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CENSUS OF THE BLOND TITI MONKEY *CALLICEBUS BARBARABROWNAE* (PITHECIIDAE) IN THE SEMI-DECIDUOUS ATLANTIC FOREST OF CHAPADA DIAMANTINA, BRAZIL

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Abstract

In Brazil, the destruction of the Atlantic forest and the Caatinga dry forest continues to the present, having a profound effect on the non-human primates. Here we present data on abundance of the critically endangered *Callicebus barbarabrownae* (Pitheciidae), the only primate endemic to the Caatinga, and evaluate if human presence impacts their distribution. We conducted over 152 km of line transect surveys, mostly in semi-deciduous forest near the Chapada Diamantina National Park, NE Brazil. The blond titi monkey occurred at an extremely low abundance, even when considering calls their abundance was lower than that reported for closely related species in different Atlantic forest areas surveyed previously. Although hunting pressure is high in the area, the reasons for their lower abundance are yet unclear. The presence of taller and relatively undisturbed forest seemed key factors for the presence of the species even in areas with heavy human presence. We speculate that they could prefer wetter habitats and gallery forests. Our results are the first record of blond titi monkey in protected area. The long term survival of this critically endangered species may depend on increasing the number of conservation units and stimulating conservation awareness in the local human population.

Keywords: Atlantic Forest; blond titi monkey; conservation; disturbed forest; hunting.

Resumen

En Brasil, la destrucción del bosque Atlántico y el bosque seco de Caatinga continua actualmente, ejerciendo un profundo efecto sobre los primates no humanos. Presentamos datos de abundancia del críticamente amenazado *Callicebus barbarabrownae* (Pitheciidae), el único primate endémico de la Caatinga, y evaluamos si la presencia humana impacta su distribución. Llevamos a cabo 152 km de evaluaciones por transectos lineares, principalmente en bosque semideciduo cerca del Parque Nacional Chapada Diamantina, al nororiente de Brasil. La abundancia del mono titi rubio es extremadamente baja, aun cuando se consideraron las vocalizaciones su abundancia fue más baja que la reportada para especies cercanamente relacionadas en diferentes áreas del bosque Atlántico evaluadas previamente. Aunque la presión de caza es alta en el área, las razones para de su baja abundancia no son claras aún. La presencia de bosque más alto y relativamente no perturbado parecen ser factores clave para la presencia de la especie aún en áreas con alta presencia humana. Especulamos que la especie podría preferir habitats más húmedos y bosques de galería. Nuestros resultados son el primer registro del mono titi rubio en un área protegida. La sobrevivencia a largo plazo de esta especie críticamente amenazada puede depender de incrementar el número de unidades de conservación y de estimular en la población humana local conciencia por su conservación.

Palabras clave: Bosque Atlántico; mono titi rubio; conservación; bosque intervenido; cacería.

Introduction

Habitat loss, fragmentation and hunting are the main factors accounting for the loss of biodiversity in tropical forests (Wright, 2005; Harrison, 2011). In Brazil, the Atlantic forest and the dry forest of the Caatinga have endured the havoc wrought by forest conversion since the XVI century (Dean, 1995; Coimbra-Filho and Câmara, 1996), which has had a profound effect on the non-human primates. The Atlantic forest has 19 endemic primates and many are threatened. Research and conservation efforts have helped to create conditions for their long term survival (e.g. Kierulff et al., 2012). The only endemic primate to the Caatinga dry forest is the blond titi monkey (*Callicebus barbarabrownae*), but little is known about this species and prospects for its long-term conservation are not good (Printes et al., 2011). Hershkovitz (1990), who described the species, considered it to be a subspecies of *Callicebus personatus*, but later taxonomic reviews suggested it should be a valid species (Kobayashi and Langguth, 1999; van Roosmalen et al., 2002).

The blond titi monkey (*Callicebus barbarabrownae)* is critically endangered according to the IUCN red list. The species' range is primarily the Caatinga dry forest (deciduous forest) of Northeast Brazil, and it is evidently restricted to the state of Bahia (Marinho-Filho and Veríssimo, 1997; Printes et al., 2011) although there are anecdotal reports of its occurrence in Sergipe state (Freitas et al., 2011). Present-day populations of blond titi monkeys seem to be restricted to forest fragments and, despite their cryptic and shy habits (Dacier et al., 2011), they are hunted (Souza et al., 2008; Printes et al., 2011). Hunting is a driver of extinction in fragmented landscapes (Chiarello, 1999; Chapman and Peres, 2001; Michalski and Peres, 2005; Harrison, 2011). Non-human primates have been observed to change their behavior to avoid hunters, being more cryptic, fleeing in silence or avoiding areas used by humans (Bshary, 2001). Marinho-Filho and Veríssimo (1997) report blond titi monkeys fleeing when there were people in proximity and avoiding areas where human presence was frequent. Although local or complete extinction is a constant threat, titi monkeys can survive in fragmented landscapes and in habitats with relatively high levels of disturbance (Heiduck, 2002; Michalski and Peres, 2005; Chagas and Ferrari, 2010). Their folivory (Heiduck, 1997; Palacios, 1997; Price and Piedade, 2001) and small home ranges are probably important factors for their survival in small degraded forest fragments.

Printes et al. (2011) surveyed various areas (over 353,000 km^2) in Northeast Brazil and estimated the population of blond titi monkeys to be less than 260 individuals, based on records of 65 groups. They raised concern about the long-term survival of blond titi monkeys because of their small and isolated subpopulations restricted to small forest fragments. Although Printes et al. (2011) did not record groups of blond titi monkeys in protected areas, they found evidence of their presence in fragments of semi-deciduous Atlantic Forest (highland coastal forest) on the eastern border of Chapada Diamantina. The Chapada Diamantina, of more than 60,000 km^2, is an important biogeographic sub-region (Tabarelli et al., 2010a). However, there are just seven conservation units which protect about 6% of the total area of the region (Pereira 2010). Semi-deciduous forests cover most of the eastern border of the Chapada Diamantina and are the largest forested areas in the region, although suffering disturbance due to forest cutting and logging (Funch et al., 2008). The Marimbus-Iraquara Environmental Protection area is an important conservation unit (about 125,400 ha) protecting these forests. Although this area is important for the long-term conservation of blond titi monkeys, there is no data on their abundance and their habitat preferences. Printes et al. (2011) elicited a response to playback calls from a group of *C. barbarabrownae* in a nearby area, but they were unable to estimate the number of groups. The aim of this study was to obtain data on the abundance of the blond titi monkey in the Chapada Diamantina and to evaluate if human presence affecting their occurrence there.

Methods

The study was carried out in the southern part of the Marimbus-Iraquara Environmental Protection area, Bahia state, NE Brazil (Fig 1), in the forest of the farms Marimbús and Bonito. The presence of human settlements is allowed (IUCN Category V) in this area. Annual rainfall is around 1,300 mm (Funch et al., 2002).

Surveys were carried out along eight trails (Fig. 1 and Table 1). Four (Grotão, Ntrail, W2 and Remanso farm) were cut exclusively for the censuses. One trail (Lençóis River) followed the gallery forest up the Lençóis River; the beginning of the trail was about 2 km from the town of Lençóis. Near to the river, there were some occasions when the water level was high due to heavy rains and only part of the trail could be surveyed. Only seven surveys were carried out as a consequence. The Grotão trail was cut in the evergreen forest found in ravines where moisture is high. Only a few censuses were carried out along this trail because access difficult and dangerous (along 2 km along a road), the path to the ravine was slippery, and we were informed that it was a breeding ground of *Bothrops* a venomous Brazilian pit viper.

We followed the standard procedures for the line transect census (Peres, 1999; Buckland et al., 2001). Censuses were carried out in the morning (from 06:00 h) and in the afternoon (from 14:00 h); the walking speed was about 1 km/h. Two observers (Moura and Corsini) surveyed the trails (Table I, Fig. 1) from June 2008 to May 2010. The total distance walked was 152.56 km. Our sampling effort was significantly higher (one sample *t* test, t= 2.27; df= 9; p = 0.49) compared to surveys of other closely related species of titis in the Atlantic forest (full list in Corsini 2010).

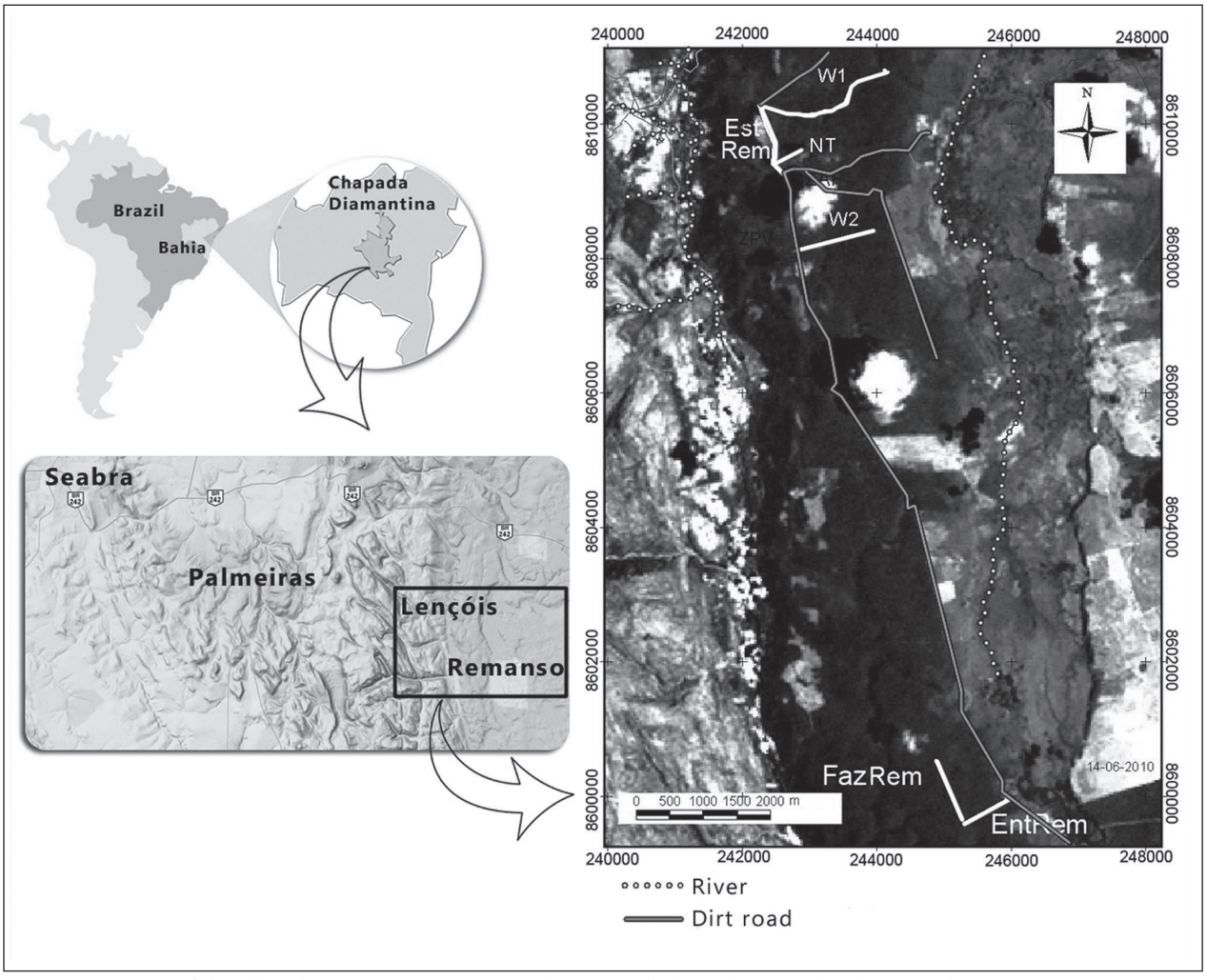

Figure 1. Location of the Chapada Diamantina region in Bahia state and the trails surveyed in the Marimbus-Iraquara protection area. Note that most of the forest near the São Jose River on the eastern side, have already been converted.

Table 1. Details of the trails surveyed and type of vegetation.

Transect	Length (km)	Vegetation type	Level human presence
Lençóis River	4	Gallery forest	Low
Grotão	0.5	Evergreen forest	Low
W1	2.05	Semi-deciduous forest (trail used by local population)	High
N trail	0.5	Semi-deciduous forest	Low
W2	1.25	Semi-deciduous forest	Low
Remanso road (Est Rem)	1.12	Semi-deciduous forest (edge forest bordering the dirt road)	High
Entrance of Remanso (Ent Rem)	0.8	Semi-deciduous forest (edge forest)	High
Remanso Farm (Faz Rem)	1.12	Semi-deciduous forest	Low

C. Corsini did about 35% of the censuses. When surveying the trail she was accompanied by a guide that followed her at a distance of about 10 m and in silence. We did not do censuses on the return walk.

We classified the trails according to the frequency of human presence and use as a shortcut by locals: a) trails with low human presence - less than four people encountered during all the census and no observable use of the trail; b) heavy human presence - encounters with humans occurred four or more times over the study and the trail was being used as shortcut. We also recorded encounters with hunters/dogs, signs of recent logging, and observed logging. We recorded group calls, which is a more effective method of detection given the cryptic and shy habits of titi monkeys in general (e.g. Aldrich et al., 2008; Dacier et al., 2011). We used sighting rates (groups/10 km walked) and calling rates (groups calling/ 10 km walked) to estimate titi monkeys abundance.

Results

Blond titi monkeys were scarce: 0.19 groups/10 km walked. We observed groups just three times (Table II). Average group size was 3.3 individuals (range = 3-4) and group spread was visually estimated at 10 m. All individuals were seen at a height of above 10 m. On 27th September 2008 an infant was observed on the back of an adult. During the censuses we encountered hunters (with guns) on eight occasions and by chance A.C.A. Moura saw a hunter carrying a dead titi monkey near Lençóis.

The number of groups registered calling (n=13, abundance of 0.85 groups/10 km, Table II) was higher than those seen. Groups were heard more often in areas where human presence was low; 1.18 groups heard/10 km walked (values based on km walked on the trails W2, Grotão, Ntrail, Lençóis River and Remanso Farm). Blond titi monkeys apparently were sensitive to human presence and activities along the trails, and abundance was low (0.68 groups heard/10 km) (W1, Remanso road and entrance Remanso). We heard and saw blond titi monkeys only in the morning; all calls were heard between 06:30 h and 10:00 h.

Discussion

The estimated abundance of blond titi monkeys in the Chapada Diamantina is lower than those of closely related species from other sites in the Atlantic forest (Corsini, 2010). Our results indicate that group calls are a more effective way to detect titi monkeys than visual encounters (see Dacier et al., 2011). However, even when using calling rate the abundance is still low. Chiarello (1999) reports an abundance of 1.66 groups/10 km in the closely related *Callicebus personatus* in a larger fragment (> 20,000 ha) of Atlantic forest which is heavily hunted. Although locals hunt monkeys and other mammals intensively throughout the area we studied, the reasons for the lower abundance of titi monkeys in our site in relation to others are yet unclear. Some studies indicate that hunting pressure and habitat loss probably lead to low densities and declines of blond titi monkeys populations throughout their range (e.g. de Freitas et al., 2011; Printes et al., 2011), but in these studies groups were found in small forest fragments.

The blond titi monkeys showed a preference for the more structured and taller forest that occurs in areas with a higher availability of water in the soil. For example, along W1 trail the forest became taller (>15 m) after the first 0.7 km, and titi monkeys were heard only after this point. We also noticed the same pattern in W2 trail and in the Remanso Farm trail, the calls of the two groups heard come from an area with more water availability. Interestingly, a group of titi monkeys was observed and heard a couple of times in the trail with the highest disturbance level (logging, vehicles and people activity), but they were found only in the area with a taller and more humid forest. These results indicate that forest condition could be a more important factor for determining titi monkey distribution than avoidance or fear of humans. The closely related *Callicebus coimbrai* and *Callicebus melanochir* prefer undisturbed forest (Heiduck, 2002; Chagas and Ferrari, 2010), which usually have higher tree diversity and probably more resources (Tabarelli et al., 2010b). It is possible that titi monkeys have a preference for habitats along rivers, where forest could be taller, with more tree species and with a more complex structure. Ferrari et al. (2007) observed that *Callicebus moloch* in Amazonia forest was absent in three sites of terra firma forest in the Tocantins-Xingu interfluvium, but they were common in sites along the Tocantins River. The authors suggested that *Callicebus moloch* may prefer riparian habitats.

We did not record blond titi monkeys along the gallery forest of Lençóis river. This was probably due to heavy hunting and low sampling effort. However, during a brief survey (about 10 km walked) in the Toalhas area about 30 km north from our main study site, the locals reported blond titi monkeys as extremely common, and larger areas of gallery forest are common there. Although Toalhas is situated in the Chapada Diamantina National Park, there are illegal human settlements in the area. When talking with locals elsewhere, we were informed that titi monkeys were common in forests along rivers and in wetter areas. The gallery forest has the highest diversity of trees among the different forests occurring in the Chapada Diamantina (Funch et al., 2008). It is possible that a high availability of resources in these areas could have a positive effect on the abundance of blond titi monkeys. Although speculative, the hypothesis that blond titi monkeys would prefer wetter

Table 2. Groups of blond titi monkeys sighted and heard during the census. Trails with two groups heard, the groups were heard at the same time, in the W1 trail this happened just once and both groups were included in analyses.

Trail	# Groups sighted	# Groups heard	Sampling effort (km)
Lençóis River			13.8
Grotão		2	1
W1		5	61.9
Ntrail		1	2.5
W2		1	21.75
Remanso road (Est Rem)	3	2	28.8
Entrance Remanso (Ent Rem)			11.2
Remanso farm (Faz Rem)		2	11.61

areas with taller and more diverse forest deserver further investigation.

Hunting, habitat fragmentation and human disturbance, such as fires and logging, increase extinction risk for the blond titi monkey (Harrison, 2011; Printes et al., 2011). We surveyed a relatively large forest (about 3,850 ha), but it is criss-crossed by hunter trails and dirt roads, and the removal of timber is frequent. The long-term survival of the species may depend on increasing the number and the area of conservation units as suggested by Printes et al. (2011) and notably on increasing conservation awareness in the local human populations. Although the abundance we observed in the Marimbus-Iraquara Protection area was low, this area should be considered as priority for conservation measures because it has larger forested areas and with an effective protection this area could be a long term survival guarantee for blond titi monkeys.

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