the anteromedial margin of the rostral tympanic process of the petrosal relative to the promontorium:

0 = not significantly raised from the promontorium

1 = significantly raised from the promontorium

MC87 / CIB074) Contact of the anteromedial margin of the rostral tympanic process of the petrosal with the basioccipital:

0 = does not extend to contact the basioccipital

1 = extends medially to contact the basioccipital

The state 1 of this character is one of the 3 synapomorphies giving support to the monophyly of *Monodelphis*.

4.4.1.1.1.2. Rostral tympanic process of the petrosal – rtp posteromedial margin / ridge

MC88 / CIB075) Presence and shape of the posteromedial margin of the rostral tympanic process of the petrosal:

0 = absent

1 = present, slightly salient with a rounded edge

2 = present in the shape of a shelf that partially floors the stapedia fossa anteriorly providing a ventral cover to the fenestra cochleae

This character state 0 provides the second synapomorphy giving support to node 31, a clade uniting the *henseli* species group to the grouping of the *brevicaudata* species group, *M. palliolata*, *M. domestica* and the sister group clade containing *M. adusta* and *M. kungsi*. Voss & Jansa's (2009) character 76 (development of the rostral and caudal tympanic processes of petrosal as a unit) addresses a specific aspect of both my characters MC88 (development of the rostral tympanic process of the petrosal) and my MC103 (contact between the rostral tympanic process of the petrosal, the exoccipital process, and the caudal tympanic process of the petrosal). My observations of petrosal morphology independent variation among these structures within *Monodelphis* lead me to partition these phenotypes into discrete characters. See further development of similarities between their character 76 and my MC103 below.

State 2 is one of the four synapomorphies giving support to the sister group relationship among *Monodelphis* and *Marmosa*.

4.4.2. PARS CANALICULARIS

There are two ridges at roughly right angles to one another on the pars canalicularis that meet at the posterolateral corner of the petrosal: the caudal tympanic process of the petrosal and the crista parotica. At their juncture is the posterolaterally directed mastoid process, which is covered anterolaterally by the posttympanic process of the squamosal. The caudal tympanic process of the petrosal runs posteromedially from the mastoid process (Wible 2003). Characters presented in this research were observed at ventral view only of the pars canalicularis as is in place in the skull.

4.4.2.1. Anteroventral portion, lateral to the promontorium

Between the crista parotica and the fenestra vestibuli is a broad, shallow, anteriorly directed facial sulcus, so-called because its principal occupant is the facial nerve. Within the sulcus, lateral to the facial nerve runs the much smaller lateral head vein. Opening posteromedially into the lateral aspect of the facial sulcus at the level of the anterior edge of the fenestra vestibuli is the tympanic aperture of the prootic canal (Wible 2003). The prootic canal is the route by which the prootic sinus communicates with the lateral head vein (Wible, 1990; Wible and Hopson, 1995). At the level of the prootic canal, the facial sulcus turns anteromedially and enters the secondary facial foramen (Wible 2003).

4.4.2.1.1. Bony shelf lateral to the facial sulcus [epitympanic recess]

According to the CM sample, Wible made the following description: “Lateral to the facial sulcus is a bony shelf of similar dimensions, but whose surface is very irregular. The lateral edge of this shelf has a ridge that is hidden in the skull by the squamosal and that ends anteriorly in a sharp, anteroventrally directed process. This process is called the tuberculum tympani, because it resembles the structure so identified by Toeplitz (1920) in pouch young *Didelphis marsupialis*. Following Kuhn and Zeller (1987), this is the homologue of the tegmen tympani of placentals.” The shelf has two depressions. Posteriorly is a smaller, circular, deeper depression, the fossa incudis for the short process (crus breve) of the incus. The fossa incudis is bordered medially by the crista parotica and laterally by the squamosal bone. Anterior to and continuous with the fossa incudis is a broader, shallower depression, the epitympanic recess over the mallear-incudal articulation (Klaauw, 1931). The epitympanic recess is bordered medially by a very low ridge, the anterior continuation of the crista parotica, and laterally by the lateral ridge and squamosal.”

I found the following alternative phenotypes of the pars canalicularis.

MC89 / CIB076) Contact between the anterior limit of the bony shelf lateral to the facial sulcus and the posterior limit of the roof of the alisphenoid hypotympanic sinus:

0 = by way of a smooth contact, not forming a sphenoid septum nor a tuberculum tympani ventral to this suture, so the surface on each side of the suture is flattened

1 = there is a change in direction resembling a stair-step beyond the surface adjacent to the suture, forming a ledge or an offset, that resembles a step of a stairway, but not forming a sphenoid septum nor a tuberculum tympani ventral to this contact

2 = extends further anteriorly forming a sphenoid septum, that is, an anterior ridge.

MC90M, MC91F / CIB077) Bony shelf lateral to the facial sulcus, sphenoid septum:

0 = without tuberculum tympani, straight

1 = with tuberculum tympani

2 = with a peg like structure only, which might be homologous to the sphenoid septum.

Potentially sexually dimorphic trait.

M. dimidiata seems to have it double, but it is really just the lateralmost edge of the epitimpanic recess and a single blunt process anterolaterally.

MC92M, MC93F / CIB078) Shape of the tuberculum tympani:

0 = blunt

1 = triangular wide, sharp

2 = triangular narrow, sharp

3 = hook

Potentially sexually dimorphic trait.

MC94M, MC95F / CIB079) Size of the tuberculum tympani:

0 = short

1 = long

Potentially sexually dimorphic trait.

4.4.2.1.2. Crista parotica – cp

The crista parotica is the ridge that runs anteriorly from the mastoid process. Wible (2003) described it as hidden in the skull by the squamosal bone, and much shorter and thinner than the caudal tympanic process of the petrosal, extending to

approximately the level of the anterior edge of the fenestra vestibuli. He also comments that it continues anteriorly as a very low ridge bordering the epitympanic recess medially. I found the crista parotica to be visible in the sample at hand, with the following variation in *Monodelphis*.

MC96 / CIB080) Presence of the crista parotica as a ridge from the mastoid process anteriorly to the secondary facial foramen:

0 = complete from the caudal tympanic process of the petrosal septum to secondary facial foramen

1 = partial, with interruptions

2 = present only at caudal tympanic process of the petrosal

In states 1 and 2, partial or absent, the facial sulcus is still recessed from the lateral shelf, the crista parotica, but in the shape of a stair-step only.

4.4.2.1.3. Prootic canal – pc, tympanic opening of the lateral head vein

MC97 / CIB081) the prootic canal is:

0 = round

1 = elipsoid

2 = open canal

MC98 / CIB082) The prootic canal is positioned:

0 = midway of the epitympanic recess's length

1 = at or close to the epitympanic recess's anterior margin (at least about 3/4 anteriorly)

MC99 / CIB083) Lateral head vein / tympanic opening of the prootic canal, relative to the fenestra vestibuli, is:

0 = at level with

1 = anterior

4.4.2.2. Medial View of the pars canalicularis

4.4.2.2.1. Cochlear canaliculus

The cochlear canaliculus transmits the perilymphatic duct into the petrosal (Wible 2003). This is the only character studied that is not exposed on ventral or occipital view. However it can be coded by observing through the foramen magnum.

MC100 / CIB084) The cochlear canaliculus's shape is:

0 = like a fissure

1 = triangular

2 = 1/2 dome

3 = elipsoid

4 = round

4.4.2.3. Occipital View of the pars canalicularis

4.4.2.3.1. Mastoid Exposure – me

The mastoid exposure is the surface of the pars canalicularis of the petrosal exposed on the occiput. It is roughly trapezoidal (Wible 2003). It is bordered anteroventrally by the caudal tympanic process of the petrosal.

MC101 / CIB085) General shape of the mastoid exposure – me is:

0 = conspicuously longer than wide, with length to width ratio $\geq 2:1$

1 = approximately in the shape of an equilateral triangle, with length to width ratio $< 2:1$

MC102 / CIB086) The mastoid exposure is:

0 = roughly flat and irregular in texture

1 = convex and relatively smooth

4.5. CONTACT BETWEEN PETROSAL AND NEIGHBORING BONES

4.5.1. Contact between pars cochlearis, pars canalicularis and exoccipital

The paired exoccipitals have a horizontal part on the skull base and a vertical one on the occiput. In ventral view, the larger posterolateral surface extends onto the occiput, where rises up a strong, posteroventromedially directed paracondylar or exoccipital process, from which the digastric muscle originates, based on *Didelphis marsupialis* (Turnbull 1970, Wible 2003). The anterior and lateral sides of the paracondylar process are in sutural contact with the medial end of the caudal tympanic process of the petrosal.

4.5.1.1 Ventral contact

MC103 / CIB087) Ventral contact between the posterior margin of the rostral tympanic process of the petrosal, the lateral extension of the exoccipital process, and the medial margin of the caudal tympanic process of the petrosal (Figure 4D15):

0 = do not contact.

1 = contact in that order, partially encovering the fenestra cochleae ventrally.

2 = the rostral tympanic process of the petrosal almost contacts the caudal tympanic process of the petrosal, partially providing a floor to the fenestra cochleae.

3 = the caudal tympanic process of the petrosal and the lateral extension of the paracondylar process of the exoccipital extend anteriorly providing an almost complete floor to the fenestra cochleae

4 = fenestra cochleae fully covered ventrally by the full simultaneous contact among all three structures.

My character state 4 is the only that coincides with Voss & Jansa's (2009) character 76 state 1. The concealment of the fenestra cochleae in *Monodelphis* is obtained by the development of the three bony elements as described above, not only of the two tympanic processes of the petrosal. The state 1 of this character is one of the 3 synapomorphies giving support to the clade of node 36 uniting *M. emiliae* to the *americana* group.

4.5.2. Pars cochlearis – basioccipital / exoccipital contact

At the anterior portion of the pars cochlearis is the flat roof of the anteromedial flange, which has an incurved medial wall (Wible 2003 wrote lateral, but it is the medial wall of the pars cochlearis which abuts the basisphenoid and the basioccipital) that produces a distinct pocket. Based on the CT slices in Macrini (2000), this pocket accommodated the basisphenoid and basioccipital bones. I found variation in the development of this pocket (see character MC104M, MC105F below). There are specimens in which the ventral edge of the medial wall of the anteromedial flange is not developed, thus there is no pocket. The basioccipital forms the skull base between the petrosals, the foramen magnum and the basisphenoid, which lies at the level of the anterior pole of the petrosal. Wible (2003) describes the abutment of the anterolateral side of the basioccipital with the petrosal promontorium as complete except at its posterior end, where there is a gap between the petrosal, basioccipital, and exoccipital for the passage of the inferior petrosal sinus. Character MC107 addresses the variability found in *Monodelphis* regarding this contact. Wible (2003) notes that the anterolateral sides of the basioccipital project somewhat ventrally, whereas the sample studied here allowed for the observation of distinct degrees of development of the ventral projection of the basioccipital lateral margins, together with the development of the lateral margins of the exoccipital (see character MC106).

4.5.2.1. Ventral contact

MC104M, MC105F / CIB088) Medial expansion of the promontorium:

0 = absent in most of or in the entire length of the promontorium

1 = poorly developed, that is, present in part of but not along the entire length of the promontorium

2 = conspicuous as a shelf along the entire length of the promontorium, except for the gap for the passage of the inferior petrosal sinus

Potentially sexually dimorphic trait.

The development of the ventromedial expansion of the promontorium and of the anterolateral side of the basioccipital together or independently determines the

amount of contact between the basioccipital and the petrosal ventrally. Thus, it can vary from a complete abutment except at the gap for the passage of the inferior petrosal sinus, as observed by Wible (2003), to only at the anterior limit of the promontorium and the anteromedial flange.

MC106 / CIB089) Ventrolateral margin of the basioccipital and the exoccipital:

0 = poorly developed

1 = well developed laterally but not inflated

2 = well developed laterally and inflated

MC107 / CIB090) Contact between the medial expansion of the promontorium and the ventrolateral margin of the basioccipital and exoccipital bones:

0 = the contact extends posteriorly almost until the posterior lacerate foramen, so that the sulcus for the inferior petrosal sinus is completely floored.

1 = the contact is restricted to the anteriormost portion of promontorium, at level with the depressed region of the fossa for the tensor tympani muscle, so that the sulcus for the inferior petrosal sinus is incompletely floored

4.5.2.2. Intracranial contact

The occupant of the foramen for inferior petrosal sinus (Internal Jugular Canal of Archer, 1976; Inferior Petrosal Foramen of Marshall and Muizon, 1995) in didelphids (Dom *et al.*, 1970; Wible, unpubl. observ.) as well as in dasyurids is the inferior petrosal sinus (Sinus petrosus ventralis), which connects the cavernous sinus and the internal jugular vein (Wible 2003). The posterior lacerate foramen (Archer 1976; jugular foramen of Wible 2003) in dasyurids transmits cranial nerves (presumably the glossopharyngeal, vagus, and accessory nerves as in didelphids [Wible, unpubl. observ. in Wible 2003] and the dog [Evans, 1993]) and occasionally also a very small branch of the sigmoid sinus to the internal jugular vein (Wible 2003). A venous channel does not pass through the posterior lacerate foramen in *Didelphis virginiana* (Wible, 1990; Wible and Hopson, 1995) and *Monodelphis domestica* (Wible, unpubl. observ. in Wible 2003). Because this opening does not transmit the

major contributor to the internal jugular vein, Archer (1976) opted for the usage of posterior lacerate foramen rather than jugular foramen (Wible 2003), consequently it is the nomenclature I adopt here. In *Monodelphis*, both foramen for inferior petrosal sinus anteriorly and the posterior lacerate foramen posteriorly are situated between the exoccipital and petrosal.

Wible reported (2003) that as in *Monodelphis*, the posterior lacerate foramen is small with a separate foramen for the inferior petrosal sinus anterior to it in *Didelphis albiventris*, *Dasyurus maculatus*, and *Pucadelphys andinus* (Marshall and Muizon, 1995), but that there is no separate foramen for the inferior petrosal sinus in *Zalambdalestes lechei* (Wible *et al.*, in press in Wible 2003). Wible (2003) regarded the foramen for the inferior petrosal sinus and the posterior lacerate foramen as exhibiting no significant variation. There is one character describing the variation found in the intracranial contact between the exoccipital and the petrosal, which reflects the relationship between the foramen for the inferior petrosal sinus and the posterior lacerate foramen in *Monodelphis*.

MC108 / CIB091) Contact between the exoccipital and the petrosal:

0 = present as a tight fit, causing the sulcus for the inferior petrosal sinus and the posterior lacerate foramen to be distinct cavities (the promontorium has a posteromedially directed process and the exoccipital has an anterolaterally directed process)

1 = absent, or at most a delicate protrusion of the exoccipital is present, causing the inferior petrosal sinus and the posterior lacerate foramen to merge

4.6. EXOCCIPITAL – EO

4.6.1. Hypoglossal foramina – hf

The foramina for the hypoglossal nerve are located between the anterolateral margin of the exoccipital and the occipital condyle. Based on *Didelphis virginiana* and *M. domestica*, both these foramina transmit parts of the hypoglossal nerve and

accompanying arteries and veins, with the arteries ultimately being branches of the vertebral artery (Wible, unpubl. observ. in Wible 2003).

MC109 / CIB092) Relative position of the posterior hypoglossal foramen and the anterior hypoglossal foramen:

0 = foramina separate

1 = foramina close but not superimposed

2 = posterior hypoglossal foramen superimposes on anterior hypoglossal foramen, such that the floor of the posterior hypoglossal foramen is the roof of the anterior hypoglossal foramen.

MC110 / CIB093) Relative to the posterior hypoglossal foramen, the anterior hypoglossal foramen is:

0 = larger

1 = approximately of same size

2 = smaller

In the CM *Monodelphis* sample, Wible (2003) found that the relative sizes of the foramina vary. Most specimens of *M. brevicaudata* and *M. domestica* present the posterior as the larger foramen. However, in the two *M. osgoodi* holotype specimens and in some *M. brevicaudata* and *M. domestica*, the anterior is the larger. Wible's (2003) observations would be equivalent to MC110 state 0, which did not result as a synapomorphy for the grouping of *M. adusta* (a closely related species to *M. osgoodi*) and *M. brevicaudata* and *M. domestica* (node 30). Instead, MC110 state 1 came out as a synapomorphy for the clade grouping *M. domestica* to the *brevicaudata* species group (with the exception of *M. palliolata*). In fact, I interpreted the hypoglossal foramina to be unilaterally approximately of the same size in *M. osgoodi* holotype CM5242, while coded the anterior hypoglossal foramen to be larger on the other side.

4.7. MIDDLE EAR OSSICLES

The middle ear ossicles are the stapes, the incus and the malleus. Only the stapes was studied here. At around days 28-30 postnatal, the middle ear ossicles are immature but begin to separate from the mandible (Sánchez-Villagra *et al.* 2002).

4.7.1. STAPES

Voss & Jansa (2009) evaluated that “despite some intraspecific variation noted by Gaudin *et al.* (1996), most didelphids normally exhibit one or the other of two different stapedia morphotypes defined by Novacek and Wyss (1986),” that is, “most didelphids have a more or less triangular or stirrup-shaped, bicurrate stapes that is perforated by a large stapedia (obturator or intercrural) foramen” and other “have a columelliform (or columnar) stapes that is imperforate (or microperforate: with a foramen whose maximum diameter is less than the width of a surrounding crus; Gaudin *et al.*, 1996). Taxa with columelliform stapes include *Caluromysiops*, *Lestodelphys*, and several species of *Monodelphis* (e.g., *M. peruviana*, *M. theresa*).” Despite this groundplan point of view of stapedia anatomic variation evaluation, I found enough stapedia stable morphological interspecific variation in the *Monodelphis* sample studied to utilize Gaudin *et al.* (1996) as a starting point of reference for character definition, in the context of the exemplar method (Yeates 1995). A deeper search for anatomical variation patterns should be applied to the tree middle ear ossicles in order to more fairly evaluate their contribution to evolutionary biology research. Thus Voss & Jansa’s (2009) character 81 (Stapes triangular and bicurrate, perforated by a large foramen (0); or stapes columelliform and microperforate or imperforate (1)) is a composite interpretation of the stapedia anatomy, uniting different aspects of its variation, some of which reflected in the characters described below.

4.7.1.1. Stapedia crura and foramen

Wible (2003) comments about the discrepancy in the literature regarding the presence of an intracural foramen in the stapes: “The photograph of the stapes of

Monodelphis domestica in Sánchez-Villagra *et al.* (2002:fig. 10A) shows a well-developed intracural foramen, whereas Archer (1976) reported that the stapes is imperforate in *M. dimidiata* WAM M6785.” A perforate stapes occurs in 14 CM *M. brevicaudata* and 27 CM *M. domestica*. “In contrast, the stapes is imperforate in the one *M. osgoodi* (5248) preserving the bone and in two *M. dimidiata* (86608, 86609); there is a microperforation in the third *M. dimidiata* (86611) with a stapes.” These variations are described by characters MC111 and MC112M, MC113F below.

MC111 / CIB094) Stapes' crura:

0 = apart

1 = united and completely undistinguishable from each other, so that the body of the stapes is a smooth surface, and the stapedia foramen is absent (columniform)

State 1 of this character provides the second autapomorphy for the population embMTX of *M. emiliae* from Pará.

MC112M, MC113F / CIB095) Thin bony tissue connecting the stapes' crura:

0 = absent, yielding a large stapedia foramen

1 = present at the stapedia labrum, yielding an oval stapedia foramen located near the head of stapes

2 = present mainly at the head of the stapes and less at the crura's interior margins, yielding a very small stapedia foramen closest to the stapedia labrum

3 = present mainly at the crura's interior margin, and less at the head of stapes and at the stapedia labrum, yielding a narrow ellipsoid stapedia foramen located midway

4 = present throughout the crura's length so that the stapedia foramen is absent.

Potentially sexually dimorphic trait.

This character describes the morphological pattern in which, even though there is a thin sheet of bone uniting the stapedia crura, such that a foramen is absent, the crura are thicker than this connective bony tissue and still well distinguishable from each other. States 1 to 3 describe different shapes and origins of formation of the so-called microperforation of the stapes. The presence of state 2 of this character is one of the 3 synapomorphies giving support to the monophyly of *Monodelphis*.

MC114M, MC115F / CIB096) Shape of the crura:

0 = anteriorly and posteriorly convex (= towards horse-shoe shaped)

1 = anteriorly and posteriorly straight

2 = anteriorly and posteriorly concave

3 = posteriorly convex, anteriorly concave

4 = posteriorly convex, anteriorly straight

5 = posteriorly straight, anteriorly convex

6 = posteriorly straight, anteriorly concave

7 = posteriorly concave, anteriorly convex

Potentially sexually dimorphic trait.

MC116 / CIB097) Angle made by the stapes's crura:

0 = 45 degrees approximately

1 = 30 degrees or less

Indeed the syntype of *M. domestica*, a female adult from Cuiabá (NT0704 (Cerrado)) has a large stapedia foramen and crura well apart (MC111 state 0, MC11 state 0). Yet, *M. domestica* USNM293130, a young adult male from Paraguay (NT0708 (Humid Chaco) / NT0150 (Paraná-Paraíba Interior forests) / NT0210 (Chaco)) presents MC112M state 3. Among the *brevicaudata* group, all specimens presented stapes crura apart, though with several degrees of development of the thin bony tissue connecting the stapes crura. The exception is *M. orinoci*, which has a columniform stapes. Except for one unilaterally of each, all specimens of the *adusta* and the *henseli* species group present stapes's crura apart. However, in most of them, the thin bony tissue closes off the stapedia foramen. In *M. emiliae* both columniform as well as crura apart occur, with much variation regarding the development of the bony tissue between the crura. It is interesting to note that in the *americana* group, all specimens present an open crura, except for the female *M. iheringi* from São Paulo (NT0160 – Serra do Mar coastal forests; Mustrangi & Patton: Serra do Mar.)

4.8. SQUAMOSAL – sq

“The paired squamosal bones have a flattened squamous portion in the posteroventral side wall of the braincase, a zygomatic process contributing to the posterior half of the zygoma, and a glenoid fossa, the skull’s component of the temporomandibular joint. The ventral border of the squama is concave between the postglenoid and posttympanic process, and this area is occupied by the external acoustic meatus.” (Wible 2003) Based on didelphids (Wible, 1987) and dasyurids (Archer, 1976), the suprameatal foramen (subsquamosal foramen of Archer, 1976) in the metatherian squamosal, dorsal to the external acoustic meatus, carries a temporal branch of the postglenoid artery and accompanying vein to the temporal fossa. Wible (1987) identified this as a ramus temporalis of the stapedia artery system. In *M. brevicaudata*, the postglenoid foramen is entirely within the squamosal, although the anterior crus of the ectotympanic approaches the medial margin. Also, three openings are visible within the substance of the postglenoid foramen, with the posterior and largest of these three being the channel for the sphenoparietal emissary vein; the anterior two are postzygomatic foramina. In *Didelphis virginiana* (Wible, 1987, 1990) and *Monodelphis domestica* (unpubl. observ. in Wible 2003), the vein exiting the postglenoid foramen is identified as the sphenoparietal emissary vein, following Gelderen (1924) (Wible 2003). Wible (2003) considered both the suprameatal foramen and the postglenoid foramen as exhibiting significant variation.

4.8.1. Suprameatal Foramen – smf (subsquamosal foramen – ssf of Archer 1976)

MC117 / CIB098) Relative position of the postglenoid foramen and suprameatal foramen:

0 = overlap broadly

1 = the postglenoid foramen’s posterior margin is aligned with anterior margin of the suprameatal foramen

2 = far apart

MC118 / CIB099) Direction of the suprameatal foramen in ventral view:

0 = opens laterally

1 = opens ventrolaterally

2 = opens mainly ventrally

Wible (2003) described the suprameatal foramen of *M. brevicaudata* as posterolaterally directed, seemingly from a lateral point of view.

MC119 / CIB100) Size of the suprameatal foramen relative to the distance between the postglenoid process and the posttympanic process at 1.0:1 magnification:

0 = Large (approximately $\frac{1}{2}$ the length between the posglenoid process and the paroccipital process of exoccipital; minimum $\frac{1}{3}$ length)

1 = Medium (approximately $\frac{1}{4}$ the length between the posglenoid process and the paroccipital process of exoccipital)

2 = Small (significantly smaller than $\frac{1}{4}$ the length between the posglenoid process and the paroccipital process of exoccipital)

Wible (2003) made a size variation description in comparison to *M. brevicaudata* CM 52729, which from his figures 2 and 4, seems to be equivalent to MC119 state 2. ("in three *M. brevicaudata* (68358, 68361, 76732) and one *M. sp.* (5024), the suprameatal foramen is comparable in size to that of *M. brevicaudata* CM 52729). Thus in the CM 29 *M. domestica*, four *M. dimidiata*, two *M. osgoodi*, and 11 remaining *M. brevicaudata*, the suprameatal foramen is roughly twice as big, expanding posteriorly into the area where the depression is present in CM 52729." It is hard to interpret if the remaining CM sample fit into the states 0 or 1.

4.8.2. Postglenoid foramen – pgf

MC120 / CIB101) Position of the ventral margin of the postglenoid foramen:

0 = at the ventral margin of the postglenoid process

1 = at the posteroventromedial face of the postglenoid process

2 = at mid-length of the posterior wall of the postglenoid process

State 1 i one of the four synapomorphies giving support to the sister group relationship between *Monodelphis* and *Marmosa*.

MC121M, MC122F / CIB102) Width of the postglenoid foramen relative to the posterior face of the postglenoid process:

0 = postglenoid foramen wider than postglenoid process

1 = approximately equal

2 = postglenoid foramen narrower than postglenoid process

Potentially sexually dimorphic trait.

4. 9. CHARACTER MATRIX

The complete basicranial anatomy data matrix is presented in Appendix 2, and it is summarized in Appendix 3. Brackets enclose observed polymorphisms. Traits showing sex dimorphism were scored as separated characters, yielding a final data set with 122 characters. The 20 potentially sexually dimorphic characters were: CIB003, CIB009, CIB011, CIB012, CIB014, and CIB015 of basisphenoid; CIB026 of the orbitosphenoid; CIB044 and CIB055 of the alisphenoid, CIB058, CIB063, and CIB064 of the ectotympanic; CIB069 of the pars cochlearis of the petrosal; CIB077, CIB078, and CIB079 of the pars canicularis of the petrosal; CIB088 of the zone of contact between the petrosal and neighboring bones; CIB095, and CIB096 of the stapes; and CIB102 of the squamosal.

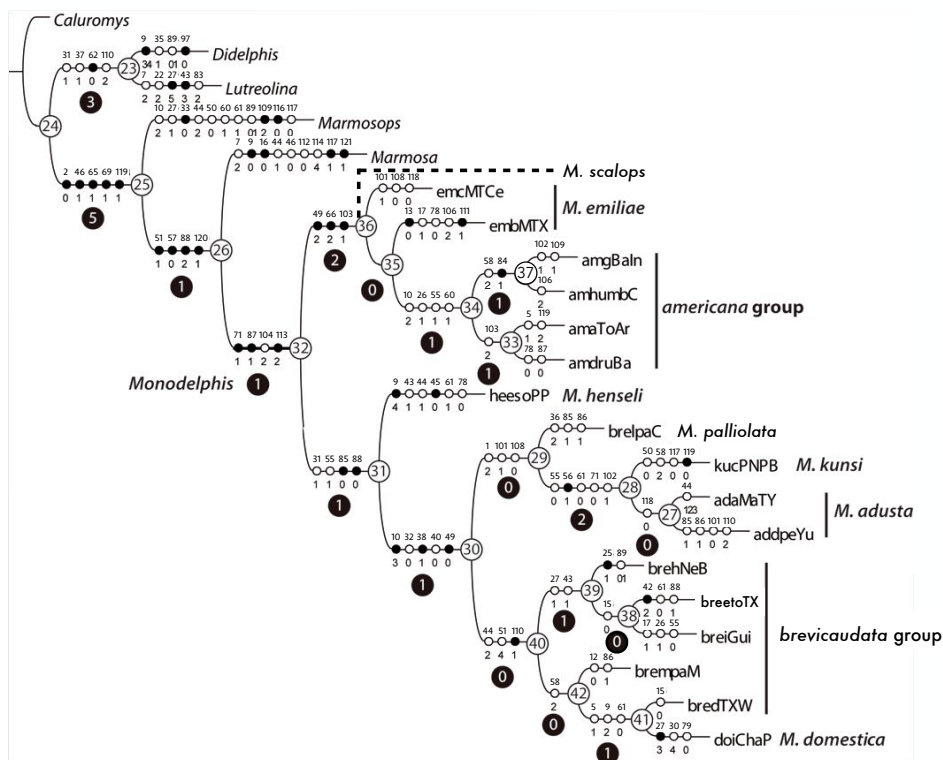
Missing data are indicated by a question mark (“?”) in the resulting basicranial anatomy data matrices (Appendix 3, upon request). Missing data were due to several causes, like specimen conservation (loss or breakage of structures, or insufficient cleaning of most delicate structures). In addition, not all specimens studied during the character building stage were available when coding the final list of characters, thus not all characters were coded for these specimens. Thus the main source of missing data in this study is not due to incomplete taxa, but to a lack of access to taxon sampling after the final character list was completed. As evidenced in Table 4.2, even after aggregating specimens into ecoregion populations, the majority of populations had quite low percentage of coded characters. Thus, the 50% minimum

character coded cut for the least inclusive OTU cladistic analysis yielded seventeen final OTUs. These final OTUs represented 27% of the total pool of ecoregion populations, all *Monodelphis* species groups, except *M. scalops*, and included *M. kungsi* with a borderline of 45% coded characters.

4.10. CLADISTIC ANALYSIS

The shortest tree for the final ecoregion aggregated population matrix was inferred using a heuristic search, starting with 1000 Wagner Trees, followed by TBR branch swapping, holding 10 trees per replicate up to a maximum of 10,000 trees. The result was six most parsimonious trees of 275 steps. A new analysis was conducted under implied weights (Goloboff 1993) to provide additional criteria to select a single tree. Analyses conducted under all concavity values assayed (k=2 to k=50), except k=1, yielded one single tree that corresponded to one of the 6 trees found under uniformly weighted parsimony. Figure 4.4.1 shows the tree inferred under implied weights, which is also one of the shortest trees, along with Bremer support for the clades recovered.

Figure 4.4.1. The shortest tree for the final ecoregion aggregated population matrix. Circles on nodes indicate node number. Black filled circles under branches indicate Bremer support. Small white circles on branches indicate apomorphies, and small black filled circles indicate synapomorphies for the branch, with character numbers on top and character states below the branch. Dotted line shows the placement inferred for *M. scalops* by the best-fit tree resulted from the implied weights analyses of the 9 most parsimonious trees of 206 steps under strict consensus.



An additional analysis was carried out in order to infer the placement of *M. scalops* within the genus. This analysis utilized the most inclusive OTUs which comprise the species *M. kunsi*, *M. scalops* and *M. emiliae*, which can be identified unequivocally, and the following five more inclusive species groups' *sensu lato*: *adusta*, *americana*, *henseli*, *brevicaudata* and *domestica*. Within the longitudinal bicolor pelage pattern, the *adusta sensu lato* group is restricted to the small exclusively Andean species *M. adusta*, *M. adusta peruviana*, and *M. osgoodi*. The large bodied *M. domestica* and *M. maraxina* were grouped into the *domestica s.l.*. Next, within the longitudinally tricolored pattern, the *brevicaudata s.l.* is restricted to the species with Amazonian and northern distribution, namely the type of *M. brevicaudata* Erxleben, *M. brevicaudata glirina*, *M. brevicaudata palliolata*, *M. brevicaudata touan*, and *M. orinoci*. The *henseli s.l.* group, present in southeastern South America, comprises *M. dimidiata*, *M. henseli* and *M. sorex*. The striped species of the transversal tricolor pattern comprise the *americana s.l.* group, which include *M. americana*, *M. iheringi*, *M. theresa*, and *M. umbristriata*. The strict consensus of the exhaustive search using implicit enumeration yielded 9 most parsimonious trees of 206 steps. Analyses under implied weights resulted in one single tree, regardless of the K value used, which in turn corresponded to one of the most parsimonious trees. The best-fit tree (not shown) recovered *M. scalops*, representing NT0101 – Araucaria moist forest in Paraná, NT0160 – Serra do Mar Coastal forests to 1400m at Pico da Bandeira in NT0103 – Bahia Coastal Forests as the sister group to a clade containing the *americana s.l.* group and *M. emiliae*. One synapomorphy support this clade (character MC52 state 2, alisphenoid tympanic process compressed posteromedially-anterolaterally), and one autapomorphy characterizes *M. scalops* (MC6 state 2, process at the vertex of the carotid foramen's ventrolateral parabolic margin short, laterally directed, forming part of a laterally directed ridge sometimes enclosing the groove of the pterygoid canal). Even though the *M. theresa* population amjtheTY did not pass the 50% coded characters cut, thus was not included in the present analysis, it is possible that, regardless of the conspecificity possibility of *M. scalops* and what had been interpreted as *M. theresa* until present, Solari's (2010) and Pine *et al.*'s (2013) molecular and nonmolecular analyses *M. theresa-M. scalops* clade may not be incompatible with the

close relationship to the *americana* species group recovered here. Pine *et al.* (2013) dismembering cladogram of the dorsally longitudinally striped species, as well as Solari's (2010, 2012) results in which the species with three dark dorsal stripes (*M. americana*, *M. theresa*, and *M. gardneri*) do not form a monophyletic group is, however, incongruent with the present results.

The synapomorphies found are listed in Appendix 4. Four synapomorphies give support to the sister group relationship between *Monodelphis* and *Marmosa* (Node 26, Bremer support 1). These are: 1) (character 51 state 1) round alisphenoid tympanic process in occlusal view; 2) (character 57 state 0); 3) (character MC88 state 2). The presence of the posteromedial margin of the rostral tympanic process of the petrosal in the shape of a shelf that partially floors the stapedia fossa anteriorly providing a ventral cover to the fenestra cochleae; and 4) (character MC120 state 1) Ventral margin of the postglenoid foramen at the posteroventromedial face of the postglenoid process. Voss & Jansa's (2009) molecular analysis strongly supported the grouping of *Marmosa*, *Monodelphis*, and *Tlacuatzin*, though analyses of concatenated sequence data from all five genes resulted in equivocal node relationships among the three genera.

Three synapomorphies give support to the monophyly of *Monodelphis*, the clade at Node 32 with Bremer support of 1: 1) (character 71 state 1) angle of the lateral expansion of the ectotympanic posterior crus with the ectotympanic's long axis greater than 45°; 2) (character 87 state 1) anteromedial margin of the rostral tympanic process of the petrosal extending medially to contact the basioccipital; and 3) (character 113 state 2) thin bony tissue connecting the stapes' crura present mainly at the head of the stapes and less at the crura's interior margins, yielding a very small stapedia foramen closest to the stapedia labrum. The monophyly of *Monodelphis* is well supported based on both molecular as well as morphological data from different anatomic complexes (e.g. Steiner & Catzeflis 2004, Vidigal 2004, Voss & Jansa 2003, 2009, Flores 2009, Pine *et al.* 2013, Pavan *et al.* 2014), with the exception of the lack of support obtained in Solari's (2010) molecular analysis. Even though Solari (2010) questioned the morphological data considered to date as defining hypotheses to the genus (Creighton 1984, Reig *et al.* 1987, Goin & Rey 1997) for not been set in a

phylogenetic context, these, together with the present basicranium as well as Voss & Jansa's (2003, 2009) nasal cavity phylogenetic characters hint to the phylogenetic signal of morphology and to its importance in *Monodelphis* systematics studies. What seems the case, given the increasing amount of morphological studies carried out to date, is that the unveiling of *Monodelphis* evolutionary history might need more in depth detailed anatomic surveys of different anatomic systems. The coding more standard traditional characters have not been able to uncover the genus genealogy. In addition, a denser taxon sampling seems also to be in great need.

Other supported nodes recovered in this analysis are described as follows. Node 36 with Bremer support 2, recovers as sister group *M. emiliae* and the populations representative of the *americana* species group (with representants of *M. americana* from Pará (amaToAr) and mainly ecoregion NT0170 – Tocantins-Araguaia-Maranhão moist forests; *M. rubida* from Bahia (amdruBa), including the Type specimen BM1855_11_26_9; *M. americana* from Minas Gerais (amgBaIn) and mainly ecoregion NT0104 – Bahia Interior Forests; and *M. umbristriata* from Minas Gerais (amhumbC) and ecoregion NT0704 – Cerrado, based on 3 synapomorphies. The basicranial synapomorphies are Characters 49 (state 2), long alisphenoid tympanic process; 66 (2) triangular medial expansion of the ectotympanic posterior crus with a sharp edge anteriorly; and 103 (1) ventral contact between the posterior margin of the rostral tympanic process of the petrosal, the lateral extension of the exoccipital process, and the medial margin of the caudal tympanic process of the petrosal in this order, partially encovering the fenestra cochleae ventrally. The close relationship between *M. emiliae* and the *americana* species group was recovered both in the analysis utilizing populations as terminals as well as using the more inclusive collapsed OTUs in the analysis including *M. scalops*. These results are congruent with those in the Vidigal's (2004) phylogenetic analysis based on external pelage and a much more reduced and simplified sample of basicranial anatomic characters. It is noteworthy that the relationships recovered solely based on basicranial anatomy coincide with those based basicranium and pelage. This is true particularly in this case, where the common presence of longitudinal dorsal stripes among species have historically been interpreted as ground for close species affinities, but this closeness has been questioned in latter

studies (Solari 2010, Solari *et al.* 2012, Pine *et al.* 2013). Pine *et al.* (2013) morphological and molecular analysis recovered a well supported sister group relationship of *M. emiliae* with *M. kungsi*. This relationship was recovered in Solari (2010) molecular survey, but with low support values. A close relationship among both species is not phenotypically easy to consider, and it was not recovered by both the current analysis as well as in Vidigal (2004). The sister group relationship of *M. emiliae* and *M. brevicaudata* based exclusively on the nonmolecular data in Voss & Jansa (2009) and Flores (2009) was not congruent with the basicranial data analysis, furthermore the relationship was not recovered by their combined molecular and nonmolecular analysis. The latest molecular survey of *Monodelphis* species also recovered a relationship in disagreement with my results, that of *M. emiliae* with *M. dimidiata* (Pavan *et al.* 2014).

Node 37, with Bremer support 1, unites *M. americana* from Minas Gerais (amgBaIn), ecoregion NT0104 – Bahia Interior Forests, and *M. umbristriata* from Minas Gerais (amhumbC), ecoregion NT0704 – Cerrado, based on one synapomorphy Character 84 (state 1): anteromedial margin of the rostral tympanic process of the petrosal expands anteriorly, forming a ridge that overlies the promontorium. Though with low Bremer support, and no unambiguous synapomorphy, the four populations of the *americana* group did clustered together as a monophyletic group at Node 34, a result most recently corroborated by the reconstruction of pelage patterns onto a molecular analysis, which resulted in dorsal stripes with a unique evolutionary origin (Pavan *et al.* 2014). The remaining two species, *M. americana* from Pará, population amaToAr, collected at ecoregion NT0170 – Tocantins-Araguaia-Maranhão Moist forests (MZUSP9930, AMNH203353, and AMNH203354) and possibly at NT0180 – Xingu-Tocantins-Araguaia moist forests (MN1304 and AMNH75170), and from Bahia, population amdruBA, collected at NT0104 – Bahia Interior forests, also came up as a sister group at Node 33, but without an exclusive synapomorphy.

At Node 31, with Bremer support 1, the *henseli* species group was recovered as the sister group to a clade that includes the *brevicaudata* species group, *M. domestica*, *M. kungsi* and the *adusta* species group, based on two synapomorphies: (Character 85, state 0) anteromedial margin of the rostral tympanic process of the petrosal blunt

edged; and (character 88, state 0) posteromedial margin of the rostral tympanic process of the petrosal absent. Pine *et al.*'s (2013) strongly supported clade “*M. sorex*”-*M. dimidiata* are in agreement to my morphological observations regarding both pelage as well as basicranial anatomy. Their clade including (*M. sorex*-*M. dimidiata*) + (*M. domestica* (*M. unistriata*-*M. iheringi*)) is congruent with the results here in showing a close relationship between *M. domestica* and the *henseli* group, but it is incongruent in the nesting of the dorsally striped *M. unistriata* and *M. iheringi*.

Node 30, with Bremer support 1, recovers a clade containing the *brevicaudata* species group, *M. domestica*, *M. kunsii* and the *adusta* species group, based on 3 synapomorphies: (character 10, state 3) transverse canal foramen floored by a ridge directed ventrolaterally from the transverse canal foramen towards the alisphenoid tympanic process's anteromedial strut, but not in contact with the alisphenoid tympanic process's anteromedial strut; (character 38, state 1) extracranial dorsal wall of the foramen rotundum present, so the canal is conspicuous dorsally; and (character 49 state 0) short alisphenoid tympanic process. The clade at Node 30 results in the *brevicaudata* species complex being a polyphyletic group, evidenced particularly by Node 41, with Bremer support 1, a sister group comprising *M. domestica* and the *brevicaudata* population bredTXW from Pará State, west NT0168 – Tapajós-Xingu moist forests. This grouping was not reproduced by Vidigal (2004), where *M. domestica* appeared as basal to all remaining *Monodelphis* species. However, a well supported clade containing specimens of the *brevicaudata* group and *M. domestica* was indeed recovered in Solari (2010), Lim *et al.* (2010), and Carvalho *et al.* (2011) molecular surveys. Within the remaining populations of the *brevicaudata* species group, for which localities are mapped on Figure 4.4.2, Node 39 comprises a tricotomy containing breetoTX + brehNeB + BreiGui, that is, a population of *M. touan* from the east bank of the Xingú river in Pará state south of the Amazon river at NT0168 – Tapajós-Xingu moist forests (breetoTX) and two populations north of the Amazon river, namely a population of *M. brevicaudata* from the northern Amazon at ecoregion NT0143 – Negro-Branco moist forests (brehNeB) and a population of *M. brevicaudata* from the eastern Venezuela ecoregion NT0125 – Guianan moist forests or NT0124 – Guayanan Highlands moist forests (BreiGui). Nevertheless, the distance among

populations does not necessarily reflect distance in historical relationships. For instance, Lim *et al.* (2009) found deep sequences divergence solely within the Guiana Shield, analysing populations from the French Guiana, Guyana and Venezuela, all within the Wallace (1852) northeastern region of the Amazon. On the other hand, Steiner & Catzeflis (2004) analysis yielded a closer relationship among populations crossing the Amazon river barrier at the eastern range, than those sharing a northeastern Amazonian distribution. They recovered a clade with Manaus populations as basal to a sister pair composed of populations from southeastern Amazonia and French Guiana populations. This clade appeared as a sister group to populations of north Guyana and Venezuela, while a geographically intermediate population at south Guyana was recovered as basal to both clades. These populations came out as a monophyletic group sister to a basal *M. glirina*, though *M. domestica* was not included in their analysis.

Finally, Node 28, with Bremer support 2, unites as sister groups *M. kunsi* and *M.*

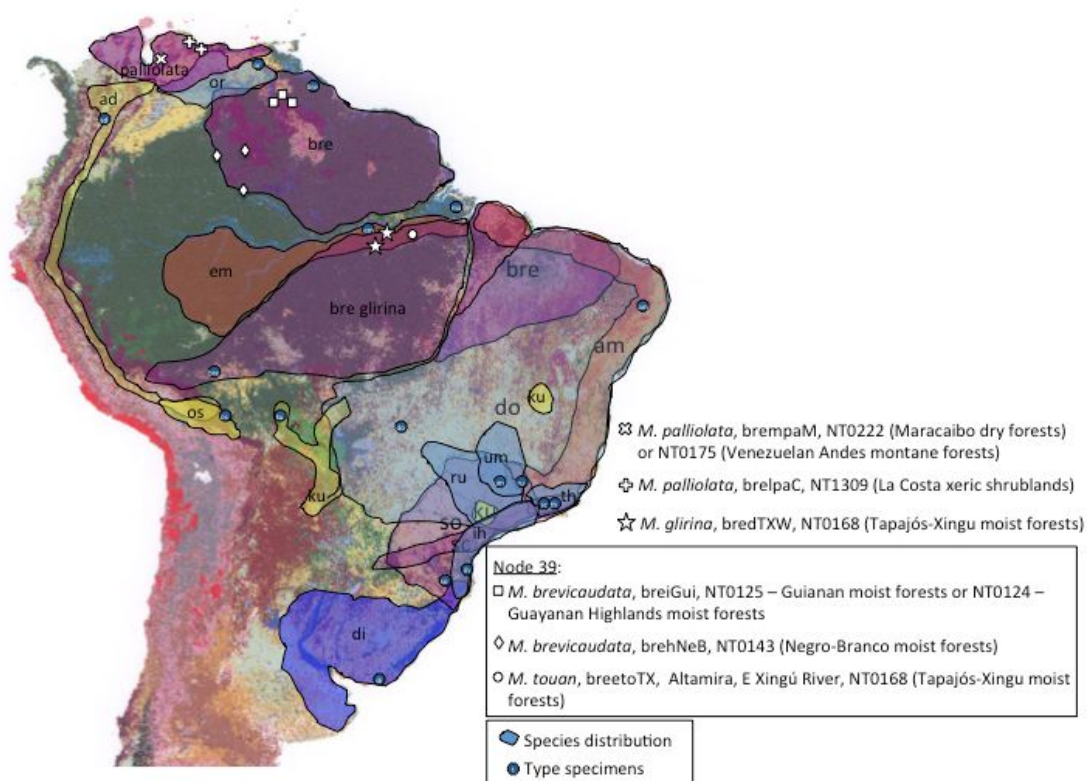


Figure 4.4.2. Localities of *M. brevicaudata* species group populations included in the cladistic analysis.

adusta (including the Type specimen of *M. adusta*, and the Type specimen of *M. adusta peruvianus*), based on Character 56 state 1: alisphenoid tympanic process opens posteroventrally, instead of encapsulating. In Vidigal (2004) *M. kungsi* resulted as the sister group to the (*M. adusta* + *M. osgoodi*) clade. The grouping of the Andean *M. adusta*, *M. osgoodi*, *M. handleyi* and *M. peruviana* was well supported in Solari's (2010) molecular analysis, though *M. kungsi* did not appear as a related taxon as was the case of my results based on pelage and basicranial anatomy. *M. adusta* and *M. osgoodi* resulted as a sister group based on the first sampling of basicranial anatomy and pelage (Vidigal 2004), also in agreement with Solari's (2010) *adusta* species group. Patton & Costa (2003) found low levels of sequence differentiation among southern and northern Peruvian samples of *M. adusta*. A close relationship between *M. kungsi* and the *adusta* species group has also been proposed by Anderson (1997) and Vargas *et al.* (2003) based on morphology, and recovered by Lim *et al.* (2010), though with low bootstrap support.

The following are the basicranial unambiguous autapomorphies characterizing *Monodelphis* populations. The population of *M. emiliae* (embMTX: MN1299 and USNM461884) from Pará, in the ecoregions NT0135 (Madeira-Tapajós moist forest) and NT0168 (Tapajós-Xingu moist forests) is supported by the autapomorphies MC13, state 0 (transverse canal foramen directed "laterally", with no anterior nor posterior components), and MC111, state 1 (stapes' crura united and completely undistinguishable from each other, so that the body of the stapes is a smooth surface, and the stapedia foramen is absent (columniform)). *M. kungsi* (kucPNPB: MZUSP480) is characterized by character MC119 state 0: suprategital foramen large relative to the distance between the postglenoid process and the posttympanic process. The population of *M. brevicaudata* from Amazonas (brehNeB: USNM406907, AMNH78096, USNM385010, EV18), mainly in the ecoregion NT0143 (Negro-Branco moist forests) is supported by the autapomorphy MC25 (state 1): posterior aperture of the pterygoid canal arc-shaped (flat dorsally). *M. brevicaudata* (breeTXE) is supported by character MC42 (state 2): anterior shape of the foramen ovale indented. *M. domestica*'s (doiChAP: USNM293130) autapomorphy is MC27 (state3): narrow groove on the basisphenoid, running along the lateral aspect of the rounded ridge, leading to

the posterior opening of the pterygoid canal, confluent with the sulcus towards the transverse canal, both directed towards the foramen for the greater petrosal nerve.

The supported groups obtained by both analyses were plotted on the *Monodelphis* area distribution map for a phylogeographic pattern evaluation (Figure 4.4.3). The patterns recovered are much similar to that obtained in Vidigal (2004), though better resolved, thus the basal polytomy was substituted by two sister clades of species.

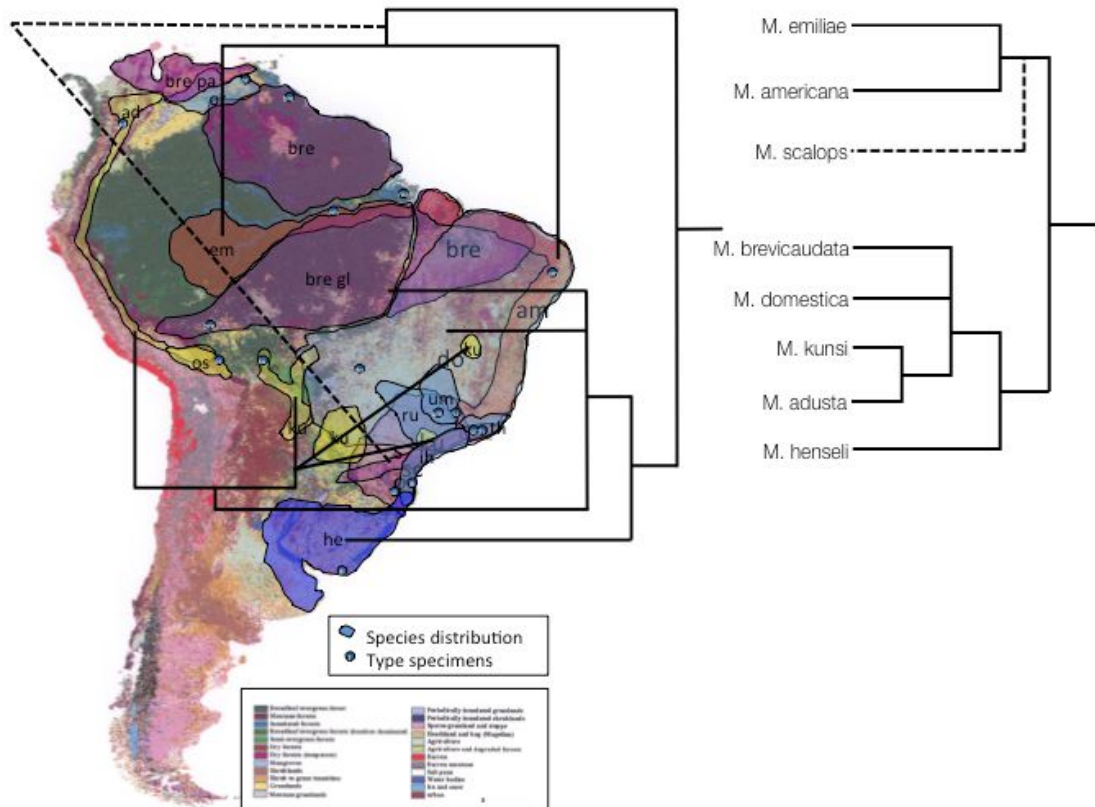


Figure 4.4.3. Phylogeographic patterns of *Monodelphis* monophyletic species groups recovered based on basicranial anatomy mapped on species and species groups distribution areas.

The monophyletic clade uniting *M. kungsi* to *M. adusta* species group replicates the recent findings (*M. americana* + *M. gardneri* in Solari 2012) pointing to the close relationship among Andean and Atlantic Forest, a pattern of distribution already found in ferns (Smith *et al.* 1999), epiphytic cacti (Ibisch 1996), *Hyla* frogs (Luna & Patterson 2003), cotinga birds (Snow *et al.* 2004). Luna and Patterson (2003)

presented *Rhagomys* as the first mammalian group to show a disjunct distribution between the Brazilian Atlantic Rainforest (*Rhagomys rufescens*) and the eastern slopes of the Andes (*Rhagomys longilingua*). The latest discovered example of the Andean-Atlantic Forest pairing is the case of the new genus *Drymoreomys* from the Brazilian Atlantic Forest and *Eremoryzomys* of Northern Peru (Percequillo *et al.* 2011). The monophyly of a group containing *M. kunsi* and the *adusta* species complex was also recovered in the most recent and comprehensive molecular survey for the genus (Pavan *et al.* 2014). In the case of *M. kunsi*, inedit sampling (de la Sancha *et al.* 2007) in intermediate localities between eastern and western previously disjunct areas of distribution points to the Paraná River basin “pathway” (Costa 2003) as a probable connecting corridor. It is noteworthy to point out the importance of trapping bias in an evaluation of species rarity (de la Sancha *et al.* 2007), clearly the case of *M. kunsi*, with an exponentially increase in sampling once Pitfall traps had been started to be used (Villalpando 2006, Caramaschi *et al.* 2011). A scenario of additional dispersion events via Central Brasil is more probable in the case of this species, which may either be more generalist in their ecological niches, given the variety of habitats it has been collected in, including Chaco and Cerrado (de la Sancha *et al.* 2007) or explore corridors of more homogeneous habitat for dispersal (Costa 2003). The close relationship recovered by this basicranial analysis among the *brevicaudata* species group, with widespread Amazonian distribution, and *M. domestica*, with widespread distribution across the intermediate Cerrado and Caatinga biomes was also supported by the relatively lower levels of sequence differentiation by Patton & Costa (2003). A close relationship between the latter pair to the *kunsi-adusta* clade, as shown when collapsing nodes with no Bremer support (Figure 4.4.3) points out to another case of relationship among these biogeographical areas (Costa 2003), with the most recent link species possibly been *M. kunsi*. Distance phenograms according to shape would seem to agree to this hypothesis (Ventura *et al.* 2004). Alternatively, when considering a close relationship between *M. palliolata* (ecoregion population brelpaC from NT1309 – La Costa xeric shrublands) and the *kunsi-adusta* pair, as recovered by this analysis, though with no Bremer support, a phylogeographic scenario closer to that of *M. reigi* and *M. adusta* (Lim *et al.* 2009) can be considered, with *M. adusta* as the Andean

linking species, instead of via Central Brasil. The *brevicaudata* species clade (Node 39), even though without internal resolution, unites the eastern Tepuis region of Venezuela with Negro-Branco rivers interfluvium down south of the Amazon, connecting Wallace's (1852) northeastern region to the southeastern region of the Amazon, a result reproduced by Steiner & Catzeflis (2004). Phylogeographic relationships and species diversity in the *brevicaudata* species complex is intriguing to say the least. Its polyphyletic nature as revealed by the present analysis was also the result of the molecular analysis of Patton & Costa (2003), with separate populations of *M. brevicaudata* differing more in genetic sequence among each other than populations of *M. brevicaudata* in comparison to *M. domestica*. It would be essential to fill the geographic sample gaps in coding in order to clarify the relationships among populations of the several ecoregions represented in such a vast territory.

M. emiliae, with a south Amazonian distribution is closely related to *M. americana* species group and *M. scalops*, which have a predominantly Atlantic Forest distribution. This phylogeographic pattern has been found for *Didelphis marsupialis* and *D. aurita* with only 3% sequence divergence; *Metachirus* from the Atlantic Forest, Southern Amazonia and south-western Amazonia with 5% divergence; *Marmosa* from central Brasil and the Atlantic Forest with 4,5% divergence; (Patton & Costa 2003). Patton & Costa (2003) reported the lowest divergence among samples of *M. emiliae* (1,3%). The biogeographic bridge to both taxa agrees with the Costa (2003) hypothesis. Even though of less apparent influence, some *americana* group species found in Cerrado biomes indicate this corridor, probably through gallery forests as another way of contact. The phylogeographic patterns observed in the *americana* species group further indicate these relationships between the Brazilian Atlantic Forest and the Amazon, with the interior biomes, namely the Caatinga and possibly Cerrado via gallery forests as dispersal units, as argued by Costa (2003). The findings herein are a contribution to the obscure and controversial phylogenetic relationships among the dorsally striped *Monodelphis* species (Solari *et al.* 2012).

Both current results as well as those from Vidigal (2004) are congruent in shedding light to these evolutionary patterns. *Monodelphis* is a very old lineage, with

an estimated origin at approximately 26 million years ago (Steiner *et al.* 2005), and species divergence events are spread over a wide time range of possible dispersal events in South America. Deep splits are shown by sequence divergences of over 10% among species and species groups (e.g. 20,2% among *M. reigi* and *M. b. brevicaudata* in Lim *et al.* 2009; *M. americana* and *M. gardeneri* with almost 16% in cytochrome b in Solari, 2012). Patton & Costa (2003) had already found a high average genetic sequence divergence (18,4%) among the eight species units they analyzed based on the cytochrome b gene. The genus widespread distribution and species richness is congruent to the multiple factor speciation model proposed by Patton & Costa (2003) and Costa (2003), where both dispersal and vicariance together with climatic and geographic longitudinal event span played important roles in a complex species diversity generation. Thus, according to a temporal multifactor complex explanation, habitat partition like the subsiding of the fluvial terraces of the Chaco, Beni and Pantanal around the Plio-Pleistocene due to tectonic movements (Iriando 1993) is only one of several species speciation events. Interestingly enough, the latest data in agreement with this model are the reconstructions of habitat occupancy of *Monodelphis* species, which suggest multiple independent invasions of open habitats by 6 of the 22 terminal species analysed (Pavan *et al.* 2014).

5. CONCLUSIONS

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The 102 characters found to describe stable variation in the basicranial anatomy passed the stability test by been constructed through the study of the 165 specimens listed here and many additional specimens from several museum collections. Completing the present matrix and coding these remaining specimens should increase the support to the present analysis, which was carried out with a population size limited sample. Nevertheless, the basicranial anatomy proved to be a stable, diverse and numerous sources of phylogenetically informative characters. Very fine complex inner, middle and outer ear interrelated morphologies account for hearing adaptations in mammals. All the intricate basicranial osteology, topology, and imprints reveal hints to function, thus natural history, as well as genealogical relationships, thus evolutionary history. Given the variety of habitats particularly associated to *Monodelphis* species, it would be very insightful to explore possible correlations between otic phenotype and species ecology and ethology.

Even though missing data decreases phylogenetic accuracy, the denser character sampling performed here allowed an insight into interspecific relationships within *Monodelphis*. My observation and preparation of the basicranium region for character search and coding allowed me to assess the main causes of missing data in basicranial or otic studies. Low coding percentages are mostly due to poor taxidermy, with the consequent time consuming and extremely delicate mechanical cleaning needed in order to make the morphology visible. A second important reason, though in much fewer cases, is inadequate or too much taxidermy, causing breakage or direct loss of basicranial bones and ossicles. Increasing taxonomic and geographic sampling, minimizing missing data in character coding, and diversifying the source of phylogenetic information (e.g. basicranium, dental, nasal, etc. as well as different nuclear and mitochondrial) with depth of anatomical characterization seems to be particularly necessary in order to shed light to the evolutionary history and phylogeography of this very revealing but historically puzzling genus.

The criteria chosen in this research to minimize missing data, aggregating specimens into ecoregion populations, is useful in three fundamental scientific aspects. First, it is replicable in future phylogenetic or morphometric studies. In the second

place, it provides a standard protocol in defining OTUs below the species level, which is particularly useful in cases where species limits are not clearly defined. This, in turn, consequently leads to the third aspect, enabling more reliable comparisons among systematic as well as ecological research, so necessary to obtain macro level estimates of complex ecological and evolutionary patterns.

In comparison to my earlier results (Vidigal 2004), extracting pelage characters and relying on a single source of phylogenetic data, the basicranial system, though with a much greater depth and density of characters yielded quite similar phylogenetic results, yet increasing resolution. The cladistic analyses corroborated the monophyly of *Monodelphis* and the placement of *Marmosa* as its sister group. Within *Monodelphis*, the supported monophyletic clades were: (*M. emiliae* (*M. americana* from NT0170 – Tocantins-Araguaia-Maranhão moist forests, *M. rubida* (*M. umbristriata*, *M. americana* from NT0104 – Bahia Interior Forests))), (*M. henseli* (*brevicaudata* species group, *M. domestica* (*M. kungsi* + *M. adusta*), and (*M. touan*, *M. brevicaudata* from NT0143 – Negro-Branco moist forests, *M. brevicaudata* from eastern Venezuela).

The phylogeographic results herein corroborate with previous phylogeographical results for several other groups of Neotropical fauna, including other *Monodelphis* species. *Monodelphis* provides three examples of the overlapping multiple evolutionary species diversity models proposed by Costa (2003) and Patton and Costa (2003) for South America. The sister group composed of *M. kungsi* and *M. adusta* indicates the relationships among the Andean and the Atlantic forests, enabling a scenario of additional dispersion events via Central Brasil or of exploitation of corridors of more homogeneous dispersal habitats (Costa 2003), like that of the Paraná River basin “pathway”. The close relationship recovered among the *brevicaudata* species group, with widespread Amazonian distribution, and *M. domestica*, with widespread distribution across the adjacent southeastern Cerrado and Caatinga, to the *kungsi-adusta* pair, points to the relationship among these vast ancient and within itself diverse biomes, with the most recent link species possibly being *M. kungsi*. Alternative to this Central Brasil pathway, an Andean linking phylogeographic scenario closer to that suggested for *M. reigi* and *M. adusta* (Lim *et al.* 2009) can be visualized when considering a close relationship between *M. palliolata* from NT1309 – La Costa xeric

shrublands, Venezuela, and the *kunsi-adusta* pair. Phylogeographic relationships and species diversity in the polyphyletic *brevicaudata* species complex provide a second example for the South America evolutionary diversification, with species uniting the eastern Tepuis region of Venezuela with Negro-Branco rivers interfluvium down to southeastern Amazonia, connecting Wallace's (1852) envisioned Amazonian subdivisions, a result reproduced by Steiner & Catzeflis (2004). The last example provided by the present modest contribution to knowledge on the genus diversity and evolutionary history is the resulted monophyletic group (*M. scalops* (*M. americana* species group, *M. emiliae*)). The clade provides a phylogeographic gradient uniting, respectively, southeastern Atlantic Forest (including Araucaria moist forest at the southmost distribution and Bahia Coastal Forests at Pico da Bandeira, 1400m) linking to Cerrado with *M. umbristriata*, through Bahia Interior Forests with *M. rubida*, turning the northeastern corner of Brazil until the Tocantins-Araguaia-Maranhão moist forests with *M. americana*, to southern Amazonia from the Xingu-Tocantins-Araguaia Moist forests, through the Tapajós river until the westernmost locality at Rondônia, these latter both in the vast Madeira-Tapajós moist forest with *M. emiliae*.

It is imperative to fill the geographic sample gaps in morphological as well as genetic coding in order to clarify the phylogenetic relationships among populations of the several ecoregions represented by species of *Monodelphis*, so that the biogeographic and evolutionary *Monodelphis* puzzle is completed. The estimated approximately synchronous origin of the genus *Monodelphis* at 26 my (Steiner *et al.* 2005) and the eastern range of the Colombian Andes at 25 my (Parra 2009), makes unravelling the coevolution of the genus to this unique massive changing environment a fascinating adventure.

6. REFERENCES

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7. RESUM DE LA TESI DOCTORAL

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7.1. INTRODUCCIÓ

Els marsupials sud-americans de cua curta del gènere *Monodelphis* Burnett 1830 ocupen els més diversos hàbitats, fins els 2200m des del sud-oest de Panamà fins a l'est d'Argentina (Figura 1.1). De mida petita, són omnívors, terrestres, de diürns a nocturns, i amb una dotació diploide de 18 cromosomes. Tot i la seva gran diversitat, amb més de 20 espècies (Pine & Handley 2007), la seva taxonomia i història evolutiva resten encara per dilucidar.

La majoria de les revisions taxonòmiques del gènere han estat limitades a un reduït nombre d'espècies (Taula 1.2.). En la darrera revisió genètica del gènere, Solari (2010) va proposar l'existència de vuit grups d'espècies: *adusta*, *americana*, *brevicaudata*, *dimidiata*, *emiliae*, *kunsi*, *theresa*, i un altre encara per anomenar. El monofiletisme del gènere ha estat corroborat per anàlisis de citocrom b (p. ex. Lim *et. al.* 2010), amb una excepció (Solari 2010), nuclears i morfològiques (Vidigal 2004, Flores 2009, Voss & Jansa 2009).

L'afinitat amb els gèneres *Lestodelphis*, *Marmosa*, *Micoureus* i *Thylamys* ha estat proposada en funció a dades morfològiques, citogenètiques i moleculars (Reig *et. al.* 1985). *Gracilinanus*, *Thylamys* i *Lestodelphys* resulten com clade germà segons la morfologia, serologia i cariotip (Reig *et. al.* 1987), i els dos últims gèneres com a grups germans atenent a caràcters d'anatomia tova i osteològics (Creighton 1984). Els estudis sobre hibridació d'ADN-ADN (Kirsch & Palma 1995), citocrom b (Patton *et. al.* 1996) i gens nuclears (Jansa & Voss 2000) han evidenciat *Marmosa* i *Micoureus* com a grup germà. Més recentment, *Marmosa* i *Tlacuatzin* apareixen com a grup germà en base a dades nuclears i morfològiques (Voss & Jansa 2009). Finalment, en l'estudi de Flores (2009), basat en caràcters postcranians, *Monodelphis* resulta grup germà dels grans marsupials americans amb $2n = 22$ (i.e. *Metachirus*, *Chironectes*, *Lutreolina*, *Philander* i *Didelphis*).

El gènere *Monodelphis* té un històric de subdivisió en més d'un gènere, subgèneres, tribus i grups d'espècies (Burmeister 1856, Thomas 1888, Matschie 1916, Cabrera 1919 i 1958, Gilmore 1941, Pine 1976, Gomes 1991, Solari 2007 i 2010;

veure Taula 3). Basat en el pelatge i l'anatomia basicraniana, la primera anàlisi cladística no molecular de Vidigal (2004) va proporcionar dos clades (*M. adusta*, *M. osgoodi* i *M. kungsi*) i (*M. scalops*, *M. emiliae* - espècies ratllades dorsalment-). L'estudi del citocrom b realitzat per Steiner & Catzeflis (2004) va confirmar l'afinitat entre *M. brevicaudata* i *M. glirina*. Els resultats de l'anàlisi del citocrom b efectuat per Lim *et. al.* (2010) van presentar *M. adusta*, incloent *M. reigi*, com un grup monofilètic i una relació de grup germans entre el complex *M. brevicaudata* i *M. domestica*.

Molts aspectes dels sistemes nerviós central, vascular del crani, auditori i masticatori poden ser reconstruïts, segons la presència de foràmens, solcs i crestes en les impressions a les superfícies òssies i en el mosaic de formes produït pels ossos que constitueixen el basicrani (Rougier *et. al.* 1992; Wible 1987, 1990; Wible & Hopson 1995). Aquests elements ossis són l'alisfenoid, el basisfenoid, el basioccipital, l'exoccipital, l'escamós, el petrós, l'ectotimpànic i els ossicles de l'oïda (el martell, l'enclusa i l'estrep; veure Figura 4.3A). Wible (2003) va proporcionar la descripció més detallada del basicrani d'un marsupial sud-americà, fent servir *M. brevicaudata* com a espècimen base i comparant-lo amb els altres exemplars de *Monodelphis* disponibles a la col·lecció del Carnegie Museum (CM).

La història evolutiva dels mamífers ha estat reconstruïda, en part, atenent a caràcters basicranials (p. ex. Mammalia: Novacek 1989; Wible 1991; Wible & Hopson 1993; Theria: Wible 1990; Eutheria: Gaudin *et. al.* 1996; Monotremata: Macrini *et. al.* 2006; Pholidota: Gaudin & Wible 1999; Primates i Insectivora: MacPhee 1981; Didelphimorphia: Reig *et. al.* 1987, Voss & Jansa 2009). La utilització de l'anatomia del basicrani a nivells taxonòmics més baixos no ha estat tan extensa, però també s'ha mostrat informativa (p. ex. Felidae: Salles (1992); Phalangeridae: Norris (1994); *Proechimys*: Gardner & Emmons (1984); *Manis* i *Patiomanis*: Gaudin & Wible (1999); marsupials de les Amèriques a nivell genèric: Voss & Jansa (2009)). Estudis anteriors del basicrani de *Monodelphis* s'han centrat en *M. dimidiata* (Archer 1976), *M. domestica* (Reig *et. al.* 1987), *M. palliolata* i *M. brevicaudata touan* (Herskovitz 1992), *M. brevicaudata*, *M. orinoci*, i *M. dimidiata* (Gómez 1998), *M. dimidiata*, *M. domestica* i *M. osgoodi* (Wible 2003), i *M. theresa* i *M. emiliae* (Voss & Jansa 2009).

7.2. OBJECTIUS

Aquest treball de recerca és una extensió a fina escala en l'estudi de l'anatomia basicraniana i la seva variació topològica i morfològica en representants de 8 grups d'espècies i 21 espècies amb la finalitat de: 1) contribuir en el camp de l'anatomia proporcionant caracteritzacions detallades de les variacions anatòmiques observades; 2) aprofundir en el coneixement de l'anatomia de *Monodelphis* comparant i contrastant les variacions trobades amb estudis previs; i 3) fer una aproximació a la història biogeogràfica del gènere per medi d'una hipòtesis sistemàtica basada en l'anàlisi cladística de caràcters basicranials.

7.3. MATERIAL I MÈTODES

La identificació d'hipòtesis d'homologia primària basada en la topologia congruent s'ha establert en funció de les descripcions i reconstruccions de l'osteologia basicraniana i l'anatomia vascular i neurològica dels marsupials, segons Archer (1976), Wible (1987, 1990, 2003), i Wible & Hopson (1995), i en les caracteritzacions ontogenètiques de *M. domestica* (Maier 1987; Clark & Smith 1993).

Per tal d'identificar els espècimens de *Monodelphis*, es varen examinar gairebé tots els espècimens tipus i es van contrastar amb les respectives diagnòs i definicions aportades en les publicacions originals i revisions de les espècies considerades. Es va detectar un solapament considerable entre les definicions d'espècies, de manera que un espècimen només podia ser identificat inequívocament basant-se, com a mínim, en un caràcter de pelatge, doncs les característiques generals del crani eren insuficients com per a arribar a una determinació taxonòmica específica. Quan això tampoc va ser possible, els exemplars varen ser classificats a nivell de grup d'espècies. A partir d'aquestes observacions es van identificar tres patrons de coloració de pelatge (Taula 3.1). A la Taula 3.2 es detallen les característiques que distingeixen les espècies. La selecció d'espècimens adults va seguir el criteri de màxima diversitat morfològica i

geogràfica. Els juvenils varen ser examinats per tal de garantir que els estats de caràcter no estiguessin condicionats per l'ontogènia. Per l'anàlisi cladística només es van analitzar individus adults, presentant desgast moderat en el 3er premolar i en el 4rt molar. Concretament, es van codificar 165 espècimens de *Monodelphis* (114 mascles, 39 femelles i 12 amb sexe no determinat) i 31 de grup extern.

La construcció de caràcters és la partició de fenotips en caràcters discrets i la partició de variants en estats de caràcter. Els individus varen ser codificats pels estats de caràcter. Les estructures del basicrani només han estat visible en molts casos després de la neteja amb agulles d'insulina i sota lupa binocular. La variació va ser exclosa només si presentava un gradient, mentres que es van descriure tots els casos de polimorfisme discontinu. Es va adoptar el mètode reduccionista de construcció de caràcters (p. ex. presència/absència). També es van considerar els caràcters de multi-estats, com les sèries de transformacions discretes. Els espècimens van ser agrupats en funció de les coordenades de la localitat de recol·lecció. Per ser membre d'una població, fora necessari presentar les característiques de pelatge que presenten en comú. La unitat taxonòmica operacional fou la compilació d'estats de caràcter de tots els individus membres. Cinc gèneres de la família Didelphidae foren examinats i seleccionats com a taxa referent en l'anàlisi cladística: *Caluromys philander*, *Didelphis albiventris*, *Marmosa murina*, *Marmosops incanus* i *Lutreolina crassicaudata*. *Caluromys* fou triat com a grup extern.

Per minimitzar l'absència de dades, es va establir un mínim del 50% de caràcters codificats per ser inclosos en l'anàlisi. Els caràcters potencialment dimòrfics es van contabilitzar per a cada sexe per separat. Per cada exemplar es va identificar la Ecorregió Terrestre de WWF equivalent a la localitat de recol·lecció (Taulas 4.1 i 4.2). Per l'anàlisi cladística es va utilitzar el programa TNT (Tree analysis using New Technology ver. 1.0, Goloboff 1999, Nixon 1999, Goloboff *et.al.* 2008) i WinClada (WinClada ver. 1.0, Nixon 2002) per tal de reconstruir els estats de caràcters ancestrals. Aquest trets varen tenir el mateix pes i els multiestats varen ser tractats com sense ordre. Quan es va trobar més d'un arbre parsimoniós, els criteri de selecció entre els arbres va ser "implied weights".

7.4. RESULTATS I DISCUSSIÓ

Els 102 caràcters trobats es resumeixen a la Taula 4.3. Es van identificar més caràcters de Matriu (MC) que caràcters cladístics de basicrani (CIB), donat que els primers inclouen la duplicació dels caràcters potencialment dimòrfics sexualment. La matriu completa de caràcters del basicrani es troba a l'Apèndix 1 i al sumari de l'Apèndix 2. Del llistat final de 122 caràcters, 20 son potencialment dimòrfics. Per manca d'accés a tots els espècimens durant el període final de codificació, tot i agregant-los per ecorregions, la majoria de poblacions ha presentat un percentatge baix de caràcters codificats. El tall a 50% mínim de caràcters codificats ha resultat en 17 OTUs, representant el 27% del total de poblacions. *M. kunsi*, amb un 45% de caràcters codificats, ha estat inclòs en l'anàlisi global, i *M. scalops* a un anàlisi cladístic addicional.

L'arbre més curt ha estat inferit heurísticament, començant amb 1000 arbres Wagner, seguit per TBR "branch swapping", i conservant 10 arbres per rèplica fins a un màxim de 10,000 arbres. Els resultats han proporcionat 6 arbres més parsimoniosos de 275 passes. Una nova anàlisi sota "implied weights" ha proveït el criteri per la tria d'un únic arbre final (Figura 4.4.1). L'anàlisi addicional amb grups d'espècies com OTUs ha resultat en 9 arbres més parsimoniosos amb 206 passes. L'únic arbre després de "l'implied weights" ha recuperat *M. scalops* com el grup germà al clade que conté el grup *americana* i *M. emiliae*, amb una sinapomorfia (caràcter MC52 estat 2) i una autapomorfia per *M. scalops* (MC6 estat 2). *Monodelphis* i *Marmosa* van resultar com clades germans amb 4 sinapomorfies (caràcter 51 estat 1, caràcter 57 estat 0, caràcter MC88 estat 2, caràcter MC120 estat 1). El monofiletisme de *Monodelphis* també va ser confirmat, amb 3 sinapomorfies (caràcters 71 estat 1, 87 estat 1, i 113 estat 2).

Un altre clade amb suport ha estat *M. emiliae* amb *M. americana*, *M. rubida* i *M. umbristriata*, amb 3 sinapomorfies (caràcters 49 estat 2, 66 estat 2, i 103 estat 1). *M. emiliae* també va resultar proper del grup *americana* a l'estudi de Vidigal (2004). Els resultats moleculars van donar a *M. emiliae* com a grup germà de *M. kunsi*, *M. brevicaudata* i *M. dimidiata* (Flores 2009; Voss & Jansa 2009; Pine *et al.* 2013; Pavan *et al.* 2014), relacions incongruents amb els obtinguts en el present estudi i difícils de

considerar fenotípicament. El node 37 uneix *M. americana* i *M. umbristriata* en base al caràcter 84 (1). Les quatre poblacions de *M. americana* s'ajunten al node 34, tot i que amb suport baix i cap sinapomorfia inequívoca, un resultat corroborat per Pavan et. al. (2014). Tampoc s'ha trobat una sinapomorfia exclusiva pel clade format al node 33 constituït per les poblacions de *M. americana* del Pará i de Bahia.

Al node 31, es recupera el grup *henseli* com a germà d'un clade que conté el grup d'espècies *brevicaudata*, *M. domestica*, *M. kungsi* i el grup d'espècies *adusta*, en funció de dues sinapomorfies: caràcters 85 estat 0 i 88 estat 0. Aquest agrupament no es va produir a l'anàlisi de caràcters de pelatge i basicrani efectuat per Vidigal (2004), on *M. domestica* apareixia com a basal a totes les altres espècies de *Monodelphis*. Pine et. al. (2013) també van trobar una relació propera entre el grup *henseli* i *M. domestica*, tot i que en aquesta agrupació també apareixien *M. unistriata* i *M. iheringi*, inclusió incongruent amb els resultats obtinguts en el present estudi. El node 30 uneix el grup d'espècies *brevicaudata*, *M. domestica*, *M. kungsi* i el grup d'espècies *adusta*, basant-se en 3 sinapomorfies: caràcters 10 estat 3, 38 estat 1, i 49 estat 0. Aquest agrupament constitueix un complex *brevicaudata* polifilètic, evidenciat pel node 41 ja que agrupa *M. domestica* i la població de *M. brevicaudata* del Pará. Estudis moleculars corroboren l'afinitat entre *M. domestica* i *M. brevicaudata sensu lato* (Solari 2010, Lim et. al. 2010, Carvalho et. al. 2011). El node 39 es compon per la població de *M. touan* al sud i dues poblacions de *M. brevicaudata* al nord del riu Amazonas (Figura 4.4.2). Finalment, el node 28 uneix *M. kungsi* i *M. adusta* (incloent els espècimens tipus de *M. adusta* i de *M. adusta peruvianus*), basat en el caràcter 56 (estat 1). Similarment, *M. kungsi* va resultar grup germà de (*M. adusta* + *M. osgoodi*) a l'anàlisi de Vidigal (2004).

Els clades amb suport Bremer obtinguts han estat superposats al mapa d'àrea de distribució de *Monodelphis* per fer una valoració filogeogràfica (Figura 4.4.3). Els patrons són molt semblants als obtinguts a Vidigal (2004), però amb millor resolució doncs la politomia basal ha estat substituïda per dos clades germans d'espècies. El clade monofilètic unint *M. kungsi* al grup d'espècies *M. adusta* coincideix amb els resultats de Solari et al. (2012) amb (*M. americana* + *M. gardneri*) en el sentit d'assenyalar una relació propera entre els boscos Andins i l'Atlàntic. Aquesta relació ja

va ser trobada en altres grups, des de plantes a mamífers (p. ex. Smith *et. al.* 1999, Percequillo *et. al.* 2011). El monofiletisme de l'agrupació entre *M. kunsi* i el complex d'espècies *M. adusta* també va aparèixer en l'anàlisi molecular de Pavan *et. al.* (2014). En el cas de *M. kunsi*, un mostreig inèdit en localitats intermèdies entre les àrees de distribució presumiblement disjunctes, a l'est i l'oest de la conca del riu Paran , apunten aquesta ruta com a probable passad  connector (Costa 2003). Tamb   s probable un escenari d'esdeveniments de dispersi o addicional via Brasil central, donat la varietat d'h bitats on va ser col·lectada aquesta esp cie i la seva possible, i conseq ent, ecologia generalista o, alternativament, la utilitzaci o de passadissos d'h bitats m s homogenis (Costa 2003). La relaci o propera obtinguda en el present estudi entre el grup *brevicaudata*, amb distribuci o amaz nica, i *M. domestica*, amb  mplia distribuci o pels biomes del Cerrado i de la Caatinga tamb  es corrobora en l'an lisi molecular realitzat per Patton & Costa (2003). L'agrupaci o entre aquest darrer clade i el format per *kunsi-adusta* apunta a un altre cas d'aproximaci o filogeogr fica entre aquestes dos regions, amb *M. kunsi* com a possible esp cie connectora m s recent. Els fenogrames de dist ncia obtinguts per Ventura *et. al.* (2004) s n congruents amb aquesta hip tesis. Alternativament, quan es t  en compte la propera relaci o entre *M. palliolata* i la parella *kunsi-adusta*, es pot deduir un escenari semblant al de *M. reigi* i *M. adusta* (Lim *et. al.* 2009), amb *M. adusta* com l'esp cie connectora pels Andes. El clade del grup *brevicaudata* uneix els Tepuis de l'Est a Vene uela amb l'interfluvi dels rius Negro i Branco al sud de l'Amaz nia, connectant les regions nord-est i sud-est amaz niques definides per Wallace (1852). *M. emiliae*, amb distribuci o sud-amaz nica, apareix relacionada amb el grup *M. americana* i *M. scalops*, ambdues  ltimes predominantment amb distribuci o al bosc Atl ntic de Brasil, un resultat observat en altres marsupials americans (Patton & Costa 2003). La pres ncia de poblacions de *M. americana* al bioma del Cerrado indica un passad  connector, probablement a trav s de boscos de galeria (Costa 2003).

Monodelphis  s un llinatge molt antic, amb un origen estimat, aproximadament, en 26 milions d'anys (Steiner *et. al.* 2005), amb diverg ncia d'esp cies espaiada en el temps i amb diferents moments de dispersi o a Sud Am rica. Diverg ncies profundes s n exemplificades per dist ncies moleculars de m s del 10%

entre espècies com, per exemple, del 20,2% entre *M. reigi* i *M. b. brevicaudata* (Lim *et al.* 2009) o del gairebé 16% entre *M. americana* i *M. gardeneri* (Solari *et al.* 2012). L' àmpliament diversificada distribució geogràfica del gènere i la riquesa en espècies és congruent amb el model d'especiació de factor múltiple de Costa (2003) i Patton & Costa (2003), suggerint que ambdós mecanismes d'especiació, dispersió i vicariància, junt amb esdeveniments climàtics i geogràfics, són condicionants importants en la generació complexa de la diversitat d'espècies. El treball més recent, congruent amb aquest model complex, temporal i de multifactors, reconstrueix l'ocupació d'hàbitats per part de les espècies de *Monodelphis*, indicant invasions independents múltiples en ambients oberts per a 6 de les 22 espècies analitzades (Pavan *et al.* 2014).

7.5. CONCLUSIONS

Els 102 caràcters basicranials descrits en aquest treball passen el test d'estabilitat al ser construïts a través de l'estudi dels 165 espècimens, juntament amb exemplars addicionals de diverses col·leccions de museus. S'ha constatat que el basicrani és una font estable, diversa i abundant de caràcters filogenètics informatius. Ampliar la mostra d'espècimens per completar la matriu de dades podria incrementar la consistència i la resolució dels resultats aquí presentats. La complexa osteologia, topologia i empremta del basicrani suggereix aspectes funcional, així com d'història natural i relacions filogenètiques, i per tant d'història evolutiva. Seria molt aclaridor investigar les possibles correlacions entre el fenotip òtic i l'ecologia i etologia de les espècies.

El criteri d'agregar espècimens en poblacions per ecoregió és útil en tres aspectes: 1) és un criteri replicable; 2) és un protocol estàndard de definició d'OTUs per sota de la categoria d'espècie, particularment adient en casos en que els límits entre les espècies no estan clarament definits; i 3) conseqüentment possibilita comparacions més fiables en estudis sistemàtics, morfomètrics o ecològics.

Extraure caràcters de pelatge (Vidigal 2004) i aprofundir en l'anatomia del basicrani ha donat resultats molt semblants, tot i que s'ha incrementat la resolució. L'anàlisi cladística ha corroborat el monofiletisme de *Monodelphis* i *Marmosa* com

grup germà. Intergenèricament, els clades monofilètics amb suport Bremer són: (*M. emiliae* (*M. americana* de NT0170 – Boscos humits Tocantins-Araguaia-Maranhão, *M. rubida* (*M. umbristriata*, *M. americana* de NT0104 – Boscos d’interior de Bahia)), (*M. henseli* (grup d’espècies *brevicaudata*, *M. domestica* (*M. kungsi*, *M. adusta*), i (*M. touan*, *M. brevicaudata* de NT0143 – Boscos humits Negro-Branco, *M. brevicaudata* de l’est de Veneçuela).

Els resultats filogeogràfics obtinguts corroboren els descrits en diversos grups de fauna neotropical. *Monodelphis* proveeix tres exemples que encaixen en el model múltiple i amb solapament de diversitat evolutiva d’espècies proposat per Costa (2003) i Patton & Costa (2003) per Sud-americà. La relació propera entre *M. kungsi* i *M. adusta* ratifica la relació entre els boscos dels Andes i l’Atlàntic, possibilitant un escenari addicional de dispersió pel Brasil Central o l’explotació de passadissos d’ambients de dispersió més homogenis, com la conca del riu Paranà. La connexió entre el grup *brevicaudata*, amb distribució àmplia a l’Amazònia, i *M. domestica*, amb distribució vasta per els adjacents sud-est Cerrado i Caatinga, amb la parella *kungsi-adusta*, apunta a la relació entre aquests biomes antics i alhora diversos, amb *M. kungsi* com a possible espècie connectora més recent. Una alternativa a Brasil Central seria el pas Andí suggerit per l’agrupació de *M. reigi* i *M. adusta* (Lim *et. al.* 2009), que es pot visualitzar quan es considera la relació propera entre *M. palliolata* de La Costa (Veneçuela) amb la parella *kungsi-adusta*. Les relacions filogenètiques i la diversitat d’espècies en el complex polifilètic *brevicaudata* proporcionen un segon exemple de la diversificació evolutiva a Sud-Amèrica, amb espècies unint els Tepuis de l’est de Veneçuela amb la regió interfluvial dels rius Negro-Branco i fins el sud-est de l’Amazònia, connectant les subdivisions amazòniques proposades per Wallace (1852), resultat corroborat per Steiner & Catzefflis (2004). L’últim exemple de la present contribució al coneixement de la diversitat i història evolutiva del gènere és el resultat grup monofilètic (*M. scalops* (grup d’espècies *M. americana*, *M. emiliae*)). Aquest clade proporciona un gradient filogeogràfic, començant per 1) el bosc Atlàntic (incloent boscos d’Araucària i boscos de la costa de Bahia), exemplificat per *M. scalops*, continuant per 2) el Cerrado, representat per *M. umbristriata* (que es troba dins el grup d’espècies d’*americana*) seguit per 3) els boscos d’interior de Bahia on

habita *M. rubida* (també dins el grup d'espècies d'*americana*) que es continua per 4) la punta nord-est de Brasil fins als boscos humits del Tocantins-Araguaia-Maranhão, representat per la resta de formes incloses dins *M. americana sensu stricto*, i finalitza travessant 5) el sud de l'Amazònia, des dels boscos humits del Xingu-Tocantins-Araguaia fins la localitat més a l'oest a Rondônia, àrea de distribució de *M. emiliae*.

És imperatiu completar geogràficament el mostreig morfològic i molecular per tal de clarificar les relacions filogenètiques entre les poblacions de les diverses ecorregions representades per les espècies de *Monodelphis* i completar l'enigma biogeogràfic i evolutiva del gènere. L'origen aproximadament sincrònic de *Monodelphis* (26 my; Steiner *et al.* 2005) i de la serralada est dels Andes colombians (25 my; Parra 2009) dona un escenari fascinant per esbrinar la coevolució del gènere en relació a aquest canvi massiu medi-ambiental a Sudamèrica.

APPENDICES

APPENDIX 1. Major patterns of pelage coloration in *Monodelphis*: A. Longitudinal bicolor, *M. domestica* USNM555659; B. Longitudinal tricolor, *M. brevicaudata touan* USNM549280; C. Transversal tricolor without stripes, *M. scalops* MZUSP30702; D. Transversal tricolor with stripes, *M. americana* MZUSP11697.



APPENDIX 2: Matrices analysed

Ecoregion aggregated population matrix of basicranium characters analyzed in this report:

adaaMaTY: [02]???0 -???? ????? ????? ????? 0???? ????? 0???? ???[123]? ???[03]1 [-4][-04]0?0 [01][03]110 01[-1]11 ???11 ?????[-2] [-12]1[01][01][12] --?0
010[01][-0] [-0]???? ?????13 1?0[-01][01] 010[01][01] 0[-2][23]-0
[01][012]0[01]1 [-12][-12]

addpeTY: [02]0??[01] [01]011? ?[01]??? ?????? ?0[01]12 00203 1??01 00100 00001 1-001
????00 1-110 01??1 0??10 01??? ?1111 -001 1100? ?????? ?????? 010??
01002 0???? ?201[12] 2-

kucPNPB: 2???? ?????? ?????? ?????? ?????? ?????? ?????? ?????? ?????? ?????? 0-??0 1-210
011-1 ???10 0?0-2 -111[012] --?00 010?? ?????? ??????3 1100- 01010 02-3- 10101
2-

amaToAr: [12]???1 0??[12] -???? ?????? ?????? 1???? ?????? 1???? ?????? ?????? 2[01] [-12]
[-1]1?1 00[01]11 [13]1[01]-1 ???1[01] ?????[02] -112- [-01][-0]?11 0122[-01]
[-0]???? [01]11[01][1234] [01]0[02]2- 11[01][012][01]0[-13][-0]2-
[01][12][01]21 2-

amdruBa: [012]???0 -??[12] [12]???? ?????? ?????? ?????? ?????? ?????? ?????? ?????? 2[-2]
1?1 00[12]1[12] [23]10[-0]1 ???10 ??[01][-01][01] [-1]102- [01]-?1[01]
002[12][01] [-1]0000 1?11[14] [01]0222 ?????? 0[34]-2- 1[012]1[01][12] 2-

amgBaIn: [12]0-2[01] [01][01]1[24]- [12][02]-1- 10-0- 00[012][12][02] 12011 0-213
10011 ?000[01] 21021 -4?[02]1 0021[12] 3???1 ?-01[01] 10-2- 1112- -0221
012?? ?????? ?????? 01[01]-2 10?12 0-2-[17] ?????? -0

amhumbC: 201-0 -1122 -21-1 -00-1 -0[01]?? 1?01? ???13 ?10?1 ??001 21021 1-1?1
0021[12] 31[01]-1 20-11 100-[01] -??2- 0-221 0122? ?????? 10113 [01]012-
20?0? 01-6- ?????? 2-

embMTX: 201-0 -0??0 -00-1 -10-0 -0[01]12 04[01]10 02-13 ?1011 ?0001 11021 1-1?2
?0110 310-? ???11 ?????0 -102- 1-?11 0?22? ?????? [01]1114 00[14]2- 2010? 1--
1- ?????? 2-

emcMTCe: [02]???? ???- [12]???? ?????? ?????? ?????? ?????? ?????? ?????? ?????? 21 [-01][-1]
1?2 00[12][01][012] [023]1-0[12] [23]??11 ?0[-02][-02][-1] [-12]1[01]2- [-1]
[-1]??1 0[01]22[-0] [-1]-[-0]-[-0] 1??[24] 10[12][-1][-1] [12][01]0[01][01]
0[-01][-24][-1][-23] [01][12]0[12][12] [-2][-02]

heesoPP: [01][01][12]-[01] 00140 -1[01]-1 -[01][01]-[01] -0[02]1[02] [01]00[13]0 11-
01 ?[01]021 10110 -0011 ???01 00110 110-1 00-11 102-1 -1013 --[12]00
[01][01]02? ?????? 1111? 0002- [12]1?1? 0[34]-[16]- ?????? 2-

bredTXW: [01]0[-0][-0]1 [02]212[-03] [-3]1[-0][-2]0 10-[-2]- [-0]011[23] [01]00[23]3
 1[-3][-0]00 2[01]120 10[02][12]1 [03]0101 4-?[02]1 00[12][01]0 01[-0][-0]1
 [014][-0][-1]11 11[-0][-02][-2] [-2]1111 --000 0[01][01]?? ????? ????? ????
 ?110[12] ????? ????? ??

breetoTX: 00[-0][-0]0 -01[124][-3] [-3][01][-2][-2]0 10-[-12][-0] [-0]211?
 01[02][123]0 1[-0][-04]01 ?01[01]0 ?2111 10[01]01 ???[012]1 001[01]0 01[-
 0][-0]1 [13][-1][-1]11 1[01]-0[-1] [-2]111[12] --00[01] 0[01]12? ????? ?????
 0[01]0[-1][-1] 1[01]?0? 0[-1][-1][-3][-3] ????? [-0][-0]

brehNeB: [01][01][-1][-4]0 -[02]11[-3] [-3][01][-1][-2]1 [01]0[-0][-1][-1] [-
 0][01][01]11 0102[024] 1[-0][-0]01 00120 [01]0[12]21 [01]00[01][01] [-1][-
 0]?0[01] 00[12][01]0 [12]1[-0][-0]1 [134][-0][-1]11 11[-2][-2][-2] [-2]11[01][-
 012] -000 [01]10[01]- -???? ?????2 000?? ?1[01]01 ????? ????? ?

breiGui: [01]0[-0][-1]0 -211[-3] [-3][01][-2][-2]0 11-[-0]- [-0][02][012][12]2
 1[13][01][23]4 1[-0][-0]0[01] 00110 1[01][012][12]1 [01]00[01]1 4-?[01]0
 00[12]10 [23]1[-0][-0]1 31-11 102-2 -11[01]- --[02]00 [01][01]02? ????? 1111?
 0[01]0[-1][-2] [01]1?[012]1 00-4- ????? [-2][-0]

brelpaC: [12]0[05]-0 -2113 -1[12]-1 -00-0 -01[12]? 0?0[12]1 10-0[01] 20110 ?0001
 10001 1-?01 00110 31[-0][-0]1 ?0-11 112-[-2] [-0]??[01][-012] --201 1102- 1-0-
 0 21112 100-2 21010 0-2?? ????? ??

brempaM: [01]0[-5][-5]0 -211[-3] [-3]0[-2][-2]1 1[01][-02][-0][-0] [-01]0[12]1?
 ??0[1234]3 [01][-0][-0]0[012] ?0120 ?[01][02][012]1 [01]000[01] ???[01]1
 00210 31[-0][-0]1 [46]-011 11[-2][-02][-2] [-2]111[12] --00[01] 1[01][01]??
 ????? ????? ????? ????? ????? ????? ??

doiChaP: [01][01]3-1 [01]01[24]3 -12-1- [01][02]-0 -01?? 03024 10-02 ?0110
 1[01]021 00?01 ???0? 002[01]0 010-? ????? ????? ????- --000 0012? ?????
 1111? 0002- 11?0? 03-1- ????? 0-

OGCal: 01??0 -0--- ----- --312 10012 0-10[23] 000?0 00031 400?1 [04]0[01]02
 010[01]0 [23]1000 ---0[01] -0221 10-2- ?????1 10?20 0---- 01113 00[23]11
 1[01]1[01]0 0[134][134][0145][0145] 12[02]22 22

OGDid: 01??0 -01[34]0 0[01][12]21 1[01][012][02][01] 0[01][23]10 00?[012]0
 10[01]01 010?1 0[02][01][01]1 4[01]011 2-1[01]2 [01]101[02] [13]0--0 ---00 -
 0--? ???0- --00- -0[01][01][02] 0---- ?0?10 0002- 10[01]02 0[23]-1- 12222 2-

Outgroup *Lutreolina*: 01??? ?211? ?1??? ????? ?21?? 05?1? 1??02 010?1 -0301 40011
 ??10? 01012 30??? ????? ????? ????- --20- -012? ?---- 11?12 ??0?? 10102 ?????
 ?2222 ??

OGMa: 0[01]??0 -2[01]0[03] 0[01][012]11 0[01][02]-0 -[012][123]1[23] 000[01][03]
0110[23] 0[01]0?1 00011 00011 1-10[12] 002[01]0 [23]???1 0001[01] 01222 -
1[01][01][012] --0[01][01] 002?? ????? ?????3 [01][01][04]11 1[01]1[01][01]
00041 11111 1-

OGMops: [01]0??0 -[01]112 21-1- 1[01]-2- 0[01]?12 [01]10[01][04] 01002 000?1
00021 10[01]10 2-[01][01][12] 01011 1???1 70011 01??0 -11[01]3 --[01]0- -
0[01][01]- -???? ?????4 00011 11120 0-0-0 00[12][01]2 -1

The sensu lato species group matrix of basicranium characters analyzed in this report is reproduced below.

adusta species group: [012]0??[01] [01]011? ?[01]??? ????? ?0[01]12 00203 1??01
00100 000[0123]1 1-0[03]1 [14][04]000 [01][03]110 01111 0??1[01] 01??2
[12]1[01][01][12] --00[01] [01]10[01]0 0???? ?0?13 [01]10[01][01]
01[01][012][012] 0[23][23]?? ?[012]0[01][12] [12][12]

kunsi species group: 2???? ????? ????? ????? ????? ????? ????? ????? ?????
[014]-0?0 1[01]2[01]0 011-1 ???10 0?0-2 -111[012] --?0[01] 010[012]0 -????
21?1[34] 1100- 01[01]10 [01]2-3- 1[012]101 [12]1

americana species group: [012]012[01] [01][01]1[124][12] [12][02]111 1000[01]
00[012][12][02] 12011 01213 [01][01]0[12]1 ?000[01] 21[01][12][01]
[12][124]1[02][01] 00[012][01][012] [0123]1[01][01][12] 2001[01]
10[01][012][012] [012]1[01]2- [01]02[12][01] 0[01]2[12][01] [01]0000
[01][01]1[01][1234] [01][01][0124]22 [12][01][01][012][012]
[01][134][02][26][17] [01][012][01][012][12] [12]0

scalops species group: [12]???1 2???? ????? ????? ????? ????? ????? [12]???? ?????
???[12]1 121?[01] 00[12]1[12] [03]1-01 ???10 ??-00 1102- [01]1?11 01220 -
???? 1[01]?1[234] [01]0[24]-1 2[01][01][02][01] 0-3-2 10202 -2

emiliae species group: [012]01-[01] 00??0 [12]00-1 -10-0 -0[01]12 [01]4[01]10 02-13
[012]1011 ?0001 110[12][12] [012][12]1?[12] 00[12][01][012] [023]100[12]
[23]??11 10[02][02][01] [12]1[01]2- 11?11 0[01]220 1-0-0 [01]111[234]
[01]0[0124][12][12] [12][01][01][01][012] [01][01][0124]1[23]
[01][12]0[12][12] 2[02]

henseli species group: [01][01][12]-[01] 00140 -1[01]-1 -[01][01]-[01] -0[02]1[02]
[01]00[13]0 11-01 2[01]021 10110 -00[012][01] [124][01]10[012]
0[013][012][01]0 [0123]1011 00-11 102-[012] 210[12]3 --[12][01][01]
[01][01][01][012][02] 0???? [01][01][01][01][234] [01]0020 [12][01][01][01]1
[01][34][14][16]- ????? 2-

brevicaudata species group: [012][01][015][0145][01] [02][02]1[124][03]
3[01][012]2[01] [01][01][02][012][01] [01][012][012][12][123]
[01][013][012][1234][01234] [01][03][04]0[012] [02][01]1[012]0
[01][012][012][012]1 [013]0[01][01][012] [124][0234][01][012][01]
0[013][012][01]0 [0123]1001 [01346][01][01]11 1[01][02][02][012]
[02]11[01][012] --[02]0[01] [01][01][01][012][12] [01]-[012][01]0
[12][012]1[01][023] [01][01]01[012] [012][01][01][012][012]
[01][01][0124][34]3 01012 [02]0

domestica species group: [012][01]3-1 [01]01[24]3 3[12]221 1[01][02]00 00[01]??
03024 10002 00[01]1[01] 1[01]0[23]1 000[01]1 [124][14][01]0[01]
0[03][12][01]0 [013]100? ???1? 1???[02] 011[01][012] --00[01]
[01][01][01][012]2 -0-0- 1[01]11[023] [01][01]02[12] [12][01][01]01 03010
11122 00

Outgroup *Caluromys*: 01??0 -0--- ----- ---- --312 10012 0-10[23] 000?0 00031 400?1
[04]0[01]02 010[01]0 [23]1000 ---0[01] -0221 10-2- ????1 10?20 0---- 01113
00[23]11 1[01]1[01]0 0[134][134][0145][0145] 12[02]22 22

Outgroup *Didelphis*: 01??0 -01[34]0 0[01][12]21 1[01][012][02][01] 0[01][23]10
00?[012]0 10[01]01 010?1 0[02][01][01]1 4[01]011 2-1[01]2 [01]101[02]
[13]0—0 ---00 -0--? ???0- --00- -0[01][01][02] 0---- ?0?10 0002- 10[01]02
0[23]-1- 12222 2-

Outgroup *Marmosa*: 0[01]??0 -2[01]0[03] 0[01][012]11 0[01][02]-0 -[012][123]1[23]
000[01][03] 0110[23] 0[01]0?1 00011 00011 1-10[12] 002[01]0 [23]???1
0001[01] 01222 -1[01][01][012] --0[01][01] 002?? ?????? ???3 [01][01][04]11
1[01]1[01][01] 00041 11111 1-

Outgroup *Marmosops*: [01]0??0 -[01]112 21-1- 1[01]-2- 0[01]?12 [01]10[01][04]
01002 000?1 00021 10[01]10 2-[01][01][12] 01011 1???1 70011 01??0 -11[01]3
--[01]0- -0[01][01]- -???? ?????4 00011 11120 0-0-0 00[12][01]2 -1

Outgroup *Lutreolina*: 01??? ?211? ?1??? ?????? ?21?? 05?1? 1??02 010?1 -0301 40011
??10? 01012 30??? ?????? ?????? ???0- --20- -012? ?---- 11?12 ??0?? 10102 ??????
?2222 ??

APPENDIX 3. Data Matrix and Specimens Examined

Specimens examined. – Abbreviations for voucher numbers are as follows: AMNH: American Museum of Natural History, BM: British Museum (Natural History), CM: Carnegie Museum, DBA: Departament de Biologia Animal, FMNH : Field Museum of Natural History, INPA: Instituto Nacional de Pesquisas da Amazônia, MBUCV: Museu de Biologia de la Universidad Central de Venezuela, MHNCI: Museu de Histsria Natural Capco da Imbzia, MN: Museu Nacional (Rio de Janeiro), MZUSP: Museu de Zoologia da Universidade de Sco Paulo, USNM: National Museum of Natural History, Smithsonian Institution, AN: Field numbers of Andréa F. P. Nunes, Museu Paraense Emmílio Goeldi, AP: Field numbers of Alexandre Palma, Universidade de Brasília, EV: Field numbers of Emerson Vieira, INPA, CTX: Taxidermy notebook numbers of MHNCI.

Data matrix available upon request.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
1	1		01 adusta / adusta	AMNH139227*	ad_a	20	16%	Colombia, Meta	f	adult	04° 9' 1.13"N 73°38'22.70"W [GE]	NT0136 (Magdalena Valley Montane Forests)
1	2		01 adusta / adusta	AMNH202650*	ad_a	43	35%	Colombia, Meta	f	adult, old	04° 9' 1.13"N 73° 38' 22.70"W [GE]	NT0136 (Magdalena Valley Montane Forests)
1	3		01 adusta / adusta	AMNH136158*	ad_a	25	20%	Colombia, Meta	m	adult	04° 9' 1.13"N 73° 38' 22.70"W [GE].	NT0136 (Magdalena Valley Montane Forests)
1	4		01 adusta TYPE Peramys adustaustus	BM1897_7_2_1*	ad_aTY	23	19%	Colombia, Cundinamarca	?	adult	04°46'N 73°58'W [GE]	NT0136 (Magdalena Valley Montane Forests)
1	5		01 adusta / adusta	FMNH70538*	ad_a	10	8%	Colombia, Antioquia	f	adult, old	07° 9' N 75° 27' W	NT0136 (Magdalena Valley Montane Forests)
1		adaaMaTY*			ad_aaTYMagdalenaValleyMontane	62	51%					ad NT0136 (Magdalena Valley Montane Forests)
2	6	adbmeP*	01 adusta / adusta melanops	USNM309263*	ad_bmeEPanamanianMontane*	11	9%	Panamá, Darién	m		08° 11'N, 77° 17'W [Cerro Tacarcuna: MapPlanet]	adme NT0122 (Eastern Panamanian Montane Forest)
3	7		02 peruviana / adusta peruviana	USNM534286*	ad_cpe	6	5%	Ecuador, Napo	m		00° 2' 44.35"N 77° 19' 57.20"W [Lumbaqui, Sucumbios: GE]	NT0121 (Eastern Cordillera Real Montane Forests)
3	8		01 ad / ad	AMNH67274*	ad_cpe	18	15%	Ecuador, Pastaza	?	adult	01° 27' 42.77"S 78° 5' 51.52"W [GE]	NT0121 (Eastern Cordillera Real Montane Forests)
3		adcpeCR*			ad_cpeECordilleraRealMontane*	23	19%					adpe NT0121 (Eastern Cordillera Real Montane Forests)
4	9		02 peruviana / adusta peruviana	USNM259433*	ad_dpe	11	9%	Peru, Huanuco	m		09° 27'S, 75° 53'W [Huanuco: GE]	NT0153 (Peruvian Yungas)
4	10		02 peruviana / adusta peruviana TYPE	FMNH19362*	ad_dpeTY	5	4%	Peru, San Martin	m	adult	06° 3' 51.64"S 76° 55' 1.81"W [GE]	NT0153 (Peruvian Yungas)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
AMNH139227*	ad_a	Villavicencia; 500m.			F: varnished
AMNH202650*	ad_a	Villavicencio	1939may22		Collector: Gilmore, R. M.
AMNH136158*	ad_a	E Colombia; Villavicencio; 500m.			
BM1897_7_2_1*	ad_aTY	W Cundinamarca, in the low-lying hot regions. Child.		"in skin: HB 100 mm, T 53, HF (moistened) 15, E (above head) (c.) 3"	Collector: Natterer.
FMNH70538*	ad_a	Valdivia, La Cabana.	1950jun26		Collector: Hershkovitz, P. Field # 4458.
	ad_aaTYMagdalena ValleyMontane				
USNM309263*	ad_bmeEPanamaniaMontane*	DARIEN, TACARCUNA VILLAGE CAMP, 3200 FT. [Cerro Tacarcuna]	1959mar20	TL 0140 MM TA 0055 MM HT 0016 MM EN 0013 MM	NMNH. LOG AMONG ROCKS ON RIVER BANK.
USNM534286*	ad_cpe	Napo, LUMBAQUI, KM 61 LAGO AGRIO-QUITO HIGHWAY.	1975feb17	TESTES 6X8 MM^35.1 G^TL 0173 MM TA 0066 MM HT 0017 MM EN 0014 MM	NMNH. Collector: MCLEAN, R. G. Field # 8879.
AMNH67274*	ad_cpe	Mera			Corroded
	ad_cpeECordilleraRealMontane*				
USNM259433*	ad_dpe	RIO CHINCHAO, HACIENDA SAN ANTONIO, 3000 FT.	1922ago12	TL 0165 MM YA 0059 MM HT 0017 MM EN 0000 MM HB 0096 MM	NMNH. Collector: HELLER, E. Field # 6585.
FMNH19362*	ad_dpeTY	Moyobamba, Moyobamba. 860 m.	21 July 1912.	173-55-16	TYPE: Collector: W.H. Osgood & M. P. Anderson. Field # 4989.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
4	11		01 adusta / adusta	USNM588019*	ad_dpe	69	57%	Peru, Cusco	?	adult	12° 44' 1.27"S 72° 35' 25.52"W [Echarate: GE]	NT0153 (Peruvian Yungas)
4		addpeTY*			ad_dpeTYPeruvianYungas*	78	64%					adpe NT0153 (Peruvian Yungas)
5	12		03 osgoodi / peruviana osgoodi HOLOTYPE	CM5242*	ad_eosTY	28	23%	Bolivia	m	adult	16° 25' 0.01"S 68° 3' 59.99"W [GE: it shows in La Paz Dept.]	NT1003 (Central Andean Wet Puna)
5	13		03 osgoodi / peruviana osgoodi PARATYPE	CM5248*	ad_eosTY	3	2%	Bolivia	m		16° 25' 0.01"S 68° 3' 59.99"W [GE: it shows in La Paz Dept.]	NT1003 (Central Andean Wet Puna)
5		adeosTY*			ad_eosTYCAndeanWetPuna*	36	30%					ados NT1003 (Central Andean Wet Puna)
6	14	adfBDP*	01 adusta / adusta	BDP3781*	ad_f*	33	27%	Peru	?	adult		
					ad_spGr*	94	77%					
7	15		04 kungsi / kungsi	MN59596*	ku_a	27	22%	Brasil, MT	m	adult, young	09° 34' 09" S 57° 23' 36" W.	NT0140 (Mato Grosso Tropical Dry Forest)
7	16		04 kungsi / kungsi	MN59598*	ku_a	15	12%	Brasil, MT	m	adult	09° 34' 09" S 57° 23' 36" W.	NT0140 (Mato Grosso Tropical Dry Forest)
7		kuaMTTD*			ku_aMatoGrossoTropDry*	33	27%					ku NT0140 (Mato Grosso Tropical Dry Forest)
8	17		04 / kungsi	MN59602*	ku_b	27	22%	Brasil, MT	m	adult, old	11° 35' 06" S 55° 08' 08" W.	NT0704 (Cerrado)
8	18		04 / kungsi	MN59600*	ku_b	15	12%	Brasil, MT	m	adult	13° 11' 00" S 57° 23' 36" W.	NT0704 (Cerrado)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
USNM588019*	ad_dpe	Tangoshiari, 2 Km SW, La Convencion Province, Cuzco	1998may20		Collector: Emmons, L. H. Field # 1484.
	ad_dpeTYPeruvian Yungas*				
CM5242*	ad_eosTY	Cochabamba Dept, Incachaca, 2600m.	1921sep12	TL 158 HB96 T62 HF(without claw)12 HF(with claw, measured dry) 15,2 E9.	HOLOTYPE: Collector: Steinback, José. Field # 1133.
CM5248*	ad_eosTY	Cochabamba Dept, Incachaca, 2600m.	1921sep23		PARATYPE
	ad_eosTYCAndean WetPuna*				
BDP3781*	ad_f*	1500-2000m. Get FMNH #!			BDP
	ad_spGr*				
MN59596*	ku_a	Apiacás.	1997feb01	? g: corpo 95 mm, cauda 49 mm, pé ?, orelha ?	Collector: Carmignotto, A. P. (MNRJ). Field # 968404. Floresta aberta ombrófila tropical (Projeto RadamBrasil, 1980). Local de coleta 14.
MN59598*	ku_a	Apiacás.	1997feb10	24 g: corpo 105 mm, cauda 56 mm, pé ?,	Collector: Carmignotto, A. P. (MNRJ). Field # 968487. Floresta aberta ombrófila tropical (Projeto RadamBrasil, 1980). Local de coleta 39.
	ku_aMatoGrossoTropDry*				
MN59602*	ku_b	Claudia, coleta a 30 km deste município.	1997mar13	13,5 g: corpo 90 mm, cauda 39 mm, pé 11,5-12,5, orelha ?	Collector: Carmignotto, A. P. (MNRJ). Field # 97057. Floresta semidecidual e submontana com dossel emergente (Projeto RadamBrasil, 1980). Local de coleta 35.
MN59600*	ku_b	Gaúcha do Norte.	1997may02	13 g: corpo 31 mm, cauda 41 mm, pé 11-12 mm, orelha ?	Collector: Carmignotto, A. P. (MNRJ). Field # 21. Mata semidecidual e submontana com dossel emergente (Projeto RadamBrasil, 1980). Local de coleta pitfall.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
8	19		04 / kungsi	MN59594*	ku_b	10	8%	Brasil, MT	M	adult, young	11° 35' 06" S 55° 08' 08" W.	NT0704 (Cerrado)
8	20		04 / kungsi	MN59601*	ku_b	9	7%	Brasil, MT	m	adult, young	13° 11' 00" S 57° 23' 36" W.	NT0704 (Cerrado)
8	21		04 / kungsi	MN36416*	ku_b	17	14%	Brasil, GO	M	adult	14° 3'1.73"S 48°13'57.63"W [GE]	NT0704 (Cerrado)
8	22		04 / kungsi	RM20*	ku_b	18	15%	Brasil, MG	m		19° 8' 16.84"S 47° 41' 28.01"W [Nova Ponte: GE]	NT0704 (Cerrado)
8	23		04 kungsi / kungsi	MN46571*	ku_b	5	4%	Brasil, GO	?			NT0704 (Cerrado)
8		kubCerr*			ku_bCerrado*	47	39%					ku NT0704 (Cerrado)
9	24	kucPNPB*	04 / kungsi	MZUSP480*	ku_cParaná-Paraliba Interior*	55	45%	Brasil, SP	m	adult, young	22° 43' 29.91"S 47° 38' 51.36"W [GE]	ku NT0150 (Paraná-Paraliba Interior Forest)
					ku_spGr*		0%					
10	25		13 americana sp group / americana	MZUSP9930*	am_a	22	18%	Brasil, PA	f		01° 27'S 48° 30'W [GE]	NT0170 (Tocantins-Araguaia-Maranhão moist forests)
10	26		13 americana sp group / americana	MN1304*	am_a	29	24%	Brasil, PA	m	adult, young	01° 27'S, 48° 29'W [Belém, MapPlanet]	NT0170, NT0180 (Xingu-Tocantins-Araguaia moist forests), (less probable: NT0168, NT0140, NT0135)
10	27		13 americana sp group / americana	AMNH75170*	am_a	43	35%	Brasil, PA	m	adult	02°14'S 50° 1'W	NT0170, NT0180, (less probable: NT0168, NT0140, NT0135)
10	28		13 americana sp group / americana	AMNH203354*	am_a	51	42%	Brasil, PA	m	adult, old	01° 40' 33.41"S 47° 45' 57.01"W [GE]	NT0170 (Tocantins-Araguaia-Maranhão moist forests)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MN59594*	ku_b	Claudia, coleta a 30 km deste município.	1997mar15	11,5 g: corpo 80 mm, cauda 38 mm, pé 11,5-12 mm, orelha 10 mm	Collector: Carmignotto, A. P. (MNRJ). Field # 97104. Floresta semidecidual e submontana com dossel emergente (Projeto RadamBrasil, 1980). Local de coleta 34.
MN59801*	ku_b	Gaúcha do Norte.	1997may03	10,5 g: corpo 74 mm, cauda 44 mm, pé 12 mm, orelha ?	Collector: Carmignotto, A. P. (MNRJ). Field # 39. Mata semidecidual e submontana com dossel emergente (Projeto RadamBrasil, 1980). Local de coleta 31
MN36416*	ku_b	Serra da Mesa			
RM20*	ku_b	Reserva do Jacob - Nova Ponte. [conforme L. P. Costa, localidade em Triangulo Mineiro, perto de Uberaba].	14/06/96. Coleta: 26/Fev/96.	cabcorp: 73. o: 10. caud: 41. tarso: 12. Peso: 9g (laboratório)	"Coletor: Eduardo Sábato, Raquel Moura." Personal Notes: skin skull. NEED UFMG #
MN46571*	ku_b	PN Chapada dos Veadeiros, 65 Km SSW Cavalcante			
	ku_bCerrado*				
MZUSP480*	ku_cParaná-Paraliba Interior*	Piracicaba	1901		Collector: ENeuring. RWThorington det. I.1986.
	ku_spGr*				
MZUSP9930*	am_a	Belém.	1957jul22	105mm 47mm 17mm 15mm	Collector: Novaes, F. NFGomes det. [I had as a MN specimen at this final Clad Matrix, check]
MN1304*	am_a	[no data]			Collector: KUHLMANN.
AMNH75170*	am_a	Patagonia, km 72.	1927aug04		Collector: Tate, Carter. Field # 4275.
AMNH203354*	am_a	Sao Domingos do Capim, Est. BR 14, km 94	1960ago1		Collector: TRVL. Field # 9784.

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10	29		13 americana sp group / americana	AMNH203353*	am_a	46	38%	Brasil, PA	m	adult, young	01° 27'S 48° 30'W [GE]	NT0170 (Tocantins-Araguaia-Maranhão moist forests)
10		amaToAr*			am_aTocantins-Araguaia-MaranhãoMoist*	65	53%					am Tocantins-Araguaia-Maranhão Moist forests
11	30	ambPE*	13 americana sp group / americana	MN24544*	am_bPernambuco*	18	15%	Brasil, PE	m	adult	08° 16' 53.02"S 35° 58' 24.45"W [Caruaru GE]	am NT0151 (Pernambuco Coastal Forests), NT0152 (Pernambuco Interior Forests)
12	31	amcBACo*	13 americana sp group / americana	MN20976*	am_cBahiaCoastal*	24	20%	Brasil, BA	m	adult, old	14° 47' 50.21"S 39° 2' 7.88"W [Ilhéus: GE]	NT0103 (am Bahia Coastal Forests)
13	32		10 rubida / rubida	MN24551*	am_dru	40	33%	Brasil, BA	m	adult	13° 31' 43.38"S 39° 58' 36.42"W [Jaguaquara: GE]	NT0104 (Bahia Interior Forests)
13	33		10 rubida / rubida TYPE Peramys rubidus	BM1855_11_26_9*	am_dru	8	7%	Brasil, BA	m	adult	13°25'S 41°59'W [GE]	NT0103 (Bahia Coastal Forests)/ NT0104 (Bahia Interior Forests); NT1304 (Caatinga), NT0703 (Campos Rupestres montane savanna), NT0202 (Atlantic Dr. Forests), NT0704 (Cerrado)
13	34		10 rubida / touan rubida	MN24550*	am_dru	44	36%	Brasil, BA	?		13° 31' 43.38"S 39° 58' 36.42"W [Jaguaquara: GE]	NT0104 (Bahia Interior Forests)
13		amdruBa*			am_druBahiaInteriorN*	63	52%					amru Bahia Interior Forests N
14	35		12 umbristriata / umbristriata	MN46570*	am_eumb	45	37%	Brasil, GO	?		14° 8' 2.25"S 47° 30' 45.80"W [Alto Paraíso, GO: GE]	NT0704 (Cerrado)
14	36		12 umbristriata / umbristriata PARALECTOTYP E	MN1313*	am_eumbTY	7	6%	Brasil, GO	?		14° 8'S 47° 30'W [Alto Paraíso de Goiás, GO: GE]	NT0704 (Cerrado)
14		ameumbTY*			am_eumbTYCerradoN*	49	40%					amumb Cerrado N
15	37		13 americana species group / americana	UnB379*	am_f	22	18%	Brasil, DF	f	adult	15°41'2.74"S 47°58'28.94"W[GE]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba interior forests)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
AMNH203353*	am_a	Belém.	1960ago1		Collector: TRVL. Field # 9635.
	am_aTocantins-Araguaia-MaranhãoMoist*				
MN24544*	am_bPernambuco*	Caruaru; FAZ.CARUARU,	1953nov13	17 G: -/95/45/13/13	Expedition: SNP. Collector: ABDIAS PINHEIRO. Field # CA3073. CAPT. EM UMA MATA. [Compare pelage with MN20976 to confirm same pop]
MN20976*	am_cBahiaCoastal*	ILHEUS; ARITAGUA, URUCUTUCA,		38 G: 125/-/63/20-21/15; OR.EXT. 10	Expedition: SEPFA. Collector: GIP [GALDINO PEREIRA]. Field # M19966.
MN24551*	am_dru	Jaguaquara; Faz. Vazante,	1953oct23	50 G: -/126/65/21/15	Collector: JOSE A. FILHO. Field # 2J2482. *P/C* CAPT. RATOEIRA LATA NO MATO CIPO, TEST. POS.
BM1855_11_26_9*	am_dru	Bahia		Feet 18, Ear 13	
MN24550*	am_dru	JAGUAQUARA; FAZ. VAZANTE,	1953out20	55 G: ;-/130/70/19/18	Expedition: SNP. Collector: JOSE A. FILHO. Field # 2J2467. CAPT. RATOEIRA LATA NO MATO CIPO, TEST. POS.
	am_druBahiaInteriorN*				
MN46570*	am_eumb	Parque Nacional Chapada dos Veadeiros, 14 Km N, 5 Km W Alto Paraiso	1996nov19		Field # CRB1085
MN1313*	am_eumbTY	Veadeiros, Goyas.			LABELS: 1 [Veadeiros, Goyas. Side2:Blaser] 2[Nao pertence a pele MN1313 F. Pires]. SKULL
	am_eumbTYCerradonN*				
UnB379*	am_f	Brasilia, Parque Nacional de Brasilia.			Field # 101.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
15	38		13 americana species group / americana	AMNH133241*	am_f	9	7%	Brasil, GO	f	adult	16° 19' 43.33"S 48° 57' 12.23"W [GE]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba interior forests)
15	39		13 americana species group / americana	UnB378*	am_f	17	14%	Brasil, DF	m	adult	15°41'2.74"S 47°58'28.94"W[GE]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba interior forests)
15		amfCPNP*			am_fCerradoParaná-ParaíbaInteriorN*	41	34%					am Cerrado / Paraná-Paraíba Interior forests N
16	40		13 americana species group / americana	AMNH61836*	am_g	12	10%	Brasil, MG/ES	f	adult	20° 22'S, 41° 48'W [MapPlanet]	NT0104 (Bahia interior forest), NT0103 (Bahia Coastal Forests)
16	41		13 americana species group / americana	USNM552401*	am_g	73	60%	Brasil, MG	f	adult	20°45' 16.52"S 42° 52' 57.09"W [GE]	NT0104 (Bahia Interior Forests)
16	42		13 americana species group / americana	USNM552402*	am_g	73	60%	Brasil, MG	f	adult	20°45' 16.52"S 42° 52' 57.09"W [GE]	NT0104 (Bahia Interior Forests)
16		amgBaln*			am_gBahiaInteriorS*	95	78%					am Bahia Interior Forests S
17	43		13 americana species group / americana	MN20972*	am_humb	18	15%	Brasil, MG	m	adult, old	20° 43' 13.29"S 46° 36' 36.32"W [GE]	NT0704 (Cerrado)
17	44		13 americana species group / americana	USNM304593*	am_humb	71	58%	Brasil, MG	m	young adult	20° 43' 13.29"S 46° 36' 36.32"W [GE]	NT0704 (Cerrado)
17		amhumbC*			am_humbCerradoS*	92	75%					amumb Cerrado S
18	45		13 americana species group / americana	MN7569*	am_i	21	17%	Brasil, MG	m	adult	21° 53' 53.00"S 42° 42' 41.99"W [Além Paraíba: GE]	NT0150 (Paraná-Paraíba Interior forests) / NT0104 (Bahia Interior Forests). Mustrangi&Patton: Serra da Mantiqueira.
18	46		13 americana species group / americana	MN43900*	am_i	19	16%	Brasil, RJ	m	adult, young	22° 2' 33.80"S 43° 12' 29.85"W [Município Comendador Levy Gasparian: GE]	NT0150 (Paraná-Paraíba Interior forests) / NT0104 (Bahia Interior Forests). Mustrangi&Patton: Serra da Mantiqueira.

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
AMNH133241*	am_f	Annapolis. 1000m.			M3642.
UnB378*	am_f	Brasilia, Parque Nacional de Brasilia.			Field # 95.
	am_fCerradoParaná ParafbaInteriorN*				
AMNH61836*	am_g	Serra do Caparaó, Fazenda Cardosa. 3360ft.			F: MG/ES; Serra do Capara'o, Fazenda Cardosa. 3360ft. #37.
USNM552401*	am_g	Viçosa 6 KM SW; MATA DA PREFEITURA; STATION G-83	1977nov16	29 G^TL 0146 TA 0045 HT 0018 EN 0000	
USNM552402*	am_g	VICOSA^6 KM SW, MATA PREFEITURA, STATION G-48	1977nov19	35 G^TL 0110 TA 0050 HT 0017 EN 0000	
	am_gBahiaInteriorS*				
MN20972*	am_humb	PASSOS. 728 M.	1945sep25	43.5 G: 114/-/53/14-13/10; OR.EXT.9, TUBERC.5.5/5.5.	Expedition: SEPFA. Collector: C.LAKO. Field # 800.
USNM304593*	am_humb	PASSOS			Collector: LAKO, C.
	am_humbCerradoS*				
MN7569*	am_i	ALEM PARAIBA; FAZ. SAO GERALDO,	1943apr28	15 G: 130/-/45/15-17/11; OR.EXT.8, TUBERC.5.5/5.5.	Expedition: SEPFA. Collector: G.P.. Field # M15728. MATO FECHADO NO BAMBUZAL.
MN43900*	am_i	LEVI GASPARIAN; FAZ. AMAZONAS,	1992jun24	10.8 G: 123/-/44/14-15/13	Collector: ALFREDO LANGGUTH. Field # AL3500.

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18		amIPNPB*			am_jParaná-ParalbalInteriorBahialnteriorSerraMantiqueira*	28	23%					am Paraná-Paraíba Interior forests / Bahia Interior forests / Serra da Mantiqueira
19	47		11 theresa / theresa TYPE theresa	BM1921_8_6_2*	am_jtheTY	21	17%	Brasil, RJ	f	adult, young	22°24'44.37"S 42°57'59.16"W [GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
19	48		11 theresa / theresa TOPOTYPE	FMNH25739*	am_jtheTY	14	11%	Brasil, RJ	m		22° 27' S 43° 0' W.	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
19	49		13 theresa / americana	MN24400*	am_jthe	18	15%	Brasil, RJ	m	adult, old	23° 8' 29.55"S 44° 10' 58.67"W [Ilha Grande: GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
19	50		13 theresa / americana	MN10305*	am_jthe	20	16%	Brasil, RJ	m	adult, old	22° 48' 38.55"S 43° 1' 26.58"W [Tijuca: GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
19		amjtheTY*			am_jtheTYSerraMarRJCoastal*	44	36%					amjthe Serra do Mar Coastal forests / Coastal Rio de Janeiro
20	51		09 / iheringi	MZUSP873*	am_kih	27	22%	Brasil, SC	m	adult, almost old	26° 26' 5.74"S 49° 14' 51.85"W [Corupá: GE]	NT0160 (Serra do Mar coastal forests) / NT0101 (Araucaria moist forest)
20	52		09 / iheringi	MZUSP3421*	am_kih	16	13%	Brasil, SC	m	adult, young	26° 19' 20.50"S 48° 52' 7.41"W [GE]	NT0160 (Serra do Mar coastal forests)
20		amkihAr*			am_kihSerraMarCoastalAraucariaMoist*	34	28%					amkih Serra do Mar Coastal forests /Araucaria Moist forests
21	53		13 americana species group / americana	MZUSP29200*	am_lih	22	18%	Brasil, SP	f		23° 31'S 46° 36'W [GE]	
21	54		09 / iheringi	FMNH94736*	am_lih	14	11%	Brasil, SP	m		23° 36' S 46° 37' W	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.
21	55		09 / iheringi	MZUSP1517*	am_lih	19	16%	Brasil, SP	m	adult	24° 41' 54.51"S 47° 34' 18.76"W [GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
	am_jParaná- ParalbalInteriorBahia InteriorSerraManti queira*				
BM1921_8_6_2*	am_jtheTY	Theresopolis		Corpo 80, T 36, F 14, E 10	Collector: Hill, J. P.
FMNH25739*	am_jtheTY	Teresópolis, 3800 '.	1926jul11		TOPOTYPE: Collector: Sanborn, C.C.
MN24400*	am_jthe	ILHA GRANDE, ANGRA DOS REIS; P. VERMELHA,	1976mar05	25 G: -/95/50/15/12	Collector: NELSON ANTUNES. Field # 23.
MN10305*	am_jthe	TIJUCA; TRAPICHEIRO,		22 G: 157/-/47/13-15/14; OR.EXT.9, TUBERC.5.5/6.6.	Expedition: SEPFA. Collector: L.C.F.. Field # M16501. CHEGOU MORTO EM 8/3/1944.
	am_jtheTYSerraMar RJCoastal*				
MZUSP873*	am_kih	Corupá. [Etiqueta do frasco líquido diz] "Colonia Hansa"			Vieira det.
MZUSP3421*	am_kih	Joinville			Vieira det.
	am_kihSerraMarCo astalAraucariaMoist *				
MZUSP29200*	am_lih	SP			Collector: Musturangi, M. A. Field # MAM175.
FMNH94736*	am_lih	São Paulo, Ipiranga. 728 m.	1961oct20		Collector: Olalla, A. M. Field # 1521.
MZUSP1517*	am_lih	Iguape			Krone, RWThorington det. 1.1986. [partial basi astp only]

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21	56		13 americana species group / americana	MZUSP10206*	am_ljh	17	14%	Brasil, SP	m	adult, old	23° 19' 39.76"S 46° 23' 7.69"W [GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.
21		amIjhSP*			am_ljhSerraMarCoastalSP*	51	42%					amIjh Serra do Mar Coastal forests / Serra do Mar São Paulo
22	57	ammCePN*	10 / rubida	MZUSP1523*	am_mCerradoParaná-ParaíbaInteriorS*	11	9%	Brasil, SP	f		22° 43' 29.91"S 47° 38' 51.36"W [GE]	am Cerrado / Paraná-Paraíba Interior forests S: NT0150 (Paraná-Paraíba Interior Forest) / NT0704 (Cerrado)
					am_spGr_sl*		0%					
23	58		14 scalops / emiliae	MN32166*	sc_a	14	11%	Brasil, ES	m	adult, old	20° 25' 40.04"S 41° 47' 35.29"W [Pico da Bandeira: GE]	NT0104 (Bahia interior forest), NT0103 (Bahia Coastal Forests)
23	59		14 scalops / emiliae	MN32167*	sc_a	14	11%	Brasil, MG	m		20° 25' S 41° 51'W [GE]	NT0104 (Bahia interior forest), NT0103 (Bahia Coastal Forests)
23		scaBaIC*			sc_aBahiaInteriorCoastal*	15	12%					sc Bahia Interior forest / Bahia Coastal Forests
24	60		14 scalops / scalops	MN7247*	sc_b	22	18%	Brasil, RJ	m	adult	22° 23' 4.76"S 42° 52' 41.55"W [GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
24	61		14 scalops / scalops	MN6419*	sc_b	17	14%	Brasil, RJ	m	adult, old	23° 13' 30.26"S 44° 42' 53.38"W [Parati: GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
24		scbSMRJ*			sc_bSerraMarCoastalRJ*	25	20%					sc NT0160 (Serra do Mar Coastal forests). Mustrangi&Patton: Coastal Rio de Janeiro.
25	62	sccSMSP*	14 scalops / scalops	MZUSP1528*	sc_cSerraMarCoastalSP*	43	35%	Brasil, SP	f		23° 45' 39.76"S 45° 24' 43.51"W [GE]	sc NT0160 (Serra do Mar Coastal forests). Mustrangi&Patton: Serra do Mar. São Paulo
26	63		14 scalops / scalops	MHNCI2794*	sc_d	28	23%	Brasil, PR	m	adult	25° 42' 26.45"S 51° 38' 0.27"W [Pinhão: GE]	NT0101 (Araucaria moist forest)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MZUSP10206*	am_ljh	Morro Grande	1962nov11	90mm 40mm 15mm 10mm	Ex Inst. Adolpho Lutz 1270. NFGomes det.
	am_ljhSerraMarCoastalSP*				
MZUSP1523*	am_mCerradoParaná-ParabalInteriorS*	Piracicaba.	1901		Collector: ENehring. RWThorington det. 1.1986. [I had as a MN specimen at this final Clad Matrix, check]
	am_spGr_sl*				
MN32166*	sc_a	Parque Nacional de Caparaó. 4.7 km N 6.3 km E do Pico da Bandeira, rio Pedra Roxa. 1100m.	32434	200/70/19-20/=-49g	P.Hershkovitz.#10335. Col.PRR1. 19x92.
MN32167*	sc_a	Parque nacional do caparaó, 1.5km N 0.7 km W do Pico da Bandeira, Vale Verde. 1400m.	32414	192/61/20-21/19=40g	Hershkovitz#10119. Col. VV16.
	sc_aBahiaInteriorCoastal*				
MN7247*	sc_b	TERESÓPOLIS; BOA FÉ,	1943sep8	176/-58/21/16; OR.EXT.11	Expedition: SEPFA. Collector: P.M.BRITTO. Field # M20984.
MN6419*	sc_b	PARATI; PEDRA BRANCA,	1942nov		Collector: ERWIN
	sc_bSerraMarCoastalRJ*				
MZUSP1528*	sc_cSerraMarCoastalSP*	São Sebastião	1898		Vieira det.
MHNCI2794*	sc_d	Foz do rio Jordão ("Pinhão - atual Município de Foz do Jordão").			

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
26	64		14 scalops / scalops	MHNCI3334*	sc_d	16	13%	Brasil, PR	m	adult	25° 32' 11.44"S 49° 12' 14.94"W [SJ dos Pinhais: GE]	NT0101 (Araucaria moist forest)
26		scdArau*			sc_dAraucariaMoist*	32	26%					sc Araucaria Moist forest
					sc_spGr*		0					
27	65	emaXTAM*	15 emilliae / emilliae	AMNH96810*	em_aXingu-Tocantins-AraguaiaMaranhãoMoist*	19	16%	Brasil, PA	m	adult	02°41'0.07"S 49°40'42.57"W [GE]	em_a NT0180 (Xingu-Tocantins-Araguaia Moist forests) / NT0170 (Tocantins-Araguaia-Maranhão Moist forests)
28	66		15 emilliae / emilliae	MN1299*	em_b	25	20%	Brasil, PA	m	adult	04° 25' S 56° 17' W [ME]	NT0135 (Madeira-Tapajós moist forest) / NT0168 (Tapajós-Xingu moist forests)
28	67		15 emilliae / emilliae	USNM461884*	em_b	57	47%	Brasil, PA	m	adult	04° 16' 12.41"S 55° 59' 14.39"W [Itaituba: GE]	NT0135 (Madeira-Tapajós moist forest) / NT0168 (Tapajós-Xingu moist forests)
28		embMTX*			em_bMadeira-Tapajós-XinguMoist*	90	74%					em_b Madeira-Tapajós Moist forest / Tapajós-Xingu Moist forests
29	68		15 emilliae / emilliae	APC155*	em_c	52	43%	Brasil, MT	f	adult, to old adult	10° 19' 25" S 58° 29' 34" W	NT0135 (Madeira-Tapajós moist forest)
29	69		15 emilliae / emilliae	MN59593*	em_c	50	41%	Brasil, MT	f	adult, to old adult	10° 10' 32" S 59° 27' 05" W	NT0135 (Madeira-Tapajós moist forest)
29	70		15 emilliae / emilliae	APC199*	em_c	48	39%	Brasil, MT	m	adult	10° 10' 32" S 59° 27' 05" W	NT0135 (Madeira-Tapajós moist forest)
29	71		15 emilliae / emilliae	RON018*	em_c	45	37%	Brasil, RO	?			NT0135 (Madeira-Tapajós moist forest), NT0704 (Cerrado)
29		emcMTCe*			em_cMadeira-TapajósMoistCerrado*	66	54%					em_c NT0135 (Madeira-Tapajós Moist forest) NT0704 (Cerrado)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MHNCI3334*	sc_d	Guaricana, São José dos Pinhais.			
	sc_dAraucariaMoist*				
	sc_spGr*				
AMNH96810*	em_aXingu-Tocantins-AraguaiaMaranhãoMoist*	rio Tocantins, Baião.			#6349.
MN1299*	em_b	TAPAJOS; VILA BRAGA,	1917feb25	;-/153/61/16/22	
USNM461884*	em_b	ITAITUBA, JACAREACANGA KM 200.	1973dec01	56 G**MEASUREMENTS ORINGIALLY APPEAR AS 130-50-20 18-8(13)	Collector: PINHEIRO, F. DE P. Field # 989.
	em_bMadeira-Tapajós-XinguMoist*				
APC155*	em_c	Juruena	1997jun11	35g: Corpo 115 mm, Cauda 45 mm, Pé 17-18,5 mm, Orelha 15 mm	Collector: Carmignotto, A. P. (MNRJ). Local de coleta: 10. Floresta equatorial amazônica de terra firme (Projeto RadamBrasil, 1980). Monodelphis sp. 3.
MN59593*	em_c	Aripuanã.	1997ago30	23 g: corpo 99 mm, cauda 48 mm, pé 16-17,5 mm, orelha 13 mm	Collector: Carmignotto, A. P. (MNRJ). Field # APC256. Floresta equatorial amazônica de terra firme (Projeto RadamBrasil, 1980). Local de coleta Manual-derrubada-mata. Definitely much smaller than male APC199 of same locality!!!
APC199*	em_c	Aripuanã.	1997aug25	66 g: corpo 132 mm, cauda 63 mm, pé 20-22, orelha 16 mm	Collector: Carmignoto, A.P. (MNRJ). Floresta equatorial amazônica de terra firme (Projeto RadamBrasil, 1980). Local de coleta B 5.
RON018*	em_c	INPA.			Collector: MNFS
	em_cMadeira-TapajósMoistCerrado*				

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
30	72		15 emiliae / emiliae	INPA3039*	em_d	31	25%	Brasil, AC	f	adult, young	08° 40' S 72° 47' W [ME]	(NT0166) Southwest Amazon moist forests
30	73		15 emiliae/ emiliae	MVZ190334*	em_d	16	13%	Brasil, AM	f		06° 45' S 70° 51' W.	(NT0166) Southwest Amazon moist forests
30	74		15 emiliae / emiliae	INPA3040*	em_d	24	20%	Brasil, AM	m	adult	06° 50' S 70° 45' W	(NT0166) Southwest Amazon moist forests
30	75		15 emiliae / emiliae	FMNH58955*	em_d	13	11%	Peru	m		03° 50'S 73° 05'W [MapPlanet GmbH: Rio Cura-yacu (name variant) Location	(NT0166) Southwest Amazon moist forests, NT0128 (Iquitos Varzea)
30	76		15 emiliae / emiliae	MUSM13298*	em_d	26	21%	Peru	?	adult		(NT0166) Southwest Amazon moist forests, NT0128 (Iquitos Varzea), NT0174 (Ucayali moist forests), NT0153 (Peruvian Yungas), NT0163 (Solimões-Iapurá moist forests), NT0142 (Nano moist forests)
30		emdAmiq*			em_dSWAmazonMoistIquitosVarzea*	55	45%					em_d NT0166 (Southwest Amazon Moist forests) NT0128 (Iquitos Varzea)
					em_spGr*		0%					
31	77		16 / dimidiata	AMNH208970*	he_adi	16	13%	Uruguay	m	adult	34° 41' 17.84"S 55° 42' 13.47"W [GE]	NT0710 (Uruguayan savanna)
31	78		16 / dimidiata	MZUSP1527*	he_adi	16	13%	Brasil, RS	m	adult, old	31° 22' S 51° 58' W [ME]	NT0710 (Uruguayan savanna)
31	79		16 / dimidiata	MZUSP1435*	he_adi	15	12%	Brasil, RS	m	adult, old	31° 22' S 51° 58' W [ME]	NT0710 (Uruguayan savanna)
31	80		16 / dimidiata	MN1312*	he_adi	7	6%	Brasil, RS	m	adult, old very	30°24'S 50° 53'40"W [GE]	NT0710 (Uruguayan savanna), NT0150 (Paraná-Paraíba interior forests), NT0101 (Araucaria moist forests)
31		headIUS*			he_adiUruguayanSavanna*	34	28%					hedi Uruguayan Savanna (NT0710)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
INPA3039*	em_d	Igarapé Porongaba, right bank Rio Juruá	1992feb-mar		Collector: da Silva, MNF. Field # MNFS1412.
MVZ190334*	em_d	Condor, Left bank Rio Juruá, Amazonas, Brasil.	28 Sept. 1991.	160+ - 40+ - 18 - 14= 34 g.	Collector: Patton, J. L. Field # 15686. skin. skull.
INPA3040*	em_d	Penedo, margem direita do Rio Juruá.	1991aug-sep		Collector: da Silva, MNF. Field # MNFS524.
FMNH58955*	em_d	Loreto, Quebrada Aucayo	1972mar06		Collector: Soini, P.
MUSM13298*	em_d				F. At AMNH. [MUSM: Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Perú]
	em_dSWAmazonM oistlquitosVarzea*				
	em_spGr*				
AMNH208970*	he_adi	Canelones, Soca.			# 966.
MZUSP1527*	he_adi	São Lourenço.	1896		Collector: Enslin. Vieira det.
MZUSP1435*	he_adi	São Lourenço.	1904		Collector: Enslin. Vieira det.
MN1312*	he_adi	[No Data]			Field # 136.932. OFERTA DO DR. ROUNA.
	he_adiUruguayans avanna*				

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
32	81		17 henseli / brevicaudis	CTX3355*	he_bbris	28	23%	Brasil, PR	f	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	82		17 henseli / brevicaudis	CTX3371*	he_bbris	33	27%	Brasil, PR	f	adult, you	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	83		17 henseli / brevicaudis	CTX3378*	he_bbris	33	27%	Brasil, PR	f	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	84		17 / henseli	CTX3126*	he_bbris	12	10%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	85		17 henseli / brevicaudis	CTX3358*	he_bbris	26	21%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	86		17 henseli / brevicaudis	CTX3379*	he_bbris	14	11%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	87		17 henseli / brevicaudis	CTX2996*	he_bbris	14	11%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	88		17 henseli / brevicaudis	CTX3127*	he_bbris	23	19%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	89		17 henseli / brevicaudis	CTX3207*	he_bbris	15	12%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	90		17 henseli / brevicaudis	CTX3261*	he_bbris	15	12%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	91		17 henseli / brevicaudis	CTX3094*	he_bbris	14	11%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	92		17 henseli / brevicaudis	CTX3178*	he_bbris	14	11%	Brasil, PR	m	adult, old very	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
CTX3355*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3371*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3378*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3126*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3358*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3379*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX2996*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3127*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3207*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3261*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3094*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3178*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
32	93		17 henseli / brevicaudis	CTX3260*	he_bbris	14	11%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	94		17 henseli / brevicaudis	CTX3263*	he_bbris	14	11%	Brasil, PR	m	adult	25° 30' S 53° W [ME]	NT0150 (Paraná-Paraíba interior forest)
32	95		18 / sorex	MZUSP2823*	he_bbris	10	8%	Paraguay	m	adult	25° 21' S 54° 56' W [ME]	NT0150 (Paraná-Paraíba interior forest)
32		hebbris*			he_bbrisParaná-ParáibaInterior*	45	37%					hebris Paraná-Paraíba Interior forest (NT0150) S
33	96		17 henseli / henseli	MHNCI3146*	he_c	34	28%	Brasil, PR	f	adult, old	25° 22' 2.48"S 49° 4' 40.55"W [Quatro Barras: GE]	NT0101 (Araucaria moist forest)
33	97		17 henseli / brevicaudis	MHNCI1104*	he_c	25	20%	Brasil, PR	m	adult	25°10'S 49°43'W [GE]	NT0101 (Araucaria moist forest), NT0160 (Serra do Mar coastal forests)
33		hecArau*			he_cAraucariaMoist*	46	38%					he Araucaria Moist forest (NT0101)
34	98		17 henseli / brevicaudata	MN24549*	he_d	24	20%	Brasil, SP	m	adult, old very	23° 31' 56.83"S 45° 50' 47.20"W [Salesópolis: GE]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.
34	99		18 / sorex	MZUSP7671*	he_d	15	12%	Brasil, SP	m	adult, old	23° 32' S 46° 37' W [ME]	NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.
34		hedSeMa*			he_dSerraMarCoastal*	27	22%					he NT0160 (Serra do Mar Coastal forests). Mustrangi&Patton: Serra do Mar.
35	100		17 henseli / sorex	USNM460504*	he_eso	82	67%	Brasil, SP	m	old adult	22° 11' 32.34"S 48° 46' 51.86"W [Boracéia: GE] 22°10'00"S, 48°45'00"W [MapPlanet]	NT0150 (Paraná-Paraíba Interior Forest) / NT0704 (Cerrado) / NT0160 (Serra do Mar coastal forests). Mustrangi&Patton: Serra do Mar.
35	101		17 henseli / sorex	USNM484016*	he_eso	60	49%	Brasil, SP	m	adult	22° 42' S 47° 25' W [Ribeirão da Lagoa Nova, MapPlanet: GE]	NT0150 (Paraná-Paraíba Interior Forest) SE, NT0704 (Cerrado)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
CTX3260*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
CTX3263*	he_bbris	Capitão Leônidas Marques, Represa da Usina Hidrelétrica de Salto Caxias.	1998oct		CTX = caderno de taxidermia de mamíferos do MHNCI.
MZUSP2823*	he_bbris	Alto Paraná: Puerto Yaguarazapá.	1909		Collector: Maynhausen. RWThorington det. I.1986
	he_bbrisParaná-ParalbaInterior*				
MHNCI3146*	he_c	Taquari, Quatro Barras.			
MHNCI1104*	he_c	Leste do Paraná.			
	he_cAraucariaMoist*				
MN24549*	he_d	SALESOPOLIS; CASA GRANDE,	1967mar30	;-/135/68/20/15	Collector: E.DENTE. Field # 79-144. M.H.N. U.F.M.G. BELO HORIZONTE.
MZUSP7671*	he_d	São Paulo, Freguesia do Ó.	1952nov		Ex Inst. Biológico. RWThorington det. I.1986.
	he_dSerraMarCoastal*				
USNM460504*	he_eso	CASA GRANDE, BORACEIA.	1965jan02	TL 0110 MM TA 0085 MM HT 0015 MM EN 0011 MM	Collector: DE SOUZA LOPES, O. Field # AN5958.
USNM484016*	he_eso	RIBEIRAO DA LAGOA	1966oct28	TL 0175 MM TA 0030 MM HT 0013 MM EN 0013 MM HB 00145 MM	Collector: DE SOUZA LOPES, O. Field # AN5950.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
35		heesoPP*			he_esoParaná-ParalbalInteriorSECerrado*	101	83%					heso NT0150 (Paraná-Paraíba Interior Forest) SE, NT0704 (Cerrado)
					he_spGr*		0%					
36	102		25 brevicaudata species group / brevicaudata	MZUSP20082*	bre_a	21	17%	Brasil, RO	f		9°11'59.99"S 62°55'0.01"W [GE]	NT0135 (Madeira-Tapajós moist forest)
36	103		25 brevicaudata species group / brevicaudata	MN59610*	bre_a	20	16%	Brasil, MT	m	adult, young	09° 34' 09" S 57° 23' 36" W.	NT0135 (Madeira-Tapajós moist forest)
36	104		25 brevicaudata species group / brevicaudata	MN59606*	bre_a	15	12%	Brasil, MT	m	adult	10° 19' 25" S 58° 29' 34" W	NT0135 (Madeira-Tapajós moist forest)
36	105		25 brevicaudata species group / brevicaudata	MN59608*	bre_a	29	24%	Brasil, MT	m	adult, young	10° 10' 32" S 59° 27' 05" W	NT0135 (Madeira-Tapajós moist forest)
36	106		25 brevicaudata species group / brevicaudata	MZUSP20093*	bre_a	31	25%	Brasil, RO	m	adult	9°11'59.99"S 62°55'0.01"W [GE]	NT0135 (Madeira-Tapajós moist forest)
36		breaMaT*			bre_aMadeira-TapajósMoist*	37	30%					bre_a NT0135 (Madeira-Tapajós Moist forest)
37	107		25 brevicaudata species group / brevicaudata	AN228*	bre_b	36	30%	Brasil, AM	f	adult	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	108		25 brevicaudata species group / brevicaudata	AN235*	bre_b	38	31%	Brasil, AM	f	adult	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	109		25 brevicaudata species group / brevicaudata	AN213*	bre_b	14	11%	Brasil, AM	m	adult, young	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	110		25 brevicaudata species group / brevicaudata	AN227*	bre_b	15	12%	Brasil, AM	m	adult	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
	he_esoParaná-ParalbaInteriorSEC errado*				
	he_spGr*				
MZUSP20082*	bre_a	Santa Barbara.	1985set26	221mm 70mm 17mm 20mm 718mm	Expedition: MZ-Polonoroeste. Collector: Northern, J.R.. Field # 85.0001. Northern det.
MN59610*	bre_a	Apiacás.	1997feb08	93 g: corpo 153 mm, cauda 87 mm, pé 18 mm, orelha 14 mm	Collector: Carmignoto, A.P. (MNRJ). Field # M968468. Floresta aberta ombrófila tropical (Projeto RadamBrasil, 1980). Local de coleta 18.
MN59606*	bre_a	Juruena,	1997jun10	52 g: corpo 135 mm, cauda 88 mm, pé 20-22 mm, orelha 21 mm	Collector: Carmignoto, A.P. (MNRJ). Field # APC151. Floresta equatorial amazônica de terra firme (Projeto RadamBrasil, 1980).
MN59608*	bre_a	Aripuanã.	1997aug24	106 g: corpo 166, cauda 106 mm, pé 22-24 mm, orelha 21,5 mm	Collector: Carmignoto, A. P. (MNRJ). Field # APC194. Floresta equatorial amazônica de terra firme (Projeto RadamBrasil, 1980). Local de coleta D 20.
MZUSP20093*	bre_a	Santa Barbara.	1985oct05	59g: 218mm 71mm 19mm 19mm; test. Escrotais 10mm x 8 mm	Expedition: MZ-Polonoroeste. Collector: Northern, J.R.. Field # 85.0012. Northern det.
	bre_aMadeira-TapajósMoist*				
AN228*	bre_b	Humaitá.			
AN235*	bre_b	Humaitá.			
AN213*	bre_b	Humaitá.			
AN227*	bre_b	Humaitá.			

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
37	111		25 brevicaudata species group / brevicaudata	AN229*	bre_b	15	12%	Brasil, AM	m	adult, old	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	112		25 brevicaudata species group / brevicaudata	AN248*	bre_b	15	12%	Brasil, AM	m	adult	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	113		25 brevicaudata species group / brevicaudata	AN224*	bre_b	27	22%	Brasil, AM	m	adult	7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37	114		25 brevicaudata species group / brevicaudata	AN252*	bre_b	14	11%	Brasil, AM			7°30'51.77"S 63° 1'49.16"W [GE]	NT0135 (Madeira-Tapajós moist forest), NT0157 (Purus-Madeira moist forests)
37		brebPMa*			bre_bPurus-Madeira-TapajósMoist*	51	42%					bre_b NT0135 (Madeira-Tapajós Moist forest), NT0157 (Purus-Madeira Moist forests)
38	115		21 touan / brevicaudata	INPA2835*	bre_c	22	18%	Brasil, PA	m	adult, young	05° 48' S 50° 45' W [ME]	NT0180 (Xingu-Tocantins-Araguaia moist forests), NT0140 (Mato Grosso tropical dry forests)
38	116		25 brevicaudata species group / brevicaudata	MZUSP21285*	bre_c	20	16%	Brasil, PA	f		03° 48'S, 52° 32'W [MapPlanet]	NT0180 (Xingu-Tocantins-Araguaia moist forests), NT0168 (Tapajós-Xingu moist forests)
38		brecXTA*			bre_cXingu-Tocantins-AraguaiaMoist*	28	23%					bre_c NT0180 (Xingu-Tocantins-Araguaia Moist forests)
39	117		25 brevicaudata species group / brevicaudata	USNM546197*	bre_d	68	56%	Brasil, PA	f	adult	04° 55'S 55° 36'W [Itaituba: GE 4°16'12.41"S 55°59'14.39"W]	NT0168 (Tapajós-Xingu moist forests)
39	118		25 brevicaudata species group / brevicaudata	USNM546207*	bre_d	68	56%	Brasil, PA	m	young adult	04° 55'S 55° 36'W [Itaituba: GE 4°16'12.41"S 55°59'14.39"W]	NT0168 (Tapajós-Xingu moist forests)
39	119		25 brevicaudata species group / brevicaudata	AMNH94902*	bre_d	15	12%	Brasil, PA	m	adult	03° 5' 11.47"S 55° 6' 47.09"W [Tauari: GE]	NT0168 (Tapajós-Xingu moist forests)
39		bredTXW*			bre_dTapajós-XinguMoistW*	90	74%					bre_d NT0168 (Tapajós-Xingu Moist forests) W

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
AN229*	bre_b	Humaitá.			
AN248*	bre_b	Humaitá.			
AN224*	bre_b	Humaitá.			
AN252*	bre_b	Humaitá.			
	bre_bPurus-Madeira TapajósMoist*				
INPA2835*	bre_c	Floresta Nacional Tapirapé-Aquiri, Área da Companhia Vale do Rio Doce, Carajás.			
MZUSP21285*	bre_c	Cachoeira do Espelho, Rio Xingu	1986mar27		Collector: Carleton, M.D. Field # MDC 540. ABC-CNEC. MDCarleton det.
	bre_cXingu-Tocantins-AraguaiaMoist*				
USNM546197*	bre_d	ITAITUBA, BR. 165, SANTAREM-CUIABA, ZONA SUL, KM 446, RIO JAMANXIZINHO,	1976apr20	55 G^TL 0225 MM TA 0085 MM HT 0020 MM EN 0020 MM	
USNM546207*	bre_d	ITAITUBA, BR. 165, SANTAREM-CUIABA, ZONA SUL, KM 446, RIO JAMANXIZINHO,	1976may07	50 G^TL 0210 MM TA 0080 MM HT 0018 MM EN 0016 MM	
AMNH94902*	bre_d	Para; Rio Tapajoz, Tavyary.			#4096
	bre_dTapajós-XinguMoistW*				

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
40	120		21 touan / brevicaudata	USNM549279*	bre_eto	70	57%	Brasil, PA	f	young adult	03° 39'S 052° 22'W. 3° 11'40.55"S 52°12'33.53"W [Altamira: GE]	NT0168 (Tapajós-Xingu moist forests)
40	121		21 touan / brevicaudata	USNM549280*	bre_eto	76	62%	Brasil, PA	m	adult	03° 39'S 052° 22'W. 3° 11'40.55"S 52°12'33.53"W [Altamira: GE]	NT0168 (Tapajós-Xingu moist forests)
40		breetoTX*			bre_etoTapajós-XinguMoistE*	95	78%					bre_e NT0168 (Tapajós-Xingu Moist forests) E
41	122		21 / touan	MN20218*	bre_fto	20	16%	Brasil, AP	m	adult, young	00°58'N, 52°02'W [MapPlanet]	NT0173 (Uatuma-Trombetas moist forests)
41	123		21 touan / brevicaudata	AN603*	bre_fto	29	24%	Brasil, AP	m	adult, to old adult	02° 1' N 50° 46' W[ME]	NT0173 (Uatuma-Trombetas moist forests), NT0125 (Guianan moist forests)
41		breftoUT*			bre_ftoUatuma-TrombetasMoistE	36	30%					bre_f NT0173 (Uatuma-Trombetas Moist forests) E
42	124		21 touan / brevicaudata	INPA535*	bre_g	32	26%	Brasil, AM	f	adult, young	03° 6' 25"S 60° 1' 34"W [GE]	NT0173 (Uatuma-Trombetas moist forests)
42	125		21 touan	MN16802*	bre_g	29	24%	Brasil, AM	m	adult	03° 07' S 60° W[ME]	NT0173 (Uatuma-Trombetas moist forests)
42	126		25 touan / brevicaudata	INPA1788*	bre_g	14	11%	Brasil, AM	m	adult, old	02° 22' S 59° 53' W	NT0173 (Uatuma-Trombetas moist forests)
42	127		25 brevicaudata species group / brevicaudata	MZUSP4513*	bre_g	14	11%	Brasil, AM	m	adult, old	03° 08' S 58° 26' W [ME]	NT0173 (Uatuma-Trombetas moist forests), NT0141 (Monte Alegre varzea)
42		bregUTW*			bre_gUatuma-TrombetasMoistW	47	39%					bre_g NT0173 (Uatuma-Trombetas Moist forests) W
43	128		25 brevicaudata species group / brevicaudata	USNM406907*	bre_h	67	55%	Venezuela, Amazonas	f	young adult	02° 37'N 66° 19'W. [GE 2° 35'57.95"N 66°20'3.73"W]	NT0143 (Negro-Branco moist forests)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
USNM549279*	bre_eto	ALTAMIRA, 52 KM SSW, E BANK RIO XINGU,	1986ago16		
USNM549280*	bre_eto	ALTAMIRA, 52 KM SSW, E BANK RIO XINGU,	1986set18		
	bre_etoTapajós-XinguMoistE*				
MN20218*	bre_fto	TEREZINHA, RIO AMAPARI, SERRA DO NAVIO	1965jul27	85 G: -/160/85/22-24/19; OR.EXT. 13, L 950, TUBERC. 6.6/5.5	Expedition: IOC. Field # M15526.
AN803*	bre_fto	Amapá.			
	bre_ftoUatuma-TrombetasMoistE				
INPA535*	bre_g	Manaus, Conjunto Aquariquara.			
MN16802*	bre_g	Manaus.	1960jul11	70 G: -/160/80/20/15	Expedition:INPA . Collector: CLAUDIONOR ELIAS. Field # M169. SER.LAB.NR.1345.
INPA1788*	bre_g	PDBFF, Fazenda Porto Alegre. Reserva 3209 Ponto A6.			
MZUSP4513*	bre_g	Itacoatiara.	1937apr06	223mm 85mm 24mm	Collector: Olalla, A.M. Field # 783. RWThorington det. I.1986.
	bre_gUatuma-TrombetasMoistW				
USNM406907*	bre_h	AMAZONAS, CAPIBARA, 106 KM SW ESMERALDA, BRAZO CASIQUIARE, 130 M. SMITHSONIAN VENEZUELAN PROJECT.	1967jun01	LACTATING^62.4 G^TL 0205 MM TA 0077 MM HT 0021 MM EN 0018 MM	TROPICAL HUMID FOREST. SNAP TRAP BESIDE HOLE IN FOREST.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
43	129		25 breviceaudata species group / breviceaudata	AMNH78096*	bre_h	17	14%	Venezuela, Amazonas	f	adult	02° 30'N 66° 30'W [GE]	NT0143 (Negro-Branco moist forests)
43	130		25 breviceaudata species group / breviceaudata	USNM385010*	bre_h	68	56%	Venezuela, Amazonas	m	adult	03° 11'N 65° 33'W. [GE 3° 9'52.48"N 65°33'4.90"W]	NT0143 (Negro-Branco moist forests)
43	131		25 breviceaudata species group / breviceaudata	EV18*	bre_h	26	21%	Brasil, AM	m	adult	0°05'S 65°55'W [MapPlanet]	NT0143 (Negro-Branco moist forests), NT0124 (Guayanian Highlands moist forests)
43		brehNeB*			bre_hNegro-BrancoMoist*	95	78%					bre_h NT0143 (Negro-Branco Moist forests)
44	132		20 breviceaudata / breviceaudata	USNM385005*	bre_i	69	57%	Venezuela, Bolívar	f	adult	06° 10' N 61° 21' W	NT0125 (Guianan moist forests), NT0124 (Guayanian Highlands moist forests)
44	133		25 breviceaudata species group / breviceaudata	AMNH130564*	bre_i	17	14%	Venezuela, Bolívar	m	adult	06° 13' 58.57"N 62° 50' 59.34"W [Canaïma: GE]	NT0124 (Guayanian Highlands moist forests), NT0709 (Llanos)
44	134		20 breviceaudata / breviceaudata	USNM385004*	bre_i	95	78%	Venezuela, Bolívar	m	adult	07° 00'N 62°15'W	NT0125 (Guianan moist forests), NT0124 (Guayanian Highlands moist forests)
44		breiGul*			bre_JGulananMoistGuayanianHighlandsMoist*	105	86%					bre_J NT0125 (Guianan Moist forests) / NT0124 (Guayanian Highlands Moist forests)
45	135		25 breviceaudata species group / breviceaudata	AMNH75685*	bre_j	18	15%	Venezuela, Bolívar	m	adult	05° 00'N 60° 36'W [Roraima em Números 2005" / DEES, Divisão de Estatística - Boa Vista	NT0707 (Guyanan savanna), NT0169(Tepuis)
45	136		25 breviceaudata species group / breviceaudatamar	AMNH75520*	bre_j	19	16%	Brasil, RR	m	adult	03° 55' 49.84"N 60° 29' 55.20"W [GE]	NT0707 (Guyanan savanna)
45		brejGuy*			bre_JGuyananSavanna*	22	18%					bre_J NT0707 (Guyanan Savanna)
46	137		23 orinoci / breviceaudata orinoci	MBUCV1890*	bre_kor	30	25%	Venezuela, Guaríco	f	adult, you	08° 52' N 67° 23' W	NT0709 (Llanos) W

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
AMNH78096*	bre_h	rio Casiquiare, Casiquiare	1929apr14		Collector: Olalla Brothers. Field #607.
USNM385010*	bre_h	AMAZONAS, ESMERALDA, 135 M, SMITHSONIAN VENEZUELAN PROJECT.	1966nov03	TESTES 12 X 8 MM^TL 0228 MM TA 0085 MM HT 0023 MM EN(0018)MM	TROPICAL HUMID FOREST. SNAP TRAP.
EV18*	bre_h	Parque Nacional do Pico da Neblina.			
	bre_hNegro-BrancoMoist*				
USNM385005*	bre_i	BOLIVAR, EL MANACO, KM 88, 150 M, SMITHSONIAN VENEZUELAN PROJECT.	1966may19	.1 G^TL 0237 MM TA 0076 MM HT 0023 MM EN 0020 MM	TROPICAL HUMID FOREST. HAND CAUGHT ON ROAD IN FOREST.
AMNH130564*	bre_i	Auyan-tepui.			#5909.
USNM385004*	bre_i	BOLIVAR, RIO SUPAMO, 50 KM SE EL MANTECO, ^150 M, SMITHSONIAN VENEZUELAN PROJECT. [EI Manteco, Bolivar: GE 7°27'0.00"N 62°20'59.99"W]	1966apr08	TESTES 12 X 8 MM^94.5 G^TL(0234)MM TA(0064)MM HT 0021 MM EN 0000 MM	PREMONTANE HUMID FOREST. LIVE TRAP ON LOG IN JUNGLE.
	bre_JGuayanMoist GuayananHighland sMoist*				
AMNH75685*	bre_j	Mt. Roraima; Arabapo.			#4708.
AMNH75520*	bre_j	Roraima; R. Cotinga, Limão.			#4414.
	bre_JGuyananSavanna*				
MBUCV1890*	bre_kor	Guarico, Estacion Biologica de los Llanos, Calabozo.	1970jan25	TL 194 T 68 HF 17 E 15	Collector: Garcia, E.. Field # 95. 100 m. Det. RPH.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
46	138		23 orinoci /brevicaudata orinoci	MBUCV1879*	bre_kor	25	20%	Venezuela, Guarico	M	adult, you	08° 52' N 67° 23' W	NT0709 (Llanos) W
46		brekorL*			bre_korLlanosW*	40	33%					breor_1 NT0709 (Llanos) W
47	139		24 palliolata / brevicaudata	MBUCV1440*	bre_lpal	30	25%	Venezuela, Aragua	f	adult	10° 14' 49N 67° 35' 37.43"W [Maracay: GE]	NT1309 (La Costa xeric shrublands)
47	140		25 brevicaudata species group / brevicaudata	AMNH144834*	bre_lpal	17	14%	Venezuela, Aragua	m	adult	10° 4' 0.42"N 67° 32' 36.02"W [GE]	NT1309 (La Costa xeric shrublands)
47	141		24 palliolata / brevicaudata	USNM371282*	bre_lpal	62	51%	Venezuela, Yaracuy	m	old adult	10° 35'N 68° 15'W	NT1309 (La Costa xeric shrublands)
47		bre_lpaC*			bre_lpalLaCostaXericShrublands*	104	85%					bre_lpa_m NT1309 (La Costa Xeric Shrublands)
48	142		24 palliolata / brevicaudata	USNM370013*	bre_mpal	57	47%	Venezuela, Trujillo	f	adult	09° 32'N 70° 40'W.	NT0222 (Maracaibo dry forests), NT0175 (Venezuelan Andes montane forests)
48	143		24 palliolata / brevicaudata	USNM371285*	bre_mpal	63	52%	Venezuela, Trujillo	f	adult	09° 31'N 70° 35'W	NT0222 (Maracaibo dry forests), NT0175 (Venezuelan Andes montane forests)
48	144		24 palliolata / brevicaudata	USNM371289*	bre_mpal	58	48%	Venezuela, Trujillo	m	adult	09° 31'N 70° 44'W	NT0222 (Maracaibo dry forests), NT0175 (Venezuelan Andes montane forests)
48		brempaM*			bre_mpalMaracaiboDryVenezuelanAndesMontane*	77	63%					brempa_n NT0222 (Maracaibo Dry forests), NT0175 (Venezuelan Andes Montane forests)
49	145	breNTY*	20 brevicaudata / TYPE Didelphys brevicaudata	BM1867_4_12_540*	breNTY*	32	26%		f	adult		?
					bre_spGr*		0%					

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MBUCV1879*	bre_kor	Guarico, Estacion Biologica de los Llanos, Calabozo.	1970jan24	28,2 g: TL 182 T 66 HF 17,3 E 15,8	Collector: Garcia, E.. Field # 91. 100 m. Det. RPH.
	bre_korLlanosW*				
MBUCV1440*	bre_lpal	Aragua, Portachuelo, Estacion Biologica de Rancho Grande	1962apr19	56 g: TL 205 T 78 HF 10 E 12	Collector: Vegas, E.
AMNH144834*	bre_lpal	Rancho Grande.			
USNM371282*	bre_lpal	FALCON, BOCA DE YARACUY, 28 KM WNW PTO. CABELLO, 2 M, SMITHSONIAN VENEZUELAN PROJECT.	1965set29	^TESTES 7 X 6 MM^TL 0255 MM TA 0093 MM HT 0022 MM EN 0019 MM	TROPICAL DRY FOREST. RAT TRAP IN ROOTS.
	bre_lpalLaCostaXericShrublands*				
USNM370013*	bre_mpal	TRUJILLO, VALERA, 25 KM NW VALERA, NR. AGUA SANTA, , 90 M, SMITHSONIAN VENEZUELAN PROJECT.	1965ago21	LACTATING. TL 0200 MM TA 0081 MM HT 0019 MM EN 0021 MM	TROPICAL DRY FOREST, IN HOLLOW LOG IN PALM GROVE.
USNM371285*	bre_mpal	TRUJILLO, VALERA, 19 KM N VALERA, NR. AGUA VIVA, 164 M, SMITHSONIAN VENEZUELAN PROJECT.	1965set05	TL 0226 MM TA 0085 MM HT 0021 MM EN 0021 MM	TROPICAL HUMID FOREST. LIVE TRAP.
USNM371289*	bre_mpal	TRUJILLO, VALERA, 30 KM NW VALERA, NR. EL DIVIDIVE, 90 M, SMITHSONIAN VENEZUELAN PROJECT.	1965oct14	TESTES 9 X 6 MM^TL 0238 MM TA 0093 MM HT 0022 MM EN 0022 MM	TROPICAL DRY FOREST. LIVE TRAP AT BASE OF GRASS, VINES, SHRUBS. [10 potentially sexually dimorphic chars relative to females of pop I (USNM370013, USNM371285).]
	bre_mpalMaracaiboDryVenezuelanAndesMontane*				
BM1867_4_12_540*	breTY*				Skull Label: "Peramys brevicaudatus Erxl. Liotr or Jeudr Colll. Seba pl. XXXI. Fig. 6. In al."
	bre_spGr*				

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
50	146	doamaTY*	27 / maraxina PARATYPE maraxina	BM12_5_11_13*	do_amaTYMarajóVarzea*	11	9%	Brasil, PA	m			NT0138 (Marajó Varzea)
51	147	dobXITo*	26 domestica / domestica	MZUSP9931*	do_bXingu-Tocantins- AraguaiaMoistMatoGross oTropicalDry*	11	9%	Brasil, MS	m	adult, young	06° 39'S, 51° 59'W [Na Web sai em São Félix do Xingu, PA:MapPlanet:]	NT0180 (Xingu-Tocantins-Araguaia Moist forests), NT0140 (Mato Grosso Tropical Dry forests)
52	148		26 domestica / domestica	MN16476*	do_c	26	21%	Brasil, CE	m	adult, young	07° 14' S 39° 24' W [ME]	NT1304 (Caatinga)
52	149		26 domestica / domestica	MN17013*	do_c	14	11%	Brasil, PE	m	adult, young	07° 47' 6.84"S 39° 56' 25.28"W [Bodocó: GE]	NT1304 (Caatinga)
52	150		26 domestica / domestica	MN16904*	do_c	20	16%	Brasil, PE	m	adult	07° 47' 6.84"S 39° 56' 25.28"W [Bodocó: GE]	NT1304 (Caatinga)
52	151		26 domestica / domestica	MN16881*	do_c	13	11%	Brasil, PB	m	adult	07° 44' 13.40"S 37° 59' 36.48"W [Princesa Izabel: GE]	NT1304 (Caatinga)
52	152		26 domestica / domestica	MN16729*	do_c	19	16%	Brasil, PB	m	adult	07° 44' 13.40"S 37° 59' 36.48"W [Princesa Izabel: GE]	NT1304 (Caatinga)
52	153		26 domestica / domestica	MN30552*	do_c	15	12%	Brasil, RN	m	adult, young	06° 22' 13.40"S 35° 0' 11.89"W [Baía Formosa: GE]	NT1304 (Caatinga), NT0102 (Atlantic Coast Restingas), NT0152 (Pernambuco interior forests)
52		docCaa*			do_cCaatinga*	35	29%					NT1304 (Caatinga)
53	154	dodCaAI*	26 domestica / domestica	MN34394*	do_dCaatingaAtlanticDry*	25	20%	Brasil, MG	m	adult, young	16° 10' S 43° 21' W [ME].	NT1304 (Caatinga), NT0202 (Atlantic Dry forests)
54	155		26 domestica / domestica	MN36129*	do_e	16	13%	Brasil, GO	m	adult	14° 3'1.73"S 48°13'57.63"W [GE]	NT0704 (Cerrado)
54	156		26 domestica / domestica	MN46579*	do_e	11	9%	Brasil, GO	m	adult	13° 47' S 47° 29' W [ME]	NT0704 (Cerrado)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
BM12_5_11_13*	do_amaTYMarajóV arzea*	Marajó			
MZUSP9931*	do_bXingu- Tocantins- AraguaiaMoistMato GrasslandTropicalDry*	Gorotire, Rio Fresco [Ecoregion: Most prob NT0180, possibly near NT0168]		75mm 124mm 21mm 14mm	Collector: MSA & CT Carvalho. Ex Museu Goeldi 1309. CTCarvalho det.
MN16476*	do_c	CRATO; ST. ARISCO,	1952jul15	261/179/92/30/23	Expedition: SNP. Collector: J.FELIPE. Field # CR178. SEM FICHA DO SNP.
MN17013*	do_c	BODOCO; ST. ARAPUA,	1953ago27	90 G: ;-/170/90/22/26	Expedition: SNP. Collector: DJALMA FEITOZA. Field # BO1234. CAPTURADO EM FURNAS DE PEDRA
MN16904*	do_c	BODOCO; ST. ARAPUA,	1953jul16	60 G: ;-/155/89/20/20	Expedition: SNP. Collector: SINESIO MACEDO. Field # BO1047. CAPTURADO EM FURNAS DE PEDRA
MN16881*	do_c	PRINCESA ISABEL; ST. CAJUEIRO 1,	1953dec2	100 G: ;-/175/108/21/22; A MEDIDA DE ORELHA NA FICHA DE CAMPO DO SNP E DE 26.	Expedition: SNP. Collector: A.CABRAL. Field # TR2649. CAP. NUMA FURNA DISTANTE 200 METROS DO PREDIO N.16
MN16729*	do_c	PRINCESA ISABEL; ST. CALDEIRAO,	1953may04	87 G: ;-/160/85/20/25	Expedition: SNP. Collector: AGENOR CABRAL. Field # TR1898. CAPTURADO NUMA CERCA DE PEDRAS, DISTANTE 50 KM DO PREDIO N.41
MN30552*	do_c	BAHIA FORMOSA; MATA ESTRELA,	1991may/23	66 G: 244/-/89/19-21/23	Collector: ALFREDO LANGGUTH. Field # AL3079. CARÇA NO ALCOOL, PROJeto INVenário Mata ATLântica.
	do_cCaatinga*				
MN34394*	do_dCaatingaAtlânti cDry*	Jaiba.			
MN36129*	do_e	Serra da Mesa			Salles et al.1999.
MN46579*	do_e	PN CHAPADA DOS VEADEIROS, 65 KM SSW CAVALCANTE.	1996ago18	65 G: 232/-/80/16-17/21	Collector: C. R. BONVICINO. Field # CRB995.

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
54	157		26 domestica / domestica	MN46575*	do_e	28	23%	Brasil, GO	m	adult	13° 47' S 47° 29' W [ME]	NT0704 (Cerrado)
54	158		26 / domestica SYNTYPE Didelphys domestica	BM1887_10_25_1*	do_eTY	25	20%	Brasil, MT	f	adult		NT0704 (Cerrado)
54		doeCeTY*			do_eTYCerrado*	50	41%					NT0704 (Cerrado)
55	159		26 / domestica	MZUSP1711*	do_f	17	14%	Brasil, MS	f		22° 02' S 53° 44' W [ME]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba Interior Forest)
55	160		26 domestica / domestica	MZUSP1707*	do_f	15	12%	Brasil, MS	m	adult	22° 02' S 53° 44' W [ME]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba Interior Forest)
55	161		26 domestica / domestica	MZUSP1706*	do_f	24	20%	Brasil, MS	m	adult, old	22° 02' S 53° 44' W [ME]	NT0704 (Cerrado), NT0150 (Paraná-Paraíba Interior Forest)
55		dofCePP*			do_fCerradoParaná-ParáibaInterior*	44	36%					NT0704 (Cerrado), NT0150 (Paraná-Paraíba Interior Forest)
56	162	dogBeni*	26 domestica / domestica	USNM461347*	do_gBeniSavannaSWAmazonMoist*	55	45%	Bolívia, Beni	f	adult	15° 13' 60.00"S 64° 57' 60.00"W [GE]	NT0702 (Beni Savanna), NT0166 (Southwest Amazon Moist forests)
57	163	dohChac*	26 domestica / domestica	AMNH260024*	do_hChaco*	19	16%	Bolivia	m	adult	18° 25' S 62° 10' W	NT0210 (Chaco)
58	164	doiChaP*	26 domestica / domestica	USNM293130*	do_iHumidChacoParaná-ParáibaInterior*	70	57%	Paraguay	m	young adult		NT0708 (Humid Chaco) / NT0150 (Paraná-Paraíba Interior forests) / NT0210 (Chaco)
					do_spGr*		0%					
59	165		28 Monodelphis sp.	MZUSP12207*	sp_a*	45	37%	Brasil, PA	m	adult, old	04° 32' 45.51"S 56° 18' 24.20"W [Mapa Geomorfológico do Município de Itaituba	

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MN46575*	do_e	PN CHAPADA DOS VEADEIROS, 65 KM SSW CAVALCANTE.		75 G: 233/-78/18-20/24	Collector: C. R. BONVICINO. Field # CRB923.
BM1887_10_25_1*	do_eTY	Cuyaba	1924apr21	Ear 18	Collector: Thomas, O.
	do_eTYCerrado*				
MZUSP1711*	do_f	Porto Faia.	1904nov		Collector: Garbe. Vieira det.
MZUSP1707*	do_f	Porto Faia.	1904nov		Collector: Garbe. Vieira det.
MZUSP1706*	do_f	Porto Faia.	1904nov		Collector: Garbe. Vieira det.
	do_fCerradoParaná-Paralbalinterior*				
USNM461347*	do_gBeniSavannaSWAmazonMoist*	EL BENI, LA GRANJA, 4 KM N MAGDALENA, LA GRANJA.	1970dec20		Collector: KUNS, M. L. Field # 022931.
AMNH260024*	do_hChaco*	Santa Cruz; Tita. 300m.			#8546. Mus. SW Biol. NK 12538, et, karyo.
USNM293130*	do_iHumidChacoParaná-Paralbalinterior*	[no data]	1950apr20		Collector: WHARTON, C. H. Field # 106.
	do_spGr*				
MZUSP12207*	sp_a*	Uruá, Parque Nacional do Tapajós	1978aug22		Collector: Branch, L. B-M-1

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
60	1		Caluromys philander	UnB1653*	Calphi	15	12%		?	adult		
60	2		Caluromys philander	UnB1650*	Calphi	12	10%		?	adult, old		
60	3		Caluromys philander	UnB1675*	Calphi	42	34%		?	adult		
60	4		Caluromys philander	UnB1657*	Calphi	43	35%		?	adult		
60					Calphi*	61	50%					
61	5		Caluromys	I-1549*	Cal*	52	43%	Venezuela, Bolivar	f	adult, young		
					OGCal*		0%					
62	1		Didelphis albiventris	UnB1573*	Dialb	47	39%	Brasil	f	adult		
62	2		Didelphis albiventris	MN30379*	Dialbmale	17	14%	Brasil, CE	m	adult		
62	3		Didelphis albiventris	MN43054*	Dialbmale	22	18%	Brasil, GO	m	adult		
62			Didelphis albiventris	Didelphisalbadmale		27	22%					
62	4		Didelphis albiventris	UnB615*	DialbYad	41	34%	Brasil, MT	m	adult, young		
62	5		Didelphis albiventris	UnB387*	DialbYad	52	43%	Brasil, GO	m	adult, young		
62	6		Didelphis albiventris	UnB156*	DialbYad	59	48%	Brasil	m	adult, young		
62			Didelphis albiventris	DidelphisalbYadmale		85	70%					
62			Didelphis albiventris	DidelphisalbUnB			0%					
62					Didalb*	109	89%					
					OGDid*		0%					
64			Lutreolina	UBDBA-m1*	OGLut*	70	57%	?	?	adult, old		
65	1		Marmosa murina	UnB1259*	Mamur	55	45%	Brasil, ES	f	adult, young		

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
UnB1653*	Calphi				
UnB1650*	Calphi				Need taxi on basicranium
UnB1675*	Calphi				
UnB1657*	Calphi				
	Calphi*				
I-1549*	Cal*	Los Pijiguaos. [GE 6°35'17.68"N 66°45'24.82"W]	1987, oct		
	OGCal*				
UnB1573*	Dialb				C.
MN30379*	Dialbmale				
MN43054*	Dialbmale				
Didelphisalbadmale					
UnB615*	DialbYad	UHE Manso - Chapada dos Guimarães			C. No (e, m, R i)
UnB387*	DialbYad	Minaçu (SAMA)			C. No (R pmax, e, ossicles except R s & part of i)
UnB156*	DialbYad				C.
DidelphisalbYad male					
DidelphisalbUnB					
	Didalb*				
	OGDid*				
UBDBA-m1*	OGLut*			TL T HF E	Expedition: . Collector: . Field # .
UnB1259*	Mamur	Reserva Florestal (CVRD) - Linhares			p/c. Need tx

Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)
65	2		Marmosa murina	MN24700*	Mamur	12	10%	Brasil, BA	m	adult		
65	3		Marmosa murina	MN5611*	Mamur	21	17%	Brasil, ES	m	adult		
65	4		Marmosa murina	UnB1264*	Mamur	42	34%	Brasil, ES	m	adult, young		
65	5		Marmosa murina	UnB1262*	Mamur	55	45%	Brasil, ES	m	adult, young		
65	6		Marmosa murina	UnB1268*	Mamur	46	38%	Brasil, ES	m	adult, young		
65	7		Marmosa murina	UnB1278*	Mamur	43	35%	Brasil, ES	m	adult, young		
65	8		Marmosa murina	MN59603*	Mamur	12	10%	Brasil, MT	m	adult		
65					Mamur*	99	81%					
66	1		Marmosa robinsoni	MBUCV397*	Marob*	25	20%	Venezuela	?	adult		
					OGMa*		0%					
67	1		Marmosops incanus	MN31417*	Mopsincmale	25	20%	Brasil, BA	m	adult, old		
67	2		Marmosops incanus	UnB1405*	Mopsincmale	43	35%	Brasil, BA	m	adult, young		
67			Marmosops incanus		Mopsincmale*	75	61%					
67	3		Marmosops incanus	UnB448*	Mopsincf*	52	43%	Brasil, RJ	f	adult, young		
67					Mopsinc*	75	61%					
68	4		Marmosops parvidens	MN59604*	Mopspar*	12	10%	Brasil, MT	f			
					OGMops		0%					
Index OTU	Index specimens	Cladistic analysis label	species: vcsv id / museum label id	Museum #	Ecoregion Population	N Coded Char	% Coded Char	Country, State	Sex	Age	Coordinates	Ecoregion (when >1, in order of probability)

Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES
MN24700*	Mamur	Buerarema, Ribeirão da Fortuna, Ilhéus			
MN5611*	Mamur	Colônia Bof. Paganini, Pau Gigante			
UnB1264*	Mamur	Reserva Florestal (CVRD) - Linhares			p/c. Need tx
UnB1262*	Mamur	Reserva Florestal (CVRD) - Linhares			p/c. Need tx
UnB1268*	Mamur	Reserva Florestal (CVRD) - Linhares			p/c. Need tx
UnB1278*	Mamur	Reserva Florestal (CVRD) - Linhares			p/c. Need tx
MN59603*	Mamur				Field # 97171.
	Mamur*				
MBUCV397*	Marob*				
	OGMa*				
MN31417*	Mopsincmale				
UnB1405*	Mopsincmale	Sebastião Laranjeiras (Estreito IV).			Field # 863. p/c. Need tx.
Mopsincmale*					
UnB448*	Mopsincf*	CPRJ - Magé.			Field # MK119. p/c. Need tx.
	Mopsinc*				
MN59604*	Mopspar*				[Actually need to confirm if (MN59604 f Field # 976273) or (MN59605 m Field # 968586)
	OGMops				
Museum #	Ecoregion Population	Locality, specific	Collection date	Measurements	NOTES

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
AMNH139227*	ad_a	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	[12 3]	?	?	?	?	?	3	?	-	4	0	?	
AMNH202650*	ad_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	0	?	?	
AMNH136158*	ad_a	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	[12 3]	?	?	?	?	?	0	?	4	-	0	?	
BM1897_7_2_1*	ad_aTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	4	4	0	?	
FMNH70538*	ad_a	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	-	4	0	?	
	ad_aaTYMagdalenaValleyMont	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	[12 3]	?	?	?	?	?	[03]	1	[-4]	[-04]	0	?	
USNM309263*	ad_bmePana manianMontane	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	4	-	0	?	
USNM534286*	ad_cpe	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
AMNH67274*	ad_cpe	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	4	4	0	?	
	ad_cpeECordilleraRealMontan	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	[14]	[-4]	0	?	
USNM259433*	ad_dpe	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
FMNH19362*	ad_dpeTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM588019*	ad_dpe	2	0	3	1	?	?	0	1	?	0	1	0	0	0	0	0	0	1	1	-	0	0	1	?	?	?	0	
	ad_dpeTYPeruvianYungas*	2	0	3	1	?	?	0	1	0	0	1	0	0	0	0	0	0	1	1	-	0	0	1	?	?	?	0	
CM5242*	ad_eosTY	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	[12 3]	?	?	?	?	?	0	?	4	-	0	?	
CM5248*	ad_eosTY	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	ad_eosTYCAndeanWetPuna*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	[12 3]	?	?	?	?	?	0	?	4	-	0	?	
BDP3781*	ad_f*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	0	?	?	?	?	0	?	?	?	?	0	?
	ad_spGr*	2	0	3	1	?	?	0	1	0	0	1	0	0	0	0	[01 23]	1	1	-	0	[03]	1	[14]	[04]	0	0	?	
MN59596*	ku_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN59598*	ku_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
	ku_aMatoGrossoTropDry*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN59602*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN59600*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN59594*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN59601*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN36416*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
RM20*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	4	-	0	?	
MN46571*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	ku_bCerrado*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	[14]	-	0	?	
MZUSP480*	ku_cParaná-Paraliba	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	0	-	?	?	
	ku_spGr*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	[01 4]	-	0	?	
MZUSP9930*	am_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	-	1	1	?	
MN1304*	am_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?	
AMNH75170*	am_a	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	2	-	?	?	
AMNH203354*	am_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	1	-	1	?	
AMNH203353*	am_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	2	-	?	?	

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81
AMNH139227*	ad_a	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	-	1	1	0	[01]	?	-
AMNH202650*	ad_a	0	0	0	1	1	0	0	1	-	1	?	?	?	?	1	1	?	?	?	?	-	2	1	1	1	?	-
AMNH136158*	ad_a	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	2	-	1	0	[01]	?	-
BM1897_7_2_1*	ad_aTY	?	?	3	?	1	0	?	1	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[12]	-
FMNH70538*	ad_a	?	1	3	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_aaTYMagdalenaValleyMont	0	[01]	[03]	1	1	0	0	1	[-1]	1	1	?	?	?	1	1	?	?	?	?	[-2]	[-12]	1	[01]	[01]	[12]	-
USNM309263*	ad_bmePana manianMontane	?	1	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM534286*	ad_cpe	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
AMNH67274*	ad_cpe	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	2	2	?	?	[01]	?	-
	ad_cpeECordilleraRealMontan	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	2	2	?	?	[01]	?	-
USNM259433*	ad_dpe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
FMNH19362*	ad_dpeTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM588019*	ad_dpe	0	1	-	1	1	0	0	1	?	?	1	0	?	?	1	0	0	1	?	?	?	?	1	1	1	1	-
	ad_dpeTYPeruvianYungas*	0	1	-	1	1	0	0	1	?	?	1	0	?	?	1	0	0	1	?	?	?	?	1	1	1	1	-
CM5242*	ad_eosTY	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	2	-	1	0	[01]	?	-
CM5248*	ad_eosTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_eosTYCAndeanWetPuna*	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	2	-	1	0	[01]	?	-
BDP3781*	ad_f*	?	1	3	?	1	0	?	1	?	?	?	?	?	?	1	?	?	?	?	?	?	?	1	1	1	[12]	-
	ad_spGr*	0	[01]	[03]	1	1	0	0	1	1	1	1	0	?	?	1	[01]	0	1	?	?	2	[12]	1	[01]	[01]	[12]	-
MN59596*	ku_a	?	?	0	2	0	-	0	1	1	-	?	?	?	?	1	0	?	?	?	?	2	-	1	1	1	[01]	-
MN59598*	ku_a	0	?	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
	ku_aMatoGrossoTropDry*	0	?	1	2	[01]	0	0	1	1	-	?	?	?	?	1	0	?	?	?	?	2	-	1	1	1	[01]	-
MN59602*	ku_b	0	?	0	2	1	0	0	1	1	-	?	?	?	?	1	?	0	?	?	?	2	-	1	1	1	[01]	-
MN59600*	ku_b	0	?	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
MN59594*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
MN59601*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
MN36416*	ku_b	0	?	?	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
RM20*	ku_b	0	?	?	?	[01]	0	0	1	1	-	?	?	?	?	?	?	?	?	?	?	2	-	?	?	?	?	?
MN46571*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ku_bCerrado*	0	?	0	2	[01]	0	0	1	1	-	?	?	?	?	1	?	0	?	?	?	2	-	1	1	1	[01]	-
MZUSP480*	ku_cParaná-Paraliba	0	1	-	2	1	0	0	1	1	-	1	?	?	?	1	0	0	?	0	-	2	-	1	1	1	[01]	-
	ku_spGr*	0	1	[01]	2	[01]	0	0	1	1	-	1	?	?	?	1	0	0	?	0	-	2	-	1	1	1	[01]	-
MZUSP9930*	am_a	?	0	0	1	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	-
MN1304*	am_a	1	?	0	?	1	1	3	1	0	-	?	?	?	?	1	0	?	?	?	?	2	-	?	?	2	-	[01]
AMNH75170*	am_a	1	0	0	1	1	1	3	?	?	?	?	?	?	?	1	1	?	?	?	?	0	-	1	1	2	-	0
AMNH203354*	am_a	1	0	0	[01]	1	1	1	1	1	-	1	?	?	?	1	0	?	?	?	?	0	-	1	1	2	-	[01]
AMNH203353*	am_a	1	0	0	[01]	1	1	3	1	1	-	1	?	?	?	1	1	?	?	?	?	2	-	1	1	2	-	0

Museum #	Ecoregion Population	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	
AMNH139227*	ad_a	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
AMNH202650*	ad_a	-	?	?	0	0	1	0	[01]	-	-	?	?	?	?	?	?	?	?	?	3	1	?	0	-	1	0	1
AMNH136158*	ad_a	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
BM1897_7_2_1*	ad_aTY	-	?	?	?	?	?	0	[01]	0	0	?	?	?	?	?	?	?	?	1	?	?	?	0	[01]	[01]	?	?
FMNH70538*	ad_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_aaTYMagdalenaValleyMont	-	?	?	0	0	1	0	[01]	[-0]	[-0]	?	?	?	?	?	?	?	?	1	3	1	?	0	[-01]	[01]	0	1
USNM309263*	ad_bmeEPanamanianMontane	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM534286*	ad_cpe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
AMNH67274*	ad_cpe	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
	ad_cpeECordilleraRealMontan	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
USNM259433*	ad_dpe	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
FMNH19362*	ad_dpeTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM588019*	ad_dpe	-	0	0	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	?	?	0	1
	ad_dpeTYPeruvianYungas*	-	0	0	1	1	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	?	?	0	1
CM5242*	ad_eosTY	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	0	?	?	?	1	1	0	0	-	?	1	
CM5248*	ad_eosTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_eosTYCAndeanWetPuna*	-	?	?	?	?	?	0	?	?	?	?	?	?	?	0	?	?	?	?	1	1	0	0	-	?	1	
BDP3781*	ad_f*	-	?	?	?	?	?	0	[01]	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	?	?	?	1
	ad_spGr*	-	0	0	[01]	[01]	1	0	[01]	0	0	?	?	?	?	0	?	1	3	[01]	1	0	[01]	[01]	0	1		
MN59596*	ku_a	-	?	0	0	0	?	0	[01]	-	-	?	?	?	?	?	?	?	?	?	4	1	1	0	?	?	?	1
MN59598*	ku_a	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
	ku_aMatoGrossoTropDry*	-	?	0	0	0	?	0	[01]	-	-	?	?	?	?	?	?	?	?	?	4	1	1	0	?	?	?	1
MN59602*	ku_b	-	?	0	1	0	?	0	2	?	?	?	?	?	?	?	?	?	?	?	3	1	1	0	?	?	?	1
MN59600*	ku_b	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MN59594*	ku_b	-	?	0	1	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	3	?	?	?	?	?	?	1
MN59601*	ku_b	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MN36416*	ku_b	-	?	0	0	0	?	0	2	?	?	?	?	?	?	2	1	?	1	3	1	1	?	?	?	?	?	
RM20*	ku_b	?	?	?	?	?	?	?	2	0	-	?	?	?	?	?	1	?	1	?	1	1	0	?	?	?	?	
MN46571*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ku_bCerrado*	-	?	0	[01]	0	?	0	2	0	-	?	?	?	?	2	1	?	1	3	1	1	0	?	?	?	1	
MZUSP480*	ku_cParaná-Paraliba	-	?	0	0	0	1	0	?	?	?	?	?	?	?	?	?	?	?	?	3	1	1	0	0	-	0	1
	ku_spGr*	-	?	0	[01]	0	1	0	[01]	0	-	?	?	?	?	2	1	?	1	[34]	1	1	0	0	-	0	1	
MZUSP9930*	am_a	0	?	?	?	?	?	2	2	-	0	?	?	?	?	?	?	?	?	1	4	0	0	?	?	?	?	1
MN1304*	am_a	-	?	1	1	?	?	2	2	0	-	?	?	?	?	0	?	?	?	1	3	1	0	2	?	?	?	1
AMNH75170*	am_a	-	?	?	1	0	1	2	?	?	?	?	?	?	?	?	?	?	?	?	[123]	0	0	0	2	-	1	1
AMNH203354*	am_a	-	?	?	1	0	1	2	2	1	-	?	?	?	?	1	1	1	0	[123]	0	0	0	2	-	1	1	
AMNH203353*	am_a	-	?	?	1	0	1	2	2	0	-	?	?	?	?	?	?	?	?	?	[123]	1	0	0	2	-	1	1

Museum #	Ecoregion Population	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
AMNH139227*	ad_a	0	0	1	?	?	?	?	?	?	?	?	?	?	?	?
AMNH202650*	ad_a	0	1	0	0	-	3	-	0	1	2	0	0	1	-	2
AMNH136158*	ad_a	0	0	1	?	?	?	?	?	?	2	0	1	1	2	-
BM1897_7_2_1*	ad_aTY	?	?	?	0	2	2	?	?	0	[01]	0	0	1	1	1
FMNH70538*	ad_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_aaTYMagdalenaValleyMont	0	[01]	[01]	0	[-2]	[23]	-	0	[01]	[012]	0	[01]	1	[-121]	[-12]
USNM309263*	ad_bmeEPanamanianMontane	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM534286*	ad_cpe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
AMNH67274*	ad_cpe	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?
	ad_cpeECordilleraRealMontan	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?
USNM259433*	ad_dpe	0	0	2	?	?	?	?	?	?	?	0	?	2	?	?
FMNH19362*	ad_dpeTY	?	?	?	?	?	?	?	?	?	2	0	1	1	2	-
USNM588019*	ad_dpe	0	0	?	0	?	?	?	?	?	?	?	?	1	?	?
	ad_dpeTYPeruvianYungas*	0	0	2	0	?	?	?	?	?	2	0	1	[12]	2	-
CM5242*	ad_eosTY	0	[02]	[01]	0	3	-	?	?	?	?	0	0	1	?	?
CM5248*	ad_eosTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ad_eosTYCAndeanWetPuna*	0	[02]	[01]	0	3	-	?	?	?	?	0	0	1	?	?
BDP3781*	ad_f*	0	0	1	0	?	?	?	?	?	2	0	1	1	?	?
	ad_spGr*	[01]	[012]	[012]	0	[23]	[23]	?	?	?	[012]	0	[01]	[12]	[12]	[12]
MN59596*	ku_a	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN59598*	ku_a	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	ku_aMatoGrossoTropDry*	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN59602*	ku_b	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN59600*	ku_b	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN59594*	ku_b	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN59601*	ku_b	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN36416*	ku_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
RM20*	ku_b	?	?	?	[01]	[-2]	-	?	?	1	?	?	?	?	?	?
MN46571*	ku_b	?	?	?	?	?	?	?	?	?	[12]	1	0	1	1	1
	ku_bCerrado*	1	?	?	[01]	[-2]	-	?	?	1	[12]	1	0	1	1	1
MZUSP480*	ku_cParaná-Paralba	0	1	0	0	2	-	3	-	1	0	1	0	1	2	-
	ku_spGr*	[01]	1	0	[01]	2	-	3	-	1	[012]	1	0	1	[12]	1
MZUSP9930*	am_a	[01]	?	?	0	-	0	?	?	?	?	?	?	?	?	?
MN1304*	am_a	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
AMNH75170*	am_a	[01]	0	1	?	?	?	2	-	0	2	0	2	1	2	-
AMNH203354*	am_a	[01]	[12]	0	0	1	-	2	-	1	1	1	2	1	2	-
AMNH203353*	am_a	0	[01]	[01]	0	[13]	-	2	-	0	1	0	2	1	2	-

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	am_aTocantins-Araquaiá	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	2	[01]	[-12]	[-1]	1	?
MN24544*	am_bPernambuco*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN20976*	am_cBahiaCoastal*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?
MN24551*	am_dru	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	-	?	?
BM1855_11_26_9*	am_dru	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?	?	?	?
MN24550*	am_dru	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	2	1	?
	am_druBahiaInteriorN*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	[-2]	1	?
MN46570*	am_eumb	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	2	1	?
MN1313*	am_eumbTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_eumbTYCerradoN*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	2	1	?
UnB379*	am_f	?	?	?	?	-	2	1	?	?	1	?	2	1	?	?	0	?	?	?	?	?	0	?	?	?	?	?
AMNH133241*	am_f	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB378*	am_f	?	?	?	?	1	-	?	?	?	1	?	2	1	?	?	?	?	?	?	?	?	1	?	?	?	?	?
	am_fCerradoParaná-	?	?	?	?	[-1]	[-2]	1	?	0	1	?	2	1	?	?	0	?	?	?	?	[01]	?	?	?	?	?	?
AMNH61836*	am_g	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	-	4	?	?
USNM552401*	am_g	0	1	1	0	-	2	1	3	?	0	0	1	1	?	0	0	0	1	2	1	0	2	1	?	?	?	0
USNM552402*	am_g	0	1	1	0	-	2	1	3	?	0	0	1	1	?	?	0	0	0	-	?	0	2	1	?	?	?	2
	am_gBahiaInteriorS*	0	1	1	0	-	2	1	3	1	0	0	1	1	?	0	0	0	[01]	2	1	0	2	1	-	4	?	[02]
MN20972*	am_humb	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	-	1	?
USNM304593*	am_humb	0	1	?	?	?	?	1	3	?	1	0	?	1	?	?	0	0	1	2	1	0	2	1	?	?	?	?
	am_humbCerradoS*	0	1	?	?	?	?	1	3	?	1	0	?	1	?	?	0	0	1	2	1	0	2	1	1	-	1	?
MN7569*	am_j	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?
MN43900*	am_j	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?
	am_jParaná-ParabalInterior	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?
BM1921_8_6_2*	am_jtheTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	-	1	1	?
FMNH25739*	am_jtheTY	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?
MN24400*	am_jthe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?	?	?	?
MN10305*	am_jthe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	1	?
	am_jtheTYSerraMarRJCoastal*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	[12]	?	[-1]	[-1]	1	?
MZUSP873*	am_kih	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?
MZUSP3421*	am_kih	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_kihSerraMarCoastalAraucario	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?
MZUSP29200*	am_ljh	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	-	1	1	?
FMNH94736*	am_ljh	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?
MZUSP1517*	am_ljh	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	-	1	?
MZUSP10206*	am_ljh	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_ljhSerraMarCoastalSP*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	[12]	1	[-1]	[-1]	1	?

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	
	am_aTocantins-Araquaiá	1	0	0	[01]	1	1	[13]	1	[01]	-	1	?	?	?	1	[01]	?	?	?	?	[02]	-	1	1	2	-	[-01]	
MN24544*	am_bPernambuco*	?	?	?	?	1	1	?	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
MN20976*	am_cBahiaCoastal*	1	?	0	2	1	1	3	?	?	?	?	?	?	?	1	?	?	?	?	?	0	-	1	0	2	-	[01]	
MN24551*	am_dru	1	?	0	2	1	2	2	1	0	-	1	?	?	?	1	0	?	?	[01]	-	0	-	1	0	2	-	[01]	
BM1855_11_26_9*	am_dru	?	?	?	?	1	2	?	1	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN24550*	am_dru	1	0	0	1	1	1	3	1	0	0	1	?	?	?	1	0	?	?	[01]	[01]	1	1	1	0	2	-	?	
	am_druBahiaInteriorN*	1	0	0	[12]	1	[12]	[23]	1	0	[-0]	1	?	?	?	1	0	?	?	[01]	[-01]	[01]	[-1]	1	0	2	-	[01]	
MN46570*	am_eumb	1	0	0	1	1	1	0	1	0	0	2	?	?	?	1	1	1	?	[01]	[01]	0	0	1	1	2	-	?	
MN1313*	am_eumbTY	?	?	?	?	1	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	am_eumbTYCerradoN*	1	0	0	1	1	[01]	0	1	0	0	2	?	?	?	1	1	1	?	[01]	[01]	0	0	1	1	2	-	?	
UnB379*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
AMNH133241*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	-	0	?	?	2	-	-	
UnB378*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	am_fCerradoParaná-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	-	0	?	?	2	-	-	
AMNH61836*	am_g	?	?	?	?	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	-	
USNM552401*	am_g	1	0	0	2	1	2	3	?	?	?	1	?	-	0	1	0	1	0	-	2	-	1	1	1	2	-	-	
USNM552402*	am_g	1	0	0	2	1	1	3	?	?	?	1	?	-	0	1	1	1	0	-	2	-	1	1	1	2	-	-	
	am_gBahiaInteriorS*	1	0	0	2	1	[12]	3	?	?	?	1	?	-	0	1	[01]	1	0	-	2	-	1	1	1	2	-	-	
MN20972*	am_humb	1	?	0	2	1	1	3	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM304593*	am_humb	1	0	0	2	1	2	3	1	0	-	1	2	0	-	1	1	1	0	0	-	[01]	-	?	?	2	-	0	
	am_humbCerradoS*	1	0	0	2	1	[12]	3	1	[01]	-	1	2	0	-	1	1	1	0	0	-	[01]	-	?	?	2	-	0	
MN7569*	am_i	1	?	0	?	1	2	3	?	?	?	?	?	?	?	1	?	1	?	?	?	2	-	1	0	2	-	[01]	
MN43900*	am_i	1	?	0	?	1	1	3	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
	am_iParaná-ParabalInterior	1	?	0	?	1	[12]	3	1	1	-	?	?	?	?	1	?	1	?	?	?	2	-	1	0	2	-	[01]	
BM1921_8_6_2*	am_itheTY	?	?	0	?	1	1	?	1	-	1	?	?	?	?	1	?	?	?	?	?	-	2	1	0	2	-	?	
FMNH25739*	am_itheTY	?	0	0	?	1	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN24400*	am_ithe	?	?	?	?	?	?	?	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]
MN10305*	am_ithe	1	?	0	2	0	-	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]
	am_itheTYSerraMarRJCoastal*	1	0	0	2	[01]	1	[13]	1	[-1]	[-1]	?	?	?	?	1	?	?	?	?	?	-	2	1	0	2	-	[01]	
MZUSP873*	am_kih	0	?	0	1	0	-	3	1	1	-	?	?	?	?	1	0	?	?	?	?	2	-	1	1	2	-	[01]	
MZUSP3421*	am_kih	?	?	?	?	?	?	?	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]
	am_kihSerraMarCoastalAraucar	0	?	0	1	0	-	3	1	1	-	?	?	?	?	1	0	?	?	?	?	2	-	1	1	2	-	[01]	
MZUSP29200*	am_lih	0	0	0	2	1	1	3	?	?	?	?	?	?	?	?	?	?	?	?	?	-	0	?	?	2	-	-	
FMNH94736*	am_lih	?	0	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP1517*	am_lih	?	0	0	2	1	0	3	1	1	-	1	?	?	?	1	0	?	?	0	-	2	-	?	?	?	?	?	
MZUSP10206*	am_lih	?	?	?	?	1	2	?	1	1	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]
	am_lihSerraMarCoastalSP*	0	0	0	2	1	[01]	[03]	1	1	-	1	?	?	?	1	0	?	?	0	-	[-2]	[-0]	?	?	2	-	[-01]	

Museum #	Ecoregion Population	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107		
	am_aTocantins-Araquaiá-	[-0]	?	1	1	0	1	2	2	[-01]	[-0]	?	?	?	?	[01]	1	1	[01]	[1234]	[01]	0	[02]	2	-	1	1		
MN24544*	am_bPernambuco*	-	?	1	1	?	?	2	2	0	-	?	?	?	?	?	?	?	?	1	4	1	1	1	?	?	?	0	
MN20976*	am_cBahiaCoastal*	-	?	1	1	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	1	?	?	?	[01]	
MN24551*	am_dru	-	?	1	1	?	?	2	2	0	-	?	?	?	?	1	?	?	?	1	4	0	0	2	?	?	?	?	
BM1855_11_26_9*	am_dru	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN24550*	am_dru	?	?	?	0	0	0	2	1	1	1	0	0	0	0	1	?	1	1	1	1	0	2	2	2	?	?	?	
	am_druBahiaInteriorN*	-	?	1	[01]	0	0	2	[12]	[01]	[-1]	0	0	0	0	1	?	1	1	[14]	[01]	0	2	2	2	?	?	?	
MN46570*	am_eumb	?	?	?	0	0	1	?	[12]	?	?	?	?	?	?	1	1	?	0	?	0	0	2	2	2	2	1		
MN1313*	am_eumbTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
	am_eumbTYCerradoN*	?	?	?	0	0	1	?	[12]	?	?	?	?	?	?	1	1	?	0	?	0	0	2	2	2	2	1		
UnB379*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
AMNH133241*	am_f	0	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
UnB378*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
	am_fCerradoParaná-	0	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
AMNH61836*	am_g	0	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?		
USNM552401*	am_g	0	2	2	1	0	1	2	?	?	?	?	?	?	?	?	?	?	?	?	0	1	0	-	2	1	0		
USNM552402*	am_g	0	2	2	1	0	1	2	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	2	1	0		
	am_gBahiaInteriorS*	0	2	2	1	0	1	2	?	?	?	?	?	?	?	?	?	?	?	?	0	1	[01]	-	2	1	0		
MN20972*	am_humb	?	?	?	?	?	?	2	2	?	?	?	?	?	?	1	0	?	1	3	1	0	?	?	?	?	?		
USNM304593*	am_humb	-	2	2	1	0	1	2	2	?	?	?	?	?	?	?	?	?	?	?	0	0	1	2	-	2	0		
	am_humbCerradoS*	-	2	2	1	0	1	2	2	?	?	?	?	?	?	1	0	1	1	3	[01]	0	1	2	-	2	0		
MN7569*	am_i	-	?	1	1	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	[01]	
MN43900*	am_i	-	?	1	1	?	?	2	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	
	am_iParaná-ParabalInterior	-	?	1	1	?	?	2	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	[01]	
BM1921_8_6_2*	am_jtheTY	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
FMNH25739*	am_jtheTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	
MN24400*	am_jthe	-	?	1	1	?	?	2	2	?	?	?	?	?	?	1	?	?	?	?	0	1	0	[41]	?	?	?	0	
MN10305*	am_jthe	-	?	1	1	?	?	2	2	?	?	?	?	?	?	?	?	?	?	?	3	0	1	?	?	?	?	1	
	am_jtheTYSerraMarRJCoastal*	-	?	1	1	?	?	2	2	?	?	?	?	?	?	1	?	?	?	?	[13]	0	[01]	[0141]	?	?	?	[01]	
MZUSP873*	am_kih	-	?	1	1	?	?	2	2	?	?	?	?	?	?	?	?	?	?	?	3	0	1	4	?	?	?	0	
MZUSP3421*	am_kih	-	?	1	1	?	?	2	2	?	?	?	?	?	?	0	1	?	?	?	0	1	?	?	?	?	?	[01]	
	am_kihSerraMarCoastalAraucar	-	?	1	1	?	?	2	2	?	?	?	?	?	?	0	1	?	?	?	0	3	0	1	4	?	?	?	[01]
MZUSP29200*	am_ljh	0	?	?	?	?	?	2	2	-	0	?	?	?	?	?	?	?	?	?	4	?	1	?	?	?	?	0	
FMNH94736*	am_ljh	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
MZUSP1517*	am_ljh	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP10206*	am_ljh	-	?	1	1	?	?	2	2	?	?	?	?	?	?	?	?	?	?	?	0	?	1	3	0	1	?	?	0
	am_ljhSerraMarCoastalSP*	[-0]	?	1	1	?	?	2	2	-	0	?	?	?	?	?	?	?	?	?	[34]	0	1	?	?	?	?	[01]	

Museum #	Ecoregion Population	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
	am_aTocantins- Araquaiá-	[01]	[012 1]	[01]	0	[- 13]	[-0]	2	-	[01]	[12]	[01]	2	1	2	-
MN24544*	am_bPembuco*	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN20976*	am_cBahiaCoastal*	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN24551*	am_dru	?	?	?	0	[34]	-	2	-	1	2	1	1	1	2	-
BM1855_11_26_9*	am_dru	?	?	?	?	?	?	?	?	?	?	?	?	2	2	-
MN24550*	am_dru	?	?	?	?	?	?	?	?	?	[01]	1	0	2	?	?
	am_druBahiaInteriorN*	?	?	?	0	[34]	-	2	-	1	[012 1]	1	[01]	[12]	2	-
MN46570*	am_eumb	1	[12]	0	?	?	?	?	?	?	2	1	2	1	?	?
MN1313*	am_eumbTY	?	?	?	?	?	?	?	?	?	2	?	?	1	?	?
	am_eumbTYCerradoN*	1	[12]	0	?	?	?	?	?	?	2	1	2	1	?	?
UnB379*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
AMNH133241*	am_f	?	2	0	?	?	?	?	?	?	?	?	?	?	?	?
UnB378*	am_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_fCerradoParaná-	?	2	0	?	?	?	?	?	?	?	?	?	?	?	?
AMNH61836*	am_g	?	0	2	?	?	?	?	?	?	?	?	?	?	?	?
USNM552401*	am_g	?	1	?	0	-	2	-	7	?	?	?	?	?	?	?
USNM552402*	am_g	?	1	?	0	-	2	-	1	?	?	?	?	?	-	0
	am_gBahiaInteriorS*	?	1	2	0	-	2	-	[17]	?	?	?	?	?	-	0
MN20972*	am_humb	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM304593*	am_humb	?	0	?	0	1	-	6	-	?	?	?	?	?	2	-
	am_humbCerradoS*	?	0	?	0	1	-	6	-	?	?	?	?	?	2	-
MN7569*	am_i	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN43900*	am_i	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_iParaná-ParabalInterior	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
BM1921_8_6_2*	am_jtheTY	0	?	?	?	?	?	?	?	?	0	1	0	2	-	0
FMNH25739*	am_jtheTY	0	2	0	?	?	?	?	?	?	?	?	?	?	?	?
MN24400*	am_jthe	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN10305*	am_jthe	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_jtheTYSerraMarRJCoastal*	[01]	2	0	?	?	?	?	?	?	0	1	0	2	-	0
MZUSP873*	am_kih	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP3421*	am_kih	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_kihSerraMarCoastalAraucaria	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP29200*	am_lih	1	?	?	1	-	-	?	?	?	?	?	?	?	?	?
FMNH94736*	am_lih	0	0	1	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP1517*	am_lih	?	?	?	?	?	?	?	?	?	?	1	0	1	1	-
MZUSP10206*	am_lih	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	am_lihSerraMarCoastalSP*	[01]	0	1	1	-	-	?	?	?	?	1	0	1	1	-

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
MZUSP1523*	am_mCerradoP araná- am_spGr_sl*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
		0	1	1	0	1	2	1	3	[01]	[01]	0	[12]	1	?	0	0	0	[01]	2	1	[01]	[12]	[01]	[12]	[12]	4	1	[02]
MN32166*	sc_a	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?	
MN32167*	sc_a	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?	
	sc_aBahialInteri orCoastal*	?	?	?	?	?	?	?	?	[12]	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	1	?	
MN7247*	sc_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	?	?	
MN6419*	sc_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?	?	?	?	
	sc_bSerraMarC oastalRJ*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	?	?	
MZUSP1528*	sc_cSerraMarC oastalSP*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	-	2	?	?	
MHNCI2794*	sc_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	1	?	
MHNCI3334*	sc_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	sc_dAraucariaM oist*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	1	?	
	sc_spGr*	?	?	?	?	?	?	?	?	[12]	?	?	?	?	?	?	?	?	?	?	?	?	[12]	1	1	2	1	?	
AMNH96810*	em_aXingu- Tocantins-	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	1	?	
MN1299*	em_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	1	-	1	?	
USNM461884*	em_b	[01]	1	0	0	2	-	1	3	?	1	0	1	1	?	0	0	0	1	1	1	0	?	?	?	?	?		
	em_bMadelra- Tapalós-	[01]	1	0	0	2	-	1	3	?	1	0	1	1	?	0	0	0	1	1	1	0	2	1	1	-	1	?	
APC155*	em_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	-	1	1	?	
MN59593*	em_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	-	1	1	?	
APC199*	em_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	[01]	-	1	?	
RON018*	em_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	?	?	1	?	
	em_cMadeira- TapalósMoistCe	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	-	[1]	1	?	
INPA3039*	em_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	2	-	2	?	?	
MVZ190334*	em_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	-	2	1	?	
INPA3040*	em_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	1	-	1	?	
FMNH58955*	em_d	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
MUSM13298*	em_d	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	1	?	
	em_dSWAmazo nMoistIquitosVa	?	?	?	?	?	?	?	?	[02]	?	?	?	?	?	?	?	?	?	?	?	?	[12]	2	-	[2]	1	?	
	em_spGr*	[01]	1	0	0	2	-	1	3	[01]	1	0	1	1	?	0	0	0	1	1	1	0	[12]	[12]	[01]	[12]	1	?	
										2]																			
AMNH208970*	he_adi	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP1527*	he_adi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP1435*	he_adi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	4	-	?	?	
MN1312*	he_adi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	he_adiUruguay anSavanna*	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	1	1	4	-	?	?	
CTX3355*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	0	?	?	
CTX3371*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	-	0	?	?	
CTX3378*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	0	-	0	?	?	

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	
MZUSP1523*	am_mCerradoP araná- am_spGr_sl*	?	?	?	?	1	2	3	?	?	?	?	?	?	?	?	?	?	?	?	?	-	0	?	?	2	-	-	
		[01]	0	0	[01 2]	[01 2]	[01 23]	1	[01]	[01]	[12]	2	0	0	1	[01]	1	0	[01]	[01 2]	[01 2]	[01 2]	[01 2]	1	[01]	2	-	[01]	
MN32166*	sc_a	?	0	0	?	1	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN32167*	sc_a	?	0	0	?	1	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	sc_aBahiaInteri orCoastal*	?	0	0	?	1	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN7247*	sc_b	0	?	0	2	1	1	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
MN6419*	sc_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
	sc_bSerraMarC oastalRJ*	0	?	0	2	1	2	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
MZUSP1528*	sc_cSerraMarC oastalSP*	1	0	0	1	1	2	3	1	-	0	1	?	?	?	1	0	?	?	-	0	-	1	?	?	2	-	-	
MHNCI2794*	sc_d	0	?	0	?	1	1	3	?	?	?	?	?	?	?	1	0	?	?	?	?	0	-	1	0	2	-	[01]	
MHNCI3334*	sc_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	[01]	
	sc_dAraucariaM oist*	0	?	0	?	1	1	3	?	?	?	?	?	?	?	1	0	?	?	?	?	0	-	1	0	2	-	[01]	
	sc_spGr*	[01]	0	0	[12]	1	[12]	[03]	1	-	0	1	?	?	?	1	0	?	?	-	0	0	1	1	0	2	-	[01]	
AMNH96810*	em_aXingu- Tocantins-	?	?	?	?	1	1	?	?	?	?	?	?	?	?	1	?	1	?	?	?	0	-	1	0	2	?	?	
MN1299*	em_b	2	?	0	1	1	0	3	?	?	?	?	?	?	?	1	1	?	?	?	?	0	-	1	0	2	-	1	
USNM461884*	em_b	?	?	?	?	?	?	?	1	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	em_bMadelra- Tapalós-	2	?	0	1	1	0	3	1	0	-	?	?	?	?	1	1	?	?	?	?	0	-	1	0	2	-	1	
APC155*	em_c	2	0	0	[12]	1	2	[03]	1	-	0	2	?	?	?	1	1	?	0	-	[02]	-	1	1	0	2	-	-	
MN59593*	em_c	2	0	0	1	0	-	3	1	-	0	2	?	?	?	1	1	?	0	-	[02]	-	2	1	0	2	-	-	
APC199*	em_c	2	0	0	1	1	0	3	?	?	?	2	?	?	?	1	1	?	0	[02]	-	1	-	1	0	2	-	1	
RON018*	em_c	2	0	0	2	1	1	2	1	?	?	1	[23]	?	?	?	1	1	?	?	?	?	?	?	1	1	2	-	?
	em_cMadeira- TapalósMoistCe	2	0	0	[12]	[01]	[01 2]	[02 3]	1	-	0	[12]	[23]	?	?	1	1	?	0	[- 02]	[- 02]	[-1 12]	[- 12]	1	[01]	2	-	[-1]	
INPA3039*	em_d	1	0	0	1	1	0	3	1	-	0	?	?	?	?	?	?	?	?	?	?	-	1	?	?	2	-	-	
MVZ190334*	em_d	?	0	0	?	[01]	0	[23]	1	-	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
INPA3040*	em_d	1	?	0	2	0	-	[30]	?	?	?	?	?	?	?	1	1	1	?	?	?	?	0	-	1	0	2	-	1
FMNH58955*	em_d	?	0	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MUSM13298*	em_d	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	1	?	?	?	?	?	?	1	0	2	-	?
	em_dSWAmazo nMoistIquitosVa	1	0	0	[12]	[01]	0	[02 3]	1	-	0	?	?	?	?	1	1	1	?	?	?	?	[-0]	[-1]	1	0	2	-	[-1]
	em_spGr*	[12]	0	0	[12]	[01]	[01 2]	[02 3]	1	0	0	[12]	[23]	?	?	1	1	1	0	[02]	[02]	[01]	[12]	1	[01]	2	-	1	
AMNH208970*	he_adi	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	?	?	1	3	-	
MZUSP1527*	he_adi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-
MZUSP1435*	he_adi	?	?	3	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-
MN1312*	he_adi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	-
	he_adiUruguay anSavanna*	?	?	3	?	1	0	0	?	?	?	?	?	?	?	1	?	?	?	?	?	2	-	?	?	1	3	-	
CTX3355*	he_bbris	0	0	0	2	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	-	2	?	?	1	3	-	
CTX3371*	he_bbris	1	0	0	2	1	0	3	1	-	1	?	?	?	?	?	?	?	?	?	?	-	2	?	?	1	3	-	
CTX3378*	he_bbris	0	0	0	?	1	0	3	1	-	1	?	?	?	?	?	?	?	?	?	?	-	2	?	?	1	3	-	

Museum #	Ecoregion Population	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	
MZUSP1523*	am_mCerradoP araná- am_spGr_sl*	0	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	3	?	1	?	?	?	?	1	
		0	2	[12]	[01]	0	[01]	2	[12]	[01]	[01]	0	0	0	0	[01]	[01]	1	[01]	[123 41]	[01]	[01]	[012 41]	2	2	[12]	[01]	
MN32166*	sc_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MN32167*	sc_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
	sc_aBahiaInteri orCoastal*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MN7247*	sc_b	-	?	1	1	?	?	2	2	?	?	?	?	?	?	1	1	?	1	4	1	0	?	?	?	?	[01]	
MN6419*	sc_b	-	?	1	1	?	?	2	2	?	?	?	?	?	?	1	1	?	1	3	1	0	4	?	?	?	[01]	
	sc_bSerraMarC oastalRJ*	-	?	1	1	?	?	2	2	?	?	?	?	?	?	1	1	?	1	[34]	1	0	4	?	?	?	[01]	
MZUSP1528*	sc_cSerraMarC oastalSP*	1	?	?	1	0	1	2	?	?	?	?	?	?	?	?	?	?	?	4	1	0	2	-	1	2	0	
MHNCI2794*	sc_d	-	?	1	1	?	?	2	2	0	-	?	?	?	?	1	0	?	1	2	1	0	4	?	?	?	[01]	
MHNCI3334*	sc_d	-	?	1	1	?	?	2	2	0	-	?	?	?	?	1	1	?	1	3	0	0	?	?	?	?	0	
	sc_dAraucariaM oist*	-	?	1	1	?	?	2	2	0	-	?	?	?	?	1	[01]	?	1	[23]	[01]	0	4	?	?	?	[01]	
	sc_spGr*	1	?	1	1	0	1	2	2	0	-	?	?	?	?	1	[01]	?	1	[234]	[01]	0	[24]	-	1	2	[01]	
AMNH96810*	em_aXingu- Tocantins-	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	0	
MN1299*	em_b	-	?	1	1	?	?	2	?	?	?	?	?	?	?	?	?	?	?	4	0	0	4	?	?	?	0	
USNM461884*	em_b	?	?	1	1	0	?	2	2	?	?	?	?	?	?	[01]	1	1	1	?	0	0	1	2	-	2	0	
	em_bMadelra- Tapalós-	-	?	1	1	0	?	2	2	?	?	?	?	?	?	[01]	1	1	1	4	0	0	[14]	2	-	2	0	
APC155*	em_c	1	?	?	1	0	0	2	2	-	1	-	0	-	0	1	?	?	?	4	1	0	2	-	1	2	0	
MN59593*	em_c	1	?	?	1	0	[01]	2	2	-	1	-	0	-	0	?	?	?	?	2	1	0	[12]	-	1	1	0	
APC199*	em_c	-	?	?	1	0	[01]	2	2	0	-	-	-	-	-	?	?	?	?	2	1	0	1	1	-	1	0	
RON018*	em_c	?	?	?	1	0	1	2	2	?	?	?	?	?	?	?	?	?	?	?	?	?	[12]	?	?	1	1	
	em_cMadeira- TapalósMoistCe	[-1]	?	?	1	0	[01]	2	2	[-0]	[-1]	-	[-0]	-	[-0]	1	?	?	?	[24]	1	0	[12]	[-1]	[-1]	[12]	[01]	
INPA3039*	em_d	1	?	?	1	0	0	2	2	-	1	?	?	?	?	?	?	?	?	3	0	0	?	-	2	1	[01]	
MVZ190334*	em_d	?	?	?	?	?	?	?	2	-	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
INPA3040*	em_d	-	?	1	1	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	[01]	?	?	?	0
FMNH58955*	em_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MUSM13298*	em_d	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	?	?	?	0
	em_dSWAmazo nMoistIquitosVa em_spGr*	[-1]	?	1	1	0	0	2	2	-	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]
		1	?	1	1	0	[01]	2	2	0	1	-	0	-	0	[01]	1	1	1	[234 1]	[01]	0	[012 41]	[12]	[12]	[12]	[12]	[01]
AMNH208970*	he_adi	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1
MZUSP1527*	he_adi	-	?	0	0	0	?	0	[01]	2	-	?	?	?	?	?	?	?	?	1	3	1	0	0	?	?	?	1
MZUSP1435*	he_adi	-	?	0	0	0	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0
MN1312*	he_adi	-	?	0	0	0	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	he_adiUruguay anSavanna*	-	?	0	0	0	?	[01]	[01]	2	-	?	?	?	?	?	?	?	?	1	3	1	0	0	?	?	?	[01]
CTX3355*	he_bbris	-	?	?	0	0	1	0	[01]	-	-	?	?	?	?	?	?	?	?	?	3	1	0	?	-	0	1	1
CTX3371*	he_bbris	-	?	?	0	0	[01]	0	2	-	0	?	?	?	?	1	?	1	1	3	1	0	?	-	0	1	1	
CTX3378*	he_bbris	-	?	?	0	0	1	0	2	-	0	?	?	?	?	1	1	0	1	3	1	0	?	-	0	1	1	

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
CTX3126*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?
CTX3358*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	1	2	-	?	?
CTX3379*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	?	?
CTX2996*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	2	-	?	?
CTX3127*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	2	-	?	?
CTX3207*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	2	-	?	?
CTX3261*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	2	-	?	?
CTX3094*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	4	-	?	?
CTX3178*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	4	-	?	?
CTX3260*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	4	-	?	?
CTX3263*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	4	-	?	?
MZUSP2823*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	he_bbrisParaná-ParabalInterior*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01 2]	[01 124]	[- 124]	[- 0]	?	?
MHNCI3146*	he_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	1	1	?
MHNCH1104*	he_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	2	-	?	?
	he_cAraucariaMoist*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	1	[-2]	[-1]	1	?
MN24549*	he_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?
MZUSP7671*	he_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	he_dSerraMarCoastal*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?
USNM446054*	he_eso	0	1	0	1	1	-	0	1	?	[01]	0	2	1	1	0	1	1	0	-	0	0	1	1	?	?	?	0
USNM4484016*	he_eso	0	3	0	1	1	-	0	1	?	1	0	2	1	?	?	1	?	0	-	0	0	?	?	?	?	?	?
	he_esoParaná-ParabalInterior	0	[13]	0	1	1	-	0	1	?	[01]	0	2	1	1	0	1	1	0	-	0	0	1	1	?	?	?	0
	he_spGr*	0	[13]	0	1	1	-	0	1	2	[01]	0	2	1	1	0	1	1	0	-	0	0	[01 2]	[01 4]	[12 4]	[01]	1	0
MZUSP20082*	bre_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	4	?	?
MN59610*	bre_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?
MN59606*	bre_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?
MN59608*	bre_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?
MZUSP20093*	bre_a	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	1	-	?	?
	bre_aMadeira-TapaíosMoist*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	1	[-1]	[-4]	?	?
AN228*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	3	?	?
AN235*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	3	?	?
AN213*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?
AN227*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?
AN229*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	1	?
AN248*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	?	1	-	?	?
AN224*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?
AN252*	bre_b	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	
CTX3126*	he_bbris	?	?	?	?	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-		
CTX3358*	he_bbris	0	?	1	2	1	0	2	?	?	?	?	?	?	?	1	?	?	?	?	?	0	-	1	0	1	3	-	
CTX3379*	he_bbris	?	?	0	?	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX2996*	he_bbris	?	?	0	?	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3127*	he_bbris	?	?	0	2	0	-	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3207*	he_bbris	0	?	0	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3261*	he_bbris	1	?	0	?	1	0	[03]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3094*	he_bbris	?	?	3	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3178*	he_bbris	?	?	3	?	1	0	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3260*	he_bbris	?	?	3	?	1	0	[02]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
CTX3263*	he_bbris	?	?	3	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
MZUSP2823*	he_bbris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	he_bbrisParaná-ParabalInterior*	[01]	0	[01]	2	[01]	0	[02]	1	-	1	?	?	?	?	1	?	?	?	?	?	?	[-0]	[-2]	1	0	1	3	-
MHNCH3146*	he_c	2	0	0	2	0	-	3	1	-	1	?	?	?	?	?	?	?	?	?	?	?	-	2	?	?	1	3	-
MHNCH1104*	he_c	1	?	1	0	1	0	[23]	?	?	?	?	?	?	?	1	?	?	?	?	?	?	0	-	1	0	1	3	-
	he_cAraucariaMoist*	[12]	0	[01]	[02]	[01]	0	[23]	1	-	1	?	?	?	?	1	?	?	?	?	?	?	[-0]	[-2]	1	0	1	3	-
MN24549*	he_d	1	?	?	?	?	?	2	?	?	?	?	?	?	?	1	?	?	?	?	?	?	0	-	1	0	1	3	-
MZUSP7671*	he_d	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	-
	he_dSerraMarCoastal*	1	?	?	?	?	?	2	?	?	?	?	?	?	?	1	?	?	?	?	?	?	0	-	1	0	[12]	[-3]	-
USNM460504*	he_eso	1	0	0	1	1	0	1	1	0	-	1	0	0	-	1	1	1	0	2	-	1	-	1	0	1	3	-	
USNM484016*	he_eso	?	?	?	?	?	?	?	1	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-
	he_esoParaná-ParabalInterior	1	0	0	1	1	0	1	1	0	-	1	0	0	-	1	1	1	0	2	-	1	-	1	0	1	3	-	
	he_spGr*	[01]	0	[01]	[01]	[01]	0	[01]	1	0	1	1	0	0	-	1	1	1	0	2	-	[01]	2	1	0	[12]	3	-	
MZUSP20082*	bre_a	?	0	0	1	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-	
MN59610*	bre_a	1	?	0	?	1	0	0	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	[01]	-
MN59606*	bre_a	1	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-	
MN59608*	bre_a	1	?	0	2	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-	
MZUSP20093*	bre_a	0	?	0	2	1	0	0	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	[01]	-
	bre_aMadeira-TapaíósMoist*	[01]	0	0	[12]	1	0	[01]	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	[01]	-
AN228*	bre_b	?	0	0	2	1	0	0	1	-	0	?	?	?	?	1	1	?	?	?	?	?	-	2	?	?	[01]	[01]	-
AN235*	bre_b	1	0	0	[12]	0	-	0	1	-	0	?	?	?	?	1	1	?	?	?	?	?	-	2	?	?	[01]	[01]	-
AN213*	bre_b	?	?	0	?	1	0	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
AN227*	bre_b	1	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
AN229*	bre_b	?	?	0	?	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
AN248*	bre_b	1	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-
AN224*	bre_b	?	?	0	2	0	-	0	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	?	?	1	[01]	-
AN252*	bre_b	?	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-

Museum #	Ecoregion Population	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
	bre_bPurus-Madeira-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
INPA2835*	bre_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP21285*	bre_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_cXingu-Tocantins-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM546197*	bre_d	[01]	0	-	0	1	[02]	2	1	2	-	3	1	-	2	-	1	0	-	2	-	0	0	1	?	3	0	0	
USNM546207*	bre_d	0	0	0	-	1	2	2	1	2	[03]	-	1	0	-	0	-	-	-	-	-	-	0	1	1	2	1	0	
AMNH94902*	bre_d	0	?	?	?	1	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	
	bre_dTapajós-XinguMoistW*	[01]	0	[-0]	[-0]	1	[02]	2	1	2	[-	[-3]	1	[-0]	[-2]	0	1	0	-	[-2]	-	[-0]	0	1	1	[23]	[01]	0	
USNM549279*	bre_eto	0	0	-	0	?	?	?	0	1	[24]	-	3	1	-	2	-	1	0	-	[12]	-	0	?	1	1	?	0	?
USNM549280*	bre_eto	0	0	0	-	0	-	0	1	1	3	-	0	2	-	0	-	-	-	-	0	-	2	1	1	?	0	1	
	bre_etoTapajós-XinguMoistE*	0	0	[-0]	[-0]	0	-	0	1	[12	[-3]	[-3]	[01]	[-2]	[-2]	0	1	0	-	[-	[-0]	[-0]	2	1	1	?	0	1	
MN20218*	bre_fto	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
AN603*	bre_fto	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_ftoUatuma-TrombetasMoist	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
INPA535*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MN16802*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
INPA1788*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP4513*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_gUatuma-TrombetasMoist	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM406907*	bre_h	1	0	-	4	0	-	0	1	1	-	3	0	-	2	-	[01]	0	-	1	-	0	0	1	1	?	?	1	
AMNH78096*	bre_h	0	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	
USNM385010*	bre_h	0	[01]	1	-	0	-	2	1	1	3	-	[01]	1	-	1	-	0	0	-	1	-	[01]	[01]	1	1	?	1	
EV18*	bre_h	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_hNegro-BrancoMoist*	[01]	[01]	[-1]	[-4]	0	-	[02]	1	1	[-3]	[-3]	[01]	[-1]	[-2]	1	[01]	0	[-0]	[-1]	[-1]	[-0]	[01]	[01]	1	1	0	1	
USNM385005*	bre_i	[01]	0	-	1	0	-	2	1	1	-	3	[01]	-	2	-	1	1	-	0	-	0	0	2	2	2	?	[13]	
AMNH130564*	bre_i	0	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	
USNM385004*	bre_i	0	0	0	-	0	-	2	1	1	3	-	[01]	2	-	0	-	-	-	-	-	-	2	[01]	[12]	?	?	[13]	
	bre_iGuluananMoistGuayananHi	[01]	0	[-0]	[-1]	0	-	2	1	1	[-3]	[-3]	[01]	[-2]	[-2]	0	1	1	-	[-0]	-	[-0]	[02]	[01	[12]	2	1	[13]	
AMNH75685*	bre_j	0	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	
AMNH75520*	bre_j	1	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	
	bre_jGuyananSavanna*	[01]	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	
MBUCV1890*	bre_kor	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MBUCV1879*	bre_kor	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_korLlanosW*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MBUCV1440*	bre_lpal	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
AMNH144834*	bre_lpal	1	?	?	?	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	
USNM371282*	bre_lpal	2	0	[05]	-	?	?	2	1	1	3	-	1	[12]	-	1	-	0	0	-	0	-	0	1	[12]	?	?	?	

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	bre_bPurus- Madelra-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	1	[-1]	[-3]	1	?		
INPA2835*	bre_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?		
MZUSP21285*	bre_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	2	1	?		
	bre_cXingu- Tocantins-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	[-1]	[-2]	1	?		
USNM546197*	bre_d	0	3	3	1	-	0	0	0	?	1	1	2	0	1	0	[02]	1	1	[03]	0	1	0	1	?	?	?	0	
USNM546207*	bre_d	0	2	3	1	3	-	0	0	?	0	1	2	0	1	0	2	2	1	0	0	1	0	1	?	?	?	2	
AMNH94902*	bre_d	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	0	?	4	-	?	?		
	bre_dTapajós- XinguMoistW*	0	[23]	3	1	[-3]	[-0]	0	0	2	[01]	1	2	0	1	0	[02]	[12]	1	[03]	0	1	0	1	4	-	?	[02]	
USNM549279*	bre_eto	2	[23]	?	?	-	[04]	0	1	?	0	1	1	0	?	?	?	1	?	?	0	0	0	1	?	?	?	0	
USNM549280*	bre_eto	0	1	0	1	0	-	0	1	?	0	1	0	0	?	2	1	1	1	1	0	1	0	1	?	?	?	[12]	
	bre_etoTapajós- XinguMoistE*	[02]	[12]	0	1	[-0]	[-04]	0	1	?	0	1	[01]	0	?	2	1	1	1	1	0	[01]	0	1	?	?	?	[01]	[21]
MN20218*	bre_fto	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
AN603*	bre_fto	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	2	-	?	?	
	bre_ftoUatuma- TrombetasMoist	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	2	-	?	?	
INPA535*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	-	2	?	?		
MN16802*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?		
INPA1788*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?		
MZUSP4513*	bre_g	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?		
	bre_gUatuma- TrombetasMoist	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	[-1]	[-2]	?	?		
USNM406907*	bre_h	0	2	4	1	-	0	0	1	?	0	1	2	0	1	0	1	2	1	1	0	0	0	1	?	?	?	0	
AMNH78096*	bre_h	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	-	0	?	?		
USNM385010*	bre_h	0	2	[02]	1	0	-	0	1	?	0	1	2	0	0	0	2	2	1	[01]	0	0	0	[01]	?	?	?	0	
EV18*	bre_h	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	1	-	?	?		
	bre_hNegro- BrancoMoist*	0	2	[02]	1	[-0]	[-0]	0	1	0	0	1	2	0	[01]	0	[12]	2	1	[01]	0	0	[01]	[01]	[-1]	[-0]	?	0	
USNM385005*	bre_i	[01]	[23]	4	1	-	0	0	[01]	?	0	1	1	0	1	1	[12]	1	1	[01]	0	0	0	1	?	?	?	[01]	
AMNH130564*	bre_i	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	4	-	?	?		
USNM385004*	bre_i	0	2	4	1	0	-	0	1	?	0	1	1	0	1	0	[02]	2	1	0	0	0	1	1	?	?	?	1	
	bre_iGulananM- oistGuayananHi	[01]	[23]	4	1	[-0]	[-0]	0	[01]	0	0	1	1	0	1	[01]	[01]	[12]	1	[01]	0	0	[01]	1	4	-	?	[01]	
AMNH75685*	bre_j	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	4	-	?	?		
AMNH75520*	bre_j	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?		
	bre_jGuyananS- avanna*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	0	?	[14]	-	?	?		
MBUCV1890*	bre_kor	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	2	-	2	?	?		
MBUCV1879*	bre_kor	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	1	?		
	bre_korLlanosW*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	[12]	[-1]	[-2]	1	?		
MBUCV1440*	bre_lpal	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
AMNH144834*	bre_lpal	?	?	?	?	?	?	?	?	2	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?		
USNM371282*	bre_lpal	0	[12]	1	1	0	-	0	[01]	?	0	1	1	0	?	0	0	0	1	1	0	0	0	1	?	?	?	0	

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81		
	bre_bPurus-Madela	1	0	0	[12]	[01]	0	[01]	1	-	0	?	?	?	?	1	1	1	?	?	?	[-2]	[-2]	?	?	[01]	[01]	-		
INPA2835*	bre_c	?	?	0	2	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
MZUSP21285*	bre_c	1	0	0	1	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
	bre_cXingu-Tocantins	1	0	0	[12]	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
USNM546197*	bre_d	1	0	0	[12]	[01]	0	0	1	-	0	1	[01]	-	1	1	1	1	1	1	-	[02]	-	2	1	1	1	1	1	-
USNM546207*	bre_d	1	0	0	2	0	-	?	1	0	-	1	[04]	0	-	1	1	1	1	0	-	2	-	1	1	1	1	1	-	
AMNH94902*	bre_d	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	-		
	bre_dTapajós-XinguMoistW*	1	0	0	[12]	[01]	0	0	1	[-0]	[-0]	1	[01]	[-0]	[-1]	1	1	1	1	1	[-0]	[-021]	[-2]	[-2]	1	1	1	1	-	
USNM549279*	bre_eto	1	0	0	1	[01]	0	0	1	-	0	1	[13]	-	1	1	1	1	[01]	-	0	-	2	1	1	1	[12]	-		
USNM549280*	bre_eto	1	0	0	1	[01]	0	0	1	0	-	1	3	1	-	1	1	1	0	?	?	1	-	?	?	1	1	-		
	bre_etoTapajós-XinguMoistE*	1	0	0	1	[01]	0	0	1	[-0]	[-0]	1	[13]	[-1]	[-1]	1	1	1	[01]	-	0	[-1]	[-2]	1	1	1	[12]	-		
MN20218*	bre_fto	?	?	?	?	0	-	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
AN603*	bre_fto	1	?	1	2	1	0	[12]	?	?	?	?	?	?	?	1	?	1	?	?	?	?	0	-	1	1	1	[01]	[01]	-
	bre_ftoUatuma-TrombetasMoist	1	?	1	2	[01]	0	[12]	?	?	?	?	?	?	?	1	?	1	?	?	?	?	0	-	1	1	1	[01]	[01]	-
INPA535*	bre_g	?	?	?	0	1	0	2	1	-	0	?	?	?	?	1	1	?	?	?	?	-	2	?	?	[01]	[01]	[01]	-	
MN16802*	bre_g	1	?	0	2	1	0	[23]	?	?	?	?	?	?	?	1	?	?	?	?	?	?	0	-	1	1	1	[01]	[01]	-
INPA1788*	bre_g	?	?	0	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
MZUSP4513*	bre_g	?	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	[01]	-	
	bre_gUatuma-TrombetasMoist	1	?	0	[02]	1	0	[12]	1	-	0	?	?	?	?	1	1	?	?	?	?	?	?	?	?	[01]	[01]	[01]	-	
USNM406907*	bre_h	0	0	0	2	1	0	[12]	1	-	0	1	[14]	-	1	1	1	1	1	-	2	-	2	1	1	0	-	-		
AMNH78096*	bre_h	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	-	2	?	?	[01]	?	-		
USNM385010*	bre_h	0	0	0	[12]	[01]	0	2	1	0	-	1	[34]	0	-	1	1	1	1	2	-	2	-	1	1	1	1	-		
EV18*	bre_h	1	?	0	2	1	0	2	?	?	?	?	?	?	?	1	?	?	?	?	?	?	2	-	1	1	1	[01]	[01]	-
	bre_hNegro-BrancoMoist*	[01]	0	0	[12]	[01]	0	[12]	1	[-0]	[-0]	1	[13]	[-0]	[-1]	1	1	1	1	1	[-2]	[-2]	[-2]	[-2]	1	1	[01]	[-012]	-	
USNM385005*	bre_i	?	0	0	2	1	0	2	1	-	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-		
AMNH130564*	bre_i	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	2	-	1	1	1	?		
USNM385004*	bre_i	0	0	0	[12]	1	0	3	1	0	-	1	3	1	-	1	1	1	0	2	-	2	-	1	1	0	-			
	bre_iGulananMoistGuayananHi	0	0	0	[12]	1	0	[23]	1	[-0]	[-0]	1	3	1	-	1	1	1	0	2	-	2	-	1	1	[01]	-			
AMNH75685*	bre_j	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	2	-	1	1	1	?		
AMNH75520*	bre_j	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	?		
	bre_jGuyananSavanna*	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	?		
MBUCV1890*	bre_kor	1	0	0	[12]	1	0	3	1	-	0	?	?	?	?	1	?	?	?	?	?	-	2	?	?	[01]	[01]	[01]	-	
MBUCV1879*	bre_kor	1	?	0	2	1	0	3	?	?	?	?	?	?	?	1	?	1	?	?	?	?	2	-	1	1	1	[01]	[01]	-
	bre_korLlanosW*	1	0	0	[12]	1	0	3	1	-	0	?	?	?	?	1	?	1	?	?	?	?	[-2]	[-2]	1	1	[01]	[01]	[01]	-
MBUCV1440*	bre_lpal	?	?	?	?	?	?	?	1	-	0	?	?	?	?	1	1	?	?	?	?	-	0	?	?	[01]	[01]	[01]	-	
AMNH144834*	bre_lpal	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	?	?	?	?	?	2	-	?	?	1	?		
USNM371282*	bre_lpal	1	0	0	1	1	0	3	1	0	-	1	?	0	-	1	1	1	1	2	-	2	-	?	?	0	-			

Museum #	Ecregion Population	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	bre_ipallLaCosta XericShrubland	[12]	0	[05]	-	0	-	2	1	1	3	-	1	[12]	-	1	-	0	0	-	0	-	0	1	[12]	?	0	?
USNM370013*	bre_mpal	0	0	?	?	?	?	2	1	1	-	3	0	-	2	-	1	1	-	0	-	[01]	0	1	1	?	?	?
USNM371285*	bre_mpal	0	0	-	5	0	-	2	1	1	-	3	?	-	2	-	1	1	-	0	-	[01]	0	[12]	1	?	?	?
USNM371289*	bre_mpal	[01]	0	5	-	?	?	2	1	1	3	-	0	2	-	1	-	0	[02]	-	0	-	0	1	1	?	?	?
	bre_mpalMarac alboDryVenezu	[01]	0	[-5]	[-5]	0	-	2	1	1	[-3]	[-3]	0	[-2]	[-2]	1	1	[01]	[-02]	[-0]	[-0]	[-01]	0	[12]	1	?	?	?
BM1867_4_12 540*	brenTY*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	bre_spGr*	[01 21]	[01]	[01 51]	[01 45]	[01]	[02]	[02]	1	[12 41]	[03]	3	[01]	[01 21]	2	[01]	[01]	[01]	[02]	[01 21]	[01]	[01]	[01 21]	[01 21]	[12]	[12 31]	[01]	[01 31]
BM12_5_11_1 3*	do_amaTYMara jóVarzea*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP9931*	do_bXingu- Tocantins-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN16476*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN17013*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN16904*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN16881*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN16729*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN30552*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	do_cCaatinga*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN34394*	do_dCaatingaAt lanticDry*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN36129*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN46579*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN46575*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
BM1887_10_2 5_1*	do_eTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	do_eTYCerrado *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP1711*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP1707*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MZUSP1706*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	do_fCerradoPar aná-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
USNM461347 *	do_gBeniSavan naSWAmazonM	2	0	?	?	?	?	0	1	2	-	3	2	-	2	-	1	1	-	0	-	0	0	0	?	?	0	?
AMNH260024 *	do_hChaco*	2	?	?	?	1	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?
USNM293130 *	do_iHumidChac oParaná- do_spGr*	[01]	[01]	3	-	1	[01]	0	1	[24]	3	-	1	2	-	1	-	[01]	[02]	-	0	-	0	1	?	?	0	3
		[01 21]	[01]	3	-	1	[01]	0	1	[24]	3	3	[12]	2	2	1	1	[01]	[02]	0	0	0	0	[01]	?	?	0	3
MZUSP12207 *	sp_a*	[12]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1653*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1650*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1675*	Calphi	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1657*	Calphi	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	Calphi*	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
I-1549*	Cal*	0	1	?	?	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	2	1	0

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	bre_jpallLaCosta XericShrubland	0	[12]	1	1	0	-	0	[01]	2	0	1	1	0	?	0	0	0	1	1	0	0	0	1	1	-	?	0	
USNM370013*	bre_mpal	0	4	?	1	-	0	0	[12]	?	0	1	2	0	?	?	?	0	?	?	0	0	0	0	?	?	?	0	
USNM371285*	bre_mpal	0	1	3	0	-	0	0	2	?	0	1	2	0	?	1	2	2	1	1	0	?	0	1	?	?	?	0	
USNM371289*	bre_mpal	0	[23]	3	1	0	-	0	0	?	0	1	2	0	?	[01]	0	[12]	1	0	0	0	?	?	?	?	?	?	1
	bre_mpalMaracuiboDryVenezu	0	[12 34]	3	[01]	[-0]	[-0]	0	[01 2]	?	0	1	2	0	?	[01]	[02]	[01 2]	1	[01]	0	0	0	[01]	?	?	?	[01]	
BM1867_4_12 540*	brenTY*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	-	4	0	?
	bre_spGr*	[01 2]	[12 34]	[01 234]	[01]	[03]	[04]	0	[01 2]	[02]	[01]	1	[01 2]	0	[01]	[01 2]	[01 2]	[01 2]	1	[01 3]	0	[01]	[01]	[01 2]	[12 4]	[02 34]	[01]	[01 2]	
BM12_5_11_1 3*	do_amaTYMara jóVarzea*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	1	?	
MZUSP9931*	do_bXingu- Tocantins-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	
MN16476*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?	
MN17013*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN16904*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN16881*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	?	?	
MN16729*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	4	-	0	?	
MN30552*	do_c	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	?	?	
	do_cCaatinga*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	1	[14]	-	0	?	
MN34394*	do_dCaatingaAt lanticDry*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?	
MN36129*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
MN46579*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	
MN46575*	do_e	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	1	-	?	?	
BM1887_10_2 5_1*	do_eTY	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	-	4	0	?	
	do_eTYCerrado *	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	[-1]	[-4]	0	?	
MZUSP1711*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	-	1	1	?	
MZUSP1707*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	?	?	
MZUSP1706*	do_f	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1	1	-	?	?	
	do_fCerradoParaná-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	[01]	1	[-1]	[-14]	[01]	?	
USNM461347*	do_gBeniSavan naSWAmazonM	?	?	?	?	-	0	?	2	?	0	0	?	1	1	0	0	3	1	0	0	0	?	?	?	?	?	?	
AMNH260024*	do_hChaco*	?	?	?	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
USNM293130*	do_iHumidChac oParaná- do_spGr*	0	2	4	1	0	-	0	2	?	0	1	1	0	1	[01]	0	2	1	0	0	?	0	1	?	?	?	0	
	do_spGr*	0	2	4	1	0	0	0	2	0	0	[01]	1	[01]	1	[01]	0	[23]	1	0	0	0	[01]	1	[12 4]	[14]	[01]	0	
MZUSP12207*	sp_a*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	4	-	?	?	
UnB1653*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	?	?	
UnB1650*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	?	?	
UnB1675*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	0	0	?	?	
UnB1657*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	4	0	0	?	
	Calphi*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[04]	0	0	?	
I-1549*	Cal*	0	1	2	0	-	1	0	[23]	0	0	0	?	0	0	0	0	3	1	4	0	0	?	1	?	?	1	0	

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	
	bre_jpallLaCosta XericShrubland	1	0	0	1	1	0	3	1	[-0]	[-0]	1	?	0	-	1	1	1	1	2	-	[-2]	[-0]	?	?	[01]	[-012]	-	
USNM370013*	bre_mpal	1	0	0	2	1	0	3	1	-	0	1	6	-	0	1	1	1	1	-	0	-	2	1	1	1	1	[12]	-
USNM371285*	bre_mpal	1	0	0	2	1	0	3	1	-	0	1	[46]	-	0	1	1	1	1	-	[02]	-	2	1	1	1	1	1	-
USNM371289*	bre_mpal	?	0	0	?	?	?	3	1	0	-	1	[46]	?	?	1	1	1	1	2	-	2	-	1	1	1	1	1	-
	bre_mpalMarac aiboDryVenezu	1	0	0	2	1	0	3	1	[-0]	[-0]	1	[46]	-	0	1	1	1	1	[-2]	[-021]	[-2]	[-2]	1	1	1	1	[12]	-
BM1867_4_12 540*	brenTY*	?	?	3	?	1	0	?	1	-	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	[01 21]	-	
	bre_spGr*	[01]	0	[01 31]	[01 21]	[01]	0	[01 231]	1	0	0	1	[01 346]	[01]	[01]	1	1	1	[01]	[02]	[02]	[01 21]	[02]	1	1	[01]	[01 21]	-	
BM12_5_11_1 3*	do_amaTYMara jóVarzea*	1	?	0	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[12]	-	
MZUSP9931*	do_bXingu- Tocantins-	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN16476*	do_c	?	?	0	2	1	0	3	1	0	-	?	?	?	?	1	?	1	?	?	?	0	-	?	?	1	[01 21]	-	
MN17013*	do_c	?	?	0	?	1	0	3	?	?	?	?	?	?	?	1	?	?	?	?	?	0	-	?	?	1	[01 21]	-	
MN16904*	do_c	?	?	0	?	1	0	3	1	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN16881*	do_c	?	?	0	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN16729*	do_c	?	?	3	2	0	-	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN30552*	do_c	1	?	0	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
	do_cCaatinga*	1	?	[03]	2	[01]	0	3	1	0	-	?	?	?	?	1	?	1	?	?	?	0	-	?	?	1	[01 21]	-	
MN34394*	do_dCaatingaAt lanticDry*	1	?	0	2	1	0	[13]	?	?	?	?	?	?	?	1	?	1	?	?	?	2	-	1	1	1	[01 21]	-	
MN36129*	do_e	0	?	0	?	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN46579*	do_e	?	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MN46575*	do_e	1	?	0	1	1	0	3	?	?	?	?	?	?	?	1	?	1	?	?	?	0	-	1	1	1	[01 21]	-	
BM1887_10_2 5_1*	do_eTY	?	?	3	?	1	0	?	1	-	0	?	?	?	?	1	?	?	?	?	?	-	0	?	?	1	[01 21]	-	
	do_eTYCerrado *	[01]	?	[03]	1	1	0	[13]	1	-	0	?	?	?	?	1	?	1	?	?	?	[-0]	[-0]	1	1	1	[01 21]	-	
MZUSP1711*	do_f	1	0	0	1	1	0	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MZUSP1707*	do_f	0	?	0	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01 21]	-	
MZUSP1706*	do_f	0	?	0	2	1	0	3	?	?	?	?	?	?	?	1	?	1	?	?	?	0	-	1	1	1	[01 21]	-	
	do_fCerradoPar aná-	[01]	0	[03]	[12]	1	0	[01 31]	1	-	0	?	?	?	?	1	?	1	?	?	?	[-0]	[-0]	1	1	1	[01 21]	-	
USNM461347 *	do_gBeniSavan naSWAmazonM	?	?	?	1	0	-	?	1	-	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	
AMNH260024 *	do_hChaco*	?	?	?	?	1	0	?	?	?	?	?	?	?	?	1	?	1	?	?	?	0	-	1	1	1	?	-	
USNM293130 *	do_iHumidChac oParaná- do_spGr*	?	0	0	2	[01]	0	0	1	0	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	
	do_spGr*	[01]	0	[03]	[12]	[01]	0	[01 31]	1	0	0	?	?	?	?	1	?	1	?	?	?	[02]	0	1	1	[01]	[01 21]	-	
MZUSP12207 *	sp_a*	0	1	-	2	?	?	0	1	1	-	1	?	?	?	1	0	?	?	0	-	1	-	1	0	1	[01 21]	-	
UnB1653*	Calphi	2	0	1	0	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	?
UnB1650*	Calphi	2	0	1	0	0	-	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1675*	Calphi	?	0	1	0	1	0	3	1	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	-	?
UnB1657*	Calphi	2	0	1	0	1	0	[23]	1	0	0	0	?	?	?	0	0	?	?	2	2	1	1	0	-	?	?	?	
	Calphi*	2	0	1	0	[01]	0	[23]	1	0	0	0	?	?	?	0	0	?	?	2	2	1	1	0	-	2	-	?	
I-1549*	Cal*	?	0	?	?	?	?	?	?	?	?	?	?	?	0	-	-	-	0	1	-	0	-	-	?	?	?	?	?

Museum #	Ecoregion Population	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	
	bre_jpallLaCosta XericShrubland	-	2	0	1	1	1	0	2	-	1	-	0	-	0	2	1	1	1	2	1	0	0	-	2	2	1	
USNM370013*	bre_mpal	-	0	0	1	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM371285*	bre_mpal	-	0	0	1	1	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
USNM371289*	bre_mpal	-	0	0	0	1	0	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	bre_mpalMaracaiboDryVenezuela	-	0	0	[01]	1	[01]	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
BM1867_4_12_540*	brenTY*	-	?	?	?	?	?	1	2	?	?	?	?	?	?	?	0	?	1	?	?	?	0	-	2	?	1	
	bre_spGr*	-	[02]	0	[01]	[01]	[01]	[01]	[01]	[01]	[01]	[01]	[01]	[01]	0	[12]	[01]	1	[01]	[023]	[01]	[01]	0	1	[012]	[012]	[01]	
BM12_5_11_13*	do_amaTYMarajóVarzea*	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
MZUSP9931*	do_bXingu-Tocantins-	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
MN16476*	do_c	-	?	0	1	1	?	0	2	?	?	?	?	?	?	?	?	?	?	?	3	0	0	0	?	?	1	
MN17013*	do_c	-	?	0	0	0	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	
MN16904*	do_c	-	?	0	0	0	?	[01]	2	?	?	?	?	?	?	?	1	?	1	2	?	?	?	?	?	?	1	
MN16881*	do_c	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
MN16729*	do_c	-	?	0	1	1	?	1	?	?	?	?	?	?	1	0	?	1	?	?	0	?	?	?	?	?	?	
MN30552*	do_c	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
	do_cCaatinga*	-	?	0	[01]	[01]	?	[01]	2	?	?	?	?	?	?	1	[01]	?	1	[23]	0	0	0	?	?	?	1	
MN34394*	do_dCaatingaAtlanticDry*	-	?	0	1	1	?	1	?	?	?	?	?	?	?	?	?	?	?	?	2	1	0	0	?	?	1	
MN36129*	do_e	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	?	1	
MN46579*	do_e	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
MN46575*	do_e	-	?	0	0	[01]	?	1	[01]	2	-	0	-	0	-	?	?	?	?	?	0	1	0	0	?	?	1	
BM1887_10_25_1*	do_eTY	-	?	?	?	?	?	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	2	?	1	
	do_eTYCerrado*	-	?	0	0	[01]	?	[01]	[01]	2	-	0	-	0	-	?	?	?	?	?	0	1	0	0	-	2	?	1
MZUSP1711*	do_f	-	?	?	1	1	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	?	
MZUSP1707*	do_f	-	?	0	0	0	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	
MZUSP1706*	do_f	-	?	0	1	1	?	0	?	?	?	?	?	?	?	?	?	?	?	?	2	?	0	0	?	?	[01]	
	do_fCerradoParaná-	-	?	0	[01]	[01]	?	[01]	?	?	?	?	?	?	?	?	?	?	?	?	2	?	0	0	-	2	?	[01]
USNM461347*	do_gBeniSavannaSWAmazonM	-	0	0	0	1	1	[01]	2	?	?	?	?	?	?	1	0	1	1	?	0	1	0	-	1	2	1	
AMNH260024*	do_hChaco*	-	?	?	?	?	?	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	?	?	?	1	
USNM293130*	do_iHumidChacoParaná-	-	0	0	0	0	0	1	2	?	?	?	?	?	?	1	1	1	1	?	0	0	0	2	-	1	1	
	do_spGr*	-	0	0	[01]	[01]	[01]	[01]	[01]	2	-	0	-	0	-	1	[01]	1	1	[023]	[01]	[01]	0	2	[12]	[12]	[01]	
MZUSP12207*	sp_a*	-	?	0	1	0	1	0	[01]	-	-	?	?	?	?	?	?	?	?	?	[34]	1	0	0	0	-	0	1
UnB1653*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	0	3	?	?	?	
UnB1650*	Calphi	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
UnB1675*	Calphi	?	?	?	1	1	0	?	2	0	0	-	-	-	-	0	1	1	1	?	0	0	3	1	1	1	[01]	
UnB1657*	Calphi	?	?	?	1	1	0	?	2	0	0	-	-	-	-	?	?	?	?	?	3	0	0	2	1	1	0	
	Calphi*	?	?	?	1	1	0	?	2	0	0	-	-	-	-	0	1	1	1	3	0	0	[23]	1	1	1	[01]	
I-1549*	Cal*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	-	1	1	1	

Museum #	Ecoregion Population	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
	OGCal*	0	1	?	?	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	2	1	0	
UnB1573*	Dialb	0	1	?	?	0	-	0	1	3	-	0	0	-	2	-	1	1	-	[02]	-	0	[01]	3	?	?	?	0	0
MN30379*	Dialbmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN43054*	Dialbmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Didelphisalbafemale		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB615*	DialbYad	0	?	?	?	?	?	?	1	[34]	0	-	0	[12]	-	?	?	?	?	?	?	?	?	?	3	1	?	0	0
UnB387*	DialbYad	0	1	?	?	0	-	0	1	3	0	-	1	2	-	1	-	1	0	-	[01]	-	[01]	2	1	0	0	0	0
UnB156*	DialbYad	0	1	?	?	0	-	0	1	3	0	-	0	2	-	1	-	0	[12]	-	0	-	?	2	1	?	0	0	0
Didelphisalbafemale		0	1	?	?	0	-	0	1	[34]	0	-	[01]					[01]	[0121]	-	[01]	-	[01]	[23]	1	0	0	0	0
DidelphisalbUnB		0	1	?	?	0	-	0	1	[34]	[-0]	[-0]	[01]						[-012021]	[-01]	[-01]	[-01]	[01]	[23]	1	0	0	0	0
	Didalb*	0	1	?	?	0	-	0	1	[34]	0	-	[01]	[12]	2	1	1	[01]	[0121]	-	[01]	-	[01]	[23]	1	0	0	0	0
	OGDid*	0	1	?	?	0	-	0	1	[34]	0	0	[01]	[12]	2	1	1	[01]	[0121]	[02]	[01]	0	[01]	[23]	1	0	0	0	0
UBDBA-m1*	OGLut*	0	1	?	?	?	?	2	1	1	?	?	1	?	?	?	?	?	?	?	?	?	?	2	1	?	?	0	5
UnB1259*	Mamur	0	0	?	?	0	-	2	1	0	-	0	0	-	1	-	0	-	-	-	-	-	[01]	1	1	?	0	0	
MN24700*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN5611*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1264*	Mamur	0	1	?	?	0	-	2	0	-	3	-	?	2	-	1	-	1	0	-	0	-	[01]	2	1	3	0	0	
UnB1262*	Mamur	0	1	?	?	0	-	2	1	0	3	-	1	2	-	1	-	0	0	-	0	-	2	3	1	3	0	0	
UnB1268*	Mamur	0	0	?	?	0	-	2	1	0	0	-	0	1	-	1	-	1	[02]	-	0	-	?	3	1	2	0	0	
UnB1278*	Mamur	?	?	?	?	0	-	2	1	0	3	-	?	0	-	1	-	1	0	-	0	-	[01]	[23]	1	3	0	0	
MN59603*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	Mamur*	0	[01]	?	?	0	-	2	[01]	[-0]	[-031]	[-0]	[01]	[0121]	1	1	0	[01]	[-021]	-	[-0]	-	[0121]	[1231]	1	[23]	0	0	
MBUCV397*	Marob*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	OGMa*	0	[01]	?	?	0	-	2	[01]	0	[03]	0	[01]	[0121]	1	1	0	[01]	[02]	-	0	-	[0121]	[1231]	1	[23]	0	0	
MN31417*	Mopsincmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1405*	Mopsincmale	[01]	0	?	?	0	-	1	1	1	2	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1
Mopsincmale*		[01]	0	?	?	0	-	1	1	1	2	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	1
UnB448*	Mopsincf*	?	?	?	?	0	-	0	1	1	-	2	1	-	1	-	1	[01]	-	2	-	0	[01]	?	1	2	1	1	
	Mopsinc*	[01]	0	?	?	0	-	[01]	1	1	[-2]	[-2]	1	-	1	-	1	[01]	-	2	-	0	[01]	?	1	2	[01]	1	
MN59604*	Mopspar*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	OGMops	[01]	0	?	?	0	-	[01]	1	1	2	2	1	-	1	-	1	[01]	-	2	-	0	[01]	?	1	2	[01]	1	

Museum #	Ecoregion Population	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	OGCal*	0	1	2	0	-	1	0	[23]	0	0	0	?	0	0	0	0	3	1	4	0	0	?	1	[04]	0	[01]	0	
UnB1573*	Dialb	?	1	?	1	-	[01]	0	1	?	?	0	?	1	-	0	0	0	1	4	0	0	?	1	?	?	1	1	
MN30379*	Dialbmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
MN43054*	Dialbmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
Didelphisalbafemale		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
UnB615*	DialbYad	?	2	0	1	0	-	0	1	0	1	0	?	1	?	?	?	?	?	?	?	?	0	?	1	?	?	1	1
UnB387*	DialbYad	?	0	?	1	0	-	0	1	0	1	0	?	1	-	2	1	0	1	4	1	0	?	1	?	?	1	?	
UnB156*	DialbYad	?	2	?	1	0	-	0	1	0	1	0	?	1	0	0	1	1	1	4	0	0	?	1	?	?	1	0	
DidelphisalbYadmale		?	[02]	0	1	0	-	0	1	0	1	0	?	1	[-0]	[02]	1	[01]	1	4	[01]	0	?	1	?	?	1	[01]	
DidelphisalbUnB		?	[01 21]	0	1	[-0]	[-01]	0	1	0	1	0	?	1	[-0]	[02]	[01]	[01]	1	4	[01]	0	?	1	?	?	1	[01]	
	Didalb*	?	[02]	0	1	0	-	0	1	0	1	0	?	1	[-0]	[02]	1	[01]	1	4	[01]	0	1	1	2	-	1	[01]	
	OGDid*	?	[01 21]	0	1	0	[01]	0	1	0	1	0	?	1	0	[02]	[01]	[01]	1	4	[01]	0	1	1	2	-	1	[01]	
UBDBA-m1*	OGLut*	?	1	?	1	?	?	0	2	0	1	0	?	1	-	0	3	0	1	4	0	0	1	1	?	?	1	0	
UnB1259*	Mamur	?	1	0	0	-	1	0	?	0	[01]	0	?	1	0	0	0	1	1	0	0	0	?	1	?	?	1	0	
MN24700*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	?	
MN5611*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	1	-	?	?	
UnB1264*	Mamur	0	1	?	0	1	-	0	?	0	1	0	?	1	?	0	0	?	?	?	?	0	0	?	1	?	?	1	0
UnB1262*	Mamur	?	0	0	0	1	-	0	[23]	0	1	0	?	1	?	0	?	1	1	0	0	0	?	1	?	?	1	0	
UnB1268*	Mamur	?	0	3	0	1	-	0	3	0	?	0	?	1	?	?	0	?	?	?	?	?	?	1	?	?	1	0	
UnB1278*	Mamur	?	?	0	0	?	?	0	?	0	1	?	?	1	?	?	?	?	?	?	?	?	?	1	?	?	1	0	
MN59603*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	
	Mamur*	0	[01]	[03]	0	[-1]	[-1]	0	[23]	0	[01]	0	?	1	0	0	0	1	1	0	0	0	1	1	1	-	1	0	
MBUCV397*	Marob*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	?	?	?	
	OGMa*	0	[01]	[03]	0	1	1	0	[23]	0	[01]	0	?	1	0	0	0	1	1	0	0	0	1	1	1	-	1	0	
MN31417*	Mopsincmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	?	2	-	?	?	
UnB1405*	Mopsincmale	?	0	0	0	1	-	0	2	0	0	0	?	1	0	0	0	2	1	1	0	0	?	0	?	?	0	1	
Mopsincmale*		?	0	0	0	1	-	0	2	0	0	0	?	1	0	0	0	2	1	1	0	0	1	0	2	-	0	1	
UnB448*	Mopsincf*	0	1	4	0	-	0	0	?	0	0	0	?	1	?	?	?	?	?	?	?	?	1	?	0	?	?	1	0
	Mopsinc*	0	[01]	[04]	0	[-1]	[-0]	0	2	0	0	0	?	1	0	0	0	2	1	1	0	[01]	1	0	2	-	[01]	[01]	
MN59604*	Mopspar*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
	OGMops	0	[01]	[04]	0	1	0	0	2	0	0	0	?	1	0	0	0	2	1	1	0	[01]	1	0	2	-	[01]	[01]	

Museum #	Ecoregion Population	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81		
	OGCal*	2	0	1	0	[01]	0	[23]	1	0	0	0	-	-	-	0	[01]	-	0	2	2	1	1	0	-	2	-	?		
UnB1573*	Dialb	?	[01]	?	?	?	?	?	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	?	?		
MN30379*	Dialbmale	?	?	1	?	1	0	3	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-		
MN43054*	Dialbmale	2	?	1	0	1	2	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-	
Didelphisalbafemale		2	?	1	0			[13]	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-	
UnB615*	DialbYad	?	0	?	?	?	?	?	0	-	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
UnB387*	DialbYad	?	0	?	?	?	?	?	0	-	-	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	
UnB156*	DialbYad	?	0	?	?	?	?	?	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	?	?	?	
DidelphisalbYadmale		?	0	?	?	?	?	?	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	?	?	?	
DidelphisalbUnB		?	[01]	?	?	?	?	?	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	?	?	?	
	Didalb*	2	0	1	0	1	[02]	[13]	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	0	-	-	
	OGDid*	2	[01]	1	0	1	[02]	[13]	0	-	-	0	-	-	-	0	0	-	0	-	-	?	?	?	?	?	0	-	-	
UBDBA-m1*	OGLut*	?	0	1	0	1	2	3	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	0	-	-	
UnB1259*	Mamur	?	0	?	?	?	?	?	?	?	?	?	1	0	-	0	1	0	0	1	-	2	?	?	?	?	?	?	?	
MN24700*	Mamur	2	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-	
MN5611*	Mamur	2	?	0	2	[01]	0	3	?	?	?	?	?	?	?	1	?	?	?	?	?	?	2	-	1	0	1	2	-	
UnB1264*	Mamur	?	0	?	?	?	?	?	?	?	?	1	0	0	-	?	?	?	?	1	?	?	?	?	?	?	?	?	?	
UnB1262*	Mamur	?	0	?	?	?	?	?	?	?	?	1	0	0	-	1	1	0	1	2	-	?	?	?	?	?	?	?	?	
UnB1268*	Mamur	?	0	?	?	?	?	?	?	?	?	1	0	0	-	1	?	?	1	?	?	?	?	?	?	?	?	?	?	
UnB1278*	Mamur	?	0	?	?	?	?	?	?	?	?	1	0	0	-	1	1	0	1	2	-	?	?	?	?	?	?	?	?	
MN59603*	Mamur	1	?	?	?	1	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	[01]	-	
	Mamur*	[12]	0	0	2	[01]	0	3	?	?	?	1	0	[-0]	[-0]	1	[01]	0	1	[-2]	[-2]	2	-	1	0	1	[01]	[01]	[01]	-
MBUCV397*	Marob*	2	?	0	2	0	-	2	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	-	-	
	OGMa*	[12]	0	0	2	[01]	0	[23]	?	?	?	1	0	0	0	1	[01]	0	1	2	2	2	-	1	[01]	[01]	[01]	[01]	-	
MN31417*	Mopsincmale	2	?	1	0	1	1	1	?	?	?	?	?	?	?	1	?	?	?	?	?	?	0	-	1	1	0	-	-	
UnB1405*	Mopsincmale	?	0	?	?	?	?	?	?	?	?	1	7	0	-	?	?	?	1	?	?	?	?	?	?	?	?	?	?	
Mopsincmale*		2	0	1	0			1	?	?	?	1	7	0	-	1	?	?	1	?	?	0	-			0	-	-		
UnB448*	Mopsincf*	?	0	?	?	?	?	?	?	?	?	1	?	-	0	1	1	0	1	?	?	?	?	?	?	?	?	?	?	
	Mopsinc*	2	0	1	0	1	1	1	?	?	?	1	7	[-0]	[-0]	1	1	0	1	?	?	0	-	1	1	0	-	-		
MN59604*	Mopspar*	1	?	?	?	1	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	1	3	-	
	OGMops	[12]	0	1	0	1	1	1	?	?	?	1	7	0	0	1	1	0	1	?	?	0	-	1	1	[01]	3	-		

Museum #	Ecoregion Population	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122
	OGCal*	1	[01]	0	0	[134 1	[134 1	[014 5]	[014 5]	1	2	[02]	2	2	2	2
UnB1573*	Dialb	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN30379*	Dialbmale	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN43054*	Dialbmale	[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Didelphisalb dmale		[01]	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB615*	DialbYad	?	0	2	0	2	-	1	-	1	?	?	?	?	?	?
UnB387*	DialbYad	?	0	2	0	?	?	?	?	?	2	2	2	2	2	-
UnB156*	DialbYad	?	?	?	0	3	-	?	?	1	2	2	2	2	2	-
DidelphisalbY admale		?	0	2	0	[23]	-	1	-	1	2	2	2	2	2	-
DidelphisalbU nB		?	0	2	0	[23]	-	1	-	1	2	2	2	2	2	-
	Didalb*	[01]	0	2	0	[23]	-	1	-	1	2	2	2	2	2	-
	OGDid*	[01]	0	2	0	[23]	-	1	-	1	2	2	2	2	2	-
UBDBA-m1*	OGLut*	1	0	2	?	?	?	?	?	?	2	2	2	2	?	?
UnB1259*	Mamur	?	0	1	0	-	0	-	1	1	?	?	?	?	?	?
MN24700*	Mamur	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
MN5611*	Mamur	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1264*	Mamur	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1262*	Mamur	?	[01]	0	0	0	-	4	-	1	?	?	?	?	?	?
UnB1268*	Mamur	?	?	?	?	?	?	?	?	?	1	1	1	1	1	-
UnB1278*	Mamur	?	?	?	?	?	?	?	?	?	1	1	1	1	1	-
MN59603*	Mamur	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	Mamur*	1	[01]	[01]	0	[-0]	[-0]	[-4]	[-1]	1	1	1	1	1	1	-
MBUCV397*	Marob*	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	OGMa*	1	[01]	[01]	0	0	0	4	1	1	1	1	1	1	1	-
MN31417*	Mopsincmale	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
UnB1405*	Mopsincmale	?	2	0	?	?	?	?	?	?	?	2	0	?	?	?
Mopsincmale*		1	2	0	?	?	?	?	?	?	?	2	0	?	?	?
UnB448*	Mopsincf*	?	2	0	0	-	0	-	0	0	0	1	1	2	-	1
	Mopsinc*	1	2	0	0	-	0	-	0	0	0	[12]	[01]	2	-	1
MN59604*	Mopspar*	1	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	OGMops	1	2	0	0	-	0	-	0	0	0	[12]	[01]	2	-	1

Appendix 4: Synapomorphies list.

OGDid :	amgBaIn :	Char. 26: 0 --> 3
Char. 8: 1 --> 34	Char. 101: 0 --> 1	Char. 29: 3 --> 4
Char. 34: 2 --> 1	Char. 108: 0 --> 1	Char. 78: 1 --> 0
Char. 88: 2 --> 01	amhumbC :	kucPNPB :
Char. 96: 1 --> 0	Char. 105: 1 --> 2	Char. 49: 1 --> 0
OGMops :	embMTX :	Char. 57: 1 --> 2
Char. 9: 0 --> 2	Char. 12: 1 --> 0	Char. 116: 2 --> 0
Char. 26: 0 --> 1	Char. 16: 0 --> 1	Char. 118: 1 --> 0
Char. 32: 1 --> 0	Char. 77: 1 --> 0	Node 23 :
Char. 43: 0 --> 2	Char. 105: 1 --> 2	Char. 30: 0 --> 1
Char. 49: 1 --> 0	Char. 110: 0 --> 1	Char. 36: 0 --> 1
Char. 59: 0 --> 1	emcMTCe :	Char. 61: 1 --> 0
Char. 60: 3 --> 1	Char. 100: 0 --> 1	Char. 109: 0 --> 2
Char. 88: 2 --> 01	Char. 107: 1 --> 0	Node 24 : No
Char. 108: 0 --> 2	Char. 117: 1 --> 0	synapomorphies
Char. 115: 1 --> 0	heesoPP :	Node 25 :
Char. 116: 2 --> 0	Char. 8: 1 --> 4	Char. 1: 1 --> 0
OGLut :	Char. 42: 0 --> 1	Char. 45: 4 --> 1
Char. 6: 0 --> 2	Char. 43: 0 --> 1	Char. 64: 0 --> 1
Char. 21: 0 --> 2	Char. 44: 1 --> 0	Char. 68: 0 --> 1
Char. 26: 0 --> 5	Char. 60: 3 --> 1	Char. 118: 2 --> 1
Char. 42: 0 --> 3	Char. 77: 1 --> 0	Node 26 :
Char. 82: 0 --> 2	bredTXW :	Char. 50: 2 --> 1
OGMa :	Char. 14: 1 --> 0	Char. 56: 1 --> 0
Char. 6: 0 --> 2	breeTXE :	Char. 87: 1 --> 2
Char. 8: 1 --> 0	Char. 41: 0 --> 2	Char. 119: 2 --> 1
Char. 15: 1 --> 0	Char. 60: 23 --> 0	Node 27 :
Char. 43: 0 --> 1	Char. 87: 0 --> 1	Char. 117: 1 --> 0
Char. 45: 1 --> 0	brehNeB :	Node 28 :
Char. 111: 3 --> 0	Char. 24: 2 --> 1	Char. 54: 1 --> 0
Char. 113: 1 --> 4	Char. 88: 2 --> 01	Char. 55: 0 --> 1
Char. 116: 2 --> 1	breiGui :	Char. 60: 3 --> 0
Char. 120: 2 --> 1	Char. 16: 0 --> 1	Char. 70: 1 --> 0
adaMaTY :	Char. 25: 0 --> 1	Char. 101: 0 --> 1
Char. 43: 0 --> 123	Char. 54: 1 --> 0	Node 29 :
addpeYu :	breIpaC :	Char. 0: 0 --> 2
Char. 84: 0 --> 1	Char. 35: 0 --> 2	Char. 100: 0 --> 1
Char. 85: 0 --> 1	Char. 84: 0 --> 1	Char. 107: 1 --> 0
Char. 100: 1 --> 0	Char. 85: 0 --> 1	Node 30 :
Char. 109: 0 --> 2	brempaM :	Char. 9: 0 --> 3
amaToAr :	Char. 11: 1 --> 0	Char. 31: 1 --> 0
Char. 4: 0 --> 1	Char. 85: 0 --> 1	Char. 37: 0 --> 1
Char. 118: 1 --> 2	doiChaP :	Char. 39: 1 --> 0
amdruBa :		Char. 48: 1 --> 0
Char. 77: 1 --> 0		
Char. 86: 1 --> 0		

Appendix 4: Synapomorphies list (continued).

Node 31 :

Char. 30: 0 --> 1

Char. 54: 2 --> 1

Char. 84: 1 --> 0

Char. 87: 2 --> 0

Node 32 :

Char. 70: 0 --> 1

Char. 86: 0 --> 1

Char. 103: 1 --> 2

Char. 112: 0 --> 2

Node 33 :

Char. 102: 1 --> 2

Node 34 :

Char. 9: 0 --> 2

Char. 25: 0 --> 1

Char. 54: 2 --> 1

Char. 59: 0 --> 1

Node 35 : No
synapomorphies

Node 36 :

Char. 48: 1 --> 2

Char. 65: 0 --> 2

Char. 102: 0 --> 1

Node 37 :

Char. 57: 1 --> 2

Char. 83: 1 --> 2

Node 38 :

Char. 4: 0 --> 1

Char. 8: 1 --> 2

Char. 60: 3 --> 0

Node 39 :

Char. 57: 1 --> 2

Node 40 :

Char. 43: 0 --> 2

Char. 50: 1 --> 4

Char. 109: 0 --> 1

Node 41 :

Char. 14: 1 --> 0

Node 42 :

Char. 26: 0 --> 1

Char. 42: 0 --> 1