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New species of titi monkey, genus *Callicebus* Thomas, 1903 (Primates, Pitheciidae), from Southern Amazonia, Brazil

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ABSTRACT

The genus Callicebus *is one of the most diverse Neotropical primate groups, with 31 recognized species. However, large knowledge gaps still exist regarding the diversity of this genus. Such gaps are gradually being filled due to recent intensification of sampling efforts. Several geographic distributions have been better delimited, and six new species have been described in the last 15 years. The goal of the present study is to describe a new species of* Callicebus *belonging to the* Callicebus moloch *species group, recently discovered in an area previously considered to be part of the geographic distribution of* C. cinerascens. *Data collection was conducted through direct observations, specimen collection and interviews with local residents during four expeditions. Specimens were deposited in the mammalian collection of the Museu Paraense Emílio Goeldi. For a comparative evaluation, we examined specimens of the other species of the* Callicebus moloch *species group, especially the geographically neighboring forms,* C. bernhardi *and* C. cinerascens. *We examined 10 chromatic characters of the fur. In addition to body mass, we verified the conventional external variables and 26 craniometric variables. The new species differs from all other Amazonian* Callicebus *by an exclusive combination of characters, being easily distinguished by the light gray line of the forehead, dark ocher sideburns and throat, dark gray portions of the torso and flanks, and uniformly orange tail. The geographic distribution of the new species is limited by the Roosevelt and Aripuanã rivers, in the states of Mato Grosso and Amazonas, Brazil. Approximately 25% (1,246.382 ha) of this area falls within conservation areas, with five areas of sustainable use (746,818 ha) and three of integral protection (499,564 ha). Furthermore, a considerable portion of the distribution area is located within indigenous lands (1,555.116 ha – 32%). Therefore, 57% (2,801.498 ha) of the occurrence area of the new species falls within protected areas.*

Key-Words: Pitheciidae; *Callicebus moloch* species group; Taxonomy; Geographic distribution; Morphology.

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INTRODUCTION

The genus *Callicebus* Thomas, 1903 (Callicebinae, Pitheciidae) represents one of the most diverse Neotropical primate groups, with 31 species currently recognized (Ferrari *et al.,* 2013; Silva-Júnior *et al.,* 2013). The taxonomy of the genus has been exhaustively discussed in the literature. Elliot (1913) recognized the existence of 22 valid species. Hill (1960) listed 34 *taxa* belonging to six species. In his first systematic revision, Hershkovitz (1963) recognized only three polytypic species. Although he did not include the Atlantic forest taxa in his study, Hershkovitz (1963) suggested that those forms should be considered subspecies of *C. moloch.* Subsequently, Hershkovitz (1988, 1990) suggested that the genus *Callicebus* should be divided into four species groups (*C. modestus, C. donacophilus, C. moloch,* and *C. torquatus*), with a total of 23 taxa belonging to 13 species. Kobayashi (1995) determined the existence of five species groups in this genus (*C. donacophilus, C. cupreus, C. moloch, C. personatus,* and *C. torquatus*). The taxonomic scheme proposed by Rylands *et al.* (2000) followed the classification of Hershkovitz (1988, 1990), modified by Kobayashi & Langguth (1999). In the Rylands *et al.* (2000) scheme, all forms of *Callicebus* were considered valid species, except those of the subgenus *Torquatus* (*sensu* Goodman *et al.,* 1998; Groves, 2005; Silva-Júnior *et al.,* 2013). In a literature review on the taxonomy of *Callicebus,* Roosmalen *et al.* (2002) followed Rylands *et al.* (2000), but considered the subspecific taxa belonging to the subgenus *Torquatus* also as valid species. Roosmalen *et al.* (2002) were followed by subsequent authors (*e.g.,* Groves, 2005; Rylands & Mittermeier, 2009; Paglia *et al.,* 2012; Rylands *et al.,* 2012; Ferrari *et al.,* 2013; Silva-Júnior *et al.,* 2013).

The genus *Callicebus* has a disjunct geographic distribution, occurring in most of the Amazon and Atlantic forest, in addition to several open vegetation areas adjacent to these biomes (Silva-Júnior *et al.,* 2013). In Amazonia, the genus is absent from the areas north of the Amazon river, from the left margin of the Branco and left bank of the lower Negro rivers to the west until the Atlantic coast to the east, and also south of the Amazon river, in the region east of the Tocantins river. The distribution of the subgenus *Torquatus* is partially superimposed to that of the subgenus *Callicebus* (*Callicebus cupreus* species group). According to Roosmalen *et al.* (2002), the Amazonian distributions of *Callicebus* are always limited by the presence of rivers, and its occurs due to a combination of factors related to the animals' biology, such as the inability to swim and a preference for *terra firme* forests, which would hinder the passive population dispersal from one margin to another.

Rylands *et al.* (2012) observed that there are still large gaps in our knowledge about the taxonomy of *Callicebus,* and also about their geographic distributions. Recently, such gaps are being systematically filled due to an intensification of field efforts, especially in Amazonia. Several geographic distributions are being better delimitated, including those of lesser known species such as *C. modestus, C. olallae* (Felton *et al.,* 2006), *C. dubius* (Röhe & Silva-Júnior, 2010) and *C. cinerascens* (Noronha *et al.,* 2007; Sampaio *et al.,* 2012). In addition, six new species of the subgenus *Callicebus* were described in the last 15 years. Kobayashi & Langguth (1999) described *C. coimbrai* (*Callicebus personatus* species group) based on five specimens collected in three locations near the coast of the state of Sergipe, between the São Francisco and Real rivers in northeastern Brazil. Roosmalen *et al.* (2002) described two new species. The first, *C. stephennashi* (*Callicebus cupreus* species group), was based on five specimens of unknown origin, supposedly from the region between the Purus, Ipixuna and Madeira rivers. The second, *C. bernhardi* (*Callicebus moloch* species group), was based on three specimens from the region between the Madeira-Ji-Paraná and the Roosevelt-Aripuanã rivers. Wallace *et al.* (2006) described *C. aureipalatti* (*Callicebus cupreus* species group), discovered in the Madidi conservation area, located north of the Departmento de La Paz, northwestern Bolivia. The description was based on two specimens collected in the region of the Hondo River and on field observations. Defler *et al.* (2010) described *C. caquetensis* (*Callicebus cupreus* species group) based on two collected specimens, and on 13 social groups observed in the field. The new species was registered in 11 locations between the Orteguaza and Caquetá rivers, Colombia (Defler *et al.,* 2010). Gualda-Barros *et al.* (2012) described *C. vieirai* (*Callicebus moloch* species group) based on four museum specimens and on two specimens observed in the field. The new species was found at three locations between the Iriri and Teles Pires rivers, in the states of Pará and Mato Grosso, Brazil. According to Rylands *et al.* (2012), there are still undescribed species of *Callicebus,* which should be discovered soon as field and laboratory research intensify.

The objective of the present study is to describe a new species of *Callicebus* recently discovered in the central-southern area of Brazilian Amazonia, a

region previously considered as part of the geographic distribution of *C. cinerascens.* The new species is placed in *Callicebus moloch* species group (subgenus *Callicebus*), being very different from the other forms of the genus.

MATERIAL AND METHODS

We conducted four expeditions to the region of the Aripuanã, Roosevelt and Guariba rivers, states of Amazonas and Mato Grosso, Brazil. The first expedition was conducted from November 27th to December 19th, 2010, when we collected the holotype. The second expedition occurred in the region of the Guariba-Aripuanã from January 10th to February 5th, 2013. The third expedition occurred in the region of the Roosevelt-Aripuanã rivers from August 11th to 30th, 2013. On these occasions, we collected the six paratypes. The most recent expedition (November 9th to 25th, 2013) was conducted to add and confirm the information about the geographic distribution and limits of the new species.

Data collection in the field was conducted by walking on pre-existing trails, and in canoes on the banks of the Guariba River, near the Aripuanã River. We collected data using a combination of direct observations, collection of specimens and interviews with local residents. We used recordings of the vocalizations of *Callicebus brunneus* (present in Emmons *et al.,* 1997) in order to locate animals by playback. This procedure has been used to locate other *Callicebus* species (Printes *et al.,* 2011; Sampaio *et al.,* 2012). In total we sampled at nine localities. Specimen collection was authorized by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA, Sistema de Autorização e Informação em Biodiversidade – SISBIO (permanent collecting permit number 13507-1). For each collected specimen, we verified the age-sex class, reproductive state, body mass and biometric parameters. The specimens of the type series were deposited in the mammalian collection of the Museu Paraense Emílio Goeldi (MPEG), Belém, Pará, Brazil, representing the following voucher numbers: MPEG 42654, 42810-12, 42991-93.

For a comparative evaluation, we examined specimens of geographically neighboring species, *C. bernhardi* and *C. cinerascens,* deposited in the collections of the MPEG and of the Instituto Nacional de Pesquisas da Amazônia (INPA). This comparison also involved the examination of skins of the other forms in the *Callicebus moloch* species group, in order to verify chromatic similarities and differences. A list of the analyzed specimens is in the Appendix.

In order to determine external morphology characters, we examined the descriptions of Hershkovitz (1988, 1990), Roosmalen *et al.* (2002),

FIGURE 1: Skin of the holotype of *Callicebus miltoni* sp. nov. (MPEG 42654). **A)** Dorsal view; **B)** ventral view; **C)** lateral (right side) view. Photos: Anderson Feijó.

Wallace *et al.* (2006), Defler *et al.* (2010) and Gualda-Barros *et al.* (2012). We selected 10 chromatic pelage characters, considered informative as they showed little variation within the collected samples, and large variation between these and the other species in the *Callicebus moloch* group. The same characters analyzed by Gualda-Barros *et al.* (2012) fulfilled these criteria; therefore, we used these for descriptions and comparisons: 1) crown; 2) forehead; 3) sideburns; 4) dorsum; 5) flanks; 6) neck, chest and belly; 7) hands and feet; 8) limbs (outer face); 9) limbs (inner face); 10) tail.

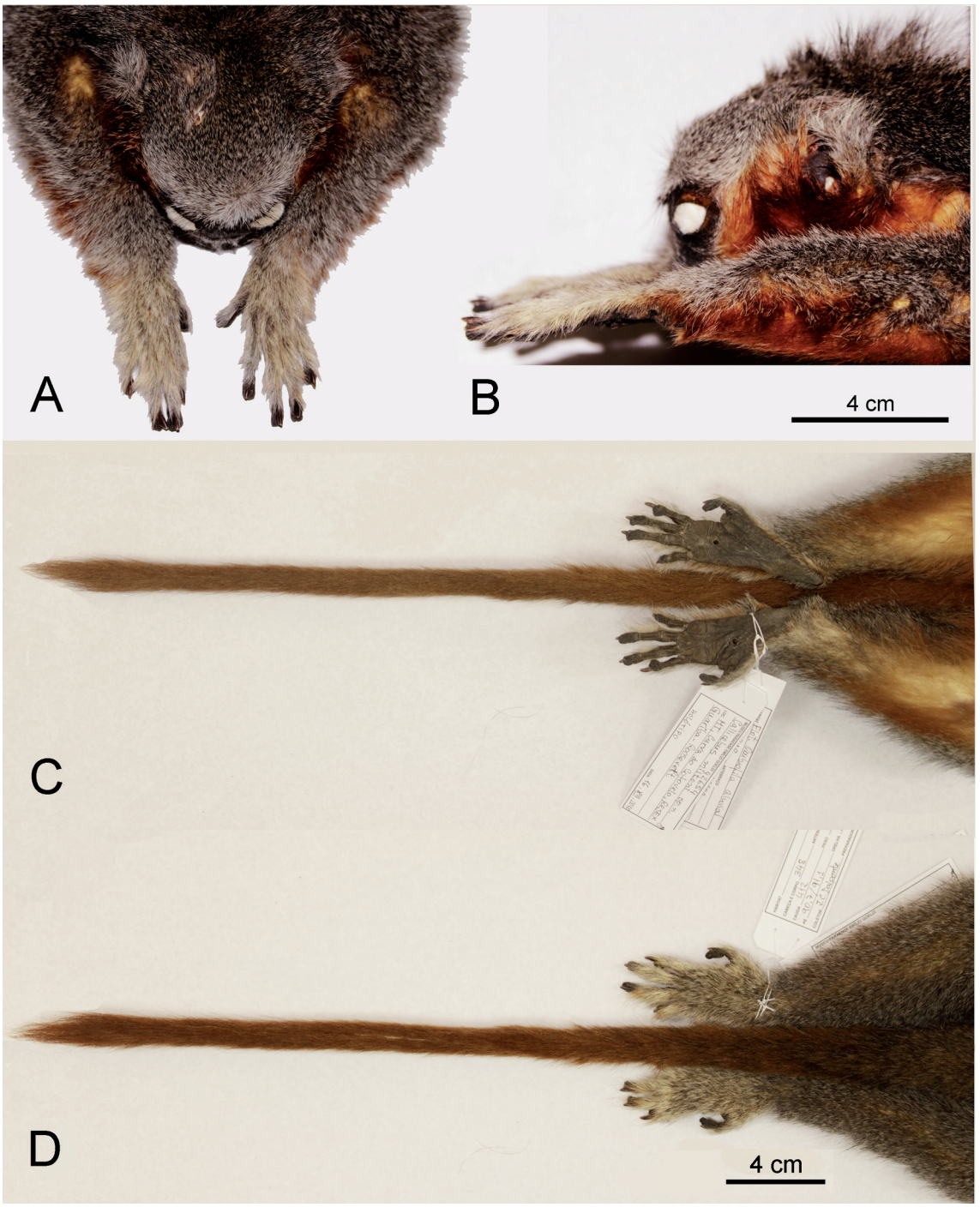

FIGURE 2: Skin of the holotype of *Callicebus miltoni* sp. nov. (MPEG 42654): **A)** Dorsal view of the head; **B)** Lateral view (left side) of the head; **C)** Ventral view of the tail; **D)** Dorsal view of the tail. Photos: Anderson Feijó.

Comparisons between external variables and craniometric variables were conducted only for adult specimens, recognizable by the presence of permanent dentition and by totally fusioned spheno-occiptal and/or spheno-ethmoidal sutures (Hershkovitz, 1977, 1990; Gualda-Barros *et al.,* 2012). Body mass and conventional external measurements (head-body length, tail, foot and ear) were taken during preparation of specimens in the field. Data from other species were obtained through specimen tags. We used digital calipers (precision 0.01 mm) to obtain craniometric variables following Hershkovitz (1977), Silva-Júnior (2001) and Gualda-Barros *et al.* (2012). The 26 cranial measures were as follows: 1) Length of mandible (LMA); 2) Mandibular ramus (width) (MAR); 3) Height of articular process (ART); 4) Height of coronoid (HCO); 5) Width across lower canines (LCA); 6) Width across lower molars (LMO); 7) Length of lower molar series including canine (LMS); 8) Width between coronoids (WCO); 9) Gnathic index (GNA); 10) Cranium length (distance prosthion-opisthocranial) (POP); 11) Nasal-opisthocranial distance (NOP); 12) Zygomatic breadth (ZIG); 13) Width across upper canines (UCA); 14) Width across upper molars (UMO); 15) Brain case width (BCW); 16) Pterion-pterion distance (PTE); 17) Length of upper molar series including canines (UMS); 18) Cranium height (CRH); 19) Palate length (PAL); 20) Palate width (PAW); 21) Breadth across sutures between frontal and malar bones (FRM); 22) Nasal-prosthion distance (NPR); 23) Orbit height (ORH); 24) Orbital width (ORW); 25) Interorbital distance (ORD); 26) Nasal width (NAW).

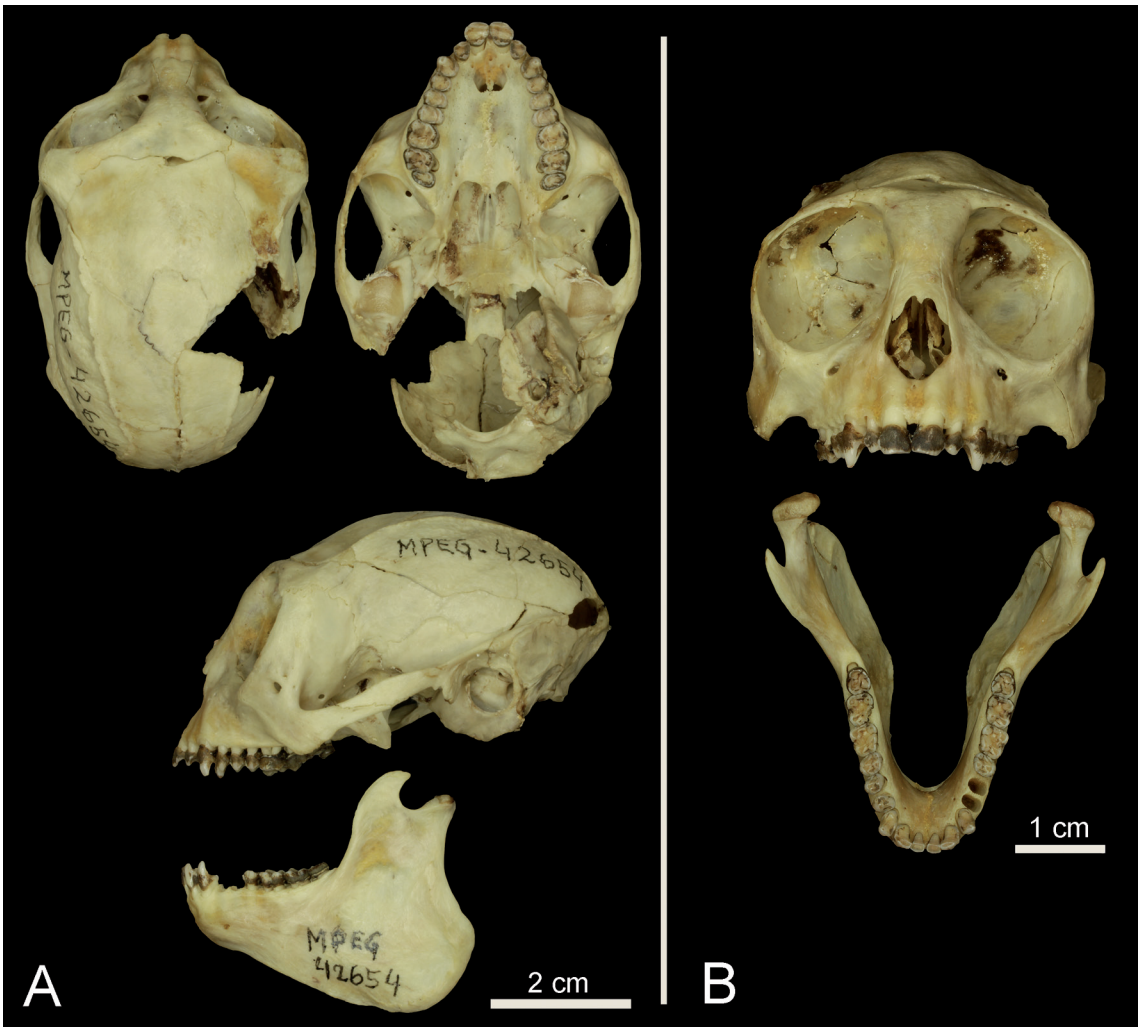

FIGURE 3: Skull of the holotype of *Callicebus miltoni* sp. nov. (MPEG 42654): **A)** Dorsal, ventral and lateral (left side) views of the braincase, and lateral (left side) view of the mandible; **B)** Frontal view of the braincase and dorsal view of the mandible. Photos: Marcelo Sturaro and Anderson Feijó.

***Callicebus miltoni* sp. nov.**

Holotype

MPEG 42654 (Figs. 1, 2A-D, 3A-B); Field number JD 550; Skin, skull and complete skeleton; Adult male; Collected by local hunter and then retrieved by J.C. Dalponte at the type locality. December 2010.

Paratypes

MPEG-42810; Field number FES 04; Adult male; Collected by Felipe Ennes Silva in secondary forest near the confluence of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and right bank of the Guariba River: 07°42'42.10349"S, 60°35'31.47013"W), municipality of Novo Aripuanã, Amazonas, Brazil; January 27, 2013.

MPEG-42811; Field number FES 05; Adult male; Collected by Felipe Ennes Silva in secondary forest near the confluence of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and right bank of the Guariba River: 07°43'14.05081"S, 60°35'17.78161"W), municipality of Novo Aripuanã, Amazonas, Brazil; January 28, 2013.

MPEG-42812; Field number FES 06; Adult female; Collected by Felipe Ennes Silva in secondary forest near the confluence of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and right bank of the Guariba River: 07°43'04.16976"S, 60°35'14.70891"W), municipality of Novo Aripuanã, Amazonas, Brazil; January 28, 2013.

MPEG 42991; Field number FES 12; Adult male; Collected by Felipe Ennes Silva and Raimundo Rodrigues da Silva in secondary forest in the left bank of the Aripuanã River, mouth of the Igarapé Jatuarana (07°44'12.24240"S, 60°31'16.16160"W), municipality of Novo Aripuanã, Amazonas, Brazil; August 23, 2013.

MPEG 42992; Field number FES 13; Adult female; Collected by Felipe Ennes Silva and Raimundo Rodrigues da Silva in secondary forest in the left bank of the Aripuanã River, mouth of the Igarapé Jatuarana (07°44'12.24240"S, 60°31'16.16160"W), municipality of Novo Aripuanã, Amazonas, Brazil; August 23, 2013.

MPEG 42993; Field number FES 14; Adult male; Collected by Felipe Ennes Silva and Raimundo Ro-

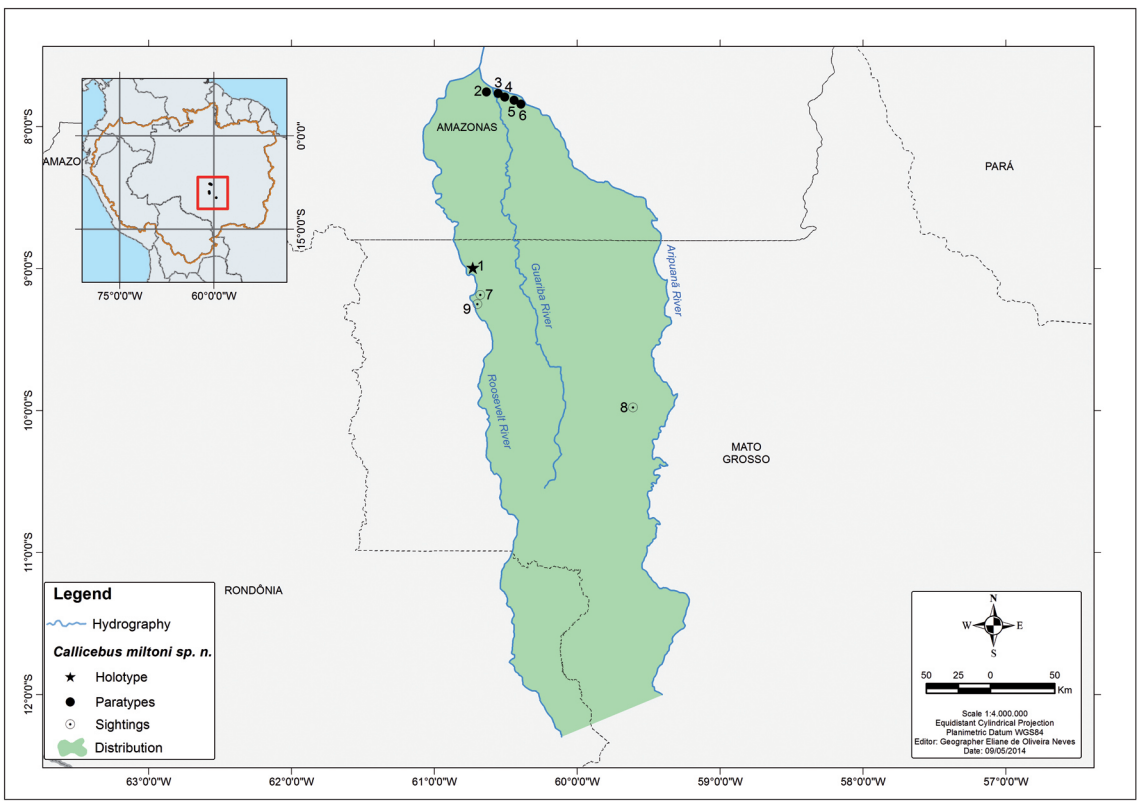

FIGURE 4: Geographic distribution of *Callicebus miltoni* sp. nov. Records numbered as in the Table 1.

TABLE 1: Records of *Callicebus miltoni* sp. nov.

SITE	LOCALITY	COORDINATES	HABITAT	RECORD TYPE
1	Curva do Cotovelo, Reserva Extrativista Guariba-Roosevelt, right bank of the Roosevelt River, Colniza, Mato Grosso	08°59'45.21"S, 60°43'42.72"W	open ombrophilous alluvial forest	COL. OBS
2	Junction of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and left bank of the Guariba River), Novo Aripuanã, Amazonas	07°42'42.10349"S, 60°35'31.47013"W	Secondary forest	COL, OBS
3	Junction of the Guariba and Aripuanã rivers (left bank of Aripuanã River and right bank of the Guariba River), Novo Aripuanã, Amazonas	07°43'14.05081"S, 60°35'17.78161"W	Secondary forest	COL, OBS
4	Confluence of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and right bank of the Guariba River), Novo Aripuanã, Amazonas	07°43'04.16976"S, 60°35'14.70891"W	Secondary forest	COL, OBS
5	Mouth of the Jatuarana stream, left bank of the Aripuanã River, Novo Aripuanã, Amazonas	07°44'12.24240"S, 60°31'16.16160"	Secondary forest	COL, OBS
6	Mouth of the Jatuarana stream, left bank of the Aripuanã River, Novo Aripuanã, Amazonas	07°44'11.17680"S, 60°30'54,83520"W	Secondary forest	COL, OBS
7	Panelas, near the ferry, right bank of the Roosevelt River, Mato Grosso	09°10'16.80"S, 60°44'16.43"W	Understory of open alluvial ombrophilous forest	OBS
8	Rio Branco, tributary of the left bank of the Aripuanã River, Indigenous Area Arara do Rio Branco, Mato Grosso	09°58'44.66"S, 59°36'31.98"W	Understory of open alluvial ombrophilous forest (edge habitat)	OBS
9	Right bank of the Roosevelt River, upstream from Panelas, Mato Grosso	09°14'59.67"S, 60°41'52.56"W	Canopy of the open alluvial ombrophilous forest	OBS

Record types: COL = Specimen collected; OBS = Direct observation.

drigues da Silva in secondary forest in the left bank of the Aripuanã River, mouth of the Igarapé Jatuarana (07°44'11.17680"S, 60°30'54.83520"W), municipality of Novo Aripuanã, Amazonas, Brazil; August 24, 2013.

Type locality

Curva do Cotovelo (08°59'45.21"S, 60°43'42.72"W), region of the mouth of the Pombal stream, Reserva Extrativista Guariba-Roosevelt, right bank of the upper Roosevelt River, municipality of Colniza, Mato Grosso, Brazil (Fig. 4).

Geographic distribution

The records of *Callicebus miltoni* sp. nov. occurred in the lowlands of the Roosevelt-Aripuanã Depression, an area previously considered by Roosmalen *et al.* (2002) and Veiga *et al.* (2008) as part of the distribution of *C. cinerascens* (Table 1; Fig. 4). The geographic distribution of the new species coincides with the interfluvial region of the Roosevelt and Aripuanã rivers, states of Mato Grosso and Amazonas, Brazil, and these rivers form the western (Roosevelt), eastern (Aripuanã) and northern limits of its distribution (Fig. 4). *Callicebus miltoni* was observed along the right bank of the Roosevelt River, replaced by *C. bernhardi* which occurs at the left bank of this river (FES, pers. observation). The series of hills resulting from the contact of the Dardanelos plateau and the Roosevelt-Aripuanã Dissected plateau whose declivity acts as an effective terrestrial barrier and represents the southern limit of the distribution of *C. miltoni*. These formations have abrupt contact with steep ledges, with the Roosevelt-Aripuanã Depression at its north face, and gradual contact with the Parecis plateau and part of the residual plateaus of Madeira-Roosevelt at the south (Brasil, 1980).

Description of the holotype

Dark-ocher (orange-brown) sideburns, with the individual hairs showing two colored stripes, one basal orange and one distal dark-ocher; forehead with a white (light gray) stripe contrasting with the dark agouti-gray crown; ears colored similarly to crown, but with white (light gray) edges and a discrete white (light gray) tuft; white vibrissae and beige eyelids (*in natura*); superior part of the body, flanks and external sides of members a uniform gray-agouti, which extends to approximately 1/10th of the tail on the anterior-superior portion; white (light gray) hands and feet, in the same tone of the forehead stripe and ear edges, contrasting with the gray-agouti of the external parts of the members; throat in the same tone as sides

of the face (dark-ocher); chest, belly and internal parts of the members light orange, visibly contrasting with the dark orange of the sideburns and throat; tail (except 1/10th of the anterior-superior portion) uniformly light orange, though the individual hairs show two stripes, one basal light orange and one distal reddish-orange (Figs. 1A-C, 2A-D, 5).

Paratypes

The type series of *C. miltoni* sp. nov., composed of seven specimens, allowed for an initial evaluation of the intraspecific variation in fur color. The observed variation in the paratypes was small, showing the stability of the set of characters that define the chromatic pattern of the species, and the absence of sexual dichromatism. The gray coloration of the crown was lighter in specimens MPEG 42810, 42811, 42812 and 42991, with effects of the distinctness of the forehead stripe. MPEG 42810 showed a very diffuse stripe, almost imperceptible, and specimens MPEG 42811, 42812 and 42991 showed a less contrasting stripe with the crown than that observed in the holotype and in the other paratypes. Specimen MPEG 42993 showed darker sideburns, with a darkened tone, and MPEG 42812 showed lighter sideburns, slightly orange. Specimens MPEG 42811 and 42812 showed a slight brown tone in the gray color of the dorsum, and MPEG 42992 showed this same coloration only in the posterior part of the dorsum (saddle). Specimens MPEG 42812 and 42992 showed a whitish longitudinal stripe in the flanks. Specimen MPEG 42810 showed a more reddish color in the throat, chest and belly, and specimens MPEG 42812, 42991, 42992 and 42993 showed a darker coloration in these regions, less contrasting with that of the throat. Specimen MPEG 42810 had darker hands and feet, less contrasting with the color of the external surface of the members; specimen MPEG 42992 showed less contrasting hands, in addition to brownish fingers, and MPEG 42812 had ankles with brownish extremities. Specimen MPEG 42812 showed a lighter external surface of the members, contrasting with the dorsum, similarly to MPEG 42811 and 42992, but with less intense contrast. MPEG 42991 showed this same pattern only in the anterior members. Specimens MPEG 42812 and 42991 had darker internal surfaces of the members, similar to that of the sideburns; the same was true for MPEG 42992 and 42993, but only in the anterior members. MPEG 42810 had a blackish tone in 2/3 of the proximal portion of the tail (dorsal side), with the ventral side showing a small black portion separating the base from the remaining of the tail. Specimen MPEG 42811 showed some sparse whitish hairs along the tail. Specimens MPEG 42811, 42810 and 42991 had shorter tails, with shorter and less dense hairs and with the coloration of the basal stripe less contrasting with the distal stripe. MPEG 42991 had the basal part of the tail composed by two pairs of small stripes, alternating between golden-yellow and dark brown. MPEG 42992 showed uniformly colored ears, similar to the color of the crown.

Diagnosis

A species of titi monkey belonging to the *Callicebus moloch* species group, subgenus *Callicebus* (*sensu* Groves, 2005). *Callicebus miltoni* sp. nov. differs from all other Amazonian species of the genus *Callicebus* by an exclusive combination of characters. It is easily distinguished from species of the same group, particularly those with adjacent distributions, *C. bernhardi* and *C. cinerascens,* by the pattern of fur coloration, especially a contrasting gray stripe on the forehead (Fig. 2A-B), orange-brown sideburns and throat, dark gray upper torso and flanks, and orange tail (except 1/10th of the dorsal surface at the base of the tail) (Fig. 5, Fig. 6). The tail turned orange-brown

FIGURE 5: Holotype of *Callicebus miltoni* sp. nov. before taxidermy, showing the whitish stripe of the forehead, dark-ocher sideburns and the orange tail. Photo: Jorge Lopes.

after taxidermy in all specimens of the type series, but this remained an exclusive trait of *C. miltoni* (Fig. 2C-D).

Comparisons

Considering the species as a member of the *Callicebus moloch* species group (Table 2), *C. miltoni* differs from its closest geographically neighbor *C. bernhardi* (Fig. 6) by the dark-ocher tone of the sides of the face and throat, contrasting with the chest and belly, rather than the brilliant orange of the latter species; by the gray stripe on the forehead contrasting with the darker gray on top of the head, not apparent in *C. bernhardi,* and by the uniformly gray mid-dorsal region, without the reddish tone of *C. bernhardi.* Differs from its also closest geographically neighbor *C. cinerascens* (Fig. 6) in all characters, including the uniform gray pattern of the dorsal region, dark-ocher sides of the face and light gray extremities, rather than the general dark-gray pattern with reddish mid-dorsum and darker extremities of *C. cinerascens.* Differs from *C. moloch* by the dark-ocher sides of the face rather than the brilliant orange, and by the uniformly gray mid-dorsum, without the reddish tone of *C. moloch.* Differs from *C. vieirai* in all characters, including dark gray agouti forehead with whitish stripe contrasting with the crown (white or white-agouti in *C. vieirai*); dark ocher (orange-brown) sideburns (white in *C. vieirai*); ocher neck, orange-brown chest and light ocher (orange) belly (uniformly light yellow to light orange underparts in *C. vieirai*); and by the uniformly light ocher (orange) tail (agouti with gray base, blackish middle and whitish tip in *C. vieirai*). Differs from *C. baptista* by the gray pattern of the dorsum, flanks and external parts of members (dark gray in *C. baptista*), gray-white member extremities and light-gray stripe of the

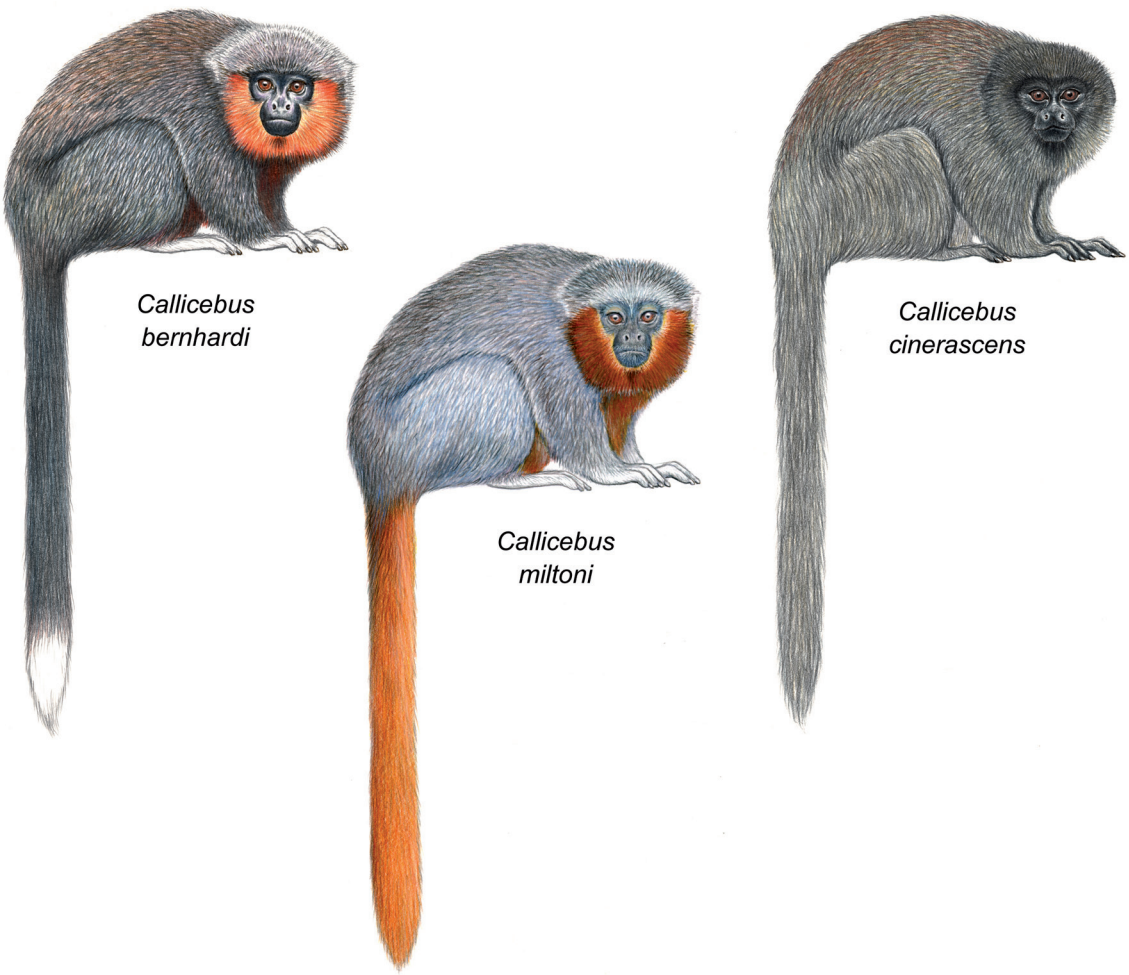

FIGURE 6: *Callicebus miltoni* sp. nov., compared to geographically neighboring species (*C. bernhardi* and *C. cinerascens*) belonging to the *Callicebus moloch* species group. Illustration by Stephen D. Nash.

TABLE 2: Chromatic characters utilized for comparisons between *Callicebus miltoni* sp. nov. and other species of the *Callicebus moloch* species group (modified from Gualda-Barros *et al.,* 2012).

Characters/Species	*C. miltoni*	*C. cinerascesns*	*C. bernhardi*	*C. moloch*
1. Crown	Dark gray agouti	Gray agouti	Dark gray agouti	Gray agouti
2. Forehead	Dark gray agouti, with whitish stripe contrasting with the crown	Gray agouti	Dark gray agouti	Gray agouti
3. Sideburns	Dark ocher (orange-brown)	Gray agouti	Dark red-brown	Light ocher (orange)
4. Dorsum	Uniform dark gray agouti	Red-brown agouti	Dark gray agouti	Gray to light brown
5. Flanks	Uniform dark gray agouti	Gray agouti	Dark gray agouti	Gray agouti to light brown
6. Neck, chest and belly	Ocher neck (orange-brownchest and belly light ocher (orange)	Gray agouti	Dark reddish-brown	Light ocher (orange)
7. Hands and feet	White-gray agouti, contrasting with members	Gray agouti	Dar gray agouti	Suede
8. Limbs (outer face)	Dark gray agouti	Gray agouti	Dark gray agouti	Suede-agouti buffy or gray to brown
9. Limbs (inner face)	Light ocher (orange)	Gray agouti	Dark redish-brown	Light ocher (orange)
10. Tail	Light ocher (orange)	Gray agouti	Agouti. Gray base, blackish middle, suede tip	Agouti Gray base, blackish middle, suede tip
Characters/Species	***C. baptista***	***C. brunneus***	***C. hoffmannsi***	***C. vieirai***
1. Crown	Blackish agouti	Brownish-yellow agouti	Gray agouti	Light gray agouti
2. Forehead	Blackish agouti	Darkened	Gray agouti	White or white-agouti
3. Sideburns	Gray agouti	Blackish agouti to dark red-brownen	Yellowish	White
4. Dorsum	Blackish agouti	Red-brown agouti	Gray agouti	Brown-gray agouti to light brown
5. Flanks	Blackish agouti	Dark red-brown agouti	Gray agouti	Light gray-brown agouti
6. Neck, chest and belly	Dark reddish-brown	Dark brown	Yellowish	Light yellow to light orange
7. Hands and feet	Blackish agouti	Darkened	Gray agouti	Whitish agouti
8. Limbs (outer face)	Blackish agouti	Dark reddish-brown agouti	Gray agouti	Light gray agouti
9. Limbs (inner face)	Dark reddish-brown	Blackish agouri to red-brown	Yellowish	Light yellow
10. Tail	Blackish agouti	Dark red-brown agouti; light brown tip	Blackish agouti	Agouti. Gray base; blackish middle; whitish tip

forehead (both darkened in *C. baptista*). Differs from *C. brunneus* in all traits, especially the gray pattern of the dorsum, flanks and external parts of the members (reddish-brown in *C. brunneus*), gray-white member extremities (darkened in *C. brunneus*), and light-gray stripe on the forehead (darkened in *C. brunneus*). Differs especially from *C. hoffmannsi* by the dark-ocher sides of the face and orange ventral parts, rather than the uniform yellowish-white of the latter.

Craniometric variables

The type series of *C. miltoni* is larger than that of other recently described *Callicebus* species, comprised of seven specimens. Despite this, the number remains low, hindering an analysis of intraspecific variation and interspecific comparisons of craniometric and external measures within the *Callicebus moloch* species group. Although all specimens are adults, the number of males (5) exceeds that of females (2). External and craniometric variables of the holotype and paratypes are presented in Table 3.

Natural history

The holotype of *C. miltoni* was collected in open ombrophilous alluvial forest, with high influence of the Roosevelt River, region of the mouth of the Pombal stream, known as "Curva do Cotovelo" (Fig. 7). In this area, the forest has four strata, with the highest stratum (average height 30 m) characterized by the occurrence of seringueira (*Hevea* spp.), jatobá

TABLE 3: Cranial and external measurements of the type series of *Callicebus miltoni.* Abbreviations of craniometric variables as described in Material and Methods.

Measurements		Holotype	Paratypes						Mean
		MPEG-42654	MPEG-42812	MPEG-42811	MPEG-42810	MPEG-42993	MPEG-42991	MPEG-42992	
External	HB	760	790	780	800	766	760	685	763.0
	T	412	480	450	460	446	450	395	441.9
	HF	91.1	91.8	92.17	87.16	95	95	85	91.0
	E	37.2	31.97	31.93	32.83	28	27	27	30.8
	W (g)	1040				1400	1500	1400	1335
Skull	LMA	44.30	40.51	43.32	39.13	41.70	43.39	41.17	41.93
	MAR	15.03	11.69	13.20	13.37	14.28	14.50	13.53	13.66
	ART	34.06	29.52	30.73	29.84	32.77	31.14	29.58	31.09
	HCO	35.92	32.42	35.73	33.25	34.92	36.33	34.70	34.75
	LCA	11.70	10.11	9.95	10.67	10.66	11.21	10.31	10.66
	LMO	19.50	19.47	19.33	18.94		18.88	19.16	19.21
	LMS	20.52	19.64	20.19	19.23	19.38	19.62	19.52	19.73
	WCO	36.89	35.41	36.19	34.26		37.67		36.08
	GNA	12.40	8.72	10.46	9.41	11.84	12.05	9.71	10.66
	POP	63.04	61.47	60.86	56.43		62.45	60.34	60.77
	NOP	57.94	49.47	51.99	54.12		51.24	50.85	52.60
	ZIG	42.56	39.89	40.29	37.97				40.18
	UCA	14.90	13.69	13.33	13.80	14.60	15.40	14.34	14.29
	UMO	22.53	20.09	20.36	19.91		20.60	20.44	17.70
	BCW	34.08	36.04	34.50	32.72		33.06	33.45	33.98
	PTE	31.32	29.65	30.60	30.37	30.77	29.97	31.32	30.57
	UMS	17.97	17.36	17.44	17.25	17.24	17.37	17.38	17.43
	CRH	26.15	24.97	26.53	24.18		25.62	27.76	25.87
	PAL	14.11	14.87	20.28	18.49		21.19	18.79	17.96
	PAW	14.60	13.25	12.73	11.85		11.96	12.13	12.75
	FRM	36.84	34.49	35.85	35.81	36.73	34.94		35.78
	NPR	12.63	13.44	11.74	12.00	12.24	12.80	10.87	12.25
	ORH	16.25	14.77	15.07	15.44	16.04	16.21	16.19	15.71
	ORW	35.81	32.46	34.03	34.04	35.14	34.15		34.27
	ORD	7.17	6.44	6.29	6.42	5.64	5.64	6.33	6.28
	NAW	6.65	7.23	6.82	7.16	7.08	6.53	6.80	6.90

External measurements: HB = Head and body length (Bregma-Ischium) (mm); T = Tail length (mm); HF = Hind foot length (mm); E = Ear length (mm); W = Body mass (g).

(*Hymenaea intermedia*), roxinho (*Peltogyne catingue*), garapeira (*Apuleia molaris*), copaíba (*Copaifera* spp.), jutaí (*Dialium guianense*), sucupira-preta (*Diplotropis racemosa*), cumaru-champanhe (*Dipteryx odorata*), tento (*Ormosia nobilis*) and faveira (*Parkia* sp.), distributed openly. The undercanopy (average height 15 m) is marked by the occurrence of matamatá-mirim (*Eschweilera wachenheimii*), aquaricara (*Geissospermum urceolatum*), tachi (*Tachigali alba*), and the palms patauá (*Oenocarpus bataua*), sete-pernas (*Sochratea exorrhiza*) and açaí (*Euterpe precatoria*). The tree stratum is characterized by *Miconia* sp. and *Psychotria* sp. (average height 2 m), distributed openly. The shrub layer (average height 0.1-0.5 m) contains *Olyra* cf. *latifolia, Selaginella conduplicata* and *Calthea altissima,* distributed sparsely (Oliveira, 2011).

In the region of the Roosevelt River, *C. miltoni* was found in the high and medium strata of the ombrophilous forest. The first images of the new species (Fig. 8) were of an adult male in the undercanopy of the forest, above Panelas, right bank of the Roosevelt River (Fig. 9). In this region, two groups (composed of four and five individuals, respectively) comprising pairs of adults with juveniles (Fig. 10) were seen feeding on fruits of ingá (*Inga* sp.), embaúba (*Cecropia* sp.; Fig. 11) and cacauí (*Theobroma speciosum*).

In the region of the mouth of the Guariba River, we located nine groups, most in the medium or high strata of the dense ombrophilous forest. The size of the groups varied between two and five individuals, but it was not possible to precisely estimate group sizes

FIGURE 7: Open ombrophilous alluvial forest at the right bank of the Roosevelt River, habitat of the Milton's titi monkey, *Callicebus miltoni* sp. nov. Photo: A. Gambarini.

FIGURE 8: *Callicebus miltoni* sp. nov., adult male observed in the undercanopy of open ombrophilous alluvial forest, right bank of the Roosevelt River, Mato Grosso, Brazil. Photo: J. Dalponte.

FIGURE 9: Undercanopy of the ombrophilous alluvial forest, typical habitat of the *Callicebus miltoni* sp. nov. in the Roosevelt River region, Mato Grosso, Brazil. Photo: A. Gambarini.

FIGURE 10: Family group of *Callicebus miltoni* sp. nov. in the undercanopy of the ombrophilous forest at Panelas, right bank of the Roosevelt River, northwestern Mato Grosso, Brazil. Photo: A. Gambarini.

FIGURE 11: Adult Milton's titi monkey eating *Cecropia* fruit while carrying a baby at Roosevelt River, Mato Grosso, Brazil. Photo: A. Gambarini.

due to the monkeys' escape behavior upon detecting human presence.

Some marked traits of the genus *Callicebus* include territoriality and long-call vocalizations (usually in the morning) as a way of maintaining intergroup distances (Robinson, 1979, 1981; Kinzey & Robinson, 1983; Wright, 2013). However, during the rest of the day, their cryptic behavior makes it difficult to locate the animals (Ferrari *et al.,* 2000; Vermeer *et al.,* 2011). *Callicebus miltoni* also behaves in this way, judging by our field observations.

The vocalizations of *C. miltoni* groups were critical to locate the animals in the field, and occurred especially early in the morning and in the rainy season. In this season, three out of four observations were aided by the morning long-calls. On only one occasion, we used a playback to locate the groups. The recordings were used to stimulate the response of the animals once located, facilitating closer observation. In the dry season, morning calls were less intense. Therefore, the playbacks were essential to locate the groups, and contributed to the five observations made in this season.

The seasonality of *C. miltoni* vocalizations followed the pattern known for other *Callicebus* species, *e.g., C. brunneus* (Wright, 2013). In that study, morning calls during the time of highest fruit availability (rainy season) were related to territorial defense and access to resources.

Conservation

The geographic distribution of *C. miltoni* is approximately 4,921.540 ha, mostly located in the state of Mato Grosso (3,379.637 ha – 69%). The remaining area is in the state of Amazonas (1,455.223 ha – 29%), and a small portion (86,682 ha – 2%) on the eastern edge of Rondônia.

Approximately 25% (1,246.382 ha) of the area of *C miltoni* is located in conservation units, five of those sustainable use preserves (746,818 ha) and three of those entirely protected (499,564 ha). The species occurs in the Reserva Extrativista Guariba-Roosevelt, Mato Grosso (138,092 ha), but its presence is predicted in various conservation units that comprise the Apuí Mosaic: Parque Estadual Guariba, Amazonas (72,296.331 ha), Reserva Extrativista do Guariba, Amazonas (57,630 ha), Floresta Estadual do Aripuanã, Amazonas (336,040.065 ha), Floresta Estadual de Manicoré, Amazonas (83,381.039 ha), Reserva de Desenvolvimento Sustentável do Aripuanã, Amazonas (224,290.817 ha), in addition to the east side of Parque Nacional dos Campos Amazônicos, Amazonas/Mato Grosso (873,570 ha) and of the Estação Ecológica do Rio Flor do Prado, Mato Grosso (8,517 ha). A significant portion of the species' distribution area is located within indigenous land (1,555.116 ha – 32%), represented by the Terra Indígena Arara do Rio Branco, Parque do Aripuanã, Kawahiva do Rio Pardo and Aripuanã. Therefore, approximately 57% (2,801.498 ha) of the distribution area of *C miltoni* is within protected areas, with the remaining 43% (2,120.044 ha) in private areas and/or settlement areas.

Landscape mapping, based on data from PRODES and DEGRAD-INPE (Irgang, 2011) to map the spatio-historical process of occupation of the conservation units of northwest Mato Grosso (Reserva Extrativista Guariba-Roosevelt, Parque Estadual Tucumã, Estação Ecológica do Rio Madeirinha and Estação Ecológica do Rio Roosevelt), shows that 86% of the deforestation occurs in the Reserva Extrativista Guariba-Roosevelt. In this area, which includes the type locality of *C. miltoni,* the greatest threats to the landscape are possible damning of the Roosevelt River, the deforestation of the Áreas de Proteção Permanente, and fire. Hunting does not appear to present a risk to the species in the region, although this may eventually happen, especially in indigenous territory. Capture of primate infants to be used as pets is frequent and common in traditional Amazonian communities. It is not uncommon for people to sell their pets to persons outside the community, and this is one of the potential conservation problems for the new species in the Reserva Extrativista Guariba-Roosevelt.

Starting from the accumulated deforestation by the year 2000 (83,021ha), we note that the occurrence area of *C. miltoni* was increasingly deforested until 2004, with 47,493 ha registered for that year. After this peak, the rates of deforestation diminished, although they are still high, with 2,775 ha recorded in 2013. The total deforested area calculated for the geographic distribution of *C. miltoni* is 231,680 ha (4,7% of the total area of occurrence of the species).

Etimology

The new species is named in honor of Dr. Milton Thiago de Mello in recognition of his contribution to development of Primatology. In particular, we note his essential participation in the creation of the Brazilian Primatology Society and of the Latin American Primatology Society, and in the education of most primatologists currently active in Brazil and abroad, among them one of the authors of this paper (JSSJ), through specialized Primatology programs that begun in the 1980s at the Universidade de Brasília.

Vernacular names

"Zogue-zogue" is the term used by the residents of the Reserva Extrativista Guariba-Roosevelt, as well as in all Brazilian Amazonia, to identify primates of the genus *Callicebus.* Initially, the new species was termed "Firetail titi monkey" due to its light orange tail, which distinguishes it from other *Callicebus* in Amazonia. After selection of the scientific name, the common name became "Milton's titi monkey".

RESUMO

O gênero Callicebus *é um dos grupos mais diversificados entre os primatas neotropicais, com 31 espécies reconhecidas. Contudo, ainda existem grandes lacunas no conhecimento acerca da diversidade contida neste gênero. Tais lacunas vêm sendo paulatinamente preenchidas graças a uma intensificação recente dos esforços de amostragem. Diversas distribuições geográficas foram melhor delimitadas, e seis espécies novas foram descritas nos últimos 15 anos. O objetivo do presente estudo é descrever uma nova espécie de* Callicebus *pertencente ao grupo de espécies* Callicebus moloch, *recentemente descoberta em uma área previamente considerada como parte da distribuição geográfica de* C. cinerascens. *Foram realizadas*

quatro expedições. A coleta de dados foi realizada através de observações diretas, coletas de espécimes e entrevistas com moradores locais. Os espécimes foram depositados na coleção de mamíferos do Museu Paraense Emílio Goeldi. Para uma avaliação comparativa, foram examinados os exemplares das demais espécies do grupo Callicebus moloch, *principalmente as formas geograficamente vizinhas,* C. bernhardi *e* C. cinerascens. *Foram examinados 10 caracteres cromáticos da pelagem. Além da massa corporal, foram verificadas as medidas externas convencionais e 26 medidas cranianas. A nova espécie difere de todas as outras espécies amazônicas do gênero* Callicebus *por uma combinação exclusiva de caracteres, sendo facilmente distinguida pela faixa grisalha clara contrastante na testa, costeletas e garganta ocre-escuras, partes superiores do tronco e flancos grisalho-escuras, e cauda uniformemente laranja. A distribuição geográfica da nova espécie é limitada pelos rios Roosevelt e Aripuanã, nos estados de Mato Grosso e Amazonas, Brasil. Aproximadamente 25% (1.246.382 ha) desta área constituem unidades de conservação, sendo cinco de uso sustentável (746.818 ha) e três de proteção integral (499.564 ha). Além disso, uma porção expressiva da área de distribuição da nova espécie está localizada dentro de terras indígenas (1.555.116 ha – 32%). Assim, 57% (2.801.498 ha) da área de ocorrência da nova espécie encontram-se dentro de áreas protegidas.*

Palavras-Chave: Pitheciidae; Grupo de espécies *Callicebus moloch;* Taxonomia; Distribuição geográfica; Morfologia.

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APPENDIX

Material examined in the Museu Paraense Emílio Goeldi (MPEG) and Instituto Nacional de Pesquisas da Amazônia (INPA)

Callicebus miltoni sp. nov.: MATO GROSSO: Curva do Cotovelo, RESEX Guariba-Roosevelt, municipality of Colniza (type locality): MPEG 42654 (holotype). AMAZONAS: Interfluvial region, near by the confluence of the Guariba and Aripuanã rivers (left bank of the Aripuanã River and right bank of the Guariba River), Novo Aripuanã: MPEG-42810, 42811, 42812; Left bank of the Aripuanã River, mouth of the Igarapé Jatuarana, Novo Aripuanã: MPEG-42991, 42992, 42993.

Callicebus bernhardi: AMAZONAS: BR-230 (Humaitá-Itaituba), km 17: MPEG 22000; Fazenda Vista Alegre, BR-230, km 150 (Humaitá-Apuí), right bank of the Marmelos River: MPEG 22996; BR-230, km 164 (Humaitá-Apuí), right bank of the s Marmelos River: MPEG 22997; Terra Preta, mouth of the Arauazinho River, left bank of the Aripuanã River: INPA 5679. RONDÔNIA: Calama, right bank of the Ji-Paraná River: MPEG 22007.

Callicebus cinerascens: AMAZONAS: Parque Nacional do Juruena: MPEG 41235; Prainha, near by Cipotuba, right bank of the Aripuanã River: INPA 4085; Castanhal, right bank of the Aripuanã River: 5682; Domo do Sucunduri, right bank of the upper Sucunduri River: FR 50.

Callicebus baptista: PARÁ: Vila Braga, Tapajós River: MPEG 251.

Callicebus brunneus: RONDÔNIA: Fazenda Rio Candeias, BR-364, km 28, Porto Velho: MPEG 10941, 10942; Cachoeira Nazaré, Ji-Paraná River: MPEG 21353, 21355-56; Usina Hidroelétrica de Samuel, Jamari River, right tributary of the Madeira River: MPEG 21686-23035, 35306.

Callicebus hoffmannsi: AMAZONAS: Near by Parintins: MPEG 250, 690; PARÁ: Arapiuns River: MPEG 587; Vila Maripá: MPEG 21444.

Callicebus moloch: PARÁ: Serra do Cachimbo: MPEG 38332; Forest of the Igarapé Refúgio, Curionópolis: MPEG 38491; São João, Araguaia River: MPEG 245; Santarém: MPEG 2396; BR-165 (Santarém-Cuiabá highway): MPEG 12627; BR-165 (Santarém-Cuiabá highway), km 212: MPEG 8122, 8123; Igarapé João Ribeiro, left bank of the Iriri River: MPEG 21837; Tucuruí, Sítio Calandrinho, above the dam, left bank of the Tocantins River: MPEG 8873, 8874; Luzilândia, near by Itaipava, left bank of the Araguaia River: MPEG 10932; Luzilândia, Xinguara, left bank of the Araguaia River: MPEG 10933, 10939; Marabá, Serra Norte, Carajás, N1, Área de Ferro: MPEG 10943, 10944, 11843; Marabá, Serra dos Carajás, N2, Área de Manganês: MPEG 11832; Saúde, 170 km South of Tucuruí, left bank of the Tocantins River: MPEG 12175; Tucuruí, left bank of the Tocantins River: MPEG 12311, 12176, 22014-18; Altamira-Marabá Highway, km 18: MPEG 14966, 21442; Itaituba, Igarapé do Patoá, left tributary of the Aruri River: MPEG 21972; 54 km S and 150 km W from Altamira, Gleba 61, Lote 02: MPEG 20181. MATO GROSSO: Alta Floresta: MPEG 24590, 24591; Rondônia: Alvorada D'Oeste, BR-429, line 64, km 87: MPEG 19709-19713.

Callicebus vieirai: PARÁ: Upper Iriri-Xingu River: MPEG 246; Igarapé Mundo Novo, right bank of the middle Iriri River: MPEG 21836.