

## PRE-CAPTURE MONITORING FOR A PLANNED TRANSLOCATION OF A NORTHERN MURIQUI (*BRACHYTELES HYPOXANTHUS*) FEMALE FROM A FOREST FRAGMENT SURROUNDING CAPARAÓ NATIONAL PARK, BRAZIL

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### Abstract

Conservation translocation may play an important and necessary role in primate conservation as several species are facing an impending extinction risk and population decline. However, translocations are a high-cost endeavor. Therefore, pre-capturing monitoring can be an essential component in the success of primate translocation. In this study, we report the first confirmed sighting of a female Northern Muriqui (*Brachyteles hypoxanthus*) stranded alone in a small fragment of Brazilian Atlantic Forest, and her pre-capture monitoring for a future planned translocation. Monitoring was realized from June 2018 to July 2019, and included data collection through direct observational and arboreal camera trap methods, and non-invasive collection of faecal samples for additional genetic studies. Our results showed that the female used the total area of the 1-ha forest fragment with an average daily displacement of  $59.6 \text{ m} \pm 76.2$ . The female spent most of the time 'Resting', followed by 'Travelling' and 'Feeding', which did not vary significantly between seasons. Intraspecific activity pattern variations may be related to the amount and quality of the feeding resources available in the forest fragments. No stereotyped behavior or advertising signals were reported during the monitoring. Our study provides insights on solitary primates living in marginal habitats and highlight the importance of pre-capture monitoring to provide important information on the general behavior of the target individuals, on the regular movements and overall home ranges, and to help to guide future translocations.

**Keywords:** Dispersal, management, conservation.

### Resumo

Translocação para conservação pode desempenhar um papel importante e necessário na conservação de primatas, uma vez que muitas espécies estão enfrentando um risco iminente de extinção e declínio populacional. No entanto, as translocações são um empreendimento de alto custo. Portanto, o monitoramento de pré-captura pode ser um componente essencial para o sucesso da translocação de primatas. Neste estudo, relatamos o primeiro registro confirmado de uma fêmea de muriqui-do-norte (*Brachyteles hypoxanthus*) vivendo sozinha em um pequeno fragmento florestal na Mata Atlântica brasileira, e seu monitoramento pré-captura para uma futura translocação planejada. O monitoramento foi realizado de junho de 2018 a julho de 2019 e incluiu coleta de dados por meio de métodos observacionais diretos e armadilhas fotográficas arbóreas, e coleta não invasiva de amostras fecais para estudos genéticos adicionais. Nossos resultados mostraram que a fêmea utilizou a área total do fragmento florestal de 1-ha com um deslocamento médio diário de  $59.6 \text{ m} \pm 76.2$ . A fêmea passou a maior parte do tempo 'Descansando', seguida por 'Descolando' e 'Alimentando', os quais não variaram significativamente entre as estações. Variações no padrão de atividade intraespecífica podem estar relacionadas à quantidade e qualidade dos recursos alimentares disponíveis nos fragmentos florestais. Nenhum comportamento estereotipado ou sinais de alerta foram relatados durante o monitoramento. Nosso estudo fornece insights sobre primatas solitários vivendo em habitats marginais e destaca a importância do monitoramento pré-captura para fornecer informações importantes sobre o comportamento geral dos indivíduos-alvo, sobre os movimentos regulares e áreas de vida gerais, e para ajudar a orientar futuras translocações.

**Palavras-chave:** Dispersão, manejo, conservação.

## Introduction

The northern miqui (*Brachyteles hypoxanthus* Wied, 1820) is endemic to the Atlantic Forest Biome of Brazil. Long-term deforestation has resulted in the fragmentation of ~88% of this biome (Ribeiro *et al.*, 2009), leading northern miquis (henceforth 'miquis') to live in small and isolated forest remnants. With less than 1,000 individuals distributed in 15 isolated remnant populations (Strier *et al.*, 2017), management actions are crucial. Most remaining populations are very small and below the minimum viable population size (Strier *et al.*, 2017), thus probably not viable in the long term, or only viable with population management such as the reintroduction or translocation of individuals (Mendes *et al.*, 2005; Jerusalinsky *et al.*, 2011). Miquis have large body size, slow life history, and delayed weaning age (Strier, 1999). Further, miquis live in social groups characterized by male philopatry and female dispersal from their natal group at puberty (Printes and Strier, 1999; Strier and Ziegler, 2000). Due to fragmentation, miqui females sometimes remain solitary for extended periods of time in isolated and small forest patches (Tabacow *et al.*, 2009; Oliveira *et al.* 2007; Pereira *et al.* 2013), and may remain solitary even in fragments that include groups of miquis (Mendes *et al.*, 2005). Translocation of isolated females is a crucial management action for the conservation of this critically endangered species (Mendes and Chiarello, 1993; Mendes *et al.*, 2007; Oliveira *et al.*, 2007; Barros *et al.*, 2011; Jerusalinsky *et al.*, 2011).

Translocation is characterized by capturing wild animals from one site within the species range and moving them into a new site, and a successful translocation will depend on several factors, including trained personnel and knowledge of the animals (Strum and Southwick, 1986). Thus, prior assessment and monitoring of the individuals to be translocated are essential to increase success and reduce the uncertainties and multiple risks inherent in the translocation process (Mendes and Chiarello, 1993; Strier, 1993; Beck, 2016). Monitoring the activity budget is important to verify if the individual exhibits typical species behaviors (Fortes and Bicca-Marques, 2005).

Here we report the first confirmed sighting of a female northern miqui in a forest fragment surrounding Caparaó National Park (PNC), southeastern Brazil, and subsequent behavioral ecology observations of that individual, as pre-translocation monitoring. The study is in line with Brazil's National Action Plan for miqui conservation (Jerusalinsky *et al.*, 2011), that requires careful monitoring of individuals or populations to be managed.

## Methods

Nearly 300 miquis, representing approximately one third of all living individuals, are distributed in seven known social groups in the Caparaó National Park

(Kaizer *et al.*, 2016, 2017), a federal conservation unit of 31,853-ha located on the border of the states of Minas Gerais and Espírito Santo. On the 3rd of May, 2018, a solitary adult female northern miqui was encountered during a routine survey conducted by the park managers in a small and isolated forest fragment surrounding the Caparaó National Park (W.P. Lopes, pers. comm.). With only about 1-ha of secondary forest (20°33'21.0"S, 41°48'04.0"W), at 1,169 m altitude, the fragment is 1 km from the border of the PNC and ~1 km away from the urban center of Pedra Menina village, municipality of Dores do Rio Pedro, State of Espírito Santo (Fig. 1A). Average annual rainfall ranges from 1,000-1,500 mm and the annual average temperature is between 16-22°C (ICMBio, 2015). Rainy season is from October to March and dry season from April to September (Massini, 2017). The forest fragment is isolated and separated from the PNC by coffee and eucalyptus plantations, grasslands, and local roads. The nearest miqui groups inhabiting the PNC are in the valleys of Fação de Pedra and Rio Preto, respectively 3-4 km and 7-8 km away (Kaizer *et al.*, 2017).

According to the landowner, the solitary female, known as Bonita, has been stranded in this forest fragment for at least 12 years. Based on this information and our own assessment of the female's appearance, we estimate that Bonita was an adult of 18 years of age at the beginning of the study (Fig. 2A-B). Monitoring was conducted from June 2018 to July 2019, including the collection of both observational and arboreal camera trap data. We also collected fecal samples as part of a larger study on conservation genetics of miquis to better inform management and decision-makers (see Kaizer, 2019).

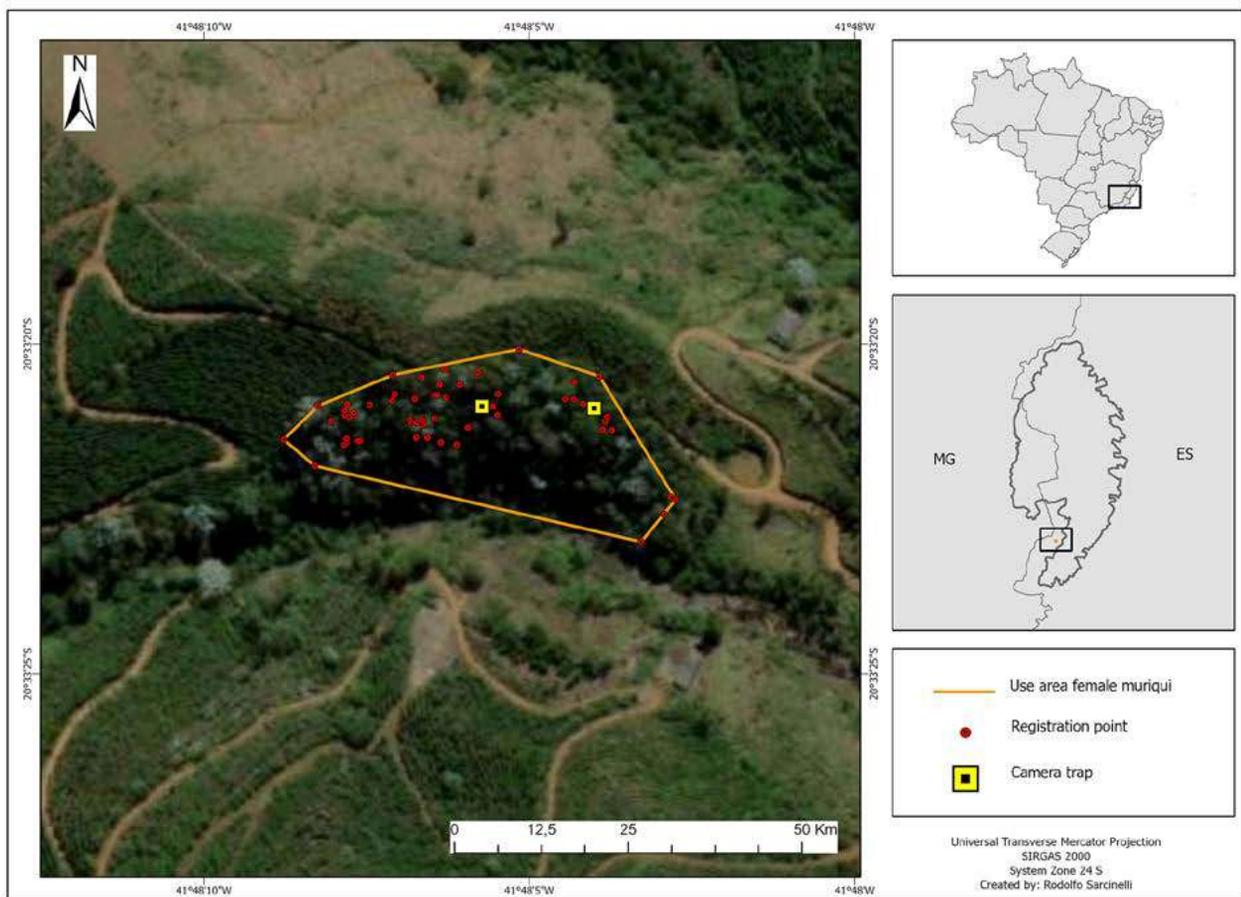
Direct systematic observation was conducted twice a week with GPS device during nine months, from July 2018 to March 2019. Habitat use was estimated based on animal location collected with a GPS device (Garmin GPSmap76 – maximum precision of 8 m) every 30 min interval. Behavioral and activity pattern data were obtained during focal animal follows (Altmann, 1974), which included systematic recording of animal activity during on-the-minute instantaneous samples of 10 min duration. A minimum interval of 10 min separated sampling bouts. Data collection was between 7 a.m. and 5 p.m. with the same sampling effort throughout days and months, and it was only paused or ended when the animal was not visible or not found. The activities scored were based on previous studies on northern miquis (Strier *et al.* 1987): traveling, feeding, resting, which was divided in long rest (e. g. animal sitting or lying down) and short rest (e. g. animal standing or suspended), and other (e. g. drinking water, self-grooming). Only focal sessions of > 8 min of observations were included in the analyses (Strier *et al.*, 2002), with a total of 48 hr 19 m of systematic observation ( $N=24$  focal days). To control for differences in observation time across hours of the day

and season, we calculated the means of the proportion of time engaged in each activity across hours of observation for each month of sampling (Strier, 1987). Additionally, two infrared camera traps (Bushnell trophy Cam; #119774C) were deployed from June 2018 through July 2019 to monitor the presence of the female in the forest fragment, totaling 178 trap-days. Camera traps were placed at two systematic locations in the forest canopy (Fig. 1B), targeting a feasible pathway where the monkey could move in the canopy (Kaizer, 2019; Kaizer *et al.* 2021), at a mean height of 15 m from the ground. Cameras were programmed to take two pictures followed by a 30-sec video every trigger event, set to high sensitivity, and active 24 hr/day. Camera trap photographs were analyzed in the WILD.ID software v0.9.28 (TEAM Network, [www.wildlifeinsights.org/team-network](http://www.wildlifeinsights.org/team-network)), and EXIF and metadata (e. g. date, hour) were automatically extracted

and exported to a *csv* format. Camera trap videos were analyzed manually in the Windows Media Player to extract behavioral data from video footage. Statistical analyses were performed in Minitab 17.1.

## Results and Discussion

According to the observational data, the total area used by the solitary female was 1-ha as estimated by the MPC method (Fig. 1B), with an average day-range length of the female of  $59.6 \text{ m} \pm 76.2$  (ranging from 15-244 m). This result was expected considering the small size of the fragment and the suitable habitat available. The use of the entire forest fragment by the individual was also found for another solitary female muriqui living in a 3-ha forest remnant in Simonésia, Minas Gerais (Pereira *et al.*, 2013).



**Figure 1.** A: Location map of study area; B: Area used by the solitary female by Minimum Convex Polygon.

The solitary female spent most of the time: ‘Resting’ (Long Rest: 46.6%; Short Rest: 22.9%) followed by ‘Travelling’ (19.32%), and ‘Feeding’ (11.11%) (Table 1). The daylight activity budget did not differ significantly across dry and rainy seasons (Kruskall Wallis one-way analysis of variance,  $H = 0.57$ ,  $df = 1$ ,  $p = 0.45$ ).

The large amount of time spent resting conforms to the activity pattern described for *Brachyteles* species (Strier, 1987; Milton, 1984). However, if we combine

the categories of ‘long rest’ and ‘short rest’ into a single category of ‘resting’, the proportion of time devoted to this activity is much higher than that found by Strier (1987) for a group of 26 muriquis at a semideciduous forest of 800-ha. The proportion of time spent on traveling and feeding activities also differed from other studies (Table 2). Less time spent feeding than traveling was similar to the pattern spent by three muriquis that inhabited a 42-ha at Rio Casca-MG (now extirpated population; Melo *et al.*, 2005), but differs from the

pattern found for a solitary female that resided in a 3-ha forest in Simonésia-MG, that spent more time feeding than traveling (Pereira *et al.*, 2013). The less time spent feeding may be related to the amount and quality of the feeding resources available in the small fragment, and should be investigated further in future studies. No stereotyped behavior or advertising signals (e.g. alarm calls, displays) was observed during the monitoring.

**Table 1.** Monthly and overall activity budget for a solitary northern murreti female.

Month	Season	Long Rest	Short Rest	Travel	Feed	Other
Jul	Dry	43.9	13.6	19.7	22.7	0.0
Aug	Dry	61.5	12.8	16.7	9.0	0.0
Sep	Dry	32.2	29.9	19.5	18.4	0.0
Oct	Rain	17.5	32.5	37.5	12.5	0.0
Nov	Rain	0.0	47.9	35.4	16.7	0.0
Dec	Rain	59.6	19.3	19.3	1.8	0.0
Jan	Rain	40.1	29.9	15.8	14.1	0.0
Feb	Rain	87.5	7.7	4.8	0.0	0.0
Mar	Rain	76.9	13.0	5.2	4.9	0.0
Overall (Mean ± SE)		46.6 ± 9.3	22.9 ± 4.3	19.3 ± 3.7	11.11 ± 2.6	0.0

We obtained a total of 50 photographs and 25 videos of the solitary female through arboreal camera trapping. All pictures and videos were recorded between 05:40hr and 17:10hr, with peaks of activity inferred from the hourly numbers of camera trap data recorded around 07:00 and 16:00, when 10 and 14 events were obtained respectively (Fig. 3). Most of the records (92%) were obtained from only one of the cameras (Cam 1, Fig. 1B), thus indicating the preferred route by the solitary female. Key behaviors observed in the camera trap videos were the female travelling (80%), feeding/foraging (16%) and short resting (4%).

**Table 2.** Variation in activity pattern of *Brachyteles hypoxanthus*.

Study	Site	Area Size (ha)	Group size	Rest (%)	Travel (%)	Feed (%)
Strier (1987)	RPPN-FMA	800-ha	26 ind.	49.3	29.4	18.8
Melo <i>et al.</i> (2005)	Fazenda Esmeralda	42-ha	3 ind.	60	23	17
Pereira <i>et al.</i> (2013)	Private Fragment	3-ha	1 female	56.6	13.8	27.4
<i>This study</i>	Private Fragment	1-ha	1 female	69.5	19.3	11.1

The behavioral ecology of primates living in marginal habitats and in social isolation is poorly understood (Wich and Marshal, 2016). The findings presented here reveal the importance of monitoring to increase our understanding of solitary females murreti living in such conditions and serve for comparison to evaluate future translocation follow-up monitoring. Further, our findings emphasize the importance of pre-capture monitoring to help to guide evidence-based decision-making and to increase success in translocation procedures.

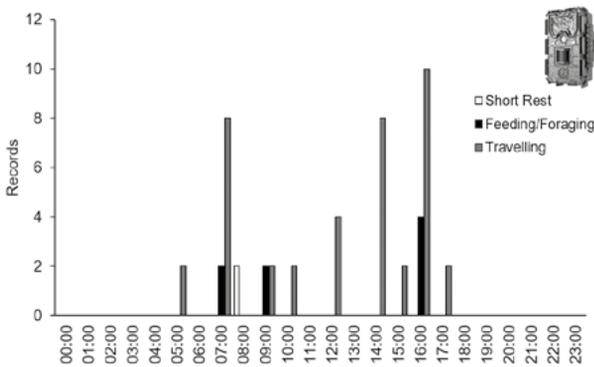
As part of the ongoing effort to manage this female, genetic studies confirmed that the solitary female shares haplotype with two different groups from the murreti population at PNC, one group located in the west side of Park approximately 8.2-km apart from the forest fragment, and another group in the east side of the Park apart 12-km (Kaizer, 2019). From the 26 haplotypes found for the entire murreti population studied by Kaizer (2019), this haplotype is unique to the northern murreti population inhabiting the Caparaó region (for more details, see Table 1 and S1 Table in Chapter IV File in Kaizer, 2019). Thus, the protection and management of this solitary female is of high importance to conservation genetics of the northern murreti (Kaizer, 2019).

Following the protocols from the Brazil's National Action Plan for murreti conservation, murreti experts decided to move the solitary female as an attempt to save and restore the murreti population in the region of Ibitipoca, in the state of Minas Gerais, approximately 250 km from the Caparaó National Park. Early November 2020, the first attempt to capture the murreti Bonita was conducted, but it was unsuccessful because the female moved to an adjacent forest that is linked to the Caparaó National Park. The area where the female was observed remains under monitoring, and at the date of this publication there is no second capture campaign planned yet due to restrictions of COVID-19.

The occurrence of a solitary female murreti in a fragment near the PNC reveals that even in a large protected area with several murreti groups, females murreti might find barriers to dispersal.



**Figure 2.** A: Solitary female of northern miqui registered by arboreal camera trap; B: Female's genitalia showing adult age (Photo: Madson Alves).



**Figure 3.** Activity pattern inferred from arboreal camera trap for a solitary miqui female from June 2018 to July 2019.

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