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Front cover: Black titi monkey (*Plecturocebus cinerascens*). Photo taken at Guaporé River, Municipality of Comodoro, Mato Grosso, Brazil. July 2015. Photo taken by Breno Dias Vitorino.

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Articles

ECOLOGICAL OBSERVATIONS ON THE PRIMATES OF THE AREA DE CONSERVACIÓN PRIVADA PANGUANA, PERUVIAN AMAZONIA

Miriam Göbel[1,2] and Eckhard W. Heymann[2,*]

[1]Abteilung Paläobiologie und Umwelt, Institut für Ökologie, Evolution und Diversität, Goethe-Universität Frankfurt, Germany, goebel_miriam@web.de
[2]Verhaltensökologie & Soziobiologie, Deutsches Primatenzentrum - Leibniz-Institut für Primatenforschung, Göttingen Germany; eheyman@gwdg.de
** Corresponding author*

Abstract

We report results from the first systematic survey and ecological observations of primates of the Área de Conservación Privada Panguana (ACPP), located in Peruvian Amazonia between the Sira Mountains, the eastern slopes of the Andes and, the Gran Pajonal. Seven primate species (*Leontocebus leucogenys*, *Saimiri boliviensis peruviensis*, *Cebus yuracus*, *Aotus nigriceps*, *Alouatta seniculus*, *Plecturocebus discolor*, *Pithecia inusta*) were encountered during the study. Their group sizes were within ranges reported for the same or for related species at other sites, but tended to range at the lower end of group size values. No habitat preferences were detected except for *L. leucogenys* and *S. boliviensis peruviensis* who were more frequently encountered around or within forest gaps. Plant species or genera consumed during our observations coincide with species and genera reported from other areas, and several are also used by humans. ACPP is an important natural refuge in a landscape otherwise that is increasingly altered by human activities.

Keywords: *Leontocebus leucogenys*, *Saimiri boliviensis peruviensis*, *Cebus yuracus*, *Alouatta seniculus*, *Plecturocebus discolor*, *Pithecia inusta*, group size, habitat use, diet

Resumen

Reportamos los resultados del primer estudio sistemático y observaciones ecológicas de los primates del Área de Conservación Privada Panguana (ACPP), ubicada en la Amazonía peruana entre los Cerros de El Sira, los vertientes orientales de los Andes, y el Gran Pajonal. Encontramos siete especies de primates (*Leontocebus leucogenys*, *Saimiri boliviensis peruviensis*, *Cebus yuracus*, *Aotus nigriceps*, *Alouatta seniculus*, *Plecturocebus discolor*, *Pithecia inusta*). El tamaño de los grupos estuvo dentro del rango reportado para las mismas especies o especies relacionadas en otros lugares, pero tendieron hacia los valores inferiores. No se encontraron preferencias de habitat, salvo en *L. leucogenys* y *S. boliviensis peruviensis*, que fueron encontradas con mayor frecuencia cerca o dentro de claros del bosque. Especies o géneros de plantas consumidas durante las observaciones coinciden con especies o géneros reportados para otras áreas, y varios de ellos son también explotados por humanos. ACPP es un refugio natural en un paisaje cada vez más alterado por actvidades humanas.

Palabras clave: *Leontocebus leucogenys*, *Saimiri boliviensis peruviensis*, *Cebus yuracus*, *Alouatta seniculus*, *Plecturocebus discolor*, *Pithecia inusta*, tamaño grupal, uso de hábitat, dieta

Introduction

Founded in 1968, Panguana is the oldest biological research station in Peru. In 2011, it was officially recognized by the Peruvian Ministry of the Environment as a private conservation concession, the Área de Conservación Privada Panguana (ACPP; https://en.wikipedia.org/wiki/Panguana). It is located in western Amazonian lowlands, but rather isolated from the major tracts of Amazonian forests due to its position between the Cerros de El Sira (Sira Mountains) to the east, the eastern slopes of the Andes to the west, and the Gran Pajonal to the south (Fig. 1). This isolation makes it an interesting place for biological research, and more than 180 papers have been published on its flora and fauna. However, primates at ACPP have only been cursorily mentioned in the context of a mammal survey that reports the presence of eight primate species in the area (Hutterer et al., 1995), and in a very short study of *Leontocebus leucogenys* (= *Saguinus fuscicollis leucogenys*) (Podloucky, 1978).

Neotropical primate communities are very variable with regards to richness and composition, with rainfall being a major determinant of this variation (Peres and Janson,

1999). Probably due to the shielding effect of the Sira Mountains, ACPP has a long season of reduced rainfall, compared to other lowland Amazonian sites (Fig. 2). Given the strong influence of seasonality on primate ecology (Brockman and van Schaik, 2005; Terborgh, 1983), this makes Panguana an interesting place for studying the ecology of the local primate community. Furthermore, ACPP is located in a region of increasing human impacts on the environment and information on its primate community is important in the context of conservation efforts. Therefore, this study aimed at providing basic ecological information on primates at ACPP, as a starting point for future detailed studies. Specifically, we report data on group size and habitat use of primates at ACPP.

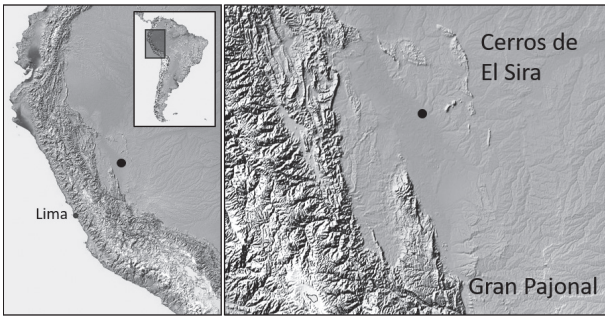

Figure 1. Geographic location of the study area. The black dot indicates the location of ACP Panguana. Map after NASA, http://photojournal.jpl.nasa.gov/jpeg/PIA03388.jpg, downloaded on 8 November 2016.

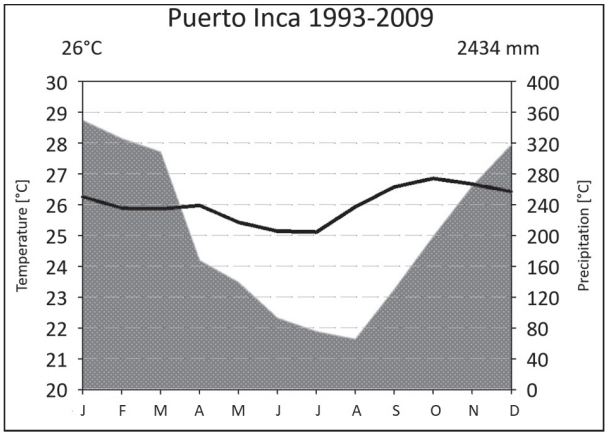

Figure 2. Climate diagram for the nearest meteorological station, Puerto Inca (09°22'53" S 74°57'39" W; 200 m a.s.l.), 1993-2009. Data from Servicio Nacional de Meteorología e Hidrología (SENAMHI; www.senamhi.gob.pe).

Methods

Study site and period

ACPP lies in the Huánuco department of Peru, on the south bank of the Río Yuyapichis (=Llullapichis), a tributary of the Río Pachitea, at 09°37'S 74°56'W and an altitude between 220 and 260 m a.s.l. (Kovařík et al., 2015). Average temperature at the nearest meteorological station (Puerto Inca, 30 km from Panguana) is 26°C, and annual precipitation 2,434 mm, with about 2.6 times more rainfall in the wet season from October to March compared to the dry season from April to September (Fig. 2). The Cerros de El Sira with elevations up to 2,500 m are situated about 40 km to the east, and the eastern slopes of the Andes about 150 km to the west of ACPP. Since these two mountain ranges meet at the Gran Pajonal in the south, the principal connection of the forests at ACPP with other tracts of Amazon rainforest is in the north.

ACPP covers an area of around 12.5 km^2. The hilly terrain is covered with little disturbed primary *terra firme* forest, characterized as evergreen seasonal rain forest of the preandine Hylaea (Ellenberg, 1959; Hutterer et al., 1995), and with secondary forest of different ages. It is interspersed with creeks and small permanent ponds. Cattle meadows limit the forest in some areas, the Río Yuyapichis limits the study area in the north. Pampas Verde, a village of the indigenous Asháninka, is the nearest human settlement at about 3 km from the study area. The next small city, Yuyapichis, is situated at a distance of about 4 km on the opposite bank of the Río Pachitea. Within the area of ACPP, a section of ca. 1 km² with existing paths was selected for the study. Paths were used to define five (non-independent) trails of about the same length (3 km) that were used for surveying and habitat characterization. Data were collected by the first author (MG) between 23 February 2016 and 28 March 2016, and between 5 May 2016 and 6 July 2016.

Primate observations

Hutterer et al. (1995) had recorded eight primate species in the area of the ACPP. We re-assigned the species occurring in Panguana in the light of recent taxonomic changes (Table 1). To collect data on primates, MG walked the five defined trails either from starting to end point or in the opposite direction five times per direction in the morning and afternoon, respectively. Thus, every trail was walked 20 times by the totally 100 walks. Walks took place from 0630 h to 1000 h and from 1400 h to 1700 h at a speed of about 1 km/h. The order of walked trails and the walking direction (starting to end point or end to starting point) were varied systematically. Upon encountering primates, on the following data were recorded: species, number of individuals sighted, habitat type (forest or gap), ranging height in trees (of the majority of animals during encounter), predominant canopy height, height of the highest tree, geographic position (recorded with a Garmin GPSMAP 64s), and time of day. Tree height was categorized in 5 m bins (5-10 m, 10-15 m etc.). Areas with very young secondary vegetation and canopy heights of <5 m were defined as gaps. We recorded habitat type as gaps if primates ranged inside or at the edge (i.e., within 5 m) of a gap.

Table 1. Primates of ACPP. Light grey cells: primate species encountered during this study.

Family	Primate species reported by Hutterer et al. (1995)	New taxonomic assignment	References for new assignments
Callitrichidae	*Saguinus fuscicollis*	*Leontocebus leucogenys*	Matauschek et al., 2011; Rylands et al., 2016
Aotidae	*Aotus nigriceps*	*Aotus nigriceps*	
Cebidae	*Cebus albifrons*	*Cebus yuracus*	Boubli et al., 2012; Ruiz-Garcia et al., 2010
	Saimiri sciureus	*Saimiri boliviensis peruviensis*	Lynch Alfaro et al., 2015
Atelidae	*Alouatta seniculus*	*Alouatta seniculus*	
	Lagothrix lagothricha	*Lagothrix lagothricha poeppigii*	Aquino et al., 2015a
Pitheciidae	*Callicebus cupreus*	*Plecturocebus discolor*	Byrne et al., 2016
	Pithecia monachus	*Pithecia inusta*	Marsh, 2014

When an exact count of individuals was not possible (either due to large group size and/or to wide group spread), group size was estimated. Precaution was taken to exclude counting the same group during the same walk. When primates were encountered outside of systematic trail walks, or, due to decreasing visibility, more than 25 m away from trails, we classified observations as chance encounter. We used the same protocol as during systematic observations. To avoid biasing results, data from chance encounters were used only for descriptive purposes, not in quantitative analyses.

Habitat characterisation

To characterise the habitat, 32 10 m x 20 m plots were established every 200 m along survey trails and their position with regard to the trail varied systematically, if possible (Fig. 3). Within each plot, mean tree height and the height of the highest tree were estimated (5 m bins). The DBH (diameter at breast height) of all trees with DBH ³5 cm was measured with a measuring tape. From this, we calculated the basal area and the number of small trees (DBH 5-10 cm), number of medium trees (DBH 10-20 cm), number of large trees (DBH ³20 cm). To estimate canopy cover, MG took photographs from ground level (Ganzhorn et al., 2011): one picture from the centre of every plot and one from each corner. Finally, MG noted size and position of all gaps within a distance of <25 m from the trails, as well as their gross shape (circular or rectangular) and estimated size in 50 m2 bins.

Data analyses

We used QGIS 2.16.1 (QGIS Development Team, 2016) for all geostatistical data management. We imported geographic coordinates of paths, primate observations, habitat plots and gaps from the Garmin GPSMAP 64s. To compute the study area, we created a buffer of 25 m along both sides of trails. We manually added sized and positioned gaps to scale at the given positions and added a buffer of 5 m to all gaps, because primates that were observed in this radius were noted as ranging in a gap. For describing habitat use of primates, we assigned all location records to the nearest habitat plot. For determination of borders between plot areas, we used Voronoi polygons. To calculate plot area sizes and total area of gaps within the observation or plot areas, we clipped the layers. We transferred the photographs of canopy covers from the plots to binary images so that black pixels could be counted. We performed both with GIMP 2.8.16 (GNU Image Manipulation Program; Kimball et al., 2012). We pooled results for each plot.

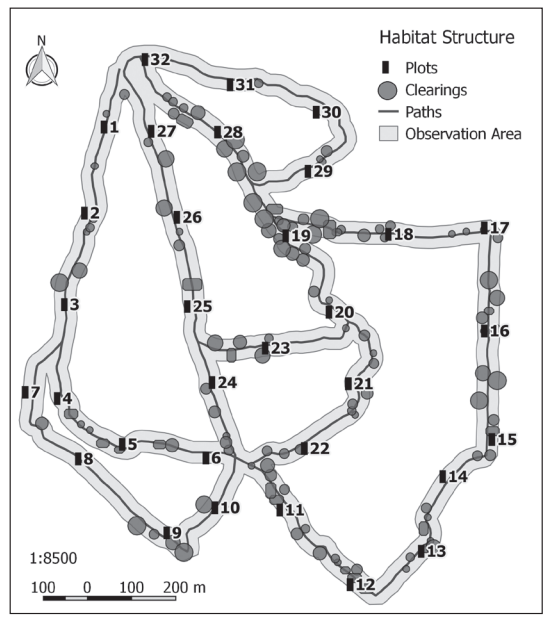

Figure 3. Location of survey trails and habitat plots.

Statistical analyses

For statistical analyses we only used systematic survey data, the significance level (p-value) for all analyses was 0.05. To test whether primates used the two principal habitat types (forest, gaps) according to availability or exhibited preference for one or the other, we performed exact binomial tests and used a Bonferroni correction to adjust significance levels (p*= 0.01). To account for co-variation between habitat variables, we computed a principal component analysis (PCA). Habitat properties (predominant canopy height, height of highest tree, basal area, canopy cover, number of small, medium and large trees, and percentage of area covered by gaps) were used as variables. Since the first two factors resulting from the PCA accounted for only 44% of variance and correlations between the variables were low

(between -0.29 and 0.51), we tested the influence of habitat properties on primate occurrence separately with a Spearman's rho rank correlation test. Again, we used a Bonferroni correction to adjust significance levels (p*=0.0065). Beforehand, we checked habitat properties for normal distribution using Shapiro-Wilk normality test. We conducted the PCA in STATISTICA 12.0 (StatSoft, Inc., 2014) and all other statistical tests in R 3.3.1 (R Core Team, 2016).

Results

We obtained a total of 279 observations of seven primate species (*A. seniculus, A. nigriceps, C. yuracus, L. leucogenys, P. inusta, P. discolor, S. boliviensis*). One hundred seventy-eight observations were made during systematic surveys, 101 observations were chance encounters. We observed *Cebus yuracus* only during systematic surveys, *A. nigriceps* only during chance encounters, and never encountered *L. lagothricha*. Numbers of observations differed largely between species, ranging from a total of two observations of *A. nigriceps* and *C. yuracus* to a total of 116 observations of *L. leucogenys*. Mean group size varied from 2.5 individuals in *P. discolor* to 22 individuals in *S. boliviensis* (Table 2). Maximum group size ranged between 4 and 8 individuals for all species except *S. boliviensis*, for which the highest count was 40 individuals.

Table 2. Observed primate group sizes at the ACP Panguana and closely related species at other locations. We pooled the data from systematic surveys and chance encounters, as means did not differ from each other. SE: standard error; n: number of sightings; Max.: maximum; NA: not available; * mode.

Group size at ACP Panguana					Group size at other locations/regions				
Species	Mean (SE)	Mode	Max.	n	Species	Group Size		Location/region	Reference
						Mean	Range		
Leontocebus leucogenys	3.8 (0.2)	4	8	112	*Leontocebus* sp.	5	2-9	3°S (northern Peru) to 18°S (southern Bolivia)	Freese et al., 1982
					Leontocebus illigeri	6*	2-10	Pacaya-Samiria National Reserve, Peru	Soini, 1987
Aotus nigriceps	NA	NA	4	2	*A. nigriceps*	2.8 ± 0.6	2-4	Río Urubamba and Río Tambo, Peru	Aquino et al., 2013
						3.6	2-4	upper Rio Urucú, Brazil	Peres, 1993
Saimiri boliviensis peruviensis	22.0 (19.3)	20	40	25	*S. b. peruviensis*	32	12-50	Pacaya-Samiria National Reserve, Peru	Soini, 1986
					S. b. boliviensis	53.7	45-75	Manu National Park, Peru	Boinski et al., 2003; Mitchell, 1994
						15.6 ± 3.1	13-19	Río Urubamba and Río Tambo, Peru	Aquino et al., 2013
Cebus yuracus	NA	NA	4	2	*C. yuracus*	8.3	5-10	Pacaya-Samiria National Reserve, Peru	Soini, 1986
						10.3 ± 2.9	6-13	Río Urubamba and Río Tambo, Peru	Aquino et al., 2013
							9-15	Huánuco a nd San Martín, Peru	Aquino et al., 2017
Alouatta seniculus	3.6 (1.0)	3	6	8	*A. seniculus*	5.5	2-13	Pacaya-Samiria National Reserve, Peru	Soini, 1986
						5.6 ± 2.1	4-8	Río Urubamba and Río Tambo, Peru	Aquino et al., 2013
						5 ±1.9	3-9	Chontayacu, Chinchao and Alto Huallaga, Peru	Aquino et al., 2015b
							2-5	Huánuco and San Martín, Peru	Aquino et al., 2017
Plecturocebus discolor	2.5 (0.2)	2	5	39	*P. discolor*	3.5 ± 0.6	2-6	Tiputini Biodiversity Station, Ecuador	Dacier et al., 2011; Van Belle et al., 2016
Pithecia inusta	3.4 (0.3)	3	7	39	*Pithecia isabela*	4 ± 1.5	2-8	Pacaya-Samiria National Reserve, Peru	Soini, 1988
					Pithecia monachus -group	1.9-5.2	2-8	Western Pando, Bolivia different locations	Izawa and Yoneda, 1981; Norconk & Setz, 2013

The observation area had a total size of 35.7 ha, 82% of which were covered by forest and 18% by gaps (including a 5m buffer around gaps). We observed *L. leucogenys* (p<0.0001) and *S. boliviensis* (p=0.0089) more often in gaps than expected by chance. *Pithecia inusta* (p=0.0156) and *P. discolor* (p=0.0484) seemed to prefer gaps, however, values were not significant when p-levels were adjusted. *Alouatta seniculus* (p = 1) did not show a preference. For *A. nigriceps* and *C. yuracus*, the number of sightings was too low to examine habitat preferences.

The frequency of sightings of *S. boliviensis* correlated with the size of the area covered by gaps (rho=0.51, p=0.003). We also noted the following trends: frequency of sightings of *S. boliviensis* and basal area (rho=0.37, p=0.0375), and frequency of sightings of *P. inusta* and maximum tree height (rho=0.43, p=0.0133); in both cases, p-values are higher than the adjusted p-values. There was no other significant correlation of trend. We observed feeding on 14 plant species directly and found residuals from six plant species below sites where we had spotted primates (Table 3).

Table 3. Plant species recorded in the diet of primates at ACPP. fl: flower; fr: fruit. *A. n.*: *Aotus nigriceps*; *A. s.*: *Alouatta seniculus*; *C. y.*: *Cebus yuracus*; *L. l.*: *Leontocebus leucogenys*; *P. d.*: *Plecturocebus discolor*; *P. i.*: *Pithecia inusta*; *S. b.*: *Saimiri boliviensis*; d: direct feeding observation; r: feeding residuals encountered below place of primate sighting.

Family	Species	Local name	Part consumed	Primate species						
				L. l.	*A. n.*	*S. b.*	*C. y.*	*A. s.*	*P. d.*	*P. i.*
Acanthaceae	*Mendoncia* cf. *lindavii*		fl							r
Anacardiaceae	*Spondias mombin*	Ubo grande	fr							d
Anacardiaceae	*Spondias* sp.	Ubo chico	fr							d
Annonaceae	*Annona* sp.	Anonilla	fr			d				d
Annonaceae	*Mosannona raimondii*		fr					d		r
Arecaceae	*Astrocaryum* sp.	Huicongo	fr							r
Arecaceae	*Attalea phalerata*	Shapaja	fr			d				
Arecaceae	*Iriartea deltoidea*	Cashapona	fr							r
Arecaceae	*Oenocarpus bataua*	Ungurahui	fr							r
Bombacaceae	*Quararibea* sp.	Sapote	fr	r						
Fabaceae	*Dipteryx odorata*	Shihuahuaco	fr			d				
Fabaceae	*Inga* sp. *1*	Shimbillo	fr			d				
Fabaceae	*Inga* sp. *2*	Shimbillo	fr			d				
Fabaceae	*Inga* sp. *3*	Shimbillo	fr		i					d
Malvaceae	*Malvaviscus concinnus*		fl, fr			d				
Malvaceae	*Theobroma cacao*	Cacao	fr	d						
Moraceae	*Ficus* cf. *pertusa*		fr					d		
Moraceae	*Ficus* sp.		fr	d	d	d				
Moraceae	*Naucleopsis glabra*	Cacahuillo	fr	r						
Myrtaceae	indet.		fr			d				

Discussion

We encountered all primate species reported by Hutterer et al. (1995) except for the largest one, *L. lagothricha*. This species has not been seen in the area of ACPP (Juliane Diller, pers. comm.; Carlos Vásquez Módena, pers. comm.) within the last 50 years. It was listed by Hutterer et al. (1995) based on skulls obtained 10 km east of Panguana and hunters seen with dead woolly monkeys outside the area. Apparently, *Lagothrix lagothricha* went locally extinct, probably due to hunting. Although hunting of primates is prohibited by Peruvian law, large species like *L. lagothricha* are heavily hunted fur bushmeat throughout Amazonia and consequently become generally rare or locally extinct (Aquino et al., 2016; Peres, 1990). *Cebus yuracus* was present in the area 20-50 years ago but had not been seen for almost 20 years (Carlos Vásquez Módena, pers. comm.). This species seems to recover, probably due to the increase in size of the protected area since the creation of ACPP in 2011.

For all species except *C. yuracus* (which was only encountered twice) group sizes observed at ACPP are within ranges reported for the same or for related species at other sites, but tended to range at the lower end of group size values. Carlos Vásquez Módena (pers. comm.) reported that group size of capuchins in the area had always been small 20-50 years ago and that they usually travelled together with *Saimiri* groups. In the absence of data on factors that might affect group size (e.g. habitat productivity), we refrain from discussing causes of the trend towards smaller group sizes of primates at Panguana.

The only species to show obvious habitat preferences were *L. leucogenys* and *S. boliviensis*. The higher encounter rates of these highly insectivorous primates close to or within gaps might relate to a higher abundance of insects (Fowler et al., 1993). However, *Leontocebus nigrifrons* does not show increased prey foraging success in young secondary forest compared to primary forest, despite probably higher abundance, at least of katydids in the former (Kupsch et al., 2014).

Almost all plant species consumed by primates during our study come from genera that have been reported to be part of the diet of primates at other sites. Given the short study period, the list of species likely represents only a small fraction of what is actually used. Several plant species are actually also exploited as food, construction material or medicine by humans (Duke and Vasquez, 1994).

In sum, our study provides the first systematic data on the primates of the ACPP. These data must be considered as preliminary and do not allow to draw far-reaching conclusions. In any case, this area warrants further study, on one hand due to its geographic location, on the other hand because its protection status converts it into an important natural refuge within an otherwise increasingly altered landscape.

Acknowledgements

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ESTADO DE LA INVESTIGACIÓN PRIMATOLÓGICA EN EL EJE CAFETERO Y ANTIOQUIA, COLOMBIA

Sebastián García-R[1,2,3], Sebastián O. Montilla[2,3], Vanessa Bustamante Manrique[3], Sebastián Bustamante Manrique[4], Camilo Cepeda-Duque[5], Juan David Sánchez Londoño[1,6], Héctor E. Ramírez-Chaves[7]

[1] Grupo Mastozoología Universidad de Antioquia. Calle 67 No. 53 – 108 Medellín, Colombia. sebasgr93@gmail.com
[2]Laboratorio de Ecología de Bosques Tropicales y Primatología, Universidad de Los Andes. Cra 1 No. 18A – 12 Bogotá, Colombia. juansomontilla94@gmail.com
[3]Fundación Proyecto Primates. Cra. 11a N° 91-55 Bogotá, Colombia. v.bustamantemanrique@gmail.com
[4]Semillero de Investigación en Primatología y Conservación de sus Ecosistemas Universidad de Caldas. Calle 65 No 26 - 10 Manizales, Colombia. sebastianbustamantemanrique@gmail.com
[5]Grupo de Investigación en Biología de la Conservación y Biotecnología. Km 4 Vía Santa Rosa de Cabal – Chinchiná, Santa Rosa de Cabal, Colombia. acinonyxjubatus96@gmail.com
[6]Facultad de Ciencias y Biotecnología, Universidad CES. Calle 10A No. 22 – 04 Medellín, Colombia. jdavids21@gmail.com
[7]Departamento de Ciencias Biológicas, Facultad de Ciencias Exactas y Naturales, Universidad de Caldas, Calle 65 # 26-10, Manizales, Colombia. hector.ramirez@ucaldas.edu.co

Abstract

The Tropical Andes Hotspot is a high conservation priority. A high proportion of the northern Colombian Andes has been deforested affecting its biological diversity, including primates, for which there are information gaps that hinder the formulation of conservation strategies. We conducted a bibliographic search on studies of non-human primates developed in the northern portion of the Central and Western cordilleras, to generate a baseline facilitating the priorization of information generation and guidelines to formulate research projects at the regional level. We updated the species list for the fourth departments evaluated, recording a total of 13 species (Antioquia: 13; Caldas: 6; Risaralda: 5; Quindío: 2). We compiled a total of 120 studies which evidenced a greater research effort in topics related to ecology, genetics, and veterinary medicine, as well as a reduced emphasis in ethnobiological research. *Saguinus leucopus* and *Alouatta seniculus* were the most studied species, contrasting with the scarce information generated for threatened species such as *Ateles fusciceps*, *Ateles hybridus*, three especies of *Aotus* (*lemurinus*, *zonalis, griseimembra*), *Alouatta palliata, Cebus versicolor*, *Lagothrix lagotricha, Saguinus geoffroyi* and *Saguinus oedipus.*

Keywords: Tropical Andes Hotspot, distribution, endemism, Primates.

Resumen

El Hotspot de los Andes Tropicales es una alta prioridad de conservación. Una gran proporción del norte de los Andes colombianos ha sido deforestado afectando su diversidad biológica, entre ella la de primates, para los cuales existen vacíos de información que dificultan la formulación de estrategias de conservación. Realizamos una búsqueda y análisis de información bibliográfica de los estudios sobre primates no humanos que se han desarrollado en la parte norte de las cordilleras Central y Occidental de Colombia, con el objetivo de generar una línea base que facilite la identificación de prioridades de generación de información y oriente la formulación de proyectos de investigación regionales. Actualizamos la lista de especies para los cuatro departamentos evaluados, registrando 13 especies (Antioquia: 13; Caldas: 6; Risaralda: 5; Quindío: 2). Con base en 120 estudios se evidenció un mayor esfuerzo de investigación en temas concernientes a la ecología, genética, y medicina veterinaria, así como un reducido énfasis en trabajos etnobiológicos. Las especies que han sido más estudiadas son *Saguinus leucopus* y *Alouatta seniculus*; lo que contrasta con la poca información que se ha generado acerca de especies amenazadas como *Ateles fusciceps*, *Ateles hybridus*, tres especies de *Aotus* (*lemurinus*, *zonalis, griseimembra*), *Alouatta palliata, Cebus versicolor*, *Lagothrix lagotricha, Saguinus geoffroyi* y *Saguinus oedipus*.

Palabras clave: Hotspot de los Andes Tropicales, distribución, endemismo, Primates.

Introducción

La región andina es considerada como un Hostpot de biodiversidad al contener un 16% de todos los vertebrados terrestres sobre el planeta, de los cuales un 60% son endémicos (Ceballos y Ehrlich, 2006; Loyola *et al.*, 2009). El impacto al que se ha visto sometida esta región en Colombia, donde el 70% de la población se concentra, ha sido extenso; entre 1985 y 2005 se deforestaron cerca de 1.460.000 ha en los Andes colombianos (Armenteras *et al.*, 2011), y 36.757 ha en 2017 (IDEAM, 2018). En el departamento de Antioquia y el Eje Cafetero (departamentos de Caldas, Quindío y Risaralda) de la región andina de Colombia, los procesos de deforestación han transformado extensamente el paisaje, el cual es dominado por potreros, pastizales, plantaciones forestales y cafetales, e inmersos en esta matriz principal se encuentran remanentes de ecosistemas naturales (Rodríguez y Arango, 2004; Orrego y Ramírez, 2011; Yepes-Quintero *et al*., 2011).

En Colombia, uno de los países con los más grandes asentamientos humanos en la zona andina, han sido registradas 38 especies de primates, de las cuales 10 son endémicas (26.3%), y 20 (52.6%) se encuentran bajo alguna categoría de amenaza (Defler, 2013; Resolución 1912 del 15 de septiembre de 2017; UICN, 2017; Asociación Primatológica Colombiana, 2018). El número de especies, así como el estado de conocimiento de los primates presentes en el Eje Cafetero y Antioquia no han sido evaluados recientemente. Sin embargo, se han listado entre 11 (Cuartas-Calle y Muñoz-Arango, 2003) y 13 especies de primates para Antioquia (Defler, 2010), entre cuatro y seis para el departamento de Caldas (Castaño *et al.,* 2003; Defler, 2010), y entre dos (Defler, 2010) y cinco especies (Castaño *et al.,* 2017) para el departamento de Risaralda (Anexo 1). Por su parte, para el Quindío no existe una lista de mamíferos del departamento, aunque existen registros de dos especies: *Alouatta seniculus* (Solari *et al.,* 2013) y *Aotus lemurinus* (Montilla *et al.*, 2018).

En este trabajo describimos la riqueza y el estado de conocimiento de los primates para la región en cuestión, con el propósito de identificar los principales vacíos de información para generar una línea base que oriente la formulación de proyectos de investigación y estrategias regionales de conservación de la fauna de primates.

Métodos

Área de estudio

El área de estudio comprende los departamentos de Antioquia, Caldas, Quindío y Risaralda, que incluye las regiones de los Andes centrales y occidentales, así como valles interandinos. Los límites abarcan desde el Valle del Magdalena Medio en Antioquia y Caldas, hasta el flanco occidental de la cordillera Occidental (que incluye la región del Pacífico antioqueño), que va desde las estribaciones de la cordillera Occidental hasta la margen oriental del río Atrato, y la vertiente del Pacífico del departamento de Risaralda. Los departamentos de Caldas, Quindío y Risaralda configuran la región del Eje Cafetero (Fig. 1), declarada como Patrimonio Cultural de la Humanidad por la UNESCO (Meskell, 2012). En conjunto, los cuatro departamentos se encuentran en las Provincias Chocó-Darién, Magdalena y Cauca (Morrone, 2014).

Revisión bibliográfica

Realizamos una búsqueda de artículos científicos, capítulos de libros, resúmenes de congresos, informes no publicados, trabajos de grado y tesis de posgrado relacionados con estudios de primates en los cuatro departamentos de interés. Recolectamos la información a través de buscadores como Google Scholar y bases de datos generales como ScienceDirect y Web of Science, y específicas de primates como PrimateLit, utilizando los nombres de los departamentos, los nombres genéricos y epítetos específicos y "Primates" como palabras clave. Incluimos estudios con datos de muestreo en campo en la región, además de listas departamentales y nacionales de especies. Estas fuentes digitales de información arrojaron resultados desde el año 1986 a 2017.

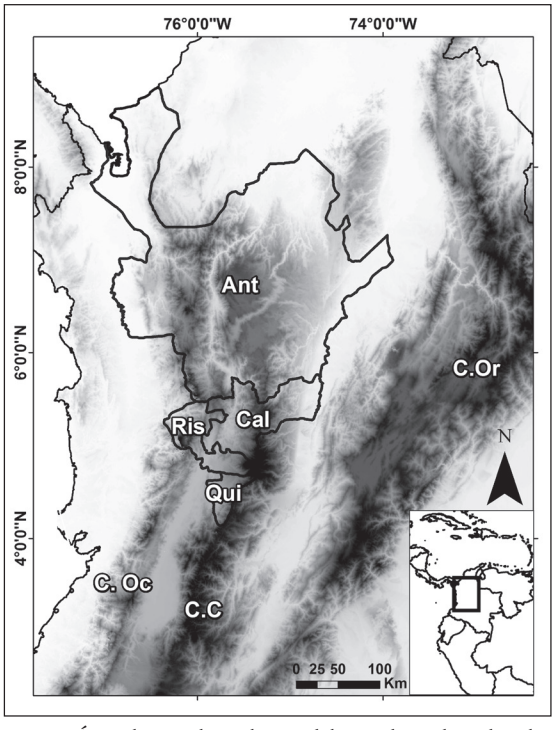

Figura 1. Área de estudio. El área delimitada incluye los departamentos de Antioquia (Ant) al norte, Caldas (Cal) al centro-oriente, Risaralda (Ris) en el centro-occidente y Quindío (Qui) al sur. C.Oc: Cordillera Occidental; C.C: Cordillera Central; C.Or: Cordillera Oriental.

Clasificamos cada una de las publicaciones e informes no publicados en cinco categorías dependiendo de su enfoque: 1. Distribución, 2. Ecología, 3. Etnobiología, 4. Genética/Molecular, y 5. Medicina Veterinaria. Además, consideramos el año de publicación, el departamento donde se realizó y las especies o el grupo de especies estudiadas.

Es importante señalar que los estudios en *Ateles geoffroyi* y *Cebus albifrons* realizados con animales en cautiverio (Ruiz-García *et al.*, 2007; Jiménez-Nicholls *et al.*, 2009; Lasprilla *et al.*, 2009; Romero *et al.*, 2011) no fueron considerados en la presente revisión, debido a la imposibilidad de confirmar su procedencia e identificación taxonómica de acuerdo con los cambios recientes. Para las demás especies evaluadas incluimos trabajos realizados tanto en cautiverio como en vida silvestre dado que se distribuyen naturalmente en la región.

Consideraciones taxonómicas

Ateles geoffroyi no se incluye en la lista de primates colombianos de la Asociación Primatológica Colombiana (APC, 2018) a pesar de que se reporta en listas de especies departamentales y nacionales de años anteriores (Cuartas-Calle y Muñoz-Arango, 2003; Solari *et al.*, 2013; Ramírez-Chaves *et al.*, 2016). En el presente trabajo consideramos a *A. geoffroyi* y *A. fusciceps* como especies con distribuciones disyuntas encontrándose la última en el territorio colombiano, y, a *C. versicolor* como especie diferente de *C. albifrons* (Rylands *et al.*, 2013; APC, 2018).

Listas departamentales de especies

Actualizamos la lista de especies por departamento a partir de la información bibliográfica, así como de especímenes de colecciones biológicas entre las que se encuentran la Colección Teriológica de Antioquia, Universidad de Antioquia (CTUA), Medellín; Museo de Ciencias Naturales de La Salle, Instituto Tecnológico Metropolitano, Medellín (ITM); el Museo de Historia Natural de la Universidad del Cauca, Popayán (MHNUC), la Colección de Mamíferos del Museo de Historia Natural de la Universidad de Caldas (MHN-UCa); Museo Universitario Universidad de Antioquia, Medellín (MUUA). El tratamiento taxonómico sigue a la lista de los primates colombianos de la Asociación Primatológica Colombiana (APC, 2018) que adoptó diversas propuestas taxonómicas (i.e. Botero *et al.*, 2010; Defler *et al.*, 2010; Ruiz-García *et al.*, 2010; Boubli *et al.*, 2012; IGUN *et al.*, 2012; Lynch-Alfaro *et al.*, 2012; Buckner *et al.*, 2015; Link *et al.*, 2015) y los cambios recientes en la lista de los mamíferos de Colombia (Ramírez-Chaves *et al.*, 2016). Finalmente, consultamos el estado de amenaza de cada especie recurriendo a la lista roja de especies amenazadas de la Unión Internacional para la Conservación de la Naturaleza (UICN, 2017) y a la Resolución 1912 del 15 de septiembre de 2017 que establece la lista de las especies silvestres amenazadas a nivel nacional.

Resultados

Especies de primates en Antioquia y el Eje Cafetero

A partir de la información consultada, reportamos para los departamentos de Antioquia, Caldas, Quindío y Risaralda, un total de 13 especies (cuatro especies y una subespecie endémica de Colombia; Tabla 1). Antioquia posee el mayor número de especies con 13, seguido por Caldas con seis y Risaralda con cinco, mientras que para el departamento de Quindío registramos dos especies. De las 13 especies reportadas, diez se encuentran bajo alguna categoría de amenaza según la lista más reciente de especies de fauna silvestre amenazadas de Colombia (Resolución 1912 del 15 de septiembre de 2017) y la UICN (2017; Tabla 1).

Tabla 1. Primates de los departamentos de Antioquia, Caldas, Quindío y Risaralda. UICN= Categorías de la Unión Internacional para la Conservación de la Naturaleza; DD= Datos insuficientes, LC= Preocupación menor, VU= Vulnerable, EN= Amenazada, CR= Críticamente amenazado.

Familia	Especie	Subespecie	Categoría de amenaza para Colombia[A]	UICN	Departamento
Aotidae	*Aotus griseimembra*[B]	-	VU	VU	Ant, Cal
	Aotus lemurinus	-	VU	VU	Ant, Cal, Qui, Ris
	Aotus zonalis	-	VU	DD	Ant
Atelidae	*Alouatta palliata*	*A. p. aequatorialis*	VU	LC	Ant, Ris
	Alouatta seniculus	-	-	LC[E]	Ant, Cal, Qui, Ris
	Ateles fusciceps	*A. f. rufiventris*	EN	CR[F]	Ant, Ris
	Ateles hybridus	-	CR	CR	Ant, Cal
	Lagothrix lagothricha	*L. l. lugens*[C]	VU	VU[G]	Ant
Callitrichidae	*Saguinus geoffroyi*	-	-	LC	Ant
	Saguinus leucopus[B]	-	VU	EN	Ant, Cal
	Saguinus oedipus[B]	-	CR	CR	Ant
Cebidae	*Cebus versicolor*[B]	-	EN[D]	EN	Ant, Cal
	Cebus capucinus	-	-	LC	Ant, Ris

[A]**Resolución 1912, 15 de Septiembre de 2017.** Bogotá, Colombia. [B]*Especie endémica de Colombia* (APC, 2018). [C]*Subespecie endémica de Colombia* (APC, 2018). [D]Defler, 2010. [E]*Alouatta seniculus seniculus.* [F]*Ateles fusciceps.* [G]*Lagothrix lagothricha.*

Estado del conocimiento de la primatofauna

Recopilamos 120 estudios sobre primates en la región, de los cuales 27 fueron investigaciones realizadas con animales en cautiverio. La mayoría de los estudios fueron realizados en el departamento de Antioquia (63%), seguidos por Caldas (18%) y Risaralda (13%) y en menor proporción el departamento del Quindío (6%). Dos investigaciones fueron compartidas entre los departamentos de Antioquia-Risaralda, y Caldas-Risaralda respectivamente.

El número de investigaciones con primates se incrementó durante la década pasada y alcanzó un máximo en el año 2010; para el año 2012 encontramos solamente cinco trabajos (Fig. 2), y desde entonces se ha incrementado nuevamente, principalmente en el departamento de Antioquia (Fig. 2). La mayor parte de documentos producidos (Fig. 3) corresponden a artículos científicos (n=74), seguidos por trabajos de grado (n=23), informes técnicos (n=14), resúmenes de congresos (n=4) y capítulos de libros (n=5).

En cuanto a los temas de investigación, encontramos que la mayoría de los trabajos correspondieron a investigaciones sobre Ecología (n=50), que incluyen estudios relacionados con patrones de actividad, dieta y densidad poblacional. Las categorías Genética/Molecular (n=26), donde se incluyen investigaciones tanto de cariología como de caracterización genética, y Medicina Veterinaria (n=22) cuentan con más de 20 trabajos, y en menor medida Distribución (n=19). Etnobiología (n=3) fue el tema menos recurrente con trabajos solo en Antioquia y Risaralda (2 y 1 respectivamente) (Fig. 4). En Antioquia se realizaron estudios relacionados con los cinco temas de investigación definidos (n=75), mientras que en Caldas y Risaralda se abordaron investigaciones en cuatro de las cinco categorías (n=22 y n=16 respectivamente), con Ecología como el área más investigada en Risaralda (75% del total) (Fig. 4). En el departamento de Caldas la investigación en Ecología (n=8) y Genética (cariología y caracterización genética; n=3) constituyeron el 50% de su contribución al conocimiento primatológico. Por último, para el departamento del Quindío se observó la menor variedad en temas de investigación, con una mayoría de estudios ecológicos (Fig. 4).

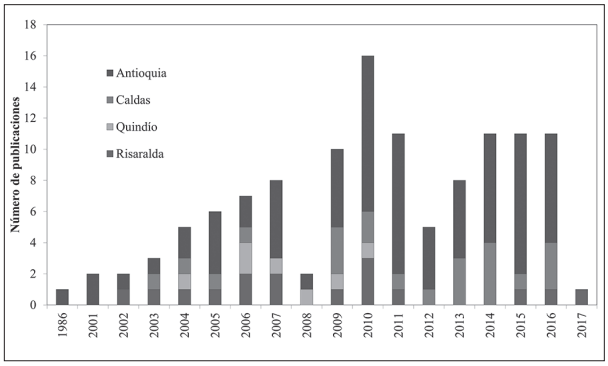

Figura 2. Número de publicaciones sobre primates no humanos de Antioquia y el Eje Cafetero por año.

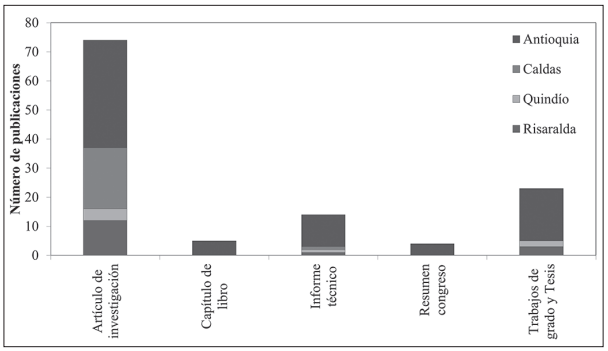

Figura 3. Número de registros por tipo de publicación sobre primates no humanos de Antioquia y el Eje Cafetero.

Con respecto a las especies, la mayor parte de la investigación se ha centrado en *Saguinus leucopus* y *Alouatta seniculus*, que doblan en número de publicaciones a las demás especies (n=59 y 40, respectivamente) (Fig. 5, Anexo 2). A pesar de que *Alouatta seniculus* está presente en el departamento de Caldas, no se tiene conocimiento de trabajos publicados en artículos científicos. Los trabajos conocidos corresponden a trabajos de grado de la Universidad de Caldas y han quedado consignados únicamente. Sin embargo, desde el 2017, el Semillero de Investigación en Primatología y Conservación de sus Ecosistemas (SIPCE), perteneciente a la misma universidad, ha adelantado trabajos con esta especie en el municipio de Neira, en temas relacionados con su ecología.

No se encontraron investigaciones sobre *Alouatta palliata aequatorialis* que, según información de registros históricos, se encuentra en el departamento de Antioquia (Anexo 1) y potencialmente se distribuye en el occidente de Risaralda. Cabe señalar que a pesar de que *C. capucinus* es la tercera especie con mayor número de estudios (n=18), la mayoría se han realizado con individuos en cautiverio (n=11). Para el caso de *Saguinus geoffroyi*, el único estudio encontrado fue realizado en cautiverio, y para *A. zonalis* sólo se encontró un reporte de distribución en un informe técnico (Fig. 5, Anexo 2).

En lo referente a las especies endémicas, de todas identificamos investigaciones, siendo *Saguinus leucopus* y *Aotus griseimembra* respectivamente, las más y menos estudiadas (n=59 y 7). En cuanto a *Ateles hybridus* sólo encontramos estudios en Antioquia y Caldas (Roncancio-Duque, 2012); la investigación de sus poblaciones en Caldas (Parque Nacional Natural Selva de Florencia) se ha visto impedida a causa de problemas de orden público en décadas anteriores (Bustamante-Manrique V, Observación personal). Evidenciamos un número bajo de estudios para *Saguinus oedipus* en la región que comprende la presente revisión (n=10, donde 6 se realizaron en cautiverio) a pesar de su condición de especie endémica con una distribución limitada al noroccidente colombiano (Savage *et al.*, 2003), y categorizada como en Peligro Crítico (Savage y Causado, 2014).

Con respecto al esfuerzo de investigación en cada departamento, la mayoría de los estudios reportados para Antioquia

se enfocaron en *S. leucopus* (n=41) y *A. seniculus* (n=22). En Caldas *S. leucopus* es la especie más estudiada (n=18) seguida por *A. lemurinus* (n=5). Por su parte, en los departamentos de Quindío y Risaralda, la investigación se ha centrado principalmente en *A. seniculus* (n=6 y 9 respectivamente).

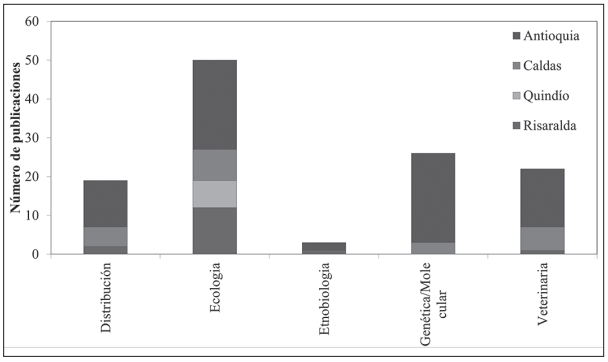

Figura 4. Número de registros por tema de investigación sobre primates no humanos de Antioquia y el Eje Cafetero.

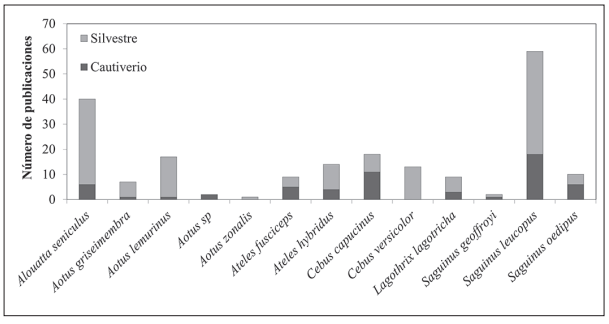

Figura 5. Número de publicaciones por especie, de primates no humanos presentes en Antioquia y el Eje Cafetero.

Discusión

El presente trabajo aporta a la sistematización de la información disponible, acerca de los estudios primatológicos desarrollados en la región del Eje Cafetero y Antioquia en las tres últimas décadas. Esta región presenta altos índices de deforestación (Etter *et al.*, 2006) pero a su vez se constituye como un importante territorio en términos de diversidad de primates, al albergar 13 de las 38 especies reconocidas actualmente en el país (APC, 2018). Sin embargo, la mayoría se encuentran en estado de amenaza (Defler, 2013) y muy poco se conoce de ellas a nivel regional (e.g. *A. fusciceps rufiventris, A. hybridus, S. oedipus, L. l. lugens, C. versicolor, A. griseimembra, A. lemurinus, A. zonalis* y *A. p. aequatorialis*) lo que dificulta en gran medida el establecimiento de acciones de conservación.

En el caso de *C. versicolor,* después de definirse como monotípica y endémica de la región del Magdalena Medio, y estar presente en una zona que ha sufrido un alto impacto por la actividad antrópica (IDEAM, 2010), es necesario fomentar estudios enfocados en su historia natural, comportamiento y ecología, con el fin de sentar las futuras bases de un plan de manejo (de la Torre *et al.*, 2015). En la región que abarca la presente revisión el mayor número de reportes corresponden a Antioquia, donde se han recolectado muestras para estudios genéticos (Ruiz-García, 2001; Ruiz-García y Álvarez, 2003; Ruiz-García *et al.*, 2010; Sánchez Castillo, 2015).

La subespecie *L. l. lugens*, endémica de Colombia, tiene un número reducido de estudios, desarrollándose la mitad de ellos en cautiverio. En la región de estudio se conocen registros de ocurrencia en el noreste Antioqueño, en jurisdicción del municipio de Zaragoza (Corantioquia, 2009), y en el piedemonte de la cordillera Central, cerca a la región del Magdalena Medio. La región se configura como una zona de estudio importante para esclarecer los límites en la distribución de las poblaciones interandinas de este taxón y tener una aproximación al estado de la conectividad entre las poblaciones del norte y sur del país.

La mayoría de las investigaciones sobre *A. griseimembra* y *A. lemurinus* corresponden a aspectos básicos de su ecología, e incluyen también valoraciones veterinarias y análisis cariológicos (Anexo 2). Estas especies presentan dificultades taxonómicas que deben abordarse principalmente a partir de estudios de genética molecular y, en segunda instancia, estudiando aspectos referentes a su distribución y morfología (Defler, 2010). Otra especie de mono nocturno con distribución potencial en la región es *Aotus jorgehernandezi.* Se cree que el espécimen tipo proviene del Parque Nacional Natural de los Nevados en límites con Risaralda, aunque fue encontrado en cautiverio en el departamento del Quindío (Torres *et al.*, 1998), sin embargo, Defler et al. (2001) descartaron la posibilidad de que fuera originario del Quindío. Desafortunadamente, el espécimen que fue depositado en el Instituto de Ciencias Naturales (ICN 14023) no ha sido localizado (Defler y Bueno, 2007; Ramírez-Chaves, 2011) por lo que no fue incluido en la presente revisión.

En la región Pacífico del área de estudio se encuentran cinco especies de primates (*Ateles fusciceps rufiventris*, *Alouatta palliata aequatorialis, Aloauatta seniculus*, *Aotus zonalis* y *Saguinus geoffroyi*) que presentan un número reducido de investigaciones. Para los dos primeros sólo se reporta una investigación en estado silvestre (Ramírez-Orjuela y Sánchez-Dueñas, 2005; Giraldo *et al.*; 2017), mientras que *A. zonalis* sólo se reporta en un listado de especies en un informe técnico. Para *S. geoffroyi* no existen estudios en estado silvestre a nivel nacional (Stevenson *et al.*, 2010) y de acuerdo con nuestros resultados, la única investigación corresponde a una evaluación genética utilizando muestras de individuos en cautiverio (Ruiz-García *et al.*, 2007).

A pesar de no encontrarse en categorías de amenaza, es necesario fomentar la investigación de *A. zonalis, C. capucinus* y *S. geoffroyi,* que no cuentan con estudios en campo en la región, para conocer su distribución y estado de amenaza. Adicionalmente, los resultados evidencian la cantidad de literatura gris que permanece sin publicar, pese al esfuerzo de investigación invertido y su potencial aporte al

conocimiento de los primates en la región. Finalmente, se invita al desarrollo de esfuerzos conjuntos entre instituciones regionales y centros académicos, que permitan abordar los principales vacíos de información y apoyar futuras estrategias de conservación.

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EDGE HABITAT PREFERENCES IN THREE TITI MONKEY SPECIES IN COLOMBIA *(CHERACEBUS LUGENS, CHERACEBUS TORQUATUS LUCIFER AND PLECTUROCEBUS ORNATUS)*

Thomas Richard Defler[1] and Xiomara Carretero-Pinzón[2]

[1] *Universidad Nacional de Colombia. Bogotá, D.C., Colombia*
[2] *University of Queensland, Hobart, Queensland, Australia*

Abstract

The three titi monkeys *Cheracebus lugens*, *Cheracebus torquatus lucifer* and *Plecturocebus ornatus* prefer edge habitat when occurring in extensive forests. We present preliminary data showing that these three species exhibit their highest densities at the edges of forest types. In gallery forests of Vichada department, *Cheracebus lugens* has densities of 8 groups / km^2. We found that the same species had crude densities of 0.68 groups/km^2 in Vaupés department, while their densities increase in edge habitats to 17.5 groups/km^2. *Cheracebus torquatus lucifer* in Amazonas department exhibits 0.47 groups/ km^2 crude densities, while their highest densities are in edge habitats along the Cotuhé River at 17.5 groups/km^2. In a large 1,080 ha forest fragment in Meta department, *Plecturocebus ornatus* exhibit higher densities (around 15 - 17 individuals /km^2) in edge habitats facing savanna, as opposed to their overall crude densities throughout this large forest fragment (1.07 ind/ km^2). In the case of these *P. ornatus*, the edge habitat is floristically more diverse than the forest 600-700 m away from the forest edge. But, in Vaupés, the edge habitats used by *C. lugens* are less diverse than forest in hilly areas found towards the interior of the forest, where *Cheracebus* densities are lower. There are no comparative floristic diversity data for the forest inhabited by the *C. torquatus lucifer* in this study. Edge habitat preference is an ecological advantage for species like *P. ornatus* when its habitat experiences high rates of loss and fragmentation.

Keywords: Forest choice, primate microhabitats, titi monkeys.

Resumen

Cheracebus lugens, *Cheracebus torquatus lucifer* y *Plecturocebus ornatus* prefieren hábitat de borde de bosque cuando estos primates se encuentran en bosques extensos. Presentamos datos preliminares que muestran que estas tres especies presentan densidades más altas en los bordes de bosques de varios tipos. En bosques de galería del departamento del Vichada, Colombia, *Cheracebus lugens* presenta densidades de 8 grupos / km^2. La misma especie tiene densidades brutas de 6.1 grupos / km^2 en el departamento del Vaupés, mientras que sus densidades aumentan en hábitats de borde de bosque a 17.5 grupos / km^2. *Cheracebus torquatus lucifer* en el departamento de Amazonas tiene una densidad bruta de 8.1 grupos / km^2, mientras que sus densidades más altas se encuentran en hábitats de borde a lo largo del río Cotuhé (17.5 grupos / km^2). En un gran fragmento de 1,080 ha en el departamento del Meta, observamos las densidades más altas de *Plecturocebus ornatus* (alrededor de 50-60 individuos / km^2), en hábitats marginales frente a una sabana, en comparación con densidades brutas totales de 1.07 ind / km^2 en este fragmento grande de bosque. En el caso de estos *P. ornatus*, el hábitat de borde de bosque es florísticamente más diverso que el bosque a 600-700 m del borde del bosque. Sin embargo, en Vaupés, los hábitats del borde utilizados por *C. lugens* son menos diversos que los bosques en las zonas de colinas encontradas hacia el interior del bosque, donde las densidades de titis son más bajas. No hay datos comparativos de diversidad florística para el bosque habitado por *C. torquatus lucifer* en este estudio. La preferencia del hábitat de bordes de bosque es una ventaja ecológica para especies como *P. ornatus* cuando el hábitat experimenta altas tasas de pérdida y fragmentación.

Palabras clave: Selección de bosque, microhábitats para primates, micos titi.

Introduction

Interesting and variable densities have been observed in various titi species, which often vary according to forest types. For example, several species of titi monkeys are known to have patchy distributions with low densities in extensive, closed-canopy forests and high densities in other types of forest habitat. *Plecturocebus moloch* of the Xingu-Tocantins interfluvium in the southern Brazilian Amazon shows sparse and interrupted distributions (Ferrari et al., 2007) suggesting habitat preferences. *Callicebus personatus personatus* have high densities in areas of secondary vegetation as opposed to lower densities in adjacent montane pluvial forest (Déda-Chagas and Ferrari, 2010; Pinto et al., 1993; Garcia-Chiarello, 1994). Wagner et al., (2009) found high densities of *Plecturocebus ornatus* in many fragments in the Llanos Orientales but there was no correlation of densities to fragment size and densities of this species are higher in fragments and secondary and disturbed forest, than in primary forests (Wagner et al., 2009; Mason, 1968; Polanco and Cadena, 1993; Hernández-Camacho and Cooper, 1976).

In Peru, van Kuijk (2013) found that *Plecturocebus oenanthe* preferred the boundary between primary and secondary forest over the primary and secondary forest interiors. In Ecuador *Plecturocebus discolor* was detected most often in liana forest (28%), in forest clearings (24%) and in high forest (24%) located in valleys (28%), slopes (24%), and terraces (24%) (Pozo, 2004).

Several species of titi monkeys live in forest fragments and many are endangered. *Plecturocebus barbarabrownae* are found in very reduced populations distributed in dry forest fragments in Bahia, Brazil. The species is Critically Endangered and there is not enough of the original forest to be able to define the species´ habitat preferences (Printes et al., 2011). *Plecturocebus modestus* (En – Endangered, Veiga et al. 2008a)) and *P. olallae* (En – Endangered, Veiga et al. 2008b) (the two species in the Río Beni, Bolivia) exist in remnants of forest vegetation surrounded by grazed woodland on cattle ranches, just as *Plecturocebus ornatus* and *Plecturocebus caquetensis* (Defler, 2010; García and Defler 2013). The first two species are over-hunted and currently three are listed an endangered (EN) (Felton et al., 2006; Veiga et al., 2008a, 2008b) while *Plecturocebus caquetensis* is listed as Critically Endangered (CR) (Defler and García 2012).

Here we discuss the patterns of density in three titi taxa (*Cheracebus lugens*, *Cheracebus t. lucifer* and *Plecturocebus ornatus*; *Cheracebus torquatus lucifer* is a taxon with the same karyomorph as *Cheracebus torquatus* (Bueno and Defler 2010; Benirschke and Bogart 1976), so we consider that *Cheracebus lucifer* is not a good species but is rather a subspecies of *Cheracebus torquatus*). We consider some hypotheses that could explain these variable densities. We also recognize that habitat preferences of many titi species include a positive edge effect and this is positive for their survival in forest fragments. There is no confirmation that *Cheracebus lugens* in Colombia is actually that species rather than *C. t. lucifer*. Despite distinguishing characters defined by Hershkovitz (1990) between these two species, the phenotypes are not distinguishable and can only be distinguished by karyotype and molecular differences (Defler, unpublished data). Hernández-Camacho realized that phenotypically the two were not distinguishable so he named all black *Cheracebus* in Colombia *C. lugens* (Hernandez-Camacho and Cooper, 1976). Using karyotype, we have confirmed that southern populations of *Cheracebus* in Colombia are, indeed, *C. torquatus lucifer* (not *C. lucifer*) (Bueno and Defler, 2010). But whether the northernmost populations of *Cheracebus* are *C. lugens* must be confirmed, although that species has been identified on the right bank of the Río Negro and naturally could extend into Colombia (Casado et al. 2006).

Methods

Density estimations

Densities of *Cheracebus lugens* in Vichada, Colombia, gallery forests, were calculated using a series of experimental transect censuses during 1979 in El Tuparro National Park, Colombia. The censuses began near the western gateway to the Park, Tapón (5º06´46”N, 69º08´55”W). Because the primate densities were already known from direct counts and knowledge of the groups present, the idea was to evaluate the efficacy of transect censuses on the three diurnal primates that were present. Since the program DISTANCE was unknown at the time, averages were calculated from repeat censuses and a detection width was used to calculate actual densities (Defler and Pinto 1985) (Fig. 1).

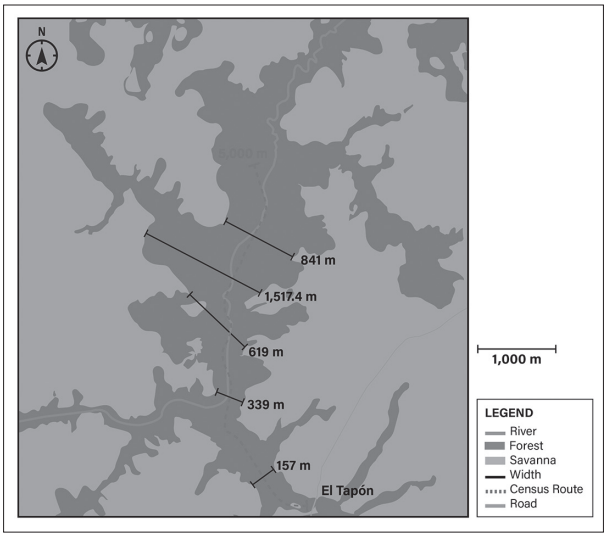

Figure 1. A censused gallery forest at Tapón (El Tuparro National Park) in Vichada, Colombia, showing the 5km census route and some measurements of the width of the forest.

2. During the years 1982-1984 six primates of a pristine closed-canopy forest in southern Vaupés (Estación Biológica Caparú, since changed to Estación Biológica Mosiro Itajura – Caparú - 1º04´58”S, 69º30´49”W) were censused monthly using a line transect, beginning from the edge of a lake towards the interior of the forest to 5 km (accumulated repeat censuses equaled 264 km). The transect towards the forest interior included 900 m of Plio-Pleistocene terrace forest and 4 km of hill forest. Also, the edge of the Igapó forest (blackwater flooded forest) was censused by canoe for 10 km (five on each side of the lake). The repeat censuses on the lake totaled 212 km. DISTANCE 4.0 was used to calculate the six primate species´ densities. There was an adjacent band of *C. lugens* groups parallel to the Igapó edge (although they only very rarely entered the Igapó), following the edge of the Pleistocene river terrace above the lake. The band parallel to the lake edge was calculated theoretically based on an adjacent string of four known groups at the edge of the Pleistocene river terrace, that in all cases descended to the edge of the local Igapó using a transition type forest between the Igapó and the Pleistocene terrace forest. A similar band of *C. lugens* groups was found along a creek one kilometer from lakeside. The animals entered and used two different forest types on the opposite sides of the creek (Fig. 2). Habitat types were previously identified by Carvajal et al. (1976).

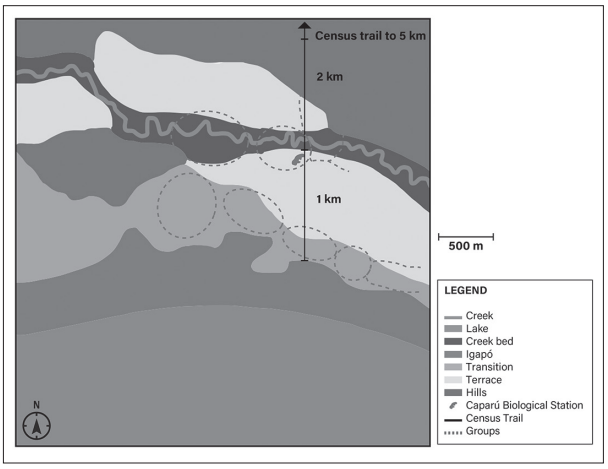

Figure 2. Census area at Estación Biológica Mosiro Itajura - Caparú from lake-side through forest types of Transition (between the Igapó and Pleistocene terrace forest), Pleistocene terrace forest, Creek bottom forest and, Hill forest (see Defler and Defler, 1996 for more discussion of forest types).

3. At the study site of another pristine forest site (3º32'09.8"S, 69º53'27.2.6"W) in southern Colombia, department of Amazonas, and parallel to the Amacayacu National Park, a census series of a five kilometer transect into the interior of the forest was carried out during the years 2000-2001 for a total of 264 km of repeat censuses, and was analyzed via the DISTANCE 4.0 program. Again, a population of *Cheracebus t. lucifer* along the edge of the river Purité, of five known groups, was used to calculate a theoretical density along the river that was much higher than that on the interior of the forest (Defler, 2013) (Fig. 3).

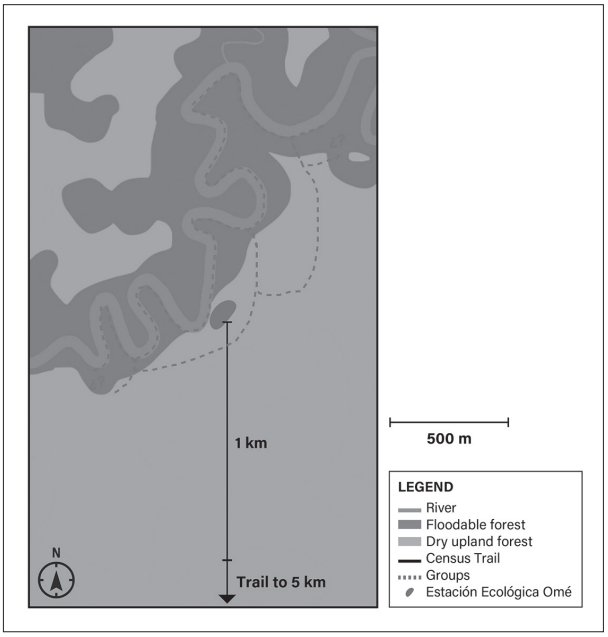

Figure 3. Census site on Purité River, Amazonas department (Omé Ecological Station) showing differing topography from floodable forest to dry upland forest.

4. During the years 2004-2009 eight forest fragments north of the town of San Martín, Meta department (3º41´54" N, 73º41´56"W) were censused for local primates, and densities calculated based on direct counts of individuals or troops at each fragment. A large fragment totaling 1,050 ha was censused and data was processed using DISTANCE 6.0 (Fig. 4).

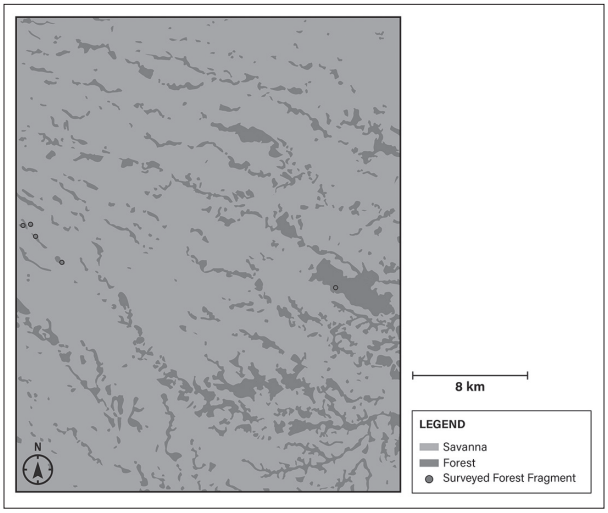

Figure. 4. Census sites in Meta department, near San Martín, during 2004-2009. The largest fragment with the red dot is shown with more detail in figure 5. It is part of the Las Unamas Reserve, a private natural reserve belonging to RESNATUR (Association of the Colombian System of Natural Reserves of the Civil Society).

5. During 2010-2012 the same large fragment that had been censused by Carretero-Pinzón (2013ab) (Fig. 5; 3º34´27.1"N, 73º27´09.9"W) was analyzed for the edge population of *P. ornatus* closest to the savanna (Defler, unpublished data). We calculated an ecological density using a determined home range of one group (about 5 ha), built up using about 250 hours of observations and extending these data through the observed band of interlocking groups (Fig. 5).

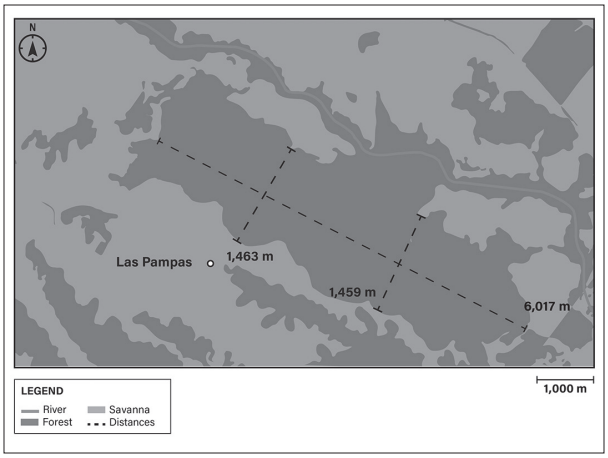

Figure 5. Large 1,000 ha forest (the Unamas Natural Reserve, 3º34´27.1"N, 73º27´09.9"W) in Meta department, Colombia, with some measurements indicated. The white circle marks the owner´s house.

Results

The calculated densities are listed in Table 1.

Table 1. Titi densities in different types of habitat in eastern Colombia.

Species	Type of Habitat	Densities	Citation
C. lugens	Gallery forest	8 groups/ km^2	Defler and Pintor, 1985
C. lugens	Interior of Amazonian forest, Estación Biológica Mosiro Itajura - Caparú, Vaupés, Colombia	0.68 groups/ km^2	Defler, 2003, 2013
C. lugens	Parallel to igapó in Amazonian forest, Estación Biológica Mosiro Itajura -Caparú, Vaupés, Colombia	17.5 groups/ km^2	Defler, 2013
C. lugens	Creek bottom in Amazonian forest, Estación Biológica Mosiro Itajura -Caparú, Vaupés, Colombia	17.5 groups/ km^2	Defler, 2013
C.t. lucifer	Interior of Amazonian forest, Estación Ecológica Omé, Amazonas, Colombia	0.16 groups/ km^2	Defler, 2013
C. t. lucifer	River edge in Amazonian forest, Estación Ecológica Omé, Amazonas, Colombia	18.1 groups / km^2	Defler, 2013
P. ornatus	Forest fragments, Meta, Colombia	7.61 – 52.98 groups km^2	Carretero-Pinzón, 2013a,b
P. ornatus	1,000 ha forest "Las Unamas", Meta, Colombia (crude density)	1.07 groups/km^2	Carretero-Pinzón, 2013a,b
P. ornatus	Population bordering savanna (ecological density) or large 1,000 ha forest "Las Unamas", Meta, Colombia	15-17 groups / km^2	Defler, unpublished data

In the Vichada gallery forest (Fig. 1) the titi monkeys have a border (or edge) on two sides of their territory. This should hypothetically promote a strong "edge effect" and perhaps be reflected in the fairly high densities of 8 groups/ km^2 that we calculated, based only on 56 accumulated kilometers of census effort. However, the well-defined borders of the habitat and visual recognition of each group resulted in high confidence in the calculation.

Figure 2 depicts the more complex topography and forest types in Estación Biológica Mosiro Itajura - Caparú and outlines known groups of *Cheracebus lugens*. The highest densities at Mosiro Itajura-Caparú are found in the band of transitional vegetation that extends from the edge of the Igapó up to the Pleistocene terrace forest, which is 10-11 m above the highwater of the Igapó. These high densities are repeated along the "bajo" or flood plain of the inland creek that passes near the installation of the research station (1 km via the principle trail from the edge of the Igapó), and ecological densities here attained about the same densities as the lakeside *Cheracebus*. The Plio-Pleistocene hill forest, considered the most diverse forest type botanically according to Defler and Defler (1996), was later contradicted by Clavijo et al. (2009) who concluded that the Pleistocene terrace forest is the most diverse forest type. The Pleistocene terrace forest is not used by the titis except from the creek flood plain and from the transition forest. The hill forest is very sparsely inhabited by titis.

Figure 3 illustrates the use of forest along the Purité River, including high densities of titis along the Purité River (a partial limit of the Amacayacu National Park). The majority of the forest use of the titis takes place over seasonally inundated forest, but the use extends partially into forest on hilly topography that does not flood. After leaving the influence of the utilized edge vegetation after about 800 m, there was only one group of titis along the rest of the 5km trail.

Figure 4 illustrates the highly fragmented habitat in western Meta Department, where censuses has taken place. The largest censused fragment is a 1,000ha forest that is part of the Natural Reserve Las Unamas and represents perhaps, the last of the remaining forest of western Meta, except for a large, closed-canopy forest along the Guayabero River to the south. The interior of these large forest appears to have very low densities of titis.

Figure 5 shows a closer view of the large, 1,000 ha forest in Las Unamas Natural Reserve. Extensive censuses here show very low densities except for the edges, where high densities are present.

Discussion

Although the majority of edge effects on different biota are negative, some species have been affected in positive ways. Some species might show positive, negative and neutral responses according to the edge type (Ries and Sisk, 2004; Murcia, 1995). There are three categories of effects on any habitat type, abiotic effects (changes in the environmental conditions), direct biological effects (changes in abundances and distribution of the species caused by the physical conditions) and indirect biological effects (species interactions,

pollination and seed dispersal) (Murcia, 1995). An abrupt end to a forest that might be facing a savanna or a body of water is an extreme edge that might generate extremely different conditions, such as xeric or hydric conditions and a complete absence of the forest type (abiotic effects). But other edges can be the interface of two types of forest (such as at the Estación Biológica Mosiro Itajura - Caparú) that also generate an edge effect because of very different flora that do not sustain the same fauna or, does so very poorly (direct and indirect effects).

Faunas can be abruptly different across different floras that are in contact (direct biological effect), for example, Klein (1989) and Spector and Ayzama (2004) have illustrated the abrupt changes in dung and other beetles across changes in vegetation, both within a forest and the forest/savanna ecotone. Many edge effects of birds have been illustrated (Broadbent et al., 2008; Burkey, 1993) and mammals (Harding and Gomez, 2006; Offerman et al., 1995). Several species of primates have also been identified that are sensitive to edge effects both positively and negatively, such as positive effects for lemur density (Lehman et al., 2006), positive effects for *Alouatta macconnelli* and *Saguinus midas*, and negative effects for *Ateles paniscus*, and neutral effects for *Chiropotes chiropotes*, (Lenz et al., 2014).

Titi distributions often show strikingly dissimilar abundances within their distributional areas. Since the previous genus *Callicebus* has recently been split into three genera (Byrne et al., 2016) (*Callicebus*, *Cheracebus* and *Plecturocebus*), it seems a bit more complicated to treat the group as one, although the group as a whole has many similarities such as general morphology, monogamy (rare in primates), territorial defense (but with some home range overlap), paternal care of infants, frequent use of lower forest strata (8-15 m), and, frequent terrestrial behaviors including travel between forest fragments (Bicca-Marques and Heymann, 2013). Some differences have been noted, such as supernumerary adults observed in some species but not in others (*Cheracebus lugens, C. t. lucifer*, *Plecturocebus cupreus, P. modetus and P. personatus*; Bicca-Marques and Heymann, 2013; Defler, 1983).

Only a few titi species have been identified that seem to have greater abundances along water courses, on edges of forest types or other special but often undefined vegetation types, but often the same species abundances fall (sometimes drastically) in parts of the same forest but away from the high-density areas. Ferrari et al. (2007) found no *P. moloch* whatsoever while censusing 812 km of forest within the known distribution of the species. Kulp and Heymann (2015) found no effects of forest edges and secondary forest on red titi (*P. cupreus*) abundances. Heiduck (2002) found that *P. melanochir* preferred primary forest and avoided disturbed forest.

An important difference of our studies from some of these other studies is that the edges of the forests that we studied along savannas were undisturbed, natural edges that had not been disturbed by recent fragmentation. Our data showed that *Cheracebus lugens* and *C. t. lucifer* and *P. ornatus* enjoyed high densities in certain types of forest such as northern gallery forests of Vichada, and vegetation bands associated with wetlands in Vaupés and in southern Amazonas, Colombia. They were very sparsely distributed in upland, inland forest. We found high densities of *P. ornatus* in forest fragments and along the edge of a large, 1,000 ha forest, bordered by savanna.

Cheracebus lugens in the Estación Biológica Mosiro Itajura – Caparú, generally show widely separated groups in the interior of the forest. For example, a five-kilometer census at this site only detected one group in the last four kilometers of the trail, despite 250 km of repeat surveys over that trail. This pattern of very low densities in the interior of the forest is repeated by *Cheracebus t. lucifer* on the Purité River, southern Colombian Amazon (Defler, 2013) and by *Plecturocebus ornatus* in closed-canopy Colombian forest near the Duda River, Meta department (Carretero-Pinzón, 2013a,b; Polanco and Cadena 1993; Stevenson pers. com.). The more homogeneous densities of *C. lugens* in the Vichada gallery forests may be due to the fact that the habitat was all edge habitat. This may explain the often, high densities of *P. ornatus* found in fragments in the llanos of western Meta as well (Carretero and Defler, 2013; Wagner et al., 2009; Carretero-Pinzón, 2013a,b) in contrast to the very low crude species densities in a large 1,000 ha fragment in Meta, Colombia.

Despite low overall crude densities of *C. lugens* in a pristine rainforest habitat in Vaupés, edge habitats defined by different forest types support an ecological density that was much higher than the crude density throughout the forest. Although these high density ecological belts were not at the edge of a forest bordering savanna, they were centered over special types of forest (Transition forest and Creek bottom forest) while extending in part into Pleistocene river terrace forest. The transition forest was sandwiched between Igapó forest (where the animals were never observed) and the river Terrace forest which were found to be of high diversity (Defler and Defler, 1996; Clavijo et al., 2009). The Creek bottom forest was sandwiched between high diversity hilly Pliocene forest and the high diversity river terrace forest. In the Colombian Llanos, where *Cheracebus lugens* exists in some pristine gallery forests of Vichada, the density of this primate was elevated and evenly spread throughout the study forest (Defler and Pintor, 1985).

In southern Colombia, a population of *Cheracebus t. lucifer* repeated the pattern of *Cheracebus lugens* at Caparú with a low, overall crude density throughout the interior of the forest, but with a very high ecological density along the Purité River. These data show that *Plecturocebus ornatus*, *Cheracebus. lugens* and *C. t. lucifer* generally have higher densities in edge habitats, whether the edge of a forest or a habitat defined by specific types of vegetation (*C. lugens*) such as at Mosiro Itajura - Caparú).

What it is that attracts several species of *Callicebus* to edge habitat is not so clear. One assumes that these habitats have a higher concentration of foods for these monkeys. In the large 1,000 ha forest at Las Unamas the edge habitat is botanically more diverse than interior parts of the forest (Carretero and Defler 2016). This could be part of the explanation, but in the Estación Biológica Mosiro Itajura - Caparú, the high-density strip around the lake is found in low-diversity vegetation, while the highest diversity vegetation in hilly forest (beginning about 1 km from the lake and its Igapó) has very low densities of *Cheracebus lugens* (Defler and Defler, 1996; Cano and Stevenson, 2009). Plant diversity at the Omé Ecológical Station is unknown, although the high density *Cheracebus* habitat tends to be in low-lying parts of forest that floods when the nearby river floods. The inland, sparsely populated forest is hilly and well-above floods.

Alouatta seniculus is known to have similar edge habitat preferences in Colombia, although this species is more apt to concentrate in edge habitat over seasonally flooded vegetation when leaf flush is high. This large primate has been found in higher densities along the edge of the Amazonian lake where the species has been studied (Palacios and Rodríguez, 2001). From extensive censuses in that locality we know that *A. seniculus* densities in the interior of the forest are so extremely low, that we could not even detect the species during the 2 ½ years of censuses. But the species was easily detectable from the edge of the forest and especially when there was leaf flush. During early high water in the llanos of Vichada the high densities of *A. seniculus* are obvious due to their vocalizations, just as they are in the Amazonian lake where the Estación Biológica Mosiro Itajura - Caparú is located. We have posited that the high *A. seniculus* densities are due to the early high-water leaf flush which is extensive (Carretero and Defler, 2017), and typical of early high water tropical environments. But this does not seem to be an adequate explanation for high edge densities of the various species of titis discussed in this article.

Edge effects might have ecotone effects that allow the titis to exploit more than one habitat type, since the ecotone presents a variation in plant species available. From this perspective, an edge to a forest might allow an elevated insect and spider population and some preferred trees that are attractive to many titis. Ecotones in a closed-canopy forest might also support a special mix of vegetation that is especially attractive to titis and that allows the maintenance of the local titis population. In future research a careful analysis of specific requirements for the titi population living in one of these higher density population should eventually identify special characteristics of this type of habitat that support such a population.

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Short Articles

CRYPTOSPORIDIUM SPP. EN *CALLICEBUS NIGRIFONS*: REPORTE DE UN CASO DE DIARREA AGUDA EN UN CENTRO DE RESCATE DE PRIMATES DEL ESTADO DE SÃO PAULO, BRASIL

Ignasi Bofill Verdaguer
Silvio Luís Pereira de Souza
Fernanda Dias de Paula
Solange Maria Gennari
Joaquin Quilez Cinca

Introducción

En Sudamérica varios centros se dedican a la conservación de especies de primates neotropicales (Aquino et al., 2007; Fi Freitas et al., 2001; Chinchilla et al., 2005). En ellos, las enfermedades asociadas a parásitos gastrointestinales se incluyen entre los problemas clínicos, debido especialmente a la gravedad de los cuadros que pueden ocasionar y su potencial zoonótico (Gonzalo y Tantaleán, 1996; F Freitas et al., 2001; Chinchilla et al., 2005; Sánchez et al., 2006).

Cryptosporidium spp. es un protozoo de interés en salud pública que puede ser causante de diarreas de forma esporádica o epizoótica (Feng, 2012). Su importancia en el contexto de los centros de rescate de animales salvajes reside en factores que pueden favorecer su transmisión, como el mantenimiento de una alta densidad de animales en ambientes confinados (Cambronero et al., 2007). La criptosporidiosis se asocia con diarreas autolimitantes tanto en humanos como en diferentes especies animales inmunocompetentes, pero el cuadro diarreico puede ser grave, persistente e incluso mortal en individuos inmundeprimidos (Chalmers y Davies, 2010; Ryan et al. 2016). En este grupo se incluyen especialmente las inmunodeficiencias primarias o secundarias de linfocitos T, como sucede en casos de linfomas, leucemia o, pacientes con Síndrome de Inmunodeficiencia Adquirida (SIDA), en los que se han descrito incluso localizaciones extraintestinales (tracto respiratorio, conductos biliares, páncreas) (Hunter y Nichols, 2002; Chalmers y Katzer, 2013; Checkley et al., 2015). También en primates no humanos se han descrito casos de criptosporidiosis, en ocasiones correlacionados con inmunodeficiencias de origen infeccioso y con localizaciones extraintestinales (Blanchard et al., 1987; Kovatch et al., 1972). A la fecha, varias especies del parasito y genotipos potencialmente patógenos para el hombre han sido identificados en primates no humanos incluyendo *Cryptosporidium parvum, C. hominis, C. felis, C. muris C. ubiquitum C. andersoni y C. bovis,* destacándose *C. parvum* en especies de primates del Nuevo Mundo *(Ateles, Alouatta)* (Du et al., 2015; Silva et al., 2008; Xiao y Fayer, 2008). Otros protozoos encontrados en primates del Nuevo Mundo son *Blastocystis hominis*, *Endolimax nana*, *Chilomastix mesnili*, *Giardia intestinais*, *Entamoeba coli*, *Iodamoeba buetschii* y *Entamoeba histolytica* (Kimberley et al., 2004; Silva et al., 2008).

Presentación del caso

Se presenta el caso ocurrido en enero de 2016 en un ejemplar hembra de *Callicebus nigrifons* llamada Gavriola, acogida desde temprana edad en el centro de rescate de primates neotropicales Projeto Mucky situado en el municipio de Itu, Brasil. Su edad estimada era de dos años y compartía vivero con un macho adulto de su misma especie y un macho juvenil descendiente de ambos. La dieta de los tres individuos era racionada en tres tomas al día y contenía un gran porcentaje de frutas y vegetales verdes (aproximadamente el 70% de la dieta) en concordancia con la dieta de la especie en estado silvestre (Carrillo, 2005; Varela, 2007). La dieta también incluía proteína de origen animal como huevo hervido o carne de pollo (alrededor del 15%) y se complementaba con papillas de cereales, insectos vivos y suplementos de vitaminas y oligoelementos. Para el forrajeo, los animales solían disponer de hojas seleccionadas por sus cuidadores a disposición *ad libitum*. Cada seis meses se les realizaba una desparasitación con Albendazol (dos tratamientos de tres días consecutivos con un intervalo de quince días entre ambos), siendo aplicado el último en julio de 2016. La hembra tenía un peso de alrededor de 1.5kg y antecedentes de graves episodios de estrés derivados del contacto con humanos, sin otros datos clínicos destacables.

En noviembre de 2015 se constata que el animal está apático, pierde peso y presenta síntomas compatibles con estrés (ausencia de apetito y vocalización e inactividad) (Brüne et al., 2006; Varela2007). El cuadro no se resuelve tras tratamiento con Metronidazol 4% (0.5 ml vía oral cada 12h durante cinco días) ni con cambios realizados en el vivero para favorecer el consumo de alimentos. El animal continúa con estos síntomas en las semanas siguientes y el 2 de enero de 2016 se observa un estado de postración alarmante y la aparición súbita de un cuadro de diarrea liquida, abundante y sin sangre. Ese mismo día se reanuda el tratamiento con Metronidazol y se decide trasladar al ejemplar de *Callicebus nigrifons* a la enfermería del Centro, para poder examinarla y observarla de forma continuada. Tras su exploración se comprueba que está postrada, presenta pérdida de peso del 20% en relación con registros anteriores, está deshidratada y sus mucosas se encuentran pálidas y secas. Otros parámetros como la frecuencia cardiaca, frecuencia respiratoria, temperatura corporal, tamaño de los linfonodos y, la reacción a la palpación abdominal, parecen normales según los parámetros establecidos (Varela, 2007). Se constata un cuadro de diarrea constante, incoercible, liquida, amarillenta y sin moco ni sangre.

Durante los tres siguientes días el animal permanece en un espacio tranquilo de la enfermaría del Centro, con signos de dolor, postración, abdomen hinchado, flatulencias y acúmulo de gas en el tracto digestivo. Además del tratamiento con Metronidazol iniciado el día anterior, se instauran

medidas de rehidratación convencional, antiespasmódicos (Dipiriona, n-butil bromuro de hioscina) y Simeticona. En este periodo, el animal presenta dos crisis caracterizadas por postración, baja frecuencia respiratoria, temperatura corporal baja (35.4ºC) y reflejos pupilares altamente disminuidos que mejoran parcialmente con soporte médico. Durante el ingreso se consigue la alimentación oral con tenebrios vivos y un preparado comercial altamente nutritivo. El 4 de enero transcurre sin cambios destacables en el cuadro y se recogen dos muestras de heces directamente del ano, una para coprocultivo en un laboratorio externo y otra se conserva a 4ºC en una solución de dicromato de Potasio al 2% para su estudio parasitológico. También se toma una muestra de sangre que se remite a un laboratorio.

El día 5 de enero se reciben los resultados del análisis de sangre, indicando varios parámetros muy alterados (Varela, 2007); moderada anositocisis y policromasia, anemia microcítica y normocrómica (hematocito 23% y hemoglobina 8 g/dl, volumen corpuscular medio levemente bajo (79.58 fl), concentración de hemoglobina corpuscular media normal, bajas proteínas totales (4.6 g/dl), neutrófilos hipersegmentados, muy destacable leucopenia, linfopenia y monocitopenia. Ese mismo día se inicia un tratamiento preventivo con Ceftriaxona y oxigenoterapia. El animal fallece esa misma noche y se decide no practicar medidas de reanimación. La necropsia del animal revela hemorragias difusas en la mucosa interna de yeyuno e íleon, paquete intestinal distendido con un poco de contenido acuoso, colitis no muy marcada y el estómago presenta moderado acúmulo de comida sin digerir. No se observan cuadros gastrointestinales agudos en otros animales del centro.

Tras la muerte del animal se dispone de los resultados del análisis parasitológico realizado en los laboratorios del *Departamento de Medicina Veterinária Preventiva e Saúde Animal* de la Universidad de São Paulo. En dicho análisis se utilizó una técnica de sedimentación y flotación en solución de sacarosa (Ferreira et al., 1962; Ogassawara y Benassi, 1980), revelando la presencia de abundantes ooquistes de *Cryptosporidium* en las heces del animal.

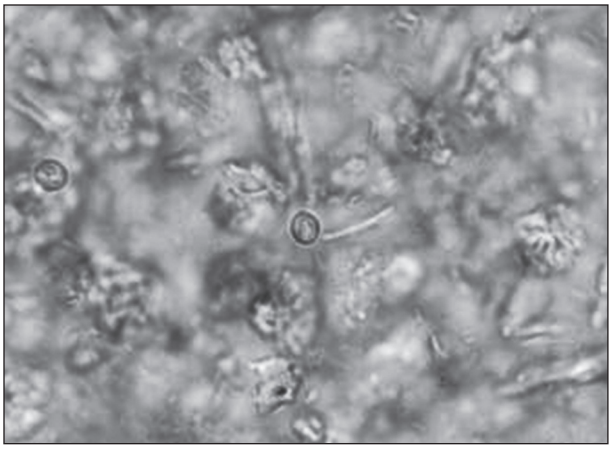

Figura 1. Ooquistes de *Cryptosporidium* en heces (1000× aumentos)

Discusión

La infección por *Cryptosporidium* spp. se transmite por la ingestión de ooquistes eliminados en las heces de otro hospedador, bien por contacto directo o indirectamente a través de comida o agua contaminada (Hunter y Nichols, 2002, Checkley et al., 2015). Las medidas de tipo higiénico-sanitario más eficaces para prevenir la infección incluyen la limpieza y desinfección de los alojamientos (especialmente antes de introducir nuevos animales) y el aislamiento de los animales enfermos. Es también importante evitar el estrés de los mismo y mantenerlos en buen estado de salud en general. Los dos viveros donde permanecieron los tres *Callicebus nigrifons* fueron desinfectados de forma preventiva.

A pesar de que la presencia de *Criptosporidium* spp. ya ha sido reportada anteriormente en primates (Du et al., 2015; Silva et al., 2008; Xiao y Fayer, 2008), existe poca literatura que asocie la presencia del parasito con patologías clínicas en primates neotropicales. En este sentido, debe ser considerada la novedad e importancia del presente caso para el correcto acompañamiento de futuros casos clínicos en *Callicebus* u otras especies de primates del Nuevo Mundo en cautiverio. En este caso clínico el desarrollo de la probable criptosporidiosis podría asociarse a la alteración de diferentes parámetros hemáticos relacionados con el estado inmunológico. Los resultados de las pruebas clínicas y la sintomatología, podría ser compatible con el "síndrome de agotamiento", relativamente común en algunas especies de primates neotropicales y cuya etología no está completamente esclarecida, aunque se sospecha de su carácter multifactorial (Varela, 2007). Este síndrome de complicado tratamiento podría haber deteriorado el estado general del animal, favoreciendo la inmunodepresión y el desarrollo de la criptosporidiosis. No disponemos de datos que apunten a otras causas responsables de la inmunodepresión, aunque parecen descartables debido a la falta de evidencias, la epidemiología y el historial clínico de la hembra.

Otro factor que pudo haber favorecido la aparición de la criptosporidiosis en este animal se relaciona con sus continuos estados de estrés, que terminaron produciendo anorexia, pérdida de peso y comportamientos anormales (Brüne et al., 2006). La presencia de neutrófilos hipersegmentados, compatibles con infecciones de larga duración, así como la alteración de algunos parámetros del leucograma compatibles con situaciones de estrés crónico soportan esta hipótesis. Es sabido que el estrés afecta negativamente a la respuesta inmune, favoreciendo la aparición de enfermedades asociadas a una escasa funcionalidad de la misma (Meyer JS. et al., 2014).

El presente caso nos sugiere que no siempre es posible establecer una sospecha clínica con la suficiente antelación. Hasta el momento en que se instaura el cuadro diarreico grave, los síntomas observados en el primate no fueron suficientemente específicos. Si bien había pérdida de peso, resultaba difícil apreciar el deterioro del estado corporal sin

realizar una exploración física. Además, los antecedentes de estrés del animal recomendaban interactuar lo menos posible con él. De cualquier modo, el primer síntoma alarmante y más específico se produjo pocos días antes de su muerte, con la aparición brusca de diarrea liquida; el carácter agudo de ésta impidió diseñar un tratamiento específico y el desenlace fue muy rápido.

Cabe destacar que no existen fármacos totalmente eficaces para el tratamiento de la criptosporidiosis. El cuadro clínico es normalmente autolimitante en individuos inmunocompetentes, lo que hace prescindible el uso de terapia específica. Sin embargo, un tratamiento farmacológico resultaría de gran interés en individuos inmunodeprimidos. Actualmente la Nitazoxanida se comercializa en algunos países, siendo parcialmente eficaz para la criptosporidiosis (Abubakar et al. 2007). Por tal razón, el tratamiento de soporte resulta esencial en pacientes inmunodeprimidos, basado en la rehidratación oral o intravenosa, el control del estado nutricional, el aporte de electrólitos perdidos y el uso de fármacos antiespasmódicos si se requieren. El presente caso clínico sugiere que el tratamiento sintomático no siempre podría revertir casos graves de la enfermedad (Chalmers y Davies, 2010). Un último aspecto a tener en cuenta hace referencia a las repercusiones zoonóticas de *Cryptosporidium*. Se han descrito numerosas especies de este género, muchas de las cuales son compartidas entre los animales y el hombre; *C. hominis* y *C. parvum* entre otras ya han sido descritas en primates no humanos (Du et al., 2015; Ryan et al. 2016; Silva et al., 2008; Xiao y Fayer, 2008; Cormier y Jolly 2017). Esto confirma el riesgo que plantea esta patología para las personas próximas a estos animales.

Conclusiones

Se presenta el caso de un ejemplar de hembra adulta de *Callicebus nigrifons* del Centro de Rescate de Primates Neotropicales Projeto Mucky en Itu, Brasil. A lo largo de varias semanas el animal presenta un cuadro inespecífico con pérdida de peso, que evoluciona súbitamente a un cuadro diarreico grave en los cinco días previos a su muerte. Se identifican abundantes ooquistes de *Cryptosporidium* spp. en sus heces mediante coprología, lo cual sugiere la conveniencia de incluir este parásito en el diagnóstico diferencial de la diarrea en primates neotropicales. Se destaca que ante un caso de estas características puede ser determinante un diagnóstico precoz y, a nivel preventivo, se sugiere establecer medidas profilácticas de tipo higiénico-sanitarias. Finalmente, se señala que *Cryptosporidium* spp. es un patógeno potencialmente transmisible al hombre y representa un riesgo potencial para la salud de las personas próximas a los animales infectados, por lo que deben instaurarse estrictas medidas de bioseguridad.

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Ignasi Bofill Verdaguer, Instituto de Ciências Biomédicas, Departamento de parasitologia de la Univerdidade de São Paulo. 05508-000. São Paulo capital, São Paulo, Brasil, E-mail: <ignasibofill@usp.br>, **Silvio Luís Pereira de Souza,** Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo – USP 05508-270, São Paulo capital, São Paulo, Brasil / Faculdade de Medicina Veterinária, Universidade Anhembi Morumbi. 03164-000, São Paulo capital, São Paulo, Brasil, **Fernanda Dias de Paula,** Médica veterinaria autónoma. 08675000. Suzano, São Paulo. Brasil, **Solange Maria Gennari,** Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, Universidade de São Paulo – USP. 05508-270. São Paulo capital, São Paulo. Brasil y **Joaquin Quilez Cinca,** Departamento de Patología Animal. Facultad de Veterinaria. Universidad de Zaragoza. 50013 Zaragoza, España.

ATUALIZAÇÃO DO CONHECIMENTO E PADRÕES DE PELAGEM DISTINTOS EM GRUPOS DE ZOGUE-ZOGUE DENTRO DA DISTRIBUIÇÃO GEOGRÁFICA DE *PLECTUROCEBUS BERNHARDI* VAN ROOSMALEN ET AL. (2002)

Odair Diogo da Silva
Thatiane Martins da Costa
Emerson Moreira de Almeida
Eder Correa Fermiano

Dentre os primatas Neotropicais os zogue-zogues constituem um dos grupos mais diversificados (Rylands et al., 2000; Van Roosmalen et al., 2002; Wallace et al., 2006; Rylands et al., 2012). Atualmente são reconhecidas 33 espécies (Byrne et al., 2016), Serrano-Villavicencio et al. (2016) também apontam duas subespécies (*Plecturocebus caligatus caligatus* e *Plecturocebus caligatus dubius*) e um hibrido, *Plecturocebus stephennashi*. Algumas variações morfológicas no padrão de pelagem dentro de algumas espécies também são citadas na literatura (Printes, 2007; Sousa et al., 2008; Aquino et al., 2008).

Nos últimos anos vários estudos vêm avaliando a taxonomia e distribuição das espécies de zogue-zogues (Van Roosmalen et al., 2002; Groves, 2005; Auricchio, 2010 e Byrne et al., 2016). No estudo de Byrne et al. (2016) estes primatas foram divididos em três gêneros distintos (*Callicebus, Plecturocebus* e *Cheracebus*). O gênero *Cheracebus* com ocorrência no norte do Brasil, na Colômbia, Venezuela, Peru e Equador, o *Callicebus* possui ocorrência restrita a floresta Atlântica brasileira e o gênero *Plecturocebus* ocorre em todo o Brasil central, nas florestas secas do Paraguai e Equador, na Colômbia e na Amazônia Peruana (Van Roosmalen et al., 2002; Byrne et al., 2016). Apesar destes novos estudos ainda há lacunas a serem preenchidas, pois o grupo é bastante diversificado e complexo, e questões taxonômicas e de distribuição das espécies ainda não estão totalmente sanadas. Outra característica dos zogue-zogues deve-se ao fato do grupo possuir muitas espécies concentradas em certas regiões. Byrne et al. (2016) aponta ocorrência de 15 espécies na margem sul do Rio Amazonas/Solimões, e na porção sudoeste da Amazônia brasileira são conhecidas quatro espécies, *P. bernhardi*, *P. cinerascens*, *P brunneus* e *P. miltoni*, podendo haver novas espécies (Rylands et al., 2012).

No sudoeste da Amazônia brasileira os estudos com as espécies do grupo iniciaram com Miranda-Ribeiro (1914), o qual realizou o primeiro registro da espécie alvo do estudo, atribuindo o nome *Callicebus geoffroyi*, posteriormente sinonimizado para *C. moloch* por Vivo (1985) e seguido por Hershkovitz (1990). Em (2002), Van Roosmalen et al. descreve *Plecturocebus bernhardi* a partir de espécimes provenientes do oeste do rio Aripuanã, inicialmente a distribuição geográfica foi delimitada entre os interflúvios Madeira/Ji-Paraná a Aripuanã/Roosevelt. Monção et al. (2008), aumentou sua distribuição para a margem esquerda do rio Ji-Paraná. Quintino & Bicca-Marques (2013), registraram a espécie na cidade de Rolim de Moura, Rondônia. Gusmão e Aguiar (2013) agruparam os registros empíricos a oeste do rio Ji-Paraná e indicaram que o registro mais ao sul corresponde a Terra Indígena Mequéns. Alves et al. (2012), relataram a ocorrência desta espécie na Reserva Biológica do Guaporé, correspondente a localidade mais a sudoeste de sua distribuição conhecida até então.

Com estes registros e o aumento da distribuição da espécie *P. bernhardi*, surgiram divergências, pois os grupos de zogue-zogues localizados a esquerda do rio Ji-paraná possuem diferenças fenotípicas significativas dos grupos localizados na outra margem do rio. Alguns autores também contestam a validade da espécie *P. bernhardi* (Auricchio, 2010; Gualda-Barros et al., 2012 e Vendramel, 2016), aumentando a divergência acerca da espécie. A espécie também enfrenta problemas por estar localizada em uma região fortemente impactada pelo desmatamento, motivado pelo avanço da agricultura, pecuária e extração ilegal de madeira (Fearnside, 2010). Estas atividades causam intensa fragmentação florestal, ocasionando perda de habitat para fauna local. Tornando a área de ocorrência da espécie fortemente impactada, sobrando apenas mosaicos de fragmentos florestais inseridos em matriz de pastagem, na maior parte de sua distribuição (Garcia et al., 2013). Este trabalho apresenta novos registros de *P. bernhardi* no sul de sua distribuição geográfica com a descrição de variação geográfica de populações situadas à margem esquerda do rio Ji-Paraná.

Métodos

Foram observados grupos de zogue-zogues entre os interflúvios Madeira/Ji-Paraná, Ji-Paraná/Roosevelt e Ji-Paraná/Guaporé, incluído registros bibliográficos e animais atropelados. Nesta região a fitofisionomia é de Floresta Ombrófila Aberta (Projeto RadamBrasil, 1978) com floresta de terra firme e inundável (igapó) em quase toda extensão. Algumas áreas com vegetação características de cerrado também são encontradas na região. O clima é quente e úmido do tipo tropical AW, com estação de estiagem durante os meses mais frios (junho a setembro) e estação chuvosa durante os meses mais quentes (dezembro a março), com temperatura média de 26°C (Alvares et al., 2014). Os principais fragmentos de floresta na região são constituídos por reservas legal (RL), áreas de preservação permanentes (APP) particulares, parques municipais, terras indígenas e poucas unidades de conservação.

Para observação/registro da espécie alvo foi utilizado um gravador Sony ICD-PX312 acoplado a uma caixa amplificadora com vocalização do *P. bernhardi*, acionado em fragmentos florestais ou áreas com informações de observação prévia da espécie. Registros ocasionais de grupos e de animais atropelados também foram utilizados. Para análise de variação na coloração da pelagem foram selecionados onze caracteres (1- Coroa; 2- Testa; 3- Costeletas; 4- Dorso; 5- Flancos; 6- Pescoço, Peito e Barriga; 7- Mãos e pés; 8- Orelhas; 9- Membros, face externa; 10-Membros, face interna e 11 - Cauda) adaptados a partir de Gualda-Barros et al. (2012) e Dalponte et al. (2014).

Resultados e discussão

Foram observados diretamente em campo 129 indivíduos, divididos em 55 grupos em 24 diferentes localidades nos municípios de Cacoal, Pimenta Bueno, Nova Brasilândia do Oeste, Castanheiras, Colorado do Oeste e Costa Marques no estado de Rondônia, sudoeste da Amazônia brasileira. Os dados foram obtidos entre os meses de março de 2015 a maio 2017.

Com base nessas observações verificamos que os grupos de *P. bernhardi* localizados à margem direita do rio Ji-Paraná, possuem a cor da pelagem diferente dos grupos localizados à margem esquerda do rio (Figs. 1, 2 e 3). Os indivíduos localizados à direita do rio possuem o dorso castanho-avermelhado, pescoço, peito e barriga alaranjado-escuro e cauda enegrecida com a ponta branca, condizendo com a descrição de Van Roosmalen et al. (2002) para a espécie. Já os indivíduos à esquerda do rio possuem dorso castanho-claro acinzentado, pescoço, peito e barriga com um amarelo-alaranjado e cauda cinza, embranquecendo gradativamente ate ficar branco na ponta (Tabela 1). Notamos que esta variação encontra-se no interflúvio Ji-Paraná/Guaporé (Fig. 4). Estes resultados corroboram com Van Roosmalen et al. (2002) e Byrne et al. (2016), uma vez que apontaram os rios como barreiras para espécies de primatas. Aquino et al. (2008) em um trabalho com *C. torquatus*, entre a margem esquerda rio Napo e na parte superior do rio Itaya na Amazônia Peruana, também apontam uma significativa variação no padrão de pelagem, e o rio isola estes fenótipos.

Descrever variações de pelagem é relevante, pois juntamente com a análise genética, é uma importante ferramenta para o reconhecimento de uma espécie (Byrne et al., 2016). Vendramel (2016) apontou que as espécies de zogue-zogues do grupo *moloch* não apresentam diferenças significativas quanto a sua morfologia, morfometria craniana e dentária, sendo a coloração a principal característica diagnóstica para as espécies do grupo. Serrano-Villavicencio et al. (2016) demonstram que as variações geográficas devem ser somadas as analises moleculares para melhor classificação taxonômica. Em conclusão os dados apresentados contribuem

para o registro destes fenótipos, e apontamos urgência de estudos genéticos aliados aos registros de variação morfológica. Pois, a conservação da biodiversidade nesta porção da Amazônia brasileira está intrinsicamente ligada ao desenvolvimento de estudos que forneçam informações básicas sobre as espécies existentes. Com a intensidade com que a destruição das florestas vem ocorrendo nesta região, aumenta a vulnerabilidade da biodiversidade local sem que ainda esteja devidamente conhecida. Particularmente, esta variação precisa ser melhor analisada, pois somente fomentando dados podemos sanar duvidas taxonômicas para esse fenótipo aqui apresentado e criar medidas de proteção que garantam sua conservação na região.

Figura 1. *Plecturocebus bernhardi* localizada a margem direita do Rio Ji-Paraná, Cacoal-RO. Foto: Odair Diogo da Silva.

Figura 2. *Plecturocebus bernhardi* localizada a margem esquerda do Rio Ji-Paraná, Cacoal-RO. Foto: Thatiane Costa.

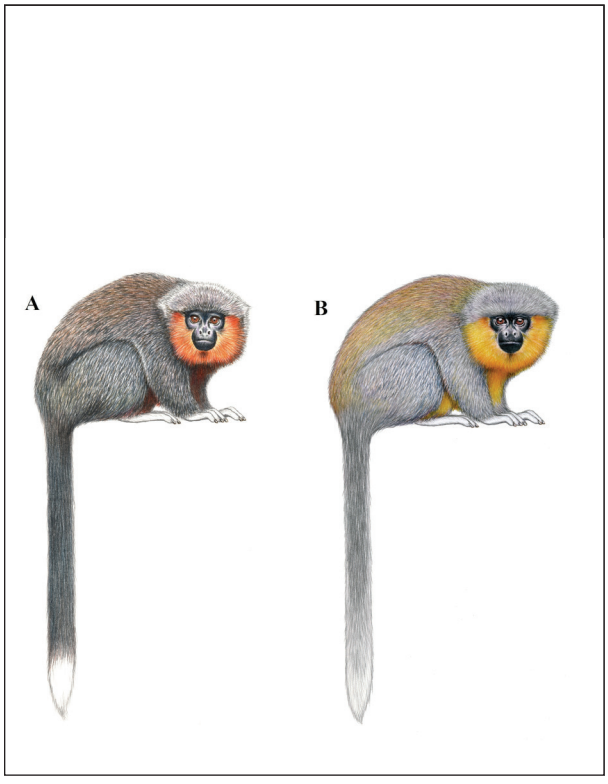

Figura 3. A) *Plecturocebus bernhardi*, margem direita do Rio Ji-Paraná, B) *Plecturocebus bernhardi*, margem esquerda Rio Ji-Paraná. Ilustração: Stephen D. Nash. Conservação Internacional.

Figura 4. Estrela - registros bibliográficos (Van Roosmalen et al., 2002 e Auricchio, 2010); **quadrados** - novos registros de *P. bernhardi* tipo; **círculos** - registros da variação aqui apresentando.

Tabela 1. Cor da pelagem utilizada para comparação entre *Plcturocebus bernhardi* típico, localizado a margem direita do rio Ji-paraná e variação localizada a margem esquerda do rio Ji-paraná, no sudoeste da Amazônia brasileira (modificada a partir de Gualda-Barros et al., 2012 e Dalponte et al., 2014).

Caracteres	*P. bernhardi* típico (Margem direita rio Ji-paraná)	Variação *P. bernhardi* (Fenótipo novo) (Margem esquerda rio Ji-paraná)
Coroa	Preto-acinzentado	Cinza
Testa	Preto-acinzentado	Cinza
Costeletas	Alaranjado-escuro	Amarelo-alaranjado
Dorso	Castanho-avermelhado	Castanho-claro acinzentado
Flancos	Preto-acinzentado	Acinzentado-claro
Pescoço, peito e barriga	Alaranjado-escuro	Amarelo-alaranjado
Mãos e pés	Embranquecidos ou prateado	Embranquecidos ou branco acinzentado
Orelhas	Negras com o ultimo tufo branco	Negras com o ultimo tufo acinzentado-claro
Membros (Face externa)	Acinzentado escuro	Acinzentado-claro
Membros (Face interna)	Alaranjado-escuro	Amarelo-alaranjado
Cauda	Enegrecida com a ponta branca	Cinza, embranquecendo gradativamente até ficar branca na ponta

Odair Diogo da Silva, Programa de pós graduação em Ambiente e Sistemas de produção agrícola – PPGASP/UNEMAT; Grupo de Trabalho e Conservação do Gavião Real no Estado de Rondônia & Laboratório de Mastozoologia da Universidade do Estado de Mato Grosso (UNEMAT), Av. Santos Dumont s/n° Cidade Universitária (Bloco II) Cáceres – MT CEP 78.200-000, E-mail: <odair_diogo@hotmail.com>, **Thatiane Martins da Costa**, Programa de pós graduação em Ciências Ambientais –PPGCA/UNEMAT; Grupo de Trabalho e Conservação do Gavião Real no Estado de Rondônia & Laboratório de Mastozoologia da Universidade do Estado de Mato Grosso (UNEMAT), Av. Santos Dumont s/n° Cidade Universitária (Bloco II) Cáceres – MT CEP 78.200-000, **Emerson Moreira de Almeida** e **Eder Correa Fermiano**, Ciências Biológicas da Faculdade de Ciências Biomédicas de Cacoal – FACIMED, Av. Cuiabá, 3087 - Jardim Clodoaldo, Cacoal - RO, CEP 76963- 665.

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OBSERVATION OF SNAKE (COLUBRIDAE) PREDATION BY YELLOW-TAILED WOOLLY MONKEYS *(LAGOTHRIX FLAVICAUDA)* AT EL TORO STUDY SITE, PERU

Vinciane Fack
Sam Shanee
Régine Vercauteren Drubbel
Marcela Del Viento
Hélène Meunier
Martine Vercauteren

Introduction

Primates display a wide variety of dietary preferences (NRC, 2003; Hublin and Richards, 2009) with the majority of species being to some extent omnivorous (NRC, 2003; Hublin and Richards, 2009). Generally, dietary strategies of primates are linked to body size, with food quality and levels of animal predation decreasing as body size increases (Ford and Davis, 1992). Nevertheless, neotropical primates of similar body size often show adaptations to different diets (Ford and Davis, 1992). Protein intake is a limiting factor in the primate diet; for maintenance of body mass, growth and reproduction (NRC, 2003; Ganzhorn et al., 2017). Whereas smaller bodied species can easily meet their protein requirements by feeding on insects, this is not a feasible strategy for larger bodied species (Ganzhorn et al., 2017).

Large bodied species, including *Lagothrix* spp., supplement their diets with leaves, which have higher protein content than fruits (Ganzhorn et al. 2017), and/or arthropods (Barnett et al. 2013). Another strategy available is to prey on smaller vertebrates. Vertebrate predation is a widespread but infrequent behaviour across primate taxa (Butynski, 1982; Fedigan, 1990; Hublin and Richards, 2009; Falótico et al., 2017). Most reports of vertebrate predation in primates come from Old World primate species. Neotropical primates are not considered as successful vertebrate predators as Old World ones (Fedigan, 1990) but, actually, most field research has focused on largely terrestrial rather than arboreal species (Butynski, 1982).

Reports of primate-snake interactions normally focus on predation of the primates involved, for example predation of *Saguinus*, *Saimiri*, *Cebus*, *Alouatta* and *Chiropotes* by boa constrictors *(Boa constrictor)* in the Neotropics (Cisneros-Heredia et al., 2005). Similarly reports exist of predation on Old World primates by reticulated pythons (*Python reticulatus*) (Quintino and Bicca-Marques, 2013). Observations of snake predations are even rarer, perhaps because of the risks involved, humans being the only primate to regularly predate on snakes (Falótico et al., 2017). To our knowledge, two reports do exist, one of *Tarsius bancanus* consuming a *Calliophis intestinalis* (Niemitz, 1973), and the other one in captive *Leontopithecus chrysomelas* and a

reintroduced *Leontopithecus rosalia* preying on coral snakes (*Micrurus* sp.) (Pissinatti in press, in Falotico et al. 2017), although in both cases the primates died from the snakes´ venom (Falótico et al., 2017).

The yellow tailed woolly monkey (*Lagothrix flavicauda*) has a varied diet comprising fruits, leaves, insects, petioles and other plant parts (Shanee and Shanee, 2011a, 2011b; Shanee, 2014). Recent observations also described geophagy in this species (Fack, 2016). To date, no reports have been made of animal predation, including snakes, by *L. flavicauda*. Here we present the first two observations of predation of a snake in a wild group of *L. flavicauda*, occurring in the dry season.

Methods

Our observations were collected during behavioural follows on a group of *L. flavicauda* at the locally named "El Toro" field site (05°40'83.2"S, 77°55'02.0"W), in the *Comunidad Campesina Yambrasbamba*, located on the eastern slopes of the Andes in Amazonas department, northern Peru. The study site comprises approximately 700 ha of disturbed montane cloud forest, pastures and agricultural lands between 1,800 and 2,400 m a.s.l. (Shanee and Shanee, 2015).

Data were collected on a group of 21 individuals of habituated *L. flavicauda*.: four adult males, eight adult females, four juvenile females, two juvenile males and three infants. Data were collected using instantaneous focal animal sampling (Altmann, 1974) during full day follows by one researcher and one local field assistant. Follows were undertaken on six consecutive days every two weeks, between 06:00 and 18:30 hours during April 2016 and August 2017, both during the dry season.

Results

At 14:15 pm on the 6th of April 2016, the focal individual, an adult male apart from the social group, was seen holding a dead snake of the family Colubridae while resting on a branch ~10m above the ground in a low tree (~13m). As it was raining at the time we were not able to observe the initial interaction between the *L. flavicauda* and the snake, therefore we do not know if it was found dead or killed by the focal individual. The focal individual then moved slowly to another tree, again to rest (~11m off the ground in a larger tree, ~15m). During this time, the focal individual was seen visually inspecting the snake, without vocalizing. At 14:25 pm the focal animal moved again, still holding the snake, to rest in another tree (~6m off the ground in a small tree, ~8m). Here the focal was within 2m of another adult male from the group, but no interaction was observed between the males. At 14:30 pm, the focal individual moved again, to the canopy (~15m) where he consumed immature leaves of *Ficus spp.* During this last move he let the snake fall to the ground; it was not recovered by another group member.

At 11:25 am on the 9th of August 2016, the focal individual, an adult female, was observed holding a live green snake, again a member of the Colubridae, in her left hand whilst moving through the canopy (~16m). The individual was alone, as she had separated from the rest of the subgroup we were following. Again, we did not see the initial encounter between the focal individual and the snake. Whilst moving towards the rest of the sub-group, the focal individual was observed by the other members and was approached by a juvenile male. However, the female did not allow the juvenile to approach too close, holding him away with her free hand. At 11:40 am the focal individual foraged on a dry branch while still in close proximity to the juvenile male and another adult male from the group. At 11:50 am the focal individual was observed manipulating the snake while resting, spinning it around her to avoid being bitten, as the snake, open mouthed, was seen trying to bite the female's arm. At 11:55 am, the sub-group started to travel faster and the focal female followed them. After a short moment out of our sight, we relocated the focal individual resting in a tree, with the snake, now dead, still in her left hand. The tail of the snake showed clear damage from being bitten.

At 12:00 pm the female began eating the snake starting with the tail, combining it with immature leaves and dry branches. Then she bit the snake in two and took a half in each hand. She kept one half in her hand while eating the other. An adult male and a juvenile male were observed approaching from ~20 m away. At 12:55 pm, the juvenile male attempted to snatch the snake from the female, but she fended him off. She continued to eat the snake, finishing the posterior half first then consuming the anterior part. She ate this until reaching the head. At 2:00 pm the focal individual finished eating and dropped what remained of the snake's skin. The female then re-entered the group, allowing other members to approach, and continued to rest and travel in the group. During this time, some "search-find" vocalizations were emitted by other members of the sub-group when the focal individual was isolated.

Discussion

Among primates, predation behaviours are mostly expressed by humans, chimpanzees and baboons (Butynski 1982). However, vertebrate predation by non-human primates has been recorded in at least 38 species from 9 families of prosimian and New and Old World monkeys and apes (Butynski 1982). Neotropical primates, including woolly monkeys, have been recorded predating on a variety of vertebrate including lizards, birds (adults and nestlings), squirrels, bats and coatis (Butynski 1982; Fedigan 1990).

To our knowledge, this is the first record of snake predation by *Lagothrix flavicauda*. This report increases our

knowledge about the diet and ecological interactions of this species. Even if it is a very rare event, it may highlight several important factors in their behavioural ecology, namely additional protein sources in their diet, the potential to discriminate venomous and non-venomous prey (Falótico et al. 2017), as well as providing a defence against potential predators (Cisneros-Heredia et al. 2005), as snakes have even been observed to prey on large bodied Atelidae (Quintino and Bicca-Marques 2013).

Observations of snake predation by non-human primates may be rare because of the potentially high risk involved. The few published reports all involved small and medium bodied primates, such as *Tarsius bancanus* (Niemitz, 1973), *Leontopithecus chrysomelas*, *Leontopithecus rosalia* (Pissinatti in press, in Falotico et al. 2017) and *Sapajus libidinosus* (Falótico et al. 2017). Falótico et al. (2017) reported that *Sapajus libidinosus* are able to differentiate between venomous and non-venomous snakes, in Brazil. They emit different cues according to the type of snakes, eliciting different responses from other group members (Falótico et al. 2017). Discrimination could have been made according to the size: small snakes were more often prey, although they can be more dangerous. Other factors may have also played a discriminatory role, such as colour and contrast colours, as well as audio cues. In both of our observations the prey snake was a member of the Colubridae, of a small, light green species. In our second observation, the focal individual was observed holding a live snake, without showing any obvious signs that the snake was considered a threat, although she did try to avoid being bitten. Similarly, we did not note any mobbing type behaviour (Crofoot, 2012) by other group members. Mobbing in the presence of venomous snakes has been reported in *S. libidinosus* by Falótico et al. (2017) and observed in *L. flavicauda* at this site, in response to the presence of a coati, *Nasua nasua* (Fack, Unpublished data).

To further these observations, it is necessary to begin an inventory of the snake species present at our study site and to record more interactions between *Lagothrix flavicauda* and snakes to determine how they behave towards different snake species and in which cases they could be predators or preys of snakes.

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Vinciane Fack, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium, Asociación Neotropical Primate Conservation Perú, La Esperanza, Yambrasbamba, Amazonas, Perú, and, Centre de Primatologie de l'Université de Strasbourg, France, E-mail : <vinciane.fack@gmail.com>**,** **Sam Shanee**, Asociación Neotropical Primate Conservation Perú, La Esperanza, Yambrasbamba, Amazonas, Perú, and, Neotropical Primate Conservation, Seaton, Cornwall, United Kingdom, **Régine Vercauteren Drubbel**, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium, **Marcela Del Viento Santoscoy**, Asociación Neotropical Primate Conservation Perú, La Esperanza, Yambrasbamba, Amazonas, Perú and Facultad de Estudios Superiores Zaragoza, UNAM, México, **Hélène Meunier**, Centre de Primatologie de l'Université de Strasbourg, France and Laboratoire de Neurosciences Cognitives et Adaptatives, UMR 7364, CNRS et Université de Strasbourg, France, and **Martine Vercauteren**, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium.

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UNEXPECTED DIVERSITY: THE POTENTIAL ROLE OF PRIVATELY-OWNED FOREST REMNANTS IN THE CONSERVATION OF THE PRIMATES OF THE HIGHLY-IMPACTED RONDÔNIA CENTER OF ENDEMISM, SOUTHWESTERN BRAZILIAN AMAZONIA

Thiago Cavalcante
Almério Câmara Gusmão
Stephen Francis Ferrari

The Rondônia center of endemism is an important component of Amazonian diversity, with a total area of 675,454 km2, which is mostly (96%) located within Brazil (da Silva *et al.*, 2005). Ongoing deforestation and logging have caused extensive habitat loss and fragmentation within this area, and constitute the main threat to its biodiversity (Gascon *et al.*, 2001). Some 27% of this area is protected, although only 3% is located within strictly protected conservation units (da Silva *et al.*, 2005). The primate diversity of the left margin of the Ji-Paraná River in southwestern Brazilian Amazonia is well known (Ferrari *et al.*, 1996; Gusmão *et al.*, 2014), although data from the right margin, especially from the middle and upper reaches of the river, are still scarce, and mostly outdated (Miranda-Ribeiro, 1914; Allen, 1916; de Vivo, 1985; Iwanaga and Ferrari, 2001). The present study reports on the primate assemblage found in an isolated forest remnant on the right margin of the upper Ji-Paraná River.

The study was conducted in a forest remnant of 543 ha located within a pasture matrix (11°28'08.81" S, 61°21'27.49" W), 229 m a.s.l., in the municipality of Cacoal, Rondônia state, Brazil (Fig. 1). This forest fragment is an area that combines the legal reserves of a number of small- and medium-sized farms. The climate is tropical humid (Aw in Köppen's classification) with a well-defined rainy season between September and May and a mean temperature of 26°C (Alvares *et al.*, 2013).

Data on the occurrence and abundance of primates within the study area were collected by line transect survey (see Peres, 1999), in which trails are walked at a mean velocity of 1.5 km/h. In the present study, the transects were conducted on two pre-existing trails; one 1.1 km in length, and the other, 0.7 km long. During these surveys, each encounter with a primate group was recorded, in which the species was identified and group size determined. Complementary data were collected during an ecological study of *Lagothrix cana* in the fragment, between March and September 2017 (Cavalcante, 2018). This study included 322 hours of behavioral monitoring, during which sightings of other primate species were recorded opportunistically, as well as during the phenological monitoring of seven 250 m trails scattered throughout the fragment. A total of 17.5 km was covered during the phenological surveys. Photographic records were obtained of all primate species, and their identification was confirmed through comparisons with the literature (Mittermeier *et al.*, 2013; Marsh, 2014; Byrne *et al.*, 2016).

Results and Discussion

We recorded 10 primate species during the present study, representing five families (Table 1). *Saimiri ustus* was by far the most abundant species, in terms of both the number of sightings and group size, whereas *Pithecia mittermeieri* was encountered only once during the transect walks. The presence of the small-bodied species, *Aotus nigriceps*, *Plecturocebus bernhardi* and *Mico nigriceps*, was only detected opportunistically, during non-survey fieldwork. These species were also recorded only once during the study. *Aotus nigriceps* has nocturnal habits and the other two species seem to use only the periphery of the study area, which was sampled less systematically during surveys. We thus confirmed the full inventory of primate species expected for this region, on the right margin of the Ji-Paraná River (see Miranda-Ribeiro, 1914; de Vivo, 1985; Iwanaga and Ferrari, 2001). Compared with the previous study of Iwanaga and Ferrari (2001) at Fazenda Mariana, approximately 50 km west of the present study site (Fig. 1), one more species

was recorded here, the nocturnal *A. nigriceps*. There are a number of differences, however, in the composition of this community in comparison with that of the left margin of the Ji-Paraná River (Ferrari *et al.*, 1996; Iwanaga and Ferrari, 2001; Gusmão *et al.*, 2014).

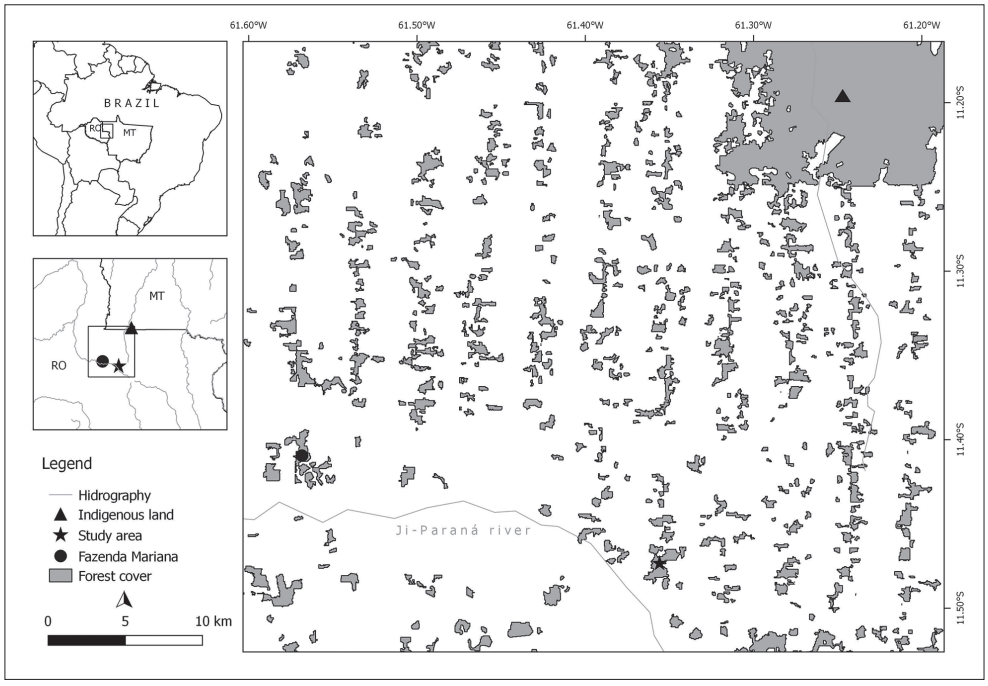

Figure 1. Location of the study area in the municipality of Cacoal, Rondônia, showing Fazenda Mariana (see Iwanaga and Ferrari, 2001) and the Sete de Setembro Indigenous Territory in southwestern Brazilian Amazonia (Mato Grosso and Rondônia).

Table 1. Sighting rates; mean, minimum and maximum group size; and opportunistic records of the platyrrhine species recorded in an isolated forest remnant in Cacoal on the upper Ji-Paraná River in Rondônia, Brazil.

Family	Species	Linear Transect			Opportunistic sightings
		Sightings per 10 km surveyed	Mean group size (individuals ± SD)	Minimum-maximum group size	
Atelidae	*Alouatta puruensis*	0.37	5 ± 1.22	3-6	X
	Ateles chamek	0.58	5.1 ± 1.12	4-7	X
	Lagothrix cana	0.66	5.7 ± 1.09	5-8	X
Cebidae	*Sapajus apella*	1.32	8.3 ± 1.60	6-12	X
	Saimiri ustus	1.39	15.4 ± 3.80	6-23	X
Pithecidae	*Plecturocebus bernhardi*	-	-	-	X
	Chiropotes albinasus	0.32	1.66 ± 0.57	1-2	X
	Pithecia mittermeieri	0.07*	-	-	-
Callitrichidae	*Mico nigriceps*	-	-	-	X
Aotidae	*Aotus nigriceps*	-	-	-	X

***Single sighting**

Although *Pithecia mittermeieri* was confirmed in the area, the single sighting during the linear transects indicates that this species occurs at a very low density, as observed at Fazenda Mariana (Iwanaga and Ferrari, 2001). By contrast, *Chiropotes albinasus*, despite having a low density, was sighted frequently during the monitoring of *Lagothrix cana* (Cavalcante, 2018), possibly due to its more extensive ranging behavior.

The apparently low density of howlers (*Alouatta*) in comparison with the other atelids (*Lagothrix* and *Ateles*) is surprising, given the relative tolerance of howlers to anthropogenic impact (Bicca-Marques, 2003), although this does appear to be typical of the occurrence of *Alouatta* in the study region (Iwanaga and Ferrari, 2001; Iwanaga and Ferrari, 2002a). Given the level of impact, and the small size

of the fragment, the results of the present study reinforce the conclusion that the principal pressure on the atelid populations in the Amazon region is hunting (Peres, 1990; Iwanaga and Ferrari, 2002b), and that even relatively small fragments, such as that found at the present study site, can support a high primate species richness.

Three of the primate species recorded in the present study are listed as endangered by the IUCN (2017). These species include the two atelines (*Lagothrix cana* and *Ateles chamek*), and the pitheciine *Chiropotes albinasus*. As the study area is part of the "arc of deforestation" of the southern Amazon basin (Michalski *et al.*, 2008), the confirmation of the presence of these species in forests outside protected areas is an important advance for conservation. The present study area, like Fazenda Mariana, is in the vicinity of the Sete de Setembro Indigenous Land, and the creation of corridors connecting these privately-owned areas with larger tracts of more continuous forest may be an essential conservation strategy in this region (da Silva *et al.*, 2005).

While the present study upholds the differences between the primate assemblages of the opposite margins of the Ji-Paraná River, and confirms its role as a geographic barrier for some species (Ferrari *et al.*, 1996; Gusmão *et al.*, 2014; this study), the absence of *Lagothrix cana* from the left margin is still enigmatic, not only because of its large body size (Ayres and Clutton-Brock, 1992), but also because of the species' apparent ecological resilience (Cavalcante, 2018, this study). As suggested previously, interspecific competition may play an important role in the zoogeography of these taxa (Iwanaga and Ferrari, 2001, 2002b). At Fazenda Mariana, Iwanaga and Ferrari (2001) found clear niche overlap, in particular with *Ateles chamek*. However, far more detailed ecological and behavioral data will be needed to evaluate these processes more conclusively. The high primate diversity found at both sites discussed here, and the fact that the atelines appear to be relatively abundant in this region's forest remnants (Iwanaga and Ferrari, 2001; Gusmão *et al.*, 2014), highlight the potential of privately-owned habitats to contribute to the development of effective conservation strategies for these species in the southwestern Amazon basin. Further research is needed, however, to verify the prospective role of these fragments for conservation at the landscape level. A quantitative and numerical evaluation of the fragments of the region, and their connectivity, will be essential to determine the real potential of these areas for primate conservation over the long term.

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Thiago Cavalcante, Laboratory of Primatology, Escola de Ciências, Pontifícia Universidade Católica do Rio Grande do Sul, Av. Ipiranga, 6681, 90619-900, Porto Alegre, Rio Grande do Sul, Brazil, E-mail: thiagocav.ferreira@gmail.com, **Almério Câmara Gusmão**, Bionorte Graduate Program, Universidade do Estado de Mato Grosso, Cáceres, Mato Grosso, Brazil; Centro Técnico Abaitará, Pimenta Bueno, Rondônia, Brazil, and, **Stephen Francis Ferrari**, Department of Ecology, Universidade Federal de Sergipe, São Cristóvão, Sergipe, Brazil.

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AGGRESIVE ENCOUNTER BETWEEN *LAGOTHRIX FLAVICAUDA* AND *NASUA NASUA* AT EL TORO, AMAZONAS, PERU.

Vinciane Fack
Sam Shanee
Régine Vercauteren Drubbel
Hélène Meunier
Martine Vercauteren

Introduction

Interaction between primates and other animals vary depending on their ecological relationship - primates behaving differently with competitors, mutualists, predators and preys. Aggressive interactions may occur with competitors, predators and prey (de Resende et al. 2004). The yellow-tailed woolly monkey (*Lagothrix flavicauda*: Atelidae) is one of the largest-bodied Neotropical primate species, and is endemic to northern Peru, in a small portion of the 'Tropical Andes biodiversity hotspot'. They live in montane cloud forests between 1,500 and 2,700 m. a.s.l., in multimale multifemale groups (up to 23 individuals). They are diurnal and arboreal, mainly omnivorous – with a diet including fruits, leaves, insects, petioles and other plant parts (Shanee, 2014).

The South American Coati (*Nasua nasua:* Procyonidae) is a medium-sized and gregarious carnivore commonly found throughout Neotropical forests (Alves-Costa et al., 2004). Juveniles and females live in groups (up to 30 individuals) while adult males are solitary (Beisiegel, 2001). They are semiarboreal (Haugaasen and Peres, 2008), mainly insectivorous-frugivorous and play an important role in seed dispersal and forest regeneration (Alves-Costa et al. 2004).

We report here an interaction between *N. nasua* and *L. flavicauda* in "El Toro" (05°40'83.2"S, 77°55'02.0"W), located 5 km north of the village of La Esperanza, northern Peru. The site encompasses approximately 700 ha of disturbed montane cloud forest with pastures and agriculture, between 1,800 and 2,400 m. a.s.l. Both species are common at the site (Shanee and Shanee, 2015).

Observations

On 27 April 2016, during behavioral follows we observed a sub-group of *L. flavicauda* (one adult male and five adult females) encounter a solitary male *N. nasua* in a stationary position in the understory (~7m). The focal animal (an adult female) approached the coati (to within 5 meters) near to the alpha male who was nearest the coati (~4 meters). The rest of the sub-group were in another tree behind the alpha male. All individuals in the sub-group observed the stationary coati, which did not stir from its initial position. The alpha male was the first to vocalize, followed by the females. When the coati did not respond, the male rapidly approached it, to within two meters, shaking branches in its direction to chase it away. Finally, the coati left the tree to move away. A few seconds later the monkeys stopped vocalizing, but the alpha male continued to look in the direction in which the coati had left. After the encounter, the focal individual continued to forage in epiphytes about 6 meters from the alpha male defending the sub-group from the intruder. The entire encounter lasted approximately 3 minutes. We believe this is the first record of an aggressive encounter between *L. flavicauda* and *N. nasua*. With both species sharing the same habitat, they probably encounter each other regularly and possibly compete for food and territory. Similar interactions have been observed between *Cebus apella* and *N. nasua* when feeding in the same area (de Resende, 2004). Further surveys of *N. nasua* habits at the study site could shed light on potential resource competition and home range overlap with *L. flavicauda*.

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Vinciane Fack, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium, Asociación Neotropical Primate Conservation Peru, La Esperanza, Yambrasbamba, Amazonas, Peru and, Centre de Primatologie de l'Université de Strasbourg, France, E-mail: <vinciane.fack@gmail.com>, **Sam Shanee**, Asociacion Neotropical Primate Conservation Peru, La Esperanza, Yambrasbamba, Amazonas, Peru and Neotropical Primate Conservation, Seaton, Cornwall, United Kingdom, **Régine Vercauteren Drubbel**, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium, **Hélène Meunier**, Centre de Primatologie de l'Université de Strasbourg, France and Laboratoire de Neurosciences Cognitives et Adaptatives, UMR 7364, CNRS et Université de Strasbourg, France, and, **Martine Vercauteren**, Université Libre de Bruxelles, Faculté des Sciences, Service d'Anthropologie et Génétique humaine CP.192, Brussels, Belgium.

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DIFFERENCES IN THE PREVALENCE OF CUTANEOUS MYIASIS BETWEEN *AOTUS VOCIFERANS* AND *AOTUS NANCYMAAE* IN THE COLOMBIAN AMAZON

Néstor Roncancio
María Alejandra Santa
Liza María Calderón
Edith Natalia Gómez
Amilvia Acosta
Lina Marcela García
Beatriz Eugenia Henao
Sandra Milena Peñuela
Erick Alexander Pinilla
Robin Andrés Poches
Erika Rodríguez

Introduction

Parasites are part of the natural processes allowing for the regulation of populations and the balance of the ecosystems (Clayton and Moore, 1997; Delahay et al., 2009). Parasites can affect population parameters such as birth and death rates (Nunn and Altizer, 2006; Delahay et al., 2009) and some mathematical models even suggest that they could play an important role in the host´s population and evolutionary dynamics (Begon et al., 2009; Nunn et al., 2011). However, the specific role of infectious diseases in population and evolutionary dynamics and details of that interaction, remains one of the biggest unanswered questions in ecology (McCAllum, 2000; Delahay et al., 2009).

Epidemiological surveillance (monitoring of the distribution, prevalence and incidence of diseases) allows the evaluation of host populations and environmental parameters and is also used in the monitoring, control, and prevention of diseases (Morner et al., 2002). From a public health perspective, primates are an important group for epidemiological surveillance due to the impact that diseases can have on their endangered populations, and also because the risk of zoonotic transmission. As some primate species are used for bush meat, biomedical models or, as pets, primates are in continuous close contact with humans, which increases the risk of cross-transmission and disease spread, highlighting the urgent need of primate epidemiological surveillance (Chapman et al., 2005). The epidemiological surveillance in primates is both noticeably lacking and inconsistent, especially in developing countries and it has been estimated that there are between 29% and 40% more species of parasites than the ones currently reported (Cooper and Nunn, 2013). Additionally, parasitic infections in primate species with nocturnal behavior have been studied even more infrequently. Specifically, only 38 parasitological studies on the genus *Aotus* has been reported, in which 12 species

of parasites were found (Cooper and Nunn, 2013). This study highlights an important parasite affecting nocturnal primates in an attempt to fill out this research gap.

During a survey of night monkeys (genus *Aotus*) in the Colombian Amazon (Bloor et al., 2014), we collected data on the presence of ectoparasites, particularly cutaneous myiasis. This disease refers to the infestation with dipterous (flies) larvae that feed on living or necrotic tissue (Hall and Wall, 1995). In this study, we present a comparison of the prevalence of cutaneous myiasis between *Aotus vociferans* and *Aotus nancymaae* in adjacent populations in the Colombian Amazon.

Materials and methods

Study area

This study was carried out between July and November of 2012 in the forest area of the municipality of Puerto Nariño, department of Amazonas (Colombia). We collected the data from nearby indigenous communities including Doce de Octubre (-70º30'15"W, -3º44'10"S), Naranjales (-70º31'47"W, -3º52'18"S), San Juan de Atacuari (-70º39'34"W, -3º49'26"S), Santa Clara de Tarapoto (-70º24'51"W, -3º48'02"S) and San Pedro de Tipisca (-70º35'36"W, -3º41`12``S). The first four sites are in the flooded plain of the Amazon River, while San Pedro de Tipisca is located in the "Terra firme" dry zone of the Loretoyacu River (Fig. 1).

Data collection

Samples were collected from live-caught individuals. These captures were done by a research team consisting of a biologist, a veterinarian, and some local experts. The local experts used certified tree-climbing equipment for their security and received from six to twelve hours of training in tree climbing techniques. To perform captures, the local experts first followed the primates from 03:00 to 06:30 hours. After confirming the presence of monkeys in a hole in a tree, the team carried out the captures between 09:30 and 15:00 hours, the period when the monkeys are asleep. After the hole was covered, the animals were extracted, put in dark bags, and examined by the veterinarian. The animals were weighed and then sedated with ketamine (5%) with doses between 5 to 15 mg/kg of weight, intramuscular. The duration of sedation was approximately 35 minutes and the time of recovery was approximately 90 minutes. The vitals for each animal were monitored continuously assessing temperature and cardiac and respiratory frequency, while the presence of cutaneous myiasis was recorded. The animals were tattooed on the thigh with a numeric code and released after their recovery.

This study was carried out under the agreement 10F of environmental authorities (Ministry of the Environment and CorpoAmazonia), supported by the National University and Instituto Sinchi (Amazon Research Institute of Colombia), all of them, part of the SINA (National Environmental System).

Data analyses

We estimated the prevalence of cutaneous myiasis of both species with Bayesian methods using an uninformative *a priori* binomial distribution (between 0 and 100%) and assuming that the posterior distributions were fitted to the uniform distribution (McCarthy, 2007; Pfeiffer et al., 2008). Prevalence estimation was done with Marcov chains with 100,000 iterations after a burn-in of 10,000 iterations for the final estimation, all using OpenBugs 3.2.2 software (Lunn-D et al., 2000). To compare the prevalence of the cutaneous myiasis between the two species, we used probability intervals (PI) graphics. When both PI showed over a 25% overlap, we assumed that there was no significant difference in the prevalence at 95% confidence level (Cumming et al., 2007).

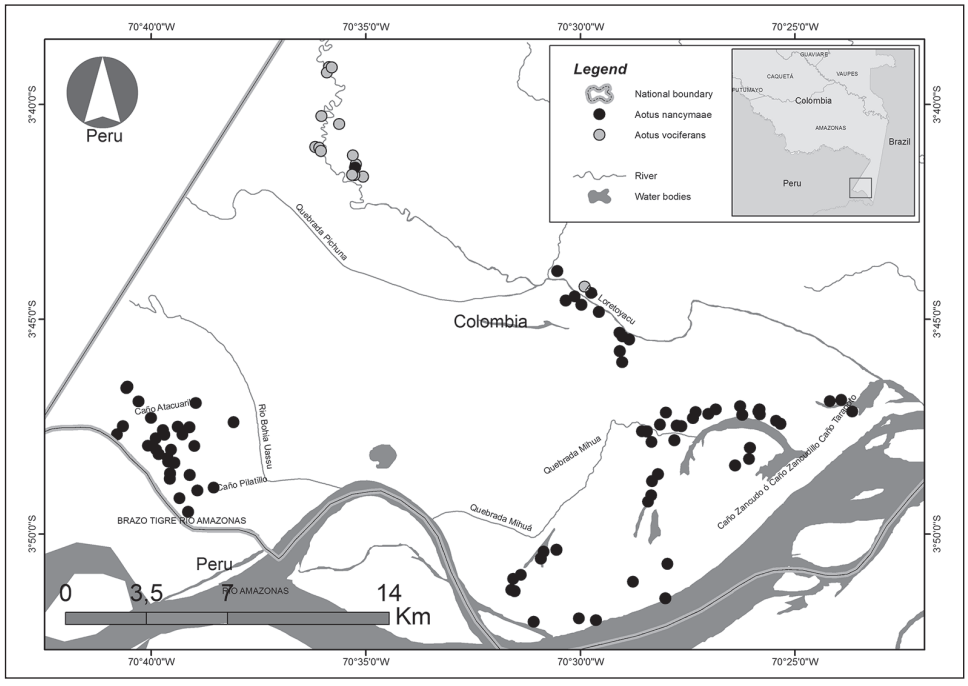

Figure 1. Site of study in the Colombian-Peruvian boundary.

Results

We captured 150 individuals of *A. nancymaae* and 19 individuals of *A. vociferans* (Bloor et al., 2014). Five *A. vociferans* and one *A. nancymaae* died during the capture. Cutaneous myiasis was found in three *A. vociferans* individuals: two juvenile males with one and four larvae respectively, and one lactating female with nine larvae. The larvae length was 1.5-2.5 cm and the skin lesion was furuncular (Fig. 2). For *A. nancymaae* we found scar lesions generated by cutaneous myiasis in one individual; and we recorded those lesions as a positive case (in order to avoid type II error related to the hypothesis that the disease affects this species in this site). The prevalence of infection in both species was 19% (PI 95%= 6 – 38) for *A. vociferans* and 1.3% (PI 95% = 0.2 – 3.6) for *A. nancymaae.* The difference in the prevalence of cutaneous myiasis between both species was statistically significantly (Fig. 3).

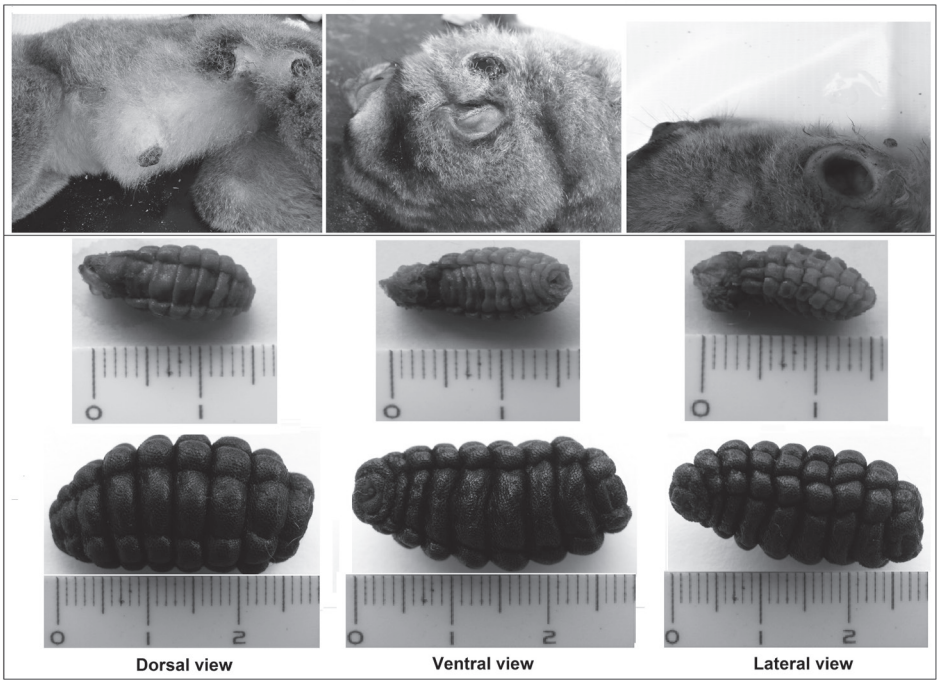

Figure 2. Lesions and some specimens of parasites recorded in sampled night monkeys (*Aotus vociferans*).

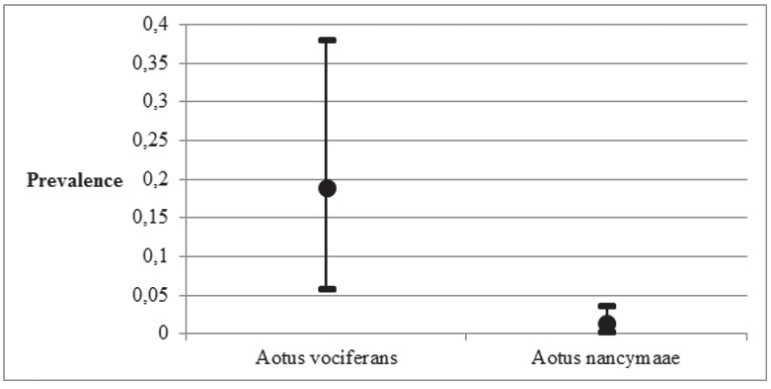

Figure 3. Probability Intervals comparison of the prevalence of cutaneous myiasis between *Aotus vociferans* and *A. nancymaae*.

Discussion

We found evidence of infestation by cutaneous myiasis in both species of night monkey, with a significantly lower prevalence in *A. nancymaae* (1.3%) compared to *A. vociferans* (19%), in spite of being adjacent populations. Cutaneous myiasis can be found in Neotropical primates, specifically howler monkeys. *Cuterebra baeri* is the main etiological agent and likely is involved in a species-specific relationship with howler monkeys (Zeledón-Araya et al., 1957; Milton, 1996; Stuart et al., 1998; de Thoisy et al., 2001; Olger Calderón-Arguedas, 2004; Arroyo-Rodríguez et al., 2008; Colwell, 2008; Cristobal-Azkarate et al., 2012; Trevez and Carlson, 2012; Guimaraes, 1971). In the case of *Aotus* sp., the same etiological agent for cutaneous myiasis was found in Brazil, likely through accidental infection (Guimaraes,

1971). In our study, the prevalences are lower compared to the ones found in howler monkeys, which are between 28.6% and 76 % (Milton, 1996; Calderón-Arguedas, 2004; Cristobal-Azkarate et al.,2012; Trevez and Carlson, 2012).

This kind of myiasis commonly generates pathological effects and is found mainly in mammals, although birds, reptiles and amphibians are occasionally hosts of the parasite (Munger and Karasov, 1994). Pathological effects vary depending on the parasite species, number of larvae, and the site of the infestation (Munger and Karasov, 1994) and include irritation, pruritus, weight loss, fertility reduction, death by tissue damage, secondary bacterial infection, dehydration, haemorrhage, anaphylaxis, and toxaemia (Wall and Shearer, 1997). In howler monkeys in Costa Rica, a correlation between the incidence of infestation and mortality was found (Milton, 1996). In the present study, the juvenile male that we captured had four larvae and was easily captured due to its weakness; it also did not survive the manipulation. Necropsy revealed extremely poor body condition, anaemia and dehydration. Likewise, the lactating female found with nine larvae had a low weight (600 g), similar to the juvenile individuals (mean weight of 635g).

The difference in the prevalence of cutaneous myiasis between these two species in adjacent and overlapping habitats, suggests the existence of different risk factors. These risks could vary with habitat preferences of the primate (Aquino and Encarnación 1988) or the parasite species and the differences in the susceptibility to disease of each primate. For example, a difference in mortality rate was found between *A. nancymaae* and *A. vociferans* in captive populations (Gozalo and Montoya, 1990). However, data analyzed in the same laboratory between 1988 and 2002 show a similar mortality rate in both species (75% in *A. nancymaae* and 77% in *A. vociferans*) by similar causes, mainly pneumonia and gastrointestinal diseases (Sánchez et al., 2006). Thus, it is necessary to increase the sampling effort of natural populations, in order to identify the habitat preferences and distribution of both species in this region, and to evaluate the association between habitat and parasite prevalence and how this can affect population dynamics (Janson, 2011).

The explicit taxonomic determination of larvae species was not possible in this study without the collection and further analysis of the specimens. However, the morphological characteristics of the larvae are similar to *Cuterebra baeri.* In general, the identification is low in similar studies (Colwell and Milton, 1998; Calderón- Arguedas, 2004). It is necessary to increase the effort to identify the species since the epidemiology and the effect on the host could vary significantly depending on the parasite species (Cristobal-Azkarate et al., 2012).

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Néstor Roncancio, Instituto Amazónico de Investigaciones Científicas – Sinchi, E-mail: <nroncancio@gmail.com>, **María Alejandra Santa**, Instituto de Genética, Universidad Nacional de Colombia, **Liza María Calderón**, **Edith Natalia Gómez**, **Amilvia Acosta**, **Lina Marcela García**, **Beatriz Eugenia Henao**, Instituto Amazónico de Investigaciones Científicas – Sinchi, **Sandra Milena Peñuela**, **Erick Alexander Pinilla**, **Robin Andrés Poches** and **Erika Rodríguez**, Instituto de Genética, Universidad Nacional de Colombia.

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Recent Publications

BOOKS

Pocket Handbook of Nonhuman Primate Clinical Medicine, edited by Angela Courtney. CRC Press. ISBN: 978-1138437227. This book supplies guidance and initial direction on diagnosis and treatment, including working doses based on past case experience. Its format gives readers easy access to clinical signs, diagnostic criteria, and options for treatment. *Contents:* 1) Anesthesia in nonhuman primates – Pacharinsak C & Sharp P; 2) Pain management - Pacharinsak C & Sharp; 3) Wounds and wound care – Courtney A; 4) Basic fluid therapy - Courtney A; 5) Management of gastrointestinal/abdominal conditions – Bawer C & Christe KL; 6) Thorax conditions – de la Garza MA; 7) Bacterial, mycotic, viral and parasitic infections – Gozalo AS & Strait KR; 8) Gestational concerns: when to intervene and what to do - Courtney A; 9) Dentistry in NHPs – McTighe MS; 10) Dermatologic and ophtamologic conditions – Strait K; 11) Strategies for management behavior problems, Funk AJW; 12) Formularies: drug dosages.

Big Data Analytics in Genomics, edited by Ka-Chun Wong. Springer. 428pp. ISBN: 978-3319823126. Recent sequencing technologies have enabled high-throughput sequencing data generation for genomics which have led to massive data accumulation at an unprecedented pace. The computational methods addressed in the book are intended to tackle crucial biological questions using big data, and are appropriate for either newcomers or veterans in the field. *Contents:* 1) Analysis in genome-wide association studies – Yang C, Wan X, Liu J, Ng M; 2) Robust methods for expression quantitative trait loci mapping – Cheng W, Zhang X, Wang W; 3) Causal interference and structure learning of genotype-phenotype networks using genetic variation – Ribeiro AH, Soler JMP, Neto EC, Fujita A; 4) Genomic applications for the Neyman-Pearson classification paradigm – Li JJ, tong X; 5) Improving re-annotation of annotated eukaryotic genomes – Gupta SK, Bencurova E, Srivastava M, Pahlavan p, Balkenhol J, Dandekar T; 6) State-of-the-art in Smith-Waterman protein batabase search on HPC platforms – Rucci E, Garcia C, Botella G, Giusti A, Naiouf M, Prieto-Macias M; 7) A survey of computational methods for protein function prediction – Shehu A, Barbará D, Molloy K; 8) Genome-wide mapping of nucleosome position and histone code polymorphism in yeast – Nagarajan M, Prabhu V; 9) Perspectives of machine learning techniques in big data mining of cancer – Prabahar A, Swaminathan S; 10) Mining massive genomic data for therapeutic biomarker discovery in cancer: tools and algorithms – Tong P, Li H; 11) NGS analysis of somatic mutations in cancer genomes . Prieto T, Alves JM, Posada D; 12) Oncominer: a pipeline for bioinformatics analysis of exonic sequence variants in cancer Leung MY, Knapka JA, Wagler AE, Rodriguez G, Kirken RA; 13) A bioinformatics approach for understanding genotype-phenotype correlation in breast cancer – Yotsukura S, Karasuyama M, Takigawa I, Matmitsuka H.

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ABSTRACTS

Abstracts from the 41st meeting of the American Society of Primatologists relating Neotropical Primates

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Wolovich, C. K., Sliwa, M., Fils-aime, G. and Blomquist, M. 2018. Behavioral responses of owl monkeys (*Aotus nancymaae*) to chemical cues of potential predators.

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Meetings

42nd MEETING OF THE AMERICAN SOCIETY OF PRIMATOLOGISTS

The 42nd meeting of the ASP will be held from August 21 - 24, 2019 in Madison, Wisconsin at the Pyle Center at the University of Wisconsin-Madison. For more information, please visit https://asp.org/meetings/conference.cfm

PRIMATE SOCIETY OF GREAT BRITAIN, SPRING MEETING

Primate Health, Captive Care and Conservation. This meeting has a broad theme which aims to unite primatologists from a variety of fields to share research and good practice for primate conservation purposes. The meeting will be one and a half days in duration; a half day on Monday 8th April from 12.30pm (plus an evening reception) and a full day on Tuesday 9th April 9.30am to 4.45pm. For more information, please visit https://www.eventbrite.co.uk/e/psgb-spring-conference-2019-tickets-54651663597

12th ANNUAL MEETING PRIMATE NEUROBIOLOGY

The annual Primate Neurobiology meeting offers a platform for European scientists, studying the electrophysiology and imaging of the central nervous system in nonhuman primates. The 12th Primate Neurobiology Meeting will be held from March 6-8, 2019 at the German Primate Center, in Göettingen. For more information, please visit https://www.dpz.eu/primneu/index.html

CONFERENCE OF THE GESELLSCHAFT FÜR PRIMATOLOGY

The Conference of the Gesellschaft für Primatology will be held at the German Primate Center in Göttingen from 13-15 February 2019. Organisers are Julia Ostner and Oliver Schülke. For more information, please visit https://www.primate-cognition.eu/en/events/events-calendar/einzelansicht-veranstaltungen/event/conference-of-the-gesellschaft-fuer-primatologie-1.html

PRIMATE BEHAVIORAL MANAGEMENT CONFERENCE

The Primate Behavioral Management Conference will be held at the Michale E. Keeling Center for Comparative Medicine and Research of The University of Texas MD Anderson Cancer Center, Bastrop, Texas, from February 26 - March 1, 2019. This conference is designed for those responsible for, or interested in, the behavioral management of nonhuman primates in captivity. For more information, please visit https://www.mdanderson.org/research/departments-labs-institutes/programs-centers/michale-e-keeling-center-for-comparative-medicine-and-research/primate-behavioral-management-conference.html

AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS MEETING

The 2019 AAPA meeting will be held in Cleveland, Ohio from March 27-30, 2019. For more information, please visit http://physanth.org/annual-meetings/88th-annual-meeting-2019/

Notes to Contributors

Scope

The journal 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.

Contributions

Manuscripts may be in English, Spanish or Portuguese, should be prepared with MS Word, and must use page and line numbering. 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 have their manuscripts written in English carefully reviewed by a native speaker. Send all contributions to: Erwin Palacios, Conservación Internacional – Colombia, e-mail: epalacios@conservation.org. Manuscripts that do not conform to the formal requirements (formatting, style of references etc.) will be returned to authors without review. They can be resubmitted, provided all formal requirements are met.

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.

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Articles

Short Articles