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- 1991; Pinto *et al.*, 1993; Hirsch, 1995; Strier and Fonseca, 1996/1997). For example, density estimates for northern muriquis (*Brachyteles arachnoides hypoxanthus*) and brown howler monkeys (*Alouatta fusca*) are much greater in the 890 ha forest at the Estação Biológica de Caratinga (EBC), in Minas Gerais, than in the nearby, 36,114 ha Parque Estadual de Rio Doce (Hirsch, 1995).

High densities, along with high dietary and habitat overlap among species, are also likely to lead to high frequencies of interspecific encounters, and possibly correspondingly high levels of direct or indirect interspecific competition (Waser, 1987). However, very little is known about how high levels of interspecific competition might affect populations of endangered species (Strier *et al.*, 2000).

In a preliminary investigation, we collected data on the contexts and outcomes of all agonistic interactions observed between northern muriquis, now classified as one of the world's 25 most endangered primates (Conservation International, 2000), and other animals at the EBC. In addition to muriquis and brown howler monkeys, the EBC primate community consists of a third endangered species of primate, the buffy-headed marmoset (*Callithrix flaviceps*), and the more widespread tufted capuchin monkey (*Cebus nigritus*).

Because larger-bodied species tend to "win" in direct contests with smaller-bodied species (Waser, 1987), we predicted that muriquis, which can weigh up to 15 kg (Aguirre, 1971) would be "dominant" in their interactions with other smaller primate species and with other smaller animals. Nonetheless, the fact that the diets of all four species of primates at the EBC overlap to varying degrees led us to predict that differences in the frequency and intensity of interspecific interactions would occur. For example, EBC muriquis and howler monkeys consume many of the same species, and in some cases, patches of fruits, leaves, and flowers (Mendes, 1989; Strier, 1991; Rímoli, 1994). Tufted capuchins are omnivorous, and have been known to prey on a variety of in-

## AGONISTIC ENCOUNTERS BETWEEN MURIQUIS, *BRACHYTELES ARACHNOIDES HYPOXANTHUS* (PRIMATES, CEBIDAE), AND OTHER ANIMALS AT THE ESTAÇÃO BIOLÓGICA DE CARATINGA, MINAS GERAIS, BRAZIL

Luiz G. Dias  
Karen B. Strier

### Introduction

The Atlantic forest of southeastern Brazil is well-known for high levels of primate species diversity and endemism (Rylands *et al.*, 1995). There are currently 24 primate species and sub-species recognized in the Atlantic forest, with up to five species still found sympatrically in a number of remaining forest tracts (Rylands *et al.*, 1996). Censuses of a number of these primate communities, particularly in the states of Minas Gerais and São Paulo, have consistently estimated higher primate population densities in the small, disturbed forest fragments than in the larger, more pristine ones (Stallings and Robinson,

Table 1. Muriqui behavior during aggressive interactions with other animals at the EBC.

Muriqui behavior*	Howlers		Capuchins		Tayra		Owl		Lizard	
	N	%	N	%	N	%	N	%	N	%
Branch shaking	9	31.0	4	33.3	1	100	1	100	1	100
Teeth-bared	1	3.4	1	8.3	-	-	-	-	1	100
Chase	26	89.0	11	91.7	1	100	1	100	1	100
Vocalize	11	37.0	11	91.7	1	100	1	100	1	100

\*Percentages for each species may exceed 100% because muriqui behaviors are not mutually exclusive.

Table 2. Contexts of agonistic interactions between muriquis and other animals at the EBC.

Muriqui activity*	Howlers		Capuchins		Tayra		Owl		Lizard	
	N	%	N	%	N	%	N	%	N	%
Traveling	7	24.1	3	25.0	-	-	-	-	-	-
Resting	3	10.3	7	58.3	1	100	1	100	1	100
Feeding	16	55.2	4	33.3	-	-	-	-	-	-
Playing infants	5	17.2	1	8.3	-	-	-	-	-	-

\*Percentages for each species may exceed 100% because muriqui behaviors are not mutually exclusive.

sects and vertebrates including lizards, bats, squirrels, young coatis, and even small primates such as owl and titi monkeys where they occur sympatrically (Freese, 1981; Fedigan, 1990; Galetti, 1990), but they also exploit many of the same fruit, flower, and nectar sources as miquis (Torres de Assumpção, 1983). Similarly, although buffy-headed marmosets rely heavily on invertebrates and gum (Ferrari, 1988), their diet overlaps with miquis in certain fruit and nectar species (Ferrari and Strier, 1992).

There are few data on miquis predators (Olmos, 1994), and there are few large carnivores or raptors at the EBC (Strier, 1986; Hirsch, 1995). However, Printes *et al.* (1996) describe two possible predations on miquis infants at the EBC, one involving a tayra ("irara", *Eira barbara*) and the other a large hawk (*Leptodon cayanensis*, Accipitridae). Thus, at least some of the miquis' interspecific interactions might involve predators with the potential to impact miquis population size and viability.

## Methods

From January to July 1999, one group of miquis was observed on a near-daily basis as part of a long-term study on the EBC population (Strier, 1999). All 59 members in the study group during this period were individually recognizable and thoroughly habituated to the presence of trained observers. Behavioral data on agonistic interactions between miquis and other species were recorded whenever observed. For each interaction, the species, context of the encounter (food or feeding site, traveling, resting site), and behavior exhibited by all species involved were noted. Behavioral categories included chases, alarm vocalizations, branch-shaking, and teeth-baring displays, as described by other authors (Strier, 1986; 1999, Petroni, 1993; Galetti, 1996). Agonistic interactions were considered to be of "low intensity" if threats, such as branch shaking or vocalizations, were limited in duration, and of "high intensity" when one or both species engaged in prolonged threats or vocalizations, or when chases or bared-teeth displays were involved.

## Results

A total of 44 interactions were observed between miquis and other animals during this seven-month study period. Of these, 65.9% involved howler monkeys and 27.3% involved capuchins. Single interactions between miquis and a tegu lizard ("teiu", *Tupinambis* sp.), a tawny-browed owl ("corujão mateiro", *Pulsatrix koenigswaldina*), and a tayra (2.3% each) were also observed.

As expected based on body size, miquis "won" all agonistic encounters with other species, which inevitably terminated the interaction by leaving the vicinity. However, there were striking differences in the intensity and contexts of interspecific interactions (Table 1). Miquis interactions with howler monkeys were generally brief and of low intensity, consistent with those described previously at the EBC (Strier, 1986; Mendes, 1989) and elsewhere (Petroni, 1993). The

slightest threat from one or more miquis made the howlers run away, even though more than half of their encounters occurred in food patches (Table 2). Capuchin monkeys, by contrast, often vocalized (75%), broke branches (41.7%), and bared their teeth (33.3%), evoking much higher intensity interactions with miquis. Nonetheless, all of these encounters ended when the capuchins moved away from the miquis.

Miquis interactions with nonprimates also differed in intensity. When they encountered the tegu lizard, the miquis were spread out resting in low branches or feeding on ferns on the ground. The lizard's sudden appearance elicited threats, but no alarm calls. Similarly, when an owl landed less than 5 m away from a resting adult female, she was clearly startled. Her alarms seemed to have a similar effect on the owl, which immediately took flight, but no other miquis resting nearby participated in the interaction. When the tayra approached, however, one miquis gave an alarm call and immediately all infants present ran to their mothers. Three adult males and one adult female that were resting in the vicinity responded to the alarm call by moving rapidly toward the tayra while vocalizing loudly, at which point the tayra ran away.

## Discussion

The frequency of agonistic encounters between miquis and howler monkeys is probably a consequence of the high density of both species in this forest (Mendes, 1989; Hirsch, 1995; Strier and Mendes, in prep.). The high percentage (55.2%) of interactions that occurred in food patches is consistent with high dietary overlap. However, the fact that both species occur at such high densities suggests that neither is yet suffering from the effects of either direct or indirect feeding competition (Waser, 1987).

More than half (58.3%) of all agonistic interactions between miquis and capuchins occurred when capuchins moved into an area where the miquis were resting. This is consistent with the high degree of overlap noted in their home ranges (Torres de Assumpção, 1983, Strier, 1986; Petroni, 1993). However, more detailed data on capuchin diets at the EBC are needed to evaluate the level of potential feeding competition (Rímoli, in prep.).

The fact that miquis interactions with capuchin monkeys were more intense than with howler monkeys could be a consequence of the higher levels of aggression capuchins display. However, although capuchins are known to prey on infants of smaller primates (Fedigan, 1990; Galetti, 1990), it is also possible that they may pose a threat to solitary infant miquis.

Many primates display aggressive behavior and alarm calls in response to the presence of predators (Cheney and Wrangham, 1987). The miquis' alarm and threatening reaction to the tayra in this study was consistent with their response described in a prior suspected predation event (Printes *et al.*, 1996). In contrast, the lack of alarm in response to the lizard is consistent with the lack of real or perceived threat.

The fact that muriquis never fled from encounters with other species is likely to be a consequence of larger body size, and thus a reflection of dominance over the three other primate species in this community. This dominance should minimize the risks of losing direct contests over food with other species. However, we cannot yet evaluate the possible effects of indirect feeding competition from howler monkeys, or even capuchins, at this site. Studies focusing exclusively on interspecific interactions, and in particular on the potential indirect effects of interspecific feeding competition, are merited at sites like the EBC, where multiple sympatric species, including those which are endangered, may occur at high densities.

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**Luiz G. Dias**, Departamento de Zoologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte 31270-901, Minas Gerais, Brazil, e-mail: <diaslg@net.em.com.br> and **Karen B. Strier**, University of Wisconsin-Madison, Department of Anthropology, 1180 Observatory Drive, 5440 Social Science Building, Madison, Wisconsin 53706, USA.

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## HUNTING IMPACT ON NEOTROPICAL PRIMATES: A PRELIMINARY CASE STUDY IN FRENCH GUIANA

Benoît de Thoisy  
David Masméjan  
Maël Dewynster

### Introduction

Rainforest still covers more than 90% of French Guiana, affording this territory a rather favorable status compared with many Neotropical countries (Whitmore, 1997). Forest wildlife may nonetheless be locally threatened by uncontrolled agriculture, habitat fragmentation from roads, tracks, a hydroelectric dam, logging, legal and illegal gold mining, and hunting. Still, no conservation and natural resource management policies exist, and the impact of human disturbance is only a recent concern (Granjon *et al.*, 1996; Vié, 1998; Cosson *et al.*, 1999). Effects of hunting on mammal communities have not yet been evaluated, although it is one of the major threats to a significant part of French Guianan wildlife (de Thoisy and Vié, 1998).

As part of a multidisciplinary program on the impact of logging in a traditionally used rainforest (hunting, non-ligneous resource use), the Counami forest was surveyed to evaluate large bird and mammal abundances, in both heavily and lightly hunted areas. Abundances were also recorded in the Trinité Natural Reserve, an area lightly hunted in the past but which has now been effectively protected for four years.

### Methods

#### Study sites

The Counami site, a lowland Neotropical rainforest (53°15'W, 5°20'N), is located in the north of French Guiana, approximately 50 km from the Atlantic Ocean (Fig. 1). The dominant tree families include: Lecythidaceae (22% of trees with DBH > 7.5 cm), Caesalpiniaceae (12%), Chrysobalanaceae (11%), and Sapotaceae (6%) (Teillier, unpub. data). Interviews with local hunters suggest that only the first 3 km of the forest, which can be accessed by cars, motorcycles, and/or boats, are regularly hunted. Two areas were sampled, one facing high hunting pressure ("CH+", at one to 3 km from the track serving the forest), and the other facing low hunting pressure ("CH-", four to 7 km from the track). The sites chosen were far from rivers or possible access by boat. The study area of Trinité (TNR, Fig. 1) is located in the northern part of the natural reserve (53°13'N, 4°43'W), in a lowland forest. Botanical surveys in this area are presently ongoing.

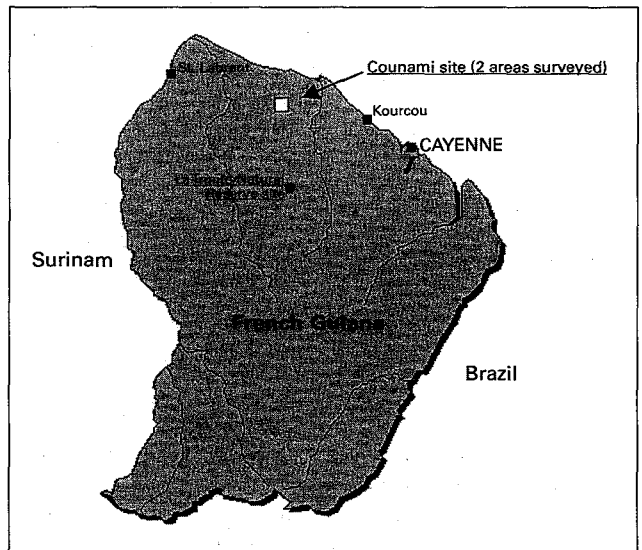


Figure 1. Site location of Counami and La Trinité Natural Reserve, French Guiana.

#### Sampling procedures

Line transects (Brockelman and Ali, 1987; Peres, 1999; de Thoisy, 2000) at the Counami sites were conducted in May and June (rainy season), and from September to November (dry season), 1998. The areas CH+ and CH- were covered by 93.5 km and 91.5 km of transect, respectively. In November 1999, 93.2 km of the TNR site were sampled and species abundance was expressed as number of groups per 10 km, with the addition of mean group size. Densities were calculated using Leopold's method, the mean of perpendicular sighting distances is used for estimation of the strip width (de Thoisy, in press). Crude biomasses (mean species weight \* density, in kg.km<sup>-2</sup>) were determined using the weights given in Robinson and Redford (1986).