Extention of *Callicebus dubius* (Primates: Cebidae) distribution and evidence of geographic invasion of *Callicebus stephennashi* domain

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Abstract. *Callicebus* Thomas, 1903, one of the most diverse genera of Neotropical primates, is distributed in the tropical forests of the Amazon and Orinoco basins, the Atlantic forest of northeastern and southeastern Brazil, and the Chaco and dry forests of Paraguay and Bolivia. *Callicebus dubius* is described as a hybrid form and rearranged in the group of *C. cupreus* species. It occurs to the south of the Ituxi River, a right bank tributary of the Purus River. In this paper we report other occurrence sites of *C. dubius* in Mucuim-Ituxi interfluves, its possible invasion of the geographic domains of *C. stephennashi* on the north bank of the Mucuim River and an agonistic territorial interaction between two *C. dubius* individuals on an unpaved road.

KEY WORDS. Primates, geographic distribution extension, agonistic behavior, zogue-zogue, Amazônia, Madeira-Purus interfluvium, bridge crossing.

Resumo. **Extensão da distribuição de *Callicebus dubius* e evidência de invasão geográfica do domínio de *C. stephennashi*.** *Callicebus* Thomas, 1903, um dos mais diversos entre todos os gêneros de primatas Neotropicais, é distribuído em florestas tropicais das bacias do Amazonas e Orinoco, estendendo-se à Floresta Atlântica do Nordeste e Sudeste brasileiros, ao Chaco e florestas secas do Paraguai e Bolívia. Descrito como uma forma híbrida, sendo posteriormente realocado no grupo de espécies *C. cupreus, C. dubius* ocorre confirmadamente ao sul do Rio Ituxi, tributário da margem direita do Rio Purus. Reportamos novos registros de ocorrência de *C. dubius* no interflúvio Mucuim-Ituxi, sua possível invasão ao domínio geográfico de *C. stephennash*i e comportamento agonístico territorial entre dois indivíduos de *C. dubius* em uma estrada não pavimentada.
PALAVRAS CHAVE. Primatas, extensão de distribuição geográfica, comportamento agonístico, zogue-zogue, Amazônia, interflúvio Madeira-Purus, travessia de pontes.

Introduction

Titi monkeys of the genus *Callicebus* Thomas 1903 (Cebidae) are one of the most diverse Neotropical primate genera. The genus competes with *Saguinus* Hoffmannsegg 1807, which comprises 34 *taxa* (including a non-described one), for the largest number of *taxa* in the New World (van Roosmalen *et al.* 2002). *Callicebus* species are distributed in the tropical forests of the Amazon and Orinoco basins, in the Atlantic forest in northeastern and southeastern Brazil in the Chaco and in dry forests of Paraguay and Bolivia. Its southern limits are the Pilcomayo and Paraguay Rivers. They are small to medium in size, weigh between one and two kilograms and range between 270–450 mm in head-body length (Hershkovitz 1990). *Callicebus dubius* is described as a hybrid form (Hershkovitz 1988) and was rearranged by van Roosmalen *et al.* (2002) as a valid species of the *C. cupreus* species group. This species is distributed south of the Ituxi River (a right bank tributary of the Purus River), eastwards as far as the Madeira River, and westwards as far as the Purus River. The southern limit is still unknown, but in lowland Amazonia, *Callicebus* distribution is invariably limited to river barriers (van Roosmalen *et al*. 2002). Rowe and Martinez (2003) surveyed titi monkeys and found that their distribution in northern Bolivia is not consistent with the possible southern limit suggested by van Roosmalen *et al*. (2002) for C. *dubius*, but the distribution of *C. brunneus* corroborates that reported by Anderson (1997) and Hershkovitz (1990).

The range of *C. dubius* is uncertain. Hershkovitz (1990) assumed it to be the right (east) bank of the Purus River, opposed to Ayapuá Lake. Both *C. caligatus* and *C. cupreus* occur in this area (van Roosmalen *et al*. 2002). Some specimens of *C. dubius*, deposited in the British Museum, were obtained in nearby Humaitá, a town on the left bank of the

Madeira River. The holotype is an adult female (skin and skull), deposited in the Field Museum of Natural History, Chicago, number 38886, collected by Carl Lako in June 1931 (van Roosmalen *et al*. 2002).

Callicebus species have typical vocal signaling with frequent vocalizations emitted by individuals of different groups within their respective territories. These calls delimit their boundaries and update the territorial limits of conspecific groups (Robinson 1979, 1981, Kinzey and Becker 1983). The aggressive displays of *Callicebus* species during encounters are usually limited to calls associated to arch postures, piloerection and tail lashing (Moynihan 1966, Mason 1966). Chases are not common but may occur between animals of a same sex (Robinson 1979). Physical aggression between animals of adjacent groups is apparently rare, because the complex calling associated to displays such as jumping, long stiff-legged jumping down onto foliage and branch and leaf shaking are enough to indicate the location of neighboring groups. Territorial struggles in *Callicebus moloch* usually occur near the geographic boundaries of the groups, potentially unstable sites of overlapping territories (Robinson 1979).

Methods

The study site was located on the left bank of the Madeira River in the municipality of Canutama, state of Amazonas, Brazil. This is a transitional environment between grassland (‘Campinas’), ‘Campinaranas’, and ‘Terra-firme’ forest, with a high density of understory babaçu-palms (*Atallea speciosa*) and typical savanna (‘Cerrado’) and grassland (‘Campinas’) vegetation in open areas (M. Hopkins, pers. comm.). About 13 km of trail routes were used to survey the mammals for 15 days.

Rapid survey methods used for rapid studies on mammals (Fonseca 2001, Young *et al*. 2003) were applied, including linear transects, search for mammal evidence (tracks, scats/regurgitations, bones etc.) and interviews with local inhabitants. However, only *C. dubius* sighting or vocalization areas were used for mapping purposes. One voucher specimen (INPA 5671) of *C. dubius* was collected to guarantee species identification on the basis of external features (such as pelt color and pattern) according to Hershkovitz (1988, 1990) and van Roosmalen *et al*. (2002). The site coordinates were obtained with GPS Garmin, and the map was produced using ArcView GIS 3.2.

Results

Nine groups of *C. dubius* were recorded in April 2007, eight of which were within the Mucuim-Ituxi interfluvium. This expands the knowledge on the geographic distribution of this species (Fig. 1). The other group was recorded on the right bank of the Mucuim River (Table 1). *C. dubius* occupied areas of 'Campinarana' and 'terra-firme' open canopy forests covered by palms. The records of *C. dubius* obtained in the present study not only confirm its occurrence on the left bank of the Mucuim River, as hypothesized by van Roosmalen *et al.* (2002), but also suggests a possible territorial expansion over a human-made bridge that spans the Mucuim River. Therefore, it seems that a peripatric anthropogenic zone was created, in which *C. dubius* is partially occupying the same geographic distribution as *C. stephennashi*, the nearest species to the north.

An agonistic interaction was observed between two individuals, probably from distinct groups, who fought on an unpaved road that crosses the Mucuim River, in the hydrographic basin of the Purus River. The animals were on the north bank of the Mucuim River, close to the wooden bridge that crosses the river, which is known to be a barrier to

the geographic distribution of *C. dubius* and *C. stephennashi* (van Roosmalen *et al*. 2002). The two titi monkeys grabbed each other and exchanged bites for nearly one minute. After the confrontation, the monkeys moved to opposite sides of the bridge. They had apparently not detected the observers, but ran away as soon as they did. The sex of the monkeys was not determined. The event was observed, photographed, and reported by M. Hopkins and P. Assunção, botanical researchers from INPA, during the first Geoma Madeira-Purus Expedition.

Territorial vocal signals emitted by *C. dubius* in the morning were recorded almost daily in the sampled areas. Similarly to *C. cupreus* observed at Rio Juruá, groups of *C. dubius* start vocalizing as rain starts to fall, at any time of the day.

More than ten primate *taxa* were observed in the study area: *Saguinus fuscicollis weddelli, S. labiatus labiatus, Saimiri madeirae, Cebus albifrons, Cebus* cf. *macrocephalus, Aotus* cf. *nigriceps, Pithecia irrorata irrorata, Alouatta puruensis, Ateles chamek* and *Lagothrix cana*. According to interviews with local inhabitants, *Cebuella pygmaea niveiventris* is also present in the region, which contains at least twelve primate species.

Discussion

As suggested by van Roosmalen *et al*. (2002) and confirmed in this study, *C. dubius* occurs on the south bank of the Mucuim River. *C. stephennashi* is restricted to the area between the north bank of the Mucuim River and the south bank of the Ipixuna River, the same site in which the agonistic interaction between *C. dubius* individuals was recorded. The geographic invasion of *C. dubius* is likely a consequence of anthropogenic influence, since it was achieved using the bridge, a man-made construction.

Bridge crossing might be a more common event than expected since other primate species also exhibit this behavior. On November 2008 a group of more than ten individuals of the Callitrichidae *Mico intermedius* was seen and three of them photographed crossing a small bridge (figure 2), within its known/expected range, of an unpaved road over the Água Branca River (exact location S 09^{o} 09' 41.4" and W 060^{o} 28' 03.7", road called MT-206 that connect Colniza – Mato Grosso State and Machadinho D`oeste, Rondonia State), a small tributary of the Guariba River in northern Mato Grosso (I. Theobald, pers. comm.). Bridges upon rivers Mucuim and Água Branca do not exceed 30 and 15 meters in length, respectively, and it remains uninvestigated the contribution of such structures on the evolutionary processes of congeners hose ranges were once fenced by small rivers.

Despite a possible recent colonization, there are no records of hybrids in the area invaded by *C. dubius*, although it is a distinct possibility. If this process is in fact occurring, it will unfortunately confirm human interference in Amazonian biogeographic processes, breaking natural patterns and influencing the evolutionary trajectory of primates from this biome. Local inhabitants have built bridges, linking interfluves along small Amazon streams, and many *taxa* are now prone to move to new geographic locations. This is a consequence of the pressure imposed by the recent colonization/invasion of congeners, which may generate hybrid forms in the anthropogenic environments, thus modifying the original biodiversity.

Investigations in a molecular approach and on the future geographical distribution of *C. dubius* are needed to determine whether it is in fact expanding its territory and populating an invaded area and to understand the evolutionary consequences of this process.

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Table 1 – New records of *Callicebus dubius* on the left bank of the Mucuim River (2-8). Record 1 shows the *Callicebus dubius* invasion on the right bank of the Mucuim River, which is a domain of *C. stephennashi*.

Localities	Coordinates
1. Mucuim River (2 individuals)	S -8° 42`02.4`` W -64° 13`24.2``
2. 'Campina' (2 individuals) INPA 5671	S -8° 39`10.5`` W -64° 21`31.3``
3. 'Campina' (3 individuals)	S -8° 39`12.9`` W -64° 21`28.0``
4. 'Trilha norte' group 1 (3 individuals)	S -8° 39`10.0`` W -64° 22`03.7``
5. 'Trilha norte' group 2 (vocal record)	S -8° 38`40.3`` W -64° 22`04.4``
6. 'Curral' (2 groups vocalizing)	S -8° 38`54.3`` W -64° 20`14.0``
7. 'Trilha sul' 1(4 individuals)	S -8° 40`34.9`` W -64° 21`52.2``
8. 'Trilha sul' 2 (vocal record)	S -8° 39`26.9`` W -64° 19`21.7``

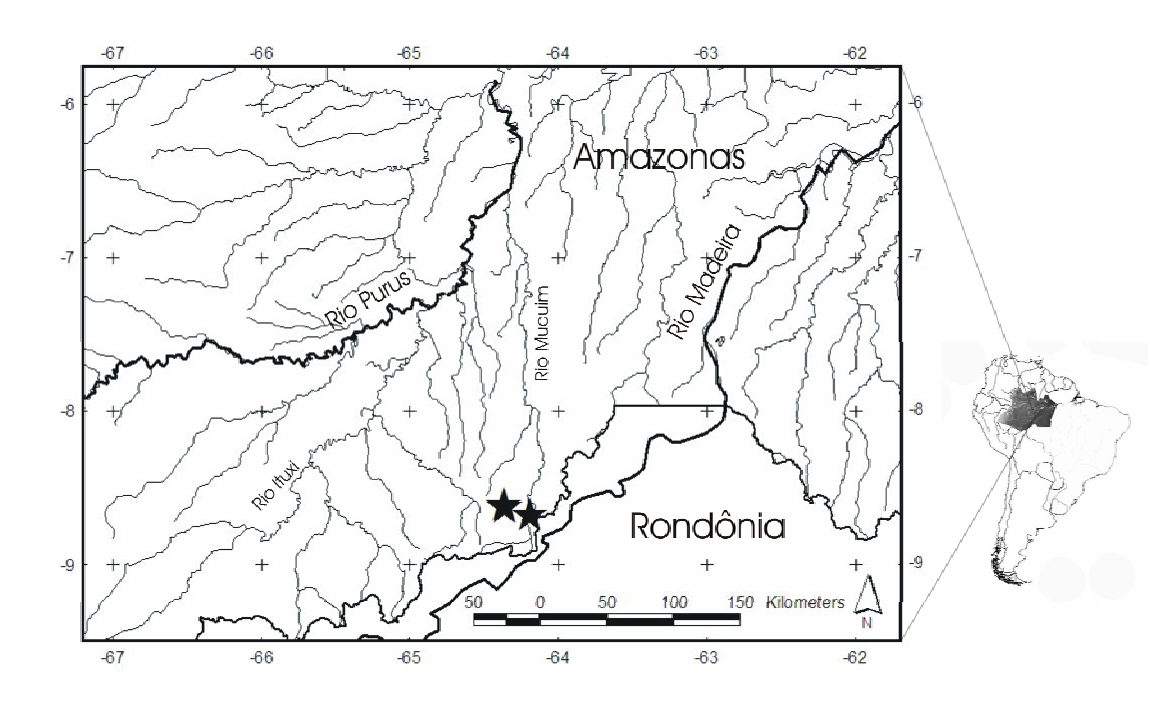

Figure 1 – Sites of new records of *C. dubius* on the left bank of the Mucuim River. The left star represents sites 2 to 8 and the right star represents site 1.

Figure 2 – Three individuals of *Mico intermedius* crossing a bridge over the Água Branca River. Two individuals are walking over the bridge and the third one is sited on the burned log right beside the river (photo Izac Theobald).

The bridge upon Mucuim River is very similar but longer.