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Diversity, Geographic Distribution and Conservation of Squirrel Monkeys, *Saimiri* (Primates, Cebidae), in the Floodplain Forests of Central Amazon

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Abstract Eleven taxa of primates are found in the floodplains of the western portion of the central Brazilian Amazon, protected in part by the Mamirauá Sustainable Development Reserve. The taxonomy of the squirrel monkeys, the number of taxa, and their geographic distributions are still poorly understood. Here we investigate differentiation among the taxa of this genus in Mamirauá, examining their morphology and geographic distribution. We registered 333 points of occurrence of squirrel monkeys and examined 117 specimens deposited in scientific collections. The results of the morphological analyses were generally in good agreement with field observations. Together they indicate the existence of three taxa: *Saimiri vanzolinii*, *Saimiri sciureus macrodon*, and *S. s. cassiquiarensis*. The restricted range of *Saimiri vanzolinii* in the southeastern portion of the reserve covers an area of 870 km^2, and it is among the smallest of the distribution areas for any Neotropical primate species. *Saimiri sciureus cassiquiarensis* has a disjunct distribution, crossing the Japurá River to the right bank into the reserve in two places, and *S. s. macrodon* is the squirrel monkey ranging widely in the northwest of Mamirauá. There are three areas of parapatry: one between *Saimiri vanzolinii* and *Saimiri sciureus macrodon* and two between *S. vanzolinii* and *S. s. cassiquiarensis*. We recommend that anthropogenic changes in

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the region be monitored, and conservation measures be taken to protect these primates, especially considering the endemism and very restricted range of *Saimiri vanzolinii* and its consequent vulnerability to extinction.

Keywords Biogeography · Endemism · Morphology · Taxonomy

Introduction

The biota of the flooded forests of western Amazonia is particularly diverse. It presents significant levels of endemism and much of it remains unstudied. The Mamirauá Sustainable Development Reserve (MSDR) is a protected area located at the confluence of the Solimões and Japurá Rivers and bounded in the west by the Auatí-Paraná (a *paraná* is a channel). The reserve covers 1,124,000 ha of floodplain (*várzea*) ecosystems (Ayres 1993; Sociedade Civil Mamirauá 1996) that experience significant yearly fluctuations in water level between the wet and dry seasons (Pires 1973); differences between high and low marks can be as great as 12 m (Ayres 1993; Junk 1989; Lamotte 1990; Ramalho *et al.* 2009). The *várzea* forests of the MSDR are made up of a variety of habitats influenced by differing extents of seasonal inundation; three are of fundamental importance to the arboreal fauna: the high *várzea*, low *várzea*, and *chavascal* (Ayres, 1993).

The current literature indicates 11 primates in 9 genera in the MSDR (Ayres, 1985a,c, 1986, 1995; Ayres and Johns, 1987; Hershkovitz, 1984, 1987; Paim and Queiroz, 2009; Valsecchi 2005; Vieira *et al.* 2008). Only two, however —the white bald uakari (*Cacajao calvus calvus*) and the red howler (*Alouatta seniculus*)— have been the subjects of long-term regional studies focusing on ecology and behavior (Ayres 1986; Queiroz 1995).

Our focus is on the squirrel monkeys (*Saimiri*) in the MSDR. The taxonomy of this genus has not been clearly resolved, not only for the squirrel monkeys in the MSDR, but also for those occurring through the entire middle Solimões region and beyond. The most recent morphological and molecular studies present divergent results in relation to the number of valid taxa, their taxonomic status, and their geographic distributions (Boinski and Cropp 1999; Costello *et al.* 1993; Hershkovitz 1984, 1987; Lavergne *et al.* 2010; Thorington 1985). Despite the differences, the taxonomic review by Hershkovitz (1984) continues to be the baseline in broad reviews and compilations of the diversity of Neotropical primates (Groves 2005; Rylands and Mittermeier 2009; Rylands *et al.* 2000, 2012). Following MacLean (1964), Hershkovitz (1984) divided squirrel monkeys into two types, Roman and Gothic, based on a number of morphological and behavioral characters (see also Boinski and Cropp 1999). In their appearance, Roman types have a black or gray cap, the same color as the forehead, which is demarcated with a thin, white, round-arching band above the eyes and a thin hair-pencil on the tail; Gothic types have a forehead that has a high, more pointed white arch over each eye, and a thick tail hair-pencil. Molecular evidence has since confirmed that the Roman group, *Saimiri boliviensis*, is sister to the Gothic species and subspecies of *Saimiri* (Chiou *et al.* 2011; Lavergne *et al.* 2010). Although found in different types of dry or wet forests, both old growth and secondary (Baldwin 1985), the Amazonian species in particular show a distinct preference for flooded habitats such as *várzea* forests (Terborgh 1983), feeding primarily on fruit and insects (Mittermeier and Van Roosmalen 1981; Terborgh 1983).

The description of the squirrel monkeys at MSDR began with the discovery of the black-headed squirrel monkey (*Saimiri vanzolinii*) at the time placed in the *Saimiri boliviensis* or Roman group (Ayres 1985b; *sensu* Hershkovitz 1984). Hershkovitz (1987) listed *Saimiri vanzolinii* as a subspecies of *S. boliviensis*. *Saimiri vanzolinii* has one of the smallest ranges of any of the Neotropical primates (Ayres 1985a,b), and for this reason it is listed as Vulnerable on national and international threatened species lists (IUCN 2013; Silva and Queiroz 2008). Ayres (1985b) indicated that its range did not exceed 950 km^2. Schwindt and Ayres (2004) later concluded that the area effectively occupied by the species was even smaller, covering only 533 km^2, although the northwestern limit of its distribution remained poorly defined.

In 2004, Schwindt and Ayres (2004) observed for the first time the presence of another squirrel monkey in the Mamirauá reserve that was of the Gothic type and that they identified as *Saimiri sciureus*. This discovery highlighted the need to delineate the exact ranges of the two taxa of *Saimiri* within the reserve. During fieldwork by F. Paim (lead author), a third phenotype, also of the Gothic type, was observed near the confluence of the Solimões and Japurá Rivers, indicating that the diversity of *Saimiri* in the MSDR was more complex than previously suggested. Paim and Queiroz (2009) reported on the differences between the phenotypes present in the MSDR; they were preliminarily identified as *Saimiri vanzolinii*, *Saimiri sciureus macrodon*, and *S. s. cassiquiarensis*. They analyzed the "cackle" vocalization of these taxa and found that the median of the maximum frequencies in their calls was highest in *Saimiri sciureus cassiquiarensis*, lower in *S. s. macrodon*, and lowest in *S. vanzolinii*. The maximum frequencies of "cackles" from animals on one bank of a river were different from those of the opposite bank. The authors suggested that the differences found could be one of the causes of the ecological separation among the taxa of *Saimiri* at MSDR, probably as a result of a lack of conspecific recognition.

We aimed to examine the morphological variation and differentiation across the three taxa of *Saimiri* found in the MSDR. We reassess the validity of the current taxonomic schemes available for squirrel monkeys in the region and delineate the respective geographic distributions for the three taxa in the reserve.

Methods

Study Area

We conducted this study in the Mamirauá Sustainable Development Reserve (03º08′–02º36′S, 65º45′ – 67º13′W) and surrounding areas, including those to the west of the Solimões River opposite the reserve and on both sides of the margins of Solimões River to the west of the Auatí-Paraná (a natural channel between the Solimões and Japurá Rivers). We also surveyed locations on the left bank of Japurá River near its mouth, including the Amanã Sustainable Development Reserve (ASDR; Fig. 1).

Field Work and Mapping

We made two 40-day expeditions during 2004 to observe and collect specimens of the Gothic types. The first was from June to July, and the second one October and November.

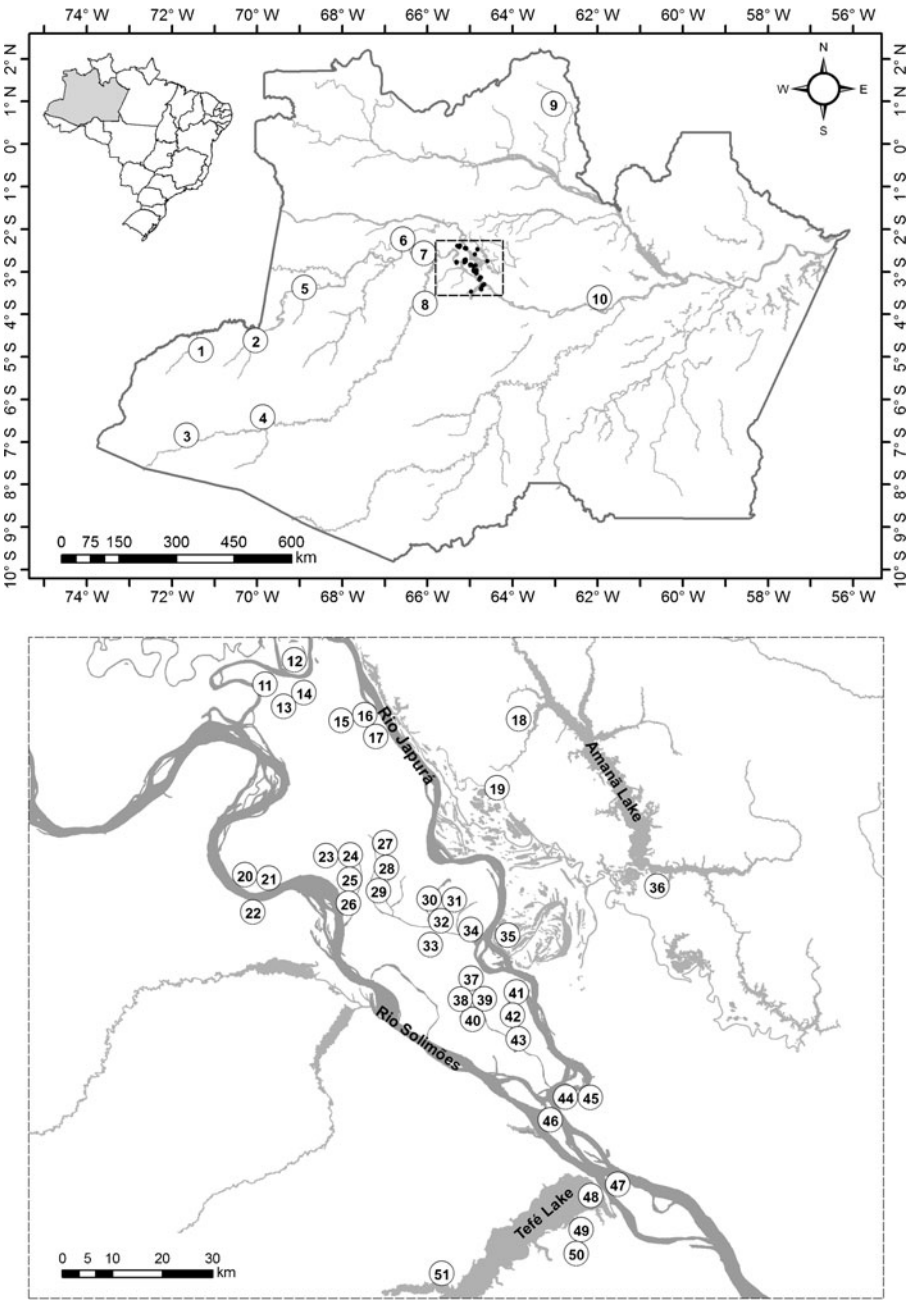

Fig. 1 Localities of specimens of *Saimiri*, middle Solimões River (see Appendix). The numbers represents the localities in which the specimens of *Saimiri* were collected. The square represents the location of the map below. The data in the MSDR were collected in 2008. See appendix for museum data.

A third expedition of 15 days was made in January 2008 to complement the samples obtained during the first trips. The specimens collected under license CGFAU/LIC

086/2004 and SISBIO 14080-1/2008 were deposited in the Mastozoology Collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, Pará.

After identification of the phenotypes, we made eight expeditions of 15 days each to register all taxa of *Saimiri* through direct observation and to map localities for each phenotype to better comprehend their range. We conducted field inventories in areas that coincide with the limits of the known distribution of *Saimiri vanzolinii*. During fieldwork, we traversed 271 km near the margins of water bodies. When flooded, we explored them by canoe. When we sighted squirrel monkeys, we recorded the date and the geographic coordinates of the location. F. Paim identified the phenotypes in the field with ease, using 8 × 36 binoculars. The field work was supported by local field assistants from the Mamirauá and Amanã Reserves. We also conducted informal interviews with local residents concerning the occurrence of different phenotypes in the MSDR.

Material Examined

We examined 87 specimens collected from 45 locations in and around the MSDR (see Appendix). They were deposited in the MPEG, the Museu Nacional of the Federal University of Rio de Janeiro (UFRJ), and the Zoology Museum of the University of São Paulo (MZUSP). For comparison with the Gothic-type squirrel monkeys in the study area, we used 10 specimens of *Saimiri sciureus sciureus* and 10 of *S. ustus* and another 10 specimens that were provisionally identified as *S. s. macrodon* 1 in the MPEG collection.

Morphological Analysis

External differences between the taxa of *Saimiri* are related to coat color and pelage patterns, as well as marked differences in anatomy (Costello *et al.* 1993; Hershkovitz 1984; Hill 1960; Thorington 1985), behavior (Boinski and Cropp 1999; Costello *et al.* 1993; Hershkovitz 1984), immunology (Hershkovitz 1984), and karyology (Costello *et al.* 1993; Hershkovitz 1984). We first evaluated 19 characters that were used by Costello *et al.* (1993), Hershkovitz (1984), Thorington (1985), and two others, which we suspected to be pertinent in our samples. From these, we selected 12 as informative, showing little variation in the samples from each locality, but differences between localities: 1) shape and extent of the superciliary arch; 2) thickness of the tail pencil; 3) hairiness of the ears; 4) conspicuousness of the supraorbital vibrissal tufts; 5) presence of a pre-auricular patch; 6) extent of the pale area of the distal part of forelimbs; 7) hair color on the limb extremities; 8) hair color of the central part of the crown; 9) hair color on the outer surfaces of the forelimbs; 10) hair color on the outer surfaces of the hindlimbs; 11) hair color on the shoulders; and 12) hair color on the median and posterior surfaces of the back. The first six characters relate to pelage patterns and the others are related to coat color.

Characters 1, 3, 7, 8, 9, and 12 were evaluated by Costello *et al.* (1993), Hershkovitz (1984), and Thorington (1985). Character 3 (hairiness of the ears) was defined by Hershkovitz (1984) and Thorington (1985) as having two states —"tufted" and "bare"— but Costello *et al.* (1993, Fig. 6, p. 196) indicated three discrete

states for this character: completely covered with hair; hairy but with skin showing; and bare. Although Costello *et al.* (1993) interpreted the partially haired ears as an intermediate state in a cline, we observed, with the larger samples used in this study, that this morphology is consistent over a wide geographic area, with no gradual transition to entirely tufted or entirely naked. Characters 10 (color of outer surfaces of hind limbs) and 11 (color of the shoulders) were defined by Hershkovitz (1984) and Thorington (1985). Character 6 (extent of the pale area of the distal part of the forelimbs) was cited by Costello *et al.* (1993) and Thorington (1985), although the color of the hand and forearms was examined only by Costello *et al.* (1993). Just as for character 3, Costello *et al.* (1993) interpreted variation in hand and forearm color as evidence of intergradation. However, data from this study indicated that differences in this character were consistent and discrete in each geographical area, as was the case in character 3. Characters 2 (thickness of the tail pencil) and 4 (conspicuousness of the supraorbital vibrissal tufts) were defined by Hershkovitz (1984). The results of the morphological analysis of Costello *et al.* (1993), Hershkovitz (1984), and Thorington (1985) were interpreted on the basis of parsimony, assessing the number of differences in the morphological patterns against the geographic distribution. Hershkovitz (1984) drew up an identification key based on these characters.

Character 5 (the presence of a pre-auricular patch) was identified as a diagnostic feature based on the examination of the specimens of *Saimiri ustus* in the collection of MPEG. Besides these, the character "width of nuchal band" also proved informative, but was dropped from the analysis because the band is generally continuous and ill defined. This character was observed by Hershkovitz (1984), which indicated two states: "interrupted" (a pale and weakly contrasting collar) for *Saimiri sciureus cassiquiarensis* and "continuous" (more or less agouti like crown and back between shoulders for *S. s. sciureus* and *S. s. macrodon*) for the other taxa. When we examined specimens, we found that the state "continuous" was represented by two states: "wide" in *Saimiri sciureus macrodon* 1 and *S. s. macrodon* 2, and "narrow" in *S. vanzolinii*, *S. s. sciureus*, and *S. ustus*. The differentiation of *macrodon* 1 and 2 was due to the characters hairiness of the ears and extension of yellowish hands. The reason for this separation was to verify whether these characters represented only a variation within the same taxon.

The other characters were not informative. The "color of the pre-auricular patch in males" and the "color of the forehead" were linked to character 8 (color of the central part of the crown). The characters "color of the nuchal band" and "color of the flanks" were linked to character 11 (color on the shoulders). The character "tail color" was related to character 10 (color of the outer surfaces of the hindlimbs). The characters "pre-auricular patch of females" and "color of the ventrum" were individually variable. The "color of the tail pencil" proved to be invariant. The selected characters were analyzed for geographic variation using the transect method (Vanzolini 1970).

Our process for identifying geographic boundaries for morphological types began with mapping the locations using ArcGIS10. First, each of the 12 morphological characters was plotted individually to verify the geographic distribution of the character state, allowing us to identify where one character state was succeeded by another. Then we superimposed the maps for each

character, and the characters showing congruent geographic distributions were regrouped.

We used the results of these morphological analyses to identify character sets corresponding to the different taxa. We compared them to the original descriptions and diagnoses of Hershkovitz (1984), Thorington (1985), and Costello *et al.* (1993) to recover the valid scientific names for the two Gothic-type squirrel monkeys. We aggregated field observations to generate polygons corresponding to the areas of occurrence of the different taxa in the MSDR.

This research complied with protocols approved by the IACUC and the legal requirements of Brazil (through licenses IBAMA/CGFAU/LIC 086/2004 and IBAMA/SISBIO 14080-1/2008).

Results

Morphological Analysis

The results of the morphological analysis indicated three phenotypes occupying distinct geographic areas in the MSDR (Fig. 2). The first phenotype was represented by samples from locations in the center and south of the eastern part of the reserve,

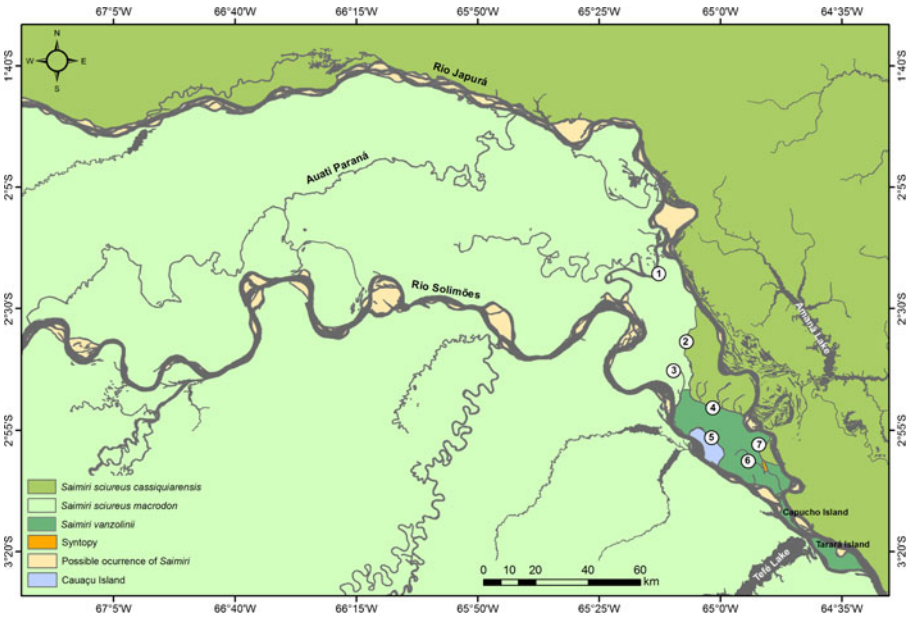

Fig. 2 Geographic distributions of *Saimiri vanzolinii*, *Saimiri sciureus macrodon*, and *S. s. cassiquiarensis* in the Mamirauá Sustainable Development Reserve and adjacent areas of the middle Rio Solimões. The numbers represent localities: 1) Aranapu Paraná; 2) limits between Jarauá and Preguiça locations; 3) Aiucá Paraná; 4) Jarauá Paraná; 5) Cauaçu Paraná; 6) Mamirauá Paraná; and 7) Apara Paraná. The data were collected between 2005 and 2008.

Table I Characters analyzed for specimens of *Saimiri* for verification of morphological differences

Characters	States					
	Saimiri vanzolinii	*Saimiri sciureus macrodon* 1	*Saimiri sciureus macrodon* 2	*Saimiri sciureus cassiquiarensis*	*Saimiri sciureus sciureus*	*Saimiri ustus*
1	Roman	Gothic	Gothic	Gothic	Gothic	Gothic
2	Thiny	Bushy	Bushy	Bushy	Bushy	Bushy
3	Densely furred	Densely furred	Sparsely furred	Densely furred	Densely furred	Bare
4	Inconspicuous	Conspicuous	Conspicuous	Conspicuous	Conspicuous	Conspicuous
5	Present	Present	Present	Present	Present	Absent
6	From hands to elbows	From hands to elbows	From hands to middle arms	From hands to elbows	From hands to elbows	Restricted to hands
7	Burned yellow	Yellowish-orange	Yellow washed with olivaceous	Reddish-orange	Yellowish-orange	Reddish-orange
8	Black	Grayish-olivaceous	Grayish-olivaceous	Dark chestnut	Brownish-gray	Bluish-gray
9	Blackish-gray	Grayish-olivaceous	Grayish-olivaceous	Clear chestnut	Brownish-gray	Bluish-gray
10	Blackish-gray	Grayish-olivaceous	Grayish-olivaceous	Clear chestnut	Brownish-gray	Bluish-gray
11	Black speckled with gray	Grayish-olivaceous	Grayish-olivaceous	Clear chestnut	Brownish-gray	Chestnut speckled with black
12	Black	Reddish-brown	Grayish-brown	Reddish-chestnut	Reddish-brown	Chestnut speckled with black

Characters numbered from 1 to 6 are structural; 7 to 12 refer to fur coloration. Characters: 1, morphology of superciliary arch; 2, morphology of tail pencil; 3, morphology of the hairiness of ears; 4, conspicuousness of the supraorbital vibrissal tufts; 5, presence of pre-auricular mark; 6, extension of the light area of forelimbs at the extremities; 7, hair coloration on the limb extremities; 8, hair coloration of central area of crown; 9, hair coloration on the outer surfaces of forelimbs; 10, hair coloration on the outer surfaces of hind limbs; 11, hair coloration on the shoulders; and 12, hair coloration of median and posterior surfaces of the back.

along with the islands of Tarará and Capucho in the Solimões River, just downstream of the MSDR. These locations correspond to the putative range of *S. vanzolinii*. The second phenotype, provisionally identified as *Saimiri sciureus macrodon* 2, was recorded from the northwest of the MSDR, extending west along the right bank of the Japurá River and south to both margins of the Solimões River. The third phenotype, identified as *Saimiri sciureus cassiquiarensis*, occurs north of the Japurá and Solimões Rivers, but with two incursions south of the river in the MSDR, over a rather extensive area in the southeast of the reserve and again in another smaller area a little further southeast. Table I gives the character states observed in each group evaluated, including *Saimiri sciureus sciureus*, *S. ustus*, and *Saimiri sciureus macrodon* 1.

All individuals in each location were consistent in their phenotype for the characters assessed except in two cases. MPEG-37120, identified as *Saimiri sciureus macrodon* 2, shared character 2 (morphology of the tail pencil) with *S. vanzolinii*. A second, MPEG-36606, was a juvenile identified as *Saimiri sciureus cassiquiarensis*, but that had a tail pencil typical of *S. vanzolinii*, along with darker hair in the central area of the crown (character 8) compared to typical adult *S. s. cassiquiarensis* (but not as dark as that of *S. vanzolinii*). In both cases, the individuals with mixed characters were from locations near the range limits of *Saimiri vanzolinii.*

Table II presents a summary of the results of the superimposition of all characters. It indicates that the phenotypes present in MSDR display a degree of differentiation between each other close to or greater than that observed between *Saimiri sciureus sciureus* and *S. ustus*. The most divergent was *Saimiri vanzolinii*, which showed differentiation in eleven characters, including five structural characters, in relation to *Saimiri sciureus macrodon* 2, and nine characters, including three structural, in relation to *S. s. cassiquiarensis*. The degree of differentiation of *Saimiri vanzolinii* in relation to *Saimiri sciureus sciureus* and *S. ustus* was of similar magnitude. *Saimiri sciureus macrodon* 1 and *S. s. macrodon* 2 differed from each other in only four characters. The Gothic types found in the reserve (*Saimiri sciureus macrodon* 2 and *S. s. cassiquiarensis*) differed by eight characters, two of which were of pelage patterns.

Table II Observed differentiation between twelve morphological characters analyzed in specimens of *Saimiri*

Rate	*Saimiri vanzolinii*	*Saimiri sciureus macrodon* 1	*Saimiri sciureus macrodon* 2	*Saimiri sciureus cassiquiarensis*	*Saimiri sciureus sciureus*	*Saimiri ustus*
S. vanzolinii	0					
S. s. macrodon 1	9	0				
S. s. macrodon 2	11	4	0			
S. s. cassiquiarensis	9	6	8	0		
S. s. sciureus	9	4	8	6	0	
S. ustus	12	9	9	9	9	0

Geographic Distribution

Fieldwork yielded results congruent with the geographic groupings indicated by the morphological analysis, showing consistency in all character sets. We recorded 333 social groups of *Saimiri*; of those, 134 were *S. vanzolinii*, 99 *Saimiri sciureus macrodon* 2, and 93 *S. s. cassiquiarensis*, in addition to 7 mixed groups. The results also indicated that the two Gothic subspecies have parapatric distributions in the MSDR.

Areas with partial superimposition of geographic distributions were located in three regions, with one presenting syntopy. The first overlapping area, between *S. vanzolinii* and *Saimiri sciureus macrodon* 2, is close to the Aiucá Paraná. The second one, with overlap between *Saimiri vanzolinii* and *Saimiri sciureus cassiquiarensis*, is near the Jarauá Paraná. The third, also between *Saimiri vanzolinii* and *Saimiri sciureus cassiquiarensis*, is near the paranás (channels) Apara and Mamirauá. In the latter, seven mixed social groups were also observed, which is evidence of syntopy. Where distributions overlapped, the individuals of each particular social group presented all the character state sets associated with a single taxon. In the case of the mixed groups, the phenotype for each individual was either *Saimiri vanzolinii* or *Saimiri sciureus cassiquiarensis*; no individual presented heterogeneous character state sets or intermediate states that would indicate a hybrid zone.

Our data allowed us to delineate the distributional limits of the three taxa of *Saimiri* inside the MSDR. This included the northwestern limit of *Saimiri vanzolinii*, which had remained uncertain since its description (Ayres 1985b). Based on our data, the range of *Saimiri vanzolinii* is larger by 26.5 km^2 in relation to that previously recorded in the literature. However, we were unable to observe a single individual of this species in two areas previously indicated as part of its range. Our interviews of local inhabitants corroborate these results. One of these areas is situated between the Solimões River and the Cauaçu Paraná (Cauaçu Island); the other is between the Japurá River and the Apara Paraná. Our results suggest that no squirrel monkeys occur on Cauaçu Island, and that only *Saimiri sciureus cassiquiarensis* occurs in the second area, north of the Apara Paraná (see Fig. 2). This resulted in an overall reduction (taking into account the added 26.5 km^2) from 950 km^2 to 870 km^2 of the total area occupied by the taxon.

Discussion

Differentiation between Taxa

Our study indicates the presence of three distinct taxa of *Saimiri* in the Mamirauá reserve: the Roman type *S. vanzolinii* and two distinct Gothic types, *Saimiri sciureus macrodon* 2 and *S. s. cassiquiarensis*. Differentiation between these taxa of *Saimiri* in the MSDR is in accordance with Hershkovitz (1984), Boinski and Cropp (1999), and Lavergne *et al.* (2010) with regard to the divergence at the species level of the Gothic and Roman types. Thorington (1985), on the other hand, recognized just two species: *Saimiri sciureus* (the Roman type *boliviensis* as a subspecies) and *S. madeirae* (referred to by us and Hershkovitz as *S. ustus*). Costello *et al.* (1993) lumped all South American *Saimiri* as one species, *S. sciureus*, and considered only the Central

American *S. oerstedii* as a second species. Our analysis of pelage and coat color patterns conform with Hershkovitz (1984, 1987) and Lavergne *et al.* (2010) in concluding that *Saimiri sciureus macrodon*, *S. s. sciureus*, and *S. s. cassiquiarensis* are distinct taxa. Thorington (1985) recognized *Saimiri sciureus cassiquiarensis* from north of the Japurá River and west of the Negro River, but considered *S. s. macrodon* to be a synonym of *S. s. sciureus*. Moreover, Costello *et al.* (1993) recognized neither *Saimiri sciureus macrodon* nor *S. s. cassiquiarensis*, considering both jointly with *S. s. sciureus* as parts of a single terminal taxon.

The two Gothic types in the MSDR are clearly different from each other and from *Saimiri sciureus sciureus*. The differences in pelage patterns and coat color between *Saimiri sciureus macrodon* and *S. s. sciureus* are fewer when compared to *S. s. macrodon* 1 of this study, but the argument that they are distinct taxa is reinforced by karyological and molecular genetic studies. Hershkovitz (1984) compared the karyologic descriptions of *Saimiri sciureus sciureus* by Jones *et al.* (1973) and *S. s. macrodon* by Bender and Metler (1958), Egozcue *et al.* (1969), Srivastava *et al.* (1969), Jones *et al.* (1973) and highlighted the difference in chromosome complements of the two taxa. The molecular genetics analyses carried out by Lavergne *et al.* (2010) led them to recognize not only their validity, but also indicated that they be considered distinct species, not subspecies.

The validity of *Saimiri vanzolinii* has already been widely discussed in the literature (Groves 2005; Rylands *et al.* 2000, 2012; Rylands and Mittermeier 2009; Silva and Queiroz 2008). Hershkovitz (1987) placed it as a subspecies of *Saimiri boliviensis*, and, based on a presumed hybrid (*vanzolinii* × *boliviensis*) specimen from Tefé, Costello *et al*. (1993) concluded that it "is best considered a member of *boliviensis* until further evidence indicates otherwise" (p. 198). The second taxon occurring in the MSDR and in the area situated on the left side of the Japurá River, was identified as *Saimiri sciureus cassiquiarensis* based on the analyses of character states that coincided with those of Hershkovitz (1984) in his diagnosis of this taxon. The third can be identified as *Saimiri sciureus macrodon*. Even though the phenotype observed in the MSDR differs from that described in populations in Ecuador, south of Colombia and Brazilian adjacent areas, this divergence was very low, involving only four character states (see results for *Saimiri sciureus macrodon* 1 and *S. s. macrodon* 2). Costello *et al.* (1993) observed this phenotype in samples on the west margin of the Tefé River, considering it as evidence of hybridization between *S. madeirae* (= *S. ustus*) and other taxa of *Saimiri*. The conclusions of Costello *et al.* (1993) are based on two samples from the MPEG collection. The first (MPEG-13209), a male, was considered a hybrid of one or two generations between *Saimiri madeirae* and *S. sciureus* (= *Saimiri sciureus macrodon sensu* Hershkovitz 1984). The second (MPEG-13210), a female, was considered a hybrid between *Saimiri madeirae* and *S. vanzolinii* or *S. boliviensis*. The same samples were examined in this present study.

Our results, including those from samples most recently collected, differ from those of Costello *et al.* (1993) in various ways: 1) Morphological differences between the two samples from the Tefé River are at the individual and sexual level, not the population level. The dark area of the pre-auricular mark and the border of the female crown is a phenotype shared with female adults of all taxa of *Saimiri* without a black crown, with the exception of *Saimiri madeirae* (*cf.* Muniz, 2005). The small variations in the colors of the back and the crown of the two samples were also observed in species from all the other locations. 2) The ranges of *Saimiri vanzolinii* and *S. boliviensis* evidently do not

extend to the Tefé River, making the existence of hybrids between these two species within the area highly unlikely. 3) Morphological traits observed in specimens from the Tefé River have a wide geographic distribution. The new samples show that this phenotype extends to the west on both margins of Solimões River, reaching the middle Juruá River and lower Javarí River. In this case, the supposed hybrid would have a distribution as wide or as great as that indicated by Thorington (1985) for one of the supposed parental taxon, *Saimiri madeirae*. Costello *et al.* (1993) argued that this phenotype would be a hybrid of *Saimiri madeirae* based on two character states (characters 3 and 6 of the present study). These authors observed sparsely furred ears and a lighter area on extremities of the forelimbs, restricted almost to the wrists, and attributed these character states to this hybridization. In the present study, the stability observed for this phenotype (*Saimiri sciureus macrodon* 2) throughout an extensive geographic area makes the aforementioned hypothesis unlikely. This region was assigned by Hershkovitz (1984) as part of the geographic distribution of *Saimiri sciureus macrodon*. The relatively minor differentiation observed between *Saimiri sciureus macrodon* 1 and *S. s. macrodon* 2 could be interpreted as geographic variation of this taxon. The transition can be observed in the specimens from Estirão do Ecuador and Atalaia do Norte. One of the specimens of Atalaia do Norte presented all the character sets of *Saimiri sciureus macrodon* 1, while the rest presented the character set of *S. s. macrodon* 2. The samples from Estirão do Ecuador were identified as *Saimiri sciureus macrodon* 1. The geographic proximity of these two locations suggests that the geographic variation has a relatively abrupt transition. The phenotype observed in *Saimiri sciureus macrodon* 2 is that described by Lönnberg (1940) for *Saimiri madeirae juruana*, considered by Hershkovitz (1984) as a junior synonym of *S. s. macrodon*. As such we have classified this form in the MSDR as *Saimiri sciureus macrodon*.

It is possible that the samples MPEG-36606 and MPEG-37120 that shared character state 2 with *Saimiri vanzolinii* represent hybrids of this species with *Saimiri sciureus cassiquiarensis* and *S. s. macrodon*, respectively. This deserves careful attention and study. Even though the presence of hybrids at the limits of geographic distribution of related taxa is to be expected, the simple fact that a character state of one individual is shared with individuals of another taxon does not constitute in itself unequivocal proof of hybridization. Moreover, data from fieldwork give indications to the contrary because all character sets of each taxon were uniform for individuals observed in the wild, even those from areas of superimposing distribution, including mixed groups. As such, even if there are cases of hybridization at the borders of the distributions of *Saimiri vanzolinii* and of the other two taxa, these certainly have a low frequency of occurrence, suggesting preferential mating.

Geographic Distribution

The identification of a population of *Saimiri sciureus macrodon* (*sensu* Schwindt and Ayres, 2004) in the MSDR is unsurprising. The entire region situated between the Solimões and Japurá Rivers had already been described by Hershkovitz (1984) as part of the range of this taxon. With the description of *Saimiri vanzolinii* in the MSDR in 1985, the idea that this taxon was the only species occupying the most southeasterly part of the reserve remained for some time. It was believed that *Saimiri sciureus macrodon* was restricted to the northwestern margin of the Aranapu Paraná. In fact, it occurs on both sides

of the Aranapu Paraná, extending south as far as the Aiucá Paraná. The Aiucá Paraná marks the northwestern limit for *Saimiri vanzolinii* along the Japurá River.

The presence of *Saimiri sciureus cassiquiarensis* in the MSDR, however, was a surprise. It has crossed the Japurá River, one of the largest black water rivers in the Amazon (Ayres and Clutton-Brock 1992). This may have been a chance crossing or may have resulted from a change in the course of the river, quite possible because the lowest reaches of the Japurá are in the youngest geological zone of the reserve, and the channel of Japurá was located to the north (northeast) at other times in the past. Peixoto (2007) has shown that the patterns of erosion and sedimentation are highly dynamic in the MSDR, a geomorphological feature responsible for complex allogenic successional dynamics, the constantly changing mosaic of the *várzea* forest types, and the diversity of habitats and species that result. The MSDR represents an important area of biogeographic interest, marking the meeting point of three taxa of squirrel monkeys. Studies in such area shed light on the origin of species diversity in Amazonia.

The three taxa of *Saimiri* identified in the MSDR occur in distinct geographic regions in the forested areas of the reserve. *Saimiri vanzolinii* has a parapatric distribution with minimal of overlap with both Gothic types (*Saimiri sciureus cassiquiarensis* and *S. s. macrodon*). The Gothic types have parapatric distributions along the Japurá River and in one area in the MSDR, between the locations denominated *Jarauá* and *Preguiça*. *Saimiri vanzolinii* to the southeast of the reserve on the islands of Tarará and Capucho in the Solimões River. The distribution of *Saimiri sciureus macrodon* extends northeast, west of the Jarauá Paraná in the MSDR, taking in the remainder of the interfluvial area of the Solimões and Japurá Rivers, and extending to the south of the Solimões River, from the Tefé River to the middle Juruá River, west into southern Colombia, northern Peru, and Ecuador (Aquino and Encarnación 1994; Defler 2004; Hershkovitz 1984; Tirira 2007). Within the MSDR, the limits between *Saimiri sciureus macrodon* and *S. vanzolinii* coincide with the Aiucá Paraná. The range of *Saimiri sciureus cassiquiarensis* includes two small areas in the northeastern part of MSDR, that to the left margin of Japurá River, and according to Hershkovitz (1984), it extends east to the Negro and Branco Rivers, north into the Venezuelan Amazon. In the MSDR, the limits between *Saimiri sciureus cassiquiarensis* and *S. vanzolinii* coincide with the paranás Jarauá, Apara, and Mamirauá.

The distribution of *Saimiri vanzolinii*, as observed by Ayres (1985b), constitutes extreme endemism, being restricted to a single area of the southeast of reserve. It has one of the smallest geographic distributions of all the Neotropical primates; at 870 km^2, it is smaller even than was estimated by Ayres (1985b). These results confirm the extreme vulnerability of this species (IUCN 2013; Machado *et al.* 2005; Silva and Queiroz 2008). This knowledge also provides essential information for the refinement of the reserve management plan, highlighting the urgent need for measures to conserve its biological diversity.

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Appendix

Table III Geographic locality and museum information of specimens of *Saimiri*

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
1	*Saimiri sciureus macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º47′33″S; 71º22′52″W	MPEG	1091
1	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º47′33″S; 71º22′52″W	MPEG	1092
1	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º47′33″S; 71º22′52″W	MPEG	1094
1	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º47′33″S; 71º22′52″W	MPEG	1604
1	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º47′33″S; 71º22′52″W	MPEG	1841
2	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º25′33″S; 70º11′48″W	MPEG	30757
2	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º25′33″S; 70º11′48″W	MPEG	30758
2	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º25′33″S; 70º11′48″W	MPEG	30759
2	*S. s. macrodon* 1	AM, Atalaia do Norte, Rio Javari	04º25′33″S; 70º11′48″W	MPEG	30760
3	*S. s. macrodon* 1	AM, Rio Juruá	07º1′19″S; 71º37′8″W	MPEG	22991
4	*S. s. macrodon* 1	AM, Eirunepé	06º33′19″S; 69º47′1″W	MPEG	22976
5	*S. s. macrodon* 2	AM, São Paulo de Olivença	03º23′7″S; 68º5′15″W	MN	23705
5	*S. s. macrodon* 2	AM, São Paulo de Olivença	03º23′7″S; 68º5′15″W	MN	23706
5	*S. s. macrodon* 2	AM, São Paulo de Olivença	03º23′7″S; 68º5′15″W	MN	23707
5	*S. s. macrodon* 2	AM, São Paulo de Olivença	03º23′7″S; 68º5′15″W	MN	23708
6	*S. s. macrodon* 2	AM, Auati-Paraná, RDS Mamirauá	02º14′42″S; 66º29′6″W	MZUSP	18894
6	*S. s. macrodon* 2	AM, Auati-Paraná, RDS Mamirauá	02º14′42″S; 66º29′6″W	MZUSP	18895
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MN	1596
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MN	2885

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MN	23703
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MN	23711
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MN	23713
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7035
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7037
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7039
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7040
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7041
7	*S. s. macrodon* 2	AM, Fonte Boa	02º32′9″S; 66º5′31″W	MPEG	7042
7	*S. s. macrodon* 2	AM, Tefé	02º32′9″S; 66º5′31″W	MPEG	7043
8	*S. s. macrodon* 2	AM, Tefé	03º32′10″S; 65º59′32″W	MPEG	13210
9	*S. s. cassiquiarensis*	AM, Rio Lobo	01º0′8″S; 63º0′37″W	MPEG	8906
10	*S. s. cassiquiarensis*	AM, Codajás	03º49′17″S; 62º02′53″W	MN	6006
10	*S. s. cassiquiarensis*	AM, Codajás	03º49′17″S; 62º02′53″W	MN	23709
10	*S. s. cassiquiarensis*	AM, Codajás	03º49′17″S; 62º02′53″W	MN	23710
10	*S. s. cassiquiarensis*	AM, Codajás	03º49′17″S; 62º02′53″W	MN	23712
10	*S. s. cassiquiarensis*	AM, Codajás	03º49′17″S; 62º02′53″W	MN	23714
11	*S. s. macrodon* 2	AM, Tefé	02º23′24″S; 65º17′41″W	MPEG	13209
12	*S. s. macrodon* 2	AM, Maraã	02º23′3″S; 65º13′57″W	MPEG	39867
12	*S. s. macrodon* 2	AM, Maraã	02º23′3″S; 65º13′57″W	MPEG	39868
12	*S. s. macrodon* 2	AM, Maraã	02º23′3″S; 65º13′57″W	MPEG	39869
13	*S. s. macrodon* 2	AM, Maraã	02º25′11″S; 65º15′7″W	MPEG	39866
14	*S. s. macrodon* 2	AM, Maraã	02º24′49″S; 65º14′49″W	MPEG	39870

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
15	*S. s. macrodon* 2	AM, Maraã	02º26′55″S; 65º6′57″W	MPEG	39863
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37101
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37102
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37103
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37111
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37120
15	*S. s. macrodon* 2	AM, Uarini, RDS Mamirauá	02º26′55″S; 65º6′57″W	MPEG	37128
16	*S. s. macrodon* 2	AM, Maraã	02º26′49″S; 65º5′46″W	MPEG	39865
17	*S. s. macrodon* 2	AM, Maraã	02º27′21″S; 65º5′24″W	MPEG	39864
18	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º28′11″S; 64º49′33″W	MPEG	36611
18	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º28′11″S; 64º49′33″W	MPEG	36618
18	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º28′11″S; 64º49′33″W	MPEG	36620
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36639
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36640
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36641
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36642
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36643
19	*S. s. cassiquiarensis*	AM, Maraã, RDS Amanã	02º35′27″S; 64º53′11″W	MPEG	36647
20	*S. s. macrodon* 2	AM, Uarini, Rio Solimões	02º46′20″S; 65º19′3″W	MPEG	39875
21	*S. s. macrodon* 2	AM, Uarini, Rio Solimões	02º46′23″S; 65º18′48″W	MPEG	39877
22	*S. s. macrodon* 2	AM, Uarini, Rio Solimões	02º47′19″S; 65º18′54″W	MPEG	39876
23	*S. s. macrodon* 2	AM, Uarini, Paraná Aiucá	02º43′43″S; 65º7′39″W	MPEG	39872

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
24	*S. s. macrodon* 2	AM, Uarini, Paraná Aiucá	02º43′56″S; 65º7′34″W	MPEG	39874
25	*S. s. macrodon* 2	AM, Uarini, Paraná Aiucá	02º45′31″S; 65º7′31″W	MPEG	39873
26	*S. s. macrodon* 2	AM, Uarini, Paraná Aiucá	02º46′26″S; 65º7′53″W	MPEG	39871
27	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º42′40″S; 65º5′56″W	MPEG	39878
28	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º44′15″S; 65º5′55″W	MPEG	39879
29	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º44′59″S; 65º6′19″W	MPEG	39880
30	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º49′40″S; 64º59′39″W	MPEG	39882
31	*S. s. cassiquiarensis*	AM, Rio Solimões	02º49′52″S; 64º58′34″W	MZUSP	17554
31	*S. s. cassiquiarensis*	AM, Rio Japurá	02º49′52″S; 64º58′34″W	MZUSP	17555
31	*S. s. cassiquiarensis*	AM, Rio Japurá	02º49′52″S; 64º58′34″W	MZUSP	17556
31	*S. s. cassiquiarensis*	AM, Rio Japurá	02º49′52″S; 64º58′34″W	MZUSP	17561
32	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º50′31″S; 65º59′10″W	MPEG	39881
33	*S. vanzolinii*	AM, Rio Japurá, RDS Mamirauá	02º5′49″S; 64º59′35″W	MZUSP	17557
33	*S. vanzolinii*	AM, Rio Japurá, RDS Mamirauá	02º5′49″S; 64º59′35″W	MZUSP	17558
33	*S. vanzolinii*	AM, Rio Japurá, RDS Mamirauá	02º5′49″S; 64º59′35″W	MZUSP	17560
34	*S. s. cassiquiarensis*	AM, Uarini, Rio Japurá	02º52′2″S; 64º55′10″W	MPEG	39883
35	*S. s. cassiquiarensis*	AM, Rio Japurá	02º51′11″S; 64º52′19″W	MZUSP	17546
35	*S. s. cassiquiarensis*	AM, Rio Japurá	02º51′11″S; 64º52′19″W	MZUSP	17548
36	*S. s. cassiquiarensis*	AM, Rio Japurá	02º45′11″S; 64º35′24″W	MZUSP	17547
36	*S. s. cassiquiarensis*	AM, Rio Japurá	02º45′11″S; 64º35′24″W	MZUSP	17549
37	*S. vanzolinii*	AM, RDS Mamirauá, Lago Teiú	02º57′36″S; 64º54′50″W	MZUSP	17559
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′41W	MPEG	36606

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	19016
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	19017
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	19027
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	19028
38	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′41″W	MPEG	36606
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15471
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15472
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15473
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15474
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15475
39	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º58′44″S; 64º54′32″W	MZUSP	15478
40	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º59′33″S; 64º54′13″W	MPEG	21362
40	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º59′33″S; 64º54′13″W	MPEG	21363
40	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º59′33″S; 64º54′13″W	MPEG	21362
40	*S. vanzolinii*	AM, RDS Mamirauá, Lago Mamirauá	02º59′33″S; 64º54′13″W	MPEG	21363
41	*S. s. cassiquiarensis*	AM, Uarini, Paraná do Apara	02º57′48″S; 64º50′45″W	MPEG	39886
42	*S. s. cassiquiarensis*	AM, Uarini, Paraná do Apara	03º0′15″S; 64º51′50″W	MPEG	39885
43	*S. s. cassiquiarensis*	AM, Uarini, Paraná do Apara	03º2′30″S; 64º51′9″W	MPEG	39884
44	*S. s. cassiquiarensis*	AM, Rio Japurá	03º08′24″S; 64º45′54″W	MZUSP	19008
45	*S. s. cassiquiarensis*	AM, Rio Solimões	03º08′02″S; 64º53′31″W	MZUSP	19009
45	*S. s. cassiquiarensis*	AM, Rio Solimões	03º08′02″S; 64º53′31″W	MZUSP	19010
45	*S. s. cassiquiarensis*	AM, Rio Solimões	03º08′02″S; 64º53′31″W	MZUSP	19011
45	*S. s. cassiquiarensis*	AM, Rio Japurá	03º08′02″S; 64º53′31″W	MZUSP	19024

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
46	*S. vanzolinii*	AM, Rio Solimões	03º10′55″S; 64º46′55″W	MZUSP	19020
46	*S. vanzolinii*	AM, Rio Solimões	03º10′55″S; 64º46′55″W	MZUSP	19021
46	*S. vanzolinii*	AM, Rio Solimões	03º10′55″S; 64º46′55″W	MZUSP	19022
47	*S. vanzolinii*	AM, Rio Solimões	03º17′38″S; 64º39′47″W	MZUSP	18898
47	*S. vanzolinii*	AM, Rio Solimões	03º17′38″S; 64º39′47″W	MZUSP	19899
48	*S. s. macrodon* 2	AM, Tefé	03º19′19″S; 64º42′34″W	MZUSP	19012
49	*S. s. macrodon* 2	AM, Tefé	03º23′14″S; 64º44′41″W	MZUSP	19023
50	*S. s. macrodon* 2	AM, Tefé	03º24′46″S; 64º44′18″W	MZUSP	19013
50	*S. s. macrodon* 2	AM, Tefé	03º24′46″S; 64º44′18″W	MZUSP	19014
50	*S. s. macrodon* 2	AM, Tefé	03º24′46″S; 64º44′18″W	MZUSP	19015
51	*S. s. macrodon* 2	AM, Tefé	03º28′11″S; 64º58′40″W	MZUSP	19019
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	03º27′43″S; 49º19′30″W	MPEG	12180
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	03º27′43″S; 49º19′30″W	MPEG	12181
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	04º21′30″S; 49º4′57″W	MPEG	12185
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	04º21′30″S; 49º4′57″W	MPEG	12186
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	03º46′43″S; 50º00′55″W	MPEG	12192
	S. s. sciureus	PA, Tucuruí, Rio Tocantins	03º46′43″S; 50º00′55″W	MPEG	12193
	S. s. sciureus	PA, Japerica	00º5′25″N; 47º7′23″W	MPEG	22972
	S. s. sciureus	PA, Japerica	00º5′25″N; 47º7′23″W	MPEG	22973
	S. s. sciureus	PA, Santa Bárbara	01º18′12″S; 48º15′54″W	MPEG	37915
	S. s. sciureus	PA, Santa Bárbara	01º18′12″S; 48º15′54″W	MPEG	37939
	S. ustus	AM, Humaitá	07º32′12″S; 62º43′46″W	MPEG	21990
	S. ustus	AM, Humaitá	07º32′12″S; 62º43′46″W	MPEG	21991

Table III (continued)

Map's number	Taxon	Locality	Geographic coordinate	Museum	Catalog number
	S. ustus	AM, Humaitá	07º26′17″S; 62º54′57″W	MPEG	21992
	S. ustus	AM, Humaitá	07º26′17″S; 62º54′57″W	MPEG	21993
	S. ustus	RO, Calama, Rio Jí-Paraná	08º3′23″S; 62º51′41″W	MPEG	21994
	S. ustus	RO, Calama, Rio Jí-Paraná	08º3′23″S; 62º51′41″W	MPEG	21995
	S. ustus	RO, Rio Jamari	08º43′58″S; 63º28′59″W	MPEG	21712
	S. ustus	RO, Rio Jamari	08º43′58″S; 63º28′59″W	MPEG	21713
	S. ustus	RO, Rio Jamari	08º43′58″S; 63º28′59″W	MPEG	21714
	S. ustus	RO, Rio Jamari	08º43′58″S; 63º28′59″W	MPEG	21715

Museums: MPEG = Museu Paraense Emílio Goledi); MN = Museu Nacional do Rio de Janeiro; MZUSP = Museu de Zoologia da Universidade de São Paulo.

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