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Front cover: Wied's black-tufted-ear marmoset (*Callithrix kuhlii*), Una, Bahia, Brazil, 1985. Photo by Russell A. Mittermeier.

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Articles

SEARCHING FOR *ALOUATTA PALLIATA* IN NORTHERN COLOMBIA: CONSIDERATIONS FOR THE SPECIES DETECTION, MONITORING AND CONSERVATION IN THE DRY FORESTS OF BOLÍVAR, COLOMBIA

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Abstract

The conservation status of *A. palliata*, commonly referred to as black mantled howler monkey, is vulnerable in Colombia because of its decline in population. The distributional limit in the northeast of the country is not well defined and the dry forests of the north of the country are being destroyed at alarming rates. In the municipality of El Guamo (Bolívar) less than 20% of the landscape is composed of forests. The two largest remnants of forests in the municipality have extensions of 3,544.7 and 879.6 ha each. From interviews with the community, I concluded that habitat loss is the main threat to primate populations. 37.6 % of the community of inhabitants said they had seen the monkey in the municipality of Guamo, however, I found no *A. palliata* during a short transect sampling. Individuals of the species *Alouatta seniculus* and *Saguinus oedipus* were detected during these walks. Conservation actions such as reforestation, establishment of agroforestry systems and corridors designed to improve the habitat of *A. palliata* should encourage the participation of the human communities.

Key Words: Black mantled howler monkey, primate conservation, dry forests, Colombia, El Guamo.

Resumen

El estatus de conservación de *A. palliata*, mico aullador negro, en Colombia es vulnerable debido al decremento en las poblaciones. El límite de distribución hacia el noreste del país no es bien definido y los bosques secos del norte del país están desapareciendo rápidamente. En El Guamo (Bolívar) menos del 20% del paisaje esta compuesto por bosque. Los dos remanentes de bosque mas grandes tienen extensiones de 3,544.7 y 879.6 ha respectivamente. De entrevistas con la comunidad se concluyó que la perdida de hábitat es la mayor amenaza para las poblaciones de primates. 37.6% de la comunidad de habitantes de El Guamo afirmó haber visto la especie en el área del municipio, sin embargo ningún individuo de *A. palliata* fue encontrado durante el recorrido de un transecto piloto. Individuos de las especies *Alouatta seniculus* y *Saguinus oedipus* fueron encontrados durante las caminatas. Las acciones de conservación en conjunto con las comunidades rurales deben ser una prioridad en la propuesta de actividades como la reforestación, el establecimiento de corredores y de sistemas agroforestales con el objetivo de mejorar las condiciones de hábitat para poblaciones de *A. palliata*.

Palabras Clave: Mico aullador negro, conservación de primates, bosques secos, Colombia, El Guamo.

Introduction

Although *A. palliata* is one of the best studied neotropical species (Neville *et al*., 1988; Defler, 2004), little is known about the state of its populations, its ecology and its geographic distribution in Colombia. *A. palliata* is listed in CITES in Appendix I and by the IUCN as Low Concern (LC), because its populations are considered abundant and stable. However in Colombia, the loss of habitat and the pressure of hunting have affected populations negatively, and presently the species is classified as vulnerable (VU) in the red lists of the IUCN for Colombia (Cuarón *et al*., 2003).

A. palliata is distributed throughout southern Mexico as well as much of Central America to the west coast of Colombia and Ecuador. In Colombia, the range of *A. palliata* includes the entire pacific coastal lowlands, except in flooded areas (Hernández-Camacho and Cooper, 1975; Defler, 2004)*;* the distribution of *A. palliata* in the North of the country is poorly defined (Defler, 2004). A specimen of the species collected by Carriker in the Cartagena region during the early 1900's (and information provided by Dugand during the 1950's about the presence of the species in a locality close to the study site of this research), suggests that the distribution of the species to the northeast

could be greater than indicated in some distribution maps (Defler, 2004). However, the few studies carried out in the Montes de Maria (Mountains of Mary), in the departments of Sucre and northern Bolivar, including Cartagena region, have not reported *A. palliata.*

The research I conducted was carried out in 2005 under the regional conservation strategy for threatened species of the Corporacion Autonoma Regional del Canal del Dique (CARDIQUE), a governmental organization with jurisdiction in the northern and central parts of the department of El Bolivar. The interest of this organization in the populations of *A. palliata* are due to a variety of reasons: the conservation status of the species in Colombia, the unknown distribution of the species in the north of the country, the lack of knowledge about the ecology of the species in dry forests of the country and lastly the repeated sightings of the species in the area.

Methods

Study Area

El Guamo is located in the department of Bolivar in northern Colombia, west side of the Magdalena River between the municipalities of Calamar and San Juan de Nepomuceno. It is located between 10° 08' and 9°57' N, and 75°05'74° 47' W. Its altitude lies between 25 and 100 m above sea level. Mean annual rainfall in this region is about 1185 mm. The area presents a dry period between December and April, and a rainy season between May and November, with a decrease in rainfall during June and July. The annual average for temperature is 28°C, with insignificant fluctuations through the year, and the annual average for relative humidity is 77% (IDEAM, 2005). The total municipality area is about 39,000 ha.

This research was divided into 4 phases: 1) identification and description of the forested landscape patterns using remote sensing 2) meetings and interviews with the community 3) pilot study and 4) description of the habitat.

Description of the forested landscape patterns using remote sensing

The description of forested areas in El Guamo was done through analysis of an ASTER satellite image taken in May of 2004 during the rainy season for a better estimation of vegetation. The analysis was done using ARC GIS. Vegetation was identified by using the Normalized Difference Vegetation Index ratio (NDVI) (NASA, 2010). The description of the landscape pattern, applied only to the patches of forests, followed the methodology for numerical and spatial data processing in landscape ecology, (Forman and Gordon, 1986; Farina, 1998), including: a) dimensions of individual elements, b) landscape composition, and c) spatial arrangements of elements. Overall analysis was focused on the identification of potential areas for monitoring and conservation of *A. palliata* with consideration of the habitat requirements of the species.

Focus groups and interviews

I conducted focus groups and interviews with the community members of El Guamo in each of the main villages in order to determine the presence of *A. palliata* in the municipality. During the focus groups I presented visual material such as pictures, only after the community described the species they allegedly saw, in order to confirm the accuracy of the information. The questions asked during the focus groups and interviews were: have you seen the black howler monkey in the forests of this area? if yes, where have you seen it?, how long ago did you see it?, are monkeys frequently hunted for bushmeat?. I asked these questions in order to confirm the presence of the species in the region and also, to determine possible locations, as well as main threats. Participation was voluntary, all responses were anonymous and no incentives were offered to survey responders. I asked the questions to each participant and the information was collated using a questionnaire during the focus groups and interviews.

Pilot census of Alouatta palliata

In 2005 I conducted a pilot census in order to determine the presence of the species in the area. The site was selected taking into account information provided by inhabitants of the region, accessibility and security. However, the presence of illegal armed groups in the area (paramilitares and guerrillas) did not allow the application of probabilities sampling. Therefore the selection of a survey site was biased by external factors. I conducted the census of *A. palliata* using the line transect method. A transect of 2000 m was cut in a fragment of forest called "La Reserva" (28.7 ha) (Figure 1). The pilot census were conducted in the morning starting at 6:00 am (during the maximum time spent by *A. palliata* in howling and traveling (Muñoz *et al.*, 2001)), and finishing

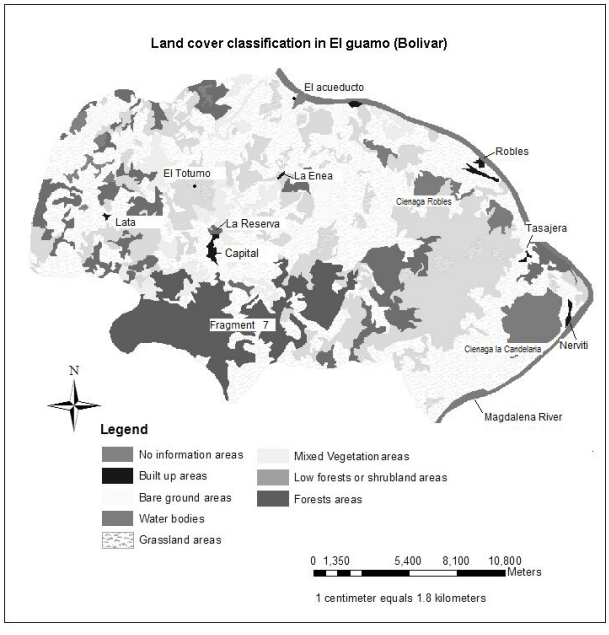

Figure 1. Land Cover map of the study area. Minimum mapping unit: 10 ha. Elaborated by Andrea Dechner.

at 12:00m, due to rainy afternoons. The speed of the walks was 1 km/h, with stops of 5 minutes each 100 m for visual or auditory indications of the presence of animals.

Description of the habitat

In order to characterize the floristic composition and structure of the vegetation of the area, a single quadrant of 1,000 m^2 was established in the area selected for the census of *A. palliata*. All trees in the quadrant with a diameter at breast height (DBH) greater than or equal to 10 cm were identified. I measured variables such as tree height, DBH, and cover, as well as altitude, presence of erosion processes and terrain inclination. Taxonomic identification of collected samples relied on Gentry (1993) and Mahecha (1997), as well as by comparison with specimens from the MOBOT- Missouri Botanical Garden.

Results

Description of the Forested Landscape Patterns Using Remote Sensing

The municipality of El Guamo consists of 38,270 ha mainly covered by grasslands or croplands (17,166 ha), followed by low forests or shrublands (8,281 ha) and well developed forests (6,834 ha) (Table 1). Forested areas represent 17.9% of the total study area and are mainly located to the south towards the border with the municipality of San Juan de Nepomuceno. There are 31 fragments of forest, presenting an average size of 220 ha. The fragment sizes vary between 10 ha (the MMU or minimum mapping unit) and 3544 ha (Table 2).

The largest fragment of forest is the fragment N° 7. It is located to the south of the capital and has an extension of 3,544 ha (Figure 1). It represents 53% of the total area of forests. However, this fragment presents small perforations which were not mapped due to their small size (i.e. under the assigned MMU). In addition it has a very irregular shape (CPA Corrected Perimeter Area Ratio = 4.6). Fragments N° 10 and 3 present the second and third largest extensions with 880 and 266 ha respectively.

The nearest neighbor observed mean distance between forests was 1,956 meters and the nearest neighbor ratio based on feature centroids had a value of 0.94. This indicates that the spatial pattern of the fragments of forests is random, neither clustered or dispersed. According to the directional distribution of the fragments of forests, the largest fragments of forests are located to the south and are connected with other forests located outside El Guamo.

Focus groups and interviews

I conducted 141 interviews in 7 different localities of the municipality of El Guamo during July-August 2005. These localities include El Guamo (capital of the municipality, 58 interviews), Nerviti (27 interviews), Tasajera (21 interviews), El Totumo (12 interviews), La Enea (5 interviews), Robles (10 interviews), and El Acueducto (8 interviews). About 62% of the participants interviewed said they have never seen *A. palliata*, while 38% said they have seen the species. Participants from localities such as La Enea and Robles affirmed they have never seen a black howler monkey, while more than the 40% of the interviewers in localities such as El Guamo, Nerviti and Tasajera said they have seen the species in nearby areas.

Approximately 30% of the interviewees said they have seen the monkey in Lata, followed by El Totumo (29%), Casablanca (12%), San Luis (9%) and La Reserva (9%). Locations where the sightings had been less included Desconsolado, Cerro de Maco, El Yucal and La Venta. The people who have seen the species more recently (i.e. between July 2004 and July 2005) said they have seen it between April and July 2005 in El Totumo, between January and April 2005 in La Reserva and Lata, and between July 2004 and January 2005 in localities such as San Luis and La Venta. Localities where it had not been seen recently include Casablanca.

Table 1. Area and relative abundance of cover types in the study area. The mixed vegetation category was given to those areas with 2 or more types of cover, where each cover had less than 10 ha (MMU).

Cover type	Total area (ha)	Relative abundance (%)
Forest	6,834.0	17.9
Low forest or shrubland	8,281.0	21.6
Mixed vegetation	2,212.0	5.8
Grassland or cropland	17,165.5	44.9
Water Bodies	2,310.8	6.0
Bare Ground	1,112.9	2.9
Built up areas	189.2	0.5
No Information	165.2	0.4
Total	38,270.7	100.0

Table 2. Characteristics of patches of forest in the study area. Table shows the details of the 3 largest fragments.

Fragment #	Area (ha)	Perimeter (m)	Patch shape	Relative abundance (%)
7	3,544.7	99,806	4.7	51.9
10	879.6	33,259	3.2	12.9
3	266.1	16,367	2.8	3.9
Following 28 fragments	2,143.8	167,779	55.8	31.3
Minimum	10.1	1373	1.2	0.1
Maximum	3544.7	99806	4.7	51.9
Average	220.5	10233.3	2.1	3.2
Total	6834	317231	66.5	100

Only 2.8% of the total participants said monkeys are frequently hunted for bushmeat. Hunted species included *Alouatta seniculus* (red howler monkey) and *Cebus capucinus* (white throated capuchin monkey). In addition, visits to places in El Guamo, La Enea and Robles, where the presence of monkeys in captivity was confirmed, uncovered no individuals of *A. palliata* in captivity. However some inhabitants said they had a black howler monkey in captivity in the past. Individuals of the species *Cebus capucinus* (white throated capuchin monkey) and *Saguinus oedipus* (cotton top tamarin), were found in captivity.

Census of Alouatta palliata

The area selected for the census of the species was La Reserva which has an extension of 28.7 ha (Fragment N° 15) (Figure 1). Although a small percentage of the interviewees said they have seen the species there, the selection of the area was made based on a convenience (non-probability) sampling due to the presence of illegal armed groups (paramilitares and guerrillas). In total I walked a distance of 22 km and no individuals of *A. palliata* were found. Troops of other primates such as *Alouatta seniculus* and *Saguinus oedipus* were observed during the census (Table 3).

Table 3. Information on the individuals of the species *Alouatta seniculus* and *Saguinus oedipus* found during the census in La Reserva.

Species	# of individuals observed	Location (Coordinates)
Alouatta seniculus	2	10°02'24.00"N, 74°58'34.49"W
Saguinus oedipus	5	10°02'24.73"N, 74°58'29.80"W

In addition, during informal walks, a troop of 9 individuals of the species *Saguinus oedipus* was observed on a single tree in a semi-open area in a place called El Acueducto (10°06'53.18" N, 74°56'41.25" W).

Description of habitat

The total tree species richness with DBH≥ 10cm was 14 species (32 individuals) in a total area of 1,000m^2 (0.1 ha). The Shannon-Weaver species diversity index was 2.2, and the Simpson diversity index was 0.8. The families with higher number of species were Leguminosae with 4 species, followed by Bignoniaceae with 2 species. Only one species was found for the rest of the families (Table 4). The most abundant species were *Astronium graveolens* (Anacardiaceae) with 34.4% of the individuals found, followed by *Bursera simaruba* (Burseraceae) and *Caesalpinia* sp. (Leguminosae), each with 12.5% of the species found.

The mean tree height was 9.4 m; the tallest trees measured were a *Girocarpus americanus* and *Caesalpinia* sp., with a total height of 16 m each; whereas the minimum height registered was for a *Cordia* sp. with 4 meters of height. The average tree diameter at breast height was 20.8 cm with a maximum diameter of 59.5 cm. The total basal area of all the tree species was 10.1m^2/ha. *Caesalpinia* sp. makes the greatest contribution to this value with 26% of the total

Table 4. Floristic composition of 0.1 ha vegetation plot in the study area.

Family	# sp.	%	Species	# ind	%
Anacardiaceae	1	7.1	*Astronium graveolens*	11	34.4
Apocynaceae	1	7.1	*Aspidosperma polyneuron*	1	3.1
Bignoniaceae	2	14.3	*Tabebuia bilbergii*	1	3.1
			Tabebuia rosea	1	3.1
Boraginaceae	1	7.1	*Cordia* sp.	2	6.3
Burseraceae	1	7.1	*Bursera simaruba*	4	12.5
Capparidaceae	1	7.1	*Capparis odoratisima*	1	3.1
Euphorbiaceae	1	7.1	*Hura crepitans*	1	3.1
Hernandiaceae	1	7.1	*Girocarpus americanus*	2	6.3
Leguminosae	4	28.6	sp 1	1	3.1
			Caesalpinia sp.	4	12.5
			Acacia sp.	1	3.1
			sp 2	1	3.1
Rubiaceae	1	7.1	*Alseis* sp.	1	3.1
Total	14	100	-	32	100

basal area, followed by *Astronium graveolens* with 21% of the total basal area. *Caesalpinia* sp. is dominating in the upper canopy with 53% of the crown cover, followed by *Astronium graveolens* (14%) and *Bursera simaruba* (6%).

Discussion

Dry forests, such as those in El Guamo, Bolivar, are considered the most endangered major tropical ecosystem because their original area has been reduced by more than 90%, and less than 2% of what remains is protected (Janzen, 1986). By 1997 only 1.5% of the original cover of the dry forests remained in Colombia (IAVH, 1997). In comparison to other ecosystems, dry forests are more exposed to human disturbances due to a variety of reasons: 1) the climate, 2) the forest structure, which make easier to cut them down for agriculture, 3) the soils, which are more fertile than the soils of rainforests, and 4) in many areas like in El Guamo, the geomorphology, which is highly suitable for livestock. Consequently, tropical dry forests are under increasing pressure and the status of conservation of this ecosystem is critical for large areas of South America (Janzen, 1986).

In El Guamo, grassland or cropland compose the matrix of the landscape being the most extensive and contiguous element in the landscape. Forests in the study area were highly fragmented, under increasing threat of being replaced for agricultural or cattle grazing lands, reducing the areas with potential value for the monitoring and conservation of biodiversity. The fragments of forests presented an irregular shape which increases significantly the amount of habitat affected by the edge effect, consequently altering plant composition, structure and the functionality of the forests (Laurance *et al*, 1997).

Considering that the habitat availability depends on the extension of the area, and that largest fragments would contain sufficient habitat to meet the needs of the species (Saunders *et al*., 1991; leigh *et al*., 1993), the largest remaining fragments should be first in consideration for monitoring and conservation actions for *A. palliata*. The average size of the fragments of forests is 220 ha, which is a favorable number considering that *A. palliata* presents a home range that varies between 10 and 60 ha (Chivers, 1969) and that the average daily path ranges between 123 and 443 m (Milton, 1980; Estrada, 1982, 1984). The nearest neighbor ratio indicates that the forest fragments are not clustered, which may have negative implications on the movement of the species that inhabit these areas. Actions toward increasing connectivity of the fragments should be considered in order to reduce the impact of the fragmentation.

Although only 37.6% of the stakeholders interviewed said they have seen the monkey, the fact that the physical descriptions of the species provided by them were so accurate (i.e. black face, body not completely black, with brown fur in the back) reinforce the idea that although in very low densities, *A. palliata* may be in the area. Also, as expressed by some farmers, the species is living sympatrically with *Alouatta seniculus* as reported by Hernandez-Camacho and Cooper (1975) in the west of the Atrato River of Colombia.

Localities such as Lata and El Totumo, should be priorities in selecting sampling areas for monitoring because results from the interviews with the community suggest the presence of the monkey in these areas (Figure 1). From the interviews it can be concluded that hunting is not currently the main threat for populations of the species. Instead, the continuing loss of forested areas to cattle grazing and crop cultivation is the main threat to species in the region. The absence of sightings of the species during the pilot study may have been due to the low density or absence of the species in the sampled area (La Reserva) and the short length of the transect (22 km). In addition, the likely absence of the species in the sampled area may have been due to habitat degradation and isolation.

The forests of the sampled area are secondary forests, and the tree species richness (14 spp.) is lower than the average richness registered in other dry forests (24.7 spp.) (Gentry, 1995). This low tree species richness value may be explained as the result of the different levels of human disturbance and selective logging. Also, the difference between species richness values may be due to the sampling size and to the fact that I sampled 0.1 ha using a single quadrant (20 × 50 m) and not 10 2 × 50 m transects like in the studies reported by Gentry (1995). Results of the most important families in number of species showed that as reported for other dry forests (Gentry, 1995; Mendoza, 1999), Leguminosae was the most speciose family (4 spp.). The second most speciose family was Bignoniaceae (2 spp.), which is described by Gentry (1995) as the "undisputed number two family of woody plants of neotropical dry forests".

Results of this study showed that by comparison with the diet of *A. palliata* in other dry forests, the potential species to be used as a source of food by *A. palliata* in the area of El Guamo include *Astronium graveolens* (Glander, 1981) with 30% of relative abundance in the study area, *Bursera simaruba* (Serio-Silva *et al*., 2002) with 13% of relative abundance, and several species of the genera *Cordia* (Estrada, 1984) also with 13% of relative abundance in the study area. Being folivore and because of their wide diet that includes mature leaves, young leaves, flowers and fruits (Glander, 1981), *A. palliata* has more food available to them in comparison with non-folivore primates. However, the food supply of the species can be affected by the phenology of the species they feed on. The relationship between the seasonality, availability of resources and the behavior in primates has been widely studied (Hladik, 1977; Overdorff, 1993; Gursky, 2000). In tropical dry forests, which are characterized by 4–6 months of drought, seasonal climate and tree phenology are not highly correlated. Phenology varies widely among plant species with shoot

growth and flowering occurring either after the leaves are dropped during the dry season or during the beginning of the rainy season (Borchert 1994, 1996).

According to the climatic information, the area of El Guamo presents a dry period between December and April, and a rainy season between May and November, with a decrease in rainfall during June and July. Plant species such as *Astronium graveolens* and *Bursera simaruba* being abundant in the study area may provide an important amount of food to the populations of *A. palliata* almost all year round. *Astronium graveolens* has been classified as drought-deciduous species with young leaves that appear together with the flowers immediately after leaf shedding during the dry season. This species can also be used for reforestation activities due to its ability to grow under full light (Marin and Flores, 2002). Similarly, *Bursera simaruba* has been described as a deciduous species, with flowering of leafless trees during the dry season and fruits almost year round. *Bursera simaruba* grows well in either poor or rich soils and adapts to severe drought periods. It has a fast germination with 80–100% of germination reaching maturity after 15 years (Navarrete-Tindall and Orellana Nunez, 2002).

In regard to the structural development of the sampled forests, results showed that the canopy height and basal area registered are lower than those registered in other dry forests. In such forests, the average canopy height varies between 10 and 40 m and the basal area varies between 17 and 40 m2/ha (Murphy and Lugo, 1986). These differences in structural terms may be the result of disturbance activities in the area. Selected areas for censusing and conservation activities should include structurally well developed forests. Fedigan *et al*. (1998) suggested that as structural requirements, *A. palliata* only feed and rest in trees that are sufficiently large to support their weight (with a minimum DBH of 20 cm and a preferred DBH of 63 cm). Then, although the habitat of the sampled area can meet the structural requirements of the species, its relatively low structural development may be the cause of the low densities or absence of the *A. palliata* in some areas and of the restricted presence of the species in other areas with greater structural development. Therefore, it is necessary to consider conservation actions in order to enhance the suitability of all the fragments of forests in the area.

Considerations for the conservation of *Alouatta palliata* in the dry forests of northern Colombia

Dry forests of El Guamo are under increasing pressure to be turned into areas for agricultural use and cattle grazing. This implies that most of primates that live in these forested areas and require relatively well developed forests are threatened, and the conservation of their habitats should be a priority in proposing strategies of conservation in the region. Conservation strategies should include actions directed to the restoration of some fragments and of the connectivity between them in order to increase the suitability of the habitat. Towards these actions, working with farmers and land owners to reduce habitat destruction is very important. Encouraging forest corridors through the cut areas will improve their habitat by allowing howlers monkeys to move between fragments of forests (Horwich, 1998). Agroecosystems with cacao, coffee and mixed plantations have proved to have a positive effect on enhancing forest habitat for primates (Estrada, 2006)

In agricultural areas, it is essential to encourage actions such as: (1) promoting the planting of food species for howlers and (2) establishing corridors to enhance the connection between isolated forests (Horwich, 1998). Choosing species that are used by *A. palliata* as resource of food could radically improve their habitat. Although species of the genus *Ficus* are an important food source for *A. palliata* (Horwich, 1998; Ramírez-Orjuela and Sánchez-Dueñas, 2005), species of this genus were not considered in this study because of their preference for humid areas.

Restoration actions should be done by planting fast to medium growing native species of trees encountered in the dry forests of the area preferred as a resource of food by *A. palliata.* Trees to be planted include *Brosimum alicastrum* and *Anacardium excelsum*. *Brosimum alicastrum* remains green during the dry season, thus being a reservoir of food for many species (Rocas, 2002). *Anacardium excelsum* drops its leaves for a short period of time (Fournier, 2002). Additionally, other species of the genera *Brosimum* and *Anacardium excelsum* were reported as food resource for *A. palliata* in the Chocó region in Colombia (Ramírez-Orjuela and Sánchez-Dueñas, 2005). Other potential species to be used in restoration activies are: *Spondias mombin*, *Muntingia calabura, Guazuma ulmifolia* and *Gliricidia sepium*. *Spondias mombin* produces fruits that are consumed by livestock and by humans, also its fruits and both young and mature leaves are consumed by *A. palliata* (Serio-Silva *et al*., 2002). *Muntingia calabura* is a very fast-growing evergreen tree characterized for being drought-resistant (Morton, J. 1987). *Guazuma ulmifolia* and *Gliricidia sepium* are fast growing medium trees that may also be used as living fence (Suttie, 2000). Additionally, *Guazuma ulmifolia* may be a source of food for livestock (Little and Wadsworth, 1964). All these tree species may play an important role in the establishment of activities to improve the suitability of habitat of populations of *A. palliata* by providing food resources to the species, services to the rural community, and by allowing and encouraging the forest regeneration.

One of the main limitations to any monitoring and conservation action in the area is the presence of illegal groups, although such topic is out of the scope of this paper, it is important for governmental and non-governmental organizations to set realistic objectives and conservation actions, as well as to make constant presence in these areas to be recognized by the different actors of the conflict as neutral in order to reach desired conservation objectives.

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DENSIDADE E TAMANHO POPULACIONAL DE PRIMATAS EM UMA ÁREA DE TERRA FIRME NA AMAZÔNIA CENTRAL

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Abstract

Brazil contains 1/3 of the world's remaining tropical forests and is recognized as one of the world's most important storehouses of biodiversity. With regard to primate species richness, it is especially prominent. There are 133 species and subspecies in Brazil – of these 80 occur in the Brazilian Amazon and 11 are in danger of extinction. In spite of these impressive numbers, there is little ecological or population data available for many of these species, especially those that occur in the Amazon. To address this lack, the objectives of this study were to: 1) record occurring primate species; 2) estimate their population densities; and 3) characterize their distributions in the Adolpho Ducke Forest Reserve. This reserve, situated on north of Manaus in the state of Amazonas, Brazil, contains 10,000 hectares of primary forest. The data were collected using linear transects, covering the entire system of trails within the reserve. In a total of 720 km of trails walked, 58 sightings were registered of *Saguinus bicolor*, 29 of *Cebus apella*, 20 of *Alouatta seniculus*, 13 of *Pithecia pithecia* and 10 of *Chiropotes sagulatus*. Sightings occurred in all types of environments (plateau, slope, and lowland). *S. bicolor* had the greatest density (1.00 group/km^2), followed by *C. apella* (0.67), *A. seniculus* (0.66), *P. pithecia* (0.64) and *C. sagulatus* (0.30). The resulting estimate of groups present in the total reserve area, not considering possible gaps, natural habitat variation, or resource availability, is 100 groups of *S. bicolor*, 67 of *C. apella,* 66 of *A. seniculus*, 64 of *P. pithecia* and 30 of *C. sagulatus.* These results demonstrate the importance of the Adolpho Ducke Forest Reserve for the maintenance of biodiversity and emphasize the need for targeted conservation policies to contain anthropogenic disturbances in the region.

Keywords: Ducke reserve, Amazon forest, linear transect, Manaus

Resumo

O Brasil apresenta 1/3 das florestas tropicais remanescentes do mundo e é reconhecidamente um dos mais importantes repositórios da diversidade biológica mundial. Quanto à riqueza de espécies de primatas, ocorrem em seu território 133 espécies e subespécies, sendo que 80 ocorrem em território amazônico e 11 estão ameaçadas de extinção. Apesar dos números expressivos, boa parte das espécies, principalmente as que ocorrem na região amazônica, apresenta carência de informações ecológicas e populacionais. Diante disto, os objetivos deste estudo foram (1) registrar as espécies de primatas, (2) estimar suas densidades e (3) caracterizar suas distribuições na Reserva Florestal Adolpho Ducke, uma área de floresta primária de 10.000 hectares situada na região de crescimento urbano norte da cidade de Manaus-AM. Os dados foram coletados por meio do método de transecção linear, cobrindo todo o sistema de trilhas da reserva. Foram percorridos 720 km e registrados 58 avistamentos de *Saguinus bicolor*, 29 de *Cebus apella*, 20 de *Alouatta seniculus*, 13 de *Pithecia pithecia* e 10 de *Chiropotes sagulatus*, distribuídos em todos os tipos de ambientes (platô, vertente e baixio). A maior densidade registrada foi de *S. bicolor* (1.00 Gr/Km^2), seguida por *C. apella* (0.67), *A. seniculus* (0.66), *P. pithecia* (0.64) e *C. sagulatus* (0.30). Assim, a estimativa de grupos presentes na área total da reserva, desconsiderando-se a possível presença de lacunas, as variações naturais do habitat ou a disponibilidade dos recursos, é de 100 grupos de *S. bicolor*, 67 de *C. apella,* 66 de *A. seniculus*, 64 de *P. pithecia* e 30 de *C. sagulatus.* Esses resultados demonstram a importância da Reserva Florestal Adolpho Ducke na manutenção da biodiversidade e impõem a necessidade de políticas conservacionistas para sua área.

Palavras-chaves: Reserva Ducke, Floresta Amazônica, transecto Linear, Manaus.

Introdução

O Brasil apresenta 1/3 das florestas tropicais remanescentes do mundo e é reconhecidamente um dos mais importantes repositórios da diversidade biológica mundial (Ayres *et al.,* 2005). Embora seja considerada a maior do planeta, a diversidade de mamíferos do Brasil ainda é pouco conhecida (Voss e Emmons, 1996). Quanto à riqueza de espécies de primatas, o Brasil apresenta um lugar de maior destaque: dos 624 taxa de primatas existentes no mundo, 133 espécies e subespécies vivem em território brasileiro (Machado *et al.*, 2005), sendo que 80 ocorrem em território amazônico e 11 estão ameaçadas de extinção (Gordo *et al*., 2008). Apesar dos números expressivos, boa parte das espécies, principalmente as que ocorrem na região Amazônica, apresenta carência de informações ecológicas e populacionais (Machado *et al*., 2005).

O comprometimento da diversidade biológica está relacionado não somente ao acelerado ritmo do desmatamento, mas também a pressão de caça e ao corte seletivo de florestas (e.g. Robinson *et al*., 1999), fatores que atuam como principais ameaças para os mamíferos, principalmente os de médio e grande porte, que necessitam de grandes áreas de vida e estão sujeitos a caça (Pardini *et al*., 2003). A perda de habitat é ainda um dos principais responsáveis por declínios de 83% dos pássaros e 85% dos mamíferos ameaçados no mundo (BirdLifeInternational, 2000; Hilton-Taylor, 2000). Nos neotrópicos, os primatas apresentam um elevado interesse para estudos de fragmentação florestal. Geralmente as espécies com grande massa corpórea, portanto com grandes exigências espaciais, tendem a ter suas densidades reduzidas significativamente ou sofrem extinções locais quando as florestas são reduzidas a pequenos fragmentos florestais (Peres, 1990). Dependendo da distância entre florestas, as áreas abertas entre fragmentos frequentemente constituem barreiras a dispersão e a colonização, impedindo o fluxo gênico entre populações (Ferrari e Diego, 1995).

Diversos estudos em áreas florestais fragmentadas na Amazônia relacionaram a abundância, densidade, ocorrência e riqueza das espécies com o tamanho do fragmento florestal, pressão de caça, estrutura da vegetação e qualidade de habitat (Schwarzkopf e Rylands, 1989; Peres, 1997; Vidal e Cintra, 2006). Muitos estudos, entre eles os de Peres (1990; 2000) e Peres e Dolmann (2000), reportam a forte pressão de caça de subsistência e comercial, especialmente sobre primatas de maior biomassa, como guaribas (*Alouatta* spp.), macacos-aranha (*Ateles* spp.) e macacos-barrigudo (*Lagothrix* spp.). O pequeno tamanho e isolamento da maioria dos fragmentos de florestas comprometem a manutenção em longo prazo de populações mínimas viáveis de primatas (Chiarello e Melo, 2001). Assim, áreas como a Reserva Florestal Adolpho Ducke (RFAD), que possuem importante função na manutenção da biodiversidade local, e que podem ser destinadas à conservação de metapopulações, merecem grande atenção para serem evitadas extinções locais de espécies (Kierulff e Rylands, 2003).

Até o momento, escassas são as pesquisas abrangendo toda a extensão da RFAD, principalmente aquelas relacionadas a grandes mamíferos. O único estudo com primatas desenvolvido em toda a área da Reserva foi realizado por Vidal e Cintra (2006), mas foi direcionado para o uso do hábitat por uma única espécie. Este é o primeiro trabalho que envolve informações sobre todas as espécies de primatas que utilizam a RFAD. Assim, de modo a contribuir com a geração de conhecimentos e explicitar a importância da RFAD para a manutenção da biodiversidade, este estudo teve como objetivos (1) registrar as espécies de primatas que ocorrem no interior da reserva, (2) estimar as densidades populacionais de cada espécie e (3) caracterizar suas distribuições espaciais nos ambientes de platô, baixio e vertente, presentes na reserva.

Material e métodos

Área de estudo

A Reserva Florestal Adolpho Ducke (Fig. 1), localizada no Km 26 da Rodovia Estadual AM 010 (02º55'-03º01'S, 59º53'-59º59' W), possui uma área de 10,000 ha, com topografia acidentada e altitude variando entre 39 e 109 m acima do nível do mar. Nas áreas altas predomina o latossolo amarelo alico (oxisol) de textura muito argilosa, e nas áreas baixas o solo é constituído de podzóis (de textura arenosa). A vegetação é do tipo floresta ombrófila densa de terra firme. O dossel é bastante fechado e o sub-bosque tem pouca luminosidade, caracterizado pela abundância de palmeiras acaules (Guillaumet e Kahn, 1982). A altura média das árvores fica entre 35 e 40 m, com indivíduos emergentes que atingem os 50 m (Ribeiro *et al.*, 1999). Por estar muito próxima a cidade, tendo somente o seu limite leste conectado a floresta contínua, a reserva apresenta considerável perturbação antrópica, sendo comuns os registros de retirada de madeira e a caça comercial e de subsistência, ações ilegais praticadas pelas populações do entorno. A expansão urbana da zona leste de Manaus poderá contribuir para o seu completo isolamento, transformando a reserva em um grande fragmento florestal urbano (Ribeiro *et al*., 1999). A precipitação anual na área varia de 1,900 a 2,500 mm, com estação chuvosa de dezembro a maio e estação seca de junho a novembro (Gascon e Bierregard, 2001). Segundo a classificação de Köeppen, a RFAD apresenta um clima do tipo Af (Equatorial úmido) com temperatura média em torno de 26°C (mínima de 19°C e máxima de 39°C). A umidade relativa varia de 77 a 88%, com média anual de 84% (Leopoldo *et al.,* 1987).

Métodos

O sistema de trilhas da RFAD é formado por 18 trilhas de 8 km, sendo que nove estão dispostas no sentido norte-sul e nove no sentido leste-oeste, formando um sistema regular de quadrantes de 1000 m × 1,000 m. As trilhas estão marcadas com tubos de PVC a intervalos regulares de 100 m. Os censos foram conduzidos de acordo com a metodologia de transecção linear (Burnham *et al.*, 1980; Buckland *et al.*, 1993), cobrindo todo o sistema de trilhas

da RFAD e realizados durante oito dias por mês, de novembro de 2002 a julho de 2003. Os censos foram realizados no período de 06:30 às 17:00 horas. Este período abrange os ciclos diários de atividades de várias espécies de primatas (Terborgh, 1983; Egler, 1986; Menezes *et al*., 1993; Vidal e Cintra, 2006). Durante o período do censo foram feitas caminhadas pelo sistema de trilhas numa velocidade em torno de 1.5 km/h. A cada 50 m parava-se por cerca de 30 s para fazer uma varredura visual e auditiva para cada lado da trilha, maximizando assim a chance de visualização dos primatas (Peres, 1997). A cada avistamento foram registradas as seguintes informações: 1) espécie observada; 2) tamanho do grupo, feito por contagem direta do número de indivíduos avistados, 3) dia e hora do avistamento; 4) número da trilha e posição do grupo na mesma; e 5) distância perpendicular do avistamento em relação à trilha (com o uso de trena de 50 m). Para estimar a distribuição espacial dos grupos registrados, os ambientes disponíveis foram classificados de acordo com as seguintes cotas altimétricas: 100- ≥120, platô; 70–99, vertente; e, ≤ 40–69, baixio.

As densidades dos grupos de primatas presentes no interior da RFAD foram estimadas dividindo-se o número de grupos avistados (n) pela área amostrada, onde l é o comprimento total da trilha e w a distância perpendicular máxima de avistamento (NRC, 1981).

$$D = n/2lw$$

As abundâncias foram estimadas dividindo-se o número de grupos avistados (n) pelo comprimento total da trilha (l).

$$A = n/l$$

Para estimar diferenças entre taxas de avistamentos nos diferentes horários do dia, os registros foram divididos nas seguintes classes de horários: 06:30–08:00, 08:01–09:30, 09:31–11:00, 11:01–12:30, 12:31–14:00, 14:01–15:30, 15:31–17:00. Qui-quadrados foram realizados para estimar diferenças nas taxas de avistamentos nas diferentes classes de horas.

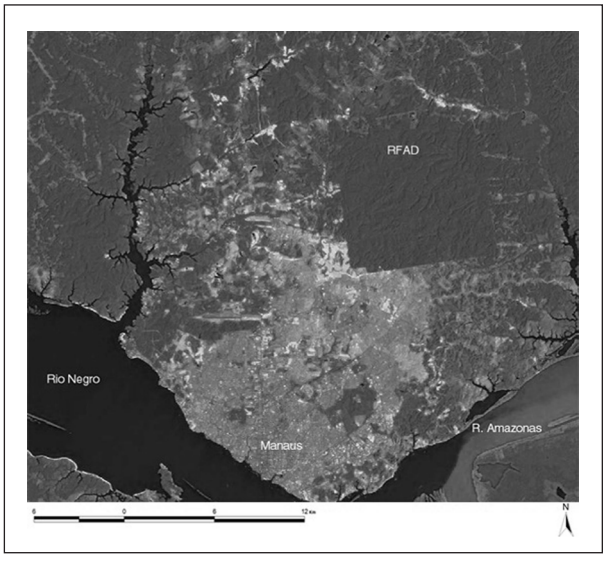

Figura 1. Imagem de satélite destacando a cidade de Manaus, os rios Negro e Amazonas, e a Reserva Florestal Adolpho Ducke (RFAD) (Fonte: ppbio.inpa.gov.br/Port/inventarios/ducke/).

Resultados

Durante os nove meses de coleta de dados foram percorridos 720 km de trilhas e registradas cinco espécies de primatas: *Saguinus bicolor* (sauim-de-coleira), *Cebus apella* (macaco-prego), *Alouatta seniculus* (guariba), *Pithecia pithecia* (parauacu) e *Chiropotes sagulatus* (cuxiú). O sauim-de-coleira foi a espécie de primata mais avistada (n=58 avistamentos), seguida pelo macaco-prego (n=29), guariba (n=20), parauacu (n=13) e cuxiú (n=10), totalizando 130 diferentes avistamentos, distribuídos nas diferentes cotas altitudinais mensuradas e, consequentemente, em todos os tipos de ambientes - platô, vertente e baixio (Fig. 2). Apenas *Saguinus bicolor* (χ^2=14.89, gl=6, p<0.02) e *Chiropotes sagulatus* (χ^2=19.40, gl=6, p<0.03) apresentaram diferenças significativas no número de grupos avistados nas diferentes classes de horários (Fig. 3). O número de indivíduos por grupo variou de um (para *A. seniculus, C. apella* e *P. pithecia*) a 15 (para *C. sagulatus*), sendo que a média dos grupos variou de 2,5 (para *P. pithecia*) a 7,7 (para *C. sagulatus*). A maior densidade foi registrada para *S. bicolor* (1.00 Gr/km^2), seguida por *C. apella* (0.67 Gr/km^2), *A. seniculus* (0.66 Gr/km^2), *P. pithecia* (0.64 Gr/km^2) e *C. sagulatus* (0.30 Gr/km^2). Esse mesmo padrão é encontrado quando calculamos a abundância relativa das espécies (Tabela 1).

Tabela 1. Informações sobre os parâmetros populacionais das espécies de primatas encontradas na RFAD.

Espécie	N° de avistamentos	Tamanho populacional*	Densidade (Gr/Km^2)	Abundância (Gr/l)
Alouatta seniculus	20	2,95 (1-6)	0,66	0,28
Cebus apella	29	5,90 (1-13)	0,67	0,40
Chiropotes sagulatus	10	7,70 (3-15)	0,30	0,14
Pithecia pithecia	13	2,54 (1-4)	0,64	0,18
Saguinus bicolor	58	5,26 (2-11)	1,00	0,80

* Entre parênteses se encontram os valores mínimos e máximos de indivíduos

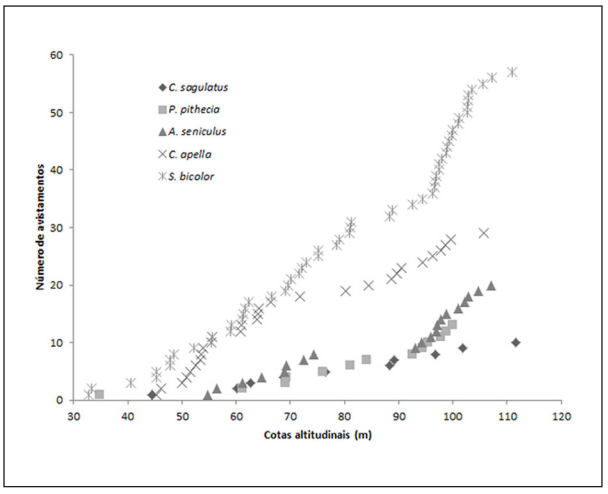

Figura 2. Número de avistamentos de primatas na RFAD em relação à variação altitudinal.

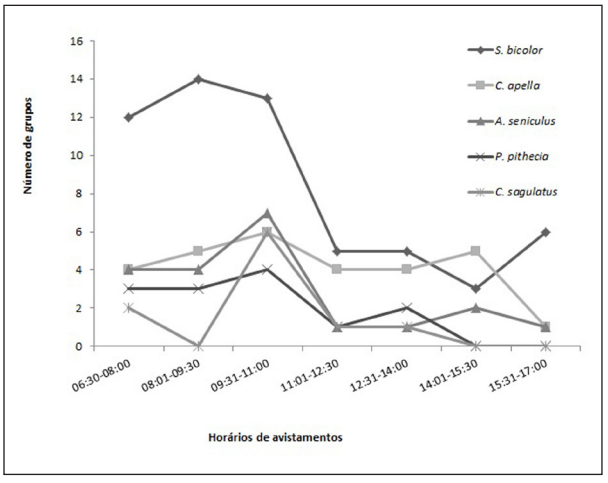

Figura 3. Número de grupos avistados nas diferentes classes de horários registrados na RFAD.

Se levarmos em conta que a RFAD abrange uma área de 10,000 ha de floresta, podemos afirmar que a estimativa de grupos presentes em sua área total, desconsiderando-se a possível presença de lacunas, as variações naturais do habitat ou a disponibilidade dos recursos, é de 100 grupos de *S. bicolor*, 67 grupos de *C. apella,* 66 grupos de *A. seniculus*, 64 grupos de *P. pithecia* e 30 grupos de *C. sagulatus.*

Discussão

Nossos resultados, registrando cinco espécies de primatas no interior da RFAD, demonstram que esta área abriga uma considerável representatividade de espécies quando comparada com outras áreas nas proximidades de Manaus. Na área de relevante interesse ecológico do Projeto Dinâmica Biológica de Fragmentos Florestais (PDBFF), unidade de conservação situada a cerca de 60 km da RFAD, a fauna de primatas é representada por seis espécies (Gilbert e Setz, 2001; Boyle, 2008). Enquanto que nas matas ciliares do rio Cuieiras, inseridas no Parque Estadual do Rio Negro Setor Sul, distante cerca de 70 km da área urbana de Manaus, a primatofauna é um pouco mais diversa, tendo sido registradas oito espécies (Spironello, 2000).

Das cinco espécies registradas em nosso estudo, *Saguinus bicolor* - o único calitriquídeo encontrado na área - é classificado como Ameaçado na Lista Vermelha da IUCN (IUCN, 2010) e Criticamente Ameaçado segundo a Lista Brasileira de Espécies Ameaçadas (Gordo, 2008). De acordo com Rylands e Mittermeier (1983), as espécies mais ameaçadas de extinção são aquelas que apresentam distribuição geográfica restrita e se encontram nas áreas mais urbanizadas, características plenamente identificáveis em *Saguinus bicolor*. Quando comparamos a densidade de grupos de sauim-de-coleira encontrada em nosso estudo com as obtidas por Subirá (1998) e Rosas-Ribeiro *et al.* (2006) (Tabela 2), podemos observar que a de nosso estudo situa-se em nível intermediário. Estas diferenças para densidade podem ser explicadas por dois motivos relacionados à metodologia aplicada: (1) os dois últimos estudos citados trabalharam somente em uma parcela da RFAD e (2) apesar das técnicas de censo utilizadas terem sido semelhantes nos três estudos, o fato das análises considerarem ou não a probabilidade diferenciada de avistamento de um animal pelo observador em relação à distância entre eles e a distância entre o animal detectado e a trilha, pode ter contribuído para subestimar os resultados ou o inverso. É importante salientar que variações intraespecíficas no tamanho das áreas de uso e na densidade dos primatas podem estar relacionadas com mudanças espaciais e temporais de recursos como alimento, água ou habitats adequados em termos de proteção contra predadores (Rylands, 1986), bem como com o grau de conservação de suas áreas.

Em nosso estudo, *Cebus apella* apresentou densidade um pouco maior que as reportadas por Rylands e Keuroghlian (1988) em uma área de floresta contínua na Amazônia Central e por Rosas-Ribeiro *et al.* (2006) em três áreas de floresta de terra firme da Amazônia Central, incluindo a RFAD (Tabela 2). *Cebus apella* é um primata que possui uma dieta generalista e apresenta grandes áreas de vida na Amazônia Central (Spironello, 1991). Reporta-se que, em fragmentos menores, estes primatas possuem densidades relativamente altas. Isto deve estar ligado ao fato destes animais apresentarem uma larga plasticidade ecológica (Robinson e Redford, 1986). Nossos resultados sugerem que, apesar da RFAD ainda estar se tornando um grande fragmento florestal dentro da cidade de Manaus, populações como as de macaco-prego já estão respondendo a essas mudanças da paisagem. Dos primatas Neotropicais com grande massa corpórea os guaribas são as únicas espécies capazes de sobreviver em fragmentos de floresta com menos de 10 ha (Rylands e Keuroghlian, 1988). Isto se deve ao fato de que as populações desses primatas apresentam uma dieta mais baseada em folhas nos meses de escassez de frutos na floresta (Crockett, 1998; Santamaría-Gómez, 1999). Apesar de apresentarem essa alta flexibilidade alimentar e fisiológica,

Tabela 2. Densidades de primatas registradas em diferentes estudos na Amazônia.

Autores	Local	Densidade (Gr/Km²)/Espécies				
		Alouatta seniculus	***Cebus apella***	***Chiropotes sagulatus***	***Pithecia pithecia***	***Saguinus bicolor***
Nosso estudo	RFAD*	0.66	0.67	0.3	0.64	1
Subirá, 1998	RFAD	-	-	-	-	0.4
Rylands e Keuroghlian, 1998	BDFFP**	2	0.4	0.4	0.2	-
Peres e Nascimento, 2000	PNJ***	1.3	3.4	-	1.2	-
Rosas-Ribeiro *et al.*, 2006	RFAD/LBA****/BDFFP	2.15	0.54	0.99	1.28	1.63

*RFAD - Reserva Florestal Adolpho Ducke; ** Projeto Dinâmica Biológica de Fragmentos Florestais; *** Parque Nacional do Jaú; **** Programa de Grande Escala da Biosfera-Atmosfera na Amazônia

a densidade dessa espécie parece ser bastante comprometida pela pressão de caça (Peres, 1997). Em nosso estudo estimamos uma densidade bem inferior àquelas encontradas em outros estudos em florestas de terra firme (Tabela 2). Essa diferença pode estar relacionada ao fato da RFAD estar imersa em uma área de franca expansão urbana e a frequente presença de caçadores em seu interior, fazendo assim com que as populações destes grandes atelídeos respondam de maneira negativa.

Quando comparamos as densidades de *Chiropotes sagulatus* e *Pithecia pithecia* encontradas por Rylands e Keuroghlian (1988) e por Rosas-Ribeiro *et al.* (2006) com os resultados que obtivemos, nota-se que houve diferença entre os três estudos. O presente estudo estimou uma densidade intermediária entre os dois anteriores (Tabela 2). Estes resultados podem ser explicados pelo fato destes estudos terem utilizado diferentes metodologias de censo para a estimativa de densidades, fazendo com que subestimem e/ou superestimem as populações estudadas. Daí a necessidade de uma padronização de metodologias para que as estimativas possam ser mais confiáveis e comparáveis. O pequeno tamanho populacional das espécies de primatas encontradas na RFAD sugere que a sobrevivência das mesmas na área pode estar ameaçada em longo prazo, visto que é necessário um valor muito maior de indivíduos/floresta para que esta seja viável e não sofra com os efeitos demográficos, genéticos e estocásticos (Reed *et al.* 2003).

As cinco espécies de primatas reportadas em nosso estudo tiveram uma ampla distribuição nos ambientes de platô, vertente e baixio. Vidal e Cintra (2006), em um estudo com *Saguinus bicolor*, mostram que essa espécie teve uma ampla distribuição na RFAD, incluindo áreas de platô, vertente e baixio. Essa ampla distribuição nos ambientes foi também documentada para outras espécies de *Saguinus* na Amazônia (Terborgh, 1983; Peres, 1994). *Alouatta seniculus* se encontra amplamente distribuído na região Amazônica, mas pode também ocupar outros tipos de hábitat como os bosques secos, com névoas, de galeria e mangues (Rylands *et al.*, 1996/1997; Crockett 1998). Segundo Crockett (1998) as espécies do gênero *Alouatta* estão catalogadas entre os maiores primatas e os mais folívoros do Neotrópico, o que deve explicar em parte essa ampla distribuição na floresta. *Cebus apella* também é um primata generalista de habitats, sendo encontrado em diferentes extratos da floresta e em diferentes fitofisionomias (Mittermeier e Coimbra-Filho, 1977; Mittermeier e van Roosmalen, 1981; Terborgh, 1983; Peres, 1994; Mendes-Pontes, 1997). Os primatas do gênero *Chiropotes*, habitam os estratos médio e superior de florestas, acima de 20 m de altura (van Roosmalen *et al.*, 1981; Ayres, 1989) e parecem ter uma forte preferência por florestas de terra firme com pouca perturbação. *Pithecia* é um gênero pouco estudado, e o que se sabe desta espécie está relacionado a estudos sobre a comunidade de primatas (Mittermeier e van Roosmalen, 1981; Rylands e Keuroghlian, 1988; Trolle, 2003). Parauacus são muito silenciosos, fugidios e rápidos, além de raros (Setz, 1993). No entanto vale ressaltar que indivíduos dos gêneros *Chiropotes* e *Pithecia* têm preferência pelas florestas de terra firme (Ayres, 1981; van Roosmalen *et al.*, 1981; Frazão, 1992; Peres, 1993; Ferrari *et al.*, 2003). Essas informações corroboram com os dados obtidos neste estudo, que evidenciam o maior encontro destas duas espécies em ambientes de terra firme.

Apesar de nosso estudo evidenciar diferenças obtidas nas visualizações de grupos em diferentes classes de horários, para duas das cinco espécies registradas há escassez de trabalhos que reportam estas características. Várias espécies de primatas neotropicais apresentam um padrão comum de atividade, concentrando suas atividades de forrageamento/alimentação e deslocamento de manhã e a tarde, e descansando nas horas mais quentes do dia (Egler, 1986; Santamaría-Gomez, 1999; Vidal e Cintra, 2006). Este padrão parece determinado parcialmente pela necessidade de satisfazer os requerimentos energéticos depois de longos períodos de inatividade noturna, e por facilitar a termorregulação durante as horas mais quentes do dia (van Roosmalen, 1985; Stevenson *et al.* 1994). Uma das espécies que apresentou diferença nos avistamentos ao longo do dia foi *Chiropotes sagulatus*. Segundo Frazão (1992), no período seco os cuxiús apresentam os maiores picos de atividades no período da manhã, onde a temperatura se apresenta mais amena. Em nosso estudo este primata foi mais visualizado neste período diário, no entanto nossa pesquisa

foi desenvolvida nos meses de novembro a julho, período que abrange o denominado "inverno" na Amazônia. Neste período, segundo Frazão (1992) eles substituem as atividades de forrageamento/alimentação por descanso. Essa última atividade poderia influenciar a detecção destes primatas na floresta, no entanto isso não pode ser observado neste estudo, visto que não realizamos censos durante o período seco. Tal como em outras pesquisas relacionadas com calitriquíneos (Terborgh, 1983; Egler, 1986; Vidal e Cintra, 2006), nossos avistamentos de *S. bicolor* sugerem um padrão típico de atividades mais intensas nas horas iniciais e finais do dia, com um período de descanso durante as horas mais quentes.

Implicações conservacionistas

Localizada na zona leste de Manaus, a RFAD representa um dos recursos ambientais mais valiosos da cidade, pois abriga uma diversidade de fauna e flora de extrema importância. Ela foi criada para preservar parte da floresta primária com toda a sua diversidade de fauna e flora para estudos científicos. No entanto, no ano 2000, foi necessário criar o Jardim Botânico de Manaus, que ocupa uma área de 5 km² da porção sul da reserva, de modo a conter o avanço das ocupações humanas nesta região. Mesmo com a construção do Jardim Botânico, em vários pontos da reserva podemos notar a destruição das cercas que demarcam os seus limites e a execução em seu interior de atividades ilegais como caça de animais silvestres, extração de madeira, retirada de frutos e queimadas.

No grupo dos primatas, espécies com baixas taxas reprodutivas, longos períodos de gestação e baixa fecundidade, como os representantes da família Atelidae, são mais sensíveis à caça que espécies com taxas reprodutivas mais altas, longevidade mais curta e menor tempo de gestação, como os ungulados e roedores (Peres, 1990; 2000). Em nosso estudo não foi confirmada a presença de macaco-aranha (*Ateles paniscus*) no interior da reserva. No entanto, segundo observação pessoal de Rodrigues, L.F., fora dos censos desse estudo, foi registrada vocalização deste primata dentro da reserva. A equipe do Protocolo de Primatas do Projeto TEAM também registrou a presença desta espécie na área (dados não publicados). Estes dados são extremamente importantes visto que a espécie há muito tempo não era visualizada na reserva. Provavelmente, estas visualizações esporádicas devem-se ao fato da RFAD possuir uma conexão, ainda que pequena, com a mata contínua, fazendo com que animais como o macaco-aranha, que possui grande área de vida (1.50 a 4.00 km² – Siemmen e Sabatier, 1996), saia da mata contínua e use eventualmente a área da reserva. Mittermeier *et al.* (1998) ressaltaram a necessidade de medidas emergenciais e de definições de prioridades para a conservação de áreas sob forte impacto de fragmentação, com consequente perda rápida de hábitat e de biodiversidade, em todas as escalas (global, regional e local). Ao avaliarmos o acelerado processo de fragmentação que a RFAD sofreu ao longo dos últimos anos, verificamos que as conclusões de Mittermeier *et al*. (1998) tomam uma proporção de urgência ainda maior, principalmente para espécies que requerem grandes áreas de vida e aquelas ameaçadas de extinção. A RFAD está inserida neste contexto e necessita de medidas que impeçam o avanço das queimadas e caça ilegal dentro da área, comprometendo assim o mais estudado fragmento florestal urbano da cidade de Manaus e as espécies que lá ocorrem. Neste sentido, torna-se necessário enfatizar a importância da criação de corredores ecológicos que liguem a RFAD a outros fragmentos florestais urbanos ou a floresta contínua, garantindo assim a sobrevivência das espécies que necessitam de extensas áreas de vida.

Em nosso estudo, a variabilidade na densidade dos primatas encontrados na RFAD, era esperada e pode estar associada às características biológicas das espécies, tais como mobilidade entre habitats, tamanho da área de uso, riqueza de recursos alimentares, entre outros. Os resultados sugerem a importância da RFAD na manutenção da biodiversidade e impõem a necessidade de políticas conservacionistas direcionadas para a contenção das perturbações antrópicas em sua área.

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POPULATION DENSITY OF BLACK-FACED LION TAMARIN (*LEONTOPITHECUS CAISSARA*)

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Abstract

Here we present the results of a population survey of the black-faced lion tamarin, *Leontopithecus caissara*, on Superagüi Island, and we extrapolate this estimation to the entire population. We used the linear transect method for surveys of the area from November 2000 to January 2002. When lion tamarins were seen in transects, we noted the perpendicular distance from the path and the number of individuals sighted in a cluster. Using the software Distance 4.0 we estimated a density of 1.79 individuals/km² and a population of 205 individuals (95% CI: 79 – 537 ind/km²) on the Superagüi Island. The extrapolation of these results to populations on the mainland gave us an estimate of 187 individuals (95% CI: 72 – 489 ind/km²). Our estimate for the total population is 392 individuals (95% CI: 218 – 1,026 ind/km²). The lower population density of *L. caissara* compared to other species of the genus, in combination with its very small geographic range, indicate that it is critically endangered. We also discuss some aspects of the limitations of the linear transect method when densities are extremely low. The Distance 4.0 software suggested a minimum of 30 sightings for a density estimate; but from the sighting frequency in our study this would require 2,489 hours and 883 surveys, not logistically viable.

Key words: Black-faced lion tamarin, *Leontopithecus caissara*, population density, line transect methodology.

Resumo

Apresentamos a estimativa populacional do mico-leão-da-cara-preta, *Leontopithecus caissara*, na Ilha do Superagüi e a extrapolação desses resultados para a população continental. Amostramos 12 trilhas por transecção linear entre os meses de Novembro de 2000 a Janeiro de 2002. Quando avistávamos micos-leões-da-cara-preta anotávamos a distância perpendicular ao transecto e o número de indivíduos presentes no grupo avistado. Utilizando o software Distance 4.0 estimamos uma densidade de 1.79 indivíduos/km² e uma população de 205 (IC 95% 79 – 537) indivíduos na Ilha do Superagüi. A extrapolação desses resultados para a porção continental de distribuição da espécie resulta em uma estimativa de 187 indivíduos (IC 95% 72 – 489). A estimativa para a população total é de 392 indivíduos (IC 95% 218 – 1,026). Estes resultados indicam uma baixa densidade de *L. caissara* comparada com as demais espécies do gênero, o que somado a sua restrita distribuição geográfica resulta em seu estatus de espécie criticamente ameaçada. Também discutimos alguns aspectos da limitação do método de transecção linear na estimativa de espécies com densidade muito baixas. O software Distance 4.0 sugere um mínimo de 30 avistamentos para a estimativa de densidade, mas com a freqüência de avistamentos desse estudo seriam necessárias 2489 horas e 883 amostragens em transectos, o que se torna inviável em termos operacionais e econômicos.

Palavras-chaves: Mico-Leão-da-Cara-Preta, Leontopithecus caissara, densidade populacional, método de transectos lineares.

Introduction

The black-faced lion tamarin, *Leontopithecus caissara*, was described in 1990, from Superagüi, an island just off the coast in the north of the state of Paraná, Brazil. It was later also found to occur in a small area of the continent, in Paraná and the extreme south of the state of São Paulo, Brazil (Lorini & Persson 1990, 1994). Lorini & Persson (1994) found the population of *L. caissara* to be very small. From their surveys by the linear transect method, they estimated an overall density of 0.3 groups/km² or 1.5 individuals/km², and a total population of 260 individuals in three separate subpopulations. The largest of these subpopulations, with 121 individuals, was that on the Island of Superagüi, with two mainland subpopulations in the states of Paraná (Guaraqueçaba) and São Paulo (Cananéia). Population density was found to be lower, and the total population and geographic range smaller (approximately

300 km²), than any of the other lion tamarins. As a result, *L. caissara* is ranked as "Critically Endangered" on the *IUCN Red List of Threatened Species* (IUCN, 2011).

Superagüi Island is part of the Superagui National Park, decreed in 1989 with an area of 24,500 ha. The initial surveys were carried out in the early 1990s, and the objective of the present study was to verify the current population size of *L. caissara* on Superagüi Island. We used the linear transect method and carried out some analyses concerning about the use of this methodology in the censusing of rare species. The fact that Superagüi is the stronghold for this species has considerably influenced investment in the management of the park. As a result of findings concerning the distribution of lion tamarin groups on Superagüi, the size of the park was increased in 1997 to 33,928 ha. Basic quantitative information on the population of this species on the Superagüi Island is crucial to our understanding of its status and viability, and for the future management of the park.

Study area and methodology

Superagüi Island (25°23'40 S, 48°13'09 W) has a total area of 114.59 km² and altitudes ranging from sea level to some small isolated hills reaching 245 m. The vegetation includes low coastal scrub and tall forest on sandy soils (*restinga* and *floresta de restinga*), some mangroves, and dense large-leafed tropical lowland and submontane forest (Prado, 1999; Schmidlin, 2004).

The surveys were carried out between November 2000 and January 2002. The linear transect method (Burnham *et al.*, 1980; Buckland *et al.*, 1993; Thomas *et al.*, 2002) was used along 12 trails totaling 37.43 km, the mean length was 3.12 km, and transects ranged from 2.25 to 4.15 km in length. In order to sample all the study area, transects were distributed along the whole island of Superagüi (Figure 1).

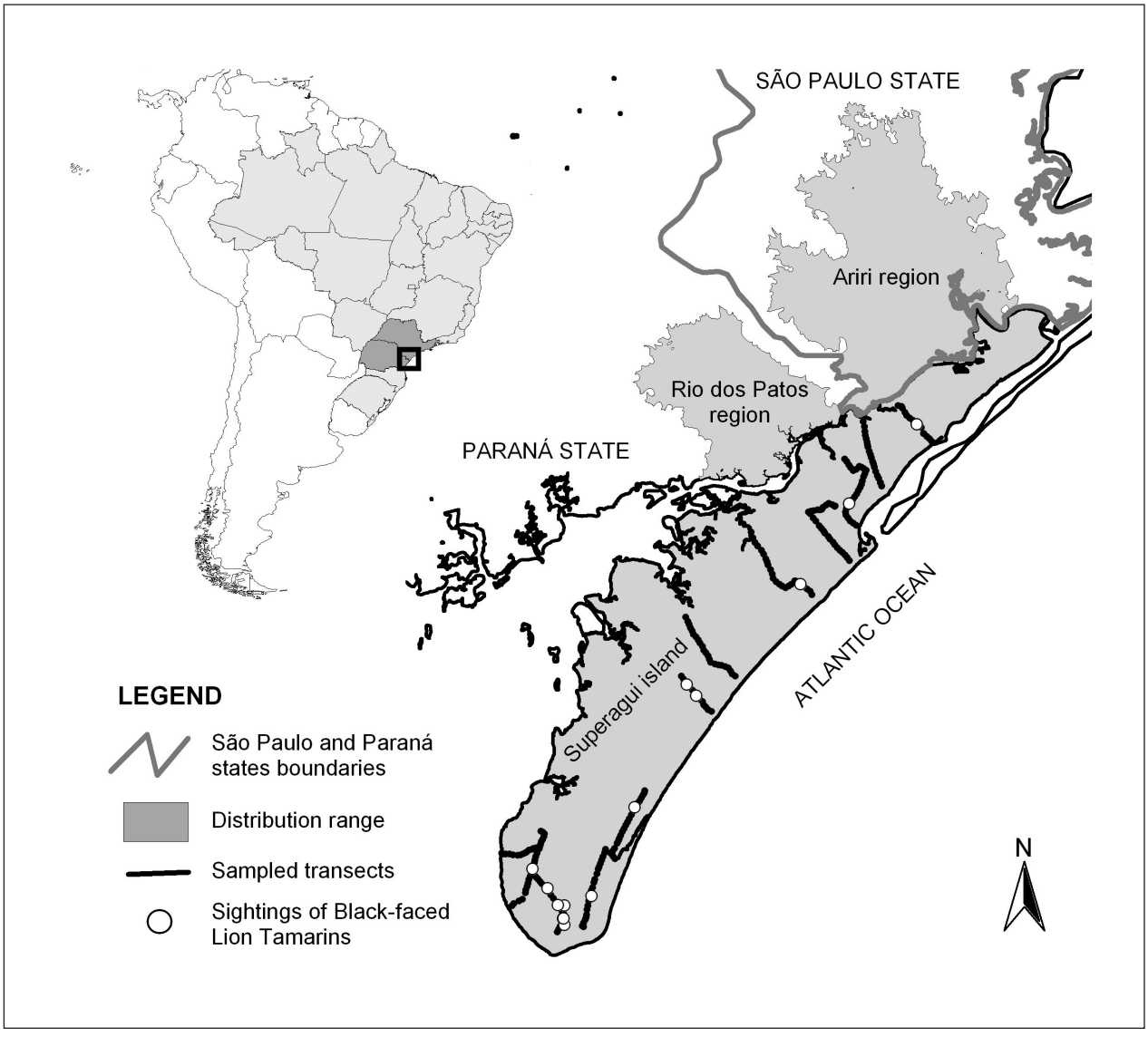

Figure 1. Location of transects on the island of Superagüi; Superagui National Park. The points indicate the locations of sightings of *L. caissara* groups.

All trails were marked at 50 m intervals to take the geographical coordinates using a GPS. The trails were censused an average of 15 times each (SE = 3.56); all between 07:00 and 16:00 h. The walking speed along the trails was approximately 1 km/hour. In order to make each census an independent sample, we use a minimum of 30 minutes to separate censuses along a trail when going out and returning, as suggested by the linear transect method (Buckland et al. 1993). On sighting a lion tamarin group, we took note of the time, the perpendicular distance from the trail of the first animal seen, the number of individuals, age/sex composition of the group where possible, and the name, height and geographical coordinates of the tree in which the individual or group was sighted. No more than 10 minutes were spent collecting the data for each group sighted. Unhabituated animals move away quickly after they perceive the presence of researchers.

Population size and density of individuals were calculated using the software DISTANCE 4.0 (Buckland *et al.*, 1993, Thomas *et al.*, 2001, 2002). The detection function for *L. caissara* was fitted by the model Half Normal Simple Polynomial, based on the smallest value of AIC (Aikaike's Information Criterion) and the larger value of GOF (Goodness of fit) (Cullen & Rudran, 2003). The estimates for the island were extrapolated to the mainland as well, in order to present an estimate of the overall population of *L. caissara*. Thomas *et al.* (2001) suggested that a minimum of 30 sightings are necessary for the survey method using linear transects. We estimated the number of surveys and hours spent in the field necessary to attain this number of sightings from the sighting rate we achieved, using the accumulated number of sightings, the distance censused and the time taken in censusing. A power function was fitted to the relationship between number of sightings and distance censused using a non-linear procedure with minimum squares as loss function and in a Quasi-Newton estimation process (Zar, 1999).

Results

Lion tamarins were sighted 13 times during 575,512 km of censusing (mean = 44.27 km per sighting). The density of black-faced lion tamarins was estimated at 1.79 individuals/km² (95% CI 0.69 – 4.69 ind/km²), and the total population for the island (114.59 km²) at 205 (95% CI 79 – 537 ind/km²) with a coefficient of variation (CV) of 48.2%. Extrapolating the same population density to the mainland occurrence area (104.28 km² including the Paraná and São Paulo populations) results in an estimate of 187 mainland individuals (95% CI 71.95 – 489.07 ind/km²). The estimate for the total population size was 392 individuals (95% CI 151 – 1,026.5 ind/km²). The mean number of individuals per group observed on the island was 4.5 (95% CI 3.64 – 5.56 ind.).

The relation between the accumulated time spent censusing (in hours) and the number of sightings showed a progressive correlation (Figure 2). According to the equation of the line estimated from the data in Figure 2, time spent surveying would have to be 7.56 times greater than was done on this study (2,489 hours) in order to obtain 30 sightings of *L. caissara*, as suggested by Thomas *et al.* (2001).

We conducted 182 independent censuses (including those on the same trail - going up the trail and then back after an interval of a half-hour or more) on the 12 transects. When the number of surveys increased, there was a non-exponential increase in the number of sightings, and, according to the equation of the curve in Figure 3, it would be necessary to carry out 883 censuses to obtain 30 sightings of lion tamarin groups.

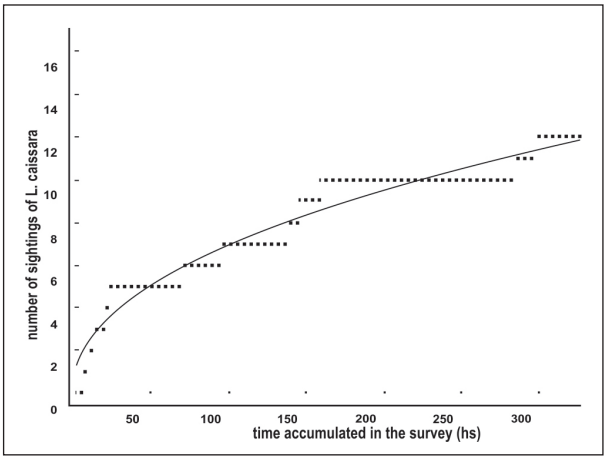

Figure 2. Time accumulated on the survey in hours in relation to the number of sightings. The equation of the line $y = 0.84x^{0.45}$ explains 94.67% of variation.

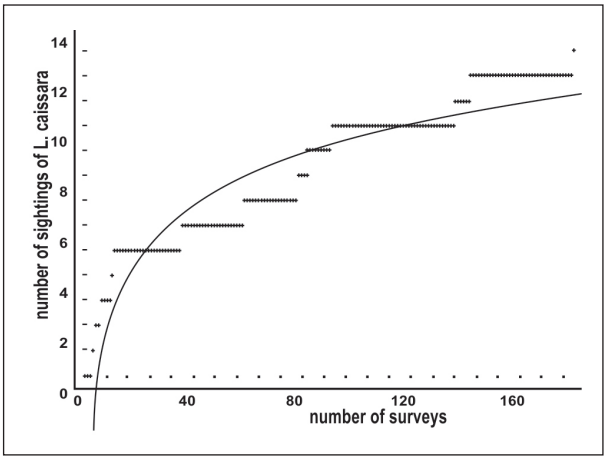

Figure 3. Correlation between the accumulation in the number of surveys and the number of sightings. The graph indicates that 95.78% of the variation displayed by the non-linear regression is explained by the equation of the line $y = 0.78x^{0.53}$.

Discussion

The estimate of 205 black-faced lion tamarins on the island of Superagüi, and our extrapolation of an estimated 187 individuals on the mainland and a total population of 392 wild individuals, has a relatively wide margin of error due to the small number of sightings (n=13) during the censuses. The coefficient of variation (48.2) of the population size estimate reflects the variation between transects (n=12) (Magnusson, 2001), resulting from such as: i) variation in the structure of the vegetation, ii) seasonality and availability of food resources, and iii) presence or absence of the capuchin monkey (*Sapajus nigritus*), a possible competitor. The two species were frequently seen eating the same fruits, and the lion tamarins seemed to avoid the capuchin monkeys.

The surveys illustrate a problem with regard to repeat transect censusing as a method for estimating population densities of rare species such as the black-faced lion tamarin. As indicated by DISTANCE 4.0, 2,489 hours of survey (Figure 2) and 883 censuses (Figure 3) would be necessary to achieve the 30 sightings necessary to reduce the confidence interval and the standard error to a more acceptable level. It would not be logistically viable. The question is whether 30 sightings are really necessary. We believe additional efforts must focus on research design and event counts, both factors affecting the error of Distance Sampling (Buckland et al., 2001). The method's accuracy would also benefit from alternative estimations of population density and the incorporation of ecological parameters into models. In this study, we propose novel strategies for population density estimates, including the use of confidence intervals and the use of home-range and home-range-overlap in association with group size.

A mean home range of 250 ha with an overlap of approximately 19%, based in data from four groups studied on Superagüi Island (F. Prado, unpublished data), and an average group size of 4.5 individuals, provides an approximate population of 244 individuals for the 11,459 ha of the island. This estimate represents the environmental carrying capacity (K) of the black-faced lion tamarins on Superagüi Island, and is within the confidence interval of the estimate from the censuses. As such it reduces the maximum value of the population of *L. caissara* in Superagüi to 244 individuals. The only previous estimate for the Superagüi population, reported by Lorini & Persson (1994), indicated 121 individuals. Ours, seven years on, is 40.98% higher, and 121 is within the confidence interval for our estimate. It important to highlight that it may also reflect a real increase in the numbers of lion tamarins due to protection in the park and the environmental education program, initiated in 1996 (Padua *et al*., 2002).

The population density we estimate for *L. caissara* on Superagüi is lower than those found for the other lion tamarins. An understanding of density and population size is, of course, a key factor, in future contingencies for the genetic management of the three sub-populations as a metapopulation. However, further research is needed to understand the habitat requirements of *L. caissara*, and what may well be significant differences in the population dynamics in the subtly diverse vegetation types they occupy in terms of structure and floristic composition, both on the island and on the mainland. Small populations with restricted geographical distributions and low population densities, as it is the case for *L. caissara*, are more susceptible to extinction, genetic problems, environmental fluctuations and extreme environmental conditions (Gilpin & Soulé, 1986; Soulé, 1987; Lacy, 1987, Ralls *et al*., 1988, Purvis *et al*., 2000). The small population and low population density confirm that the black-faced lion tamarin should be considered "Critically Endangered" and given top priority for conservation programs.

Acknowledgments

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Short Articles

MALE CARE IN MANTLED HOWLER MONKEYS (*ALOUATTA PALLIATA PALLIATA*)

Eugenia Zandonà

Introduction

Adult male-immature interactions in non-human primates range from aggressive displays – their extreme expression being infanticide (Bartlett et al., 1993) – agonistic buffering (Taub, 1980), tolerance or indifference (Baldwin & Baldwin, 1973) to affiliative and caretaking (Riedman, 1982; Buchan et al., 2003). In some monogamous species such as tamarins and marmosets (reviewed in Riedman, 1982), males participate in parental care almost as frequently as mothers. Indeed in these species, the adult males' reproductive efforts include parental care – (mainly expressed in infant transportation)- and not just mating costs as in polygamous species (Key & Aiello, 2000). Some forms of paternal care, particularly protection from danger, are also seen in polygamous species (e.g. savannah baboons, *Papio cynocephalus*; Buchan et al., 2003).

In the genus *Alouatta*, cases of infanticide by males have been reported following group take-overs (Clarke, 1983; Agoramoorthy & Rudran, 1995; Knopff et al., 2004). Nevertheless, tolerant, playful, and protective behaviors toward infants and juveniles are more common than agonistic activities (Baldwin & Baldwin, 1973; Clarke, 1986). In this paper I report on male care of an immature mantled howler monkey (*Alouatta palliata palliata*) orphan, and discuss whether it can be viewed in terms of paternal care or adoption.

Methods

The observations reported here were recorded during a study of the behavioral ecology of four groups of mantled howler monkeys in the Sectór Santa Rosa of the Area de Conservación Guanacaste (ACG) in Costa Rica (Fig. 1). The study area is a tropical dry forest with patches of semi-evergreen forest at various stages of succession, characterized by distinct wet and dry seasons (Janzen, 1986), with an annual rainfall of ~1,500. The study group was observed during a more extensive behavioral research project covering three field periods over a total of 15 months: 1) from September to November 2003, the infant's mother was still in the group; 2) from April to August 2004, interactions occurred between the immature orphan and the immature-adult male and 3) from April to October 2005, when the immature was already independent. Rare behaviors and unusual social interactions, such as those described here, were recorded *ad libitum* and "all occurrences" recording (sensu Martin and Bateson 1993), thus an exact and detailed

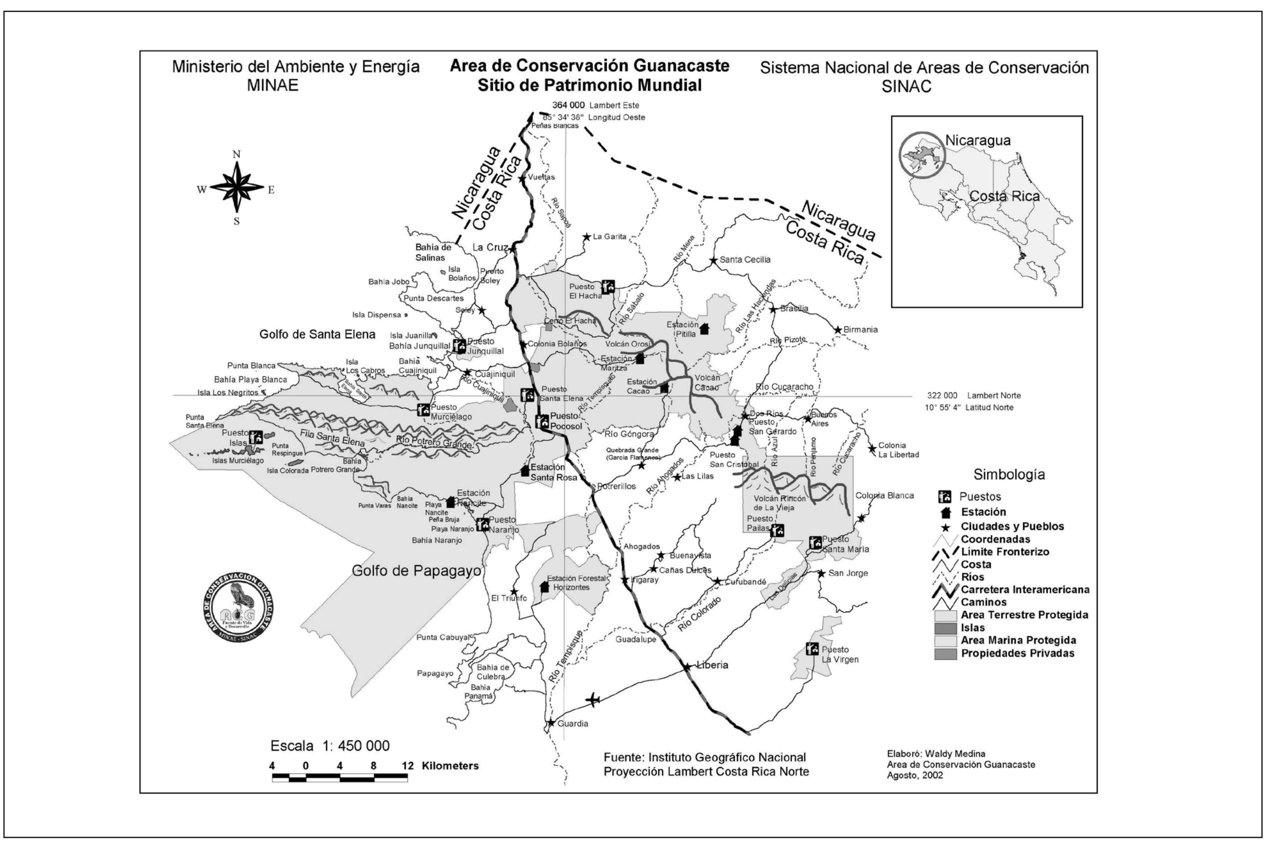

Figure 1. Map of the study site, the Area de Conservación Guanacaste (ACG) in Costa Rica. (Map credit Waldy Medina, ACG).

account of the behavior was recorded. Group composition and details of the sampling and recording methods for data collection during the three field periods are presented in Table 1. It was possible to identify all group individuals via unique physical features such as light spots underneath their feet, scars, or clitoris shape.

At the beginning of the study, the group comprised 2 adult males, 4 adult females and 3 immature, however the two key individuals in this study were an adult male, CH, and a female infant, EV. CH was probably the e lder of the two adult males, he had numerous facial wrinkles. EV's birth is estimated to have taken place in March or April 2003; so at the start of the study she was approximately 5–6 months old. When group observations resumed in 2004, EV was an orphan and her mother had disappeared from the group. Here I report on interactions between EV and CH during 2004. As the group was not the main focus of the overall research project during this year, it was followed for a shorter period (4 and 7 hours per day over 13 days) when compared to 2003 and 2005. Data reported here were collected *ad libitum* and recorded continuously (Altmann, 1974).

Results

During 2003, EV was still nursing and spending a large amount of time in proximity or in body-contact with her mother. In particular, while resting and sleeping, they were frequently in the mother-offspring resting (MOR) position, typical for an infant of EV's age. MOR is when the mother sits on her haunches on a support and the immature maintains ventral contact. In 2003, no interactions were recorded between CH and EV. By April 2004, EV was approximately 12–13 months old and an orphan, at this time she was observed interacting habitually with CH. During each of the 13 observation days, EV and CH were frequently seen resting in close proximity. On 17 occasions EV and CH were observed assuming the MOR posture, six times at sunrise, three at sunset and seven times during the day and once during a heavy rainfall event.

In the majority of cases, EV solicited that CH assume the MOR position, vocalizing, approaching him and crawling on to his body. In general, CH was passive during these interactions, simply allowing EV to attain body contact. However, on two occasions CH actively invited EV to assume the MOR posture, reaching out and pulling her gently towards him. The first event (30 Jun 2004) occurred when it was raining heavily, EV approached CH and started to emit distress calls; CH offered her protection, enabling her to position herself in ventral contact with him. The second time (23 Aug 2004), CH and EV were already in the MOR position, but after a few minutes CH removed EV, after which the infant started to produce distress calls and moved closer to CH, who then gently lifted her towards him, allowing her to return to the MOR posture. On several occasions, EV was observed following CH during travel, and feeding in close proximity to him. Play sessions were also recorded between these two individuals. No other adult was observed giving EV maternal/paternal care.

When the group was observed again in 2005, EV was 24–31 months old, she was completely independent and appeared to be healthy. She was never seen assuming the MOR posture with CH, however, affiliative interactions between the two individuals continued, mainly expressed through play (three records). EV was also seen playing with other juveniles and adult females. During the three years of observations (634 hours), EV was never observed interacting with the other adult male member of the group.

Discussion

Adult male howler monkeys are generally tolerant of infants and immatures, and have been recorded playing with them and allowing them to crawl on their bodies (Bolin 1981; Clarke, 1986). Males also occasionally baby-sit immatures when the mother moves away for short periods of time and they may also protect them in situations of potential danger (Clarke et al., 1998). Bolin

Table 1. Description of the sampling methods, group and orphan characteristics during the three years of observations for the study group. Sampling methods refer to all data collection for the study group during the larger behavioral project. EV: orphan; CH: adult male; M: adult male; F: adult female; I: immature; Fs: subadult female; MOR: mother-offspring resting posture.

Year	Sampling methods	Observation time	Group composition	EV's estimated age (months)	EV's condition	Interactions between EV and CH
2003	All occurrences, focal animal and *ad libitum*	33 days, 5–10 hr/d (Total=290 hrs)	2 M, 4 F, 3 I (Total=9)	~5–8	EV was still nursing and dependent on her mother	No interactions recorded
2004	All occurrences, *ad libitum*	13 days, 4–7 hr/d (Total=70 hrs)	2 M, 3–4 F, 3 I (Total=8–9)	~12–17	EV was an orphan	Numerous affiliative interactions were recorded, including MOR
2005	All occurrences, scan and *ad libitum*	30 days, 8–10 hr/d (Total=274 hrs)	2 M, 5 F, 2 Fs, 4 I (Total=13)	~24–31	EV was healthy and completely independent	Observed playing on 3 separate occasions

(1981) reported an increase in adult male-infant interactions with increased age of the infant in *Alouatta palliata pigra*, documenting that older infants (12 months or more, moderately independent of their mother) followed males during travel and foraged next to them. In 2004, EV and CH were observed both foraging and traveling in close proximity and playing together. However, the interactions between EV and CH were not limited to these contexts, CH undertook a role as paternal caregiver over longer periods. At night, and even during the day, they repeatedly assumed the MOR posture, which is normally restricted to the mother and infant. As infants mature (approximately 2 years in *Alouatta p. palliata*), this type of physical contact with the mother occurs less frequently, only during nighttime sleeping or heavy rainfall (pers. obs.). During these moments, older infants are still dependent on their mother for thermoregulation and protection from predators (Bicca-Marques & Calegaro-Marques, 1998). EV was orphaned at around 8–12 months, an age when she probably still needed the protection of an adult and required parental care, especially at night. Without the care of another individual of the group, she may have died. CH provided exclusive care to EV and probably contributed to her survival.

In *Alouatta palliata*, likely fathers show different forms of paternal care, such as carrying, cuddling, watching, and sitting in proximity, and have never been observed showing aggressive behavior towards their probable offspring, but they can be violent towards non-related infants (Clarke 1986; Clarke et al., 1998). During the observation period (2003–2005), CH and another individual were the only two adult males in the group. In stark contrast to the close relationship shared by EV and CH, no interactions were ever observed between EV and the other male. Although the genetic relatedness of EV and CH was never tested, it is possible that CH was EV's father.

It has been demonstrated that in some non-human primate species males can recognize their offspring and provide them with paternal care (e.g. *Papio cynocephalus*; Buchan et al., 2003). CH may have recognized EV as his daughter and taken care of her when she became an orphan, thereby substituting her mother and providing her with atypical paternal care for the species. Guaranteeing the survival of EV would thereby optimize CV's reproductive effort and increase his fitness. Infant adoption is often dependent upon the persistence of the immature in soliciting adult care, the tenacity of the infant can affect its chances of survival (Clarke & Glander, 1981; Dolhinow & Taff, 1993; Gould, 2000). In the case reported here, the female infant was often observed closely following the adult male, and more importantly, actively soliciting body contact and adoption by the male of the MOR posture. EV's insistence appeared to have paid off and she was able to secure the parental care she needed.

Biedzicki de Marquez and Ades (2000) described the only known case of male adoption in the genus *Alouatta*, where infant persistence seems also to have played a considerable role in the positive outcome of the adoption. Nevertheless, the adoption they described followed the kidnapping of the infant from another group and was undertaken by an adult female and adult male (the only two mature individuals of the group). This is somewhat different to the case described here. The orphan's survival was probably due largely to the care and protection given by the adult male, promoted by the orphan's persistence and the possible paternity of the adult male, thus this can be viewed as a case of paternal care rather than adoption.

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A PRELIMINARY STUDY OF THE GENETIC DIVERSITY OF PYGMY MARMOSET *CALLITHRIX PYGMAEA* (PRIMATES: CEBIDAE: CALLITHRICHINAE) USING SHORT SEQUENCE REPEATS (SSR)

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María de Lourdes Torres
Ana María Troya Zuleta

Introduction

Genetic diversity is a major concern in conservation biology, the loss of genetic diversity is often associated with a reduction in reproductive fitness and a population decrease. Genetic diversity is required for populations to evolve and adapt to environmental changes that in present times are more frequent and more rapid due to anthropogenic factors (Frankham et al. 2003).

Primates play a fundamental role in the dynamics of tropical ecosystems. The pygmy marmoset *Callithrix pygmaea* is the smallest primate species in Ecuador and shows a high degree of specialization in habitat and diet (de la Torre et al. 2009). This specialization combined with the increase of human activities in tropical rainforests could drive pygmy marmoset populations to genetic bottle necks with the subsequent loss of genetic diversity. Almost nothing, however, is known about the genetic diversity of this species so we began a pilot study to evaluate the genetic diversity of 3 wild groups of pygmy marmosets in one population located on the margins of the Aguarico River, in northeastern Ecuador. We developed a non-invasive protocol to obtain DNA samples from feces to characterize the genetic diversity of the groups as a first and necessary step in the implementation of a program to evaluate human impact on the genetic diversity of pygmy marmosets and other Ecuadorian primate species.

Study area and subjects

The San Pablo population is located at the margins of the Aguarico river (0°16'27"S, 76°25'29"W) (Fig 1). This area has varzea forest and is seasonally flooded by white-waters rivers. Three groups (P1, P2, P4), in this population have been monitored since the year 2000 and were the study subjects (de la Torre et al. 2009). Group size varied from 5 to 7 individuals during the sampling period. Groups P1 (5 individuals) and P2 (6 individuals) had the most distant home ranges, separated by open areas, houses and several plantations (closest linear distance between P1 and P2 home ranges: 250 m). Groups P1 and P4 (7 individuals) had a disturbed, secondary forest connecting their home range areas (closest linear distance between P1 and P4 home ranges: 165 m). Finally, between the home range areas of groups P2 and P4 there are open areas with some trees but no houses (closest linear distance between P2 and P4 home ranges: 200 m).

Methods

Collection of fecal samples

Fecal samples were collected from September 2008 through February 2009 from these three groups. Large leaves of banana (*Musa paradisiaca*) and heliconia (*Heliconia* spp.) were placed very early in the morning under the feeding tree of a group before the marmosets began their daily activities. Animals were observed by one field worker in periods of 3 hours from 0600 to 0900 and from 1500 to 1800 (local time). The leaves were checked continuously during the observation periods. Due to the collection methods, we could not accurately address a particular fecal sample to a given animal in a group; however, based on our observations, we are confident that the collected feces belonged to at least 3 different animals in each group. Collected feces were stored on filter paper and placed in a flask with a desiccant (silica gel). The closed flasks with the samples were dried with controlled sunlight (avoiding drastic rises of temperature) during one or two days to reduce the probability of contamination of the feces with fungi. The samples were later transported to Quito and placed in a freezer at –20º C.

Genetic analyses

DNA from the samples was obtained using the QIAamp DNA Stool Mini Kit (*QIAGEN*). Polymerase chain reaction technique was used to amplify nDNA microsatellites; we tested primers established by Nievergelt et al. (1998) for *Callithrix jacchus*. The PCR amplification was performed in a 25µL reaction volume which include buffer 1X, 1.5mM of $MgCl_2$, 0.2µM of dNTP`s, 0.24µM of each primer, 0.5U of Taq polymerase (Invitrogen) and 5ng of sampled DNA. The amplification program consisted of an initial denaturation of 3 min at 95º C; 40 cycles of denaturation for 1 min at 94º C, annealing for 1 min at optimum temperature (Table 1) and an elongation during 1 min at 72º C; and a final elongation at 72º C during 5 min. Polyacrylamide 6% and urea 5M gels were used to separate DNA bands.

Results

Forty two fecal samples were collected from the three groups; 23 samples from group P4, 12 samples from group P2 and 7 samples from group P1. Five of the nine loci tested (CJ-1, CJ-7, CJ-11, CJ-12, and CJ-15) showed a higher number of amplified samples (>10 amplified samples per primer) (Table 1) and were used for a preliminary analysis of the number of alleles in each loci. DNA samples from group P4 showed various alleles at the five loci tested, samples from group P2 showed alleles at 3 loci, and samples from group P1 showed alleles at four loci (samples from this group showed fixed alleles at 2 loci) (Fig 2).

Discussion

Although the number of samples for each group was small (P1 n = 7; P2 n = 12; and P4 n = 23) and the number of loci analyzed was also low (5 loci), the results evidence the

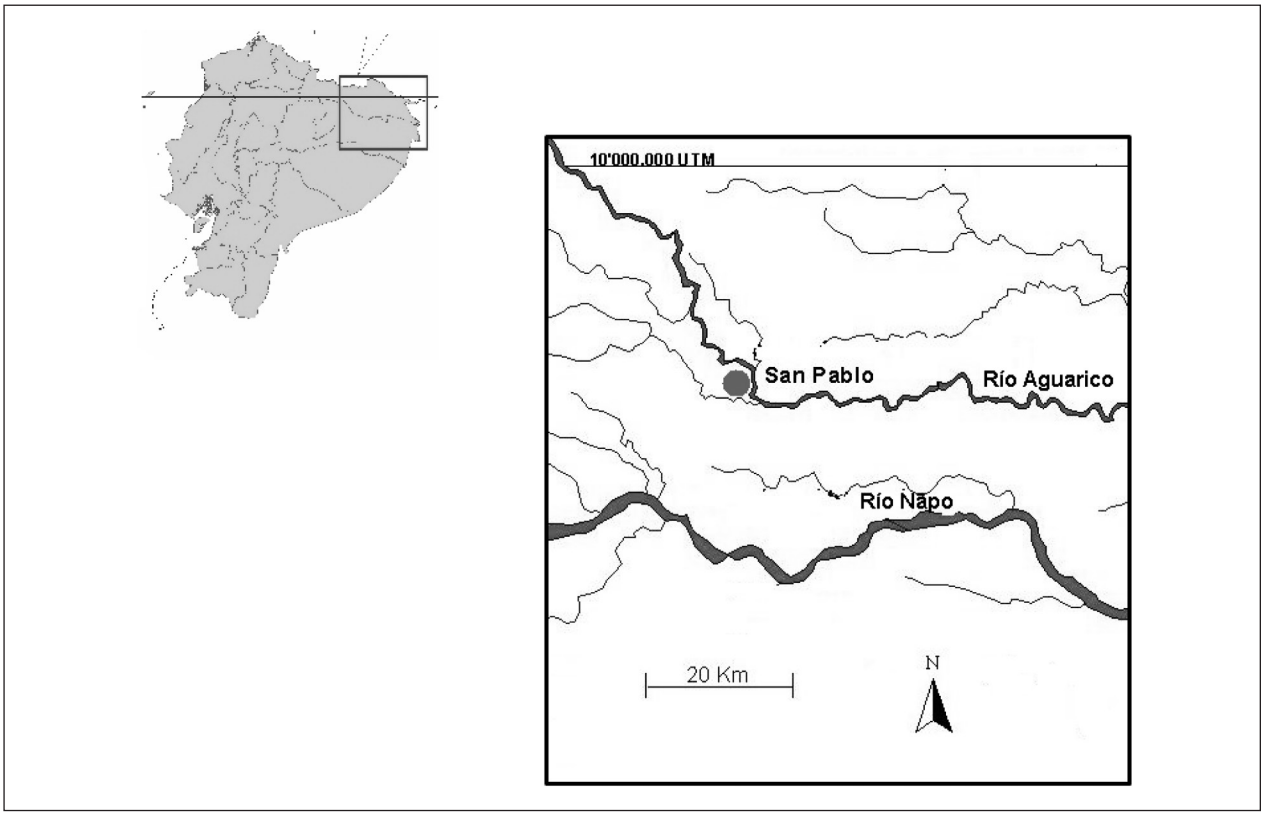

Figure 1. Location of the San Pablo population in Ecuadorian Amazonia

feasibility of inter-specific use of microsatellite primers to evaluate genetic variability of related primate species (Clisson et al. 2000, Nievergelt et al. 1998). The results also allow us to differentiate several alleles in some of the tested loci. The fixed alleles found in groups P1 and P2 could be an artefact of the collection methods (we could not address fecal samples to particular individuals) and the small sample sizes for these groups, making it possible that more than one sample belonged to the same individual. However, they could also suggest a reduced genetic variability in groups affected by strong habitat fragmentation (Frankham et al. 2003). We are now collecting more samples to identify different genotypes in each group to be able to assess genetic variability in this and other populations of pygmy marmosets.

The conservation of biodiversity is critical in tropical forests of the Amazon. The annual deforestation rate in Ecuador is estimated at around 200,000 ha and most of it takes place in the Amazon region, which is also affected by oil exploitation and mining (Ministerio del Ambiente et al. 2001, SENPLADES 2007). Molecular genetics is a tool to evaluate the impact of human activities on the populations of species inhabiting these areas, such as the pygmy marmoset. Sensitive genetic markers, such as microsatellites, have the power to detect reductions in heterozygosity and allelic diversity in small and fragmented populations (Frankham et al. 2003) and provide useful information for conservation planning. This is the first study of this type for pygmy marmosets in Ecuador and elsewhere; our results suggest that non-invasive methods to collect DNA for the evaluation of the genetic diversity can be used even for small species such as pygmy marmosets. Our next steps in this research will be to improve the collection methods in the field (to reduce DNA damage, increase sample size and identify genotypes) and include more populations in the genetic analyses.

Table 1. Annealing temperature, number of amplified samples and product size range in base pairs (bp) for the nine loci analyzed in *Callithrix pygmaea*

Primer	Annealing temperature (ºC)	# Amplified samples	Product size range in base pairs (bp)
CJ-1	58	11	128 - 176
CJ-6	58	0	-
CJ-7	50	13	119 - 127
CJ-10	50	4	217 - 243
CJ-11	50	14	106 - 142
CJ-12	58.4	27	132 – 168
CJ-13	50	0	-
CJ-14	56.2	9	156 - 184
CJ-15	50	15	124 - 138

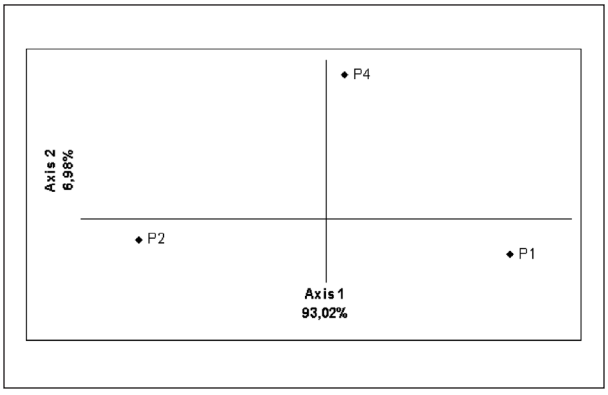

Figure 2. Allele frequencies at the five loci in the pygmy marmoset groups P1, P2, and P4 (numbers in the X axis correspond to the base pairs)

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REACTIONS OF WHITE-BELLIED SPIDER MONKEYS TO A PREDATION ATTEMPT BY A COUGAR

Ítalo Mourthé

An increasing body of evidence suggests that large felids are one of the main predators of large arboreal primates (e.g., Peetz *et al.*, 1992; Matsuda and Izawa, 2008). Predators employ highly specific hunting techniques in order to successfully capture their prey, and prey species may evolve elaborate defense behaviors in order to avoid been killed (Zuberbühler and Jenny, 2002). However, just as there are a scarce number of predation records in the wild, there are also relatively few accounts of behavioral responses by primates facing their predators (Stelzner and Strier, 1981; Heymann, 1990; Nunes *et al.*, 1998; Asensio and Gómez-Martín, 2002; Miranda *et al.*, 2006). Here, I describe the reactions of white-bellied spider monkeys (*Ateles belzebuth*) facing a large potential predator, the cougar *(Puma concolor)* at Maracá Ecological Station (MES; 3°21'44" N, 61°26'01" W), a large riverine tropical rainforest island in the state of Roraima, Brazil.

On June 22, 2010, I witnessed the furtive approach of a cougar while following a mixed-sex troop of approximately 7–9 spider monkeys in a relatively low *terra-firme* forest. The cougar was observed at 0704h moving quickly and silently, and it appeared to be pursuing the spider monkeys. During the few seconds the cougar was observed, it crouched with its head slightly raised, its ears up and facing forward, and its face oriented toward the moving monkeys. Then, it resumed tracking the monkeys' route and I did not see it again. The cougar apparently did not perceive — or ignored — my presence nearby.

The spider monkeys reacted instantly when they detected the cougar. Intense and loud barking calls were emitted and they quickly climbed as high as possible in the canopy (*ca.* 18 m). However, monkeys did not shake branches or throw sticks down as observed when they are disturbed by predators (e.g., Matsuda and Izawa, 2008)Colombia</title><secondary-title>Primates</secondary-title></titles><periodical><full-title>Primates</full-title></periodical><pages>65–68</pages><volume>49</volume><keywords><keyword>Predation</keyword><keyword>Spider monkey</keyword><keyword>Jaguar</keyword><keyword>Puma</keyword></keywords><dates><year>2008</year></dates><accession-num>PDF0219</accession-num><call-num>0869</call-num><urls></urls></record></Cite></EndNote>. Then, I noted the troop split into two vocalizing parties about 50 m apart from each other. After approximately 10 min the party I was following stopped vocalizing and resumed moving in the same direction where the other party was still barking. The 4–5 individuals moved in a single file, very slowly and silently, for about 80 m from the point where they had detected the cougar, then stopped again at 0727h in a large tree (*ca.* 30 m). There, the spider monkeys recommenced their alarm calls, varying in frequency and intensity. At this time, they moved back and forth quickly, mostly in a stereotyped way, while vocalizing—a behavior consistent with the definition of mobbing (Curio, 1978; Lloyd *et al.*, 2006)2006—on thick horizontal branches (apparently avoiding the peripheral ones), shaking, breaking, and dropping sticks from the tree. They were very agitated in the tree, and once they stopped moving, their bodies stayed oriented toward the place where, presumably, the cougar had been seen. Both males and females engaged in this mobbing. For instance, an adult female was seen going back and forth repeatedly on the same branch, vocalizing loudly and gazing up at a specific point. At 0750h I heard one loud roar from the cougar but there was no indication that a monkey had been caught. The monkeys became visibly more stressed, barking and moving more intensely and chaotically. The roaring came from the east, the direction that spider monkey barks had been oriented. At 0801h the spider monkeys stopped barking and the party resumed travelling again, slowly and silently, moving northward from that area. Approximately one minute later the other party (3–4 ind.) was also seen travelling quietly in the same direction. At that time, barking ceased completely and they joined together as one troop. In total, the troop had vocalized continuously for at least one hour. Then, the spider monkeys resumed their typical activities but several individuals remained visibly stressed and vigilant. For instance, while they were resting just around mid-day, one female suddenly start barking and other individuals joined this barking bout that lasted approximately 20 min. Some monkeys were looking down, scanning the area frequently while barking but I saw no apparent reason for this behavior.

Although I have no evidence that a predation event occurred, there is evidence that large felids prey on spider monkeys at other sites (Matsuda and Izawa, 2008)Colombia</title><secondary-title>Primates</secondary-title></titles><periodical><full-title>Primates</full-title></periodical><pages>65–68</pages><volume>49</volume><keywords><keyword>Predation</keyword><keyword>Spider monkey</keyword><keyword>Jaguar</keyword><keyword>Puma</keyword></keywords><dates><year>2008</year></dates><accession-num>PDF0219</accession-num><call-num>0869</call-num><urls></urls></record></Cite></EndNote>. In the present study, the spider monkeys were visibly alarmed by the cougar and their altered behaviors imply that they recognize cougars as a threat (Peetz *et al.*, 1992)1992. The monkeys' reactions were consistent with detecting and escaping the predator: a noisy barking followed by a mobbing attempt and finally, a silent retreat. Certain environmental variables are clearly linked to predation risk such as height or obstructive cover (Cheney and Wrangham, 1987; Miller and Treves, 2007)K.C.</author><author>Panger, M.</author><author>Bearder, S.K.</author></secondary-authors></contributors><titles><title>Predation on primates – Past studies, current

challenges, and directions for the future</title><secondary-title>Primates in Perspective</secondary-title></titles><pages>525–543</pages><dates><year>2007</year></dates><pub-location>New York</pub-location><publisher>Oxford University Press</publisher><urls></urls></record></Cite></EndNote>, and it is likely that spider monkeys were not feeling safe enough at their initial height to confront the predator—this may explain why their initial response did not include agonistic behaviors. Once they reached a taller tree, they rapidly began agonistic displays.

Previous studies have suggested that antipredator behaviors depend on the type of predator and the situation where the encounter occurs (Asensio and Gómez-Martín, 2002). Mobbing calls can communicate the presence of a predator to conspecifics as well as prompt predator to move away (Lloyd et al. 2007). Following mobbing, the spider monkeys performed a coordinated, secretive retreat, which might be a response to a cursorial predator able to pursue them throughout the forest (e.g., Zuberbühler *et al.*, 1997)1997. Antipredator behaviors in primates typically include quick escapes and noisy vocalizations (e.g., Phillips, 1995; Lloyd *et al.*, 2006; Matsuda and Izawa, 2008), but cryptic behaviors (e.g., Yeager, 1991; Zuberbühler *et al.*, 1997; Gilbert, 2000) such as the one illustrated here are not commonly reported in large species. In addition, unlike the usual pattern observed in other primates where males were the main group protectors (Cheney and Wrangham, 1987), my observations suggest that adult spider monkeys of both sexes play an active role in group defense (see also Matsuda and Izawa, 2008)Colombia</title><secondary-title>Primates</secondary-title></titles><periodical><full-title>Primates</full-title></periodical><pages>65–68</pages><volume>49</volume><keywords><keyword>Predation</keyword><keyword>Spider monkey</keyword><keyword>Jaguar</keyword><keyword>Puma</keyword></keywords><dates><year>2008</year></dates><accession-num>PDF0219</accession-num><call-num>0869</call-num><urls></urls></record></Cite></EndNote>. More research is needed to understand the impact of antipredator behaviors on primate evolution and population dynamics.

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SOUTHERN EXTENSION OF THE GEOGRAPHICAL RANGE OF THE PYGMY MARMOSET *CEBUELLA PYGMAEA NIVEIVENTRIS* (LÖNNBERG, 1940) IN THE SOUTHWESTERN AMAZON BASIN, STATE OF RONDÔNIA, BRAZIL

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In this paper we identify a southern extension of *Cebuella pygmaea niveiventris* in the upper reaches of the Rio Madeira basin, State of Rondônia, located in the Southwestern Amazon Biome, Brazil. This includes the first registered sighting of *Cebuella pygmaea niveiventris* within the State of Rondônia. We adopt the taxonomic guidelines of Lönnberg (1940) and consider the *Cebuella pygmaea* specimen collected from Lago Ipixuna (on the southern banks of the Rio Solimões) with a white chest, belly, inner surface of forelegs and hindlegs, as a subspecies (*C. p. niveiventris*). Hershkovitz (1977), on the other hand, argues that the color of the underparts in this specimen is an individual characteristic and varies locally in the *C. pygmaea* population, and so does not justify the status of subspecies.

Cebuella pygmaea niveiventris was previously thought to occur in the following locations: in Eastern Peru south of the Rio Marañon and east of the Rio Huallaga, and in the Brazilian state of Amazonas, south of the Rio Solimões and west of the Rio Purus. Its geographical distribution was later found to include the interfluvium Purus-Madeira to the southern limits of the Rio Ipixuna (or Paranapixuna) by Roosmalen and Roosmalen (1997). The presence of *C. p. niveiventris* in northern Bolivia reported by Heltne *et al.* (1976), Izawa (1979), Izawa and Bejarano (1981) and Brown and Rumiz (1986) suggests its occurrence in the upper Rio Madeira basin, as well as the eastern part of the State of Acre including the upper reaches of the Rio Abunã, a tributary of the Rio Madeira, as argued by Rylands *et al.* (1993). Ferrari (1993, 1996) also suggested that it was likely to occur along the upper reaches of the Rio Madeira basin, as local residents had reported its presence near to the Serra dos Três Irmãos Ecological Station in northwestern Rondônia. In addition, according to Messias (2002, 2004), a total of 18 out of 66 interviewees living between the Santo Antônio rapids and the convergence of the Rio Abunã with the Rio Madeira confirmed the presence of *Cebuella pygmaea niveiventris* when shown a selection of photos of various neotropical mammal species.

Sightings by riverine communities indicate that the ocurrence of *Cebuella pygmaea niveiventris* is always found in *terra firme* (non-flooded) riparian forests of the Rio Madeira and those of its major tributaries near to their confluence (Messias, 2004). The upper reaches, with high, steep banks have *terra firme* forest right up to the edge of the riverbank along almost all of its length. Interviewees explained that *Cebuella pygmaea niveiventris* visits fruit trees at the height of the rainy season, however the number of sightings has drastically decreased over the last ten years. In these interviews, the occurrence of *Cebuella pygmaea* was particularly high among the "Jatuarana" and "Cachoeira do Macaco" riverside communities, where pygmy marmosets were frequently observed eating the *Inga edulis* fruits (Messias, 2004) and associated ants (M. A. Oliveira personal observation).

Cebuella pygmaea niveiventris has never been sighted by researchers in the upper reaches of the Rio Madeira before, although several groups have been registered at the construction site of the Santo Antônio hydroelectric dam near the Santo Antônio rapids, located approximately 9 km upstream from the city of Porto Velho, Rondonia´s State capital, and the first of 16 rapids that present a major obstacle to navigation of the upper reaches of the river. Here we report a specimen that was rescued during the clearing of the Santo Antônio hydroelectric dam construction site (08º46´46.4" S; 63º 58´14.0" W) and deposited at the scientific collection of the Federal University of Rondônia (UNIR), in the Reference Mammal Collection (CRMRO) (museum catalogue: UFROM 175, adult male, skull, skin and skeleton, collected by Juliano Coragem and Ivonete Santa Rosa Gomes, October 10, 2009). The specimen is yellowish grey with a white chest, belly and inner surface of forelegs and hindlegs, and is similar to the Lönnberg description of the subspecies *Cebuella pygmaea niveiventris*.

We also report that two *Cebuella* groups were observed after the Santo Antônio hydroelectric dam construction site had been cleared; both groups were in a very small forest patch with a high density of *Cecropia* sp. trees (two individuals at 08°46'53.9" S; 63°56'11.9" W and four at 08°47'05.3" S; 63°56'11.9" W, J. Coragem, personal observation). This corroborates the ecological data from *Cebuella pygmaea niveiventris* from the lower reaches of the Rio Madeira basin, where locals reported *C. p. niveiventris* to be common but confined to *terra firme* forest (van Roosmalen and van Roosmalen, 1997).

The newly registered sightings and the collected sample confirm the southern extension of the geographical range of *Cebuella pygmaea niveiventris* to the upper reaches of the Rio Madeira basin (an area that has been highly impacted by the recent construction of two hydroelectric dams: Santo Antônio and Jirau). The preferred habitat of *Cebuella* in this region – the riparian forest of the Rio Madeira and major tributaries – is directly affected by the dam´s reservoirs, and although information is lacking in terms of the distribution and density of groups in this area, reports by local people indicate a sharp population decrease in the last 10 years. This, together with the synergetic impact of

deforestation of the reservoir areas, merit further research and monitoring in order to establish the consequences for *Cebuella pygmaea niveiventris* in the upper reaches of the Rio Madeira basin.

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OBSERVATIONS OF A FIGHT BETWEEN TWO ADULT MALE MANTLED HOWLER MONKEYS (*ALOUATTA PALLIATA*)

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Introduction

The mantled howler monkey (*Alouatta palliatta*), in the initial studies by Carpenter (1934), was considered to have very low social interaction rates and very rare aggressive behaviors. Forty years later, Klein (1974) was still able to claim that howlers exhibited the lowest levels of conspecific aggression among social primates. More recently, reports of male-male fights (Glander, 1992) and chases (Young, 1981), female-female fights (Zucker & Clarke, 1998), male-female fights leading to death of the female (Mendez-Carvajal et al., 2005), and infanticide by males (Clarke, 1983), have changed that perception. The actual observation of these aggressive interactions, however, continues to be a rare event, and has led to various indirect measures documenting aggression, such as bodily injuries of live animals in the field (Cristobal-Azkarate et al., 2004) and skeletal pathologies of collected skulls from one location (DeGusta & Milton, 1998).

Considering just potential aggressive interactions between males, individuals within the same troop may fight over access to an estrous female (Jones, 1980), or a solitary male may fight the alpha male of a troop either for control of the troop (Glander, 1992) or just to become a troop member (Estrada, 1982). If the relationship of the two males had been father-son, there probably would not have been a fight, with the displaced father either leaving or becoming a subordinate (Glander, 1992). Numerous observers have indicated the take-over of mantled howler troops by solitary males (e.g. Young, 1982). Only one publication, involving

a long-term study, indicates that a possible take-over fight was actually seen (3 times); unfortunately, descriptions of the actual fights were not included (Glander, 1992). Short-term observations, obtained due merely to chance, can sometimes provide records of rarely-occurring behavior not typically documented in long-term observations. An example of such a phenomenon is the following observations of a fight between two male mantled howler monkeys.

Observations

On 15 March 2002 on the west side of the Osa Peninsula of Costa Rica, at Drake Bay in the vicinity of the Punta Rio Clara Wildlife Refuge, a group of howlers were at a beach area with low forest canopy (height 25–40 ft) composed of the trees Manchineel (*Hippomane mancinella*) and Beach Almond (*Terminalia catappa*). Observations began 0900 h, with clear skies. The howler group was composed of 12 individuals (3 males, 6 females, 1 juvenile, 2 infants) spread out amongst several adjacent trees. All was quiet for the first hour of observation with no obvious feeding by adults and immatures. The two infants were active and separated from adults, with several adults grooming themselves or adjacent animals. At about 1000 h, an adult male (henceforth A), at the periphery of the group and adjacent to several females, began howling and making other vocalizations, began jumping from one branch to another, and in general seemed quite agitated. After several minutes of this activity, another adult male in the group (henceforth B), slightly smaller and in apparent prime condition, also became agitated. This male had been quietly reposing well within the group area, adjacent to other members of both sexes. Male B began jumping and running from limb to limb, circling male A while continuing to vocalize. Male A stayed in place but kept moving so as to continually face male B. Actual physical contact was initiated by male B, with subsequent screaming, yipping, wrestling, and biting, with blood becoming visible on both monkeys. About 20 seconds after the initial contact, both monkeys fell together approximately 20 ft to the ground. Within an approximately 6m^2 area, the two male monkeys continued vocalizing and fighting, with blood now visible on the sand as well as on bodies. The fighting involved standing upright on the rear legs and grabbing and biting of face, neck, back, arms, and legs, (but not tails); close face-to-face contact with associated body punching and scratching; all of which continued for approximately 90 seconds. Finally male B began chasing male A on the ground; when male A went up into a tree, male B followed, but when male A continued into an adjacent tree, male B did not follow. Male A continued moving through the trees, away from male B, until out of sight of the observers. Male B stayed quietly in the tree for about 10 minutes, then moved back to the trees where the other group members resided. There were no obvious sounds or movements of group members when male B arrived. All members remained quiet and inactive for the next hour, when the observations were terminated. In departing the area, the observers searched for male A in the direction that it had fled, but it was not detected. When the fighting began, the 2 infants of the group had quickly moved to adjacent adult females. The group members then vacated the tree in which the fight was occurring, moved to the surrounding trees, and faced the combat area.

Discussion

One of several unusual aspects of these observations is that both males appeared to be within the group structure – group initially quiet, the two males resting close to other group members and within the apparent borders of the spread-out group – suggesting that neither male was a 'solitary' male trying to gain access to the troop and that both may actually have been resident males. There did not appear to be an estrous female being guarded by either male, which if that had been the case, could have led to a fight (Jones, 1980). The fight also suggests that their relationship was not of father-son. Male A was the slightly larger monkey, but male B was in prime condition (no obvious scars or other damage or deformities) with a shiny coat and quite vigorous, whereas male A had several neck and facial scars, a dull coat, and seemed to be less vigorous. The very placid response of the other members of the group to the fight was also not anticipated, the minimal response suggesting that the fight was something that was expected by group members or at least was not unusual and was not something that should have led to group agitation.

The two most probable alternative interpretations of these observations are as follows: 1) Male A was the alpha male of the group, male B was a subordinate male within the group (both males had all white and fully descended scrotums) who successfully changed his position in the dominance hierarchy by defeating and chasing the alpha male from the group. The fact that male A was the first to become agitated (issuing a challenge?) suggests that there was some tension between these monkeys, and that as alpha male he was looking for a resolution, for him the removal of B from the group. Being the larger male, with some probable battle scars, would not be unusual for an alpha male (Carpenter, 1934), or, 2) Male B was the alpha male of the group, defending successfully his position from the attack by the subordinate male A. The fact that male B initiated the physical contact indicates that he was willing to actually fight, rather than merely posturing. His prime physical condition suggests that he had been well fed and cared for, also not unusual for an alpha male (Carpenter, 1934). Additional factors that seem to favor this interpretation of male B as the alpha male include his behavior once male A became agitated. Male B was the subsequent aggressor, circling male A before finally attacking, suggesting willingness for physical combat expected from an alpha male defending his status. A subordinate male would likely attempt to intimidate an alpha male by threatening behaviors but be less likely to actually fight, given that in general the possessor of resources is usually successful in defending those resources (e.g. Silk, 1987). Perhaps the most significant indication that male B was the initial alpha male

was the apparent lack of response of the group to his victory. If the subordinate male A had been the victor, immediate and considerable activity of the other group members would have been expected, particularly from the females (Young, pers. obs.).

Unfortunately, it was not possible to obtain observations of this group on the days immediately before or after the fight, observations that could have indicated the previous relationship of these two males and the subsequent fate of the defeated male and the group infants.

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Recent Publications

BOOKS

Behavioral Flexibility in Primates: Causes and Consequences (Developments in Primatology: Progress and Prospects), by Clara B. Jones. 2011. Springer. 208pp. ISBN: 978–1441936028. With numerous figures, illustrations, and tables; this book emphasizes upon both behavioral and cognitive mechanisms, conceptually unifying primatology and the other evolutionary sciences, developing novel perspectives, and integrating new literature and concepts into primatology. *Contents:* 1. Introduction to intraindividual variation of primate behavior; 2. The costs and benefits of behavioral flexibility to inclusive fitness: dispersal as an option in heterogeneous regimes; 3. Primate signatures and behavioral flexibility in heterogeneous regimes; 4. Social cognition and behavioral flexibility: categorical decision-making as a primate signature; 5. Female primates as "energy-maximizers" in heterogeneous regimes; 6. Male primates "time-minimizers" in heterogeneous regimes; 7. Intersexual interactions in heterogeneous regimes: potential effects of antagonistic coevolution in primate groups; 8. Sociosexual organization and the expression of behavioral flexibility; 9. Behavioral flexibility: interpretations and prospects.

Primate Biogeography: Progress and Prospects (Developments in Primatology: Progress and Prospects), edited by S. M. Lehman & J. G. Fleagle. 2010. Springer. 546pp. ISBN: 978–1441940087. This book highlights the many factors that may influence the distribution of primates, and reveals the wide range of approaches that are available to understanding the distribution of this order. The biogeography of primates in the past is a major component of our understanding of their evolutionary history and is an essential component of conservation biology. *Contents:* 1. Biogeography and primates: A review – S. M. Lehman & J. G. Fleagle; 2. Nested distribution patterns and the historical biogeography of the primates of Guyana – S. M. Lehman; 3. Genetic evidence pn historical biogeography of Central American howler monkeys – J. A. Ellsworth & G. A. Hoelzer; 4. Ecological biogeography of primates in Guyana – S. M. Lehman, R. W. Sussman, J. Philips-Conroy & W. Prince; 5. Contrasting phylogeographic histories of chimpanzees in Nigeria and Cameroon: A multilocus genetic analysis – M. K. Gonder & T. R. Disotell;

6. Geographic variation in savanna baboon (*Papio)* ecology and its taxonomy and evolutionary implications – J. M. Kamilar; 7. Biogeography and evolution of the *Cercocebus-. Mandrillus* clade: Evidence from the face – W. S. McGraw & J. G. Fleagle; 8. Lemur biogeography – J. U. Ganzhorn, S. M. Goodman, S. Nash & U. Thalmann; 9. Mouse lemur phylogeography revises a model of ecogeographic constraint in Madagascar – A. D. Yoder & K. L. Heckman; 10. Abiotic and biotic factors as predictors of species richness on Madagascar – N. J. Stevens & P. M. O'Connor; 11. The geography of mammals and rivers in mainland southeast Asia – E. Meijaard & C. P. Groves; 12. Primate biogeography and ecology on the Sunda Shelf Islands: A paleontological and zooarcheological perspective – T. Harrison, J. Krigbaum & J. Manser; 13. The Biogeography on primate evolution: The role of the plate tectonics, climate and chance – J. G. Fleagle & C. C. Gilbert; 14. Biogeographic origins of primate higher taxa – C. P. Heesy, N. J. Stevens & K. E. Samonds; 15. Mammalian biogeography and anthropoid origins – K. C. Beard; 16. Continental paleobiogeography as phylogenetic evidence – J. B. Rosie & E. R. Seiffert.

Conservation Refugees: The Hundred-Year Conflict between Global Conservation and Native Peoples, by M. Dowie. 2011. The MIT Press. 371pp. ISBN: 978-0262516006. This book describes how native peoples have been displaced from their lands in the name of nature conservation. It also discusses issues as differing definitions of "nature" and "wilderness," the need for Western scientists to respect and honor traditional lifeways, and the need for native peoples to blend their traditional knowledge with the knowledge of modern ecology.

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ABSTRACTS

Selected abstracts of oral presentations relating with neotropical primates from the 80th Meeting of the American Association of Physical Anthropologists, Minneapolis, Minnesota, USA, April 12 to 16, 2011

Amato KR, Yeoman CJ, Righini N, Kent A, Estrada A, Munoz D, Stumpf RM, White B, Nelson KE, Torralba M, Gillis M, Leigh SR. 2011. Gastrointestinal microbial community composition and habitat structure in howler monkeys (*Alouatta pigra*).

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Beznson M, Watts SM. 2011. Tree truthing: How accurate are substrate estimates in primate field studies?

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Connour JR. 2011. Comparison of Ateline limb bone biomechanical properties.

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Gladman JT. 2011. Linear enamel hypoplasias and the dietary adaptations of *Cebus*.

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Jaeggi AV, Van Schaik CP. 2011. The evolution of food sharing in primates.

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Kauffman L. 2011. Creating sustainable primate-based tourism: a view from the Central Suriname Nature Reserve.

Klukkert ZS, Rosenberger AL. 2011. A new angle on the anterior dentition of Platyrrhines: a preliminary report.

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Machnicki AL, Haile-Selassie Y, Spurlock L, Mendes S, Strier KB, McCollum MA, Lovejoy C. 2011. Parallel lumbar and pelvic morphology in Atelines and early hominids: clues to the earliest hominid adaptations to upright walking?

Matthews LJ, Nun CJ. 2011. Using phylogenies and social networks to detect the modality of disease transmission in wild primate social groups.

Middleton ER, Schmitt CA, Di Fiore A. 2011. Ontogenetic changes in prehensile tail use by lowland woolly monkeys *(Lagothrix poeppigii)* in Yasunı´ National Park, Ecuador.

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Russo G, Young JW, Matthews LJ. 2011. Ontogeny of caudal vertebral structure in capuchin monkeys (*Cebus albifrons* and *C. apella*).

Rutherford J, Ross C, Tardi S. 2011. Energetics and life history plasticity in Callitrichine primates: a view within and across generations.

Scarry CJ. 2011. Experimental analyses of intergroup encounters among tufted capuchin monkeys: effects of resource quality and female sexual behavior.

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Spence-Aizenberg A, Di Fiore A, Fernandez-Duque E. 2011. Pairbonded adult titi monkeys of Ecuador (*Callicebus discolor*) change their affiliative relationships in the presence of infants.

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Westin JL, Kauffman L. 2011. Tourism in Suriname: do monkeys view tourists as predators or conspecifics?

Zichello J, Steiper M. 2011. Comparison of intraspecific genetic and morphological diversity among primate

Meetings

2011

Joint Meeting opf the International Ethological Conference and the Animal Behavior Society

The International Ethological Conference and the Animal Behavior Society will have a joint meeting this year at the Indiana University, Bloomington, Indiana, USA, from July 25–30, 2011. For more information and registration go to: http://www.indiana.edu/~behav11

45th Congress of the International Society for Applied Ethology

The 45th congress of the International Society for Applied Ethology will take place in Indianapolis, USA, from July 31 to August 4, 2011. The general theme will be Scientific evaluation of behavior, welfare and enrichment; and some of the specific topics: Zoo animal behavior, Laboratory animal behavior, Engineering environments & measurement technologies for science and welfare Pain, distress & humane end-points. Abstract submission closes February 14th. For more information visit http://www.applied-ethology.org/isaemeetings.htm

34th Meeting of the American Society of Primatologists

The meeting of the American Society of Primatologist will be held in Austin, Texas, USA, fro, August 13–17, 2011. Preliminary abstracts for symposia and workshops should be submitted by January 15, 2011. General abstracts deadline March 12, 2011. For more information go to http://www.asp.org/asp2011/index.htm

Simposio La Primatología en el Perú

La Fundación Yunkawasi organiza el Simposio La Primatología en el Perú: Historia, Estado Actual y Perspectivas, el cual se llevará a cabo en Lima del 17 – 22 de Octubre de 2011. Para más información consulte http://www.yunkawasiperu.org/evento-primates.html

2012

III Congreso Colombiano de Primatología

La Asociación Primatológica Colombiana junto con la Universidad del Norte y la Fundación Proyecto Tití, organizarán el III Congreso Colombiano de Primatología dentro del marco del evento *Biodiversidad: Recurso Estratégico*, el cual se llevará a cabo en Abril de 2012, en la ciudad de Barranquilla Colombia.

XXVI Congress of the International Primatological Society

The XXVI congress of the International Primatological Society will be held at the Cancún Convention Center, Cancún, Mexico, from August 12–17, 2012. For more information visit http://www.ips2012.org.mx/

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Notes to Contributors

Scope
The journal/newsletter aims to provide a basis for conservation information relating to the primates of the Neotropics. We welcome texts on any aspect of primate conservation, including articles, thesis abstracts, news items, recent events, recent publications, primatological society information and suchlike.

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Please send all English and Spanish contributions to: Erwin Palacios, Conservación Internacional – Colombia, Carrera 13 # 71-41 Bogotá D.C., Colombia, Tel: (571) 345-2852/54, Fax: (571) 345-2852/54, e-mail: <epalacios@conservation.org>, and all Portuguese contributions to: Júlio César Bicca-Marques, Departamento de Biodiversidade e Ecologia, Pontifícia Universidade Católica do Rio Grande do Sul, Av. Ipiranga, 6681 Prédio 12A, Porto Alegre, RS 90619-900, Brasil, Tel: (55) (51) 3320-3545 ext. 4742, Fax: (55) (51) 3320-3612, e-mail: <jcbicca@pucrs.br>.

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Short articles. These manuscripts are usually reviewed only by the editors. A broader range of topics is encouraged, including such as behavioral research, in the interests of informing on general research activities that contribute to our understanding of platyrrhines. We encourage reports on projects and conservation and research programs (who, what, where, when, why, etc.) and most particularly information on geographical distributions, locality records, and protected areas and the primates that occur in them. Text should be typewritten, double-spaced with no less than 12 cpi (preferably Times New Roman) font and 3-cm margins throughout, and should not exceed 12 pages in length (including references).

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Stallings, J. D. and Mittermeier, R. A. 1983. The black-tailed marmoset (*Callithrix argentata melanura*) recorded from Paraguay. *Am. J. Primatol.* 4: 159–163.

Chapter in book
Brockelman, W. Y. and Ali, R. 1987. Methods of surveying and sampling forest primate populations. In: *Primate Conservation in the Tropical Rain Forest,* C. W. Marsh and R. A. Mittermeier (eds.), pp.23–62. Alan R. Liss, New York.

Book
Napier, P. H. 1976. *Catalogue of Primates in the British Museum (Natural History). Part 1: Families Callitrichidae and Cebidae.* British Museum (Natural History), London.

Thesis/Dissertation
Wallace, R. B. 1998. The behavioural ecology of black spider monkeys in north-eastern Bolivia. Doctoral thesis, University of Liverpool, Liverpool, UK.

Report
Muckenhirn, N. A., Mortensen, B. K., Vessey, S., Fraser, C. E. O. and Singh, B. 1975. Report on a primate survey in Guyana. Unpublished report, Pan American Health Organization, Washington, DC.

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UNESCO. 2005. UNESCO Man and the Biosphere Programme. United Nations Educational, Scientific, and Cultural Organisation (UNESCO), Paris. Website: http://www.unesco.org/mab/index.htm. Accessed 25 April 2005. ("Acessada em 25 de abril de 2005" and "Consultado el 25 de abril de 2005" for articles in Portuguese and Spanish respectively).

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Neotropical Primates
A Journal and Newsletter of the IUCN/SSC Primate Specialist Group
Vol. 18(1), June 2011

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