ISSN 1413-4703

NEOTROPICAL PRIMATES

A Journal of the Neotropical Section of the IUCN/SSC Primate Specialist Group

Volume 20
Number 1
June 2013

SSC
Species Survival Commission

CONSERVACIÓN INTERNACIONAL
Colombia

Neotropical Primates

A Journal of the Neotropical Section of the IUCN/SSC Primate Specialist Group

Conservation International
2011 Crystal Drive, Suite 500, Arlington, VA 22202, USA

ISSN 1413-4703 Abbreviation: *Neotrop. Primates*

IUCN/SSC Primate Specialist Group logo courtesy of Stephen D. Nash, 2002.

Front cover: Adult male of *Alouatta guariba clamitans* in Cachoeira do Sul, state of Rio Grande do Sul, Brazil. Photo: Júlio César Bicca-Marques.

This issue of *Neotropical Primates* was kindly sponsored by the Margot Marsh Biodiversity Foundation, 432 Walker Road, Great Falls, Virginia 22066, USA, and the Los Angeles Zoo, Director John R. Lewis, 5333 Zoo Drive, Los Angeles, California 90027, USA.

Articles

SYMPATRIC DISTRIBUTION OF TWO SPECIES OF *ALOUATTA* (*A. SENICULUS* AND *A. PALLIATA*: PRIMATES) IN CHOCÓ, COLOMBIA

Sara A. Zuñiga Leal[1] and Thomas R. Defler[2,*]

[1] *Pontificia Universidad Javeriana, Bogotá D. C., Colombia*
[2] *Universidad Nacional de Colombia, Bogotá D.C., Colombia, E-mail: <thomasdefler@gmail.com>*

Abstract

We studied a zone of sympatry between *Alouatta seniculus* and *Alouatta palliata* on the left bank of the Atrato River (Chocó). We located 110 groups of *Alouatta,* consisting of 81 groups of *A. palliata* and 29 groups of *A. seniculus*, recorded between 12 – 300 m a.s.l. *Alouatta seniculus* was associated principally with *arracachal* and *panganal* vegetation of alluvial soils alongside the Atrato River below 50 m altitude, and *A. palliata* was associated with upland vegetation of gallery forest, primary forest and secondary forest (20-300 m a.s.l.). The average number of animals per group of *A. seniculus* was 5.59 (range 2-7 individuals) while the average for *A. palliata* was 6.76 (range 2-18 individuals). No phenotypic evidence of hybridization was detected in contrast to other studies of hybridization of *Alouatta*. The condition of many of the forests in this study suggests the necessity of a conservation program in order to protect this unique zone of sympatry between the two species.

Keywords: *Alouatta seniculus*, *Alouatta palliata*, sympatry, Chocó, Colombia, primates

Resumen

Se estudió una zona de simpatría entre *Alouatta seniculus* y *Alouatta palliata* en la margen izquierda del río Atrato (Chocó). La distribución de ambas especies se determinó mediante observaciones directas y encuestas. Los árboles utilizados fueron identificados, la estructura y número de individuos en cada grupo determinado, la ubicación registrado con GPS y los datos fueron analizados con SIG para determinar posibles factores ecológicos y geográficos que limitan la presencia de las dos especies. Se observaron 110 grupos de *Alouatta* consistiendo en 81 grupos de *A. palliata* y 29 grupos de *A. seniculus* diferentes, a alturas que varían entre 12 y 400 msnm. *Alouatta seniculus* está asociada principalmente a vegetación de tierras aluviales por debajo de los 50 msnm y *Alouatta palliata* a tierras altas. El promedio del tamaño de los grupos de *Alouatta seniculus* fue de 5.59 animales (rango 2-7 individuos) y el de *A. palliata* de 6.76 (rango 2-18 individuos). No se detectó evidencia fenotípica de hibridización como se ha reportado en otros estudios de simpatría de *Alouatta*. El tipo de vegetación mayormente utilizado por *A. seniculus* fue arracachal y panganal de los bajos, y principalmente al lado del río Atrato, mientras que *A. palliata* utilizaba bosque de galería, bosque primario, y bosque secundario y rastrojo. La condición de muchos de los bosques en este estudio sugiere la urgente necesidad de un programa de conservación para proteger esta zona única de simpatría entre las dos especies.

Palabras clave: *Alouatta seniculus*, *Alouatta palliata*, simpatría, Colombia, primates

Introduction

Alouatta is the most wide-spread Neotropical primate genus, distributed from southern Mexico to northern Argentina (Milton, 1980; Crockett, 1998). In Colombia two species are found that are generally allopatric, though there are poorly defined historic records and some recent observations that suggest a large sympatric zone between *Alouatta palliata* and *A. seniculus* for northern Colombia extending from the left banks of the Peye and Atrato in the Chocó department to the region around Cartagena, south to the río Sinú (Fig. 1). Whether *A. palliata* was at all common in northern Colombia east of the Atrato River can no longer be said; it is now very scarce in the region, perhaps having been largely displaced by *A. seniculus* which has a high tolerance for anthropogenic disturbances (Defler, 2012; Eisenberg, 1979). Three of the 14 recognized *Alouatta* species are known to have allopatric distributions with other *Alouatta* species (Crockett and Eisenberg, 1987). Small sympatric overlaps are known for *Alouatta pigra* and *A. palliata* in Central America (Horwich and Johnson, 1986), *A. palliata* and *A. seniculus* in Colombia (Hernández and Cooper, 1976) and *A. caraya* and *A. fusca* in northeast Argentina (Crockett, 1998).

This study was designed to describe and characterize the area of sympatric overlap between *A. palliata* and *A. seniculus* from a zone on the left bank of the Atrato River in the Darien, Colombia, and to search for phenotypical evidence of possible hybridization. We attempted to identify ecological factors characteristic of these species that could affect their distribution along the lower Atrato River. *Alouatta seniculus* persists at least sympatrically with *A. palliata* until the latitude of Quibdó (5°42´N) and, on the left bank of the lower Atrato river, *A. palliata* is present in the same region but on generally higher ground.

Methods

Study Area

The Colombian Darién in northwestern Colombia is part of the Chocó biogeographic region, recognized for its strategic position as a bridge between Central and South America. The region comprises the Panamanian province of Darién and the northern Chocó of Colombia and includes a forested low mountainous frontier between Panamá and Colombia as well as extensive lowland swamplands on both sides of the Atrato River. The climate of the region studied is generally drier than other parts of the Chocó to the south and has a unimodal annual precipitation between 1,900-3,100 mm, contrasting with the high precipitation of the central and southern portions of the department where the highest precipitations for any rain forest have been reported (13,300 mm in Lloró, south of Quibdó). Annual temperatures in the north are also higher at around 24° C in the lowlands, compared to further south (Rangel-Ch. and Arellano-P., 2004).

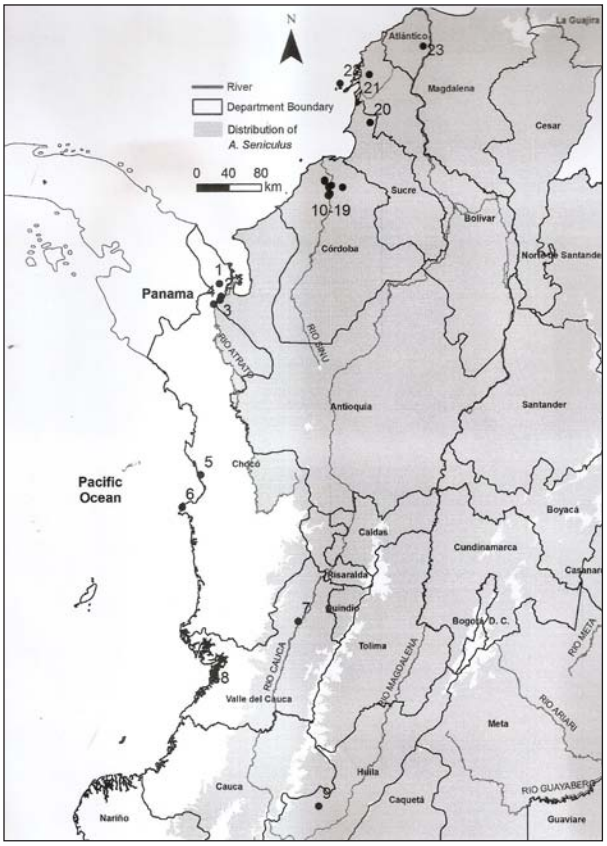

Figure. 1. Sympatry between *Alouatta palliata* (no. 2-4, 10-23) with *A. seniculus*. Numbers 10-20 are recent observations of biologists. Number 22 is an introduced island colony formed by animals introduced from the mainland (around no. 20) while 21 and 23 are historical records of past biologists.

Topography is varied from a wide belt of wetlands along the Atrato river at near sea level to hills and low mountains, that gradually increase in height towards the Panama border, becoming the low mountains of the Serranía del Darien, with average heights of only 500 m but a maximum height of 1,875 m for the Cerro Tacarcuna. Originally the entire region was covered in thick forest that could be classified as bh-T in the Holdridge life-zone system (Holdridge, 1967), but currently the region is in rapid conversion of the natural vegetation to an anthropogenic landscape (Rangel-Ch., 2004a). Current forest cover in the study area up to the boundary of Los Katios National Park is limited to fragments of primary forest and secondary forest representing distinct floristic communities. The forest fragments are generally surrounded by pasturelands used for cattle as well as cultigens (corn, yams, manioc, rice, plantains and bananas, sugar cane and some coca leaf) and tree plantations (particularly of cativo *Prioria copaifera*, ceder *Guarea aligero* and roble *Tabebuia rosea*). The principal economic activities in the zone are cattle ranching and small scale lumbering.

The study area includes the municipalities of Acandí (8°32' 00"N, 77°14'00"W) and Unguía (8°01'00"N, 77°04'07"W) [Colombian municipalities are similar to counties in the United States and include several towns and much countryside]. We selected ten localities because of confirmed presence of howlers and their locations, permitting reasonable access with manageable logistics. These localities were as follow: La Playona (Acandí), Balboa, Titumate, San Francisco, Tanela, Santa María la Nueva, Gilgal, Unguía and Los Katios National Park (Unguia). The particular characteristics of these localities are listed in Table 1. Data collection took place during the dry season between November, 2009 and February, 2010 (Table 1). The region has six sympatric species of primates; *Alouatta palliata, Alouatta seniculus, Ateles geoffroyi rufiventris* (=*Ateles fusciceps rufiventris*), *Cebus capucinus, Saguinus geoffroyi* and *Aotus zonalis,* but *Ateles geoffroyi* is becoming increasingly scarce due to hunting and habitat loss (Defler, in press-b).

Evaluating the species distribution

We used two methods to evaluate the distribution of the two species of *Alouatta*: unstructured interviews with local people and daily searches along paths and rivers (Pinto and Rylands, 1997; Iwanaga and Ferrari, 2002). The interviews consisted of questions about where groups had been seen, the color of their pelage and the type of vocalization. We also asked about hunting activities, the occupation of the interviewee and their time of residence in the area. People interviewed were principally subsistence hunters, small

farmers, park guards and farm owners. Observations were made on foot and from boat. For each locality we noted GPS coordinates, number of individual primates observed, age-class, sex, pelage phenotype, height from ground when first observed, altitude over sea level, and the forest type. Individuals were classified as adults, subadults, juveniles and infants (Defler, 1981). We analyzed the coordinates of our observations using the program ArcGIS, version 9.3 (2008) in order to map them.

Forest habitat structure was classified and sketched by topography (hilly, hill top, sides of hills, lowland and swampy), forest type (primary, secondary, re-growth, special types of forest) and altitude above sea level. Vegetation structure was analyzed measuring DBH (diameter at breast height), tree height, and the identification of tree species. We measured tree height and DBH only from trees where the groups were first seen.

Results

We completed 85 interviews and obtained 132 locations for *Alouatta* groups. We were able to locate 110 groups at these locations. The 110 groups totaled 672 individual howler monkeys of which 29 groups were *A. seniculus* and 89 groups were *A. palliata*.

Alouatta seniculus

For *A. seniculus* we found the 27 observed groups of the species in five different localities, confirming the presence of the species in four forest types varying in altitude from 7- 35 m a.s.l. (average = 19.3 m). Their distribution was restricted to floodable river plains and swampy lowlands. Eighteen of the 27 groups were seen on the left bank of the Atrato river in *panganal* (*Raphia taedigera*) associations in Katios National Park (Fig. 2).

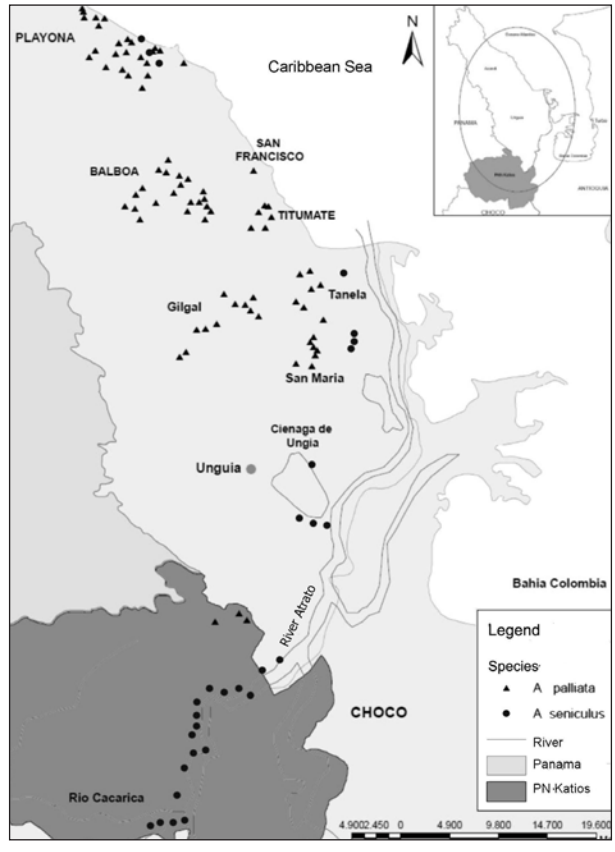

Figure 2. Distribution of howler groups in the Chocó Darien

Table 1. Sampled localities and condition of forest.

Site		Structure of Habitat	Selective Cutting		Hunting
PLAYONA		High forest and secondary fragmented vegetation surrounded by pasture	Medium/High		Very Low
BALBOA		Fragmented high forest and secondary vegetation with a mosaic of pastureland and cropland.	High During Study		Medium/High
TANELA		Very fragmented high forest surrounded by grasslands and cropland. Panganal Association is highly intervened.	Low at the present time.		Low
TITUMATE		High continuous forest surrounded by grassland and [oil] palm plantations.	Medium		Low
SAN FRANCISCO		Secondary growth surrounded by grasslands and tree plantations.	Medium		Low
SANTA MARIA		Secondary growth surrounded by grasslands and tree plantations.	Medium		Low
GILGAL		High forest, fragmented vegetation surrounded by grasslands and kitechen gardens.	High		High
UNGIA		Highly fragmented secondary vegetation surrounded by grasslands and conserved panganales.	Medium		Medium/High
PNN KATIOS		Continuous high forest and primary vegetation and conserved secondary vegetation, buffer zone wo cattle pastures.	Low		Low

The *A. seniculus* groups had an average of 5.59 +/- 2.08 (range 2-12 individuals) (Table 2). Two groups contained 11 and 12 individuals. The groups were made up of 1 or 2 adult males, 1-3 adult females and 1-3 subadults; the number of infants varied generally from 0-5. We observed two solitary adult males. The ratio of male adults to female adults was 1:1.1 and the ratio of adult females to immature (infant + juvenile) animals was 1:1.3. Pelage color was generally totally red-orange (Burnt Sienna to Mahogany Red or Chestnut according to Hershkovitz, 1949), although in some individuals there was some blackish coloring in the pelage that could not be closely observed due to the shyness of this species. Dark patches would suggest genetic introgression from *A. palliata*. We observed *A. seniculus* 55.2% of the time atop palm trees at an average height of only 12.5 m. Middle parts of the low forest at about 9.2 m were used about 44.8% of the time.

Alouatta palliata

We observed *A. palliata* in nine localities, confirming the presence of this species in five types of forest. The altitude of these groups fell between 12– 400 m a.s.l. (average 94 m). They were principally observed in gallery forests and in old growth of secondary forest. The structure and composition of 76 groups of this species averaged 6.76 animals per group (range 2-18 individuals; DS: 3.6) (Table 3). Two groups had between 17 and 18 individuals. Groups usually had 1-3 adult males, 1-4 adult females, 1-3 subadults and from 0-3 immature animals for the 76 groups. The ratio of adult males to adult females was 1:1.5 and the ratio of adult females to immature animals was 1:0.99.

Usually the pelage of this species was totally black, although occasionally there were individuals with patches of brown on

Table 2. Age-sex composition for 29 groups of *Alouatta seniculus* in the Darien region of the Colombian Chocó.

Grupo	♂A	♀A	♂S	♀S	J♂	J♀	I	Undet.	Total Ind	Altitude (m)
P12	1	3	1	1	1				7	7
P20	1	2			2				5	20
TA7	1	2			1			3	7	3
SM4	1	1			1		1	1	5	16
SM5	1	1			1				3	13
SM6	1	1		2				1	5	18
U1	1		1	1				1	4	10
U2	1	1	1	1				1	5	10
U4	1	1	1	1				1	5	10
PK1	2	1			1			1	5	18
PK2	1	2	1			1			5	27
PK3	1	1		2	1		1		6	31
PK4	1	1			1	2			5	30
PK5	2	1							3	32
PK6	2	1	3	2		2	1	1	12	22
PK7	2	2	1			1		1	7	25
PK8	1	2	2		1				6	25
PK9			2					1	3	20
PK10	1		1	1				4	7	18
PK11	1	1	2					1	5	26
PK12	1	3			1	1			6	22
PK13	2	1	3	2	2		1		11	30
PK14	1	2			2				5	23
PK15			2	1					3	27
PK16	1	1					1	3	6	27
PK17	2	2			1				5	29
PK18	1	2	1	1					3	20
TOTAL	31	35	22	15	16	7	5	20	151	
Average	1.15	1.30	0.81	0.56	0.59	0.26	0.19		5.59	

A: adult, S: subadult, J: juvenil, I: infant, und
A: adult, S: subadult, J: juvenil, I: infante, Undet.: undetermined sex
P= PLAYONA, TA= TANELA, SM= SANTA MARIA, U= UNGUIA, PK= PARQUE

Table 3. Composition of 76 Groups of *A. palliata* in the Darien region.

Group	♂*A*	♀*A*	♂*S*	♀*S*	♂*J*	♀*J*	*I*	Undet.	Total	Altitude (m)
P1	2	1			1				4	21
P3	1	1	1		1	1			5	19
P4	1	2	2	1	4		2		12	23
P5	2	1	1		1	1			6	36
P6	1	2							3	22
P7	1	2	4	4	2	3	1		17	25
P8	2	1	1	1			1		6	26
P9	2	4	1		3	4			14	24
P10	1	1							2	26
P11	3	4	3		4	2	2		18	30
P14	2	3	1		1	2			9	16
P16	1	2	3		1		2		9	25
P17	1	3	3			1	3		11	36
P18	1		1					1	3	30
P22	2		2	1			2		7	28
P23	2	3			2	1		1	9	34
P24	2	2							4	22
P25	1	2	1		1				5	29
P26	2	4			3	1			10	26
P27			2			1			3	17
B1	2	2	2			1	1		8	108
B2	2	3		2	1	1			9	102
B3	1	2	2		1	1			7	122
B4	2	2	1		1	3	2		11	110
B5	2	3	1		3	4	2		15	128
B6	1	1	2				1		5	109
B7	3	3	1			1	1		9	81
B8		1	1						2	156
B9	1	1	1	1		1			5	152
B10	2	3	1		2			1	9	167
B11	1	1	1						3	145
B12	2	4	3		1	1			11	163
B13	2	1			2	2			7	80
B14	2	1							3	83
B15	1	1	2						4	102
B17	1	2				2		1	6	110
B18	2	4			1	1			8	102
B19	1	1		1					3	146
B20	1	1							2	80
B21	2	4	1	1	2	1		1	12	114
SF	1	3	2		2	1			9	14
TA1	1	1	2			2			6	27
TA2	1	2	3	1	1				8	16
TA3	2	3			1			1	7	12
TA4	1		1	1					3	22

table continued on next page

table continued from previous page

Group	♂*A*	♀*A*	♂*S*	♀*S*	♂*J*	♀*J*	*I*	Undet.	Total	Altitude (m)
TA5	1	1							2	15
TA6	2	3			2	1			8	12
TA8		1	1						2	23
SM1	1			1				1	3	28
SM2	1	1			2	1	1		6	25
SM3	2	1							3	22
SM7	1	1							2	22
SM8	1	2	1		1				5	26
SM9	2	1							3	30
SM10	3	4			2				9	36
G1	1	2		1	1				5	209
G2	2	3	1		2			2	10	301
G3	3	1		1	1				6	322
G4	1	1							2	298
G5	2	2	1						5	298
G6	2	2	1		1	1		2	9	301
G7	1	1							2	245
G8	2	4	1		1				8	322
G9	1		1	1		1		1	5	136
G10	2	1			1				4	136
G11	2	4	1	1	2	1		2	13	79
PK1	2	3	2					1	8	19
PK2	3	1			1			2	7	35
PK3	3	2	1	1	1			1	9	31
T1	2	1			1	1			5	222
T2	1	1							2	191
T3	1	1	1		1	2	1		7	179
T4	2	1	1	1		2		1	8	100
T5	2	3			1				6	183
T6	1	2	2		3	2		1	11	169
T7	2	3	1		3	1			10	165
TOTAL	119	142	69	21	69	52	22	20	514	
Average	1.57	1.87	0.91	0.28	0.91	0.68	0.29		6.76	

A: adult, S: subadult, J: juvenile, I: infant, undet.: undetermined
ABREVIATIONS: P= PLAYONA, B= BALBOA, SF= SAN FRANCISCO, TA= TANELA, SM= SANTA MARIA, G= GILGAL, PK= PARQUE NACIONAL NATURAL LOS KATIOS, T= TITUMATE

the flanks and the dorsal area. One male adult had whitish coloration in the mesial part of the tail. There was no pelage evidence of hybridization with *A. seniculus* on these animals. We observed a total of five solitary animals, three of which were males, one was a solitary female and one was a solitary subadult sex unknown. The solitary subadult *A. palliata* was heavily infested by bot flies (*Alouattamyia baeri*?). *A. palliata* was seen 77.8% of time at canopy height of 22.7 +/- 5.0 m while the undergrowth was used only 22.2% of the time with an average height of 9.5 m +/- 3.3 m.

Forests habitat structure

Generally *A. palliata* and *A. seniculus* were associated with different types of habitat. The wetlands of Darién are dominated by plant communities like the *panganales*, *arracachales* and *cativales* (very impacted due to lumbering of the tall *cativo* tree [*Prioria copaifera*, Rangel-Ch, 2004a]) that are found along edges and dikes of the Atrato river, sometimes at the base of hills and terraces. P*anganales* are dominated by the pangana palm (*Raphia taedigera*), the *suerdo* (*Ficus dendrosida*, Cecropiaceae) and the *chachafruto*

(*Erythrina fusca,* Fabaceae). In the medium stratum *cativo* (*Prioria copaifera*, Caesalpineaceae [an endangered tree species or EN in the IUCN system for Colombia], *yarumo* (*Cecropia* sp.) and *guamo* (*Inga* spp., Mimosaceae) are common. This type of forest is the most important for *Alouatta senciculus* and *Cebus capucinus* in the Darien region. Nevertheless it is one of the most transformed associations because of extraction of woody species and the opening of canals to drain flooded areas for use as pasture land.

Arracachales dominated by the widely distributed arracacho (*Montrichardia arborescens*, Araceae) is the principal association on the flood plain of the Atrato river. The *arracacho* (*Montrichardia arborescens* reaches 10-15 species per square meter with an average height of only 2 m (Plan de Manejo Katios, 2007). Arracachos grow in association with other dominant species such as *Blechnum serrulatum, Acostichum aureum, Scleria secans, Scleria melaceuca* and species of *Thelytpteris* and *Panicum* (Rangel-Ch, 2004a), often interspersed with ferns such as *Macfadyena ungis*. *Alouatta seniculus* using this community are easily seen because of the very low vegetation, in contrast to other vegetation types.

Rastrojo had a sometimes discontinuous, sometimes continuous canopy and thick undergrowth. Important tree species were *Ficus* spp. (Moraceae), cecropia (*Cecropia* sp., Cecropiaceae), *hobo* (*Spondias mombin*, Anacardiaceae), *copey* (*Clusia* sp., Clusiaceae), *abarco* (*Cariniana pyriformis*, Lecythidaceae), *roble* (*Tabebuia rosea o Taebuia sp.*, Bignoniaceae), *cedro* (*Cedrela* cf. *angustifolia*, *C. odorata,* Meliaceae), *cativo* (*Prioria copaifera*, Caesalpinaceae), *balso* (*Ochromoa pyramidale*, Bombacaceae), *ceiba* (*Ceiba pentandra*, Bombacaceae), *caracolí* (*Anacardium excelsum*, Anacardiaceae), rubber (*Castilla* sp., Moraceae), *churimo* (*Inga* sp. probably *I. edulis*, Mimosaceae). Height of trees in this forest reaches 20–25 m, especially in the cases of *Ceiba pentandra, Anacardium excelsium* and *Jacaranda caucana* (Bignoniaceae). *Rastrojos* are often difficult of access because of the dense and closed vegetation, although some rastrojos were more open and especially exposed along the borders. These forests result from cutting the original forest for agriculture or other purposes and allowing a new forest to grow and mature on the same spot. Rastrojos were often isolated from other forest, requiring terrestrial travel for the *Alouatta* groups.

Gallery forests represented 25% of all observations of *A. palliata*. These primates were found alongside small rivers such as the Chugandi, Negro, Tanela, Tanelita, Cuti, Tibirri and the Titiza among others. Some groups were located in forest bordering very small streams and most of this forest was made up of tall (20-25 m) and continuous vegetation. Common trees of the gallery forest are *balso* (*Ochromoa pyramidale*, Bombacaceae), *guaimaro* (*Brosimum alicastrum* y *B. guianense*, Moraceae), *cedro* (*Cedrela* cf. *angustifolia*, *C. odorata,* Meliaceae), *abarco* (*Cariniana pyriformis*, Lecythidaceae), *caracolí* (*Anacardium excelsum*, Anacardiaceae). DBH´s ranged from 0.63-2.67 m. Gallery forests have been conserved in most of the *veredas* (subdivision of a *municipio* in Colombia), since the inhabitants understand the importance for water quality.

Secondary growth forests showed various states of succession. Disturbances that created clearings modify the structure of the original forest allowing the growth of many pioneer species. Common trees growing in secondary growth forests (similar to *rastrojo*) were *cedro* (*Cedrela* cf. *angustifolia*, *C. odorata,* Meliaceae), *copey* (*Clusia* sp., Clusiaceae), *palma mil pesos* (*Jessenia bataua*, Araceae), *cuipo* (*Cavanillesia platanifolia*, Bombacaceae), *guamo* (*Inga* spp,

Table 4. Altitudinal ranges of sampled sites and the number of sites with either presence or absence of the species.

Landscape type	Elevation (m)	No. Sites	*Alouatta palliata*	*Alouatta seniculus*	Both spp present
Low terraces	0-49	95	42	29	0
Slope	50-99	14	4	0	0
Low hills	100-199	35	26	0	0
Medium hills	200-499	20	9	0	0
Mountains	500-600	0	0	0	0

Table 5. Groups associated with forest types in the study area.

Forest type	*A. palliata*	*A. seniculus*	General total
A. arracachal	0	1	1
A. panganal	1	24	25
Gallery forest	21	0	21
Primary forest	15	0	15
Secondary forest	18	1	19
Cut-over regrowth	26	3	29
General total	81	29	110

Mimosaceae), *copey* (*Clusia* sp., Clusiaceae) , *yarumo* (*Cecropia* spp., Cecropiaceae), *balso* (*Ochromoa pyramidale*, Bombacaceae) , *tachuelo* (*Zanthoxylum grandifolum*, Rutaceae) and *churimo* (*Inga edulis*, Mimosaceae). These forests were usually surrounded by pasturelands used by cattle.

Primary forests were often disturbed due to logging so that species with low economic value predominated, even though three strata of trees existed. The highest stratum consisted of emergent trees up to 20-25 m, dominated by species such as *higuerón* (*Ficus* sp., Moraceae), *cedro* (*Cedrela* cf. *angustifolia*, *C. odorata* Meliaceae), *caracolí* (*Anacardium excelsum*, Anacardiaceae), *hobo* (*Spondias mombin*, Anacardiaceae), *almendro* (*Dipteryx oleifera*, Fabaceae) and *cordoncillo* (*Piper imperialis*, Piperaceae) among others. This forest type characteristically contained climbing plants and lianas, and very little undergrowth.

Of six forest types, *A. palliata* was found in five and *A. seniculus* in four (Table 5). *A. palliata* was mostly in second growth and gallery forests and never in the arracachal associations (*Montrichardia arborescens*). We observed one group of *A. palliata* in panganal (*Raphia taedigera*). In contrast, *A. seniculus* commonly used the *panganal* association and was seen very rarely in second growth (rastrojo) (Table 5). We never observed either species of *Alouatta* in tree plantations or in other crops, in contrast to *Cebus capucinus*, which we observed several times in both forest plantations and other cultivars.

Discussion

Sympatry

This study confirms the sympatry between *A. seniculus* and *A. palliata* along the west bank of the Atrato river and formally register other sites east of the Atrato river, but we cannot confirm hybridization between the two species. According to local information, sympatry between the two species continues upriver to an undetermined point along the Atrato river. Hybridization is not well-known in *Alouatta*. A study of *Alouatta* sympatry describes hybridization between *A. caraya* and *A. clamitans* in a group of eight individuals observed near the Paraná river in Brazil, in the ecotone between rain forest and the Cerrado, showing intermediate morphological variation (Aguiar *et al.,* 2007). Another study in Tabasco, Mexico, reported hybridization of individuals with a mosaic of morphological characteristics between *A. palliata* and *A. pigra*. These included individuals living in various grades of disturbed vegetation and that had characteristics of both species (Cortes-Ortiz *et al.,* 2007). Also, hybridization is known in captivity between *A. caraya* and *A. guariba* (de Souza *et al.,* 2010).

Habitat preferences

The two species of *Alouatta* in this study are not completely syntopic; their habitat preferences seem to overlap somewhat, affording some contact. According to Agostini *et al.* (2010) in undisturbed habitat the two species could be avoiding competition, employing strategies associated with different diets and different habitat use when in sympatric contact (Lehmann, 2004). Given the differences detected in the use of distinct types of forest in this research and a lack of clear-cut morphological evidence for hybrids, we suspect that the two species maintain effective separation. Further to the east in the highly disturbed and fragmented Colombian Caribbean there may be animals with mixed phenotypes (obs. pers. A. Flórez and F. Garcia-Castillo) and these animals should be studied, especially in Córdoba (Fig. 1). Bicca-Marques *et al.* (2008) indicate that the habitat and utilization of resources are not considered factors that maintain a separation of species of *Alouatta*. Other authors consider that disturbed habitats can play a fundamental role in the sympatry and overlap of species´ ranges (Aguiar *et al.*, 2007, 2008; Agostini, 2010). The situation of the Darien is of a disturbed habitat. Colonization has led to changes in vegetation cover resulting in much pastureland for cattle ranching and disturbed vegetation (Plan de Manejo Katios, 2007). Accordingly it seems logical that these activities might influence contact between the two species.

In the Chocó *A. palliata* was present at all sites sampled from sea level to above 300 m, although its presence in *panganal* was minimal. But *Alouatta seniculus* was absent on the sides of hills from primary and secondary forest, although this species has been found up to 3,200 m in the Colombian Andes and is found in many types of primary forests in the lowlands of Amazonia, as well as gallery forest in Orinoquia and sub-Andean forests in Quindío (Hernández and Cooper, 1975; Gaulin and Gaulin, 1982; Izawa, 1988; Defler, 1981, 2010; Stevenson *et al.*, 1991). In the *Darien A. seniculus* is restricted to swampy forest, *panganales* especially along the borders of rivers (Neville 1972; Defler 2010) and it is limited to elevations below 50 m. These uses of particular habitats clearly show there to be a minimum of distribution overlap in the Chocó.

The use of forest strata by *A. palliata* and *A. seniculus* is related principally to the food supply, solar exposure and locomotion (Braza *et al.,* 1981; Lehmann, 2004). These animals prefer forest with adequate connectivity between canopies (Neville, 1972; Izawa, 1976) and tall trees, generally of 20-25 cm diameters or more (Gómez-Posada *et al.,* 2007). The observations of *A. palliata* and *A. seniculus* in this research showed a preference of these primates for upper strata. During the study, *A. palliata* groups were found 77.8% of the time in the canopy. They were only found in underbrush when they were eating from low trees or resting in shade (Palma, 2005). Groups of *A. seniculus* were seen in the low canopy 55% of the times observed where they generally were eating or resting. The middle stratum was used for travel (Izawa, 1976; Braza *et al.,* 1981). They were not observed in tall emergent trees in this study, a contrast to some other studies (Defler, 1981, 2010). The forests that were sampled contained plant species that already have been reported as being highly important for the diet of the

two species of *Alouatta* (Neville *et al*., 1988). These generally correspond to the Moraceae (usually the most important family in the diet of *Alouatta*) (Milton, 1980; Crockett and Eisenberg, 1987), including especially *Ficus* spp, *Cecropia* spp. as some of the most important genera (Milton, 1980; Gaulin and Gaulin, 1982; Crockett and Eisenberg, 1987; Gómez-Posada *et al*., 2007; Giraldo *et al*., 2007).

Studies of *A. seniculus* suggest that this species is more a generalist than is *A. palliata* and usually does not depend on one type of habitat in particular (Neville, 1972; Stevenson *et al*., 1991; Julliot, 1996; Bicca-Marques, 2003). Other authors report preferences of the species for specific types of vegetation found at riversides, on river terraces, and in transitional forests and forest of Igapó during the dry season (Palacios and Rodríquez, 2001; Iwanaga and Ferrari, 2002) where they consume species such as *Cecropia* sp. and *Ficus* sp. and new leaves (Stevenson *et al.,* 1991). The densest populations known are found in the llanos of Colombia and Venezuela (Crockett and Eisenberg, 1987; Defler (in press-a). In this study *A. seniculus* was associated with vegetation that is frequently inundated and where the species *Raphia taedigera*, *Erythrina fusca* and *Cecropia* sp. were found. Such associations reached heights of only 8-9 m and did not have a continuous stratum along the edge of the Atrato river. This primate was also associated with the plant species *Welfia regia* and *Prioria copaifera* and the animals were often syntopic with *Cebus capucinus*. River and lake-side preferences of *A. seniculus* in eastern Colombia have also been described where no second species of *Alouatta* is present (Defler, in press-a)

A. palliata has demonstrated its capacity for surviving in fragmented habitats (Crockett and Eisenberg, 1987; Clarke *et al*. 2002; Rodríguez-Toledo *et al.,* 2003; Bicca-Marques, 2003). In this study this species seemed quite habituated to human beings, since during the majority of observations they continued their activities without being disturbed by our presence. Nevertheless, hunting of *A. palliata* in some parts of the Darien is reported to be very high, since they are avidly pursued by members of various indigenous ethnic groups such as the Cunas and Emberas (com. pers. various interviewees). Hunting pressure on *A. seniculus* is medium to high along the banks of the Atrato River, according to comments from locals. In other cases, for example around the Ciénega de Ungía and because of the low vegetation, the animals are harassed and chased as a diversion, causing fear towards humans in both cases (probably always a reasonable response).

Conservation issues

The Darien was considered one of the 17 most critical areas in the world for conservation, according to the concept first developed by Myers (1988), underlining the importance of conservation planning and resource management in local development. Human activities compromise the continued presence of howlers in this region, and data on hunting, descriptions of habitat alteration and diseases are relevant for the management and conservation of these species over time. Studies of the ecology of closely related sympatric species represent a challenge, since these relationships are not commonly found in all habitats and their ecological relationships are not always evident. It is particularly important to integrate the demographic history and population structure of these primates to be able to monitor the changes that occur over time (Crockett, 1998; Rodríquez *et al.,* 2003; Asencio *et al*., 2009; Defler, 2010). It is fundamental to define the technical and scientific criteria to be included in any resource planning and to include the active participation of communities in any region for the success of any future studies that facilitate the conservation of these species in the future.

Acknowledgements

Sara Zuñiga Leal especially thanks her mother, Alexandra Leal, who has supported her in these and all of her formation. We thank the people of the Chocó region, UAESPNN (Colombian Parks Service), Katios National Park, Lilia Córdoba and relatives for their support at all time. We also thank Jaime Burbano for orientation using ArcGis and Marcela Fonseca, Maritza Larrota and Silvana García for their support. Thomas Defler thanks the Universidad Nacional de Colombia for support during the writing of this article.

References

Agostini, I., Holzmann, I. and Bitetti, M. 2010. Are howler monkey species ecologically equivalent? Trophic niche overlap in syntopic *Alouatta guariba clamitans* and *Alouatta* caraya. *Am. J. Primat.* 72(2):173–186

Aguiar, L., Mellek, D., Abreu, K., Boscarato, T., Bernardi, I., Miranda, J. and Passos, F. 2007. Sympatry of *Alouatta caraya* and *A. clamitans* and the rediscovery of free-ranging potential hybrids in Southern Brazil. *Primates* 48:245–248

Aguiar, L., Pie, M. and Passos, F. 2008. Wild mixed groups of howler species *Alouatta caraya* and *Alouatta clamitans* and new evidence for their hybridization. *Primates* 49:149–152

Bicca-Marques, J. C. 2003. How do howler monkeys cope with habitat fragmentation? In: *Primates in fragments*. Marsh LK, (ed.), pp. 283-301. Kluwer Academic/ Plenum Publishers, New York.

Bicca-Marques J., Rodrigues, F. and Jones, C. (2008) Survey of *Alouatta caraya*, the blackhand-gold howler monkey, and *Alouatta guariba clamitans*, the brown howler monkey, in a contact zone, State of Rio Grande do Sul, Brazil: evidence for hybridization. *Primates* 49:246–252

Braza, F., Alvarez, F. and Azcarate, T. 1981. Behaviour of the Red Howler Monkey (*Alouatta seniculus*) in the Llanos of Venezuela. *Primates* 22(4): 459-473.

Chapman, C. and Balcombin, S. 1998. Population characteristics of howlers: Ecological conditions or group history. *Int. J. Primatol.* 19: 385-403.

Cortés-Ortiz, L., Bermingham, E., Rico, C., Rodríguez, E., Sampaio, I. and García, M. 2003. Molecular systematics and biogeography of the Neotropical monkey genus, *Alouatta*.*Mol. Phylogenet. Evol.* 26:64–81.

Cortés-Ortiz, L., Duda, Jr., T. F., Canales-Espinosa. D., García-Ordunñ, F. and Rodríguez Luna, E. and Bermingham, E. 2007. Hybridization in large-bodied New World primates. *Genetics* 176(4): 2421-2425.

Crockett, C. 1998. Conservation biology of the genus *Alouatta*. *Int. J. Primatol*. 19(3):549-598.

Crockett, C. and Eisenberg, J. 1987. Howlers: variations in group size and demography. In: *Primate Societies*, Smuts, B. B., Cheney, D. L. and Seyfarth, R. M. *et al*. (eds). The University of Chicago Press, Chicago, pp. 54-69.

Defler, T. R. 1981. The density of *Alouatta seniculus* in the eastern llanos of Colombia. *Primates* 22: 564-569.

Defler. T. R. In press-a. Species richness, densities and biomass of ten primate communities in eastern Colombia. *Rev. Acad. Colomb. Cienc. Exactas* Fís. Nat.

Defler, T. R. In press-b. Aspectos para la conservación de los primates colombianos: ¿cuál es el futuro? En. *Primates colombianos en peligro de extinction*. Defler, T. R., Stevenson, P. R. Bueno, M. L. y Guzman, D., (eds.) Asociación Primatológica Colombiana, Bogotá.

Defler. T, R. 2010. *Historia natural de los primates colombianos*. Universidad Nacional de Colombia: Bogotá, DC

de Souza Jesus, A., Schunemann, H. E., Müller, J. and da Silva, M. A. 2010. Hybridization between *Alouatta caraya* and *Alouatta guariba clamitans* in captivity. *Primates* 51:227–230

Fedigan, M., Rose, M. and Morera, R.. 1998. Growth of Mantled Howler groups in a regenerating Costa Rican dry forest. *Int. J. Primatol*. 19 (3): 405-432.

Gaulin, S. and Gaulin, C. 1982. Behavioral ecology of *Alouatta seniculus* in Andean cloud forest, Colombia. *Int. J. Primatol*. 3: 1-32.

Giraldo, P., Gómez-Posada, C., Martínez, J. and Kattan, G. 2007. Resource use and seed dispersal by red howler monkeys (*Alouatta seniculus*) in a Colombian Andean forest. *Neotrop Primates* 14(2):55-64.

Gómez-Posada, C,, Martínez, J., Giraldo, P. and Kattan, G. H. 2007. Density, habitat use, and ranging patterns of red howler monkeys in a Colombian Andean forest. *Neotrop. Primates* 14(1):2-10.

Hernández-Camacho, J., Cooper, R. W. 1976. The nonhuman primates of Colombia. In: *Neotropical Primates: Field Studies and Conservation*, Thorington, R. W., Heltne, P. G. (eds.), pp. 35–69. National Academy of Sciences, Washington, DC

Holdridge, L. R. 1967. *Life zone ecology. Tropical Science Center*. San José, Costa Rica. Horwich, H., Johnson, D. 1986. Geographical distribution of the black howler (*Alouatta pigra*) in Central America. *Primates* 27 (1): 53-62.

Iwanaga, S. and Ferrari, F. 2002. Geographic distribution of red howlers (*Alouatta seniculus*) in southwestern Brazilian Amazonia, with notes on *Alouatta caraya*. *Int. J. Primatol*. 23(6):1245-1256.

Izawa, K. 1976. Group sizes and compositions of monkeys in the upper Amazon basin. *Primates* 17: 367-399.

Izawa, K. 1988. Preliminary reports on social changes on red howlers (*Alouatta seniculus*). *Field Studies of New World Monkeys, La Macarena, Colombia* 1: 29-33.

Julliot, C. 1996. Fruit choice by red howler monkeys (*Alouatta seniculus*) in a tropical rain forest. *Am. J. Primatol*. 40: 261-282.

Lehmann, S. M. 2004. Biogeography of the primates of Guyana: effects of habitat use and diet on geographic distribution. *Int. J. Primatol*. 25:1225–1242.

Milton, K. 1980. *The foraging strategy of howler monkeys. A study in primate economics*. Columbia University Press. New York. pp. 4-51

Milton, K., Mittermeier, R. A. 1977. A brief survey of the primates of Coiba Island, Panama. *Primates* 18: 931-936.

Myers, N. 1988. Threatened biotas; "Hotspots" in tropical forests. *The Environmentalist* 8: 1-20.

Neville, M. 1972. The population structure of red howler monkeys (*Alouatta seniculus*) in Trinidad and Venezuela. *Folia Primatol*. 17: 56-86.

Neville, M. K., Glander, K. E., Braza, F., Rylands, A. B. 1988. The howling monkeys, genus *Alouatta*. In: *Ecology and Behavior of Neotropical Primates*, Mittermeier, R. A., Rylands, A. B., Coimbra-Filho, A. and Fonseca, A. B. C., (eds.). World Wildlife Fund, New York.

Palacios, E. and Rodriguez, A. 2001. Ranging pattern and use of space in a group of red howler monkeys (*Alouatta seniculus*) in a southeastern Colombian rainforest. *Am. J. Primatol.* 55: 233 – 251.

Palma, A. C. 2005. Requerimientos de espacio de *Alouatta seniculus* en la Reserva Naturalde Yotoco (Valle, Colombia). Tesis de pregrado en Biología. Universidad de los Andes. Bogotá.

Parques Nacionales Naturales 2007. Plan de manejo 2007 – 2011 Parque Nacional Natural Katios. Resumen Ejecutivo. Parques Nacionales Naturales de Colombia, Dirección Territorial Noroccidente, Medellín (Antioquia).

Peres, C. A. 1990. Effects of hunting on western Amazonian primate communities. *Biol. Conserv.* 54:47-59.

Pinto, L. P. de S., Rylands, A. 1997. Geographic distribution of the golden-headed lion conservation. *Folia Primatol*. 68:161-180.

Plan de Manejo Katios 2007. Plan de manejo 2007 – 2011 Parque Nacional Natural Los Katios: Resumen Ejecutivo. Parques Nacionales Naturales deColombia, Medellín (Antioquia), unpublished manuscript, 30 pp.

Rangel-Ch, O. 2004a. La vegetación del Chocó biogeográfico de Colombia y zonas coridilleranas aledañas - síntesis. En. *Colombia: Diversidad Biótica IV: El Chocó biogeográfico/Costa/ Pacífica*. Rangel-Ch, J. O., (ed.), pp. 769-815. Universidad Nacional de Colombia, Bogotá.

Rangel-Ch., O. 2004b. Amenazas a la biota y a los ecosistemas del Chocó biogeográfico. En: Rangel-Ch., J. O. (ed), *Colombia: Diversidad Biótica IV: El Chocó biogeográfico/*

Costa/ Pacífica, pp. 841-866. Universidad Nacional de Colombia, Bogotá.

Rangel-Ch., J. O., Arellano-P., H. 2004. Clima del Chocó biogeográfico de Colombia. En: *Colombia: Diversidad Biótica IV: El Chocó biogeográfico/Costa Pacífica*. Rangel-Ch., J. O. (ed), pp. 39-82. Universidad Nacional de Colombia, Bogotá.

Rodriguez-Toledo, E.M., Mandujano, S. and F. García-Orduña 2003. Relationships between forest fragments and howler monkeys (*Alouatta palliata mexicana*) in southern Veracruz, Mexico. En: *Primates in fragments*, Marsh, L. K., (ed.), pp. 79-97. Kluwer Academic/Plenum Publishers, New York.

Rudran, R. and Fernández, D. 2003. Demographics changes over thirty years in a red howler population in Venezuela. *Int. J. Primatol*. 24:925-945.

Rylands, A. and Mittermeier, R. 2009. The diversity of the New World primates (Platyrrhini): An annotated taxonomy. South American Primates. En: *Comparative Perspectives in the Study of Behavior, Ecology and Conservation*, Garber, P. A., Estrada, A., Bicca-Marques, J. C., Heymann, E. W. and Strier, K. B. (eds.), pp. 23-54. Springer, New York.

Stevenson, P., Quiñones, M. and Ahumada, J. 1991. Relación entre la abundancia de frutos y las estrategias alimenticias de cuatro especies de primates en el río Duda, Macarena. Informe final presentado a la Fundación para la Promoción de la Investigación y la Tecnología, Banco de la República, Bogotá.

A NEW POPULATION OF RED UAKARIS (*CACAJAO CALVUS* SSP.) IN THE MOUNTAINS OF NORTH-EASTERN PERU

Jan Vermeer[1,2,*], Julio C. Tello-Alvarado[1,3], José T. Villacis Del Castillo[1,3] and Antonio J. Bóveda-Penalba[1]

[1] *Proyecto Mono Tocón, Jr. Reyes Guerra 422, Moyobamba, Peru*
[2] *Le Conservatoire pour la Protection des Primates, La Vallée des Singes, 86700 France*
[3] *Universidad Nacional de San Martín-T, Facultad de Ecología, Jr. Prolongación 20 de Agosto, Moyobamba, Peru*[3]
[*]*Corresponding Author: Jan Veermer,* jan.veermer@telfort.nl, *0031 55 3010311(phone)*

Abstract

Here we report on the discovery of a new population of red uakaris in the mountains of northern San Martin, north-eastern Peru. This population is isolated from the other known uakari populations in the eastern lowlands, which raises questions concerning their taxonomic status and biogeographical history. This follows a recent range extension of this taxon west of the Ucayali River. Previously, the Peruvian red uakari (*Cacajao calvus ucayalii*) was only known in Peru from the lowlands between the Amazon, Ucayali and Yavarí Rivers.

Keywords : *Cacajao*, red uakari, Peru, range extension

Resumen

Reportamos aquí el descubrimiento de una nueva población de uakaris calvos en las montañas del norte de San Martín, nororiente del Perú. Esta población se encuentra aislada de las otras poblaciones conocidas de uakaris en las tierras bajas del oriente, lo cual genera preguntas relacionadas con su estatus taxonómico e historia biogeográfica. Esto se da después de una reciente extensión del rango de este taxon al occidente del Río Ucayali. Previamente, el uakari calvo peruano (*Cacajao calvus ucayalii*) era conocido en Perú solamente de las tierras bajas entre los ríos Amazonas, Ucayali y Yavarí.

Palabras clave : *Cacajao*, uakari calvo, Perú, extensión de rango

Introduction

The distributions of many primate species in Peru and other South American countries are still not well known. New taxa and populations are still detected (Aquino *et al.*, 2008; Boubli *et al.*, 2010; Boveda-Penalba *et al.*, 2009; Röhe *et al.*, 2009; Defler *et al.*, 2010; Vermeer *et al.*, 2011), and much more research is still needed to understand the distribution and taxonomy of Peruvian primates. According to Hershkovitz (1987), *Cacajao calvus ucayalii* is the subspecies of red uakari occurring in Peru. Its distribution was generally thought to range from the east bank of the Ucayali River eastwards to the Yavarí River and from the Amazonas River in the north to the Urubamba River in the south (Aquino and Encarnación, 1994). Recently, Bowler *et al.* (2009) reported on the presence of the species on the west bank of the Ucayali River, in the Pacaya-Samiria National Reserve (see Fig. 3), demonstrating that major rivers are not absolute geographical barriers for uakari dispersal. However, the extent of this population is unclear and is assumed to be small (Bowler *et al.*, 2009). Peruvian red uakaris are often thought to be flooded-forest specialists (Kinzey, 1997), but recent work by Heymann and Aquino (2010) showed that most records of this subspecies come from *terra firme* forest. The related black-headed uakaris (*Cacajao hosomi*) are also reported to inhabit a wide variety of forest types (Boubli, 1999).

To date, *Cacajao calvus ucayalii* has been recorded only at low altitudes, the highest being 600-700 m a.s.l. (Heymann and Aquino, 2010). During the surveys in 2007 and 2008 on the distribution of the endemic and critically endangered San Martin titi monkey (*Callicebus oenanthe*) by the Proyecto Mono Tocón (Bóveda-Penalba *et al.*, 2009; Vermeer *et al.*, 2011), we received information from local inhabitants on the presence of red uakaris in the mountains of the northern San Martin Department, Peru. As red uakaris were only known to live in the eastern lowlands (Hershkovitz, 1987), we considered this information as unreliable. However, reports of sightings increased and we decided to investigate the situation. In 2009, we encountered an American anthropologist who not only informed us that he had seen uakaris in northern San Martin, but also provided us with pictures of a dead specimen killed

during a hunting party expedition that he had witnessed (Shane Green, personal communication to Jan Vermeer) (Fig. 1 and 2). Additionally, we obtained pictures of Awajun people, the indigenous community of northern San Martin, with head-dresses made from red uakari skins.

Figures 1 and 2. Male red uakari killed during a hunting party in the Cordillera Cahuapanas (photo courtesy of Shane Green).

With this information, we organised field trips in 2009 and 2010 to collect scientific evidence for the presence of red uakaris in the mountains of northern San Martin.

Methods

We reviewed the literature on the distribution and taxonomy of *Cacajao* in Peru, and conducted interviews with local habitants of northern San Martin. Most of the interviewees were farmers whose plantations were in or near the forest and who regularly went hunting. Therefore, their knowledge of local wildlife was good. For the interviews, we used a series of pictures of 15 primate species that occur in Peru. The interviewed person had to name all primates that he recognized and was asked if he had ever seen them in his area. After the interview, we together judged the reliability of the information supplied. We double-checked positive reports on the presence of uakaris with other inhabitants, to determine where field surveys could lead to observations of red uakaris. Based on the information obtained, we selected three study localities on the southern slope of the central mountain range (la Cordillera Cahuapanas) for field studies (Localities 1, 3 and 4 - Fig. 3) and two sites north of the mountain range; one near the border of the Amazonas and Loreto Departments (Locality 6 - Fig. 3) and one in the Datem del Marañón Province, Loreto Department (Locality 7 - Fig. 3). On the way to survey sites, we interviewed local inhabitants to gather additional data on the presence of uakaris in the area (Localities 2 and 5 - Fig. 3).

The localities in the Cordillera Cahuapanas were several days walking distance from existing roads and well-prepared expeditions with guides and mules were necessary to reach the study sites. The other study sites could easily be reached by car and foot. Once we arrived at the chosen site, we erected a field camp and used the following days to survey the area surrounding the camp to determine if uakaris were present. We used the so-called "travel reconnaissance walks" as our survey method (Walsh and White, 1999), using pre-existing paths that were normally used by hunters or local people collecting forest products. Encounters with uakaris and other primate species were documented. When possible, the animals were photographed and filmed, and the GPS coordinates were noted.

Study areas

Cordillera Cahuapanas

The Cordillera Cahuapanas is a mountain range situated on the northern side of the Alto Mayo Valley. It is the border between the San Martin and Loreto Departments, and separates the Alto Mayo Valley from the Amazon lowland. For several species, like the endemic San Martin titi monkey (*Callicebus oenanthe*), it acts as geographical barrier to their distribution (Bóveda-Penalba *et al.* 2009). A detailed description of the geology and vegetation of the Central Cordillera Cahuapanas is provided by Treidel (2004). All forest

types above 1000 m a.s.l. were regarded as Montane Forests in field classification. According to their topographic position, Treidel (2004) divided the Montane Forest into *Montane Crest Forests*, *Montane Slope Forests* and *Montane Swale Forests*. The *Montane Slope Forest* was the most prevalent and widespread vegetation type in the Central Cordillera Cahuapanas, covering the slopes of the investigated area between 1500 and 1800 m a.s.l. With some exceptions, the tree height doesn't exceed 23 m, while the mean canopy height is only 15 m. The trees of the *Montane Swale Forests* are considerably higher, with a mean canopy height of approximately 23 m and some trees reaching heights of 36 m. *Montane Swale Forests* occur in depressions at different elevations in the Central Cordillera Cahuapanas and were recorded between 1000 m and 1570 m a.s.l. Dominant tree species do hardly vary from those of the Crest and Slope Forests. The most frequent palm tree is Huacra pona (*Socratea exorrhiza*), constituting between 20 and 30 % of all woody individuals in some zones. Rubiaceae, Lauraceae and Melastomataceae were the species-richest families in the Cordillera Cahuapanas between 1000 and 1840 m a.s.l., followed by Arecaceae, Clusiaceae, Euphorbiaceae and Sapotaceae. According to Treidel (2004), the flora of the montane forests of the Cordillera Cahuapanas contains typical elements of the lower as well as of the higher elevations, with a tendency towards the higher elevations.

Datem del Marañón

Between the Cordillera Cahuapanas, the Marañón and Huallaga Rivers, there is a vast area of lowland forest, part of the Datem del Marañón and Alto Amazonas Provinces, Loreto Department (Fig. 3). This area is approximately 16,000 km² and its altitude varies from 130-300 m a.s.l.. Considering that bald uakaris are usually known only from lowland forest, we assumed that they could live in that area and could have dispersed from the lowlands into the Cordillera Cahuapanas. As no biological information was available from that region, we decided to visit the small river town of Saramiriza (locality 7 - Fig. 3) to collect additional information. On our way to Saramiriza, we also conducted interviews at Santa María de Nieva (locality 6 - Fig. 3), which is near the border of the Amazonas and Loreto Departments.

Results

We encountered individuals of *Cacajao* only at two sites within the selected localities; these were near Candamo and

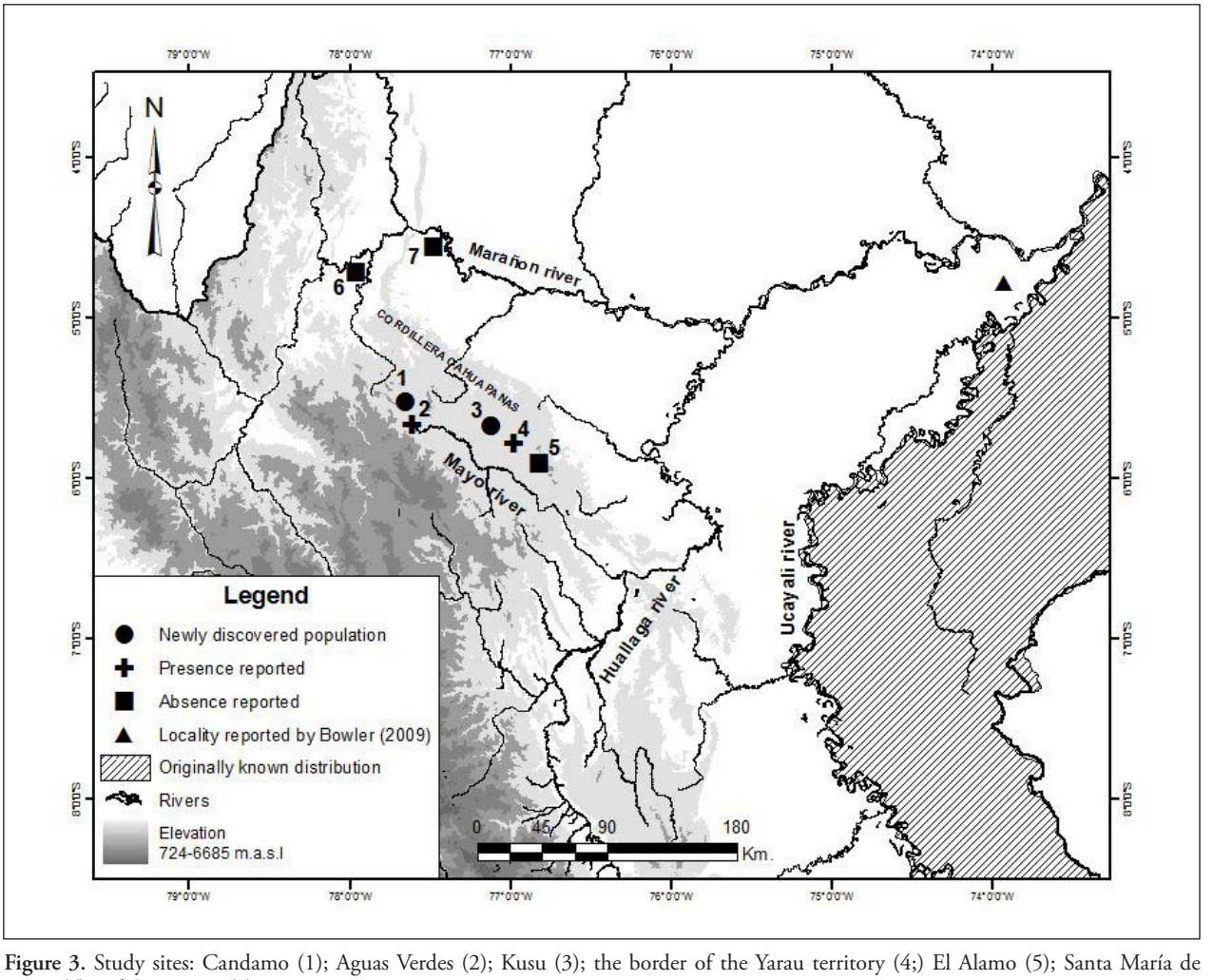

Figure 3. Study sites: Candamo (1); Aguas Verdes (2); Kusu (3); the border of the Yarau territory (4;) El Alamo (5); Santa María de Nieva (6) and Saramiriza (7).

near the native community of Kusu, both in the Cordillera Cahuapanas. In September 2009 we observed, during an expedition of seven days, two uakaris near the settlement of Candamo (05°31'S 077°39W'; altitude 1,421 m a.s.l.). The specimens were observed from several hundred meters away using 10×40 binoculars and we were not able to take photographs. Inhabitants of the Candamo sector are well acquainted with the species, which they call "mono cotulo", meaning "the monkey without a tail". A hunter even described the beautiful green eyes of a female that he had killed (at an altitude of 1,312 m a.s.l.). The species is usually not being hunted as it is too small, and the hunter regretted his deed. A second visit of 10 days to the Candamo area in April 2010 resulted in more reports from local settlers, but no observations. The presence of *Cacajao* was also reported along the path to Candamo, near Aguas Verdes (05°40'S 077°36'W; altitude 1,004 m a.s.l.).

Our 6-day expedition in July 2010 to Santa María de Nieva (04°35'S 077°52'W; altitude 208 m a.s.l.) and Saramiriza (04°33'S 077°26'W; altitude 148 m a.s.l.), on the right bank of the Marañón River and north-west of the Cordillera Cahuapanas, didn't result in any evidence that uakaris live in that area. Elders of the (native) community indicated that they had observed the species near Iquitos (which is well within their known distribution range), but never on their territory. From 18-25 of August 2010 we surveyed the area on the border of the Awajun community of Kusu (05°40'S 077°07'W; altitude 1,115 m a.s.l.). There is little human disturbance in this remote site, and already on the first day we encountered a group of 30 bald uakaris. The animals were afraid of humans, but we observed very well the group, consisting of adults, juveniles and carried infants and could take photographs and videos. No uakaris were seen during the rest of the survey.

During our last expedition from 8-17 November 2010, local settlers reported that no uakaris have ever been seen near El Alamo (05°54'S 076°50'W; altitude 1,416 m a.s.l.) or elsewhere in their territory. However, one person had observed the species on the territory of the neighbouring Awajun Yarau community. Therefore we set up our camp on the border of their territory and the Yarau community (05°54'S 076°49'W; altitude 1,021 m a.s.l.). During the eight days that we surveyed the area, no uakaris were observed. This site is some 35 kilometres east of Kusu and also south of the Cordillera Cahuapanas (Fig. 3), and was chosen to investigate the eastern extent of the population.

The living and dead animals we saw during our surveys and on the pictures mentioned before match phenotypically with *C. c. ucayalii*, although they might be slightly larger.

During the study we collected data on the distribution of 11 other primate species, of which 6 were observed (Table 1).

Table 1. Reports and observations of other primate species at three study localities on the southern slope of the central mountain range (la Cordillera Cahuapanas), and two additional ones near the border of the Amazonas and Loreto Departments and in the Datem del Marañón Province, Loreto Department, Peru.

Locality	Observations		Reports
	Species	Altitude (m a.s.l.)	Species
Candamo	*Ateles belzebuth*	1,162	-
	Alouatta seniculus	1,412	-
	Cebus apella	1,163	-
	Cebus albifrons	1,200	-
	Saguinus fuscicollis	1,370 + 1,170	-
Saramiriza	*Saguinus fuscicollis*	148	*Ateles belzebuth*
			Ateles chamek
			Alouatta seniculus
			Cebus albifrons
			Cebus apella
			Callicebus discolor
			Pithecia sp.
			Aotus sp.
			Saimiri sciureus
			Callithrix pygmaea
Kusu	*Lagothrix poeppigii*	1,046	
	Saguinus fuscicollis	1,065	
Yarau	*Cebus apella*	1,021	
	Saguinus fuscicollis	1,370	
El Alamo	*Pithecia sp.*	1,309	

Discussion

The discovery of this population of red uakaris is of great biogeographic and conservation interest. The population is separated from the known population in the east by more than 365 kilometres and by the wide and fast flowing Huallaga River. Although uakaris have recently shown to exist west of the Ucayali River (Bowler *et al.*, 2009), the western extent of this population is thought to be limited as the species has never been observed in the western part of the Pacaya-Samiria National Reserve (personal communication with guides living on the western border of the reserve to Jan Vermeer). The large gap between the populations is difficult to explain. The forest between both populations is continuous, and there are relatively few people living in the area. Common woolly monkeys (*Lagothrix poeppigii*), which we observed near Kusu (Locality 3 - Fig. 3), also live in the Pacaya-Samiria National Reserve (personal observations, Jan Vermeer). The same is true for saki monkeys (*Pithecia sp.*), although the taxonomy of this genus is unclear and it is possible that the species observed during this study is different from the animals in the Pacaya-Samiria National Reserve. The Brazilian subspecies of *Cacajao calvus calvus and*

Cacajao calvus rubicundus seem to have disjunct distribution ranges, although their precise distribution is still poorly understood (Veiga *et al.*, 2008). Our observations become even more interesting as they extend the recorded altitudinal range of the species. The animals in Kusu were encountered at an altitude of 1,115 m a.s.l., and we observed some individuals at an altitude of 1,421 m a.s.l. near Candamo. This is more than 700 meters higher than the former highest known altitude for Peruvian red uakaris (Heymann and Aquino, 2010). Only one other uakari species, the black *Cacajao hosomi*, is also known to be flexible in altitudes, as it has been reported from both the lowland and the montane forests at altitudes of 1,500m in Pico da Neblina Tepui mountain (Boubli, personal communication). Black uakaris are known to migrate seasonally to other areas, following the seasonal variation in fruit availability (Boubli 1999). It is possible that San Martin's uakaris have descended in the past into the lowland forests of the Alto Mayo Valley (800-1,000 m a.s.l.), towards the Mayo River, as local inhabitants reported that the species occupied once the lowlands south of the Mayo River (personal communication of local settlers to Julio C. Tello-Alvarado). The flooded forests near the Mayo River resemble in many aspects the forests of the Amazon lowlands. The Aguajal palm (*Mauritia flexuosa*) is common and the Aguajal swamp forests are comparable to those in the Amazon lowlands where *Cacajao calvus ucayalii* is common (Börner, 2000). In eastern Peru, the fruit of *Mauritia flexuosa* is an important food resource for *Cacajao calvus ucayalii*, although probably not essential (Aquino and Encarnacion, 1999; Bowler and Bodmer, 2011). However, since the completion in 1975 of the Carretera Marginal through the Alto Mayo Valley, immigration and illegal settlement has resulted in a high annual human population growth and much forest has been converted to agricultural lands. In most areas, the connection between the montane forests and the lowland forests has been disrupted. If access to the lowland forest of the Alto Mayo Valley was essential for the survival of this population, the disruption of the connection between the Cordillera Cahuapanas and the lowland forests, with its extensive Aguajal swamps, could have serious consequences for its future. On the other hand, the review of the habitat of *Cacajao calvus ucayalii* by Heymann and Aquino (2010) shows that the species is flexible, and it is possibly that these uakaris are able to adapt to a new situation.

We were not able to determine the extent of the distribution range of this population within the confines of this study, but assume it to be small. The most western observation, in the Candamo sector, is on the eastern border of the Bosque de Protección Alto Mayo, a large nature conservation area. If the species were widespread further west, it would already have been reported by guards or scientists working in the reserve. The most eastern of the new localities from where the species is reported here is the native community of Yarau, only 100 km east of the Candamo sector. It is not reported from the lowlands north of the Cordillera Cahuapanas, while most of the southern lowlands have been deforested. Additional surveys will be needed to estimate the total distribution range of the population. More interviews with the native communities living north of the Mayo River may result in more data on the (historical) distribution range of the species, and the importance of the lowland forests near the Mayo River for this population.

Considering their distant separation from the other populations, one could expect to find genetic differences and that the mountain uakaris represent a new taxon, as was the case in the black uakaris reported by Boubli *et al.* (2008). Additional studies should provide evidence as to whether this is correct or if these animals represent a separate population of *Cacajao calvus ucayalii*. In any case, the population seems to be small and have a restricted range. Given their possible ecological discrepancy from other red uakari populations (i.e. altitudinal range) efforts to protect these "mountain red uakaris" and their habitat are urgent. Proyecto Mono Tocón intends to assist local organisations with the protection of their mountain habitat.

Acknowledgements

The Proyecto Mono Tocón was initiated by Le Conservatoire pour la Protection des Primates of La Vallee des Singes Primate Park in Romagne, France. We are grateful to Eckhard W. Heymann (German Primate Center, Göttingen), Kevin Caley (Twycross Zoo) and two anonymous reviewers for their valuable revisions of the publication. We want to thank CEPA (Conservation des Espèces and Populations Animales, France) and especially Zoo de La Boissière du Doré for the financial support of the study. Additional financial support for the study was received from La Vallée des Singes, the Friends of Blackpool Zoo, Apenheul Primate Park, Twycross Zoo, the Zoological Society of London, the Shaldon Wildlife Trust, Zodiac Zoos and Basel Zoo. We thank Shane Green for the providing the pictures of the hunters with the dead uakari. During the fieldwork we were accompanied by Fernando Guerra Vásquez, Majorie Vermeer, César Manuel Paredes Arévalo, Eder Murrieta Villalobos and Ramiro Galoc Pinedo (ranger of BPAM). Special thanks go to the habitants of Santa María de Nieva, Saramiriza, Aguas Verdes, Candamo, El Inca, La Verdad and El Alamo for their support during the field studies. We thank the Jefatura del Bosque de Protección Alto Mayo (BPAM) and the Dirección General Forestal y de Fauna Silvestre (DGFFS) for their permission to conduct the study (permits nr. 006-2009-SERNANP/BPAM, 002-2010-SERNANP-BPAM and 0305-2010-AG-DGFFS-DGEFFS) and their support.

References

Aquino, R. and Encarnación, F. 1994. Primates of Peru. *Primate Report* 40:1–127.

Aquino R. and Encarnación, F. 1999. Observaciones preliminares sobre la dieta de *Cacajao calvus ucayalii* en el nor-oriente peruano. *Neotrop. Primates* 7:1–5.

Aquino, R., Terrones, W., Cornejo, F., & Heymann, E. W. 2008. Geographic distribution and possible taxonomic distinction of *Callicebus torquatus* populations in Peruvian Amazonia. *Am. J. Primatol.* 70:1181–1186.

Börner, A. 2000. Classification of premontane tropical Forests at the Eastern Slope of the Andes in the Río Avisado Watershed, Alto Mayo Region, Northern Perú. Doctoral Thesis in Geoecology, University of Bayreuth, Bayreuth, Germany.

Boubli, J. P. 1999. Feeding Ecology of Black-headed Uacaris (*Cacajao melanocephalus melanocephalus*) in Pico da Neblina National Park , Brazil. *Int. J. Primatol.* 20(5):719–749.

Boubli, J. P. da Silva, M. N. F., Amado, M. V., Hrbek, T., Boavista Pontual, F. and Farias, I. P. 2008. A taxonomic Reassessment of *Cacajao melanocephalus* Humboldt (1811), with the Description of Two New Species. *Int. J. Primatol.* 29(3):723–741.

Bóveda-Penalba, A., Vermeer, J., Rodrigo, F. & Guerra-Vásquez, F. 2009. Preliminary report on the distribution of the Rio Mayo Titi Monkey (*Callicebus oenanthe*) on the eastern feet of the Andes. *Int. J. Primatol.* 30:467–480.

Bowler M, and Bodmer, R. E. 2011. Diet and food choice in Peruvian red uakaris (*Cacajao calvus ucayalii*): selective or opportunistic seed predation? *Int. J. Primatol*. 32:1109–1122.

Bowler, M., Noriega Murrieta, J., Recharte, M., Puertas, P. and Bodmer, R. 2009. Peruvian Red Uakari Monkeys (*Cacajao calvus ucayalii*) in the Pacaya-Samiria National Reserve — A Range Extension Across a Major River Barrier. *Neotrop. Primates* 16(1):34–37.

Defler, T. R., Bueno, M. L. and García, J. 2010. *Callicebus caquetensis*: A new and critically endangered titi monkey from southern Caquetá, Colombia. *Primate Conservation* 2010 (25): 1–9.

Hershkovitz, P. 1987. Uacaries, New World monkeys of the genus *Cacajao* (Cebidae, Platyrrhini): A preliminary taxonomic review with the description of a new subspecies. *Am.J.Primatol.* 12:1–53.

Heymann, E. W. & Aquino, R. 2010. Peruvian red uakaris, *Cacajao calvus ucayalii*, are not flooded-forest specialists. *Int. J. Primatol*. 31(5): 751–758.

Kinzey, W. G. 1997. *New World primates: Ecology, evolution, and behavior*. New York: Aldine de Gruyter.

Röhe, F., de Sousa e Silva Jr, J., Sampaio, R. and Rylands, A. B. 2009. A new subspecies of *Saguinus fuscicollis* (Primates, Callitrichidae). *Int. J. Primatol.* 30: 533–551.

Treidel, H. 2004. Geomorphologic features, soils and vegetation of the central cordillera Cahuapanas (Alto Mayo, Peru). Doctoral thesis in geoecology, University of Bayreuth, Bayreuth, Germany.

Veiga, L. M., Bowler, M., Silva Jr., J. S., Queiroz, H. L., Boubli, J. P. and Rylands, A. B. 2008.*Cacajao calvus*. In: IUCN 2011. IUCN Red list of threatened species. Version 2011.2. <www.iucnredlist.org>. Downloaded on 19 April 2012.

Vermeer, J., Tello-Alvarado, J., Moreno-Moreno, S. & Guerra-Vásquez, F. 2011. Extension of the geographical range of white-browned titi monkeys (*Callicebus discolor*) and evidence for sympatry with San Martin titi monkeys (*Callicebus oenanthe*). *Int. J. Primatol.* 32(4): 924–930.

Walsh, P. D. and White, L. J. T. 1999. "What will it take to monitor forest elephant populations?" *Conservation Biology* 13: 1194–1202.

PRIMER REPORTE DE PARÁSITOS INTESTINALES EN *CALLICEBUS MODESTUS* DEL DEPARTAMENTO DE BENI, BOLIVIA

José Luis Mollericona[1], Jesús Martínez[1], Rolando Limachi[1], Pamela Carvajal [1] y Erika Alandia-Robles[1, 2]

[1] *Programa Gran Paisaje Madidi-Tambopata, Wildlife Conservation Society, Calle Gabino Villanueva #340 Calacoto, Casilla 3-35181 S.M., La Paz*
[2] *Wildlife Health Program, Wildlife Conservation Society, New York, USA*

Resumen

La diversidad de parásitos intestinales presente en *Callicebus modestus* de vida libre fue evaluada en dos grupos presentes en la provincia José Ballivián del Departamento de Beni-Bolivia. Durante 10 meses (septiembre 2010 a junio 2011) se colectaron muestras fecales de los miembros de una pareja de adultos, macho y hembra (grupo A), así como de un segundo grupo (grupo B) que incluía a un par de monos adultos (macho y hembra), un juvenil (hembra) y una cría (macho) habitando una zona poco fragmentada en relación al grupo A. Mediante pruebas coproparasitológicas se identificaron formas inmaduras de parásitos del orden Strongylida, orden Spirurida y representantes de los géneros *Strongyloides* y *Bertiella*. Los huevos del parásito *Strongyloides* spp. fueron los más prevalentes a lo largo del periodo de estudio (presente en 9 de los 10 meses), seguidos de huevos del parásito Strongylida (presente en 6/10 meses de estudio). Formas inmaduras de los parásitos del orden Spirurida y del género *Bertiella* fueron observados únicamente al final de la época de lluvias. Ninguno de los individuos monitoreados presentó indicios de problemas sanitarios relacionados a la presencia de estos parásitos, sin embargo, cabe resaltar el hallazgo de huevos del parásito *Bertiella* spp. por las implicancias que puede tener para la salud pública.

Palabras clave: Parásitos intestinales, *Callicebus modestus*, primates silvestres, Bolivia

Abstract

Intestinal parasite diversity was evaluated in two groups of free-ranging *Callicebus modestus* from the José Ballivián Province of the Beni Department, Bolivia. During 10 months (September 2010 to June 2011) fecal samples were collected from an adult pair (group A), and a second group (group B) living in a less fragmented area than group A composed by an adult pair, a juvenile female and an infant male. Immature structures from parasites belonging to the Strongylida and Spirurida orders and the *Strongyloides* and *Bertiella* genera were detected through coproparasitology. Eggs from *Strongyloides* spp. were the most prevalent along the study (present in 9 of 10 months), followed by Strongylida eggs (present in 6 of 10 months). Immature structures of parasites from the Spirurida order and the genera *Bertiella* were only observed at the end of the rainy season. None of the monitored individuals presented evidence of health problems related to the presence of parasites, however, the presence of *Bertiella* spp. eggs is relevant for its public health implications.

Keywords: Intestinal parasites, *Callicebus modestus*, free-ranging primates, Bolivia

Introducción

Los primates del género *Callicebus* son considerados los más diversos en la región neotropical habiéndose reconocido a la fecha 30 especies (Roosmalen *et al*., 2002; Wallace *et al*., 2006; Gualda *et al*., 2012). En Bolivia se tiene confirmada la presencia de las especies *C. donacophilus*, *C. aureipalatii* y *C. pallescens* que habitan los departamentos de Beni, Pando, Norte de La Paz, Cochabamba y Santa Cruz; y las especies endémicas, *C. modestus* y *C. olallae*, que habitan el Suroeste del departamento del Beni (Martínez y Wallace, 2010). *Callicebus modestus*, conocido localmente como mono lucachi, tiene una distribución que abarca un área de ocurrencia de 1,800 km^2 y un área ocupacional altamente restringida de 450 km^2. El hábitat de esta especie está constituido por islas de bosque fragmentadas compuestas por vegetación de porte bajo, las cuales suelen encontrarse en medio de establecimientos ganaderos. La coexistencia de factores como la fragmentación de los bosques, actividades de ecoturismo no reguladas y el mejoramiento de la carretera “Corredor del norte" hace que el hábitat de *C. modestus* sea susceptible a disiparse, con el consecuente riesgo de extinción de la especie (Martínez y Wallace, 2007). Adicionalmente, la aparición de enfermedades infecciosas y no infecciosas puede provocar cambios conductuales, fisiológicos y de patrones de movimiento de

los primates, pudiendo así repercutir negativamente en las tasas de natalidad y mortalidad de las poblaciones (Suzán *et al*., 2000).

Si bien la fauna parasitaria en algunas especies del género *Callicebus* fue estudiada en algunos países de Sudamérica (Tabla 1), los estudios de parásitos de primates en Bolivia no brindan información para este género y se limitan a especies de las familias Cebidae y Atelidae (Notarnicola *et al*., 2007; Beltrán *et al*., 2009), la primera en cautiverio y la otra un espécimen de cacería. Dado el grado de endemismo y las amenazas existentes para la conservación de *C. modestus*, conocer los factores ecológicos y la dinámica de las enfermedades que podrían afectar a las poblaciones de estos primates en Bolivia se torna un aspecto de gran importancia. Es así que el presente trabajo contribuye con información referida a la diversidad de parásitos intestinales identificados en dos grupos de *C. modestus* en vida libre.

Materiales y métodos

El estudio fue realizado en la Estancia Ganadera San Miguel, ubicada aproximadamente a 15 km del pueblo de Santa Rosa del Yacuma en la provincia José Ballivián del Departamento del Beni, Bolivia (-13°57'7.13"S y 66°50'5.20"O). La zona pertenece a la ecoregión de pampa mojeña y consiste en un área de bosque fragmentado de baja altura inmerso en una matriz de pasturas que se encuentran bajo manejo para la alimentación de ganado vacuno. En esta zona la época seca abarcó los meses de julio a octubre.

En el área de estudio se identificaron dos grupos de *C. modestus*: un grupo A conformado por dos monos lucachis adultos (macho y hembra), y un grupo B que incluía a un par de adultos (macho y hembra), acompañados de un juvenil (hembra) y una cría (macho). Ambos grupos fueron seleccionados para formar parte de un estudio de ecología de comportamiento de la especie, para lo cual se caracterizó a los individuos de cada grupo en base al sexo, tamaño y coloración del pelo. Luego de un periodo de habituación, el cual sirvió para afirmar el reconocimiento de cada uno de los individuos, se inició el registro de comportamiento. Los grupos fueron observados por periodos de 10 días por mes. Adicionalmente, entre septiembre 2010 y junio 2011 se colectaron mensualmente muestras de heces de los seis individuos con el objetivo de levantar una línea base de la fauna parasitaria de *C. modestus*. Durante los periodos de observación, cuando alguno de los animales era observado defecando y previa identificación del individuo, se procedía a ubicar la muestra en el suelo para luego conservarla en un frasco con formol al 10%. Dado que los análisis de materia fecal requieren muestras de 5-10 gr, a cada individuo se le asignó un frasco para cada periodo de observación en el cual se agruparon sus deyecciones.

Tabla 1. Parásitos reportados en primates no-humanos del género *Callicebus* en Sudamérica.

Especie	Parásitos	País	Referencia
Callicebus cupreus	*Raillietina trinitatae* *Prosthenorchis elegans* *Bertiella mucronata* *Atriotaenia megastoma*	Perú	Dunn (1962, 1963)
Callicebus moloch	*Trichospirura leptostoma*	Colombia	Orihel y Seibold (1971)
Callicebus personatus	*Bertiella mucronata*	Perú	Brack (1987)
Callicebus personatus	*Primasubulura jacchi*	Brasil	Melo *et al*. (1995)
Callicebus caligatus	*Subulura distans*	Brasil	Vicente *et al*. (1997)
Callicebus personatus	*Strongyloides* sp. Strongyloidea *Trichuris* sp. Ascaridoidea *Giardia* sp.	Brasil	Figueiroa *et al*. (2001)
Callicebus torquatus	*Trypanoxyuris croizati*	Venezuela	Hugot *et al*. (1994)
Callicebus nigrifrons	*Mathevotaenia megastoma* *Hymenolepis* spp. *Primasubulura jacchi* *Trichospirura leptostoma*	Brasil	Pacheco *et al*. (2003)
Callicebus cupreus	*Prosthenorchis elegans*	Perú	Tantaleán *et al*. (2005)
Callicebus cupreus	*Prosthenorchis elegans* Spirurido *Strongyloides cebus*	Perú	Müller (2007)
Callicebus cupreus	*Prosthenorchis elegans*	Perú	Müller *et al*. (2010)

La presencia de formas evolutivas de parásitos gastrointestinales se determinó mediante el método de enriquecimiento de flotación por centrifugación (Hendrix, 2002) con solución de Sheater y el método de sedimentación modificada de Ueno y Gutiérrez (1983). La identificación de las formas inmaduras se realizó mediante la observación de las características estructurales y por micrometría en un microscopio óptico binocular de luz Para determinar la proporción de *Callicebus* infestados con los diferentes parásitos identificados, se consideraron los parámetros edad y sexo de los hospederos. Adicionalmente, se analizaron patrones de variación temporal en base a los meses con presencia de cada especie de parásito.

Resultados

El trabajo realizado permitió la colecta mensual de muestras fecales de seis individuos *C. modestus* de vida libre por un periodo de 10 meses. Mediante análisis coprológicos se identificaron huevos de forma elipsoidal con doble cáscara delgada y lisa, de 63.75 (±9.29) µm de longitud por 36.75 (±5.041) µm de ancho, con extremidades paralelas y morulados en el momento de la puesta. Estos huevos fueron identificados como pertenecientes al orden Strongylida (Fig. 1.A). Otros huevos con cáscara delgada y fina, con polos ligeramente aplanados y de menor tamaño que los huevos de estrongílidos, 50.09 (±9.98) µm de longitud por 27.41 (±9.102) µm de ancho, presentando una larva ya desarrollada en el momento de la puesta, fueron identificados como huevos de *Strongyloides* spp. (Fig. 1.C). Del mismo modo, se hallaron huevos de forma ovalada con paredes gruesas, de 24,5 (±1.972) µm de longitud por 10.88 (±1.449) µm de ancho y en cuyo interior se identificaron larvas individuales en desarrollo, correspondiendo esta descripción a huevos de parásitos del orden Spirurida (Fig. 1.B). Por último, se observó un cuarto tipo de huevo, de forma oval con medidas de 41.25 (±5.303) µm de longitud y 33.75 (±1.768) µm de ancho, en cuyo interior se observaba un aparato piriforme característico del cestodo anoplocefálido *Bertiella* spp. (Fig. 1.D).

El seguimiento mensual realizado mostró la eliminación de huevos de *Strongyloides* spp. a lo largo de casi todo el estudio (9/10 meses) (Figura 2). La eliminación de estos huevos fue más constante entre los miembros del grupo A (7/10 meses), mientras que en el grupo B los huevos de *Strongyloides* spp. se registraron únicamente en 3 de los 10 meses monitoreados (Fig. 3).

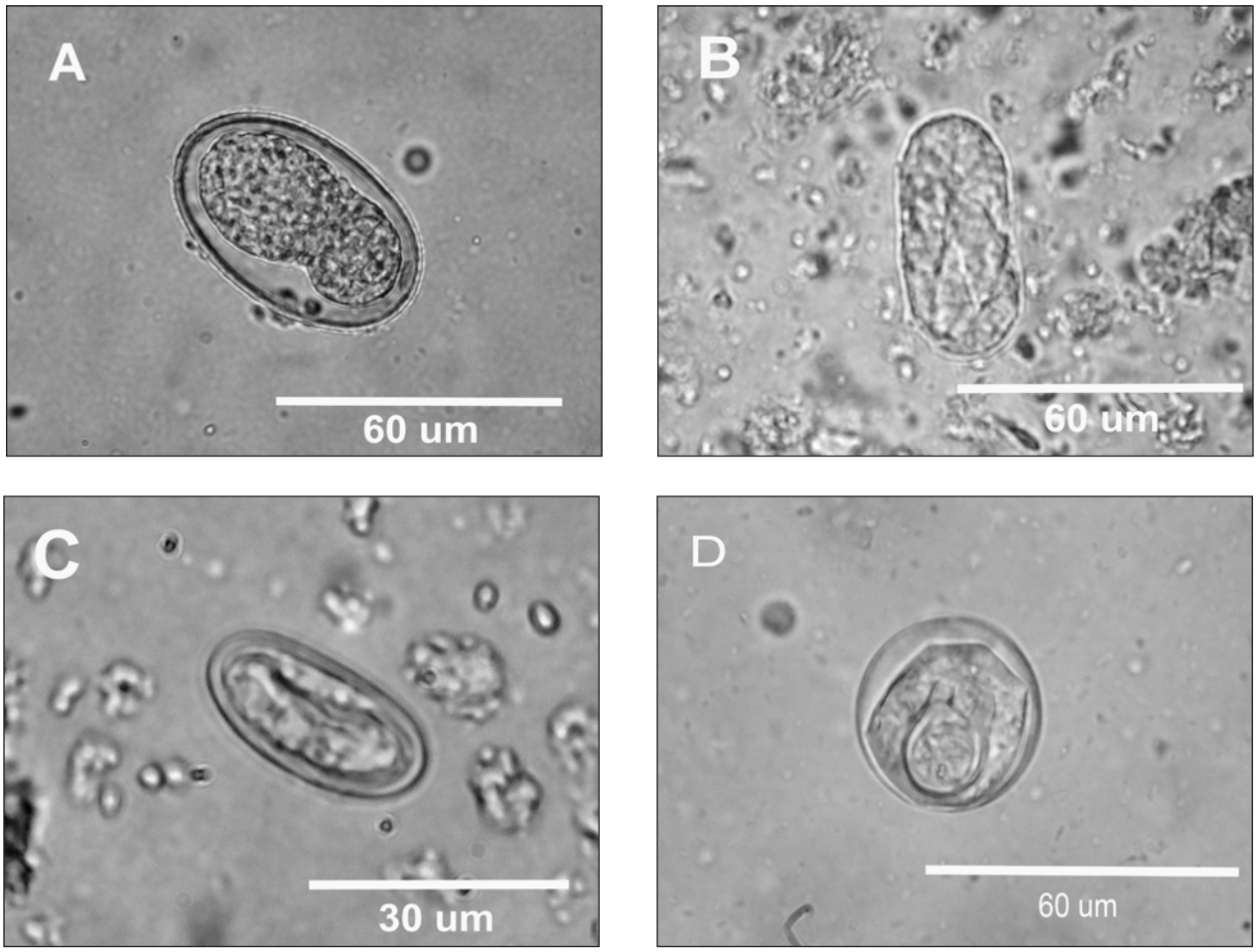

Figura 1. Formas inmaduras de parásitos intestinales identificados en *Callicebus modestus* (n=6), en la estancia San Miguel de la Provincia José Ballivián del departamento del Beni, Bolivia. A) Huevo Estrongílido; B) Huevo de *Strongyloides* spp.; C) Huevo Spirurido; D. Huevo de *Bertiella* spp.

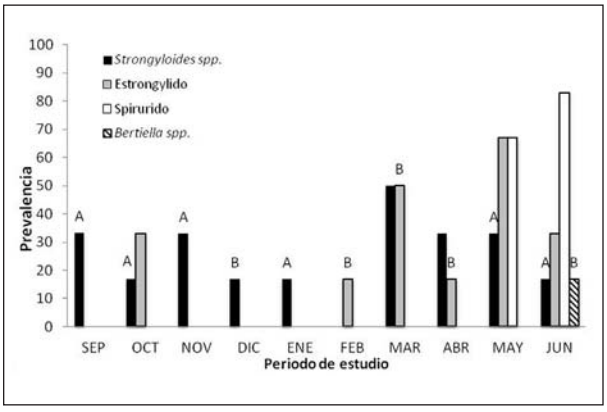

Figura 2. Variación mensual en la prevalencia de parásitos intestinales en *Callicebus modestus* de la estancia San Miguel de la Provincia José Ballivián del departamento del Beni, Bolivia. A= presencia exclusiva en el grupo A; B= presencia exclusiva en el grupo B.

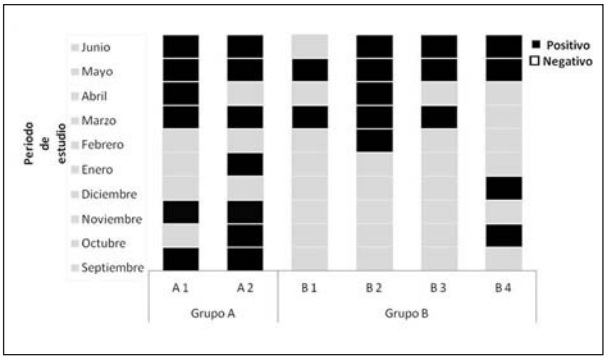

Figura 3. Presencia de huevos de parásitos intestinales en muestras fecales individuales de *Callicebus modestus* de la estancia San Miguel de la Provincia José Ballivián del departamento del Beni, Bolivia.

A1= Hembra adulta; A2= Macho adulto; B1= Hembra adulta; B2= Macho adulto; B3= Hembra juvenil; B4= Macho cría.

Los huevos del orden Strongylida se observaron en 6/10 meses de estudio, siendo su eliminación permanente entre los meses de febrero y junio en el grupo B (Fig. 2) y común a ambos grupos de *Callicebus* en los meses de mayo y junio (Tabla 2). Adicionalmente, en estos dos meses se observó un incremento en la diversidad y prevalencia parasitaria con la aparición de huevos de Spirurida en ambos grupos y la presencia de huevos del céstodo *Bertiella* spp. en el grupo B.

Si bien el limitado tamaño muestral no permite tener un poder estadístico suficiente para establecer diferencias significativas, a lo largo del estudio se observó una tendencia a que los machos de cada grupo presentan periodos de parasitosis más prolongados en relación a los otros miembros de sus grupos (Tabla 2). Así mismo, los individuos del grupo A parecen tener una tendencia a eliminar huevos de parásitos de forma más constante que los miembros del grupo B (Fig. 3).

Durante los 10 meses de seguimiento realizados, no fueron observados comportamientos anormales ni signos como diarrea, anorexia o decaimiento, que denotaran indicios de enfermedad en ninguno de los individuos monitoreados en el presente estudio.

Discusión

El presente estudio determinó la presencia de parásitos del orden Strongylida y Spirurida, *Strongyloides* spp. y *Bertiella* sp. en la especie *Callicebus modestus*. Estos hallazgos guardan relación con la fauna parasitaria descrita para los primates del género *Callicebus* en Perú y Brasil (Tabla 1). Estudios de Figueiroa *et al.* (2001), Bowman *et al.* (2004) y Chinchilla *et al.* (2010) señalan que *Strongyloides* spp. es el parásito más prevalente en los primates neotropicales. Nuestro estudio coincide con estos reportes ya que huevos del parásito *Strongyloides* spp. fueron los más frecuentemente observados. Este nemátodo presenta dos ciclos de vida (heterogónico o fase de desarrollo de vida libre, y homogónico o fase parásitaria), y cuenta además con dos vías de infección en el hospedador (vías percutánea y oral) (Ramírez-Herrera *et al.*, 2001). Estos factores podrían explicar la amplia distribución del parásito en los grupos de estudio y a lo largo del año.

Los estrongílidos presentan un ciclo de vida directo y su desarrollo se ve favorecido bajo condiciones de humedad y calor (Cordero del Campillo *et al.*, 1999). Es posible que estos factores expliquen la frecuencia de presentación

Tabla 2. Registro de parásitos por grupo, edad y sexo en dos grupos de *C. modestus* monitoreados durante 10 meses en la estancia San Miguel de la Provincia José Ballivián del departamento de Beni, Bolivia.

Parásitos	Grupo A		Grupo B			
	Adulto		Cría	Juvenil	Adulto	
	Hembra	Macho	Macho	Hembra	Hembra	Macho
Strongyloides spp	5* / 10**	7 / 10	1 / 10	1 / 10	0 / 10	1 / 10
Estrongílido	2 / 10	2 / 10	1 / 10	2 / 10	1 / 10	5 / 10
Spirurido	1 / 10	2 / 10	2 / 10	2 / 10	1 / 10	1 / 10
Bertiella spp	0 / 10	0 / 10	0 / 10	1 / 10	0 / 10	0 / 10

* Meses con observación de parásitos
** Número de meses evaluados.

de estrongílidos en 6 de los 10 meses de estudio, principalmente al final de la época de lluvias (marzo-junio). Si bien los parásitos de este orden fueron más recurrentes entre los miembros del grupo B, el número reducido de individuos estudiados no permite obtener conclusiones sobre las posibles causas de esta aparente diferencia en la prevalencia del parásito en ambos grupos. A diferencia de *Strongyloides* spp. y estrongílidos, los cuales presentan ciclos de vida directos, el nemátodo Spirurida requiere de la presencia de artrópodos como cucarachas de la familia Blatidae para desarrollarse (Campos y Vargas, 1977; Bowman *et al*., 2004). Del mismo modo, el céstodo *Bertiella* spp. requiere la presencia de ácaros oribatidos de los géneros *Dometorina, Achipteria*, *Galumna*, *Scheloribates* y *Scutovertex*, los cuales forman parte de la microflora del suelo, para completar su ciclo de vida (Acha y Szyfres, 2003; Bowman *et al*., 2004). Dado que C. *modestus* es una especie principalmente frugívora y folívora, pero también insectívora (Martínez y Wallace, 2010), la observación de Spirurida y *Bertiella* spp. al final de la época de lluvias no sería un hallazgo sorprendente.

Los estudios de Pope (1966), Hamilton y Zuk (1982), Urzúa *et al*. (2004) y Muehlenbein y Watts (2010), plantean que la hormona androgénica testosterona, de vital importancia para la expresión de caracteres secundarios como el incremento de masa corporal y crecimiento de pelo, entre otros, puede tener un efecto inmunosupresor que haría que los machos sean más vulnerables a ser parasitados. Otros factores como la conducta, territorialidad, movimiento, interacciones sociales y la dieta pueden también estar relacionados con las diferencias en la exposición de helmintos observada entre hembras y machos (Poulin, 1996). Dado que el presente estudio se enmarcó dentro de un estudio de comportamiento de monos lucachi y buscó únicamente levantar una línea base de la fauna parasitaria en esta especie, el número de individuos monitoreado y el diseño empleado no fueron adecuados para realizar inferencias estadísticas. Sin embargo, a lo largo del estudio se observó que en ambos grupos los machos adultos tendieron a presentar mayor diversidad parasitaria en relación a los otros miembros de sus grupos. A fin de establecer si la tendencia observada en el presente estudio refleja una característica del grado de exposición parasitaria observada entre géneros en esta especie, se recomienda ampliar los estudios a un mayor número de animales.

Diversos reportes señalan que los parásitos identificados en el presente estudio pueden llegar a causar efectos adversos en la salud de sus hospedadores. En el caso del parásito *Strongyloides* spp., los animales con infestaciones moderadas pueden presentar diarreas, pérdida de peso, anorexia, anemia moderada y, en infestaciones muy severas, erosión y ulceración de la mucosa intestinal (Soulsby, 1987; Tantaleán, 2009). Estos síntomas pueden verse exacerbados cuando existen infestaciones concomitantes con parásitos estrongílidos. Por su parte, los parásitos del orden Spirurida, de los cuales se reportaron en primates los géneros *Streptopharagus*, *Gongylonema*, *Protospirura*, *Physocephalus*, *Rictularia* y *Physaloptera* (Bowman *et al*., 2004), pueden llegar a causar diarreas intermitentes, inapetencia, emaciación progresiva, deshidratación y anemia (Ceballos y Noreña, 2007). Si bien en el presente trabajo se identificó la presencia de estos parásitos, ninguno de los síntomas señalados fue observado en los hospederos durante el estudio de comportamiento realizado. Esto podría estar indicando la existencia de cargas parasitarias bajas o insuficientes para causar daño en los hospederos, reflejando así un probable estado de equilibrio entre los parásitos y sus hospederos. Finalmente, cabe resaltar la presencia de céstodos del género *Bertiella* spp., cuyo representante más común en primates neotropicales es *Bertiella mucronata* (Dunn, 1963). Si bien este parásito no causa síntomas ni lesiones en sus hospederos definitivos (Souza Júnior *et al*., 2008), su hallazgo cobra importancia por constituirse en un parásito de carácter zoonótico. La infección en humanos, la cual puede llegar a producir dolor abdominal, diarrea intermitente, anorexia, constipación y pérdida de peso (Acha y Szyfres, 2003; Aibar *et al*., 2010), fue reportada en personas que co-habitan con primates (Denegri y Perez-Serrano, 1997; Bhagwant, 2004).

El presente estudio constituye el primer reporte de los parásitos intestinales presentes en *Callicebus modestus*. Los datos obtenidos mediante el uso de técnicas indirectas y poco invasivas permitieron determinar la fauna parasitaria presente en dos poblaciones de esta especie endémica del departamento de Beni. Los estudios observacionales realizados en ambos grupos sugieren que la presencia de los parásitos identificados no estaría causando efectos negativos en los individuos evaluados. Sin embargo, considerando las actividades antropogénicas a las cuales están expuestas las poblaciones de *C. modestus*, mismas que podrían tener efecto sobre su estado sanitario, se recomienda ampliar los estudios a otros grupos y otras zonas con distinto grado de intervención. Así mismo, para futuros estudios en esta y otras especies, se recomienda la utilización de técnicas adicionales que sean más sensibles para la detección de parásitos protozoarios, así como el uso de técnicas coprológicas cuantitativas a fin de poder monitorear variaciones en las cargas parasitarias, las cuales han sido reportadas como efecto de situaciones de estrés, cambios ambientales o problemas sanitarios en poblaciones silvestres (Gillespie *et al*., 2005; Chapman *et al*., 2006).

Agradecimientos

A la Fundación Bobolink, Margot Marsh Foundation y Primate Consevation Inc. por financiar este trabajo. A los asistentes de campo E. González y E. Fernández, y los propietarios de las Estancias Nogales por brindarnos acceso al sitio de estudio. A Pablo Beldomenico, Rodolfo Nallar, Marcela Uhart, Andrés Gómez, Robert Wallace y un revisor anónimo por la revisión crítica del artículo.

Referencias

Acha, P. N. y Szyfres, B. 2003. *Zoonosis y enfermedades transmisibles comunes al hombre y a los animales.* Vol III. Parasitosis 3a. ed. Organización Panamericana de la Salud, Washington, D.C.

Aibar, M. A., De Escalante, B., Ramírez, E. y Garcés, V. 2010. Infección por *Bertiella studeri* en una niña de Guinea Ecuatorial. *Cartas científicas/Enferm. Infecc. Microbiol Clín*. 28: 652–653.

Beltrán, L. F., Beldomenico, P. M. y Gonzales, J. L. 2009. Estudio coproparasitológico de mamíferos silvestres en cautiverio con destino a relocación en Santa Cruz, Bolivia. *Vet. Zootec.* 3: 51–60.

Bhagwant, S. 2004. Human *Bertiella studeri* (Family Anoplocephalidae) infection of probable Southeast Asian origin in Mauritian children and an adult. *Am. J. Trop. Med. Hyg.* 70: 225–228.

Bowman, D. D., Lynn, R. C. y Eberhard, M. L. 2004. *Parasitología veterinaria De Georgi*. 8a ed. Elsevier. Madrid, España.

Brack, M. 1987. *Agents transmissible from simians to man*. Springer, Berlin, Heidelberg, Germany.

Campos, M. y Vargas, M. 1977. Biología de *Protospirura muricola* Gedoelst, 1916 y *Mastophorus muris* Gmelin, 1790 Nematoda: Spiruridae, en Costa Rica. I. Huéspedes intermediarios. *Rev. Biol. Trop.* 25: 191–207.

Ceballos, Y. D. y Noreña, J. E. 2007. *Prevalencia de endoparásitos en primates que ingresan al centro de atención y valoración de fauna silvestre (CAV) del área metropolitana del valle de Aburrá*. Tesis de Licenciatura, Universidad Nacional de Colombia, Medellín, Colombia.

Chapman, C., Wasserman, M., Gillespie, T., Speirs, M., Lawers, M., Saj, T. y Ziegler, T. 2006. Do food availability, parasitism, and stress have synergistic effects on Red Colobus populations living in forest fragments? *Am. J. Phys. Anthropol.* 131: 525–534.

Chinchilla, M., Urbani, B., Valerio, I. y Carlos Vanegas, J. 2010. Parasitosis intestinal en monos capuchinos cariblancos *Cebus capucinus* (Primates: Cebidae) de un área protegida en la provincia de Limón, noreste de Costa Rica. *Rev. Biol. Trop.* 58: 1335–1346.

Cordero del Campillo, M., Rojo, V., Martínez, F., Sánchez, A., Hernández, R., Díez, B. y Carvalho, V. 1999. *Parasitología veterinaria.* 1a ed. McGraw-Hill Interamericana, Madrid.

Denegri, G. M. y Pérez-Serrano, J. 1997. Bertiellosis in man: a review of cases. *Rev. Inst. Med. Trop. Sao Paulo* 39: 123–127.

Dunn, F. L. 1962. *Raillietina (R.) trinitatae* (Cameron and Reesal, 1951), Baer and Sandars, 1956 (Cestoda) from a Peruvian primate. *Helminthol. Soc. Wash. Proc.* 29: 148–152.

Dunn, F. L. 1963. Acanthocephalans and cestodes of South American monkeys and marmosets. *J. Parasitol.* 49: 717-722.

Figueiroa, M., De Oliveira, A., De Brito, M., Oliveira, R. y Sobrinho, A. 2001. Perfil coproparasitológico de mamíferos silvestres en cautiverio en el estado de Pernambuco, Brasil. *Parasitol. día* 25: 121–125.

Gillespie, T., Chapman, C. y Greiner, E. 2005. Effects of logging on gastrointestinal parasite infections and infection risk in African primates. *J. Appl. Ecol.* 42: 699–707.

Gualda, B. J., Nascimento, F. O. D. y Amaral, M. K. D. 2012. A new species of *Callicebus* Thomas, 1903 (Primates, Pitheciidae) from the states of Mato Grosso and Pará, Brazil. *Pap. Avulsos Zool*. 52: 261–279.

Hamilton, W. y Zuk, M. 1982. Heritable true fitness and bright birds: a role for parasites? *Science* 218: 384–387.

Hendrix, C. M. 2002. Internal parasites. En: *Laboratory procedures for veterinary technicians*. Hendrix, C.M. (ed.), pp. 257–321. Mosby, Missouri.

Hugot, J., Morand, S. y Guerrero, R. 1994. *Trypanoxyuris croizati* n.sp. and *T. callicebi* Hugot y Vaucher, 1985 (Nematoda: Oxyuridae), two vicariant forms parasitic in *Callicebus* spp. (Primatia, Cebidae). *Syst. Parasitol.* 27: 35–43.

Martinez, J. y Wallace, R. B. 2007. Further notes on the distribution of endemic Bolivian titi monkeys, *Callicebus modestus* and *Callicebus olallae*. *Neotrop. Primates* 14: 47–54.

Melo, A. L., Neri, F. M. y Ferreira, M. B. 1995. Helmintos de sauás, *Callicebus personatus*, recolhidos no resgate de fauna durante a construcao da usina hidreletrica Nova Ponte-MG.1-Resultados preliminares. Presentado en el VII Congreso Brasileiro de Primatología, Natal.

Muehlenbein, M. y Watts, D. 2010. The cost of dominance: testosterone, cortisol and intestinal parasites in wild male chimpanzees. *BioPsychoSocial Medicine* 4: 1–12.

Müller, B. 2007. *Determinants of the diversity of intestinal parasite communities in sympatric new world primates (*Saguinus mystax, Saguinus fuscicollis, Callicebus cupreus*)*. Tesis de Doctorado, Tierärztliche Hochschule Hannover, Hannover, Germany.

Müller, B., Mätz-Rensing, K., Pérez Yamacita, J. G. y Heymann, E. 2010. Pathological and parasitological findings in a wild red titi monkey, *Callicebus cupreus* (Pitheciidae, Platyrrhini). *Eur. J. Wildl. Res*. 56: 601–604.

Notarnicola, J., Jiménez, F. A. y Gardner, S. L. 2007. A new species of Dipetalonema (Filarioidea: Onchocercidae) from *Ateles chamek* from the Beni of Bolivia. *J. Parasitol.* 93: 661–-667.

Orihel, T. C. y Seibold, H. R. 1971. Trichospirurosis in South American monkeys. *J. Parasitol.* 57: 1366–1368.

Pacheco, L. R., Neri, F. M., Frahia, V. T. y de Melo, A. L. 2003. Parasitismo natural em sauás, *Callicebus nigrifrons* (Spix, 1823): variacao na eliminacao de ovos de nematoda e cestoda. *Neotrop. Primates* 11: 29–32.

Pope, B. L. 1966. Some parasites of the howler monkey of Northern Argentina. *J. Parasitol.* 52: 166–168.

Poulin, R. 1996. Sexual inequalities in helminth infections: a cost of being a male? *Am. Nat.* 147: 287–295.

Ramírez-Herrera, O., Rodríguez-Vivas, R. I., Montes-Pérez, R. y Torres-Acosta, J. F. 2001. Seguimiento anual de la parasitosis gastrointestinal del tepezcuintle, *Agouti*

paca (Rodentia: Agoutidae) en cautiverio en el trópico mexicano. *Rev. Biol. Trop.* 49: 1171–1176.

Roosmalen, M. G. V., Roosmalen, T. V. y Mittermeier, R. A. 2002. A taxonomic review of the titi monkeys, genus Callicebus Thomas, 1903, with the description of two new species, *Callicebus bernhardi* and *Callicebus stephennashi*, from Brazilian Amazonia. *Neotrop. Primates* 10: 1–52.

Soulsby, E. J. L. 1987. Parasitología y enfermedades parasitarias en los animales domésticos. 7a. ed. Interamericana, México.

Souza Júnior, J. C., Goulart, J. A. G. G., Varnier, S. V., Denegri, G., Silva Filho, H. H. y Hirano, Z. M. B. H. 2008. Bertiellosis in Brazilian non-human primates: natural infection in *Alouatta guariba clamitans* (Cabrera, 1940) (Primates: Atelidae) in Santa Catarina State, Brazil. *Rev. Patol. Trop.* 37: 48–56.

Suzán, G., Galindo, F. y Ceballos, G. 2000. Importancia del estudio de enfermedades en la conservación de fauna silvestre. *Vet. Méx.* 31: 223–230.

Tantaleán, M., 2009. Parasitismo en animales silvestres. Presentación en Powerpoint. Brigada Fauna Silvestre, Perú. Website: http:/www.es.scribd.com. Consultado el 20 de julio de 2012.

Tantaleán, M., Sánchez, L., Gómez, L. y Huiza, A. 2005. Acantocéfalos del Perú. *Rev. peru. Biol.* 12: 83–92.

Ueno, H. y Gutiérrez, V. C. 1983. *Manual de laboratorio para el diagnostico de helmintos en rumiantes.* Universidade Federal do Rio Grande do Sul, Porto Alegre, RS. Brasil.

Urzúa, C., Morales, M. A., Vergara, U., Palau, M. T. y Zúñiga, C. 2004. Sexo del hospedero y dosis infectante de parásitos como factores en el desarrollo de la infección con *Trypanosoma cruzi* en un modelo murino. *Parasitol. Latinoam*. 59: 104–109.

Vicente, J. J., Rodrigues, H. de O., Gomes, D. C. y Pinto, R. M. 1997. Nematóides do Brasil. Parte V: Nematóides de mamíferos. *Rev. bras. Zool*. 14: 1–452.

Wallace, R. B., Gómez, H., Felton, A. y Felton, A. M. 2006. On a new species of titi monkey, genus *Callicebus* Thomas (Primates, Pitheciidae), from Western Bolivia with preliminary notes on distribution and abundance. *Primate Conserv.* 20: 29–39.

VARIABLE DENSITY RESPONSES OF PRIMATE COMMUNITIES TO HUNTING PRESSURE IN A WESTERN AMAZONIAN RIVER BASIN

Cooper Rosin[1] & Varun Swamy[1,2]

[1] *Nicholas School of the Environment, Duke University, P.O. Box, 90328, Durham, NC 27708. E-mail: cooper.rosin@duke.edu*
[2] *Harvard Forest, 324 North Main St., Petersham, MA 01366*

Abstract

Large-bodied game species are in decline in tropical forests worldwide due to unsustainable extraction levels by hunters, which can result in cascading effects on vertebrate community structure. In this study, we examine the density responses of primate populations to different levels of hunting pressure in the Madre de Dios river basin, Peru. Across three surveyed sites, both small- and mid-sized primates exhibited population-level density compensation in response to the extirpation of sympatric large primates. Small primate density at one heavily hunted site was 5x that of a comparable nonhunted site, while the highest density of mid-sized primates was recorded at mid-level hunting pressure. Primate response to hunting pressure appears to be influenced by reproductive rate, with strong interspecific variability. High reproductive rate, infrequent extraction, and the relaxation of competitive interactions with extirpated large primates appear to facilitate increasing density of the smallest-bodied species. Evidence from elsewhere in the Madre de Dios basin suggests that large primates are particularly slow to recover from past hunting pressure, with continuing recovery even in sites that have not been hunted for several decades. These variable density responses to hunting pressure alter inter-specific and community dynamics, with potentially expansive short- and long-term ecosystem-level effects.

Key Words: Competitive release; conservation; density compensation; distance sampling; game vertebrates; hunting; tropical forest.

Resumen

Los vertebrados de tamaño grande están en declive en los bosques tropicales a nivel mundial debido a niveles insostenibles de extracción por cazadores, lo cual puede resultar en efectos de cascada sobre la estructura de la comunidad de vertebrados. En este estudio, examinamos el efecto de diferentes niveles de presión de caza sobre primates en cuanto a la estructura de la comunidad y densidades de sus poblaciones en la cuenca del Río Madre de Dios, Perú. En los tres sitios estudiados, los primates de tamaños pequeño y mediano mostraron compensación de densidad al nivel de la población como respuesta a la extirpación de los primates grandes simpátricos. La densidad de primates pequeños en un sitio con alta cacería fue cinco veces más que en un sitio comparable sin cacería, mientras que la densidad más alta de primates de tamaño mediano fue registrada en el sitio con una presión mediana de caza. La respuesta de los primates a la presión de caza parece estar influida por la tasa de reproducción, con una fuerte variabilidad inespecífica. Altas tasas de reproducción, extracción infrecuente, y la disminución de interacciones competitivas con especies de primates grandes extirpados parecen facilitar una densidad creciente de primates de tamaño pequeño. Evidencia de otras partes de la cuenca del Río Madre de Dios sugiere que los primates grandes se recuperan lentamente de la presión de caza, presentándose recuperación continua aún en sitios en los cuales no se ha cazado por varias décadas. Estas respuestas de densidad variables a la presión de caza cambian las dinámicas interespecíficas y de la comunidad entera, con efectos potencialmente amplios al nivel del ecosistema a corto y largo plazo.

Palabras Clave: Liberación de competencia; conservación; compensación de densidad; muestreo de distancias; vertebrados de caza; cacería; bosque tropical.

Introduction

Subsistence and commercial demand drives hunting pressure on primates and other game vertebrates, resulting in increasingly "empty" forests worldwide (Redford, 1992; Wilkie *et al.*, 2011). In recent decades, expanding road networks have allowed unprecedented access to Neotropical forests for extractive purposes, with the extent of accessibility approaching 100% in the Brazilian Amazon (Peres and Lake, 2003). Our current understanding of tropical forest primate communities and associated ecological dynamics should therefore be reexamined in the context of human disturbance, particularly with regard to directly extractive activities such as hunting. Hunters in Neotropical forests can be highly selective, targeting large-bodied vertebrates (Redford and Robinson, 1987); in primate communities specifically, large Ateline monkeys (*Ateles* spp., *Lagothrix* spp.) are subject to intense hunting pressure while small and medium-sized primates are often ignored (Peres, 1990). In the absence of anthropogenic disturbance, the largest primate species are dominant, conspicuous, and highly abundant, particularly in sites that support high densities of fleshy-fruited tree species (Terborgh, 1983). When subject to hunting pressure, these ecological mainstays are increasingly replaced by their smaller counterparts (Peres and Dolman, 2000). Targeted hunting of the largest species can thus be a transformative force on the faunal assemblage.

If inter-specific competition for resources plays an important role in vertebrate population regulation, smaller vertebrates may exhibit a compensatory response from competitive release in the absence of large vertebrates, a phenomenon known as density compensation (MacArthur et al., 1972). Although density compensation has been studied most extensively in island and fragmented avifaunas (Diamond, 1970; Wright, 1980; Feeley and Terborgh, 2008) and its underpinnings have been debated (Faeth, 1984), some evidence of such responses exists for Amazonian primate communities, with increased abundance of small and mid-sized primates in response to the hunting-induced decline of large-bodied species (Peres and Dolman, 2000). However, more evidence of density compensation from additional sites – particularly for the smallest-bodied species – is necessary in order to better understand the long-term impacts of hunting on the vertebrate community of tropical forests. This study examines the density responses of primate populations to different levels of hunting pressure in the Madre de Dios river basin, Peru. We hypothesize that response to hunting pressure is influenced by reproductive rate, with strong interspecific variability. Infrequent extraction, higher reproductive rate, and the relaxation of competitive interactions with extirpated large primates may thus facilitate increasing density of the smallest-bodied species with hunting.

Methods

Field sites

The Madre de Dios river basin in southeastern Peru comprises ca. 80,000 km2 of lowland tropical forest, including several large protected areas. Human use of the area ranges from small-scale swidden agriculture to more intensive logging, mining, and hunting, as well as expanding development around urban centers such as Puerto Maldonado. Three sites under varying degrees of protection from hunting pressure were selected for faunal surveys (Fig. 1), based on documented and anecdotal historical information on human pressures, and an initial assessment of surrounding landuse via satellite imagery. We used the size of the focal protected area and straight-line distance to the nearest human settlement as proxies for ranking the degree of hunting pressure. The sites were selected to minimize potentially confounding natural variation and allow for the isolation of specific effects of hunting pressure from other forms of anthropogenic disturbance such as logging and agriculture.

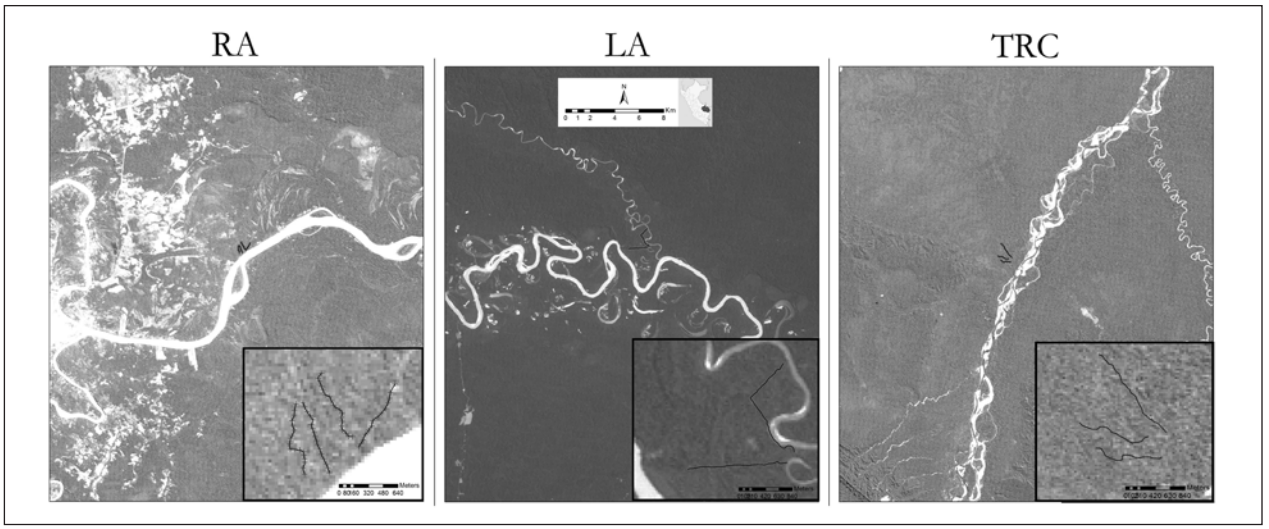

Figure 1. Field sites and transects in the Madre de Dios river basin, Peru; Reserva Amazónica (RA), Los Amigos (LA), and Tambopata Research Center (TRC). Human use surrounding field sites is evident in extensive landuse change (RA) and remnant mining pools (LA).

Reserva Amazónica (RA) [12°32'4"S, 69°3'13"W] is a 17,000 hectare private ecological reserve, owned and managed by the Asociación Inkaterra, a Peruvian ecotourism company. Given its relatively small size and proximity to Puerto Maldonado (1km from nearest human settlement, 16 km from Puerto Maldonado population center), the forest within the RA site has faced substantial human pressure in recent years. The lands surrounding the reserve are dominated by human use, with forests converted for farming, mining, and urban expansion. The RA region is characterized as a site under low protection from hunting pressure. The Los Amigos Biological Station / Centro de Investigación y Capacitación Rio Los Amigos (LA) [12°34'10"S, 70°4'52"W] is a 453 hectare research center adjacent to the 146,000 hectare Los Amigos Conservation Concession (2km from the nearest human settlement, Boca Amigos). The Concession was established in 2001 by two non-governmental organizations: the Peruvian Asociación para la Conservación de la Cuenca Amazónica (ACCA) and the US-based Amazon Conservation Association. The immediate grounds and many of the station facilities themselves were formerly the headquarters of a large gold mining enterprise. During the peak period of mining activity on the station grounds, from the late 1980s to early 1990s, the high density of miners – up to 120 at one point (Pitman, 2010) – fueled active hunting in the immediate area. Although the permanent mining settlement was abandoned and later repurposed with the designation of the land as a conservation concession, artisanal mining persists, scattered along the river. Overall, LA is characterized as a site under medium protection from hunting pressure. The Tambopata Research Center (TRC) [13°7'9"S, 69°36'59"W] is an eco-lodge and research facility located within the 275,000 hectare Tambopata National Reserve, and adjacent to the million-hectare Bahuaja-Sonene National Park (>50km from the nearest human settlement). The facilities are managed by the eco-tourism company Rainforest Expeditions, while the majority of the land is managed for strict conservation by the Peruvian government. Prior to the 1990 establishment of the reserve zone, gold mining operations existed in the region, with activity tapering off after designation of the reserve and as a likely result of resource overexploitation in the region. The intensity of human disturbance is minimal and the site is well-protected from hunting. TRC is characterized as a site under high protection from hunting pressure.

Documenting vertebrate abundance

Our research team followed line transect protocol as described in the literature specific to tropical forest surveys of primates (Peres, 1999a; Marshall et al., 2008; Buckland et al., 2010), with minor modifications to account for site-specific circumstances. We implemented line transects of 1m width and varying length (from 750m to 1,500m, according to terrain conditions and station layout) at each site. Given the small size of each focal area, transects were placed in parallel or "zig-zag" orientations to ensure systematic and efficient sampling (Peres, 1999a; Buckland, 2001), with four transects at RA and three each at LA and TRC, spaced no fewer than 200m apart. Trail heads were located at a distance greater than 500m from the station base, and all transects were contained within mature floodplain forest. We flagged and georeferenced each transect at 50m intervals, and left all transects to rest for at least 1 day prior to sampling. Transects were surveyed in sequence during two daily periods corresponding to peak activity of study subjects: in the morning (0630-1100 h) and afternoon (1300-1730 h). We did not sample transects under rainy conditions. To survey each transect, a team of two (CR plus a trained field technician familiar with local fauna) walked quietly at a mean pace of ~1.5km/hour, listening for detection cues and scanning the transect line and surrounding forest. We stopped briefly approximately every 100m to listen for any additional cues. Focal species included diurnal primates present across the three study sites (Table 1). For each primate sighting, several data were recorded: time of day, species, number of individuals, perpendicular distance from transect ("PD", in meters), detection mode (visual or acoustic), and group diameter when applicable. For group encounters, PD was measured to the center of the group (Marshall et al., 2008). Large dispersed groups were sub-grouped to the greatest extent possible to maximize the likelihood that all individuals were counted and that PD measurements were accurate. PDs were measured via pacing, with regular re-calibration to ensure accuracy and consistency.

Analyzing transect data

For each species surveyed, we calculated an individual encounter rate per every 10km of sampled transect. Vertebrate transect data was modeled by functional group using the program Distance v. 6.0, a Windows-based computational package, to generate site-specific population density estimates for each focal species (Buckland, 2001). Distance allows for selection among several models; here, the Hazard-rate model with a Cosine adjustment offered the best density estimator for forest primates, as determined by the minimum Akaike information criterion (Peres, 1997; Buckland, 2001). All data were truncated to exclude the largest 5% of perpendicular distance values, which further benefitted model fit. Although sightings can be infrequent for some species – particularly when hunting reduces encounters of fauna already occurring at naturally low densities – small sample sizes can provide robust density estimates given a favorable distribution of data (Peres, 1999a). Given these constraints, we pooled detection data across sites to increase robustness of analysis. Analysis of Variance (ANOVA) comparing PD values across sites provided statistical support for data pooling. Data from the Monk Saki (Pithecia monachus) was not included in final density estimates, as the species did not occur at all three sites.

Results

We collected data over a total of 304.95km of transect survey effort, with 100.15km at RA, 102.3km at LA, and

102.5km at TRC. The total number of encounters was 29 for large primates (Ateles chamek [23] and Alouatta seniculus [6]), 44 for mid-sized primates (Cebus apella and Cebus albifrons), and 43 for small primates (Saimiri boliviensis, Saguinas fuscicollis, and Saguinas imperator). The majority of detections (74%) resulted from an initial auditory cue, primarily from vocalizations or locomotion. Values of the coefficient of variation (CV) for some density estimates are expectedly high given constraints on detection frequency (see Figure 2 description). Data pooling benefitted statistical robustness of model outputs; ANOVA results were non-significant (p>.05), with the exception of Saimiri boliviensis, for which further ANOVA of a subset of the data indicated that pooling was appropriate across two – rather than all three – sites.

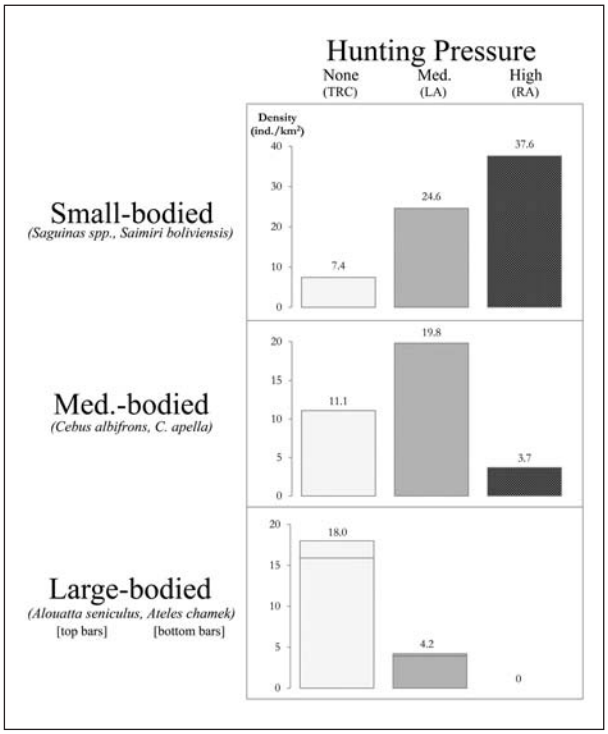

Figure 2. Densities of focal species by body size and hunting pressure at three sites: TRC site (no hunting), LA site (medium hunting pressure), and RA site (high hunting pressure). Large-bodied primates are further separated as folivorous (*Alouatta seniculus*: top bars) and frugivorous (*Ateles chamek*: bottom bars). CV values are as follows: small primates 26.8 (TRC), 31.5 (LA), 50.5 (RA); mid-sized primates 38.6 (TRC), 42.4 (LA), 85.7 (RA); large primates 58.8 (TRC), 89.7 (LA).

Observed encounter rates (Table 1) and *Distance*-derived density estimates (Fig. 2) reflect the impact of protection from hunting on relative densities of primate species at each site. At the RA site, large primates are completely absent, with low densities of mid-sized primates, and high densities of small primates. Conversely, at the large and well-protected TRC site, large primates are abundant, while mid-sized and small primates occur at lower densities. The LA site, representing a forest under moderate protection, exhibits mid-level densities for most species, with a notable abundance of mid-sized primates.

Discussion

Density responses to hunting

Hunting most dramatically affects large-bodied vertebrates – those greater than 5kg – which comprise the largest component (65-78%) of animal biomass at nonhunted sites (Peres, 1990; 2000). In primate communities, population declines of the Atelid monkeys (*Ateles chamek* and *Alouatta seniculus* in this study region) represent the main effect of hunting (Peres, 1990; 1999b). Such declines are the result of both hunter preference and low fecundity (see below). Large frugivorous primates are often abundant and highly conspicuous at nonhunted sites. Given their large body mass and gregarious social structure, large primates are prized prey species for human hunters, providing easy detectability and a large meat payoff. Hunter preference can vary based on several of these factors, as well as cultural taboos (da Silva *et al.,* 2005), but the strongest determinant of preference is large body size (see Table 1). Given this size selectivity, large game vertebrates may be drastically reduced at hunted sites while smaller non-target species escape hunting pressure. Our results support this assertion, with a complete absence of large primates at our least protected site.

Table 1. Body mass, hunter preference (Peres and Lake 2003), and encounter rate of focal species across three study sites.

Common Name	Latin Name	Body Mass (kg)	Hunter Preference*	Encounter Rate (ind./ 10km)		
				RA	*LA*	*TRC*
Spider monkey	*Ateles chamek*	9.0	4	–	1.4	6.8
Red howler monkey	*Alouatta seniculus*	6.5	3	–	0.3	2.2
Brown capuchin	*Cebus apella*	2.9	3	1.0	7.9	6.2
White-fronted capuchin	*Cebus albifrons*	2.7	2	0.4	2.8	–
Monk saki	*Pithecia monachus*	2.2	2	–	0.7	–
Squirrel monkey	*Saimiri boliviensis*	0.9	0	2.3	6.1	2.7
Saddleback tamarin	*Saguinus fuscicollis*	0.4	0	9.5	5.4	2.8
Emperor tamarin	*Saguinus imperator*	0.4	0	–	0.3	–

** Degree of hunter preference on a scale of 0 (always ignored) to 4 (never ignored)*

Drastic reductions of dominant species such as the spider monkey (*Ateles chamek*) and the howler monkey (*Alouatta seniculus*) also impact the broader faunal assemblage. Results from this study suggest a compensatory response of smaller-bodied primates at hunted sites (Fig. 2). The density of small primates was lowest at the nonhunted site (TRC) and highest at the most heavily hunted site (RA). At the RA site, the predominant small primate was the saddleback tamarin (*Saguinas fuscicollis*). *S. fuscicollis* is normally subordinate to larger primates and subject to frequent agonistic displacement at fruiting trees (Terborgh and Stern, 1987). The absence of large primates frees up space, time, and resources previously unavailable due to inter-specific competition. *S. fuscicollis* could be considered hyperabundant at RA, given densities five times larger than our comparable non-hunted site and cohesive "supergroups" as large as 17 individuals – well above estimates of typical mean group size (5 individuals per group; Terborgh, 1983) and range (2-12 individuals per group; Emmons and Feer, 1997). The response of mid-sized primates (*Cebus spp.*) to hunting appears dependent on the degree of pressure. *Cebus spp*. occurred at very low density under intense hunting pressure, but increased to its greatest density in moderately hunted – rather than nonhunted – forest. This is likely due to two factors. First, under mid-level hunting pressure mid-sized primates are less targeted, while intense hunting pressure results in their being taken as well (Peres, 1990). Second, like *S. fuscicollis, Cebus spp.* may respond negatively to the presence of sympatric primates – particularly *Ateles chamek* – and benefit from relaxed competition for shared resources when these large primates are no longer abundant (Fig. 2). Both small- and mid-sized primates in this study appear to exhibit population-level density compensation responses to the extirpation of sympatric large primates. Though our scope of inference is limited to three sites within a small geographic range, these results are potentially indicative of similar changes to primate community structure in other hunted forests.

Observed composition and density of primate populations in forests subject to hunting are likely influenced by species-specific reproductive rates and strategies. In general, smaller relative body size is a strong predictor of higher intrinsic rates of population increase in mammals (Fenchel, 1974). For Neotropical primates specifically, shorter interbirth interval may be a function of smaller relative brain weight (Fedigan and Rose, 1995). Both factors offer smaller primates greater resilience and faster recovery when subject to hunting pressure. Evidence from elsewhere in the Madre de Dios basin suggests that even in forests that have not experienced any hunting pressure for decades, primate populations may still be undergoing recovery from past disturbances. Symington (1988), in a complete census of the local spider monkey (*Ateles chamek*) population in the vicinity of Cocha Cashu Biological Station in Manu National Park, documented the total presence of 77 individuals. In a follow-up census 19 years later, Gibson (2008) found that the same population had grown to 119 individuals. While this notable increase may be due to several factors, it is likely that these populations were still recovering from local hunting pressure during the rubber boom at the turn of the 20th century, more than 75 years prior to Symington's survey (Terborgh, pers. comm.). This may explain differences seen in population densities between other sites in the basin as well (e.g. Endo *et al.,* 2010). *Ateles chamek* population densities in TRC – less isolated and more recently protected than Manu – are considerably lower than those documented at Cocha Cashu (Gibson, 2008). This suggests that the TRC populations may also be in a state of recovery and increasing abundance. The fact that populations of game vertebrates such as Ateline primates can be so slow to recover from disturbance does not bode well for their long-term viability in unprotected forests.

Conservation implications

Hunting is not an ephemeral or geographically limited activity. Wild game can be a major food resource for subsistence hunters across the Neotropics (Redford, 1992). In tropical forest localities, the estimated carrying capacity for humans dependent exclusively on wildlife for protein may be as low as 1 person/km^2 (Robinson and Bennett, 2000), though population densities exceed this nearly everywhere across the tropics. Many large game vertebrates are inherently vulnerable to major population declines, given their low reproductive capacity. Atelid monkeys in particular take several years to reach reproductive age, and then have long interbirth intervals with extended nursing periods (Milton, 1981; Symington, 1987). Hunting of large primates is therefore likely to be unsustainable in many areas, except perhaps when adjacent to large, strictly protected source reserves (da Silva *et al.,* 2005; Ohl-Schacherer *et al.*, 2007). Even moderate hunting pressure may be problematic, as large vertebrate dispersers need not be completely eliminated for hunting to have secondary impacts. Species in "half-empty forests" (Redford and Feinsinger, 2001) may be sufficiently reduced that they cease to provide ecological services such as seed dispersal before they become locally extinct (McConkey and Drake, 2006).

In addition to altering vertebrate population structure, hunting can have broad effects on the forest community as a whole. In general, frugivorous vertebrates suffer more severe declines at hunted sites than either granivorous or folivorous species, regardless of body size (Peres and Palacios, 2007). By mediating the dispersal of a majority of large-seeded fleshy-fruited canopy tree species, large vertebrate frugivores are crucial in maintaining biodiversity and regeneration dynamics in tropical forests (Janzen, 1970; Connell, 1971). Smaller non-targeted species, even with increased abundance, cannot adequately replace the dispersal function of larger ones due to inherent anatomical and physiological limitations (Peres and Van Roosmalen, 2002; Poulsen *et al.*, 2002; Knogge and Heymann, 2003; Stoner *et al.*, 2007). Under high hunting pressure, tree species most reliant on large frugivores may experience substantially reduced recruitment, which can dramatically

alter forest regeneration processes at the community level (Wright *et al*., 2007; Nuñez-Iturri *et al*. 2008; Terborgh *et al.,* 2008). Increased population densities of smaller-bodied species may, however, favor the smaller-seeded plants which they consume, given limited dispersal distances of larger-seeded counterparts whose dispersers are hunted (Wright *et al*., 2007). Changes to plant recruitment success based on traits such as seed size and type of fruit may thus accompany shifts in faunal communities, to the detriment of species dependent on hunted wildlife and the benefit of those which are not. In the long term, the hunting-induced disruption of game- and non-game vertebrate population dynamics is thus likely to effect change beyond faunal density responses, with expansive transformations to tropical forest community composition and biodiversity.

Acknowledgments

We are grateful to John Terborgh for his insight and thoughtful review, Rachel Rosin for her extensive assistance with the project, and to the following sources of funding for field data collection: the Kuzmier-Lee-Nikitine Endowment Fund, the Nicholas School International Endowment Fund, and the Lazar Foundation. Anonymous review also substantially improved the quality of this manuscript.

References

Buckland, S. T. 2001. *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press.

Buckland, S., A. Plumptre, L. Thomas, and E. Rexstad. 2010. Design and analysis of line transect surveys for primates. *Int. J. Primatol.* 31: 833–847.

Connell, J. H. 1971. On the role of natural enemies in preventing competitive exclusion in some marine animals and in rain forest trees. *In*: *Dynamics of populations*. den Boer, P. J. and G. R. Gradwell (eds.). Centre for Agricultural Publications and Documentation. Wageningen, The Netherlands.

da Silva, M. N. F, G. H. Shepard, and D. W. Yu. 2005. Conservation implications of primate hunting practices among the Matsigenka of Manu National Park. *Neotrop. Primates* 13: 31–36.

Diamond J. M. 1970. Ecological consequences of island colonization by Southwest Pacific birds. *P. Natl. Acad. Sci. USA* 67: 1780–1786.

Emmons, L. and F. Feer. 1997. *Neotropical rainforest mammals: a field guide.* University of Chicago Press, Chicago IL.

Endo, W., C. A. Peres, E. Salas, S. Mori, J. L. Sanchez-Vega, G. H. Shepard, V. Pacheco, and D. W. Yu. 2010. Game vertebrate densities in hunted and nonhunted forest sites in Manu National Park, Peru. *Biotropica* 42: 251–261.

Faeth, S. 1984. Density compensation in vertebrates and invertebrates: a review and an experiment. *Ecological communities: conceptual issues and the evidence*. Princeton, NJ: Princeton University Press.

Fedigan, L. M. and L. M. Rose. 1995. Interbirth interval variation in three sympatric species of neotropical monkey. *Am. J. Primatol.* 37: 9–24.

Feeley, K. J. and J. W. Terborgh. 2008. Direct vs. indirect effects of habitat reduction on the loss of avian species from tropical forest fragments. *Anim. Conserv.* 11: 353–360

Fenchel, T. 1974. Intrinsic rate of natural increase: the relationship with body size. *Oecologia* 14: 317–326.

Freese, C. H., P. G. Heltne, C. R. Napoleon, and G. Whitesides. 1982. Patterns and determinants of monkey densities in Peru and Bolivia, with notes on distributions. *Int. J. Primatol.* 3: 53–90.

Gibson, K. N. 2008. Mating tactics and socioecology of white-bellied spider monkeys (*Ateles belzebuth chamek*). PhD Dissertation, Yale University.

Janzen, D. H. 1970. Herbivores and the number of tree species in tropical forests. *Am. Nat.* 104: 501–528.

Knogge, C. and E. W. Heymann. 2003. Seed dispersal by sympatric tamarins, (*Saguinus mystax*) and (*Saguinus fuscicollis*): diversity and characteristics of plant species. *Folia Primatol.* 74: 33–47.

MacArthur R. H., J. M. Diamond, and J. R. Karr. 1972. Density compensation in island faunas. *Ecology*: 330–342.

Marshall, A. R., J. C. Lovett, and P. C. L. White. 2008. *Am. J. Primatol.* 70: 452–462.

McConkey, K. R. and D. R. Drake. 2006. Flying foxes cease to function as seed dispersers long before they become rare. *Ecology* 87: 271–276.

Milton, K. 1981. Estimates of reproductive parameters for free-ranging *Ateles geoffroyi*. *Primates* 22: 574–579.

Nuñez-Iturri, G., O. Olsson, and H. F. Howe. 2008. Hunting reduces recruitment of primate-dispersed trees in Amazonian Peru. *Biol. Cons.* 141: 1536–1546.

Ohl-Schacherer, J., G. H. Shepard Jr., H. Kaplan, C. A. Peres, T. Levi, and D. W. Yu. 2007. The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park, Peru. *Cons. Biol.* 21: 1174–1185.

Peres, C. A. 1990. Effects of hunting on western Amazonian primate communities. *Biol. Cons.* 54: 47–59.

Peres, C. A. 1997. Primate community structure at twenty western Amazonian flooded and unflooded forests. *J. Trop. Ecol.* 13: 381–405.

Peres, C. A. 1999a. General guidelines for standardizing line-transect surveys of tropical forest primates. *Neotrop. Primates* 7: 11–16.

Peres, C. A. 1999b. Effects of subsistence hunting and forest types on the structure of Amazonian primate communities. In: *Primate Communities.* Fleagle, J. G., C. Janson, and K. Reed (eds.). Cambridge University Press, Cambridge, UK.

Peres, C. A. 2000. Effects of subsistence hunting on vertebrate community structure in Amazonian forests. *Cons. Biol.* 14: 240–253.

Peres, C. A and J. W. Terborgh. 1995. Amazonian nature reserves: an analysis of the defensibility status of existing conservation units and design criteria for the future. *Cons. Biol.* 9: 34–46.

Peres, C. A. and P. M. Dolman. 2000. Density compensation in neotropical primate communities: evidence from 56 hunted and nonhunted Amazonian forests of varying productivity. *Oecologia* 122: 175–189.

Peres, C. A. and M. van Roosmalen. 2002. Patterns of primate frugivory in Amazonia and the Guianan shield: implications to the demography of large-seeded plants in overhunted tropical forests. In: *Seed dspersal and frugivory: ecology, evolution and conservation*. D.J. D.J. Levey, W.R. Silva, and M. Galetti (eds.). Oxford, UK: CABI International.

Peres, C. A. and I. R. Lake. 2003. Extent of nontimber resource extraction in tropical forests: accessibility to game vertebrates by hunters in the Amazon basin. *Cons. Biol.* 17: 521–535.

Peres, C. A., J. Barlow, and W. F. Laurance. 2006. Detecting anthropogenic disturbance in tropical forests. *Trends Ecol. Evol.* 21: 227–229.

Peres, C. A. and E. Palacios. 2007. Basin-wide effects of game harvest on vertebrate population densities in Amazonian forests: implications for animal-mediated seed dispersal. *Biotropica* 39: 304–315.

Pitman, N. C. A. 2010. An overview of the Los Amigos watershed, Madre de Dios, southeastern Peru. February 2010 version of an unpublished report available from the author at ncp@duke.edu.

Poulsen, J. R., C. J. Clark, E. F. Connor, and T. B. Smith. 2002. Differential resource use by primates and hornbills: implications for seed dispersal. *Ecology* 83: 228–240.

Redford, K. H. 1992. The Empty Forest. *BioScience* 42: 412–422.

Redford, K. H and J. G. Robinson. 1987. The game of choice: patterns of indian and colonist hunting in the Neotropics. *Am. Anthropol.* 89: 650–667

Redford, K. H. and P. Feinsinger. 2001. *The half-empty forest: sustainable use and the ecology of interactions.* Conservation Biology Series, Cambridge, UK: Cambridge University Press.

Robinson, J. G. and K. H. Redford. 1986. Intrinsic rate of natural increase in Neotropical forest mammals: relationship to phylogeny and diet. *Oecologia* 68:516–520.

Robinson, J. G. and E. L. Bennett. 2000. *Hunting for sustainability in tropical forests*. Columbia University Press.

Stoner, K. E., K. Vulinec, S. J. Wright, and C. A. Peres. 2007. Hunting and plant community dynamics in tropical forests: a synthesis and future directions. *Biotropica* 39: 385–392.

Symington, M. M. F. 1987. Sex ratio and maternal rank in wild spider monkeys: when daughters disperse. *Behav. Ecol. Sociobiol.* 20: 421–425.

Symington, M. M. F. 1988. Demography, ranging patterns, and activity budgets of black spider monkeys (A*teles paniscus chamek*) in the Manu National Park, Peru. *Am. J. Primatol.* 15: 45–67.

Terborgh, J. 1983. *Five New World Primates.* Princeton, NJ, Princeton University Press.

Terborgh, J. and M. Stern. 1987. The surreptitious life of the saddle-backed tamarin, *Am. Sci.* 75: 260–299.

Terborgh, J., G. Nuñez-Iturri, N. C. A. Pitman, F. H. C. Valverde, P. Alvarez, V. Swamy, E. G. Pringle, and C. E. T. Paine. 2008. Tree recruitment in an empty forest. *Ecology* 89: 1757–1768.

Wilkie, D. S., E. L. Bennett, C. A. Peres, A. A. Cunningham. 2011. The empty forest revisited. *Ann. NY. Acad. Sci.* 1223: 120–128.

Wright, S. J. 1980. Density compensation in island avifaunas. *Oecologia* 45:385–389.

Wright, S. J., A. Hernández, and R. Condit. 2007. The bushmeat harvest alters seedling banks by favoring lianas, large seeds, and seeds dispersed by bats, birds, and wind. *Biotropica* 39: 363–371.

ATUALIZAÇÃO DO CONHECIMENTO SOBRE O SAUIM-DE-CARA-SUJA, *SAGUINUS WEDDELLI* (PRIMATES, CALLITRICHINAE), NO ESTADO DE RONDÔNIA

Almério Câmara Gusmão[1], Marcella Alves Crispin[2], Sandro Leonardo Alves[3], Kurazo Mateus Okada Aguiar[4], Ricardo Sampaio[5], José de Sousa e Silva Júnior[6]

[1]*Secretaria de Estado da Educação (SEDUC), Escola Carlos Gomes. 76.960-000, Cacoal, Rondônia, Brasil. E-mail: almeriocg@hotmail.com*
[2]*Av. Nações Unidas, 2096, Bairro Pincesa Isabel.76.960-000, Cacoal, Rondônia, Brasil*
[3]*Programa de Pós-Graduação em Zoologia, Universidade Federal do Pará / Museu Paraense Emílio Goeldi, caixa postal 399, 66040-170, Belém, Pará, Brasil*
[4]*Av. Diogenes Silva, 1118, apto E, Buritiza, 68901-090l, Macapá, Amapá, Brasil*
[5]*Floresta Nacional do Purus, Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Rua Cecília Leite, 67, 69850-000, Boca do Acre, Amazonas, Brasil*
[6]*Coordenação de Zoologia, Museu Paraense Emílio Goeldi (MPEG), caixa postal 399, 66040-170, Belém, Pará, Brasil*

Resumo

O presente estudo consiste em uma atualização do conhecimento sobre a distribuição geográfica e dados populacionais do sauim-de-cara-suja (*Saguinus weddelli*) na área situada a leste do rio Madeira, em Rondônia. Foi realizado um levantamento bibliográfico e uma série de expedições aos municípios de Cacoal, Machadinho D'Oeste, Nova Brasilândia D'Oeste, Chupinguaia, São Francisco do Guaporé e Costa Marques. Os resultados indicaram a existência de 39 pontos de registros empíricos de *S. weddelli* na área de estudo, 31 dos quais foram extraídos da literatura e oito resultaram dos trabalhos de campo. Um dos novos registros situa-se além da distribuição geográfica conhecida, representando uma extensão da mesma. Apesar deste táxon não ser considerado como ameaçado de extinção, sua situação na área de estudo requer cuidados, uma vez que têm sido registrados altos índices de desmatamento nesta região nos últimos 40 anos.

Palabras-chave: *Saguinus weddelli*, distribuição geográfica, Rio Madeira, Brasil

Abstract

This study consists of an update on the knowledge of the geographical distribution and population data of the saddle-back tamarin (*Saguinus weddelli*) in the area lying east of the Madeira River in Rondônia. A literature review were conducted as well as a series of expeditions in the municipalities of Cacoal, Machadinho D'Oeste, Nova Brasilândia D'Oeste, Chupinguaia, São Francisco do Guaporé and Costa Marques. The results indicated the existence of 39 sites where *S. weddelli* was recorded in the study area, 31 obtained from the literature and eight resulting from fieldwork. One of the new records is located beyond the known geographic range of the species, representing an extension of such a range. Although this taxon is not considered endangered, its status in the study area deserves attention, since high rates of deforestation in this region have been recorded during the past 40 years.

Keywords: *Saguinus weddelli*, geographic range, Madeira River, Brazil

Introdução

Saguinus weddelli (Deville, 1849) é um primata de pequeno porte, insetívoro, frugívoro e gumívoro (Ferrari e Martins, 1992; Ferrari *et al*., 1993; Power, 1996), que ocorre em uma grande variedade de habitats nas florestas tropicais no sudoeste da Amazônia (Lopes e Ferrari, 1994). Em sua diagnose, Hershkovitz (1977) ressaltou a coloração da pelagem negra na cabeça, membros anteriores, peito e nuca, com membros posteriores laranja; dorso rajado de preto e marrom-claro; cauda negra, com a base castanho-escura; face negra, com as regiões perinasal e circum bucal claras, e as sobrancelhas brancas (Fig. 1). Tais características foram revistas por Röhe et al. (2009). Até recentemente, este táxon foi considerado uma das 14 subespécies de *Saguinus fuscicollis* (Spix, 1823), seguindo o esquema taxonômico proposto por Hershkovitz (1977). Entretanto, de acordo com Rylands et al. (2000), com a invalidação de *S. f. acrensis* por se tratar de uma forma híbrida (*sensu* Peres, 1993) e a elevação de *S tripartitus, S. melanoleucus*

e *S. crandalli* à categoria da espécie (Thorington, 1988; Rylands *et al*., 1993, 2000; Groves, 2005), este número ficou reduzido para 10: *S. f. fuscicollis* (Spix, 1823), *S. f. fuscus* (Lesson, 1840), *S. f. lagonotus* (Jiménez de la Espada, 1870), *S. f. leucogenys* (Gray, 1866), *S. f. illigeri* (Pucheran, 1845), *S. f. nigrifrons* (I. Geoffroy, 1850), *S. f. avilapiresi* Hershkovitz, 1966, *S. f. cruzlimai* Hershkovitz, 1966, *S. f. primitivus* Hershkovitz, 1977 e *S. f. weddelli* (Deville, 1849). Com a descoberta e descrição de um novo táxon (*S. f. mura* Röhe et al., 2009) distribuído na Amazônia central, o número de subespécies de *S. fuscicollis* foi elevado para 11. Mais recentemente, com base nos resultados de análises moleculares, Matauschek et al. (2011) elevaram *S. lagonotus*, *S. leucogenys*, *S. illigeri*, *S. nigrifrons* e *S. weddelli* à categoria da espécie, sendo seguidos por Rylands et al. (2012) e pelos autores do presente estudo.

Saguinus weddelli é a única espécie do gênero encontrada a leste do rio Madeira, em Rondônia (Fig. 2). Os primeiros registros para esta região foram publicados por Vivo (1985). Ferrari & Lopes (1992) revisaram a distribuição geográfica desta espécie, confirmando o interflúvio Ji-Paraná-Madeira-Guaporé como parte de sua área de ocorrência. Durante estudos do Programa Integrado de Desenvolvimento do Noroeste do Brasil (POLONOROESTE), Ferrari et al. (1998) identificaram 25 áreas de ocorrência de *S. weddelli* distribuídas no oeste, centro e norte de Rondônia. Por sua vez, três levantamentos de mamíferos registraram *S. weddelli* na porção central de Rondônia (Ferrari et al., 1996; Selhorst, 2008; Gusmão et al., 2010a), ampliando a distribuição geográfica conhecida da espécie. Apesar destes avanços, as informações disponíveis para a parte sul e leste do estado ainda são escassas. O objetivo do presente estudo é atualizar o conhecimento sobre a distribuição geográfica e dados populacionais de *S. weddelli* em Rondônia, na área situada a leste do rio Madeira.

Material e métodos

Na maioria dos locais de ocorrência de *S. weddelli* na área de estudo, a vegetação é constituída por floresta de terra firme e inundável (igapó) do bioma Amazônia. Observa-se também, no extremo oriental desta região, vegetação transicional com o cerrado. A classificação fitofisiológica é a Floresta Ombrófila Aberta (Projeto Radambrasil, 1978). O clima é do tipo tropical AW, com estação seca durante os meses mais frios (junho a setembro) e estação chuvosa durante os meses mais quentes (dezembro a março), e temperatura média de 26ºC (Köppen, 1948). Uma revisão bibliográfica permitiu que as informações sobre ocorrências e dados populacionais de *S. weddelli* na área de estudo fossem extraídas da literatura. Além disso, foram realizadas expedições aos municípios de Chupinguaia, Cacoal, Machadinho D'Oeste, Nova Brasilândia D'Oeste, São Francisco do Guaporé e Costa Marques. Os dados foram obtidos pelo método de transecção linear (Burckland et al., 2010), que consiste no registro de animal-transecção, animal-observador, horário, altura dos animais avistados e caminhada do observador a uma velocidade de 1,5 km/h. O reduzido número de observações (> 30) impediu o cálculo da densidade populacional. Contudo, foi considerado o cálculo de abundância relativa (taxa de indivíduos por cada 10 km percorridos). Para a identificação dos animais, foram obtidos registros fotográficos (Fig. 1), os quais foram comparados com as diagnoses e ilustrações disponíveis na literatura (Hershkovitz, 1977; Rylands et al., 2008; Röhe et al., 2009; Bairrão Ruivo, 2010), e também com os exemplares pertencentes ao acervo da coleção de mamíferos do Museu Paraense Emílio Goeldi.

Os registros no distrito de Vila Boa Esperança, município de Chupinguaia, foram realizados em janeiro de 2010 (100 km/esforço de amostragem, totalizando 66h) e em outubro do mesmo ano (20 km/esforço de amostragem, totalizando 12h). Duas transecções de 4 km foram percorridas, sempre pelas manhãs (05:30h às 11:00h), por cinco pesquisadores. Os registros no interior do depósito de resíduos sólidos da prefeitura municipal de Cacoal e no município de Machadinho D'Oeste foram realizados através de buscas aleatórias no interior e borda de fragmentos florestais das duas localidades. Foi adotado um esforço de amostragem de duas horas de busca direta, entre 8h e 10h do dia 22 de dezembro de 2009, no fragmento de floresta do depósito de resíduos sólidos do município de Cacoal, e duas horas de amostragem, das 8h às 10h do dia 03 de janeiro de 2010, em um fragmento de floresta no perímetro urbano de Machadinho D'Oeste. O reduzido esforço de amostragem em ambos os fragmentos se deveu ao tamanho extremamente reduzido dos mesmos (< 15 ha). Na fazenda Soares, município de Nova Brasilândia D'Oeste, o registro foi obtido em uma incursão ocorrida entre 12 e 14 de abril de 2009. Trilhas de 3,6 km, 0,8 km e 0,3 km foram percorridas por um pesquisador em um fragmento de mata, entre 7h e 11h, totalizando 12 h de esforço de amostragem. Em Costa Marques e São Francisco do Guaporé, o esforço de amostragem foi concentrado na Reserva Biológica do Guaporé, uma Unidade de Conservação com cerca de 600,000 hectares, e áreas do entorno. Entre os anos de 2006 e 2010, as espécies de primatas foram registradas por meio de observações ocasionais durante incursões realizadas principalmente ao longo dos rios Guaporé e São Miguel (Alves et al., 2012). Registros no interior da Reserva Biológica do Guaporé foram obtidos através de censos utilizando a metodologia de transecção linear (617.8 km de esforço de amostragem) em 13 transecções distribuídas por floresta de terra firme, floresta de igapó e cerradão.

Resultados e discussão

De acordo com o levantamento bibliográfico realizado, 14 publicações continham registros de *Saguinus weddelli* na área de estudo (Tabela 1). O conhecimento atual indica a existência de 39 pontos de registro empírico (Tabela 1, Figura 2), 23 deles com dados de censos (Ferrari et al., 1998; Messias, 2001, 2004a,b; Ferronato *et al.*, 2005;

Tabela 1. Registros empíricos de ocorrências e dados de censos de *Saguinus weddelli* na área de estudo.

Sítio	Referência	Localidade	Coordenadas geográficas	Obs./10km²
1	Vivo (1985)	Porto Velho	08°46'S, 63°55'W	-
2	Vivo (1985)	Alto Paraíso	09°37'S, 63°27'W	-
3	Lopes e Ferrari (1994); Bonavigo *et al.* (2004); Ferrari *et al.* (1998)	Candeias do Jamari (cachoeira Samuel)	08°45'S, 63°28'W	-
4	Ferrari *et al.* (1998)	Porto Velho (foz do rio Jí-Paraná)	08°05'S, 62°55'W	-
5	Ferrari *et al.* (1998)	Nova Mamoré (Parque Estadual Guajará-Mirim)	10°19'06"S, 64°32'31"W	0,2
6	Ferrari *et al.* (1998)	Campo Novo (rio Jaci-Paraná)	10°25'30"S, 64°07'50"W	0,7
7	Ferrari *et al.* (1998)	Nova Mamoré (sítio do Antônio)	10°19'07"S, 64°34'26"W	0,6
8	Ferrari *et al.* (1998)	Nova Mamoré (sítio do Cabo Cleto)	10°19'16"S, 64°37'04"W	0,2
9	Ferrari *et al.* (1998)	Campo Novo (fazenda do A. Dias)	10°25'25"S, 64°06'26"W	0,2
10	Ferrari *et al.* (1998)	Nova Mamoré (fazenda do Luiz)	10°24'12"S, 64°48'10"W	0,1
11	Ferrari *et al.* (1998)	Campo Novo (sítio do Lourival)	10°30'45"S, 63°47'03"W	0.5
12	Ferrari *et al.* (1998)	Campo Novo (fazenda do Reuter)	10°35'28"S, 64°39'30"W	0,4
13	Ferrari *et al.* (1998)	Ariquemes (fazenda Nova Vida)	10°12'58"S, 62°43'57"W	0,4
14	Ferrari *et al.* (1998)	Machadinho do Oeste (fazenda do Maurício)	09°01'17"S, 62°01'57"W	0,6
15	Ferrari *et al.* (1998)	Guajará-Mirim (RESEX Ouro Preto I)	10°49'39"S, 64°25'46"W	0,6
16	Ferrari *et al.* (1998)	Guajará-Mirim (RESEX Ouro Preto II)	10°45'37"S, 64°43'36"W	0,4
17	Ferrari *et al.* (1998)	Guajará-Mirim (RESEX Ouro PretoIII)	10°49'58"S, 64°54'36"W	0,2
18	Ferrari *et al.* (1998)	São Miguel do Guaporé (fazenda do Mansur)	11°41'55"S, 62°47'33"W	0,4
19	Ferrari *et al.* (1998)	São Francisco do Guaporé (fazenda do Geraldo)	12°01'37"S, 63°18'42"W	1,7
20	Ferrari *et al.* (1998)	Parecis (fazenda Arara Azul)	12°12'03"S, 61°25'59"W	0,1
21	Ferrari (2001)	Guajará Mirim (REBIO Traçadal)	11°51'34"S, 64°35'39"W	0,3
22	Messias (2001)	Guajará Mirim (REBIO do Rio Ouro Preto)	10°49'58"S, 64°54'36"W	2,1
23	Messias (2004 a)	Porto Velho (Est. Ecol. Antônio Mugica Nova)	10°19'06"S, 64°32'31"W	1,2
24	Messias (2004 b)	Guajará Mirim (PARNA Serra da Cutia)	10°45'37"S, 64°43'36"W	0,2
25	Ferronato *et al.* (2005)	Cujubim (fazenda Manoa)	08°54'27"S, 62°10'06"W	1,2
26	Oliveira *et al.* (2005)	Município de Porto Velho	10°19'07"S, 64°34'26"W	-
27	Gusmão *et al.* (2008)	Pimenta Bueno (Parque Natural Municipal de Pimenta Bueno)	11°29'21" S, 61°26'20" W	-
28	Selhorst (2008)	Alto Alegre dos Parecis (fazenda Santa Rita)	12°04'23"S, 63°58'34"W	-
29	Gusmão *et al.* (2010a)	Seringueiras (fazenda Estrela do Oeste)	11°41'55"S, 62°47'33"W	-
30	Gusmão *et al.* (2010b)	Cacoal (RPPN Água Viva)	11°36'47S, 62°08'42"W	2,0
31	Presente estudo	Cacoal (depósito de resíduos sólidos da prefeitura municipal)	11°28'53"S, 61°28'23"W	-
32	Presente estudo	Machadinho do Oeste (perímetro urbano)	08°59'23'S, 62° 38' 28'' W	-
33	Presente estudo	Nova Brasilândia (fazenda Soares)	12°01'37"S, 63°18'42"W	-
34	Presente estudo	Chupinguaia (Vila Boa Esperança)	11°28'53"S, 61°28'22" W	-
35	Presente estudo	Porto Murtinho (São Francisco do Guaporé)	12°17'30"S, 63°28'40"W	-
36	Presente estudo	Município de Costa Marques (perímetro urbano)	12°26'35"S, 64°13'45"W	-
37	Presente estudo	Mata ciliar do rio São Miguel (São Francisco do Guaporé)	12°30'10"S, 64°13'45"W	-
38	Presente estudo	Fazenda Pirapora (São Francisco do Guaporé)	12°19'12"S, 63°31'57"W	-
39	Alves *et al.* (2012)	REBIO Guaporé	12°19'42"S, 63°20'00"W	1,9

Gusmão et al., 2010b) e três com dados de comportamento e dieta (Ferrari e Martins, 1992; Ferrari *et al.*, 1993; Lopes e Ferrari, 1994).

Distribuição geográfica

Rylands e Mittermeier (2008) haviam atualizado a distribuição de *S. weddelli* (no bojo do mapa de distribuição de *S. fuscicollis*) com base na literatura até então disponível, indicando como limite sudeste o rio São Miguel. Contudo, Rylands e Mittermeier (2008) não haviam tido acesso aos dados de Ferrari et al. (1996), Ferrari et al. (1998), Gusmão et al. (2008) e Selhorst (2008). Posteriormente, Ferrari et al. (2010), Gusmão et al. (2010b) e Alves et al. (2012) publicaram novas ocorrências além desse limite. No presente estudo, das 39 localidades com registros de *S. weddelli*, oito representam novos registros (Tabela 1; Fig. 2). *S. weddelli* ocorre na maior parte do estado de Rondônia, e seus limites de distribuição parecem ser delineados principalmente por barreiras fluviais. Dos oito novos registros, um situa-se na porção nordeste, três no centro-leste, e quatro no centro-sul de Rondônia.

Figura 1. *Saguinus weddelli* em Vila Boa Esperança, Chupinguaia (Localidade # 34). Foto. K. M. O. Aguiar.

Os dados permitiram um maior refinamento do conhecimento acerca dos limites da distribuição de *S. weddelli* no estado de Rondônia. Como observado por Lopes e Ferrari (1992) e Ferrari et al. (2010), os limites norte, nordeste e leste coincidem com a margem esquerda do rio Ji-Paraná/Machado, em toda sua extensão. Entretanto, as observações em Vila Boa Esperança (Localidade # 34) indicam a presença da espécie além da distribuição geográfica conhecida. Assim, a ocorrência de *S. weddelli* à esquerda do rio Apidiá (Fig. 1) representa uma pequena extensão de sua distribuição geográfica no sudeste do estado. Ferrari et al. (1998) sugeriram que os limites meridionais da distribuição geográfica de *S. weddelli* seriam delineados pela Chapada dos Parecis. De acordo com Ferrari *et al.* (1998), estes limites estariam sob influência de fatores bióticos,

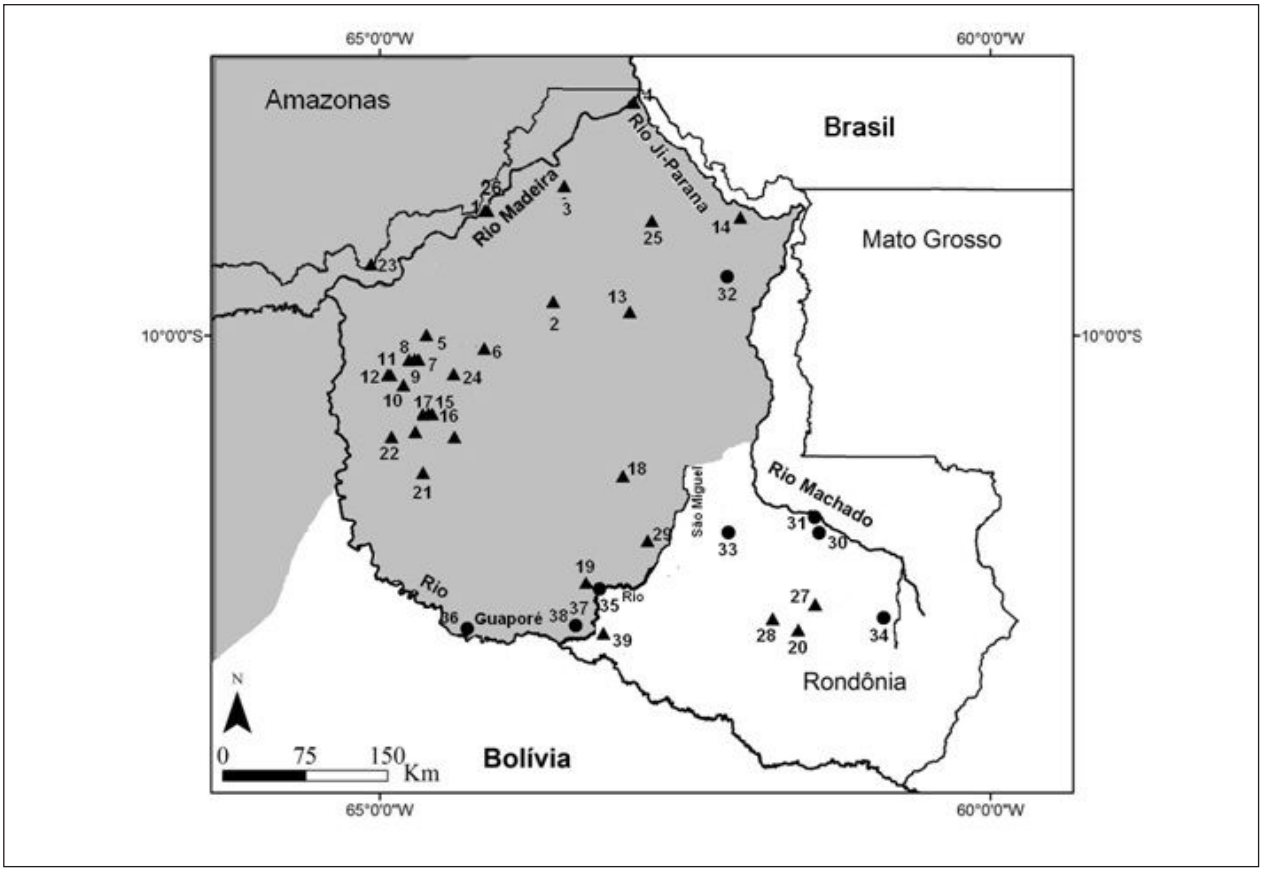

Figura 2. Registros de *S. weddelli* em Rondônia, Brasil. O polígono cinza mostra parte da distribuição geográfica publicada por Rylands e Mittermeier (2008). As localidades (numeradas de acordo com a Tabela 1) representadas por triângulos pretos indicam os registros encontrados na literatura. Os círculos pretos representam os oito novos registros.

como as formações distintas de florestas e ambientes abertos do bioma Cerrado naquela região. Entretanto, permeando a vegetação de cerrado da Chapada dos Parecis, existem corredores e manchas de tipologias florestais (cerradão, florestas estacionais, floresta de galeria) que, aliados a fatores históricos, poderiam permitir a ocorrência de *S. weddelli* além destes limites. Contudo, ainda não existem inventários no extremo sul do estado. Segundo Vivo (1996, 2007) e Silva Júnior (1998), a deficiência de amostragem é um dos principais empecilhos para o avanço no conhecimento sobre a diversidade e distribuição geográfica dos mamíferos no Brasil. Assim, a realização de novos estudos nesta região certamente propiciará um delineamento mais seguro dos limites da distribuição geográfica de *S. weddelli* nesta porção do estado de Rondônia.

S. weddelli ocorre em simpatria com duas espécies da mesma subfamília (Callitrichinae) na área de estudo. A simpatria com *Mico rondoni* já havia sido bem documentada (Ferrari e Martins, 1992; Lopes e Ferrari, 1994; Haymann e Buchanan-Smith, 2000; Ferrari et al., 2010). Recentemente, S. Alves observou simpatria de *S. weddelli* com *Mico melanurus* na região do vale do Guaporé. É reconhecido que *S. weddelli* leva vantagem competitiva sobre *M. rondoni* na busca por alimentos, e sua distribuição geográfica não é limitada por competição com outras espécies de calitriquíneos (Lopes e Ferrari, 1994). Esta hipótese pode ser agora testada através da realização de novos estudos com o objetivo de avaliar a convivência simpátrica de *S. weddelli* com a outra espécie da mesma subfamília, *M. melanurus*.

Dados populacionais

A revisão bibliográfica indicou que os grupos de *S. weddelli* são compostos por dois a nove indivíduos (e.g. Messias, 2001; Gusmão et al., 2010b). A abundância de *S. weddelli* foi semelhante na maior parte dos locais estudados. Destaca-se, entretanto, a Reserva Biológica do Rio Ouro Preto (Messias, 2001) e a Reserva Particular do Patrimônio Natural (RPPN) Água Viva (Gusmão et al., 2010b), com os maiores números de observações por 10 km percorridos. Os resultados obtidos na RPPN Água Viva (Gusmão et al., 2010b), onde o número de observações foi proporcionalmente superior quando comparado com os resultados de outros trabalhos realizados em Rondônia (Tabela 1), foram congruentes com os de Bonavigo *et al.* (2005b). Segundo estes autores, diferenças nas abundâncias relativas podem ser causadas por um adensamento de fauna nas áreas mais modificadas pela ação humana. Isto se mostrou verdadeiro para *S. weddelli*, uma vez que os valores de abundância relativa aumentaram em função do nível de alteração do fragmento de floresta estudado.

No presente estudo, um grupo com nove indivíduos, composto por cinco adultos, dois juvenis e dois infantes, foi observado no interior do fragmento de mata de terra firme localizado no depósito de resíduos sólidos da prefeitura municipal de Cacoal (Localidade # 31). Um grupo com cinco indivíduos, todos adultos, foi encontrado em um fragmento de mata com floresta de terra firme na fazenda Soares, município de Nova Brasilândia D'Oeste (Localidade #33). Um grupo com três indivíduos, composto por dois adultos e um jovem, foi observado em um fragmento de floresta de terra firme no perímetro urbano do município de Machadinho D'Oeste (Localidade # 32). Cinco grupos foram encontrados em um fragmento com vegetação de transição entre floresta e cerrado no distrito de Vila Boa Esperança (Localidade # 34), totalizando 17 indivíduos observados. O tamanho médio dos grupos nestas localidades variou entre dois e três indivíduos. Durante censos realizados no interior da Reserva Biológica do Guaporé (Localidade # 39) e Porto Murtinho, mata ciliar do rio São Miguel e Fazenda Pirapora (Localidades # 35, 37, 38, respectivamente), município de São Francisco do Guaporé, foram obtidos nove registros da espécie em floresta de terra firme e um em floresta de igapó. O tamanho médio dos grupos nestas localidades variou entre um e três indivíduos.

Conservação

S. weddelli não foi citado na lista da fauna brasileira ameaçada de extinção (Machado *et al.*, 2005). Por sua vez, Rylands & Mittermeier (2008) avaliaram este táxon (identificado como *Saguinus fuscicollis weddelli*), classificando-o como não ameaçado. Apesar disso, grande parte da região identificada no presente estudo como parte da área de distribuição desta espécie vem sendo alvo de intensa atividade humana, o que requer cuidados. A grande modificação da vegetação nativa decorrente da extração de madeira e desmatamento ocorridos durante a colonização de Rondônia (Oliveira, 2002; Fearnside, 2005; Ferreira et al., 2005) ocasionou a perda de hábitat para as espécies nativas, isolando populações em remanescentes de floresta. No entanto, *S. weddelli* foi registrado em importantes Unidades de Conservação no norte e oeste do estado, como a REBIO do Rio Ouro Preto (Messias, 2001), Reserva Extrativista (RESEX) Ouro Preto, Parque Estadual Guajará-Mirim (Ferrari *et al.*, 2010), Estação Ecológica de Samuel (Ferrari e Martins, 1992; Lopes e Ferrari, 1994; Bonavigo et al., 2005a) e Reserva Biológica do Guaporé (Alves et al., 2012). Além destas, existem outras de provável ocorrência da espécie, como a RESEX do Bom Futuro e o Parque Nacional dos Pacaás Novos, e que podem abrigar populações viáveis. Contudo, a porção sudeste, além de concentrar a maior faixa da área desflorestada de Rondônia, também é carente de áreas protegidas. Medidas urgentes para a conservação de populações de vertebrados no sudeste de Rondônia envolvem a implantação de corredores ecológicos conectando estes remanescentes de floresta. Outras medidas que, certamente, serão de grande valia para a conservação desta e de outras espécies da fauna da área de endemismo Rondônia (*sensu* Cardoso da Silva et al., 2005) são o incentivo à implantação de RPPNs e outras Unidades de Conservação nas áreas de floresta ainda existentes, principalmente no vale do Guaporé, uma intensificação da fiscalização das atividades de desmatamento e captura, e a realização de programas de educação ambiental.

Agradecimentos

À Secretaria de Estado de Desenvolvimento Ambiental – SEDAM/Rondônia, Dr. Mário de Vivo e Dione Seripierri (Museu de Zoologia da Universidade de São Paulo) pelo envio de literaturas e Celso C. Santos Júnior pela colaboração em campo.

Referências

Alves, S. L., Santos Júnior, C. C. e Lopes, M. A. 2012. Mamíferos não-voadores da Reserva Biológica do Guaporé: estado atual do conhecimento. *In*: *VI Congresso Brasileiro de Mastozoologia*, Corumbá, Mato Grosso do Sul, Brasil.

Bairrão Ruivo, E. 2010. *Eaza Husbandry Guidelines for Callitrichidae. 2nd Edition*, Beauval zoo. Saint Aignan sur Cher, France.

Bonavigo, P. H., Ferronato, M. L. e Messias, M. R. 2005a. Mamíferos diurnos de médio e grande porte da estação ecológica de Samuel/RO: área fonte para a mastofauna da região centro-norte do estado. *In*: *III Congresso Brasileiro de Mastozoologia*, *Anais do III Congresso Brasileiro de Mastozoologia*. Aracruz, Espírito Santo, Brasil.

Bonavigo, P. H., Ferronato, M. L. e Messias, M. R. 2005b. Levantamento de mamíferos de hábitos crípticos da área de manejo florestal da fazenda Manoa. *In*: *III Congresso Brasileiro de Mastozoologia*, *Anais do III Congresso Brasileiro de Mastozoologia*. Aracruz, Espírito Santo, Brasil.

Buckland, S. T., Plumptre A. J., Thomas L. and Rexstad, E. A.. 2010. Design and analysis of line transect surveys for primates. *Int. J. Primatol.* 31: 833-847.

Cardoso da Silva, J. M., Rylands, A. B. e Fonseca, G. A. B. 2005. O destino das áreas de endemismo da Amazônia. *Megadiversidade* 1: 124–131.

Ferrari, S. F. and Martins, E. S. 1992. Gummivory and gut morphology in two sympatric callitrichids (*Callithrix emiliae* and *Saguinus fuscicollis weddelli*) from Western Brazilian Amazonia. *Am. J. Phys. Anthropol.* 88: 97–103.

Ferrari, S. F. and Lopes, M. A. 1992. New data on the distribution of primates in the region of the Jiparana and Madeira River in Amazonas and Rondônia, Brazil. *Goeldiana Zool.* 11: 2–12.

Ferrari, S. F., Lopes, M. A. e Krause, E. A. K. 1993. Gut morphology of *Callithrix nigriceps* and *Saguinus labiatus* from western Brazilian Amazonia. *Am. J. Phys. Anthropol.* 90: 487–493.

Ferrari, S. F., Iwanaga S. and Silva, J. 1996. Platyrrhines in Pimenta Bueno, Rondonia, Brazil. *Neotrop. Primates*, 4(4): 151–153.

Ferrari, S. F., Iwanaga, S., Messias, M. R., Cruz Neto, E. H., Ramos, E. H., Ramos, P. C. S. e Silveira, A. P. A. 1998. Um estudo dos efeitos da colonização humana sobre as populações de mamíferos em Rondônia. *In*: *Resumos XXII Congresso Brasileiro de Zoologia*, Recife, Pernambuco, Brasil.

Ferrari, S. F., 2001. *A fauna de mamíferos não voadores da Reserva Biológica TraçadalRO*. Relatório Técnico não publicado, Governo do estado de Rondônia. Porto Velho, DC.

Ferrari, S. F., Sena, L., Schneider, M. P. C. e Silva-Júnior, J. S. 2010. Rondon's marmoset, *Mico rondoni* sp. n., from Southwestern Brazilian Amazonia. *Int. J. Primatol.* 31: 693–714.

Ferreira, L. V., Venticinque, S. e Almeida, S. S. 2005. O Desmatamento na Amazônia e a importância das áreas protegidas. *Estudos Avançados*, 19 : 1–10.

Ferronato, M. L., Bonavigo, P. H. e Messias, M. R. 2005. Mastofauna de médio e grande porte na fazenda Manoa, Cujubim/RO: um estudo de caso do impacto da exploração florestal manejada na mastofauna amazônica. *In*: *III Congresso Brasileiro de Mastozoologia*, *Anais do III Congresso Brasileiro de Mastozoologia*. Aracruz, Espírito Santo, Brasil.

Fearnside. P. M. 2005. Desmatamento na Amazônia brasileira: História, índices e conseqüências. *Megadiversidade* , 1: 113–123.

Groves, C. P. 2005. Order Primates. *In*: *Mammal Species of the World: A Taxonomic and Geographic Reference,* 3ª ed., D. E. Wilson and D. M. Reeder (eds.), pp.111–184. The Johns Hopkins University Press, Baltimore.

Gusmão, A. C., Pazzer, A. C., Naujokat, E. M., Domingues, S. P. e Dos Santos, W. V. 2008. Primatas do Parque Natural Municipal de Pimenta Bueno, Pimenta Bueno, Rondônia. *Rev. Cient. Facimed*, 1: 1–5.

Gusmão, A. C., Casagrande L. P., Souza, M. R., Suszek, E., Brizidio, K., Garcia, J. R. F., Melo, P. e Santos, W. V. 2010a. Mamíferos de médio e grande porte na Fazenda Estrela do Oriente, município de Seringueiras – RO. *In*: *XXVIII Congresso Brasileiro de Zoologia. Belém*, Brasil.

Gusmão, A. C., Crispim, M. A. e Ferronato, M. L. 2010b. Riqueza relativa e composição de grupo de *Saguinus fuscicollis weddelli* (Devile, 1849) na RPPN Água Viva. *In*: *II Simpósio de Iniciação Científica da Facimed*. Cacoal, Rondônia, Brasil.

Hershkovitz, P. 1977. *Living New World monkeys, with an introduction to primates* V. 1. Chicago University Press. Chicago.

Heymann, E. W. and Buchanan-Smith, H. M. 2000. The behavioural ecology of mixed-species troops of Callitrichine primates. *Biol. Rev*., 75: 169–190.

Köppen, W. 1948. *Climatologia com un estudio de los climas de la tierra.* Fondo de Cultura Econômica, Mexico.

Lopes, M. A. and Ferrari, S. F. 1994. Foraging behavior of a tamarin group (*Saguinus fuscicollis weddelli*) and interations with marmosets (*Callithrix emiliae*). *Int. J. Primatol.* 15(3): 373–387.

Machado, A. B.; Martins, C. S. e Drummond, G. M. 2005. *Lista da fauna brasileira ameaçada de extinção incluindo as espécies quase ameaçadas e deficientes em dados*. Fundação Biodiversitas. Belo Horizonte, Minas Gerais.

Matauschek, C., Roos, C. & Heymann, E.,W. 2011. Mitochondrial phylogeny of tamarins (*Saguinus* Hoffmannsegg, 1807) with taxonomic and biogeographic implications for the *S. nigricollis* species group. *Am. J. Phys. Anthropol.*, 144: 564–574.

Messias, M. R. 2001. Mamíferos de médio e grande porte da Reserva Biológica Estadual do Rio Ouro Preto, Rondônia – Brasil. *Publicações Avulsas do Instituto Pau Brasil de História Natural,* 4: 27–35.

Messias, M. R. 2004a. Mastofauna diurna da Estação Ecológica Estadual de Antônio Mujica Nava. *In*: *XXV Congresso Brasileiro de Zoologia.* Brasília, Distrito Federal.

Messias, M. R. 2004b. Mastofauna diurna do PARNA Serra da Cutia /RO: Subsídio à elaboração do Plano de Manejo. *In*:*XXV Congresso Brasileiro de Zoologia.* Brasília, Distrito Federal.

Oliveira, M. A., Gomes, I. B. S. R. e Messias, M. R. 2005. Formação de bando mistos em fragmentos florestais em Porto Velho/RO entre *Mico nigriceps*, *Saguinus fuscicollis*, *Callicebus brunneus*, *Pithecia irrorata* e *Cebus apella*. *In*: *III Congresso Brasileiro de Mastozoologia*. Aracruz, Espírito Santo, Brasil.

Oliveira, O. A. 2002. *Geografia de Rondônia – espaço e produção*Dinâmica, Porto Velho, Brasil.

Peres, C. A. 1993. Notes on the primates of the Juruá river, western Brazilian Amazonia. *Folia Primatol.*, 61: 97–103.

Power, M. L. 1995. The other side of Callitrichine gumnivory: Digestibility and nutritional value. *In*: M. A. Norconk, A. L. Rosenberger and P. A. Garber (eds.), *Adaptive radiations of Neotropical primates*, pp.87–107. Plenum Press, New York.

Projeto RadamBrasil. 1978. *Geologia, geomorfologia, pedologia, vegetação e uso potencial da terra.* Departamento Nacional de Produção Mineral, Vol. 1–34. Brasília, Distrito Federal.

Röhe, F., Silva-Júnior, J. S., Sampaio, R. and Rylands, A. B. 2009. A new subspecies of *Saguinus fuscicollis* (Primates, Callitrichidae). *Int. J. Primatol.*, 30: 533–551.

Rylands, A. B., Coimbra-Filho, A. F. and Mittermeirer, R. A. 1993. *Systematics, distributions, and some notes on the conservation status of the Callitrichidae*. *In*: Marmosets and Tamarins: Systematics, Behavior and Ecology, A. B. Rylands (ed.), pp.11–77. Oxford University Press, Oxford.

Rylands, A. B., Schneider, H., Langguth, A., Mittermeier, R. A., Groves, C. and Rodríguez-Luna, E. 2000. An assessment of the diversity of New World primates. *Neotrop. Primates*, 8(2): 61–93.

Rylands, A. B. and Mittermeier, R. A. 2008. *Saguinus fuscicollis* ssp. *weddelli*. *In*: IUCN 2012. *IUCN Red List of Threatened Species*. Version 2012.2. Website: www.iucnredlist.org. Consultado em 6 de dezembro de 2012.

Rylands, A. B., Mittermeier, R. A., Coimbra Filho, A. F., Heymann, E. W,, Torre, S. L., Silva-Júnior, J. S., Noronha, M. A. and Röhe, F. 2008. *Marmosets and Tamarins Pocket Identification guide.* Conservation International.

Rylands, A. B., Mittermeier, R. A. and Silva-Júnior, J. S. 2012. Neotropical primates: taxonomy and recently described species and subspecies. *Int. Zoo Yearbook,* 46: 11–24.

Selhorst, V. C. 2008. *Levantamento da mastofauna de médio e grande porte em fragmentos florestais no município de Alto Alegre dos Parecis, Rondônia*. Monografia. Faculdade de Ciências Biomédicas de Cacoal – FACIMED. Rondônia, BR.

Thorington Jr., R. W. 1988. Taxonomic status of *Saguinus tripartitus* (Milne-Edwards, 1878). *Am. J. Primatol.*, 15: 367–371.

Silva-Júnior, J. S. 1998. Problemas de amostragem no desenvolvimento da sistemática e biogeografia de primatas neotropicais. *Neotrop. Primates*, 6(1): 21–22.

Vivo, M. 1985. On some monkeys from Rondônia, Brazil (Primates: Callitrichidae, Cebidae). *Papéis Avulsos de Zoologia, Museu de Zoologia da Universidade de São Paulo*, 36: 103–110.

Vivo, M. 1996. How many species of mammals are there in Brazil? *In*: C. E. Bicudo and N. A. Menezes (Eds.), *Biodiversity in Brazil: A First Approach.* Proceedings of the Workshop "Methods for the assesment of Biodiversity in Plants and Animals".Campos do Jordão, São Paulo.

Vivo, M. 2007. Problemas da mastozoologia brasileira. *Boletim da Sociedade Brasileira de Mastozoologia,* 48: 1–4.

Short Articles

TWO NEW SPECIMENS FOR THE BOLIVIAN ENDEMIC TITI MONKEYS, *CALLICEBUS OLALLAE* AND *CALLICEBUS MODESTUS*

Jesús Martínez
Robert B. Wallace
Heidy López-Strauss
Paula De La Torre
Hugo Aranibar

Introduction

The genus *Callicebus* is one of the most diverse for Neotropical primates (Van Roosmalen *et al.,* 2002; Wallace *et al.,* 2006; Defler *et al.*, 2010). Six species of titi monkeys are now considered present in Bolivia including two endemics, *Callicebus olallae* and *Callicebus modestus* (Anderson, 1997; Wallace & Mercado, 2007; Martinez & Wallace, 2010). Lönnberg (1939) described these two endemic primate species based on only three specimens: one for *C. olallae* and two for *C. modestus,* collected by the Ollala brothers in a 1937-1938 fieldtrip. Despite the low number of specimens and the proximity of the original collection sites (Patterson, 1992; Anderson, 1997), Lönnberg found sufficient evidence to consider them as separate species, and this position has been upheld in more recent taxonomic revisions of the genus (Hershkovitz, 1990; Kobayashi, 1995). No further information was available on these species until 2002 when researchers of the Wildlife Conservation Society (WCS) began field studies on the distribution, abundance and genetics of both endemic primates (Felton *et al.,* 2006; Barreta, 2007, Martínez & Wallace, 2007; Lopez-Strauss, 2008). These studies noted several differences in pelage color between the two species. However, in the field this represents a great challenge because of the need to observe hair coloration patterns with observations at great distances and under difficult light conditions. The scientific collection of further specimens of these species for a complete taxonomic revision has not been considered due to their endemic status and probable low population sizes (Martínez & Wallace, 2007; Lopez-Strauss, 2008). Instead, emphasis has been placed on collecting fresh scats in order to facilitate genetic analyses of taxonomic status (Wallace *et al.*, 2013; Barreta *et al.*, unpublished data).

The area where these primates occur also includes other species of scientific and conservation interest, for example, the wattled curassow, *Crax globulosa*, which was rediscovered in 2001 (Hennessey, 2003). During a 2005 field trip along the Negro River, near the Beni River (Fig. 1) to document the biology of this regionally threatened cracid, HA was able to photograph a juvenile or subadult captive *C. modestus* individual in the Monte Rey community (13.284611 S; 67.259861 W). On a return visit in June 2005 HA was able to collect the recently deceased monkey that had been decomposing for almost a week and preserved it in alcohol. This specimen was frozen in the laboratory of the Institute of Molecular Biology and Biotechnology from the Universidad Mayor de San Andrés in La Paz. In May 2009, the *C. modestus* specimen was prepared, and subsequently deposited in the Mammalogy Department of the Colección Boliviana de Fauna in La Paz (Specimen Number: CBF 8381). In June 2007, JM began a behavioral ecology study on *C. olallae* at La Asunta (14.236483 S; 66.982533 W), a private cattle ranch adjacent to the Yacuma River (Figure 1). On 15th June 2007, he rescued a *C. olallae* skin from ranch workers that had been hunted opportunistically for fishing bait. This adult male skin had already been cleaned, stretched and dried in sunlight, and is incomplete because the head, feet and hands were removed and not preserved. This skin was also deposited in the Colección Boliviana de Fauna in La Paz (Specimen Number: CBF 8380). Here we describe these new specimens and compare pelage color and characteristics with previous descriptions (Lönnberg, 1939; Hershkovitz, 1990; Felton *et al.*, 2006; Martinez & Wallace, 2007).

Results

The new *C. modestus* skin is predominantly a non-uniform brown color with orange tones (Fig. 2a). This color is somewhat darker dorsally becoming paler on the ventral portions of the specimen. The pelage, particularly dorsally, shows a conspicuous agouti pattern with light and dark bands alternating along each hair, resulting in the non-uniform brown appearance (Fig. 2b). The tail is conspicuously dark gray and contrasts clearly with body color (Fig. 2c). Fore and hindquarters are also non-uniform brown although somewhat lighter than body, and hand and feet pelage include black and gray hairs (Fig. 2d and 2e). A noticeable feature, despite the partial deterioration of the *C. modestus* specimen, is that in general the pelage of appears to be short and somewhat disheveled. The previous description is consistent with previous holotype skin and field observation descriptions which have mentioned the agouti pattern of body pelage, overall pelage coloration and the different color of tail as defining characteristics (Lönnberg, 1939; Hershkovitz, 1990; Felton *et al.*, 2006; Martinez & Wallace, 2007). The original descriptions by Lönnberg (1939) indicated a general gray tone in all the pelage and field observations of Felton *et al* (2006) and Martínez & Wallace (2007) reported a pale zone at the ventral base of tail. Neither of these characteristics was observed in this new juvenile specimen.

The skin of the new *C. olallae* specimen is characterized by a uniform reddish brown pelage color (Fig. 3a). Individual hairs do not show agouti banding patterns. Instead hairs show a broad orange brownish band with dark brown hair tips (Fig. 3b). Body color is darker dorsally turning paler on the ventral side of the body, arms and legs (Fig.

3c, 3d & 3e). Tail color is darker than the body but does not contrast as markedly as in *C. modestus* (Fig. 2a, 2c and 3a). However, at the base of the tail there is a 6.7 cm long band that appears markedly paler (Fig. 3c). The long hairs of the body and tail give the pelage a very silky texture. This *C. olallae* specimen shows the characteristic features mentioned in previous descriptions (Lönnberg, 1939; Hershkovitz, 1990; Felton *et al.*, 2006; Martinez & Wallace, 2007).

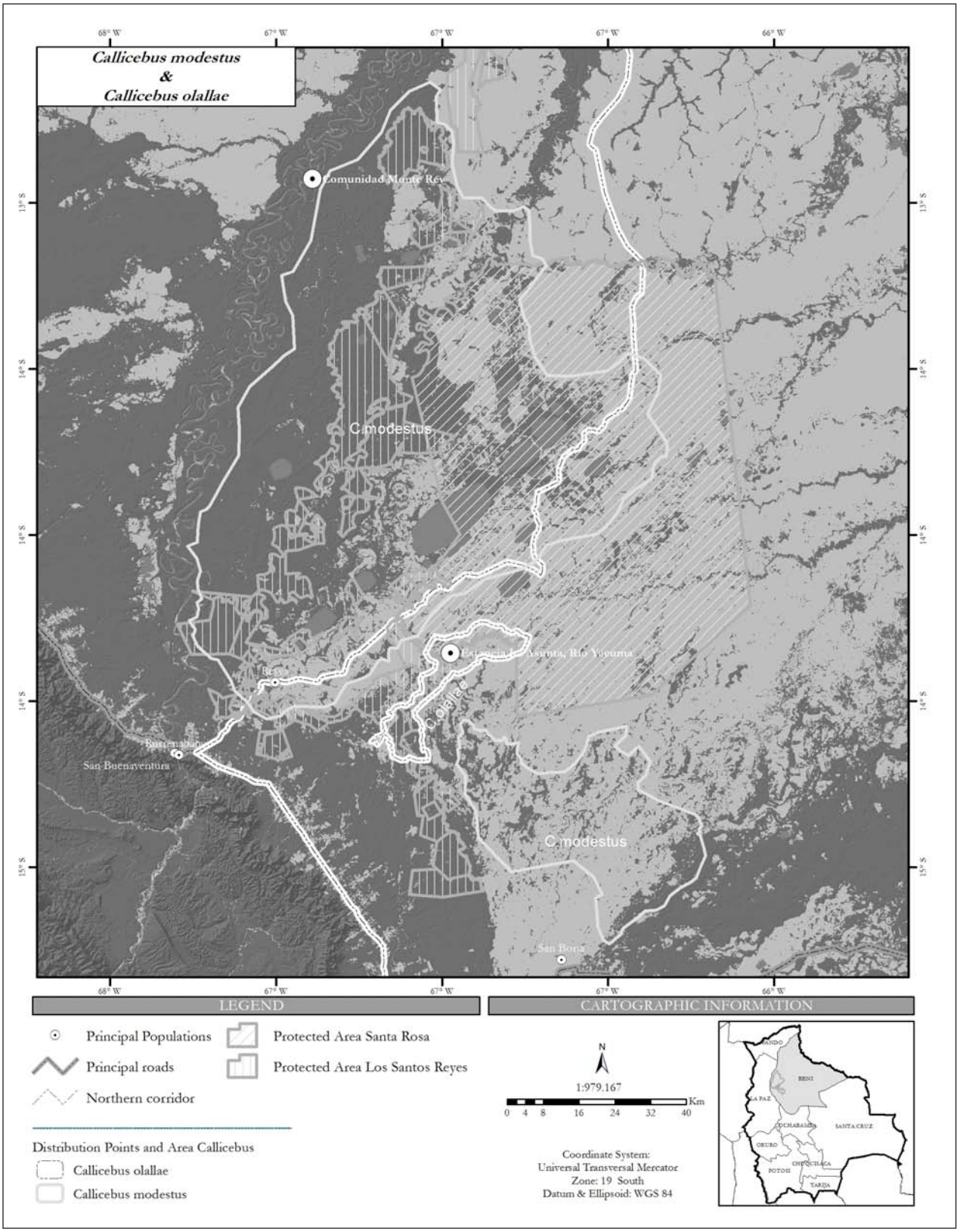

Figure 1. Original localities of the skins of *Callicebus modestus* and *Callicebus olallae*.

Figure 2. *Callicebus modestus* skin (a), and details showing (b) agouti coloration pattern of hair, (c) coloration of body and tail pelage, (d) hairs on arm and hand and (e) leg and foot.

Figure 3. *Callicebus olallae* skin (a), and details showing (b) hair coloration pattern, (c) basal tail pelage, (d) hairs on arm and hand and (e) leg and foot.

Table 1. Some comparative measurements of the hair of the new specimens in relation with the holotypes.

Source	*Callicebus modestus*			*Callicebus olallae*		
	Lönnberg (1939)	Hershkovitz (1990)	New specimen	Lönnberg (1939)	Hershkovitz (1990)	New specimen
# of individuals observed	2	2	1	1	1	1
Average hair length [mm]	45			45		
Maximum hair length [mm]	50			60		
Back hair length [mm]			40			53
Head-Body length [mm]	315	315	315	*410	325	**290
Tail length [mm]	400	400	240	*340	425	500

*: These data maybe incorrect in Lönnberg (1939). Therefore we recommend using the Hershkovitz (1990) measurements.
**: Note: this skin was lacking head, hands and feet and as such the true value would be slightly larger.

However, Felton *et al* (2006) reported disheveled pelage textures more similar to *C. modestus*, but this may have been due to recent rain and resulting wet fur in their field observations (A. Felton *pers. comm.*to Wallace, 2002). This change in appearance was also observed for *C. olallae* in a behavioral study (Martínez *pers. obs.,* 2007).

We measured the skins and the hair (Table 1). Lönnberg (1939) reported average hair length for each species, however, there is no description of how he did this and so we measured back hair length from the central part of the back. Hair length is slightly longer in *C. olallae* than in *C. modestus*, an observation similar to previous examinations by Lönnberg (1939) and Hershkovitz (1990). Differences in the age of the specimens (*C. modestus* was a juvenile or subadult) as well as the incomplete nature of the *C. olallae* skin (lacking of head, hands and feet portions), makes body size measurement comparisons challenging. The condition of the *C. olallae* skin also precludes the possibility to compare facial and head hair color. It is also important to recognize that the new *C. modestus* specimen does not completely show the adult representative coloration patterns, although observed differences increase our knowledge about the development and morphology of this species. Nevertheless, all descriptions refer to the conspicuous banding present in *C. modestus* hairs as the most relevant diagnostic characteristic between the two species. *C. olallae* has longer and silky hair than *C. modestus*, and the tail coloration in *C. olallae* is more similar to the body hair color although the base of the tail is paler. Tail color in *C. modestus* is entirely dark grayish and clearly different from body color. These are useful diagnostic characteristic and confirm field observations (Martinez & Wallace, 2007). Although the preservation of these specimens by local people did not follow standard taxidermy standards, this study underlines the potential importance of local people for donating valuable scientific material that would otherwise be thrown out as garbage or consumed by domestic animals.

Conclusions

These new *C. olallae* and *C. modestus* specimens represent a unique opportunity to compare previous taxonomy and to confirm field identifications, particularly if we consider that the original descriptions of both species were made over seventy years ago using only two individuals for *C. modestus* and one for *C. olallae*. Considering their similar appearance, close proximity, threatened status and the ongoing ecological studies that have been initiated on both Bolivian endemic monkeys, the confirmation of their identification using genetic material such as the opportunistically collected specimen reported herein and/or scat material (Barreta *et al*., unpublished data) is of paramount importance.

Jesús Martínez*, **Robert B. Wallace**, Wildlife Conservation Society, Greater Madidi Landscape Conservation Program, Casilla 3-35181, San Miguel, La Paz, Bolivia and Wildlife Conservation Society, 185th Street and Southern Boulevard, Bronx, New York, 10460, U.S.A. E-mail: *<jesmarmo@gmail.com>, **Heidy López-Strauss**, Wildlife Conservation Society, Greater Madidi Landscape Conservation Program, Casilla 3-35181, San Miguel, La Paz, Bolivia, **Paula De La Torre**, Wildlife Conservation Society, Greater Madidi Landscape Conservation Program, Casilla 3-35181, San Miguel, La Paz, Bolivia and Carrera de Biología, Universidad Mayor de San Andrés, La Paz, Bolivia, and, **Hugo Aranibar**, Asociación Armonía, Santa Cruz, Bolivia.

References

Anderson S. 1997. Mammals of Bolivia: taxonomy and distribution. *B. Am. Mus. Nat. His*. New York.

Barreta, J. 2007. Caracterización genética de dos especies de monos tití *Callicebus olallae* y *Callicebus modestus* del Departamento del Beni. Informe técnico. Wildlife Conservation Society & Instituto de Biología Molecular y Biotecnología, La Paz, Bolivia. 15 pp.

Defler, T. R., M. L. Bueno & J. Garcia. 2010. *Callicebus caquetensis*: a new and critically endangered titi monkey

from southern Caquetá, Colombia. *Primate Conserv*. 25: 1–9.

Felton A., A. M. Felton, R. B. Wallace, H. Gómez. 2006. Identification, distribution and behavioural observations of the titi monkeys *Callicebus modestus* Lönnberg 1939, and *Callicebus olallae* Lönnberg 1939. *Primate Conserv*. 20: 40–46.

Hennessey, B. 2003. Conservation presentation to Tacana communities within the last Bolivian site of the Wattled Curassow (*Crax globulosa*). Informe Técnico. Wildlife Conservation Society & Armonía, La Paz, Bolivia. 5 pp.

Hershkovitz P. 1990. Titis, New World monkeys of the genus *Callicebus* (Cebidae, Platyrrhini): a preliminary taxonomic review. *Fieldiana Zool*. N. S. (55): 1–109.

Kobayashi S. 1995. A phylogenetic study of titi monkeys, genus *Callicebus*, based on cranial measurements: I. Phyletic groups of *Callicebus*. *Primates* 36: 101–120.

Lönnberg E. 1939. Notes on some members of the genus *Callicebus*. *Arkiv. Zoologi. Stockholm.* 31A (13): 1–18.

Lopez-Strauss, H. 2008. Estimación de densidad y composición de grupos de dos primates, *Callicebus olallae* y *Callicebus modestus*, especies endémicas del sud-oeste del Departamento del Beni – Bolivia. Undergraduate thesis, Universidad Mayor de San Andrés, La Paz, Bolivia.

Martínez J., R. B. Wallace. 2007. Further notes on the distribution of endemic Bolivian titi monkeys, *Callicebus modestus* and *Callicebus olallae*. *Neotrop. Primates* 14: 47–54.

Martínez, J., R. B. Wallace. 2010. Pitheciidae. Pp. 305-330. In: Wallace R. B., D. Rumiz & H. Gomez (eds.). Mamíferos Medianos y Grandes de Bolivia: Distribución, Ecología y Conservación. Editorial: Centro de Ecología y Difusión Simón I. Patiño, Santa Cruz, Bolivia.

Patterson, B. D. 1992. Mammals in the royal natural history museum, Stockholm, collected in Brazil and Bolivia by A.M. Olalla during 1934-1938. *Fieldiana Zool*. N.S. No. 66.

Van Roosmalen M. G. M., T. Van Roosmalen, R. A. Mittermeier. 2002. A taxonomic review of the titi monkeys, genus *Callicebus* Thomas, 1903, with the description of two new species, *Callicebus bernhardi* and *Callicebus stephennashi* from Brazilian Amazonia. *Neotrop. Primates* 10: 1–52.

Wallace, R. B., H. Gomez, A. Felton, A. M. Felton. 2006. On a new species of titi monkey, genus *Callicebus* Thomas, from western Bolivia (Primates, Cebidae) with preliminary notes on distribution and abundance. *Primate Conserv*. 20: 29–39.

Wallace R. B., N. Mercado. 2007. La diversidad, distribución y abundancia de primates en Bolivia: recomendaciones preliminares para su conservación. V Congreso Nacional de Biología para la Conservación y el Desarrollo Sostenible, 28-30 de Marzo de 2007, Santa Cruz, Bolivia.

VARIACION MENSUAL DEL USO DEL TERRITORIO POR EL MONO CHORO *LAGOTHRIX CANA* EN EL PARQUE NACIONAL YANACHAGA CHEMILLEN, PERU.

Deisi Vanessa Luna Celino

Introducción

La extensión y calidad del territorio en el cual se mueve un primate suele depender de factores importantes como los recursos naturales explotables: alimento, agua y sitio para dormir. Para los monos del género *Lagothrix* que viven en el bosque tropical con árboles grandes, el factor más influyente en el uso del territorio es el recurso alimenticio (Defler, 1989). Como animales predominantemente frugívoros (Di Fiore y Campbell, 2007), los monos choro tienen un área domiciliaria extensa para poder localizar los frutos consumibles que se encuentran en el bosque en forma de parches dispersos de manera azarosa o agregada (Defler 1989; Peres, 1996). A nivel temporal, la fruta tampoco está distribuida uniformemente. Se tienen picos de fructificación a lo largo del año que suelen coincidir con la estación lluviosa. Ante esta situación los monos del género *Lagothrix* deben modificar su dieta, patrones de actividad e incluso el uso del territorio para satisfacer los requerimientos energéticos de todos los individuos que conforman el grupo (Defler 1989, 1995; Peres 1994,1996; Stevenson *et al.,* 1994; Defler y Defler, 1995; Soini 1995a, 1995b; Di Fiore, 2003; Stevenson, 2006).

El presente trabajo evalúa la variación, a lo largo de nueve meses, en el uso del territorio por parte de un grupo de *Lagothrix cana* en el Parque Nacional Yanachaga Chemillén, selva central del Perú. El hábitat se evalúa en términos de la topografía y de los tipos de bosque por medio del Análisis de Disponibilidad de Hábitat (Pozos y Youlatos, 2005). Este estudio aporta información ecológica sobre esta especie de mono choro en su ubicación más cercana a los Andes dentro de su rango de distribución (Fooden, 1963, Groves, 2000).

Materiales y Métodos

Area de estudio

Se encuentra en las inmediaciones de la Estación Biológica Paujil (S10°22'34" W75°14'35"), en el extremo oriental del Parque Nacional Yanachaga Chemillén, departamento de Pasco, Perú (Fig. 1). El área de estudio comprende una extensión de 300 ha entre los 400 a 600 msnm., con una topografía predominantemente ondulada. Es un Bosque Húmedo Tropical (bh–T) con temperaturas medias anuales de entre 23°C a 25°C y precipitaciones anuales por encima de los 3,000 mm (datos de la estación meteorológica más cercana para la misma zona de vida en Puerto Bermúdez: S 10° 18' 1", O 74° 54' 1"). La estación lluviosa va de octubre

a abril con un pico hacia el mes de marzo, mientras que la temporada seca es corta y se da entre mayo a setiembre.

Grupo de estudio

Compuesto por siete individuos (dos hembras adultas, cuatro machos adultos y una juvenil), además de una cría nacida en abril que ya no fue vista más en las siguientes evaluaciones. Todos ellos identificados por la forma del cuerpo, color de pelaje y marcas naturales. El grupo pudo ser habituado sin mucha dificultad durante el mes y medio anterior al inicio de la toma de datos. Adicionalmente, se realizó seguimiento a otros dos grupos con el propósito de evaluar el grado de superposición del territorio con el grupo de estudio.

Evaluación de la Preferencia de Hábitat (EPH)

Desde abril a noviembre del 2012 se acumularon 236 horas de seguimiento a individuos focales, distribuidas equitativamente a los largo de 6 evaluaciones mensuales; es decir, del final de la estación lluviosa, durante toda la estación seca e inicios de la siguiente estación lluviosa. Cada mes fue evaluado entre 5 y 8 días, dependiendo de la acumulación de las horas de seguimiento diario. Cada 30 minutos se registró la posición (con GPS) y el tipo de bosque y topografía en el que se encontraba el grupo, totalizando 510 registros que indican la preferencia de hábitat. Los datos fueron obtenidos a partir del individuo focal, sin embargo, debido al alto grado de cohesión del grupo (observación personal), pueden ser considerados para todo el grupo. Los puntos de posición fueron analizados con el método de Polígono Convexo Mínimo (MCP) usando el 100%, 95% y el 50% de los puntos más cercanos. El MCP es una herramienta de HRTools para ArcGis 9.3 con el que se pudo obtener áreas domiciliares mensuales.

Análisis de la disponibilidad de hábitat (ADH)

Se aplicó la metodología usada por Pozo y Youlatos (2005) a un bosque de tierra firme de 300 ha. -que incluye el área domiciliaria del grupo de estudio-, donde se han recorrido 3 transectos paralelos de 1 kilómetro cada uno separados 500 metros entre sí. Cada 10 m dentro de dichos transectos se tomaron datos del tipo de topografía (cima, ladera, terraza, quebrada) a partir de la pendiente del suelo, y del tipo de bosque (bosque primario, bosque de galería y bosque secundario), totalizando en 279 puntos que indican la disponibilidad de hábitat.

Tipos de bosque

Fue establecido a partir de la medición del DAP, la altura y la densidad de los árboles (datos no publicados) dispuestos

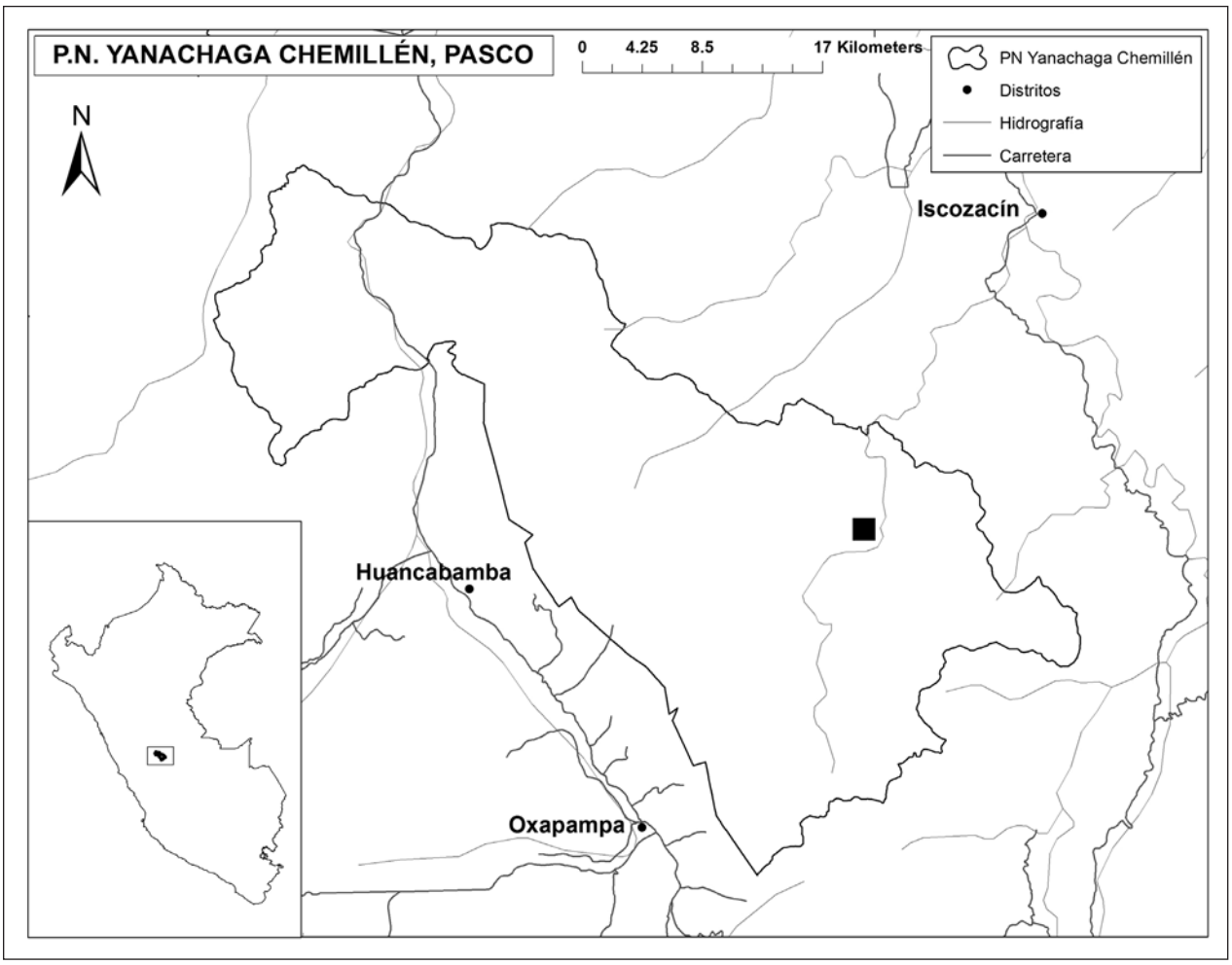

Figura 1. Área de estudio: Parque Nacional Yanachaga Chemillén

Figura 2. Área domiciliaria de *L. cana* y los transectos usados para el análisis de la estructura de hábitat

en los 5 metros a ambos lados del punto usado para el ADH. Asimismo, se tomó en cuenta la presencia de ciertas especies indicadoras. Se tienen cuatro tipos de bosque: a) El bosque secundario, producto de la agricultura de roce y quema a finales de los años 60's que se dio en parte de lo que ahora es el sitio de estudio (INRENA, 2005); b) el bosque primario, con árboles de 20-30 metros de alto y dosel continuo con árboles emergentes de hasta 40 metros; c) bosque de galería, según Malleux (1982), localizado en colinas y terrazas con fuerte erosión eólica y cercanas a quebradas grandes, resultando en un dosel discontinuo y numerosos árboles caídos; y d) claros de bosque, zonas donde la erosión eólica ha sido bastante fuerte como para dejar áreas extensas descubiertas (de más de 0.1 ha). Finalmente, a partir del ADH y de la EPH se obtuvo el Índice de Preferencia (IP) de la topografía y del tipo de bosque de acuerdo a la siguiente relación: IP = Preferencia/Disponibilidad.

Resultados y discusión

Respecto al uso total del territorio, los monos usaron un territorio de 209.4 ha a lo largo de los 9 meses que duró la evaluación. Sin embargo, solo 25 puntos (5%) adicionaron 90 ha, el 43% del área domiciliaria total, el que perteneció casi exclusivamente al mes de junio (ver diferencias entre MCP 95 y MCP 100, Fig. 2). Adicionalmente sólo en los meses de abril, julio, agosto, setiembre y noviembre la curva de acumulación de hectáreas se aplana mostrando un adecuado esfuerzo de muestreo (Fig. 3).

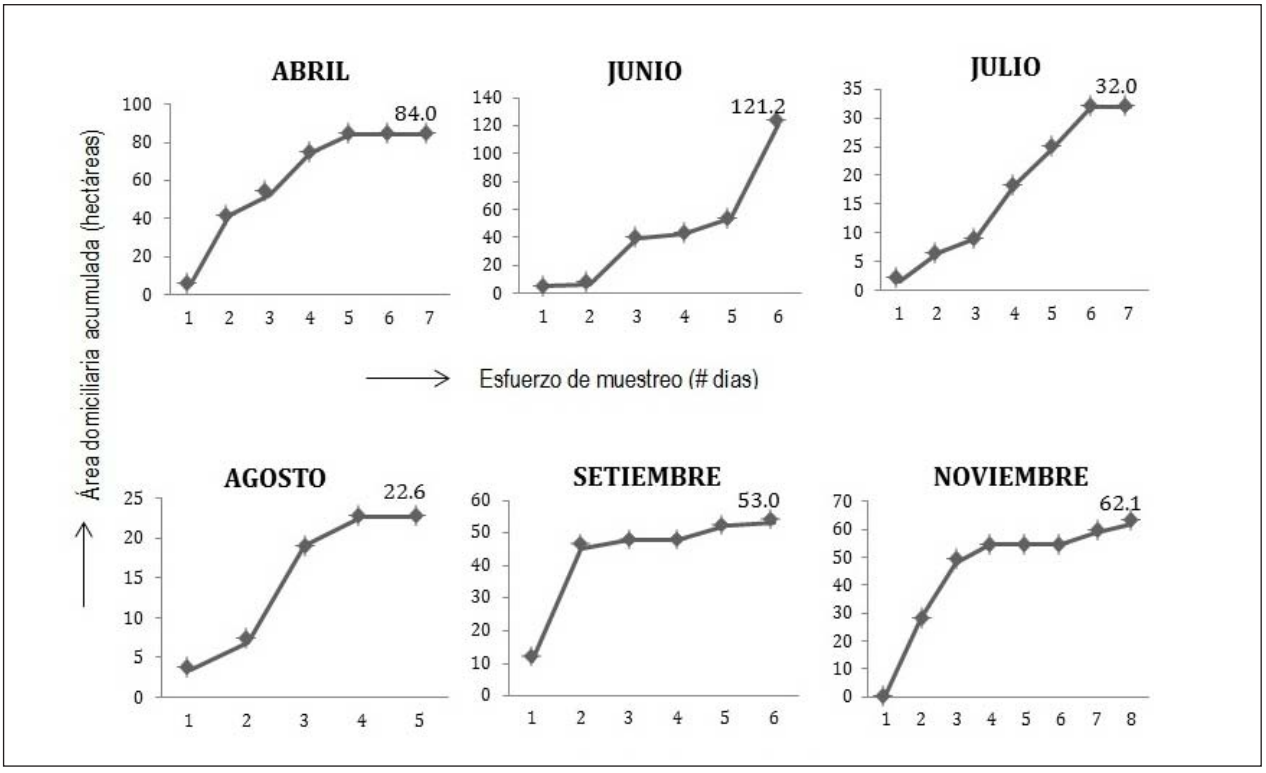

Figura 3. Curvas de acumulación de áreas domiciliares mensuales

Disponibilidad y preferencia topográfica

El área de estudio presenta una topografía ondulada donde predominan terrazas (60%), laderas (35%) y cimas (2%). Se observó que los mayores índices de preferencia de hábitat se dan sobre el tipo topográfico cima (IP=7.8), seguido por la terraza (1.7) y la ladera (1.4). Las cimas de las colinas fueron preferidas probablemente porque permiten mayor facilidad de traslado en recorridos largos, tal como fue encontrado en Di Fiore y Suarez (2007) para monos atelidos en Yasuní. Además, muchos de los frutos que consumieron se encontraban en los bosques de galería, que están mayoritariamente sobre terrenos con pendiente. Pozo (2009) encontró que las preferencias topográficas de los monos choros responderían en parte a evitar la competencia con otras especies de monos atélidos. Ante la inexistencia de otras especies de monos atélidos en el área de estudio, lo que podría estar ocurriendo es la competencia con grupos vecinos de *Lagothrix cana,* más grandes en número de individuos, con los que el grado de superposición de territorio es por lo menos del 60%. Nuestro grupo de monos también comparte territorio con otras especies de primates, como los pichicos (*Saguinus sp.*) y capuchinos (*Cebus albifrons*), que son especies de menor tamaño y probablemente por ello no causarían ningún efecto en la preferencia topográfica (Stevenson *et al.,* 2000).

Disponibilidad y preferencia de los tipos de bosque

En el área de estudio predomina el bosque primario (72%) sobre el bosque de galería (16%), el bosque secundario (6%) y los claros de bosque (6%). Se encontró que los IP mensuales del bosque de galería y del bosque primario variaron inversamente; es decir, que mientras terminaba la estación lluviosa, y avanzaba la estación seca, hubo un aumento en el uso del bosque de galería, para luego disminuir hacia inicios de la siguiente estación lluviosa (Fig. 4). Con ello se aprecia un incremento del uso del bosque de galería con el consumo de las especies *Cecropia sciadophylla*, *Ficus americana, Ficus krukovii* e *Inga alba*, las que juntas conformaron el 49% y 71% de la dieta en frutos para los meses de julio y agosto, respectivamente (Luna, datos no publicados). Estas especies se caracterizan por su rápido crecimiento, heliotrofía, crecimiento en ambientes degradados y fenología asincrónica (Guariguata y Kattan, 2002), tal como ocurre en el Yanachaga. Con ello la preferencia a este tipo de bosque pareciera ser dependiente de las especies que están produciendo frutos en él, como se ha encontrado en Tinigua (Stevenson, 2006).

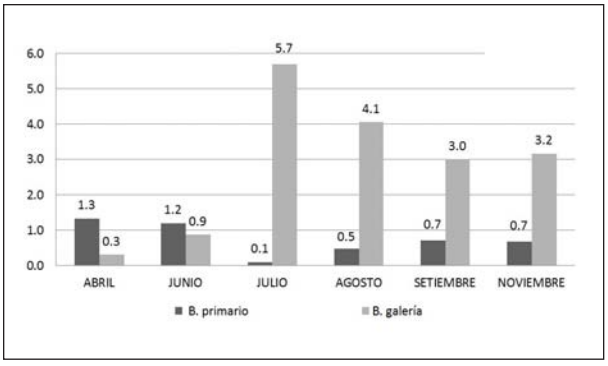

Figura 4. Índice de preferencia del tipo de bosque

Los IP promedio de todo el periodo de evaluación del bosque primario y del bosque de galería son similares y se acercan a uno (1.2 y 1.1, respectivamente. Fig. 4). Sin embargo, estos son datos no incluyen un adecuado muestreo de la estación lluviosa donde se esperaría, según la tendencia, un mayor uso del bosque primario. Por otro lado, el IP del bosque secundario siempre fue bajo (menor de 0.1), lo que demuestra el comportamiento evasivo de los monos hacia este tipo de formación boscosa, por la ausencia de una adecuada cobertura arbórea que permita el fácil desplazamiento (Emmons y Gentry, 1983) y evite el ataque de los depredadores (Di Fiore, 2002). Dicho comportamiento fue reportado por Peres (1996) y Stevenson (2006), donde los monos choro también rechazaban los bosques secundarios, sobre todo los más jóvenes. Sin embargo, queda pendiente evaluar por qué el bosque secundario de la zona de estudio se mantiene tal cual después de 40 años de haber acontecido la ocupación. Para Peres (1996) y Stevenson (2006) el uso de territorio en la estación seca fue bastante variable, lo que se cumplió en los monos del Yanachaga solo para inicios de dicha estación, en el mes de junio, cuando el consumo de hojas nuevas fue mayor -del 33% frente al 12% en promedio para toda la evaluación- (Luna, datos no publicados), y se usó un territorio de 121 ha. De hecho, en este mes no hubo una correspondencia entre la extensión de territorio utilizado y el esfuerzo de muestreo (Fig. 3). Para el resto de la estación seca el área domiciliaria fue menos extensa y el recorrido diario del grupo se hizo más predecible, debido a que las plantas que les proveyeron de frutos se encontraban en forma de parches dentro del bosque de galería.

El presente estudio pone nuevamente en evidencia el grado de plasticidad en el uso de hábitats de los monos *Lagothrix* como respuesta a una potencial variación espacio-temporal en la disponibilidad de recursos, siendo este un aporte al conocimiento de la ecología de *Lagothrix cana*, la especie de mono choro común menos estudiada hasta ahora, en su distribución dentro del piedemonte andino amazónico. El sitio de estudio particularmente cuenta con bosques con cierto grado de perturbación, sobre todo debido a los efectos de la erosión eólica, de allí que se resalte la importancia de los géneros *Cecropia*, *Ficus* e *Inga* en la dieta de los monos en los meses pico de la estación seca.

Agradecimientos

A la Fundación Liz Claiborne-Fundación Art Ortenberg y al Jardín Botánico de Missouri por financiar y asesorar este proyecto de investigación. A Rodolfo Vásquez y Rocío Rojas por el apoyo durante todo el trabajo de campo, así como por la asesoría en temas botánicos, y a Erwin Palacios por los comentarios pertinentes al presente manuscrito.

Deisi Vanessa Luna Celino, Investigadora asociada del Jardín Botánico de Missouri-Perú. Prolongación Bolognesi 399, Oxapampa-Pasco, Perú. E-mail: <deisiluna@gmail.com>.

Referencias

Defler, T. R. 1989. Recorrido y uso del espacio en un grupo de *Lagothrix lagothricha* (Primates: Cebidae) mono lanudo churuco en la Amazonía Colombiana. *Trianea* 3: 183–205.

Defler, T. R. 1995. The time budget of a group of wild woolly monkeys (*Lagothrix lagotricha*). *Int. J. Primatol*. 16: 107–120.

Defler, T. R. y Defler, S. B. 1995. Diet of a group of *Lagothrix lagothricha lagothricha* in southeastern Colombia. *Int. J. Primatol*. 17: 161–190.

Di Fiore, A. 2002. Predator sensitive foraging in ateline primates. En: *Eat or Be Eaten: Predator Sensitive Foraging among Primates*, L. E. Miller (ed.), pp. 242–267. Cambridge University Press, Cambridge.

Di Fiore, A. 2003. Ranging behavior and foranging ecology of lowland woolly monkey (*Lagothrix lagothricha poeppigii)* in Yasuni National Park, Ecuador. *Am. J. Primatol*. 59: 47–66.

Di Fiore, A. y Campbell, C. 2007. The Atelines: variation in ecology, behavior, and social organization. En: *Primates in Perspective*, C. Campbell, A. Fuentes, K. MacKinnon, M. Panger y S. Bearder (eds.), pp. 155-185. Oxford University Press, New York.

Di Fiore, A. y Suarez S. A. 2007. Route-based travel and shared routes in sympatric spider and woolly monkeys: cognitive and evolutionary implications. *Anim. Cogn.* 10: 317–329.

Emmons, L. H. y Gentry, A. 1983. Gliding and prehensile-tailed vertebrates and the structure of the tropical forest canopy. *Am. Nat*. 121: 513–524.

Fooden, J. 1963. A revision of the woolly monkeys (genus *Lagothrix*). *J. Mamm*. 44: 213–247.

Groves, C. 2000. An assessment of the diversity of New World primates. *Neotrop. Prim*. 8: 61–93.

Guariguata, M. R. y Kattan, G. H. 2002. Ecología y conservación de bosques neotropicales. 1ª. ed. Ediciones LUR, Cartago (Costa Rica).

INRENA. 2005. *Plan Maestro del Parque Nacional Yanachaga Chemillén 2005-2009*. Ministerio de Agricultura. Lima (Perú).

Malleux, J. 1982. *Inventarios Forestales en Bosques Tropicales*. Universidad Nacional Agraria La Molina, Lima.

Peres, C. A. 1994. Diet and feeding ecology of gray woolly monkeys (*Lagothrix lagotricha cana*) in Central Amazonia: comparisons with other atelines. *Int. J. Primatol*. 15: 333–372.

Peres, C. A. 1996. Use of space, spatial group structure, and foraging group size of gray woolly monkeys (*Lagothrix lagotricha cana*) at Urucu, Brazil. En: *Adaptive Radiations of Neotropical Primates*, M. A. Norconk, A. L. Rosenberger y P. A. Garber (eds.), pp. 467–488. Plenum Press, New York.

Pozo, W. E. 2004. Preferencia de hábitat de seis primates simpátricos del Yasuní, Ecuador. *Ecología Aplicada* 3: 128–133.

Pozo, W. E. 2009. Uso preferencial de hábitat en primates atélidos en el Parque Nacional Yasuní, Ecuador. *Boletín Técnico* 8, *Serie Zoológica* 4-5: 25–34

Pozo, W. E. y Youlatos, D. 2005. Una metodología rápida y económica: el análisis de la estructura de hábitat en estudios primatológicos. *Boletín Técnico* 5*, Serie Zoológica* 1: 7–17.

Soini P. 1995a. Informe preliminar de la ecología y dinámica poblacional del 'choro' *Lagothrix lagotricha* (Primates). En: *Reporte Pacaya-Samiria: Investigaciones en la Estación Biológica Cahuana 1979–1994*, P. Soini, A. Tovar N. y U. Valdez Q. (eds.), pp. 227–234. Universidad Nacional Agraria La Molina, Lima.

Soini P. 1995b. La dieta del mono choro (*Lagothrix lagotricha*). En: *Reporte Pacaya-Samiria: Investigaciones en la Estación Biológica Cahuana 1979–1994*, P. Soini, A. Tovar N. y U. Valdez Q. (eds.), pp. 251–266. Universidad Nacional Agraria La Molina, Lima.

Stevenson, P. R. 2006. Activity and ranging patterns of Colombian woolly monkeys in north-western Amazonia. *Primates* 47: 239–247.

Stevenson, P. R., Quiñones, M. J., y Ahumada, J. A. 1994. Ecological strategies of woolly monkeys (*Lagothrix lagotricha*) at Tinigua National Park, Colombia. *Am. J. Primatol*. 32: 123–140.

Stevenson, P. R., Quiñones, M. J., y Ahumada, J. A. 2000. Influence of fruit availability on ecological overlap among four Neotropical primates at Tinigua National Park, Colombia. *Biotropica*. 32: 533–544.

RELATO DE CASO DE MORTE POR AGRESSÃO ENTRE MACACOS-PREGO *SAPAJUS NIGRITUS* (PRIMATES: CEBIDAE) NO JARDIM BOTÂNICO DO RIO DE JANEIRO

Cristiane Hollanda Rangel
José Gustavo V. Adler
Gabriela C. Heliodor
Anderson Santos Jr.
Carlos Eduardo Verona

Introdução

Interações agressivas resultando em morte têm sido relatadas em primatas não-humanos como chimpanzés (Wrangham, 1999; Watts & Mitani, 2001), gorilas-da-montanha (Watts, 1989), colobus-vermelhos (Starin, 1994), Muriqui-do-sul (Talebi *et al*, 2009) e também em caiararas (Miller, 1998; Gros-Louis *et al*, 2003), e em macacos-pregos (Ramírez-Llorens *et al*, 2008; Scarry e Tujague, 2012). A manutenção do monopólio sobre os recursos alimentares na área de vida e/ou sobre as potenciais parceiras reprodutivas, são fatores que exercem forte pressão sobre animais sociais, principalmente em primatas, fazendo com que os animais invistam em interações agonísticas intensas. Estas podem incluir contato físico e até mesmo serem fatais (Sasaki,

1998; Di Bitetti, 2001; Campbell, 2006; Harris, 2010). Interações agonísticas fatais em macacos-prego e caiararas podem ser motivadas por disputa de poder, agressão contra novos indivíduos no grupo, e encontro entre grupos com consequente disputa por território (Gros-Louis *et al*, 2003). O risco de encontro com machos de outros grupos ou machos solitários é a maior preocupação dos *C. capucinus* machos no comportamento de vigília (Rose e Fedigan, 1995).

Recentemente o gênero *Cebus* foi separado em dois, *Sapajus* e *Cebus* (Lynch Alfaro *et al*, 2012), e talvez existam diferenças entre eles no que se refere à suas interações intraespecíficas e à importância delas para a dinâmica dos grupos. *Sapajus apella*, por exemplo, parece ser menos agressivo durante encontros intergrupais do que *Cebus capucinus* e *C. albifrons* (Becker & Berkson, 1979; Defler, 1982; Perry 1996; Gros-Louis *et al*, 2003; Ramírez-Llorens *et al*, 2008). As disputas de poder são eventos bastante conflitantes podendo resultar em morte em *Cebus* (Gros-Louis *et al*, 2003; Scarry e Tujague, 2012). Muitos estudos com ambos os gêneros relatam casos de infanticídio por machos assim que conquistam o mais alto nível hierárquico do grupo (Izar *et al*, 2007; Ramírez-Llorens et al. 2008; Rose, 1994), o que reforça o quadro agonístico dos casos de disputa hierárquica. O presente estudo relata o caso de um indivíduo de macaco-prego (*Sapajus nigritus* - Goldfuss, 1809) macho adulto, encontrado gravemente ferido no arboreto do Jardim Botânico do Rio de Janeiro, pelos pesquisadores do Projeto de Conservação da Fauna.

Metodologia

A área de estudo faz parte do Instituto de Pesquisas Jardim Botânico do Rio de Janeiro (JBRJ) localizado na zona sul da cidade do Rio de Janeiro (22°57' a 22°59' S e 43°13' a 43°14' W). Sua área física compreende 137 hectares, sendo 54 ha do arboreto com cultivo de cerca de 8,000 espécies arbóreas entre nativas e exóticas de várias partes do mundo, e 83 ha de remanescentes florestais de Mata Atlântica contínuas ao Parque Nacional da Tijuca (PNT). Essa ligação com o parque permite o trânsito da fauna autóctone, que utiliza o arboreto do JBRJ para se alimentar, nidificar e se estabelecer (Rangel, 2010). Apesar de ser uma área de conservação *ex situ* de plantas, o JBRJ funciona como zona de amortecimento desta unidade de conservação federal e colabora para diminuir seus efeitos de borda, sendo, portanto, uma área de conservação *in situ* para a fauna.

Desde 2007 o Projeto de Conservação da Fauna no JBRJ, um projeto de longa duração, monitora a comunidade de primatas de vida livre na área. Durante esse tempo, pelo menos um dia por semana há pesquisadores observando os grupos de macacos-prego, com esforço médio de 8 horas diárias, em estudos de área de vida, comportamento e dieta. Os macacos-prego dos grupos estudados foram classificados como *Sapajus nigritus* devido às suas características morfológicas, de acordo com Silva Jr. (2001). Dois grupos de *Sapajus nigritus* vem sendo acompanhados desde 2007. O grupo 1 usa o arboreto e parte baixa da área de mata secundária do JBRJ, é o mais avistado, estudado e com composição conhecida. O grupo 2, que usa a parte mais alta da mata secundária, se sobrepõe parcialmente com a área do grupo 1 (Fig. 1), e é avistado apenas ocasionalmente. Na data da observação do animal ferido, o grupo 1 de macacos–prego possuía 21 indivíduos: três machos adultos, dois machos sub adultos, sete fêmeas adultas, quatro jovens, e cinco infantes. Nas poucas ocasiões em que o grupo 2 foi acompanhado, seu tamanho estimado foi de cerca de 10 indivíduos, com possibilidade de haver mais.

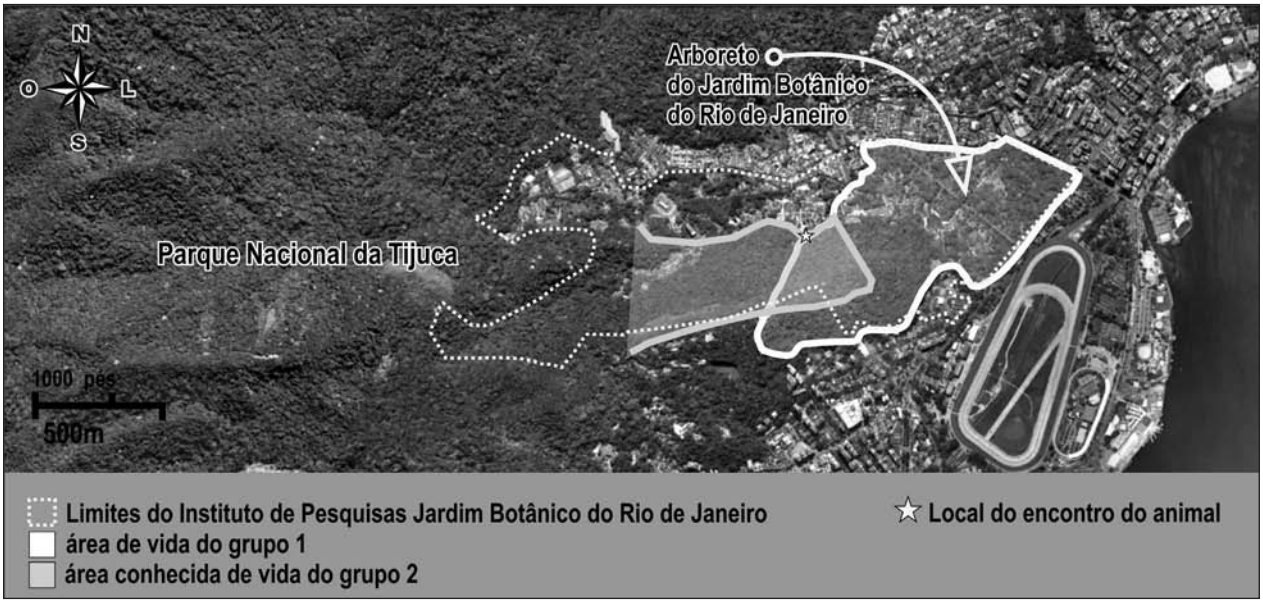

Figura 1. Detalhamento das áreas do Jardim Botânico do Rio de Janeiro ocupadas pelos grupos 1 e 2 de macacos-prego (S*apajus nigritus*), indicando sua zona de sobreposição e local de encontro do animal ferido. Adaptado de Google Maps.

Resultados

Um macaco-prego macho adulto ferido foi encontrado na zona de sobreposição dos dois grupos às 14h de 20/07/2012 com lacerações recentes e graves em três membros e na cintura pélvica. Realizou-se o resgate e contenção do animal para encaminhamento, pela Patrulha Ambiental, para a Clínica de Reabilitação de Animais Silvestres (CRAS). O animal, porém, não resistiu aos ferimentos e veio a óbito antes mesmo do atendimento veterinário. A necropsia realizada no referido animal indica uma série de ferimentos que, pelas formas e medidas das lacerações e perfurações, assim como marcas deixadas na pele e musculatura, são compatíveis com mordidas de macacos-prego (a Figura 2 apresenta maiores detalhes das lesões).

O animal necropsiado apresentava lacerações ocorridas em dias distintos, algumas mais recentes, outras ocorridas dias antes do óbito, verificado pelo início de formação de tecido cicatricial nas bordas lesionadas. Os ferimentos dos membros anteriores incluíam lacerações com marcas de dentes, por mordidas e amputações de partes de membros como terceira falange do dedo médio, por arrancamento. Incluíam também lesões indicativas de ações defensivas, como ferimentos nas palmas dos membros anteriores e posteriores. A fratura exposta de tíbia e fíbula também sugeria que a lesão havia sido criada por um episódio de conflito físico, assim como todas as outras lesões, por ser observada a presença de mordidas nos locais. A lesão na região ventro-lateral da virilha direita mostra nitidamente a impressão de dentes compatíveis com as dimensões e similaridades anatômicas da dentição de primatas do gênero *Sapajus* adultos, tanto na pele quanto na musculatura. Acompanhamentos posteriores do grupo 1 mostraram que sua composição não havia sido alterada, sugerindo então que o macho adulto que veio a óbito seria proveniente do grupo 2, ou seria um macho solitário.

Discussão e conclusão

O local de encontro do animal e as características das feridas sugerem a ocorrência de uma interação agonística física intraespecífica como causa do óbito. A ausência de mudança na composição do grupo 1 mostra que o animal encontrado poderia ser do grupo 2, que teria se envolvido em conflito intragrupal ou com o grupo 1, ou um animal solitário ferido em um conflito no encontro com um dos grupos. Este caso reforça os padrões de comportamento encontrados em outros estudos quanto a agressividade de um conflito intraespecífico em *Sapajus nigritus* (Di Bitetti, 2001; Lynch e Rimoli 2000; Scarry e Tujague, 2012), e levanta questões quanto à ecologia e sociedade da espécie, tais como pressão na sobrevivência do grupo e em sua dinâmica.

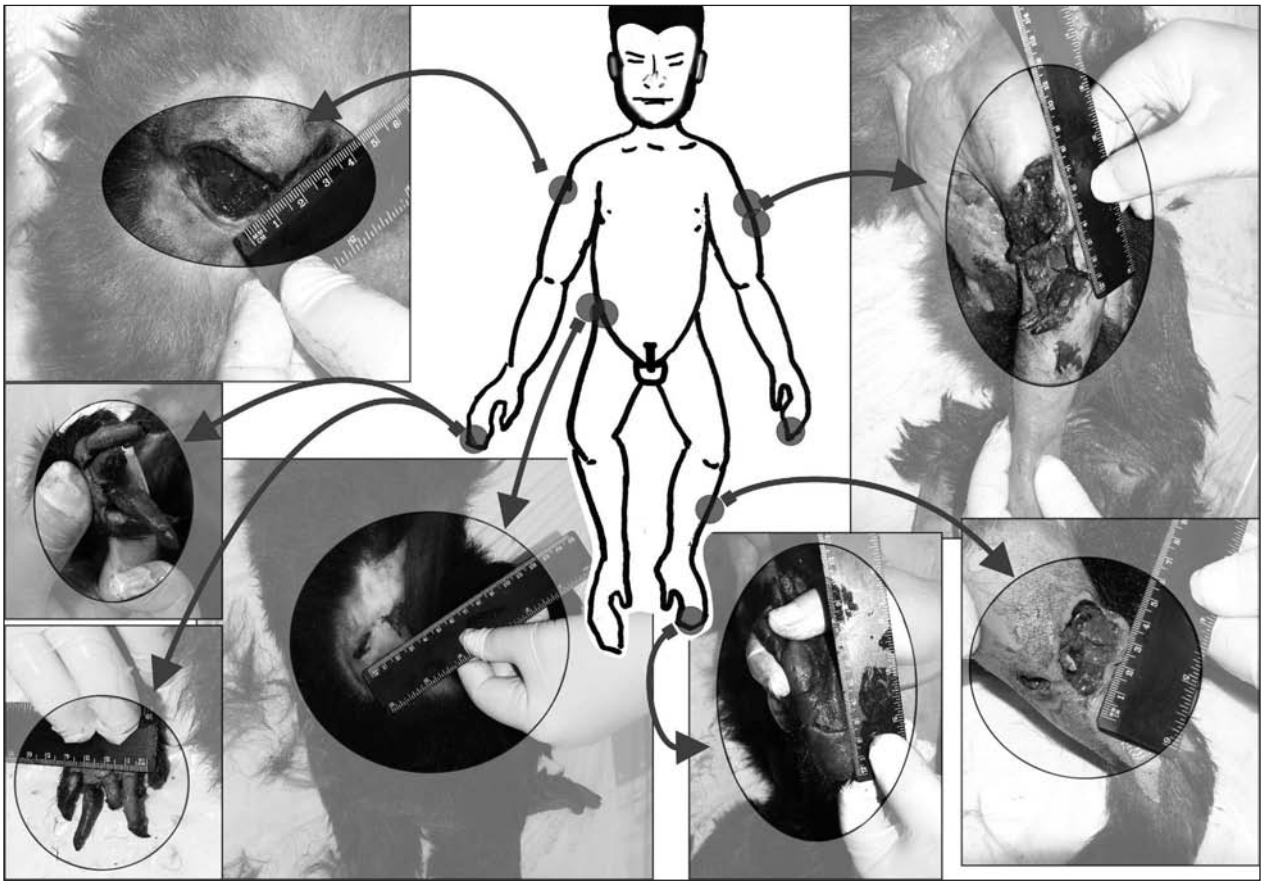

Figura 2. Esquema da localização e imagens dos ferimentos do macaco-prego (*Sapajus nigritus*) encontrado no Jardim Botânico do Rio de Janeiro.

Os registros sobre os potenciais predadores de macacos-prego na área indicam a presença de jibóia (*Boa constrictor*), gavião-pega-macaco (*Spizaetus tyrannus*), e cães e gatos domésticos, porém nenhum deles capazes de produzir lesões com as características documentadas. Os machos adultos de caiararas passam a maior parte do tempo em comportamento de vigília por conta da presença de indivíduos estranhos ao grupos, mais do que ameaças de predadores (Rose e Fedigan, 1995), revelando a importância de conflitos intraespecíficos na dinâmica do grupo, o que parece ser o caso do presente estudo com *S. nigritus*.

A disputa por sítio alimentar parece ser um fator importante no presente estudo. No local onde o indivíduo ferido foi encontrado há uma jaqueira onde, frequentemente, os dois grupos foram observados se alimentando, mas nunca ao mesmo tempo. A jaqueira (*Artocarpos heterophyllus*) é uma árvore exótica, presente em quase todo o JBRJ e no Parque Nacional da Tijuca, e seus frutos representam grande parte da dieta dos macacos-prego durante todo o ano (Rangel, 2010). É provável que esta jaqueira tenha influência no encontro entre os dois grupos, revelando o valor alimentar das áreas de vida como um fator relevante no comportamento agressivo contra potenciais invasores (Enquist e Leimar, 1987; Vogel *et al*, 2007; Harris, 2010). A zona de sobreposição das áreas dos dois grupos também é o caminho de acesso para o arboreto do JBRJ, que é uma fonte de recursos alimentares pois diariamente visitantes fornecem alimento diretamente aos animais, ou indiretamente, nas lixeiras exploradas como locais de forrageamento (Rangel, 2010).

Outro fator que pode ter influência na postura agressiva é a diferença de tamanho de cada grupo. O grupo 1 parece ser consideravelmente maior, o que poderia encorajar sua investida contra o grupo menor na zona de sobreposição, fora do núcleo do território do grupo menor. Grupos maiores aumentam sua probabilidade de vitórias, exceto nos núcleos do território de um dos grupos, onde a tendência é o grupo residente, mesmo em menor número, ganhar a disputa (Crofoot *et al*, 2008). Um terceiro aspecto que pode influenciar relações agonísticas é a oportunidade de parceiras de reprodução, provocando competição e defesa de parceiras (Rose, 1994; Perry 1996; Campbell, 2006).

Uma quarta possibilidade seria de um conflito intragrupal no grupo 2. Conflitos intragrupais, incluindo infanticídio, podem resultar em graves ferimentos ou mortes por consequência de uma disputa pela hierarquia do grupo, como fora relatado em *Cebus capucinus* e *Sapajus nigritus* (Gros-Louis *et al*, 2003; Izar *et al*, 2007; Ramírez-Llorens *et al*, 2008; Rose, 1994; Lynch & Rímoli, 2000; Scarry e Tujague, 2012). Os conflitos intragrupais são potenciais pressões seletivas para o comportamento e dinâmica dos machos e fêmeas nos grupos. De certo, o risco de ter um dos seus descendentes mortos, afetando a propagação de seus caracteres genéticos, exerce pressão sobre os machos alfa, sendo mais um dos fatores que os predispõem a atitudes agressivas diante de disputas hierárquicas. Ramírez-Llorens e colaboradores (2008) apontam para uma estratégia de evitação do infanticídio pelas fêmeas prenhes de *S. nigritus* ao se acasalarem imediatamente com o novo macho alfa, enquanto que as fêmeas de *C. capucinus* grávidas procuram acasalar ainda com machos imigrantes mesmo que de menor nível hierárquico. Seriam necessários mais estudos com outras espécies dos dois recentes gêneros para verificar se a diferença é válida e ocorre entre os gêneros. É provável que as disputas por status e suas consequências exerçam forte papel na disposição do gênero *Sapajus*, dispondo-os a se engajar em brigas intragrupais intensas, enquanto nas interações intergrupais tende a encontros mais brandos (Defler, 1982; Becker & Berkson, 1979).

Os achados macroscópicos de necropsia não são suficientes para indicarem a *causa mortis*. A extensão das lacerações, fraturas e mutilações sofridas pelo animal agredido em diferentes momentos, provavelmente em intervalo de dias, sugere que o animal tenha vindo a óbito em decorrência de infecções septicêmicas como osteomielite, por exemplo. A agressividade e as extensões das lesões, assim como suas características anatômicas e biométricas, sugerem que as agressões foram realizadas por diferentes indivíduos adultos do gênero *Sapajus*. Sem a observação e registro da interação que resultou no quadro do animal, não é possível no presente estudo verificar os padrões e características do conflito. Porém o estudo endossa o quadro geral encontrado em macacos-prego e caiararas quanto a importância dos conflitos agonísticos para a dinâmica dos grupos e sobrevivência dos indivíduos como um dos fatores de grande pressão para a espécie.

Cristiane Hollanda Rangel*, **José Gustavo V. Adler**, Projeto de Conservação da Fauna, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, RJ, Brasil. *E-mail: <cristiane@jbrj.gov.br>, **Gabriela C. Heliodoro**, Projeto de Conservação da Fauna, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, RJ, Brasil, e Clínica de Reabilitação de Animais Silvestres (CRAS), Universidade Estácio de Sá *campus* Vargem Grande, Rio de Janeiro, RJ, **Anderson Santos Jr.**, Projeto de Conservação da Fauna, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, RJ, Brasil, e **Carlos Eduardo Verona**, Universidade do Estado do Rio de Janeiro (UERJ) e Instituto Brasileiro para Medicina da Conservação – Tríade.

Referências

Becker, J. D. e Berkson, G. 1979. Response to neighbors and strangers by capuchin monkeys (*Cebus apella*). *Primates* 20(4): 547–551.

Campbell, C. J. 2006. Lethal intragroup aggression by adult male spider monkeys (*Ateles geoffroyi*). *Am. J. Primatol.* 68: 1197–1201.

Crofoot, M. C., Gilby, I. C., Wikelski, M. C., e Kays, R. W. 2008. Interaction location outweighs the competitive advantage of numerical superiority in *Cebus capucinus*

intergroup contests. *Proc. Nat. Acad. Sci. USA* 105: 577–581.

Defler, T. R. 1982. A comparison of intergroup behavior in *Cebus albifrons* and *C. apella*. *Primates* 23: 385–392.

Di Bitetti, M. S. D. 2001. Home-range use by the tufted capuchin monkeys (*Cebus apella nigritus*) in a subtropical rainforest of Argentina. *Journal of Zoology* 253:33-45.

Enquist, M. e Leimar, O. 1987. Evolution of fighting behavior: the effect of variation in resource value. *J. Theor. Biol.* 127: 187–205.

Gros-Louis, J., Perry, S. e Manson, J. H. 2003. Violent coalitionary attacks and intraspecific killing in wild white-faced capuchin monkeys (*Cebus capucinus*). *Primates* 44(4): 341–346.

Harris, T. R. 2010. Multiple resource values and fighting ability measures influence intergroup conflict in guerezas (*Colobus guereza*). *Anim. Behav.* 79(1): 89–98.

Izar, P., Ramos-da-Silva, E. D., Resende, B. D., and Ottoni, E. B. 2007. A case of infanticide in tufted capuchin monkeys (*Cebus nigritus*). *Mastozoologia Neotropical* 14(1): 73–76.

Lynch Alfaro, J. W., Silva Jr., J. S. S., and Rylands, A. B. 2012. How different are robust and gracile capuchin monkeys? An argument for the use of *Sapajus* and *Cebus*. *Am. J. Primatol.* 74: 273–286.

Lynch, J. W. & Rímoli, J. 2000. Demography of a group of tufted capuchin monkeys (*Cebus apella nigritus*) at the Estação Biológica de Caratinga, Minas Gerais, Brazil. *Neotrop. Primates* 8(1): 44–49.

Miller, L. 1998. Fatal attack among wedge-capped capuchins. *Folia Primatol.* 69: 89–92.

Perry, S. 1996. Intergroup encounters in wild white-faced capuchins (*Cebus capucinus*). *Int. J. Primatol.* 17(3): 309–330.

Ramírez-Llorens, P., Di Bitetti, M.S., Baldovino, M.C.,e Janson, C.H. 2008. Infanticide in black capuchin monkeys (*Cebus apella nigritus*) in Iguazú National Park, Argentina. *Am. J. Primatol.* 70: 473–484.

Rangel, C. H. 2010. *Ecologia e comportamento de Callitrichidae (Primates) no Jardim Botânico do Rio de Janeiro.* Dissertação de Mestrado, Universidade Estadual do Rio de Janeiro, Rio de Janeiro, BR.

Rose, L. 1994. Benefits and costs of resident males to females in white-faced capuchins, *Cebus capucinus*. *Am. J. Primatol.* 32: 235–248.

Rose, L. M. e Fedigan, L. M. 1995. Vigilance in white-faced capuchins (*Cebus capucinus*) in Costa Rica. *Anim. Behav.* 49: 63–70.

Sasaki, C. 1998. Aggressive intergroup encounters in two populations of Japanese macaques (*Macaca fuscata*). *Primates*, 39(3): 303–312.

Scarry, C. e Tujague, P. 2012. Consequences of lethal intragroup agression and alpha male replacement on intergroup relations and home range use in tufted capuchin monkeys (*Cebus apella nigritus*). *Am. J. Primatol.* 74: 804–810.

Silva Jr., J. S. 2001. *Especiação nos macacos-prego e caiararas, gênero* Cebus *Erxleben, 1777 (Primates, Cebidae).* Tese de Doutorado, Universidade Federal do Rio de Janeiro, Rio de Janeiro, BR.

Starin, E. D. 1994. Philopatry and affiliation among red colobus. *Behaviour* 130:253–270.

Talebi, M. G., Beltrão-Mendes, R. e Lee, P.C. 2009. Intra-comunity coalitionary lethal attack of na adult male southern muriqui (*Brachyteles arachnoides*). *Am. J. Primatol.* 71: 860–867.

Vogel, E. R., Munc, S. B. H., e Son, C. H. J. A. N. 2007. Understanding escalated aggression over food resources in white-faced capuchin monkeys. *Anim. Behav.* 74: 71–80.

Watts, D. P. & Mitani, J. C. 2001. Boundary patrols and intergroup encounters in wild chimpanzees. *Behaviour* 138(3): 299–327.

Watts, D. P. 1989. Infanticide in mountain gorillas: new cases and a reconsideration of the evidence. *Ethology* 81:1–18.

Wrangham, R. W. 1999. Evolution of coalitionary killing. *Yearb. Phys. Anthrop.* 42:1–30.

USO DO CHÃO POR *BRACHYTELES ARACHNOIDES* NO PARQUE NACIONAL SERRA DOS ÓRGÃOS, TERESÓPOLIS, BRASIL

Paula Breves
Austem Stravs Andrade Dias
Alcides Pissinatti
Jean Philippe Boubli

O muriqui-do-sul, *Brachyteles arachnoides*, é uma espécie ameaçada de extinção (Brasil-IBAMA, 2008; IUCN, 2008) endêmica do bioma Mata Atlântica (Aguirre, 1971) e o maior macaco da região Neotropical juntamente com o seu congênere, o muriqui-do-norte, *B. hypoxanthus* (Nishimura et al., 1988). O muriqui-do-sul tem sua distribuição restrita aos estados do Rio de Janeiro, São Paulo e Paraná no sudeste e extremo norte do sul do Brasil, onde pode ser encontrado principalmente em unidades de conservação (UCs) e alguns fragmentos florestais isolados. No Rio de Janeiro, os muriquis-do-sul ocorrem em, pelo menos, sete UCs: Parque Nacional da Serra dos Órgãos, Parque Nacional do Itatiaia, Parque Estadual dos Três Picos, Parque Estadual do Desengano, Parque Estadual do Cunhambebe, APA Federal de Guapiaçu e Reserva Estadual Pico do Cairuçu (Garcia, 2005; Breves et al., 2009; Cunha et al., 2009).

As maiores populações do muriqui-do-sul no território fluminense ocorrem na região da Serra dos Órgãos do Rio de Janeiro, onde existem os maiores remanescentes de Mata Atlântica primária (Brasil-ICMBIO, 2007). Com uma população estimada em 82 indivíduos (Cunha et al., 2009), o PARNA da Serra dos Órgãos (PARNASO) abrange uma área de 20,030 ha e se localiza entre os municípios de Petrópolis, Teresópolis, Guapimirim e Magé (22°23'28"-22°35'02"S, 42°58'54"-43°10'47"O), com altitudes que variam de 300 a 2,263 m (Castro,

2008). O PARNASO é considerado uma das seis áreas prioritárias para a conservação da espécie devido à sua posição central no Mosaico Central Fluminense (Jerusalinsky et al., 2011).

Os primatas neotropicais são mamíferos arborícolas (Heymann, 1998), cujos eventos de uso do chão têm sido relacionados, principalmente, a contextos de fragmentação do habitat e exploração de recursos específicos (Schön-Ybarra, 1984; Fragaszy, 1986; Mendes, 1989; Bicca-Marques e Calegaro-Marques, 1995; Almeida-Silva et al., 2005; Defler, 2009; Haugaasen e Peres, 2009; Spagnoletti et al., 2011; Link et al., 2011; Barnett et al., 2012). Mourthé et al. (2007) propõem que a perturbação do habitat e a presença de pesquisadores parecem facilitar o uso do chão por muriquis-do-norte habituados na Reserva Particular do Patrimônio Natural Feliciano Miguel Abdala em Caratinga (MG), enquanto Tabacow et al. (2009) sugerem que o comportamento desta população representa uma expansão de nicho em um habitat fragmentado, onde as oportunidades de dispersão são limitadas, facilitada por uma difusão da tradição entre os indivíduos. Ao redescobrirem o muriqui no PARNASO, Garcia e Andrade Filho (2002) relataram um "comportamento de enfrentamento" dos animais à presença dos pesquisadores, o que corrobora a ideia de que os primatas não estavam habituados a encontros com seres humanos nesta área altamente conservada (Castro, 2008). Garcia e Andrade Filho (2002) também relatam a observação de muriquis correndo pelo chão antes de entrarem em um mosaico arbustivo de altura baixa na região do Dedo de Deus a 2,000 m de altitude (relato que amplia o limite altitudinal da espécie em 200 m; limite proposto anteriormente por Aguirre, 1971: 1,800 m). Recentemente, Dias et al. (2012) adicionaram dois relatos de uso do chão por muriquis na região do Rancho Frio no PARNASO a 1,600 m de altitude.

Em setembro de 2012 um grupo de escaladores registrou um muriqui no chão em uma formação rochosa na região do Dedo de Deus a cerca de 1,650 m de altitude (Fig. 1). O indivíduo, que estava acompanhado por sete muriquis que permaneceram em árvores próximas, passou cerca de duas horas se alimentando de vegetação no chão. Esta observação corrobora relatos anteriores quanto ao uso do chão pelos muriquis desta área do PARNASO. Segundo Dias et al. (2012), a ocorrência deste comportamento em muriquis-do-sul pode estar relacionada a uma necessidade frequente destes macacos de atravessarem as áreas abertas com afloramentos rochosos e campos de altitude características desta região montanhosa (Castro, 2008). A aplicação de modernas técnicas de radiotelemetria em estudos de monitoramento do muriqui-do-sul em ambientes montanhosos possui grande potencial para testar esta hipótese e fornecer subsídios para estratégias e ações de conservação da espécie.

Figura 1. Muriqui-do-sul alimentando-se no chão na região do Dedo de Deus - PARNASO. Foto: Roberto Thomé.

Agradecimentos

Especiais agradecimentos ao Instituto Chico Mendes de Conservação da Biodiversidade (ICMBIO) e ao Parque Nacional Serra dos Órgãos (PARNASO) pelo apoio e amparo à pesquisa, aos funcionários do PARNASO, principalmente aos analistas ambientais (Leandro Goulart, Cecilia Cronemberger de Faria, Raquel Batista Junger) por não medirem esforços para nos apoiar com as pesquisas. Ao Clube de Montanhistas Brasileiro (CEB) e aos montanhistas Roberto Thomé e Adilson Peçanha que gentilmente cederam as fotos e os dados. À Conservation International (CI) pela constante cooperação no programa de reprodução de primatas do Neotrópico e conservação da biodiversidade brasileira. Ao Centro de Primatologia do Rio de Janeiro (CPRJ-INEA) e ao Instituto Estadual do Ambiente (INEA) pela parceria e apoio nas pesquisas com o muriqui. Ao Dr. Fabiano Melo pela parceria e revisão desse trabalho.

Paula Breves, Sociedade Ecoatlantica, Humaitá, RJ, Brasil, E-mail: <paula@ecoatlantica.org.br>, **Austem Stravs Andrade Dias**, Centro Universitário Serra dos Órgãos – UNIFESO, Teresópolis, RJ, Brasil, **Alcides Pissinatti**, Centro de Primatologia do Rio de Janeiro - INEA, Guapimirim, Brasil, E-mail: <pissinatticprj@globo.com>, **Jean Philippe Boubli**, University of Salford, Salford M5 4WT, UK, E-mail: <j.p.boubli@salford.ac.uk>.

Referências

Aguirre, A. C. 1971. O mono *Brachyteles arachnoides* (E. Geoffroy). Situação atual da espécie no Brasil. Academia Brasileira de Ciências, Rio de Janeiro. 53pp.

Almeida-Silva, B., Guedes, P. G., Boubli, J. P. e Strier, K. B. 2005. Deslocamento terrestre e o comportamento de beber em um grupo de barbados (*Alouatta guariba clamitans*) em Minas Gerais, Brasil. *Neotrop. Primates* 13: 1–3.

Barnett, A. A., Boyle, S. A., Norconk, M. A., Palminteri, S., Santos, R. R., Veiga, L. M., Alvim, T. H. G., Bowler, M.,

Chism, J., Di Fiore, A., Fernandez-Duque, E., Guimarães, A. C. P., Harrison-Levine, A., Haugaasen, T., Lehman, S., MacKinnon, K. C., Melo, F. R., Moreira , L. S., Moura, V. S., Pinto, L. P., Port-Carvalho, M., Setz, E. Z. F., Shaffer, C., Silva , L. R. , Silva , R. F. S. , Silva, S. S. B. , Thompson, C. L., Vieira, T. M., Vreedzaam, A., Walker-Pacheco, S. E., Spironello,W. R., MacLarnon, A. e Ferrari, S. F. 2012. Terrestrial activity in Pitheciins (*Cacajao*, *Chiropotes* and *Pithecia*). *Am. J. Primatol.* 74: 1106–1127.

Bicca-Marques, J. C. e Calegaro-Marques, C. 1995. Locomotion of black howlers in a habitat with discontinuous canopy. *Folia Primatol*. 64: 55–61.

Brasil-IBAMA. 2008. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Brasília. Website: http://www.ibama.gov.br/documentos/lista-de-especies-ameacadas-de-extincao. Acessada em 18 de novembro de 2012.

Brasil-ICMBIO. 2007. Instituto Chico Mendes de Conservação da Biodiversidade: Natureza local. Website: http://www.icmbio.gov.br/parnaso. Acessada em 19 de novembro de 2012.

Breves, P., Porto, M., Chame, M. e Pissinatti, A. 2009. Ocorrência histórica de *Brachyteles arachnoides* (E. Geoffroy, 1806) (Primatas: Atelidae) no Estado do Rio de Janeiro. Em: *XIII Congresso Brasileiro de Primatologia*. Sociedade Brasileira de Primatologia, Blumenau.

Castro, E. B. V. 2008. *Plano de Manejo do Parque Nacional da Serra dos Órgãos*, ICMBIO, Teresópolis.

Cunha, A. A., Grelle, C. E. V. e Boubli, J. P. 2009. Distribution, population size and conservation of muriquis, *Brachyteles arachnoides* in Rio de Janeiro State, Brazil. *Oryx* 43: 254–257.

Defler, T. 2009. Some evolutionary tendencies of Neotropical primates. *Acta Biol. Colombiana* 14: 399–414.

Dias, A. S. A., Moura, R. C., Pereira, F. A., Cronemberger, C., Breves, P. e Boubli, J. P. 2012. Relato de caso: uso de solo por *Brachyteles arachnoides*, E. Geoffroy, 1806. Em: *6º Congresso Brasileiro de Mastozoologia*. Sociedade Brasileira de Mastozoologia, Corumbá.

Fragaszy, D. M. 1986. Time budgets and foraging behavior in wedge-capped capuchins (*Cebus olivaceus*): age and sex differences. Em: *Current Perspectives in Primate Social Dynamics*, D. M. Taub e F. A. King (eds.), pp. 159–174. Van Nostrand, New York.

Garcia, V. L. A. 2005. Status of the muriqui (*Brachyteles*) populations remaining in the state of Rio de Janeiro, Brazil: Projeto Muriqui-Rio. *Neotrop. Primates* 13 (suppl.): 73–78.

Garcia, V. L. A. e Andrade Filho, J. M. 2002. Muriquis no Parque Nacional da Serra dos Órgãos. *Neotrop. Primates* 10: 97.

Haugaasen, T. e Peres, C. A. 2009. Interspecific primate associations in Amazonian flooded and unflooded forests. *Primates* 50: 239–251.

Heymann, E. W. 1998. Giant fossil New World primates: arboreal or terrestrial. *J. Hum. Evol.* 34: 99–101.

IUCN. 2008. IUCN Red List of Threatened Species. Website: http://www.redlist.org/. Acessada em 13 de novembro de 2012.

Jerusalinsky, L., Talebi, M. e Mello, F. R. (Orgs.) 2011. *Plano de Ação Nacional para a Conservação dos Muriquis*. ICMBIO, Brasília.

Link, A., Galvis, N., Fleming, E. e Di Fiore, A. 2011. Patterns of mineral lick visitation by spider monkeys and howler monkeys in Amazonia: are licks perceived as risky areas? *Am. J. Primatol.* 73: 386–396.

Mendes, S. L. 1989. Estudo ecológico de *Alouatta fusca* (Primates: Cebidae) na Estação Biológica de Caratinga, MG. *Rev. Nordest. Biol*. 6: 71–104.

Mourthé, I. M. C., Guedes, D., Fidelis, J., Boubli, J. P., Mendes S. L. e Strier, K. B. 2007. Ground use by northern muriquis (*Brachyteles hypoxanthus*). *Am. J. Primatol*. 69: 706–712.

Nishimura, A., Fonseca, G. A. B., Mittermeier, R. A., Young, A. L., Strier, K. B. e Valle, C. M. C. 1988. The muriqui, genus *Brachyteles*. Em: *Ecology and Behavior of Neotropical Primates – vol. 2*, R. A. Mittermeier, A. B. Rylands, A. F. Coimbra-Filho e G. A. B. Fonseca (eds.), pp. 557–610. World Wildlife Fund-US, Washington, DC.

Schön-Ybarra, M. A. 1984. Locomotion and postures of red howlers in a deciduous forest-savanna interface. *Am. J. Phys. Anthropol*. 63: 65–76.

Spagnoletti, N., Visalberghi, E., Ottoni, E. B., Izar, P. e Visalberghi, E. 2011. Stone tool use by adult wild bearded capuchin monkey (*Cebus libidinosus*): frequency, efficiency and tool selectivity. *J. Hum. Evol.* 61: 97–107.

Tabacow, F. P., Mendes, S. L. e Strier , K. B. 2009. Spread of a terrestrial tradition in an arboreal primate. *Am. Anthropol*. 111: 238–249.

ARTIFICIAL INSEMINATION IN COMMON MARMOSETS USING SPERM COLLECTED BY PENILE VIBRATORY STIMULATION

Hidetoshi Ishibashi
Hideyuki H. Motohashi

Introduction

Many New World primate species are endangered in the wild by habitat destruction and hunting. Captive breeding programs are needed urgently to help rescue such species, as an adjunct to habitat conservation. Unfortunately, primates may not breed well in captivity, and assisted breeding techniques, such as artificial insemination (AI), are needed to increase the number of individuals and facilitate their effective genetic management. AI offers the potential to exchange genetic material between colonies without the risk of disease transmission or injury inherent in moving animals. Although AI has been used in domestic animals for many years, attempts to transfer this technique to primates have met with limited success (reviewed in Wolf, 2009).

Among members of the Callitrichidae, the common marmoset (*Callithrix jacchus*) has been an important model

species in reproductive research (Hearn, 1986; Dukelow, 1993). Several approaches for marmoset sperm collection have been reported, as outlined below. Epididymal sperm can be collected from surgically dissected epididymis (Morrell *et al.*, 1997). This approach is invasive and not repeatable. It is, therefore, a last resort when other methods cannot be used. Rectal probe electro-ejaculation has been extensively used in larger Old World species (Schaffer *et al.*, 1989), but not widely used in marmosets since it is invasive and therefore requires anesthesia that may depress the neural responsiveness. The third approach, vaginal washing after natural copulation (Morrell *et al.*, 1998), requires intensive observation and suffers from contamination with mucus from the female genital tract. The forth approach, penile vibratory stimulation (PVS) has been described as a repeatable noninvasive method of sampling enhanced quality of semen (Schneiders *et al.*, 2004). However marmoset offspring has not been produced by AI with sperm collected by PVS, and it is this approach we follow in this study.

Methods

Animals

We used common marmoset monkeys as subjects. Animal experiments were approved by the ethics committee for primate research of the National Center of Neurology and Psychiatry, Japan, and conducted in accordance with the institutional guidelines. The marmosets were caged indoors, with light on from 0700 to 1900 hours, temperature at 26 to 28 degree Celsius and humidity at 40 to 60%. The marmosets were fed monkey chow (CMS-1M, Clea Japan Inc.) at 50 gr per day, with a vitamin supplement, and fruit. Water was available ad libitum. Blood samples (0.1 mL) were taken from the femoral vein and plasma progesterone concentrations were determined using an enzyme immunoassay (AIA-360, Tosoh Corp.). The day of ovulation (Day 0) was taken as the day preceding that in which the progesterone concentration had risen from basal levels to higher than 10 ng/mL (Harlow *et al.*, 1983).

Artificial insemination

We artificially inseminated two female marmosets, once for each animal, on Day 0. On the day of artificial insemination, we collected semen by vibratory stimulation of the penis as described previously (Kuederling *et al.*, 2000) with minor modification as follows. Unsedated male marmoset was placed on a holding apparatus (CL-4532, Clea Japan Inc.) and its stand in a dimly-lighted room. Prior to and after semen collection, animals were given an edible reward. As a vibrator, we used an electric toothbrush with a frequency of 117 Hz (DB-3, Minimum Corp.) or 100 Hz (Clinica, Lion Corporation), fitted with a 5.5 or 6.5 mm o.d. silicone tube. The ejaculated semen was collected into a tube containing 200 microliter of sperm washing medium (1012, SAGE In-Vitro Fertilization, Inc.) in the first case, or a tube containing 50 microliter of test yolk buffer (90128, IS Japan Co., Ltd.) in the second case, and was suspended by gentle pipetting. The sperm was checked for motility and was purified in the first case: the suspension was centrifuged at 500 g for 5 minutes and pellet was subjected to swim-up purification. A female was sedated with an intramuscular administration of the mixture of 70 microgram of midazolam and 14 microgram of butorphanol tartrate per kilogram of body weight and anesthesia was maintained by inhalation of isoflurane or sevoflurane. The animal was placed, dorsally recumbent, on the holding apparatus with the pelvis slightly raised. An 8 cm long sterile catheter (NM-AIH10, Nipro) was attached to a 1 mL syringe, inserted into the vagina and the sperm suspension injected.

Results

We have performed artificial insemination twice and obtained normal delivery in both cases. A lineage of marmosets described in this study is shown in Fig. 1. A male marmoset Nukky was subjected to PVS and collected semen was purified and used for AI to a female marmoset Sunny, who conceived and delivered twin babies within the normal gestation period (Day 143). The offspring, Johnny and Jenny, were morphologically normal, raised by their mother, and developed normally (Fig. 2). To examine the sexual capacity of AI offspring, Johnny was subjected to PVS after the sexual maturation. Collected semen was used for AI. The inseminated female, Ayataka, conceived and delivered twin babies within the normal gestation period (Day 148). The offspring, Suzume and Tsubame, were morphologically normal, raised by their mother, and developed normally (Fig. 2).

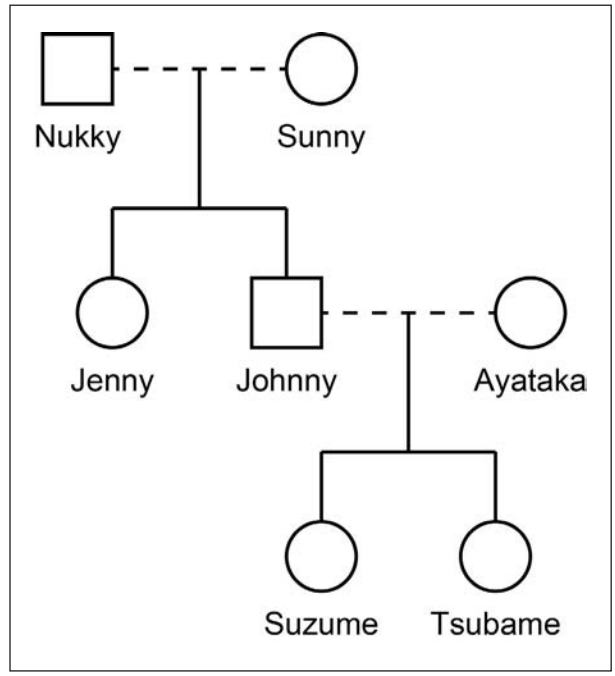

Figure 1. Lineage of marmosets used in this study. Square: male. Circle: female. Dotted line: artificial insemination.

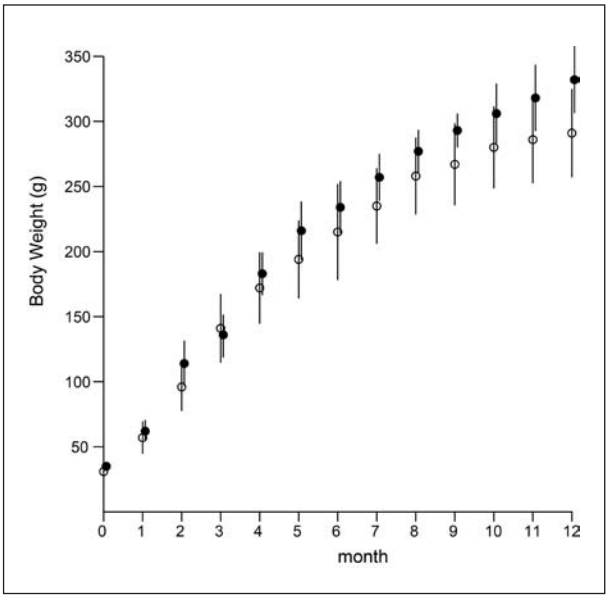

Figure 2. Body weight of offspring born after artificial insemination. Open symbols: average of the institute. Filled symbols: average of AI offspring. Error bar denotes standard deviation.

A female marmoset Jenny, born by AI, has been a subject of embryo collection study, and offers normal embryos repeatedly (results will be described elsewhere). Other two offspring, Suzume and Tsubame, have not reached sexual maturity as of manuscript preparation and thus their fertility has not been confirmed.

Discussion

In this study we have shown, for the first time, the production of primate offspring by AI with sperm collected by PVS. Since conceptions occurred, the viability and fertilizing capacity of the sperm were not adversely affected by the preparation procedure. AI offspring developed normally, and have sexual capacity. Therefore we conclude that AI can be successfully performed with PVS sperm. It is, at present, not clear whether this technique is applicable to wide range of primate species, since seminal fluidity varies among primate species. It is correlated with the mating system of the species: coagulation rating is high in those genera where females mate with multiple partners and low in genera where females are monogamous (Dixson and Anderson, 2002). Chimpanzee and macaque monkeys, characterized by multimale-multifemale social system, show high coagulation ratings. Meanwhile, monogamy is the modal social grouping of any callitrichid taxon (Anzenberger and Falk, 2012). Thus, although the physical characteristics of the other members of the family Callitrichidae are not well-known, it is expected to be rather common among family members. This technique is simple and all instruments except hormone measurement apparatus are easily available. Semen collection by PVS required only one male unlike vaginal washing which requires a pair of animals. Although the subjects in this study are captive common marmosets, the simple features of the technique, i.e., simple procedure, relatively affordable apparatus, and least number of animals, are likely to apply to the breeding of endangered animals belonging to the family Callitrichidae.

References

Anzenberger, G. and Falk, B. 2012. Monogamy and family life in callitrichid monkeys: deviations, social dynamics and captive management. *Int. Zoo Yb.* 46: 109–122.

Dixson, A. L. and Anderson, M. J. 2002. Sexual selection, seminal coagulation and copulatory plug formation in primates. *Folia Primatol.* 73: 63–69.

Dukelow, R. W. 1993. Assisted reproduction in New World primates. In: *In Vitro Fertilization and Embryo Transfer in Primates*. D. P. Wolf, R. L. Stouffer and R. M. Brenner (eds.) pp.73–84. Springer-Verlag, New York.

Harlow, C. R., Gems, S., Hodges, J. K. and Hearn, J. P. 1983. The relationship between plasma progesterone and the timing of ovulation and early embryonic development in the marmoset monkey (*Callithrix jacchus*). *J. Zool. Lond.* 201: 273–282.

Hearn, J. P. 1986. The embryo-maternal dialogue during early pregnancy in primates. *J. Reprod. Fertil.* 76: 809–819.

Kuederling, I., Schneiders, A., Sønksen, J., Nayudu, P. L. and Hodges, J. K. 2000. Non-invasive collection of ejaculates from the common marmoset (*Callithrix jacchus*) using penile vibrostimulation. *Am. J. Primatol.* 52: 149–154.

Leutenegger, W. 1980. Monogamy in callitrichids: A consequence of phyletic dwarfism? *Int. J. Primatol.* 1: 95–98.

Morrell, J. M., Nowshari, M., Rosenbusch, J., Nayudu, P. L. and Hodges, J. K. 1997. Birth of offspring following artificial insemination in the common marmoset, *Callithrix jacchus*. *Am. J. Primatol.* 41: 37–43.

Morrell, J. M., Nubbemeyer, R., Heistermann, M., Rosenbusch, J., Küderling, I., Holt, W. and Hodges, J. K. 1998. Artificial insemination in *Callithrix jacchus* using fresh or cryopreserved sperm. *Anim. Reprod. Sci.* 52: 165–174.

Schaffer, N., Cranfield, M., Meehan, T. and Kempske, S. 1989. Semen collection and analysis in the conservation of endangered nonhuman primates. *Zoo Biol. Supple.* 1: 47–60.

Schneiders, A., Sonksen, J. and Hodges, J. K. 2004. Penile vibratory stimulation in the marmoset monkey: a practical alternative to electro-ejaculation, yielding ejaculates of enhanced quality. *J. Med. Primatol.* 33: 98–104.

Wolf, D. P. 2009. Artificial insemination and the assisted reproductive technologies in non-human primates. *Theriogenology* 71: 123–129.

Hidetoshi Ishibashi1 and **Hideyuki H. Motohashi1**, Department of Neurophysiology, National Institute of Neuroscience, NCNP, Japan, 4-1-1 Ogawa-Higashi, Kodaira, Tokyo 187-8502, Japan. E--mail: <ishiba@ncnp.go.jp>

AGONISTIC COMPETITION FOR FRUIT AMONG MEMBERS OF A TITI MONKEY (*CALLICEBUS COIMBRAI*) GROUP DURING A SEVERE DROUGHT

Fernanda B.A. Correia
Sirley A.A. Baião
Stephen F. Ferrari

Titi monkeys (*Callicebus* spp.) rarely exhibit overtly agonistic behavior except in the context of intergroup encounters, possibly because social groups are almost invariably composed of a breeding pair and their immature offspring (Bicca-Marques and Heymann, 2013). Long-term data on *Callicebus coimbrai* from two sites in the Brazilian state of Sergipe indicate that the species is primarily frugivorous-folivorous (Souza-Alves et al., 2011; Santana, 2011), but that the composition of the diet fluctuates considerably between seasons and among years. During 2012, the long-term drought affecting northeastern Brazil appeared to have a marked effect on the diet of one study group, at the Fazenda Trapsa, in the municipality of Itaporanga d'Ajuda (11°12'S, 37°14'W), which became increasingly folivorous in comparison with previous years (Souza-Alves, 2013). The present study describes social interactions observed in the group during a three-day period in January 2013 (January 2nd-4th). The group consisted of an adult male, an adult female, and a juvenile male, all presumed to be siblings, based on the long-term monitoring of the group (Souza-Alves and Ferrari, 2012). For the present report, data on social interactions were collected by behavioral sampling (cf. Martin and Bateson, 1993) during the monitoring of the group for the collection of feeding tree focal samples, as part of an ongoing study of seed dispersal (see Baião, 2013). During all-day follows, all events of significant social interactions (affiliative and agonistic) were recorded, with detailed data taken on the individuals involved, and the sequence and timing of events.

Results

During the study period, the group members fed mainly on leaves which was typical of the group's diet during the same period (mid-dry season) in previous years (Souza-Alves et al., 2011). Unlike previous years, however, the consumption of fruit was observed very rarely, on only three occasions during the three days of monitoring. On all three of these occasions, the group member feeding on the fruit was approached and displaced agonistically by a second group member, which obtained and ingested the fruit. On January 2nd, at approximately 09:00 h, the adult male dropped a partially-eaten *Passiflora contracta* (Passifloraceae) fruit, which the juvenile retrieved from the ground. As the juvenile began to feed on a branch at a height of 2 m, the female approached immediately from a distance of 1m and displaced the juvenile, pushing him away approximately 0.5 m with both hands while taking the fruit, which she ingested. No vocalizations were emitted by either individual during this sequence of events.

Fruit feeding was next observed on the third day of monitoring, January 4th. On the first occasion, during fruit feeding in a *Xylopia frutescens* (Annonaceae) tree at around 08:30h, the adult male vocalized aggressively and grimaced, displaying his teeth, as he approached the female and displaced her without physical contact to gain access to an unripe fruit. The female lost her balance and almost fell as the male approached, and then she moved away approximately 5 m to an adjacent tree crown. At 10:20 h, the group visited a second fruiting tree of an unidentified species, known locally as “pau coceira", a small drupe, where the juvenile was feeding on a fruit. The adult male leapt silently onto the branch on which the juvenile was sitting and approached him rapidly and surreptitiously, making physical contact and pushing him away with his hands, although it is not clear whether the adult actually bit the juvenile. The juvenile squealed loudly when displaced and continued vocalizing in apparent distress as it moved immediately to the adjacent tree crown.

During the same three-day period, the study group visited 10 trees to feed on leaves, but on none of these occasions was any agonistic behavior observed. This suggests clearly that the agonistic behavior was motivated primarily by the perceived nutritional value of the food item. The local field assistant, Adriano Rodrigues, reported that the adult male repeatedly displaced the juvenile during visits to fruiting trees in November 2012, although similar behavior was not observed during December, which was marked by a birth and atypical behavior patterns (see Correia et al., 2013). Overall, then, while the number of events was small, the adult male appeared to be the dominant member of the group, and the juvenile, the most subordinate.

Discussion

With a few exceptions (see e.g., Cäsar et al., 2008), agonistic behavior in titi monkeys (including *C. coimbrai*) is generally limited to intergroup encounters or interactions between same-sex adults in the context of dispersal from the natal group (Fernandez-Duque et al., 2000; Bicca-Marques and Heymann, 2013). The present study group is unusual for a number of reasons, however, including the fact that all the members were probably siblings, rather than parents and their offspring (the female and juvenile were born into the study group to the same parents, and the adult male was present as a nonbreeding member when monitoring began). The group had been monitored more or less continuously since the second half of 2009, and a large body of data has been collected on the composition of its diet (Souza-Alves *et al.*, 2011; Souza-Alves, 2013). While fruit is a major component, its contribution may decline considerably during some dry season months. 2012 represents the second of two consecutive La Niña years, during which

severe droughts were recorded in northeastern Brazil and appeared to greatly reduce the availability of fruit at the study site, both in general, and during the dry season, in particular. Disputes for access to food items were never observed during the first two years of monitoring, when the composition of the group was more typical, i.e., a breeding pair and their offspring. While the sum of the evidence indicates that resource scarcity during an atypical dry season was a primary factor determining the observed agonistic encounters, it remains unclear whether and to what extent the composition of the group may have contributed.

Acknowledgments

We are grateful to Sr. Ary Ferreira for authorizing fieldwork on his property at Fazenda Trapsa, Adriano Rodrigues ("Xinxinho") for field assistance, and João Pedro Souza-Alves for his valuable input. Fieldwork at the site has been supported by CNPq, FAPITEC-SE, and CAPES. We would also like to thank Jessica Lynch Alfaro for her helpful comments on the original draft of the manuscript.

Fernanda B. A. Correia, Sirley A. A. Baião, Graduate Program in Development and Environment – PRODEMA, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, Rosa Elze, 49.100-000 São Cristóvão–SE, Brazil. E-mail: <fernanda_aragao@yahoo.com.br>, and **Stephen F. Ferrari,** Department of Ecology, Universidade Federal de Sergipe, São Cristóvão–SE, Brazil.

References

Baião, S. A. A. 2013. Macaco guigó (*Callicebus coimbrai*): dispersão de sementes e conhecimento ecológico na Mata Atlântica de Sergipe. MSc thesis, Universidade Federal de Sergipe, São Cristovão, Brazil.

Bicca-Marques, J. C. and Heymann, E. W. 2013. Ecology and behavior of titi monkeys (genus *Callicebus*). In: *Evolutionary Biology and Conservation of Titis, Sakis, and Uacaris*, L.M. Veiga, A.A. Barnett, S.F. Ferrari and M.A.Norconk (eds.), pp. 196–207. Cambridge University Press, Cambridge.

Cäsar, C., Franco, E. S., Soares, G. C. N. and Young, R. J. 2008. Observed case of maternal infanticide in a wild group of black-fronted titi monkeys (*Callicebus nigrifrons*). *Primates* 49: 143–145.

Correia, F. B. A., Baião, S. A. A. and Ferarri, S. F. 2013. Dysfunctional parenting behavior in a male titi (*Callicebus coimbrai)*. II Congresso Latino Americano de Primatologia/XV Congresso Brasileiro de Primatologia, Recife, Brazil.

Fernandez-Duque, E., Valeggia, C. R. and Mason, W. A. 2000 Effects of pair-bond and social context on male–female interactions in captive titi monkeys (*Callicebus moloch*, Primates: Cebidae). *Ethology* 106: 1067–1082.

Martin, P. and Bateson, P. 1993 *Measuring Behavior: an Introductory Guide*. Cambridge University Press, Cambridge.

Santana, M. M. 2012. Comportamento, dieta e uso de espaço em um grupo de guigó-de-Coimbra (*Callicebus coimbrai* Kobayashi &Langguth, 1999) no RVS Mata do Junco, Capela-SE. MSc thesis, Universidade Federal de Sergipe, São Cristóvão, Brazil.

Souza-Alves, J. P. 2013. Ecology and life-history of Coimbra-Filho's titi monkeys (*Callicebus coimbrai*) in the Brazilian Atlantic Forest. Doctoral dissertation, Universidade Federal da Paraíba, João Pessoa, Brazil.

Souza-Alves, J. P., Fontes, I. P., Chagas, R. R. D. and Ferrari, S. F. 2011. Seasonal versatility in the feeding ecology of a group of titis (*Callicebus coimbrai*) in the northern Brazilian Atlantic Forest. *Am. J. Primatol.* 73: 1199–1209.

Souza-Alves, J. P. and Ferrari, S. F. 2012. Unwanted homecoming: an adult male titi (*Callicebus coimbrai*) returns to its natal group. XXIV Congress of the International Primatological Society, Cancún, Mexico.

EXTRAGROUP COPULATION IN A SMALL AND ISOLATED *ALOUATTA GUARIBA CLAMITANS* POPULATION

Elisa Brod Decker
Júlio César Bicca-Marques

Copulation solicitation and promiscuity appear to characterize female mating behavior in all atelid genera so far studied (no data is available for *Oreonax*; Di Fiore et al., 2011). Extragroup copulations (EGCs), on the other hand, have been reported only in *Brachyteles* (Strier, 1997) and *Alouatta* (Kowalewski and Garber, 2010). In the latter, EGCs have been described in five taxa (*A. arctoidea*, Agoramoorthy and Hsu, 2000; *A. caraya*, Kowalewski and Garber, 2010; *A. guariba clamitans*, Fialho and Setz, 2007; Lopes and Bicca-Marques, 2011; *A. palliata*, Glander, 1992; *A. pigra*, Van Belle et al., 2009).

Here we report an EGC in a brown howler monkey (*Alouatta guariba clamitans*) population studied from February to August 2012 in a 10-ha fragment of semideciduous Atlantic forest (30°49'25.53"S, 51°47'59.87"W; *ca.* 75-115 m a.s.l.), Camaquã, state of Rio Grande do Sul, Brazil, near the southern limit of the species' distribution. This fragment is immersed in a matrix of crops and pastures and is about 3.5 km distant from the nearest forest potentially inhabited by howler monkeys (information from local inhabitants). This is the third report of EGC in this taxon.

Results

Three howler groups (G1 and G3=5 individuals each, G2=3 individuals) live in the fragment. In February 2012 G1 was composed of two adult males (Barba Ruiva and Damasco), two adult females (Jane and Gorda), and one juvenile male (Dionivá), whereas G3 was composed of one adult male (Morfeu), two adult females (Caraya and

Adela), one juvenile male (Feli), and one juvenile female (Amanda). An infant was born in each group during the study (G2 in April, and G1 and G3 in July), but those of G1 (mother: Jane) and G2 disappeared one month after birth due to unknown causes. The G3 infant (Bini; mother, Adela) was alive at the end of the research, increasing group size to six individuals. Each study group was followed from dawn to dusk during 4-5 days per month (27 days of data collection per group or a total sampling effort of 81 days). There is no data on the degree of relatedness within and between groups. However, aimed at its small size and spatial isolation it is likely that the study population shows a level of inbreeding higher than that found in larger populations.

A total of 19 intergroup encounters between G1 and G3 were observed during the study (February and June, n=5 each; March, April, and July/August, n=3 each). Most of them (n=18 or 95%) occurred at important food trees (*Ficus cestrifolia*, *Ficus luschnathiana* or *Schefflera morototoni*). During these encounters G1 often left the area before G3 (16 out of 18 cases or 89%; it was not possible to identify which group left first in one encounter), although each group arrived first at similar frequencies (G1: n=11 or 58%; G3: n=8 or 42%). Only in the last encounter occurred the EGC between a G1 adult female and the G3 adult male reported here. Intergroup encounters between G1 and G2 were more frequent (n=33), but none EGC was recorded. Intragroup copulations were recorded only twice during the study, once in February (G3, Morfeu and Adela) and another in May (G1, Barba Ruiva and Gorda).

Nine agonistic interactions were observed during the encounters between G1 and G3 (a rate of almost one interaction every two encounters). Most of them (n=7) involved the G3 adult male (Morfeu) chasing both G1 adult males (Barba Ruiva and Damasco). In one situation the G1 male Damasco chased a G3 adult female whose identity could not be determined. The last intergroup agonistic interaction involved both G3 females (Adela and Caraya) chasing the G1 female Jane after her EGC with Morfeu (described below).

On 2 August 2012 G1 arrived first in a fig (*Ficus cestrifolia*) tree frequently used by G3 as a food source and sleeping site (the exact time of arrival is unknown because EBD was following G3).

12:30 - G3 begins moving in the direction of the fig tree.

12:55 - All G1 individuals are resting when G3 members probably see the intruding group. G3 individuals stop moving and start to rest in another fig (*Ficus luschnathiana*) tree in front of the *F. cestrifolia* tree where G1 continues resting. Morfeu, Caraya, and a juvenile (probably Amanda) stay about 4 m from G1, whereas Adela (carrying the infant in her belly) and the other juvenile (probably Feli) are further away (2 m from their group mates).

13:20 - Morfeu moves 2 m to a place closer to G1 than the other G3 members.

13:45 - G1 members are feeding on leaves from both (*F. cestrifolia* and *F. luschnathiana*) fig trees. Morfeu, Adela (carrying the infant), and both juveniles move about 2 m toward them and they retreat about 3 m.

13:50 - Morfeu starts barking. He barks for about 4 minutes.

13:55 - G1 adult female Jane moves to the *F. cestrifolia* tree where Morfeu is barking and they copulate in a dorso-ventral posture for about 4 minutes. The other G3 members witness the EGC and the G1 members (at least some of them) may also have witnessed it. Soon after mating Jane is chased by the G3 adult females, Adela and Caraya, and runs toward her group members. Morfeu, on the other hand, rubs his chin in a trunk of the tree where they mated and starts barking.

14:10 - Morfeu is piloerected and starts howling. Adela, by his side, joins him a few seconds later. They howl for 5 minutes.

14:16 - Caraya joins the chorus and they howl until 14:30.

14:33 - G1 is about 7 m distant from G3 and starts moving in its direction.

14:36 - Morfeu chases Barba Ruiva, Damasco and an adult female running and the G1 group leaves the area.

15:00 - G3 group members feed on ripe fruit from a morototo (*Schefflera morototonii*) tree distant about 20 m from the encounter area and 15 m from the tree where the EGC took place.

Discussion

In sum, the EGC between Jane and Morfeu followed the pattern observed in previous studies, in which a female either took the initiative of leaving her group or moved with a male during intergroup encounters to a place outside the view of their respective group members to mate (for a review see Van Belle and Bicca-Marques, in press). Nevertheless, unlike Lopes and Bicca-Marques (2011), Jane was chased by the adult females of Morfeu's group. Within-group promiscuity and EGCs have been related to a female strategy of increasing paternity confusion to decrease the risk of infanticide following rank reversals or group takeovers, increasing the genetic diversity and quality of offspring, lowering the risk of male infertility or promoting sperm competition (see Van Belle and Bicca-Marques, in press). However, considering that female promiscuity probably is a primitive atelid trait and that howler monkeys tend to live in smaller groups (with less adult males) than the atelines (Di Fiore et al., 2011), it is also possible that *Alouatta* females seek EGCs to avoid within-group mating with kin males without incurring the

risks of leaving their groups. Data on individual relatedness are needed to test this hypothesis.

Acknowledgements

We thank Profa. Ana Biondi, head of the Escola Municipal de Ensino Fundamental Chequer Buchaim – Unidade Agropecuária, and the biologist Amanda Piper Grupelli for her help in the field. This study was approved by the Scientific Committee of the Faculdade de Biociências/Pontifícia Universidade Católica do Rio Grande do Sul (#033/11). EBD was supported by a CAPES Masters Scholarship and JCBM by a CNPq PQ-1D grant (# 303154/2009-8).

Elisa Brod Decker and **Júlio César Bicca-Marques**, Laboratório de Primatologia Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS 90619-900, Brasil. E-mails: elisabroddecker@gmail.com and < jcbicca@pucrs.br>.

References

Agoramoorthy, G. and Hsu, M. J. 2000. Extragroup copulation among wild red howler monkeys in Venezuela. *Folia Primatol.* 71: 147–151.

Di Fiore, A., Link, A. and Campbell, C. J. 2011. The atelines: behavioral and socioecological diversity in a New World monkey radiation. In: *Primates in Perspective*, C. J. Campbell, A. Fuentes, M. C. MacKinnon, S. K. Bearder and R. M. Stumpf (eds.), pp. 155–188. Oxford University Press, New York.

Fialho, M. S. and Setz, E. Z. F. 2007. Extragroup copulations among brown howler monkeys in southern Brazil. *Neotrop. Primates* 14: 28–30.

Glander, K. E. 1992. Dispersal patterns in Costa Rican mantled howling monkeys. *Int. J. Primatol.* 13: 415–436.

Kowalewski, M. M. and Garber, P. A. 2010. Mating promiscuity and reproductive tactics in female black and gold howler monkeys (*Alouatta caraya*) inhabiting an island in the Parana river, Argentina. *Am. J. Primatol.* 72: 734–748.

Lopes, K. G. D. and Bicca-Marques, J. C. 2011. Extragroup copulations in *Alouatta guariba clamitans*. *Neotrop. Primates* 18: 52–53.

Strier, K. B. 1997. Mate preferences in wild muriqui monkeys (*Brachyteles arachnoides*): reproductive and social correlates. *Folia Primatol.* 68: 120–133.

Van Belle, S. and Bicca-Marques, J.C. In press. Insights into the reproductive strategies and sexual selection in howler monkeys. In: *Howler Monkeys: Examining the Evolution, Physiology, Behavior, Ecology and Conservation of the Most Widely Distributed Neotropical Primate*, M. M. Kowalewski, P. A. Garber, L. Cortés-Ortiz, B. Urbani and D. Youlatos (eds.). Springer, New York.

Van Belle, S., Estrada, A., Ziegler, T. E. and Strier, K. B. 2009. Sexual behavior across ovarian cycles in wild black howler monkeys (*Alouatta pigra*): male mate guarding and female mate choice. *Am. J. Primatol.* 71: 153–164.

A QUEBRA DE BARREIRAS NATURAIS POR CONEXÕES ARTIFICIAIS: O RELATO DA TRANSPOSIÇÃO DO RIO SÃO FRANCISCO POR MACACOS-PREGO NO NORDESTE DO BRASIL

Maria do Socorro da Silva
Wallace Pinto Batista
Mônica Mafra Valença-Montenegro
Amely Branquinho Martins
Sérgio Luiz Malta de Azevedo
Marcos de Souza Fialho

O uso de passagens artificiais para a fauna silvestre é amplamente promovido como uma ferramenta conservacionista que visa reduzir o isolamento de animais e populações por obstáculos artificiais, tais como estradas (Jackson e Griffin, 2000). Por outro lado, as barreiras naturais impõem limites à distribuição dos táxons (Cox e Moore, 2010), promovendo o isolamento reprodutivo de espécies parapátricas potencialmente hibridáveis, como proposto para diversos gêneros de primatas na Amazônia (Ayres e Clutton-Brock, 1992).

O rio São Francisco atua como barreira da distribuição da maioria das espécies de primatas autóctones do nordeste brasileiro. Contudo, a partir da década de 1940 diversas usinas hidroelétricas (UHEs) foram construídas ao longo de seu curso, dentre as quais se destaca o complexo de Paulo Afonso (9°23'50''S, 38°12'00''O) formado pelas UHEs de Paulo Afonso I, II, III, IV e Apolônio Sales (Moxotó) entre os estados de Alagoas e Bahia. O complexo, administrado pela Companhia Hidro Elétrica do São Francisco (CHESF) e inserido na unidade de conservação federal "Monumento Natural do Rio São Francisco", gera 4,280 MW (Fig. 1a). As estruturas construídas associadas a estas barragens incluem três pontes sobre o rio São Francisco: uma ponte de alvenaria com 20 m de comprimento e duas pontes metálicas estaiadas (suspensas por cabos) com 240 m de comprimento cada (todas possuem 4 m de largura). Essas pontes são utilizadas para o deslocamento de funcionários envolvidos na manutenção das UHEs e suas subestações entre os dois estados (Fig. 1b).

Esta pesquisa visou verificar a veracidade de relatos de funcionários da CHESF de que saguis (*Callithrix jacchus*) e macacos-prego (*Sapajus* sp.) usam as três pontes para se deslocar entre as margens do rio São Francisco. Foram realizadas entrevistas com 15 trabalhadores/moradores das proximidades das três pontes, instaladas duas armadilhas fotográficas em uma ponte metálica, as quais ficaram expostas ininterruptamente durante 3 dias em abril e 8 dias em maio de 2013, e realizadas 50 campanhas de monitoramento das pontes entre abril e agosto de 2013. Dentre os entrevistados, 12 (80%) relataram terem observado macacos-prego se deslocando por uma ponte metálica, mas nenhum mencionou a travessia das pontes

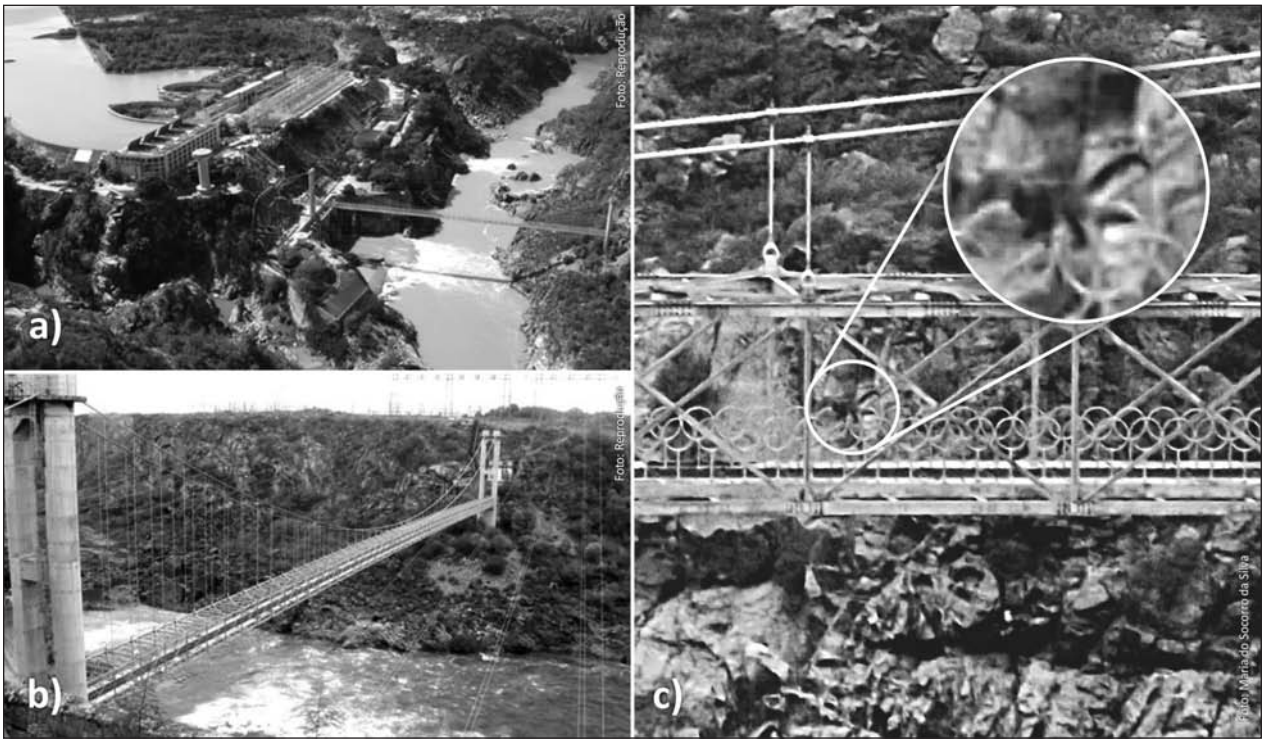

Figura 1. - a) Vista parcial de usinas do complexo Paulo Afonso, Estado da Bahia, Brasil; b) Ponte metálica estaiada utilizada pelos macacos-prego; c) Macaco-prego (*Sapajus* sp.) atravessando a ponte estaiada.

por saguis. Também não houve registro de travessia por meio das armadilhas fotográficas. Um grupo de macacos-prego (*Sapajus* sp.) composto por 18 indivíduos foi observado utilizando uma ponte metálica para se deslocar da Bahia para Alagoas por volta das 16:00 do dia 1º de agosto de 2013 (Fig. 1c). Essa ponte encontra-se a *ca.* 80 m acima do nível do rio em frente a um vertedouro de água do complexo.

Este é o primeiro relato confirmado de uso de uma ponte de longa extensão para o deslocamento de macacos-prego, os quais são conhecidos por sua elevada capacidade cognitiva e flexibilidade comportamental e ecológica (Fragaszy et al., 2004). Na região amazônica há registros de indivíduos de *Mico intermedius* e *Callicebus dubius* atravessando pontes de madeira com 15 e 30 m de extensão, respectivamente. No caso de *C. dubius*, a existência da ponte proporcionou o deslocamento dos zogue-zogues para a área de ocorrência da congenérica *C. stephennashi* (Röhe e Silva Júnior, 2009). Além de sua relevância científica, o uso destas estruturas possui importantes implicações para a concepção e implantação deste tipo de obra de infraestrutura. A possibilidade dos macacos utilizarem pontes para vencer barreiras geográficas é particularmente crítica na região amazônica, onde a construção prevista de dezenas de novas UHEs ameaçará o isolamento e a integridade das assembleias de primatas únicas de cada interflúvio. Desta forma, é urgente a necessidade de desenvolvimento de estruturas que inibam ou inviabilizem este tipo de deslocamento da fauna para garantir a integridade biológica das espécies e ecológica de suas comunidades.

Agradecimentos

Agradecemos o apoio da CHESF pelo fornecimento de informações e por permitir o acesso às dependências do complexo de UHEs de Paulo Afonso.

Maria do Socorro da Silva, **Sérgio Luiz Malta de Azevedo**, Programa de Pós-graduação em Ecologia Humana e Gestão Socioambiental, Universidade do Estado da Bahia – UNEB, R. do Bom Conselho 179, Alves de Souza, CEP: 48608-240, Paulo Afonso, BA, Brasil., **Wallace Pinto Batista**, Associação Nordesta – Reflorestamento e Educação, Rua Arlindo Rodrigues de Miranda 458, CEP: 35588-000, Cidade Nova, Arcos, MG, Brasil., **Mônica Mafra Valença-Montenegro**, **Amely Branquinho Martins**, **Marcos de Souza Fialho**, Centro Nacional de Pesquisa e Conservação de Primatas Brasileiros – CPB, Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio, Praça Antenor Navarro 5, Varadouro, CEP: 58010-480, João Pessoa, PB, Brasil, E-mail: <monica.montenegro@icmbio.gov.br>.

Referências

Ayres, J. M. e Clutton-Brock, T. H. 1992. River boundaries and species range size in Amazonian primates. *Am. Nat.* 140(3): 531–537.

Cox, C. B. e Moore, P. D. 2010. *Biogeography: an Ecological and Evolutionary Approach.* 8 ed. Wiley, Oxford.

Fragaszy, D. M.; Visalberghi, E. e Fedigan, L. M. 2004. *The Complete Capuchin: the Biology of the Genus Cebus*. Cambridge University Press, Massachusetts.

Jackson, S. D. e Griffin, C. R. 2000. A strategy for mitigating highway impacts on wildlife. In: *Wildlife and Highways: Seeking Solutions to an Ecological and Socioeconomic Dilemma*, T.A. Messmer e B. West (eds.), pp. 143–159. The Wildlife Society, Nashville.

Röhe, F. e Silva Júnior, J.S. 2009. Confirmation of *Callicebus dubius* (Pitheciidae) distribution and evidence of invasion into the geographic range of *Callicebus stephennashi*. *Neotrop. Primates* 16(2): 71–73.

OCCURRENCE OF *CALLICEBUS BERNHARDI* IN ROLIM DE MOURA, RONDÔNIA, BRAZIL

Erika Patrícia Quintino
Júlio César Bicca-Marques

In their description of the Prince Bernhard's titi monkey, *Callicebus bernhardi*, van Roosmalen et al. (2002) suggested that it might occur on the west bank of the Rio Ji-Paraná in the state of Rondônia, Brazil, based on the observation of an undetermined greyish titi monkey at the Pimenta Bueno Municipal Park in Pimenta Bueno by Ferrari et al. (1996; later identified as *C. moloch* by Ferrari et al., 2000). The presence of *C. bernhardi* in this region was confirmed by Monção et al. (2008) in Alto Alegre dos Parecis. Here we report its occurrence in forest fragments to the west of the Rio Ji-Paraná in Rolim de Moura.

Figure 1. Adult Prince Bernhard's titi monkey carrying the newborn (see the tip of its tail above the adult's left leg). Photograph by E. P. Quintino.

Social groups of Prince Bernhard's titi monkeys were sighted in the following forest fragments from January to October 2013:

- Sítio Nossa Senhora Aparecida (11°47'59.87"S, 61°47'03.19"W; *ca.* 2.3 ha) - group composed of four individuals (an adult male, an adult female, a juvenile, and an infant born in August 2013; Fig. 1). These titi monkeys were observed *ad libitum* (Altmann, 1974) feeding on fruit of *Oenocarpus distichus* and *Orbignya phalerata* (Arecaceae) and fruit and young leaves of *Inga* sp. (Fabaceae) and unidentified shrubs and lianas;

- Sítio São José (11°48'38.54"S, 61°46'31.85"W; *ca.* 2.5 ha) - group composed of, at least, five individuals;

- Sítio Nova Boa Esperança (11°48'07.52"S, 61°47'00.98"W; *ca.* 2 ha) - group composed of, at least, two individuals.

Acknowledgements

We thank the owners of the study sites, Salete Bergamin Quintino, Osvaldo Pivolio and Reinaldo Prudente Ribeiro, for the permission to visit their ranches. Mrs. Salete B. Quintino also provided logistical and financial support for this study. EPQ is supported by a Graduate (M.Sc.) fellowship from the Brazilian Higher Education Authority/CAPES and JCBM is supported by a research fellowship from the Brazilian National Research Council/CNPq (PQ 1D #303154/2009-8). This study was approved by the Scientific Committee of the Faculdade de Biociências/ Pontifícia Universidade Católica do Rio Grande do Sul (#033/11).

Erika Patrícia Quintino and Júlio César Bicca-Marques, Laboratório de Primatologia, Faculdade de Biociências, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, RS 90619-900, Brasil. E-mails: < erika_estrela@yahoo.com.br> and <jcbicca@pucrs.br>.

References

Altmann, J. 1974. Observational study of behavior: sampling methods. *Behaviour* 49: 227–267.

Ferrari, S. F., Iwanaga, S. and Silva, J. L. 1996. Platyrrhines in Pimenta Bueno, Rondônia, Brazil. *Neotrop. Primates* 4: 151–153.

Ferrari, S. F., Ivanaga, S., Messias, M. R., Ramos, E. M., Ramos, P. C. S., Cruz Neto, E. H. and Coutinho, P. E. G. 2000. Titi monkeys (*Callicebus* spp., Atelidae: Platyrrhini) in the Brazilian state of Rondônia. *Primates* 41: 229–234.

Monção, G. R., Selhorst, V. and Soares-Filho, J. A. R. 2008. Expansão da distribuição geográfica de *Callicebus bernhardi* a oeste do rio Ji-Paraná, Estado de Rondônia, Brasil. *Neotrop. Primates* 15: 67–68.

van Roosmalen, M. G. M., van Roosmalen, T. and Mittermeier, R. A. 2002. A taxonomic review of the titi monkeys, genus *Callicebus* Thomas, 1903, with the description of two new species, *Callicebus bernhardi* and *Callicebus stephennashi*, from Brazilian Amazonia. *Neotrop. Primates* 10 (suppl.): 1–52.

News

NUEVA BIBLIOTECA PRIMATOLÓGICA

La Red-Primatológica de la Asociación Primatológica Colombiana inaugura la nueva Biblioteca Primatológica (BiblioPrim), en dónde podrás acceder a cientos de artículos, libros y capítulos de libros sobre primates. La BiblioPrim cuenta actualmente con enlaces a más de 300 estudios realizados en el campo de la primatología publicados en revistas especializadas como Neotropical Primates, International Journal of Primatology, American Journal of Primatology y Primates, entre otros. Visítala en http://www.asoprimatologicacolombiana.org.

INFLUENCE OF FRUIT AVAILABILITY AND PHYSICOCHEMICAL CHARACTERISTICS OF FRUIT ON THE ECOLOGY OF PRIMATES IN A NORTHERN AMAZONIAN FOREST

On November 5th, 2012, Ítalo Mourthé defended his doctoral thesis for the Graduate Program in Ecology at Instituto Nacional de Pesquisas da Amazônia (INPA), in Manaus, Amazonas, Brazil. The thesis was on the feeding ecology and frugivory of primates at Maracá Ecological Station, a large riverine island in the Uraricuera River, state of Roraima, northern Brazil. His supervisor was Renato Cintra Soares (INPA). The study was funded by Conselho Nacional de Desenvolvimento Científico e Tecnológico, Fundação Estadual do Meio Ambiente e Recursos Hídricos de Roraima, Mohamed bin Zayed Species Conservation Fund, and Idea Wild. The following is a summary of his thesis.

The fluctuation of food resources limits plant and animal populations. Although well studied among small frugivores such as birds and rodents in temperate regions, the relationship among the fluctuation of resources, quality, and their effects on the ecology of large tropical frugivores in seasonal forests remains largely unknown. The exuberance and high diversity of tropical forests give a false idea of continuous abundance of food resources, but as seen in other environments, these forests also go through relatively long periods of shortage, imposing limitations to frugivores. Here, I investigate the effects of fruit shortage on the ecology of frugivorous primates at Maracá Ecological Station (MES), a highly seasonal forest in northern Amazonia. The main focus of the study is on the feeding ecology of an endangered primate, *Ateles belzebuth*. Surveys on primate and fruit density and frugivory were carried out concomitantly through line-transect method. Fruit samples were collected and assessed through morphological and nutritional assays. Additionally, I conducted a detailed study on the feeding ecology of a well-habituated group of *A. belzebuth*.

Fruit supply, especially for Sapotaceae, positively influenced *A. belzebuth* local density, which was concentrated in areas with high fruit density in particular, during fruit shortages. However, *Alouatta macconnelli* and *Cebus olivaceus* did not follow the same pattern. During shortage periods, spider monkeys were more likely to eat fruit with a high lipid and high ash content. Although these nutrients influenced fruit choices, a comparison of the nutritional profile of fruits consumed by spider monkeys and that of fruits available in the local plant pool indicated that nutrients were consumed according to their local availability. A natural experiment concerning pulp variation in four fruits often consumed by several frugivores in the study site, including *A. belzebuth*, showed that unusual droughts do not appear to affect the amount of pulp produced. Finally, a relatively large sampling effort is needed to reach mammal survey completeness in species-poor sites such as in the study site than required in other Amazonian sites, possibly due to the relatively large number of rare species in this assemblage. To survive periods of fruit shortage, *A. belzebuth* adopted foraging strategies of both energy maximization and time minimization. This highly frugivorous primate invests their foraging effort in areas with a high fruit supply of abundant species, and they consume high energy fruits in an opportunistic way.

Ítalo Martins da Costa Mourthé, Instituto Nacional de Pesquisas da Amazônia,Núcleo de Pesquisas de Roraima, Rua Coronel Pinto, 315, Centro, 69.301-150, Boa Vista, RR, Brazil. E-mail: <imourthe@gmail.com>

Reference

Mourthé, I. M. C. 2012. Influência das características físico-químicas e disponibilidade dos frutos na ecologia dos primatas em uma floresta no norte da Amazônia. Tese de doutorado, Instituto Nacional de Pesquisas da Amazônia, Manaus. 133 p.

DEMOGRAPHY AND LIFE HISTORY OF OWL MONKEYS (*AOTUS AZARAI AZARAI*) IN THE HUMID ARGENTINEAN CHACO

On September 14, 2012, Cecilia Paola Juarez defended her doctoral dissertation at the University of Tucumán, Argentina. Her research draws on work conducted at the Owl Monkey Project of the Argentinean National Council of Research (CONICET) and also at the Centro de Ecología Aplicada del Litoral (CECOAL), Argentina. Her

supervisor was Professor Dr. Eduardo Fernandez-Duque of the Department of Anthropology of the University of Pennsylvania. Her research was funded by an education grant to C. Juarez (CONICET) and investigation grants (Conservation Small Grants-ASP-2010 and Conservation Grant-IPS-2010). The following is a summary of her thesis.

In Argentina, owl monkeys (*Aotus azarai azarai*) are restricted to the Chaco and Formosa province. In the Argentinean Humid Chaco, owl monkeys inhabit gallery forest, high canopy forest and low canopy scrub forest (*Prosopis sp.*). Generally this two latter ambient to forest, more xeric, sometimes form islands of different sizes. The goal of this study was to investigate what is the demographic structure of owl monkey populations that inhabit the humid Chaco, how it changes in space and time, and what some of the factors that regulate these changes may be. The working hypothesis proposes that the demography and life history characteristics of owl monkeys will be strongly associated with spatial factors (environmental units different in gallery forest and forest islands) and abiotic (precipitation and temperature). Two studies were conducted to evaluate the hypothesis.

The aim of the first study was to understand the demographic structure of the owl monkey population in the east of the humid Chaco of the Formosa province and how different the social groups when exposed to different spatial factors may be. This work describes and compares, with basic demographic parameter, social groups in gallery forest (continuous forest) and forest islands (naturally isolated environments) inhabiting two areas with similar characteristics: Pilcomayo National Park and Guaycolec Ranch. Since October 2006 to February 2011, I collected demographic data from 84 social groups inhabiting gallery forest (n=54) and forest islands (n=30). For each social group we recorded group size, age structure and estimated the population density (ecology and relative). Four variables were included in statistical models predicting the presence-absence in forest islands: sampling site and surface, forest structure and insolate degree of islands. The aim of the second study was to evaluate changes in demographics and life history in relation with abiotic factors. This work analyses demographic data from nine social groups ("population system") studied between 1997 to 2010. Life history variables were birth rate, mortality rate, emigration and migration related with temperature and precipitation. Life table was constructed and population growth rate was calculated for the owl monkey population in Guaycolec Ranch.

The first study suggests that group size, age structure and birth rate were similar between sampling sites. Density was higher in Guaycolec Ranch than Pilcomayo National Park. The group size differences between continuous forest and forest islands showed that group size and densities were higher in gallery forest than forest islands. Birth rate was higher in gallery forest compared to forest islands in Guaycolec Ranch, but not statistically different between environments in Pilcomayo National Park. Presence of owl monkeys in forest islands was strongly associated to the surface of forest islands. There is a 50% probability of finding owl monkeys in forest islands with an area of 5.6 ha and a 90% probability of finding owl monkeys in forest islands with an area of 11.4 ha. The second study showed that the owl monkey population in Guaycolec Ranch ("population system") was fluctuating between 11 and -18% with a growth rate (r) of -0.02 over 14 years. The years with higher rainfall were associated with larger group size. But there was no association between mortality rate and dispersals to rainfall or temperatures. Life table showed high mortality from birth to first year of life. After-3-year survival decreases coinciding with the period of dispersal.

In conclusion, low densities of *A. azarai* are found in Rio Pilcomayo National Park, the only nationally protected habitat of owl monkeys, shows that the species has a critical demographic state. The study results show how natural habitat fragmentation can influence the structure of population and basic demographic parameters (such as birth rate, and group size and density). We do not know, however, how individuals survive in patches of forest and how dispersal occurs between patches of forest. This work is important in the conservation of owl monkeys in Argentina as it is the first time that we evaluate density in the only national park designated to their protection. Additionally, study groups of the same subspecies under different environmental conditions contributes to understanding the phenotypic plasticity of the subspecies, which can be used to assess potential effects on different populations under anthropic fragmentation along their distribution.

Cecilia Paola Juárez, Centro de Ecología Aplicada del Litoral (CECOAL, CONICET). Barrio General José de San Martín, casa 100, manzana 55. Código Postal 3600. Provincia de Formosa, Argentina, E-mail: <cecijuarez@arnet-biz.com.ar>.

Reference

Juárez, C. P. 2012. Demographic and life history of owl monkeys (*Aotus azarai*) in the Argentinean humid Chaco. Doctoral dissertation. School of Natural Sciences and Miguel Lillo Institute (FCN e IML). University of Tucumán. Tucumán Province, Argentina, 182pp.

EFFECTS OF FOREST FRAGMENTATION ON BROWN SPIDER MONKEYS (*ATELES HYBRIDUS*) AND RED HOWLER MONKEYS (*ALOUATTA SENICULUS*)

The increasing intensity of anthropogenic land use and conversion has immense impacts on ecosystems worldwide and often results in habitat fragmentation. Fragmentation and other anthropogenic disturbances (e.g. hunting and logging activities) pose major threats to numerous animal

species. Species vary greatly in their resilience to these disturbances and in their ability to survive in forest fragments. Animals might have to adjust their behavior, their grouping patters and/or dietary strategies to survive in anthropogenically altered habitats. Human-induced alterations can also result in long-term elevations of glucocorticoids (cortisol or corticosterone), which can have deleterious effects on growth, reproduction and immune system activity of animals.

To broaden our understanding of how animals cope physiologically and behaviorally with anthropogenic disturbances I studied two Neotropical primate species, brown spider monkeys (*Ateles hybridus*) and red howler monkeys (*Alouatta seniculus*) for my doctoral thesis at the University of Göttingen, Germany (Rimbach, 2013). The specific aims of this thesis were to 1) validate an enzymeimmunoassay (EIA) for the analyses of fecal glucocorticoid metabolite (FGCM) levels of both study species, 2) to investigate the species-specific differences in the physiological responsiveness to anthropogenic disturbances and 3) to examine how spider monkeys adjust their grouping patterns and social behavior when living in a small forest fragment.

The validation of the EIA, for which I used the stress response to anesthesia and reverse-phase high pressure liquid chromatography analysis (HPLC), was a crucial pre-requisite for the analyses of FGCM levels. The results demonstrated that both species differ in terms of basic factors influencing their adrenocortical activity (e.g. diurnal rhythm of GC excretion) (Rimbach *et al.*, 2013). To investigate the physiological responsiveness to anthropogenic disturbances of both species I collected fecal samples in several forest fragments in Colombia that differed in size (4.21 ha - 500 ha) as well as in the level of human impact (determined through the occurrence and/or absence of hunting and logging activities). Using the previously validated EIA I determined FGCM levels and examined species-specific differences in the physiological responsiveness to both fragment size and level of human impact. Fragment size did not influence FGCM levels of either species. But spider monkeys showed elevated FGCM levels in fragments where both hunting and logging occurred, whereas howler monkeys did not show such a response. This suggests that hunting and logging activities can potentially create long-term elevations of GC levels in brown spider monkeys and emphasizes why they are at a higher extinction risk than red howler monkeys when living in anthropogenically altered habitats (Rimbach *et al.*, in revision).

To better understand how spider monkeys cope with fragmentation, I studied the flexible grouping patterns and social behavior of two brown spider monkey groups living in a small forest fragment (65 ha) in Colombia. I collected data on subgroup sizes, aggressive interactions, habitat-wide fruit availability and collected fecal samples to determine FGCM levels. Both groups ranged in smaller subgroups and showed higher FGCM levels in periods of high fruit availability compared to periods of low availability. These results were unexpected because (1) primates like spider monkeys and chimpanzees, that exhibit fission-fusion dynamics, typically show the opposite grouping pattern and (2) a major function of glucocorticoids (GC) is the release of energy during the stress response. Consequently, GC levels typically increase in periods of low resource availability. Spider monkeys are generally considered to be ripe fruit specialists. However, both study groups have a more folivorous diet than has been reported for other spider monkey populations. This could be a strategy to reduce the level of competition for fruit, especially in periods of low availability. When fruit availability is high in this fragment it appears that the intra-group feeding competition for fruit is also high. This would also explain why FGCM levels were higher and subgroup size smaller in periods of high fruit availability. This is further reinforced by high rates of female-female aggression, which were higher in periods of high fruit availability than in periods of low availability. These results illustrate how fragmentation can alter the grouping patterns and social behavior of this species and that the relationship between resource availability, grouping patterns, aggression rates and stress levels can be more complex than assumed so far.

Population densities are often high in forest fragments and resource availability is frequently altered. Moreover, animals that live in fragments often have to reduce the size of their home range. These conditions can potentially lead to high levels of intra-specific competition for resources and space. The confinement to a small amount of space can furthermore result in inter-specific competition, especially between species that overlap in their ecological niches. I report several cases of severe aggression and two cases of interspecific infanticide from spider monkeys directed at infant howler monkeys and capuchins in a small fragment with high primate population densities. This behavior might be either "pathological" or a strategy to eliminate potential future competitors for resources or space (Rimbach *et al.*, 2012). In conclusion, this study demonstrates species-specific differences in the ability to cope with anthropogenic disturbances and that these differences might be, at least partly, due to different levels of physiological responsiveness. In addition, the results suggest that hunting and logging activities may create long-term stress for spider monkeys that could impair their long-term population viability. Importantly, this thesis illustrates the use of GC measurements as a tool to monitor populations in disturbed and fragmented areas, and to evaluate and improve conservation strategies.

Rebecca Rimbach, Abt. Verhaltensökologie & Soziobiologie, Deutsches Primatenzentrum, Kellnerweg 4, 37077 Göttingen, Germany, E-Mail: <RRimbach@dpz.eu>

References

Rimbach, R. 2013. Effects of forest fragmentation on brown spider monkeys (*Ateles hybridus*) and red howler monkeys (*Alouatta seniculus*). Doctoral thesis. University of Göttingen. Available at: http://hdl.handle.net/11858/00-1735-0000-0001-BB7B-2

Rimbach, R., Heymann, E.W., Link, A., Heistermann, M. 2013. Validation of an enzyme immunoassay for assessing adrenocortical activity and evaluation of factors that affect levels of fecal glucocorticoid metabolites in two New World primates. *Gen. Comp. Endocrinol.* 191: 13-23.

Rimbach, R., Pardo-Martinez, A., Montes-Rojas, A., Di Fiore, A., Link, A. 2012. Interspecific infanticide and infant-directed aggression by spider monkeys (*Ateles hybridus*) in a fragmented forest on Colombia. *Am. J. Primatol.* 74: 990-997.

Rimbach, R., Link, A., Heistermann, M., Gómez-Posada, C., Galvis, N., Heymann, E.W. Effects of human impact and forest fragment size on physiological stress levels of two sympatric ateline primates in Colombia. *Conserv. Physiol.*, in revision.

Recent Publications

BOOKS

Primate ecology and conservation (Tecs): a handbook of techniques, edited by Eleanor Sterling, Nora Bynum and Mary Blair. 2013. Oxford University Press. 448pp. ISBN: 978-0199659449. This practical volume synthesizes field, laboratory, and conservation management techniques for primate ecology and conservation. This book's particular focus is on innovative ways to study primates in a changing world, including emerging methods such as non-invasive genetic techniques and advanced spatial modeling. *Contents:* 1. Introduction – Sterling E, Bynum N & Blair M; 2. Primate census and survey techniques – Plumptre AJ, Sterling E & Buckland S; 3. Darting, anesthesia and handling – Glander K; 4. Health assessment and epidemiology – Muehlenbein MP & Lewis CM; 5. Behavior within groups – Kaplin BA & Willian A; 6. Habitat assessment and species niche modeling – Rode J, Stengel CJ & Nekaris AI; 7. Characterization of primate environments through assessment of plant phenology – Marshall AJ & Wich S; 8. Methods in ethnoprimatology – Riley EP & Ellwanger AL; 9. Social and spatial relationships between primate groups – Brown M & Crofoot M; 10. Experiments in primatology – Janson C & Brosnan SF; 11. Diet and nutrition – Rothman JM, Vogel ER & Blumenthal SA; 12. Physiology and energetic – Schmid J; 13. Primate behavioral endocrinology – Nguyen N; 14. Population genetics, molecular phylogenetics and phylogeography – Blair ME & Morales-Jimenez AL; 15. Demography, life histories and population dynamics – Montenegro OL; 16. Determining conservation status and contributing to conservation action – Blair MA, Bynum N, Sterling E; 17. Captive breeding and ex-situ conservation – Gibson D & McCann C; 18. Primates in trade – Linder J, Sawyer S & Brashares J; 19. Conclusion – Serling E, Bynum N, Blair ME.

Primate sexuality: comparative studies of the prosimians, monkeys, apes, and humans, by Alan F. Dixon. 2013. Oxford University Press. 808pp. ISBN: 978-0199676613. This book provides an authoritative and comprehensive synthesis of current research on the evolution and physiological control of sexual behaviour in the primates - prosimians, monkeys, apes, and human beings. This new edition has been fully updated and greatly expanded throughout to incorporate a decade of new research findings. It maintains the depth and scientific rigour of the first edition, and includes a new chapter on human sexuality, written from a comparative perspective.

Primates in fragments: complexity and resilience, edited by Laura K. Marsh & Colin Chapman. 2013. Springer. 500pp. ISBN: 978-1461488385. In this new volume we continue to address issues regarding primates within a fractured landscape. The book is divided in seven sections. In the Introductory section, authors discuss the issues surrounding primates in remnant habitats as well as encourage discussion about what we mean by fragmentation on a landscape scale. In the Long-Term and Regional Studies section, authors present information on changes that have occurred during longer studies as well as changes that have occurred over regions. In the Landscape, Metapopulations and the Matrix section, authors cover topics from dry to moist forests, and from metapopulations to single species use of multiple fragments locations. In Feeding and Behavioral Ecology, authors take a closer look at the flexibility and responsiveness of primates in fragments in terms of their food choices, resource use, and behavioral changes. In Endemic, Endangered, and Nocturnal Primates authors uncover details involving critical primates living in major city centers to the heights of the Himalayas. In Genetics, Disease and Parasites authors cover topics including population viability, disease and parasite transmission between primates in fragments and humans. Finally, in the Conservation and Ecology: Threats and Management section, we synthesize information in this volume and make recommendations for the future of work in this field and the survivability of primates in fragments.

Lessons from other mammals

Review of: *Bones, Clones, and Biomes. The History and Geography of Recent Neotropical Mammals*, edited by Bruce D. Patterson and Leonora P. Costa, 2012. Chicago: University of Chicago Press. ISBN-13: 978-0-226-64919-1 (cloth). Price: US-$ 65.00, £ 42.00

Readers of this journal are familiar with the fact that New World primates are the most diverse radiation within the primate order. Similarly, the Neotropical mammalian fauna in general is extremely rich and diverse, accounting for almost one third of all mammalian species living on earth. Exploring the reasons for this diversity in terms of processes that date far back into the geological past (Mesozoic, Paleogene) or took place in the more recent geological periods (Neogene) is the central theme of this book.

Apart from a general introduction to the history and geography of Neotropical mammals by the editors, the book is divided into two large parts. Part 1, containing six chapters, deals mainly with the "older times", i.e. the origin and evolutionary history of Neotropical mammals, while the nine chapters of Part 2 focus primarily on determinants of the diversity and composition of more extant mammal assemblages in different regions of the Neotropics.

Primates do not figure prominently in this book, but this is definitely not a taint. Rather, I think that Neotropical primatologists can learn different lessons from this book. One is the understanding of the larger setting into which the ancestors of New World primates arrived after having somehow crossed the Atlantic Ocean. Another one is the range of hypotheses that are deployed in this book to explain the current diversity and patterns of Neotropical mammal distribution. I found of particular interest chapters dealing with speciation patterns in Amazonia (chapter 12), the role of fragmentation for the diversity in Atlantic forests (chapter 13), and the role of the Andes for diversity and distribution. E.g., obvious links between sub Andean/western Amazonian and Atlantic forest mammals made me think about how Amazonian and Atlantic forest primates are interrelated and how they became separated from each other. While this question has already been addressed quite some time ago (e.g. Kinzey 1982), the issue is far from resolved. Furthermore, using the combination of different biogeographic hypotheses for analyzing the distribution of New World primates primates will likely provide a much better understanding than focusing only on refuges (e.g. Kinzey 1982) or riverine barriers (e.g. Peres et al. 1996).

The main title of the book ("Bones, Clones, and Biomes") nicely reflects the variety of approaches and perspectives taken by the different chapter authors that range from "classical" paleontology ("bones") through molecular methods ("clones") to biogeographic analyses of regional assemblages ("biomes"). The overall quality of this book is high, although there is some variation between chapters. The writing style is generally accessible, even in relatively specialized chapters. Overall, I can recommend this book for everyone who wants to look beyond the primatological horizon and learn about historical and recent diversity and biogeography of Neotropical mammals.

Eckhard W. Heymann, Abt. Verhaltensökologie & Soziobiologie, Deutsches Primatenzentrum, Kellnerweg 4, D-37077 Göttingen, e-mail: <eheyman@gwdg.de>.

References

Kinzey, W. G. 1982. Distribution of primates and forest refuges. In: *Biological Diversification in the Tropics*, G. T. Prance (ed.), pp. 455–482, Columbia University Press, New York.

Peres, C. A., J. L. Patton, and M. N. F. da Silva. 1996. Riverine barriers and gene flow in Amazonian saddle-back tamarins. *Folia Primatol.* 67: 113–124.

ARTICLES

Aquino R, Cornejo FM, Pezo E, Heymann EW. 2013. Distribution and abundance of white-fronted spider monkeys, *Ateles belzebuth* (Atelidae), and threats to their survival in Peruvian Amazonia. *Folia Primatol.* 84(1):1–10

Arnold C, Einspanier A. 2013. Medical treatment improves social behavior in a primate endometriosis model (*Callithrix jacchus*). *J. Med. Primatol.* 42(3): 112–119

Barnett AA, Ronchi-Teles B, Almeida T, Deveny A, Schiel-Baracuhy V, Souza-Silva W, Spironello W, Ross C, McLarnon A. 2013. Arthropod predation by a specialist seed predator, the golden-backed Uacari (*Cacajao melanocephalus ouakary*, Pitheciidae) in Brazilian Amazonia. *Int J. Primatol.* 34(3): 470–485

Bergstrom ML, Fedigan LM, 2013. Dominance style of female white-faced capuchins. *Am. J. Phys. Anthropol.* 150(4): 591–601

Blair ME, Gutiérrez-Espeleta GA, Melnick DJ. 2013. Subspecies of the central american squirrel monkey (*Saimiri oerstedii*) as units for conservation. *Int J. Primatol.* 34(1)

Bueno MG, Rohe F, Kirchgatter K, Di Santi SMF, Guimaraes LO, Witte CL, Cista-Nascimento MJ, Toniolo CRC, Catao-Dias JL. 2013. Survey of *Plasmodium* spp. in free-ranging Neotropical primates from the Brazilian Amazon region impacted by anthropogenic actions. *Ecohealth.* 10(1): 48–53

Bullinger AF, Burkart JM, Melis AP, Tomasello M. 2013. Bonobos, *Pan paniscus*, chimpanzees, *Pan troglodytes*, and marmosets, *Callithrix jacchus*, prefer to feed alone. *Ani. Behav.* 85(1): 51–60

Chaves OM, Bicca-Marques JC. 2013. Dietary flexibility of the brown howler monkey throughout its geographic distribution. *Am. J. Primatol.* 75(1): 16–29

da Silva GA, Monteiro FOB, Dias HLT, Cavalcante RO, Sampajo AI, da Conceicao MEBAM, Takeshita RSC, de Castro PHG, Feijó FMC, Rahal SC. 2013. Qualitative analysis of preputial and vaginal bacterial microbiota in owl monkeys (*Aotus azarai infulatus*) raised in captivity. *J. Med. Primatol.* 42(2): 71–78

Demes B, O'Neil MC. 2013. Ground reaction forces and center of mass mechanics of bipedal capuchin monkeys:

Implications for the evolution of human bipedalism. *Am. J. Phys. Anthropol.* 150(1): 76–86

Duarte T, Beltrao-Mendes R, Ferrari SF. 2013. Use of alternative plant resources by common marmosets (*Callithrix jacchus*) in the semi-arid Caatinga scrub forests of northeastern Brazil. *Am. J. Primatol.* 75(4): 333–341

Dunn JC, Cristobal-Azkarate J, Schulte-Herbruggen B, Chavira R, Vea JJ. 2013. Travel time predicts fecal glucocorticoid levels in free-ranging howlers (*Alouatta palliata*). *Int J. Primatol.* 34(2): 246–259

Fernandez VA, Kowalewski M, Zunino GE. 2013. Who is coordinating collective movements in black and gold howler monkeys? *Primates* 54(2).

French JA. 2013. The Role of androgenic steroids in shaping social phenotypes across the lifespan in male marmosets (*Callithrix* spp.). *Am. J. Primatol.* 75(3): 212–221

Iurck MF, Nowak MG, Costa LCM, Mendes SL, Ford SM, Strier KM. 2013. Feeding and resting postures of wild northern muriquis (*Brachyteles hypoxanthus*). *Am. J. Primatol.* 75(1): 74–87

Jarcho MR, Power ML, Layne-Colon DG, Tardif SD. 2013. Digestive efficiency mediated by serum calcium predicts bone mineral density in the common marmoset (*Callithrix jacchus*). *Am. J. Primatol.* 75(2): 153–160

Kelaita MA, Cortés-Ortiz L. 2013. Morphological variation of genetically confirmed *Alouatta pigra* × *A. palliata* hybrids from a natural hybrid zone in Tabasco, Mexico. *Am. J. Phys. Anthropol.* 150(2): 223–234

Liborio RA, Martins MM. 2013. Body size in predator–prey interactions: an investigation of Neotropical primates and their predators. *Stud. Neotrop. Fauna E.* 48(1): 81–87

Link A, Di Fiore A. 2013. Effects of predation risk on the grouping patterns of white-bellied spider monkeys (*Ateles belzebuth belzebuth*) in Western Amazonia. *Am. J. Phys. Anthropol.* 150(4): 579–590

Mantilla-Meluk H. 2013. Subspecific variation: an alternative biogeographic hypothesis explaining variation in coat color and cranial morphology in *Lagothrix lugens* (Primates: Atelidae). *Prim. Conserv.* 26: 33

Mayor P, Bowler M, López-Plana C. 2013. Functional morphology of the female genital organs in the peruvian red uakari monkey (*Cacajao Calvus Ucayalii*). *Am. J. Primatol.* 75(6): 545–554

Mendez-Carvajal PG. 2013. Population size, distribution and conservation status of howler monkeys (*Alouatta coibensis trabeata*) and spider monkeys (*Ateles geoffroyi azuerensis*) on the Azuero peninsula, Panama. *Prim. Conserv.* 26: 3–17

Meno W, Coss RG, Perry S. 2013. Development of snake-directed antipredator behavior by wild white-faced capuchin monkeys: I. Snake-species discrimination. *Am. J. Primatol.* 75(3): 281–291

Meno W, Coss RG, Perry S. 2013. Development of snake-directed antipredator behavior by wild white-faced capuchin monkeys: II. Influence of the social environment. *Am. J. Primatol.* 75(3): 292–300

Oirá A, Pinna MH, Estrela A, Junios DG, Liborio FA, Dorea FA, Oliveira AVD, Nogueira M, Requiao K. 2013. Exophthalmos due to odontogenic intraorbital abscess in *Cebus apella*. *J. Med. Primatol.* 42(2): 101–104

Parr NA. Fedigan LM. Kutz SJ. 2013. A coprological survey of parasites in white-faced capuchins (*Cebus capucinus*) from sector Santa Rosa, ACG, Costa Rica. *Folia Primatol.* 84: 102–114

Petracca MM, Caine NG. 2013. Alarm calls of marmosets (*Callithrix geoffroyi*) to snakes and perched raptors. *Int. J. Primatol.* 34(2): 337–348

Phillips KA, Thompson CR. 2013. Hand preference for tool-use in capuchin monkeys (*Cebus apella*) is associated with asymmetry of the primary motor cortex. *Am. J. Primatol.* 75(5): 435–440

Porter LM, Garber P. 2013. Foraging and spatial memory in wild Weddell's saddleback tamarins (*Saguinus fuscicollis weddelli*) when moving between distant and out-of-sight goals. *Int. J. Primatol.* 34(1): 30–48

Raboy BE, Neves LG, Zeigler SL, Oliveira LC. 2013. Occurrences of the golden-headed lion tamarin (*Leontopithecus chrysomelas*) above 500 meters in southern Bahia, Brazil and implications for conservation planning. *Prim. Conserv.* 26: 25–33

Rapaport LG, Kloc B, Warneke M, Mickelberg JL, Ballou JD. 2013. Do mothers prefer helpers? Birth sex-ratio adjustment in captive callitrichines. *Anim. Behav.* 85(6): 1295–1302

Roudebush WE, Nethery RA, Helderth T. 2013. Presence of anti-müllerian hormone in the squirrel monkey (*Saimiri boliviensis*): gender and seasonal differences. *J. Med. Primatol.* 42(1): 15–19

Rovirosa-Hernandez MJ, Cortés-Ortiz L, García-Orduña F, Guzmán-Gómez D, López-Monteon A, Caba M, Ramos-Ligonio A. 2013. Seroprevalence of *Trypanosoma cruzi* and *Leishmania mexicana* in free-ranging howler monkeys in southeastern Mexico. *Am. J. Primatol.* 75(2): 161–169

Ruiz M, Vásquez C, Camargo E, Castellanos LF, Gálvez H, Leguizamón N, Shostell M. 2013. Molecular genetics analysis of mtDNA COII gene sequences shows illegal traffic of night monkeys (*Aotus*, Platyrrhini, Primates) in Colombia. *J. Prim.* 2:107.

Scarry CJ. 2013. Between-group contest competition among tufted capuchin monkeys, *Sapajus nigritus*, and the role of male resource defense. *Anim. Behav.* 85(5): 931–939

Schoof VAM, Jack KM, 2013. The association of intergroup encounters, dominance status, and fecal androgen and glucocorticoid profiles in wild male white-faced capuchins (*Cebus capucinus*). *Am. J. Primatol.* 75(2): 107–115

Seidel V, Hoffmann R, Braun A, Seehase S. knauf S, Kaup FJ, Bleyer M. 2013. Distribution and morphology of Clara cells in common marmosets (*Callithrix jacchus*). *J. Med. Primatol.* 42(2): 79–88

Shaffer CA. 2013. Feeding Ecology of Northern Bearded Sakis (*Chiropotes sagulatus*) in Guyana. *Am. J. Primatol.* 75(6): 568–580

Shaffer CA. 2013. GIS analysis of patch use and group cohesiveness of bearded sakis (*Chiropotes sagulatus*) in the upper Essequibo conservation concession, Guyana. *Am. J. Phys. Anthropol.* 150(2): 235–246

Shanee S, Allgas N, Shanne N. 2013. Preliminary observations on the behavior and ecology of the Peruvian night monkey (*Aotus miconax*: Primates) in a remnant cloud forest patch, north eastern Peru. *Trop. Conserv. Sci.* 6(1): 138–148

Shanee S, Tello-Alvarado JC, Vermeer J, Bóveda-Penalba AJ. 2013. GIS risk assessment and GAP analysis for the andean titi monkey (*Callicebus oenanthe*). *Prim. Conserv.* 26: 17–25

Sirianni G, Visalberghi E. 2013. Wild bearded capuchins process cashew nuts without contacting caustic compounds. *Am. J. Primatol.* 75(4): 387–393

Spehar SN, Di Fiore A. 2013. Loud calls as a mechanism of social coordination in a fission–fusion taxon, the white-bellied spider monkey (*Ateles belzebuth*). *Behav. Ecol & Sociobiol.* 67(6): 947–961

Teixeira MG, Ferreira A, Antunes A, Fernandes S, de Melo ME, Guedes FL. 2013. Hematologic and blood chemistry values of healthy *Cebus flavius* kept in northeast of Brazil. *J. Med. Primatol.* 42(2): 51–56

Thompson CL, Robl NJ, Melo LC, Valenca-Montenegro MM, Maranhao YB, Borstelmann MA, Vinyard CJ. 2013. Spatial distribution and exploitation of trees gouged by common marmosets (*Callithrix jacchus*). *Int. J. Primatol.* 34(1).

Van Belle S, Estrada A, Garber P, 2013. Collective group movement and leadership in wild black howler monkeys (*Alouatta pigra*). *Behav. Ecol & Sociobiol.* 67(1): 31–41

Verderane MP, Izar P, Visalberhi E, Fragaszy DM. 2013. Socioecology of wild bearded capuchin monkeys (*Sapajus libidinosus*): an analysis of social relationships among female primates that use tools in feeding. *Behavior.* 150(6): 659–689

Ziegler TE, Colman RJ, Tardif SD, Sosa ME, Wegner FH, Wittwer DJ, Shrestha H. 2013. Development of metabolic function biomarkers in the common marmoset, *Callithrix jacchus. Am. J. Primatol.* 75(5): 500–508

ABSTRACTS

Selected abstracts relating with Neotropical primates from the XV Congress of Brazilian Primatology, 4-9 August 2013, Recife, Brazil.

Sousa R, Bicca-Marques JC. 2013. Ecologia cognitiva de macacos-da-noite (*Aotus infulatus* e *A. nigriceps*) em cativeiro.

Soares CS, Revôredo L, Bicca-Marques JC. 2013. Memória espacial no forrageio do sagui-comum (*Callithrix jacchus*) em uma parcela de alimentação artificial.

Delval IS, Presotto A, Tokuda M, Izar P. 2013. Efeito do clima sobre os padrões de navegação de *Sapajus nigritus* no Parque Estadual Carlos Botelho, SP.

Gomes H, Bicca-Maques JC. 2013. Informação espacial no forrageio de grupos selvagens de micos-leões-dourados (*Leontopithecus rosalia*) e saguis híbridos (*C. penicillata x C. jacchus*).

Gonzalez L, Izar P. 2013. Percepção de risco de predação por um grupo de macacos-prego (*Sapajus nigritus*) do Parque Estadual Carlos Botelho

Marquez A, Santillán AM, Arenas RV, Ordoñez JD, Aguillón MA. 2013. Vocalizaciones asociadas a la afiliación de monos arañas (*Ateles geoffroyi*).

Da Silva PK, Lessa AM, Araujo A. 2013. Relações sociais de *Callithrix jacchus* machos: competição ou cooperação?.

Souza JP, Chagas RRD, Ferrari SF. 2013. Single or multiple central place foraging? Behavioral strategies of *Callicebus coimbrai* in a fragment of Atlantic Forest in Northeastern Brazil.

De Lima EM, Pessoa DMA, Sena LS, Melo AGC, Castro PHG, Oliveira AC, Pessoa VF, Schneider PC. 2013. Polimorfismo da visão de cores em *Chiropotes tahickae hershkovitz*, 1985 (Cuxiú-Cinza) cativos.

Suscke P, Izar P. 2013. Socioecologia de *Sapajus xanthosternos* na Reserva Biológica de Una, sul da Bahia.

Winandy MM, Verderane MP, Ferreira RG, Izar P. 2013. Mudanças na demografia afetam a hierarquia de fêmeas em macacos-prego (*Sapajus* sp.).

Spuza JP, Ferrari SF, Ross C. 2013. Aspects of the life history of *Callicebus coimbrai* in fragments of Atlantic Forest in the northeastern Brazilian state of Sergipe.

Gonçalves Jr, Bicca-Marques JC. 2013. Comportamento de um grupo suplementado de bugios-ruivos (*Alouatta guariba clamitans*) em uma paisagem urbanizada.

Monteiro J, Vleeschouwer K, dos Reis P, Grelle C, Oliveira LC. 2013. Comportamento anti-predação do mico-leão da cara dourada em áreas com diferentes riscos de predação.

Bruno G, Ocampo F, Mudry MD. 2013. Social behavior of black howler monkeys (*Alouatta caraya*) in semi-captivity, in an area outside its natural range.

Paim F, Rabelo R, Queiroz H. 2013. Diferentes métodos aplicados à captura de espécies de *Saimiri* em uma área de várzea.

Hilario RR, Ferrari SF. 2013. Environmental correlates of the density of *Callicebus coimbrai* populations in northeastern Brazil.

Chavez OM, Camaratta D, Bicca-Marques JC. 2013. Fragment size influences the diet of *Alouatta guariba clamitans* in southern Brazil.

Landis M, Pedroso R, Passamani M. 2013. Fragment size explains occupancy probabilities of *Callicebus nigrifrons* in southeastern Brazil.

Centoducatte L, Crepaldi MOS, Santos BS, Paula CM, Martinelli FS, Mendes SL. 2013. Definição de corredores funcionais para o muriqui, *Brachyteles hypoxanthus*, com base em critérios econômicos e ecológicos.

Culot L, Boutefeu M, Galetti M. 2013. Post dispersal fate of seeds dispersed by the two last Neotropical megafrugivores: the muriqui and the tapir.

Suzini A, Back LP, Ciacchi A, Aguiar LM. 2013. Relações entre humanos e macacos-prego em um bosque urbano em Foz do Iguaçu, Alto Rio Paraná.

Detogne N, Bergallo HG, Pereira DG. 2013. O sagui exótico invasor (*Callithrix* spp.) em um parque urbano na cidade do Rio de Janeiro, Brasil.

Rabelo R, Silva F, Paim F, Valsecchi J. 2013. Novos registros e expansão da área de distribuição geográfica de *Ateles chamek.*

Coutinho K, Montenegro V, Castro CSS. 2013. Padrão de atividades e dieta de um grupo de macaco-prego-galego (*Sapajus flavius* Schereber, 1774) na RPPN Engenho Gargaú, Paraíba, Brasil.

Guevara R, Gordo M, Lopes MA. 2013. Dispersão de sementes por sauins-de-coleira (*Saguinus bicolor)*: Efeitos do padrão de deslocamento na formação de sombra de sementes.

Quintana P, Hernandez LT, Morales J, Rico V. 2013. Dinámica de interacciones intergrupales y explotación de recursos por dos grupos de monos *Alouatta palliata mexicana* en Los Tuxtlas, Veracruz, México.

Arenas RV, Santillán A, Marquez A, Gasca M. 2013. Rehabilitación de mono mexicanos de ser mascota.

Fragoso A, Romero DC, Castro FJV, Quináglia GA, Sá LRM. 2013. A utilização de *Callithrix* spp no monitoramento da poluição atmosférica por chumbo em centro urbano: viável ou não?

Kowalewski M, Martinez R, Gillespie T. 2013. Patterns parasitism in howler monkeys across their distribution.

Bezerra R, Henrique P, Ferreira RG. 2013. Ser Dominante é estressante: estereotipia e comportamentos sociais em macacos-prego (*Sapajus libidinosus*) em condições de cativeiro.

Ash H, Buchanan H. 2013. Breeding and rearing practices in the common marmoset (*Callithrix jacchus*).

Menendez AC, Silva LMP, Shiramizu VKM, Ferreira RG, Galvao NL. 2013. Avaliação do bem-estar em machos e fêmeas de sagui comum (*Callithrix jacchus*): estresse físico e social no cativeiro.

Ramos G, Pinacho B. 2013. Patrones de asociación y proximidad espacial en monos araña (*Ateles geoffroyi yucatanensis*).

Biondi L, Wright K, Fragazy D, Izar P. 2013. Bipedalismo em macacos-prego (*Sapajus libidinosus*) e a hipótese da postura de forrageamento.

Peternelli L, Verderane M, Izar P. 2013. Qualidade da dieta e o uso de ferramentas: comparação de duas populações de macacos-prego (*Sapajus* sp.).

Hernández LT, Rodríguez P, Morales J. 2013. Estrategia sensorial del mono araña (*Ateles geoffroyi*) en la selección de alimento cultivado y silvestre.

Hernández LT, Espinosa C, Gómez S. 2013. Estrategias digestivas de monos aulladores mexicanos (*Alouatta palliata* y *Alouatta pigra*) ante variaciones en la calidad de su dieta.

Verderane M, Sasaki R, Izar P. 2013. Uso de cavernas por macacos-prego (*Sapajus libidinosus*) em área de ecótono Cerrado/Caatinga no Piauí.

Rezende GC, Knogge C, Valladares CB. 2013. The black lion tamarin conservation program: a model for primate species conservation.

Silva FE. 2013. Sobre a redescoberta de *Mico marcai* e os desafios para o conhecimento da diversidade de primatas no médio Aripuanã, Amazônia, Brasil.

Lanna A, Santos R, Mendes PS. 2013. Demografia de um pequeno grupo isolado de muriqui-do-norte (*Brachyteles hypoxanthus*).

Mendes RB, Ferrari SF. 2013. Occurrence of *Cebus xanthosternos* in mangrove forests: habitat preference or last resort?.

Mendes S, Santos R, Chaves PB, Fagundes V, Strier KB. 2013. Os desafios para a conservação do muriqui-do-norte *(Brachyteles* hypoxanthus) em uma paisagem altamente fragmentada: dez anos de experiencia.

Hilario R, Jerusalinsky J, Santos SS, Mendes R, Ferrari SF. 2013. Coimbra's titi (*Callicebus coimbrai* Kobayashi & Langguth 1999) at risk in northeastern Brazil: local extinctions recorded over the past 10 years.

Silva VM, Neves MB, Azevedo WTR, Chávez OM, Bicca-Marques JC. 2013. Influência do bolo fecal na germinação ex situ de sementes de *Guapira opposita* dispersadas por *Alouatta guariba clamitans.*

Thompson C, Montenegro MV, Oliveira L, Valle Y, Oliveira M. 2013. Common marmosets (*Callithrix jacchus*) more intensely exploit trees with the less mechanical resistance to fracture.

Morales B, Souto A, Schiel N. 2013. Versatilidade no uso de pedras como ferramentas por *Sapajus libidinosus.*

Baiao S, Aragao F, Souza JP, Ferrari SF. 2013. Fruit feeding and seed dispersal in Coimbra's titi (*Callicebus coimbrai*).

Baiao S, Aragao F, Ferrari SF. 2013. A coprological study of free-ranging titis (*Callicebus coimbrai*).

Silvestre SM, Dantas JO, Rocha PA, Mendes RB, Ferrari SF. 2013. Diet of the common marmoset (*Callithrix jacchus* linnaeus, 1758) at the ufs campus in São Cristóvão, Sergipe, based on fecal analysis.

Sala E, Canela G, Talebi M. 2013. Dureza como determinante de preferências alimentares de *A. clamitans* (Cabrera, 1940) e *B. arachnoides* (Geoffroy, 1806) em natureza: dados preliminares.

Fortes V, Marafiga A, Veiga JB, Bicca-Marques JC. 2013. Composição e dinâmica de grupos de bugios-ruivos (*Alouatta guariba clamitans* Cabrera, 1940) em área impactada por febre amarela no Rio Grande do Sul.

Silva M, Soares T, Oliveira D, Talebi M. 2013. Percurso diário e área de vida do bugio-ruivo (*Alouatta clamitans* Cabrera, 1940) em fragmento urbano da cidade de São Paulo.

Kaizer M, ypung R, Strier KB. 2013. Diferença de sexo no padrão de atividade de jovens muriquis (*Brachyteles hypoxanthus*).

Abondano L, Palma A, Alvarez S, Link A, Di Fiore A. 2013. Self-anointing behavior in white-bellied spider monkeys

(*Ateles belzebuth*): insights for olfactory social communication in a Neotropical primate.

Cardoso T, Silvestre SM, Hilario RR, Mendes RB, Ferrari SF. 2013. Comparative analysis of the habituation process to the common marmoset (*Callithrix jacchus*) in different habitats, Ibura National Forest, Brazil.

De Carvalho RS, Loyola S, da Silva DA, Pereira DG, Brainer T, Bergallo HG. 2013. Podem marcadores mitocondriais identificar grupos mistos de saguis da Mata Atlântica do sudeste brasileiro?.

Ribeiro J, Oliveira MAB. 2013. Influência de fatores associados à urbanização no comportamento de *Callithrix jacchus* em uma área de manguezal.

Santana K, Holanda D, Camara M, Fontenele J. 2013. A new non-invasive device for studying locomotor activity and sleep-wake cycle in captive common marmosets (*Callitrhix jacchus*).

Vasconcelos J, Marinho Y, Castro S. 2013. Comparativo de repertorio comportamental de *Callithrix jacchus* antes e durante a reabilitação.

Rangel A, Dias P, Chavira R, Canales D. 2013. Efectos de cambios en la composición grupal en los niveles de cortisol de monos aulladores negros (*Alouatta pigra*).

Rodrigues RS, Cortes L, García F, Guzman D, Lopez A, Caba M, Ramos A. 2013. Seroprevalencia de *Trypanosoma cruzi* y *Leishmania mexicana* en monos aulladores silvestres del sureste de México.

García F, Rovirosa MJ, Jagunes O, Guzman D, Lopez A, Caba M, Ramos A. 2013. Detección de *Trypanosoma cruzi* en grupos de mono araña mexicano en condiciones de cautiverio.

Nieves M, Marañon D, Bailey S, Mudry MD. 2013. Stress biomarkers in *Ateles* (Atelidae, Platyrrhini) genus.

Serrano J, Pacheco V. 2013. Morphological description and diagnosis of yellow-tailed woolly monkey: *Lagothrix flavicauda* (Humboldt 1812) (Primates, Atelidae)

Pereira NA, Affonso PR, Lemos RB, Carneiro JC, Sampaio MIC, 2013. Marcadores moleculares revelam mistura de espécies e indícios de hibridação entre macacos-prego (gêneros *Cebus* e *Sapajus*) em cativeiro na Bahia.

Garbino G. 2013. The taxonomic status of and a new synonym for Marca's marmoset *Mico marcai* (Alperin, 1993) (Cebidae: Callitrichinae)

Garbino G. 2013. How many genera of marmosets (Cebidae: Callitrichinae) are there? The morphological phylogenetic evidence.

Martins A, Gomes F, Carneiro J, Sampaio I, Schneider H. 2013. Uma ferramenta rápida e prática para identificação molecular dos gêneros *Cebus* (Cebidae) e *Sapajus* (Cebidae): o marcador molecular Alu Cebidae 5.

Carneiro JC, Sampaio I, Schneider H. 2013. Uma ferramenta molecular para demonstrar hibridização em *Saimiri*.

Avila R, Santos SHD, Galimberti VS, Muller CA, Todeschini F, Bicca-Marques JC, Fernandes FA, Chaves OM, Silva ACA, Oliveira GT. 2013. Análise coprológica de parasitos gastrointestinais de *Alouatta guariba clamitans.*

Meetings

II SIMPOSIO DE PRIMATOLOGIA EN EL PERÚ

El Centro Alemán de Primates, Yunkawasi, la Universidad Nacional de la Amazonía Peruana y la Sociedad Peruana de Mastozoología se complacen en invitar al II Simposio de Primatología en el Perú, que se llevará a cabo en la ciudad de Iquitos del 7 al 10 de Noviembre del 2013. Para más información visita http://www.monosperu.org/2do-simposio.html

25RD CONGRESS OF THE INTERNATIONAL PRIMATOLOGICAL SOCIETY

The 25rd Congress of the International Primatological Society is scheduled to take place in Vietnam on 11-16 August, 2014. The congress is to be held at Melia Hotel, Hanoi. The theme of the conference will be *Meeting the Challenges of Conserving Primate Diversity*. Abstract submission deadline: 31st of January, 2014. For more information go to http://ips2014.vnforest.gov.vn/

37TH MEETING OF THE AMERICAN SOCIETY OF PRIMATOLOGISTS

The 37th meeting of the American Society of Primatologists (ASP) will be held in Decatur, GA from September 12-15, 2014. On-line conference registration and abstract submission will be available in the ASP website in January 2014. For more information go to www.asp.org/meetings/

Monkeys of the Guianas Pocket Identification Guide
Mail and Fax Order Form

Monkeys of the Guianas: Guyana, Suriname, French Guiana Pocket Identification Guide by Russell A. Mittermeier, Anthony B. Rylands, Marc G. M. van Roosmalen, Marilyn A. Norconk, William R. Konstant and Lisa Famolare. ISBN: 978-1-934151-19-8. First Edition.

Price: $7.95 (includes ***UPS Ground*** shipping within the continental United States)
For orders requiring faster service than UPS Ground, you will be responsible for paying all shipping costs.

Please call the phone number listed below for: overnight deliveries, wholesale orders, and international orders.

Please complete the following form, print it out and mail or fax to:

Jill Lucena
Conservation International
2011 Crystal Drive, Suite 500
Arlington, VA 22202 USA
Tel (703) 341-2536
Fax (703) 553-4817
Email: j.lucena@conservation.org

First Name Last Name

Company Name

Mailing Address City State Zip Code

Telephone Fax

E-Mail Address

Order Form should include credit card information or be sent along with check or money order, in U.S. dollars, made payable to Conservation International. Please allow 2-3 weeks for delivery.

Quantity _____ x $7.95 each Total: _____
_____Payment Enclosed (check or money order in US $ only)
Charge my credit card: _____VISA _____Mastercard
Name (as it appears on card)_____
Card Number _____
Expiration Date _____
Signature _____

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.

Submissions

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>.

Contributions

Manuscripts may be in English, Spanish or Portuguese, and should be double-spaced and accompanied by the text on CD for PC compatible text-editors (MS-Word, WordPerfect, Excel, and Access), and/or e-mailed to <epalacios@conservation.org> (English, Spanish) or <jcbicca@pucrs.br> (Portuguese). Hard copies should be supplied for all figures (illustrations and maps) and tables. The full name and address for each author should be included. Please avoid abbreviations and acronyms without the name in full. Authors whose first language is not English should please have their English manuscripts carefully reviewed by a native English speaker.

Articles. Each issue of *Neotropical Primates* will include up to three full articles, limited to the following topics: Taxonomy, Systematics, Genetics (when relevant for systematics and conservation), Biogeography, Ecology and Conservation. Text for full articles should be typewritten, double-spaced with no less than 12 cpi font (preferably Times New Roman) and 3-cm margins throughout, and should not exceed 25 pages in length (including references). Please include an abstract in the same language as the rest of the text (English, Spanish or Portuguese) and (optional) one in Portuguese or Spanish (if the text is written in English) or English (if the text is written in Spanish or Portuguese). Tables and illustrations should be limited to six, except in cases where they are fundamental for the text (as in species descriptions, for example). Full articles will be sent out for peer-review. For articles that include protein or nucleic acid sequences, authors must deposit data in a publicly available database such as GenBank/EMBL/DNA Data Bank of Japan, Brookhaven, or Swiss-Prot, and provide an accession number for inclusion in the published paper.

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).

Figures and maps. Articles may include small black-and-white photographs, high-quality figures, and high-quality maps. (Resolution: 300 dpi. Column widths: one-column = 8-cm wide; two-columns = 17-cm wide). Please keep these to a minimum. We stress the importance of providing maps that are publishable.

Tables. Tables should be double-spaced, using font size 10, and prepared with MS Word. Each table should have a brief title.

News items. Please send us information on projects, field sites, courses, Thesis or Dissertations recently defended, recent publications, awards, events, activities of Primate Societies, etc.

References. Examples of house style may be found throughout this journal. In-text citations should be first ordered chronologically and then in alphabetical order. For example, "…(Fritz, 1970; Albert, 1980, 2004; Oates, 1981; Roberts, 2000; Smith, 2000; Albert *et al.*, 2001)…"

In the list of references, the title of the article, name of the journal, and editorial should be written in the same language as they were published. All conjunctions and prepositions (i.e., "and", "In") should be written in the same language as rest of the manuscript (i.e., "y" or "e", "En" or "Em"). This also applies for other text in references (such as "PhD thesis", "accessed" – see below). Please refer to these examples when listing references:

Journal article

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.

Website

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).

For references in Portuguese and Spanish:

"and" changes to "e" and "y" for articles in Portuguese and Spanish respectively.

"In" changes to "Em" and "En" for articles in Portuguese and Spanish respectively.

"Doctoral thesis" changes to "Tese de Doutoramento" and "Tesis de Doctorado" for articles in Portuguese and Spanish respectively.

"MSc Thesis" changes to "Dissertação de Mestrado" and "Tesis de Maestría" for articles in Portuguese and Spanish respectively.

"Unpublished report" changes to "Relatório Técnico" and "Reporte no publicado" for articles in Portuguese and Spanish respectively.

Neotropical Primates
A Journal and Newsletter of the IUCN/SSC Primate Specialist Group
Vol. 20(1), June 2013

Contents

Articles

Short Articles