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ARTICLES

ACTIVITY BUDGET, FOOD PREFERENCE AND HABITAT USE OF A TROOP OF EX-PET YUCATAN BLACK HOWLER MONKEYS (*ALOUATTA PIGRA*) FOLLOWING RELEASEDavid Feeney¹, Paul Walker² and William O. H. Hughes³¹*Institute of Integrative and Comparative Biology, University of Leeds, Leeds LS2 9JT, UK.*²*Wildtracks, PO Box 278, Belize City, Belize.*³*School of Life Sciences, University of Sussex, Brighton, BN1 9QG, UK. E-mail: william.hughes@sussex.ac.uk***Abstract**

Rehabilitation and reintroduction of endangered species have numerous conservation benefits, including assisting in repopulating local areas depleted of such wild species and encouraging the preservation of the habitat for other species. Recovery and release of ex-pet howler monkeys have the added incentive of increasing public interest and awareness in mammal rehabilitation in a Neotropical context. The activity budget, food preference and spatial movements of a troop of three ex-pet Yucatan black howler monkeys (*Alouatta pigra*) were studied during the six weeks immediately following their release at Fireburn Reserve in northeast Belize. The ex-pet howler monkeys seemed to be more active than wild howler monkeys, with leaves comprising a relatively high proportion of their diet. The troop used a very small number of individual fruiting trees to maintain their frugivorous needs. Fruiting trees seemed to exert a decisive influence on the troop's distribution, resulting in non-random use of habitats. Similar detailed data from other reintroduced ex-pet monkeys are needed to confirm the results. Nevertheless, our data support the preservation of multiple habitat types in a forest environment to benefit howler monkeys' survival and suggest that ex-pet animals can adapt successfully following release.

Keywords: Reintroduction, primate, Belize, activity budget, micro-habitat.

Resumen

La rehabilitación y reintroducción de especies amenazadas tiene numerosos beneficios para la conservación, incluyendo el ayudar a repoblar áreas locales de donde se han extirpado tales especies silvestres y promoviendo la preservación del hábitat donde son liberados para otras especies. La recuperación y liberación de monos aulladores que fueron mascotas tiene el incentivo adicional de incrementar el interés y preocupación del público en la rehabilitación de mamíferos en un contexto Neotropical. El presupuesto de actividades, preferencia de alimentos y movimientos espaciales de un grupo de tres monos aulladores negros de Yucatán (*Alouatta pigra*) que fueron mascotas, fueron estudiados durante seis semanas inmediatamente después de su liberación en la Reserva Fireburn en el nororiente de BÉlize. Estos monos aulladores parecieron ser más activos que los monos aulladores silvestres, y las hojas representaron una proporción relativamente alta de su dieta. El grupo utilizó un muy pequeño número de árboles fructificando para satisfacer sus necesidades frugívoras y los árboles en fruto parecieron ejercer una influencia decisiva sobre la distribución del grupo, resultando en un uso no al azar de los hábitats. Datos detallados similares de otros monos que han sido mascotas reintroducidos, se necesitan para confirmar los resultados, pero estos apoyan la preservación de múltiples tipos de hábitats en el bosque para beneficiar la sobrevivencia de los aulladores y sugieren que animales que han sido mascotas pueden adaptarse exitosamente después de su liberación.

Palabras clave: Reintroducción, primate, BÉlize, presupuesto de actividades, micro-hábitat

Introduction

The howler monkeys (*Alouatta*) have the greatest geographical distribution of any Neotropical primate genus, but include a number of species of conservation concern that are listed as Vulnerable, Endangered or Critically Endangered

by the IUCN (Neville et al., 1988; IUCN, 2015). These include the Yucatan black howler monkey, *A. pigra*, which is listed as endangered having experienced a population decline of as much as 60% over a three generational period due to the effects of deforestation, disease, and the pet trade (Marsh et al., 2008). Yucatan black howler monkeys occur

in Belize, northern Guatemala and Mexico's Yucatan Peninsula, and generally live in relatively small, stable groups of 2-11 individuals, with average troop sizes ranging from 4-7 animals (Crockett and Eisenberg, 1987; Baumgarten and Williamson, 2007; Gavazzi et al., 2008; Dias et al., 2015). Howler monkeys are primarily folivorous, with very variable frugivory levels that can be as high as 95%, and a dietary flexibility that may be enhanced by compensatory shifts in their gut microbiota (Altmann, 1959; Neville et al., 1988; Bravo and Sallenave, 2003; Rodríguez-Luna et al., 2003; Amato and Garber, 2014; Dias et al., 2014; Zárata et al., 2014; Amato et al., 2015). This dietary flexibility is critical to why howlers can occupy a diversity of habitats, including secondary and fragmented forests, and to their ability to adapt to habitat disturbance (Arroyo-Rodríguez and Dias, 2010; Behie and Pavelka, 2012). Howlers can remain feeding in one tree for relatively long time periods compared with other primate species, without even briefly moving from it, and may spend as much as 80% of the daytime resting amid tree branches (Richard, 1970; Anzures-Dadda and Manson, 2007; Palma et al., 2011; Pozo-Montuy et al., 2013; Amato and Garber, 2014). Howlers tend to have a daily routine, with the midday resting, and dawn and dusk feeding that is characteristic of tropical animals, including primates (Altmann, 1959; Bernstein, 1964; Chivers, 1969; Estrada et al., 1999). Howlers can also reduce their physical activity to compensate for low energetic return from leaves when fruit is scarce (Pinto et al., 2003). They show 'foci of activity' associated with their feeding (i.e., specific locations within which most feeding occurs), which usually alter from month to month, coinciding with seasonal availability of preferred foods, with the 'core area' concept describing areas often used for sleeping (Burt, 1943; Palma et al., 2011; Jung et al., 2015).

Food abundance and its distribution can strongly influence how howler monkey troops form and maintain a recognisable territory, thought of as a relatively stable and clearly defined area (Chivers, 1969). Territorial establishment seems to depend on the initial formation of one or more 'home ranges' which, unlike the broader territory, will vary over time (Ostro et al., 1999). Home range is used to express the area of aggregations of day ranges (the linear distances of day travel), thus referring to an area generally traversed by a troop during its daily activities over a specified period. Home range would hence seem to be heavily interlinked to the 'foci of activity' concept, and thus food resource availability is a primary determinant of home range size for Yucatan black howler monkeys, with food availability being in turn affected by factors such as habitat fragmentation and population density (Gavazzi et al., 2008; Arroyo-Rodríguez and Dias, 2010). Indeed, howler monkey troops establish ranges based on experience regarding fruiting cycles, and can move between locations depending on wet or dry seasonal influences on food abundance (Freese, 1976; Napier and Napier, 1985). Originally, it was thought that *A. pigra* preferred extensive, undisturbed and mesic tropical forest (Smith, 1970), but subsequent studies also found *A. pigra*

to inhabit highly disturbed semi-deciduous forests and to be able to supplement their diet in some areas by raiding crops (Horwich and Johnson, 1986; Arroyo-Rodríguez and Dias, 2010; Pozo-Montuy et al., 2013; Zárata et al., 2014). Consequently, howlers are considered a pioneer species that can adapt to diverse habitats (Eisenberg, 1979). However, it is still not completely understood how habitat and food resource variability influences the spatial decision making of howler monkeys, particularly among newly introduced groups, such as translocated troops. Translocated monkeys have been observed still not forming a recognisable territory six months after release into new forest (Silver and Marsh, 2003). Hence, analysing initial development of occupied areas, and later home ranges, seems critical to inform spatial studies of released howlers.

The behavioural and genetic diversity of *A. pigra* needs a combination of conservation approaches to support as many sustainable wild populations as possible. Trade operations in endangered primates, such as howler monkeys, for the pet market continue despite anti-hunting legislation throughout most primate ranges (Peres, 1997; Cheyne, 2010). Rehabilitation and reintroduction projects offer simultaneous solutions to both concerns, as they can recover the pet primate itself, and gather public support to protect wild habitat where reintroductions occur. Yet, while increasingly viewed as a valuable conservation strategy, release of captive individuals can be complex and controversial, particularly as little outcome data exist due to limited monitoring and reporting post-release (Terborgh, 1983; Yeager, 1997; Tutin et al., 2001; Strum, 2005). For example, a review of 87 researched animal reintroductions found that 19 were successful, 22 failed and 46 had unknown outcomes (Fischer and Lindenmayer, 2000). Furthermore, only about 50% of reintroduction projects have attempted release of threatened or endangered species (Beck et al., 1994). Reasons for high failure rates among primate reintroductions include an absence of release site surveying for habitat suitability or food availability (Cheyne, 2010). To facilitate successful primate releases, natural habitats must not host conditions that had caused wild populations to originally become endangered, such as hunting or deforestation. Previous studies of primate reintroductions have focused on translocated monkeys, moved from one part of their range to another (Ostro et al., 1999; Richard-Hansen et al., 2000). There has been no comparable research of released ex-pet black howler monkeys, although they are likely to differ in important ways from translocated animals. For instance, whereas both translocated and ex-pet monkeys require time to adjust to their new habitats, translocated primates would be expected to be already experienced from their previous forest environment. In contrast, released ex-pet monkeys would have most likely little to no previous experience in searching for and locating their own food, or forming and maintaining home ranges and territories, other than that provided as part of a pre-release rehabilitation programme. In this study, we therefore investigated the behaviour and habitat usage of a small troop of

ex-pet Yucatan black howler monkeys during the initial six weeks after release in order to gain insight into their ability to adapt to their new habitat immediately following release.

Methods

The study was conducted over a six-week period from June to July 2011 at the Fireburn Reserve, Corozal District, Belize (18°12'02" N, 88°11'59" W). Fireburn Reserve is an 1,818 acre protected area managed in partnership between the local community and Wildtracks, a conservation nongovernmental organisation. The study site is predominantly tropical, lowland forest, but includes a diversity of habitats including mangrove savannahs. Forest condition (stature and species composition) is variable, and in part reflects the impacts of historical logging, hurricanes and past agriculture. The north and east of the site is dominated by cohune palm, a species that is known to be a successful colonizer on some soil types and to then dominate forest species composition for centuries. Within the "Tropical evergreen seasonal broadleaf lowland forest over calcareous soils: Yucatan variant ecosystem", the six micro-habitats in the area are: 1) medium height lowland moist forest, 2) shorter lowland moist forest, 3) lowland moist forest with cohune, 4) dense cohune, 5) scattered cohune, and 6) secondary growth pioneer species. The region receives rainfall of between 1,200–1,500 mm per annum, with the wet season being June to November, and exhibits a decline in the number of fruiting tree species from the peak month of May. Howler monkeys were once present in the area of Fireburn Reserve, but disappeared from the area in the 1940's/1950's most likely due to the same factors that have caused the declines of other *Alouatta* populations, i.e. hunting, disease, and hurricanes (Pavelka et al., 2007; Marsh et al., 2008). The protected nature of the reserve, strong community support, and provision of diverse, high density potential food resources, now makes Fireburn Reserve suitable to support a howler monkey population. However, natural repopulation of the area is inhibited by the increasing removal by farming of forest corridor linkages with other areas.

The howler monkey troop that was studied consisted of three individuals: a 3 year old female, a 2.5 year old female and a 2.5 year old male. The monkeys had been confiscated from the illegal pet trade by the Belize Forest Department and subsequently transferred to Wildtracks' Primate Rehabilitation Centre for reintroduction into Fireburn Reserve as part of the Belize government's rehabilitation programme for ex-pet monkeys. The monkeys were initially quarantined for 30 days and screened for possible pathogens, before being housed as a group in a forest cage enriched with natural vegetation to enable social bonding, and then housed for several months in a pre-release forest enclosure to encourage the development of foraging skills and group cohesion, following IUCN guidelines for the re-introduction of primates (Baker, 2002). The troop was released on 17th May 2011, and supplementary fruit

and water were provided continuously at the release site in order to assist the initial adaptation of the troop to their new habitat. Observations on the troop were carried out for six weeks as part of the study described here, but were continued after this time by Wildtracks as part of its standard post-release monitoring of reintroduced monkeys.

A total of 31 days of observation were conducted from dawn to dusk (a 13–14 h period) over the six weeks. On each day, the troop was located and its position, activity and movement subsequently tracked until dusk. The position of the troop was recorded with a GPS (accurate to \pm 7 m under the rainforest canopy) when the troop was resting, feeding and every 3–6 min when moving. The GPS records were then integrated with a habitat map for the area to determine habitat usage. Following Rodríguez-Luna *et al.* (2003), the activity of the troop was recorded at 1 min intervals as either: 1) resting (stationary, sitting, standing or lying down without activity, or in activities such as yawning, stretching, or intermittently flicking its tail); 2) feeding (occupied with consuming food, or looking for and holding/reaching for food items); 3) moving (walking, running, climbing or jumping from tree to tree or between branches of a tree, but not including travelling within a tree when foraging); or other behaviour (playing, drinking, vocalizations, mating, physical or vocal aggression, urination and defecation). As observations were recorded at a fine temporal scale of 1 min, consecutive observations of the same activity were assumed to reflect the same activity bout, with the duration of activities then being the time until the monkeys switched to a different activity. Variation in tracking time meant that the calculated percentage durations of each activity often differed considerably between days. In particular, feeding and moving percentages were probably disproportionate on days of short observation times (i.e., under 5 h). In general, on these days the monkeys were followed in their foraging phase, but were lost from view before their likely resting periods. Additionally, as the troop did not have consistent sleeping areas, likely resting time after dawn was often not accounted for. During feeding episodes, it was noted whether the monkeys were eating leaves, fruit, flowers or other material (bark, stems, or fungus). The species of the food plant was recorded where possible, or marked for future identification. To analyse the troop's distribution and microhabitat use, the area was divided into four quadrants with the release site as their centre point. Within each quadrant, the abundance of the five tree species most commonly used as food by the monkeys was surveyed along four 200 m x 6 m transects from this release site. These were: *Ficus* sp. (fig), *Cecropia peltata*, *Brosimum alicastrum* (ramon), *Protium copal* (copal) and *Spondias radlkoferi* (hog plum).

Statistical analysis

Chi-squared or Fisher's Exact tests were used to compare the frequencies of sightings between quadrants and habitats to determine if the use of the site was random. The frequencies of feeding tree species recorded during the

observations and transect surveys were also compared with Chi-squared tests to investigate if plant species were fed on more than expected given their relative abundance in the habitat. The relationship between the arcsine transformed percentage of fruit foraging and the time since release was examined using a Pearson's correlation. In order to check whether the number of observations on the relevant day affected the records of fruit feeding, we also examined this relationship with Pearson's correlation.

Results

Over the initial six weeks following the release of the monkeys, we spent 31 days in the field, with 240 hours of troop tracking time, providing 119 observation/contact hours. Three tracking days contained no troop sightings, but there were no consecutive days of non-sightings. On average 285 ± 31 (mean \pm SE) observations were made per day (minimum 20, maximum 555).

Behavior

The howler monkeys spent the majority of their time engaged in either resting or feeding (Fig. 1). Resting activity was recorded least often of the principal activities (172 separate activity bouts), but unsurprisingly had by far the largest duration, while feeding was recorded more often (284 activity bouts) but lasted for shorter periods of time. Feeding was generally longer when the troop was feeding on fruit (20–60 min) than when they were feeding on leaves (2–15 min). The most common activity in which the troop was observed was movement (334 activity bouts), but this was generally of a much shorter duration than other activities. Compared with published data on wild translocated or established troops of howler monkeys, the troop of ex-pet howler monkeys were observed less frequently resting and more frequently feeding (Fig. 1).

Habitat usage

The furthest distance the troop was observed from their release cage was 277 m in a NW direction (Fig. 2a). The number of sightings per quadrant were 716 (NW), 55 (NE), 69 (SE) and 5 (SW), with the difference in the number of sightings between quadrants being significant ($\chi^2 = 635$, $df = 3$, $P < 0.001$). There was a significant difference between the total number of sightings in each habitat and the extent of that habitat in the study area ($\chi^2 = 179$, $df = 6$, $P < 0.001$). The monkeys were most commonly found in lowland moist forest with cohune (which tended to also contain *Ficus*, *Protium* and *Brosimum* plant species), despite this habitat representing only 6.5% of the study area (Fig. 2b). In contrast, the monkeys were never found in shorter lowland moist forest despite of this occupying a greater proportion of the overall area (Fig. 2b). Most sightings of the monkeys during the first two weeks were in lowland moist forest with cohune or dense cohune (Fig. 2a). Their daily occupied area experienced a pronounced shift westwards in the subsequent two weeks, with the majority of sightings in lowland moist forest with cohune. During

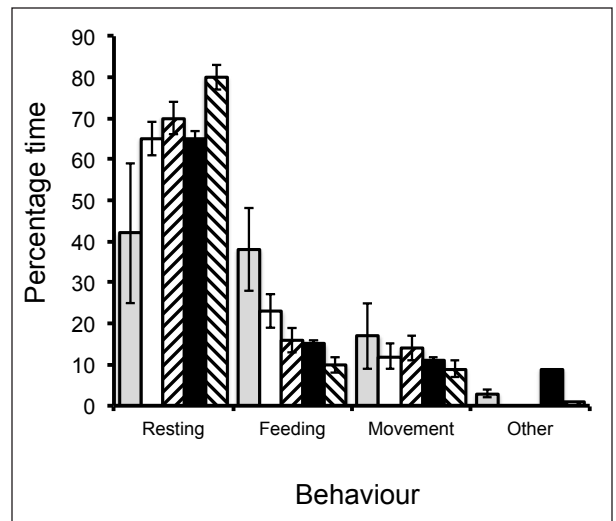


Figure 1. Mean (\pm SE) percentage of time that black howler monkeys were observed engaging in resting, feeding, movement or other behaviours for the troop of ex-pet monkeys (this study; grey), compared with similar data from other studies for translocated wild monkeys (Rodríguez-Luna et al. 2003; white), and wild established monkeys (Richard 1970; Milton 1980; Rodríguez-Luna et al. 2003; right diagonal lines, black, and left diagonal lines, respectively).

the final two weeks of observation, the troop shifted northwards and most sightings were in medium height lowland moist forest.

Foraging

Of the observations of feeding by the howler monkeys, $61.3 \pm 5.3\%$ were on leaves, $38.7 \pm 5.3\%$ on fruit and 0.19% on flowers, with 93.3% of the fruit feeding observations being on only three individual fruiting trees. Overall, there was a significant difference between the frequency at which the howlers were seen eating from a particular tree species and the abundance of that species in the habitat ($\chi^2 = 9.66$, $df = 4$, $P = 0.046$). The monkeys fed on *Ficus* sp., *Cecropia peltata* and *Protium copal* at similar frequencies to their presence in the habitat, but fed more frequently on ramon trees ($\chi^2 = 5.51$, $df = 1$, $P = 0.019$), and less frequently on hog plum ($\chi^2 = 5.31$, $df = 1$, $P = 0.021$), than would have been expected given the relative abundance of these species in the area (Fig. 2c).

There was no significant change in the percentage of observations eating fruit over the six-week period ($r = 0.341$, $P = 0.095$; Fig. 3a). The slight positive trend seemed to be largely due to three data points on days 27, 30 and 31, which showed noticeably high fruit percentages. These were days with less than 5 h observation, thus most likely missing much leaf eating activity. Although there was no significant relationship between the percentage of time eating fruit and number of observation hours on a particular day ($r = -0.340$, $P = 0.097$), it did appear that a lower proportion of time eating fruit was recorded on days when observation time was greater (Fig. 3b). After day 5,

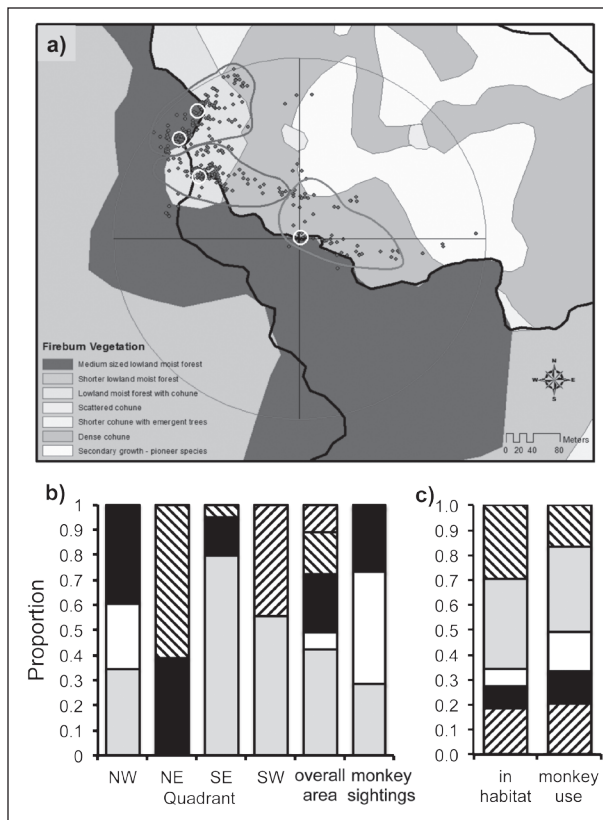


Figure 2 a) Map of the release area for the troop of ex-pet black howler monkeys, showing the areas of each habitat, locations where the howler monkeys were sighted over the six weeks following their release, and the three principal areas in which the howler monkeys were sighted (outlined in grey) with the foci of activity (white circles; the central circle is the site of release, and the circles to the northwest and then north were occupied subsequently). There were no consecutive days of non-sightings, so it is very unlikely that the troop moved far outside these occupied areas during the study. **b)** Proportion of area of each quadrant and of the overall area that was occupied by each habitat (colour coding as in Fig 2a): medium height lowland moist forest (dark green), lowland moist forest with cohune (light green), scattered cohune (lightest yellow-green, not visible as < 2%), dense cohune (dark brown), secondary growth with pioneer species (light brown), and short lowland moist forest (medium green), and the proportion of sighting of the howler monkey troop in each habitat. **c)** Relative abundance of *Ficus* (right diagonal black lines), *Cecropia* (black), ramon (white), copal (grey) and hog plum (left diagonal grey lines) trees in the area as proportions of total, and the proportion of monkey feeding sightings on each of the tree species.

the troop never returned to avail itself of the supplementary fruit provided at the release site.

Discussion

The troop of ex-pet howler monkeys appeared to adjust rapidly to its new environment, making no use of the supplementary food provided after five days following introduction, and surviving and foraging well for the six-week duration of the study. The troop spent a comparatively higher proportion of its time feeding and moving, and a lower proportion resting, than previous studies suggest is

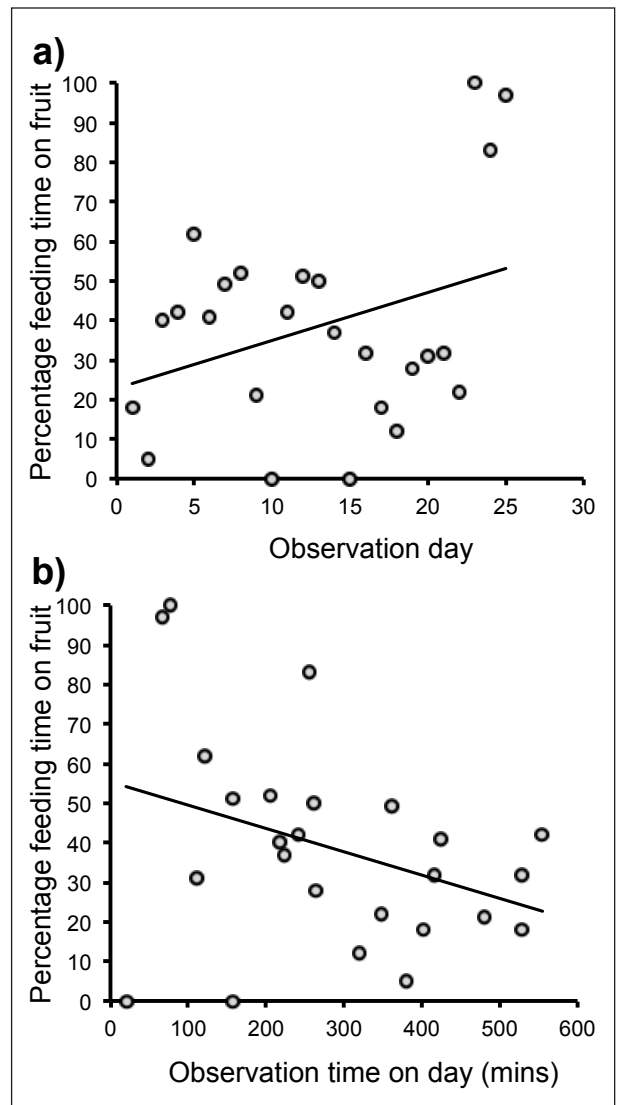


Figure 3. Relationships between the percentage of total feeding time that a troop of ex-pet black howler monkeys spent feeding on fruit each day and a) the day of observation after release, and b) the total length of time the monkeys were observed on that day. The lines of best fit are respectively $y = 1.22x + 22.8$ ($R^2 = 0.116$), and $y = -0.058x + 55.3$

the case for translocated, established and wild troops of howler monkeys (Richard, 1970; Milton and Milton, 1980; Rodríguez-Luna et al., 2003). The relatively high variation in the data, as well as the high proportion of feeding observations and low proportion of resting observations, were at least in part likely due to variation in tracking time on different days. Habitat use by the troop within the study area was non-random, with the troop spending most time in the NW quadrant and displaying a marked preference for certain habitats. There was spatial evidence of shifts in occupied area between habitats with time.

The howler troop was selective in its choice of trees for foraging. Despite the number of fruiting tree species declining at the site with the commencement of the wet season, there was no significant decline in fruit feeding. This was

primarily due to just three individual fruiting trees, one of which was known locally as the “magic tree” (*Pouteria* sp.), on which the howlers spent 93% of their fruit feeding time. The troop was also selective in its foraging on leaves, with preferred species being fed on more frequently than their abundance in the area would have predicted. Wild howler monkeys have previously been observed to be selective in their use of a small number of species as their principal food sources (Chapman, 1988; Peres, 1997; dos Santos et al., 2013; Pozo-Montuy et al., 2013; Amato and Garber, 2014), and the same seems true of the ex-pet howler monkeys in this study.

The troop had a diurnal activity cycle and movement pattern similar to that of wild and translocated howler monkeys (Altmann, 1959; Bernstein, 1964; Silver and Marsh, 2003; Anzures-Dadda and Manson, 2007; Palma et al., 2011; Amato and Garber, 2014), with long periods with little or no travel being punctuated by occasional periods of long and relatively continuous movement. The periods of travel appeared to often be led by the male. The troop shifted its location over the course of the study, conforming to the concept of howler monkeys having food-associated ‘foci of activity’ to inform spatial movements over time (Chivers, 1969). Two fruiting trees, located 220 m and 255 m northwest of the release point, were particularly focal points of activity. The ripening time of fruits appears to be an important factor in determining the activity of wild, and particularly translocated, howler monkeys too (Richard, 1970; Ostro et al., 2000). It is notable that the attraction of the ex-pet howlers to the fruiting trees resulted in most of their activity being in the northwest quadrant even though this quadrant had a lower abundance of the most favoured tree species for leaf feeding than other quadrants.

Anthropogenic and climate impacts have created a spatial heterogeneity in Fireburn’s habitats and forest canopy. The howler monkey troop clearly utilised some habitats significantly more than others, in keeping with studies of wild howler monkeys at Lamanai Archaeological Reserve, northern Belize (Gavazzi et al., 2008). Monkeys were found most often in lowland moist forest with cohune habitat, despite this making up a relatively small proportion of the area. Although medium height lowland moist forest habitat had the second highest number of howler monkey sightings, these were heavily concentrated in the northwest, with large areas of similar habitat to the south being left unexplored. It is unclear why the troop chose their first occupied range to be east and north of their release site, rather than moving southwards, but it may have been due to the relatively low canopy of forest habitat to the south; a result of past hurricane activity. The similar sighting durations in the three most frequented habitats suggest that where the troop found food in each habitat, they often tended to subsequently rest for long periods on trees close by. Within the observation period, there seemed to be no particular tree species or habitat that influenced where the troop rested. During the troop’s exploratory travel movements, they

were observed moving through dense cohune and onwards into secondary growth with pioneer species. The rapid return (within 1–2 days) to their most frequently occupied areas on each occasion suggested that, despite the occurrence of edible leaf bearing tree species in the areas, a lack of fruiting trees caused the troop to relegate such habitat as a viable extension to their occupied range. These recordings further substantiate observations of *A. pigra* troops seeming to select forest habitat based upon vegetative differences (Ostro et al., 2000), with seasonal fruiting trees being the primary driver of movements within territories. While the troop’s eventual home range would most likely increase in response to seasonal food fluctuations, the observations support food resource availability being more critical to howler monkey survival than actual habitat size (Rodríguez-Luna et al., 2003; Arroyo-Rodríguez et al., 2013). Even small numbers of fruiting trees may be particularly important. Although the activity budget of the ex-pet howler monkeys was somewhat different from that found for translocated and wild howler monkeys, the observations suggest that ex-pet howler monkeys can adjust quickly following release, preferring less recently disturbed forest and possibly benefiting from a mix of habitats. There are of course many considerations which need to be taken into account when considering the release of primates (Baker, 2002), but the results presented here suggest that the release of effectively rehabilitated ex-pet howler monkeys may be viable, providing due regard is given to the habitat structure and food availability at the planned release site.

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UNUSUAL INTERGROUP MOVEMENT OF YOUNG MALES IN A MALE PHILOPATRIC SOCIETY

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Abstract

Deviations from sex-biased dispersal patterns of primate species have often been attributed to local demography, particularly in cases of dispersal by males in what are typically male philopatric societies. Here, we evaluate the demographic conditions associated with novel observations of intergroup movements by two male northern muriquis, *Brachyteles hypoxanthus*, monitored since their births at the Reserva Particular do Patrimônio Natural - Feliciano Miguel Abdala, in Caratinga, Minas Gerais, Brazil. Specifically, we compare the size and operational sex ratios (OSR) of all four muriqui groups in the study population at the time the two males, aged 5.4 and 7.9 years, left their natal group to associate with members of a non-natal group, and again 3 months later, when the older male, ZS-J, returned to his natal group. We also use Association Indices to evaluate the males' spatial relationships in their natal and non-natal groups to better understand the social conditions that may have also affected their unusual movements. The two males initially moved from their natal group (Jaó), which had the highest OSR in the population, into the smallest group with the most favorable OSR (M2). However, ZS-J subsequently returned to his natal group despite its much higher OSR. Both males had strong spatial associations in their natal group prior to their departures, but only the younger male achieved similar spatial associations in M2 group, where he remained. ZS-J's extreme spatial peripheralization in M2 group may have contributed, at least in part, to his return to Jaó group, where his earlier strong spatial associations were restored. These findings suggest that social and demographic factors may be involved in individual deviations from a species or population's normative dispersal patterns. They also demonstrate the value of long-term field studies of recognized individuals over the duration of their lives for documenting behavioral flexibility.

Keywords: *Brachyteles hypoxanthus*, male dispersal, male philopatry, demography, operational sex ratio, association index.

Resumen

Desviaciones de patrones de dispersión ligados al sexo de especies de primates han sido a menudo atribuidas a la demografía local, particularmente en casos de dispersión de machos en lo que son típicamente sociedades filopátricas de machos. Aquí, evaluamos las condiciones demográficas asociadas con observaciones novedosas de movimientos intergrupales de dos machos de muriquis del norte, *Brachyteles hypoxanthus*, monitoreados desde sus nacimientos en la Reserva Particular do Patrimônio Natural - Feliciano Miguel Abdala, en Caratinga, Minas Gerais, Brasil. Específicamente, comparamos el tamaño y proporciones de sexo operacional (OSR) de todos los grupos de muriquis en la población de estudio en el momento en que los dos machos, de 5.4 y 7.9 años de edad, dejaron su grupo natal para asociarse con miembros de otro grupo, y de nuevo 3 meses después, cuando el macho mayor, ZS-J, regresó a su grupo natal. También usamos Índices de Asociación para evaluar las relaciones espaciales de los machos en sus grupos natales y no natales para entender mejor las condiciones sociales que pueden también haber afectado sus inusuales movimientos. Los dos machos inicialmente se movieron de su grupo natal (Jaó), que tenía el más alto OSR en la población, hacia el grupo más pequeño con el más favorable OSR (M2). Sin embargo, ZS-J después regreso a su grupo natal a pesar de su más alto OSR. Ambos machos tenían fuertes asociaciones espaciales en su grupo natal antes de partir, pero solamente el macho más joven logró similares asociaciones espaciales en el grupo M2, donde permaneció. La extrema periferalización espacial de ZS-J en el grupo M2 pudo haber contribuido, por lo menos parcialmente, a su retorno al grupo Jaó, en donde sus anteriores fuertes asociaciones espaciales fueron restauradas. Estos hallazgos sugieren que factores sociales y demográficos pueden estar involucrados en desviaciones individuales de aquellos patrones de dispersión normales de una especie o una población. También demuestran el valor de los estudios a largo plazo de individuos reconocidos durante la duración de sus vidas para documentar la flexibilidad comportamental.

Palabras Clave: *Brachyteles hypoxanthus*, dispersión de machos, filopatría de machos, demografía, proporción de sexo operacional, índice de asociación.

Introduction

Dispersal patterns of primates exhibit strong phylogenetic signals and are therefore often regarded as phylogenetically conservative traits in comparative models of social evolution (Lee and Kappeler, 2003; Clutton-Brock and Lukas, 2012; Lee and Strier, 2015). However, while male-biased dispersal with female philopatry appears to be a highly stable dispersal regime in cercopithecines (Di Fiore and Rendall, 1994), both bi-sexual and female-biased dispersal regimes exhibit higher levels of facultative responsiveness to local demographic and ecological conditions (Fredysted *et al.*, 2007; Strier *et al.*, 2014; Lee and Strier, 2015). Observational and genetic data have revealed cases in which same-sexed offspring of either sex have remained in their natal groups in species with normative bi-sexual dispersal regimes, *e.g.*, callitrichids: Goldizen (2003); howler monkeys: Van Belle *et al.* (2014a); Van Belle *et al.* (2014b); gibbons: Brockelman *et al.* (1998); gorillas: Robbins and Robbins (2015). Comparable exceptions to female-biased dispersal have also been reported, with cases of females remaining in their natal groups, *e.g.*, chimpanzees: Pusey and Schroepfer-Walker (2013); northern muriquis: Strier *et al.* (2006).

Exceptional cases of dispersal by males in male philopatric societies have similarly been reported (*e.g.* bonobos: Hohmann (2001); woolly monkeys: Di Fiore and Fleischer (2005); Maldonado and Botero (2009); and spider monkeys: Aureli *et al.* (2013). The observation of dispersal by a pair of bonobo males was hypothesized to be a response to the favorable adult sex ratio in the group they joined (Hohmann, 2001). Variable male dispersal was also suspected from the lack of close genetic relatedness among male woolly monkey group members (Di Fiore and Fleischer, 2005). Observations of male spider monkeys in non-natal groups have been attributed to singular circumstances, such as the small number of resident males, but the risk of aggression toward immigrant males is thought to limit the occurrence of dispersal of males in these male-philopatric societies (Aureli *et al.*, 2013).

Here, we add to this growing literature with new observations of young males traveling with a non-natal group in another ateline, the northern muriqui (*Brachyteles hypoxanthus*). We compare the size and operational sex ratios of all four northern muriquis groups in the study population to evaluate the potential demographic conditions that might have stimulated these males to leave their natal group to associate with members of a non-natal group, and in the case of the older male, to return to his natal group 3 months later. We also evaluate the males' spatial relationships with one another and with other members of their natal group and non-natal group to better understand the social correlates of their unusual movements.

Methods

The study was conducted at the Reserva Particular do Patrimônio Natural - Feliciano Miguel Abdala (RPPN - FMA), a 1,000 ha fragment of Atlantic forest in Caratinga, Minas Gerais, Brazil (19°50' S, 41°50' W). Climate is seasonal at this site, with an annual rainy season from November–April, when more than 80% of the mean annual rainfall of 1,134±266 mm falls, and a distinct dry season from May–October (Strier *et al.*, 2001). Annual temperatures average 20.6 ± 2.9°C (Jung *et al.*, 2015). We investigated four muriqui groups (*i.e.* Matão, M2, Nadir and Jaó groups; Table 1), where animals were individually identified through natural marks. Data were collected from August 2014 to July 2015 on a daily basis, except from 24 December 2014 to 12 January 2015 when no observations were conducted.

Group size was calculated from the number of observed individuals in each group and summarized on a monthly basis. We calculated the Operational Sex Ratio (OSR), or the ratio of the number of breeding males to the number of sexually receptive females (Kvarnemo and Ahnesjö, 1996) in each of the groups at the start of the two months (1 December 2014 and 1 March 2015) that intergroup transfers involving at least one of the young males occurred. Our calculations of OSR included all males > 7 years of age and females > 7 years that were not carrying infants < 2 years of age and that did not give birth before September 2015, and could therefore be considered potentially sexually receptive during the months with male movements.

Following Tokuda *et al.* (2013), we used daily records of group composition, called roll-calls (RCs), of all individuals observed in the Jaó and M2 groups on each day of the groups to estimate Association Indices. This index is a measure of the frequency of individuals seen with each other. This analysis was made for each of the young males and all other individuals in these groups. Also following Tokuda *et al.* (2013), we used SOCPROG (Whitehead, 2009) to construct separate clusters based on the distribution of individuals across RCs during three periods of group membership: while the males were still in their natal Jaó group (1 August–10 December 2014); during the three months in which they were both associating with M2 group (11 December 2014–29 March 2015); and after ZS-J returned to Jaó group (30 March–31 July 2015). The validity of the subgroups represented by the clusters was evaluated with the coefficient of modulation of associations (Q) where $Q \geq 0.3$ was considered to be a valid subgroup. The tendency of each of the subjects to associate with other individuals in their groups was evaluated from the sum of their association indices with all others, or *Strength* (S); the higher the S value, the stronger the individual's associations.

Results

We recorded the movements of two young males that left their natal Jaó group to live with a neighboring, non-natal group (M2). The two males were last sighted with their natal group on 8 December 2014 and first sighted with the M2 group on 11 December 2014, following an encounter between the two groups on the same and prior days. The older of the two males (ZS-J; 7.9 years) returned to his natal Jaó group 3 months later, while the younger male (FRD-J; 5.4 years) has remained in the M2 group through the present (August 2016).

Group sizes and OSRs varied during the different phases of the study period due to births, migrations, and disappearances (Table 1). On 11 December 2014, the two males changed their associations from their natal Jaó group to the smallest group with one of the lowest OSRs (M2) in the population. By March 2015, however, the OSR in all but one of the groups (Nadir) had increased. By then, the OSR of the Jaó group was 46% higher than that of the M2 group.

As expected based on our observations of the groups, association patterns clearly distinguished between the M2 and Jaó groups ($Q < 0.3$) for all three phases of male group membership (Table 2). Thus, the males' intergroup movements were not related to broader group dynamics such as group fusion.

The S values differed between individuals and their groups (Table 2). The high S values of ZS-J and FRD-J in their

natal Jaó group are indicative of their strong spatial associations. In M2 group, however, the strength of FRD-J's associations remained high while ZS-J's declined. Upon his return to Jaó, ZS-J's S value rose again.

Discussion

The unusual movements of these males were partially consistent with predictions about male movement based on potential demographic advantages. While joining a smaller group might have been advantageous for reducing intra-group competition for both males, the return of ZS-J to his natal group 3 months later might have been a response to his weak spatial associations (low S value) in M2 group.

The contrast between ZS-J's intergroup movements and FRD-J's persistence in M2 group, where he has now remained for more than a year, resembles the dispersal processes of "Visit" and "Direct" described by Strier *et al.* (2015) for females in this population. Although ZS-J and FRD-J transferred together, the differences in their respective S values before and after their natal group departures suggest that their movement decisions may have been independent. Both males were well connected to other members of their natal group prior to their departures, but whereas FRD-J developed strong associations in his adopted M2 group, ZS-J's S score declined in the M2 group. Social peripheralization in the M2 group may have contributed, at least in part, to his return to Jaó group, where his earlier strong social associations were restored.

Table 1. Group size (number of individuals), Number (N) of breeding males and potentially sexually receptive females present in each group, as defined in the text, and Group OSR at the start of the months of male inter-group movements (December 2014 and March 2015). The two male subjects were included with Jaó's group size in December 2014, and with M2 group in March 2015. See text for details.

December 2014					March 2015			
Group	Group size	N Breeding males	N Potentially receptive females	OSR	Group size	N Breeding males	N Potentially receptive females	OSR
Jaó	76	22	13	1.69	81	21	8	2.63
M2	61	17	13	1.31	62	18	10	1.80
Nadir	79	22	17	1.29	82	21	17	1.24
Matão	126	33	24	1.38	133	33	21	1.57

Table 2. Strength (S) of males' association and coefficient of modulation of associations (Q) in groups in different moments.

Period of male inter-group movements	Coefficient of modulation of associations (Q)	Strength (S)	
		ZS-J	FRD-J
1 August – 10 December 2014	0.06	29.95	28.16
11 December 2014 – 29 March 2015	0.04	13.91	30.96
30 March – 31 July 2015	0.06	34.40	30.96

Being more than 2 years younger may have contributed to FRD-J's greater social assimilation in M2 group compared to ZS-J, as has been proposed for the assimilation of young dispersing male woolly monkeys (Maldonado & Botero, 2009). FRD-J also filled a vacant age class among males in the M2 group that may have contributed to his social acceptance. Although males as young as FRD-J are sexually active in this population, ZS-J may have been perceived as a competitor because he was much closer to the 8 years of age at which males in this population are known to sire offspring (Strier *et al.*, 2011).

Dispersal is fundamental to the avoidance of inbreeding in all species, yet it remains one of the most difficult behavior patterns to understand (Di Fiore *et al.*, 2009). The initial movement of males in our study into a group with a more favorable OSR also suggests that demographic conditions could be at least partially responsible for the unusual intergroup movements of the two males in our study. Indeed, favorable OSRs have previously been implicated in analyses of male group membership following group fission (Tokuda *et al.*, 2013). However, comparative OSRs do not explain why these particular males left their natal Jaó group while other male contemporaries remained. Indeed, consistent with the egalitarian relationships that distinguish males in this population (Strier *et al.*, 2011; Tokuda *et al.*, 2012), there was no evidence of overt aggression directed toward these males. Long term data on OSR influencing dispersal decisions and analyses focusing on male social networks with one another and with females may provide additional insights into the unusual dispersal patterns of individual males.

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DEEP INCURSION AND USE OF A MINERAL LICK WITHIN A NEIGHBORING TERRITORY BY A GROUP OF WHITE-BELLIED SPIDER MONKEYS (*ATELES BELZEBUTH*) IN EASTERN ECUADOR

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Abstract

One convergent aspect of the societies of chimpanzees and spider monkeys is the fact that members of a social group jointly conduct territorial boundary patrols and raids into home ranges of neighboring groups. Boundary patrols are usually perpetrated by subgroups of adult and subadult males who travel in silence into neighboring territories. Only rarely do females participate in these incursions. Moreover, for spider monkeys living in the western Amazon, mineral licks (or 'salados') seem to be key areas where animals descend to the ground and consume water and soils, most likely to acquire minerals not readily available in their diet. Based on 10 years of behavioral research, here we document a unique case in which most members of one group of white-bellied spider monkeys (*Ateles belzebuth*) collectively made a deep incursion into a neighboring group's territory and used a mineral lick well within a that group's range. This particular event raises the intriguing questions of what knowledge group members might possess about locations of key resources in adjacent territories, how they acquire this knowledge, and what motivates the use of those resources, especially when groups have other mineral licks they can frequent within their own territories. Although occasional deep incursions into other group's ranges may be part of the repertoire of intergroup interactions engaged in by wild spider monkeys, the underlying explanation behind the decision to visit and consume soil from mineral licks in neighboring territories remains largely unexplained.

Key words: Boundary patrol, inter-group competition, mineral lick, territorial behavior

Resumen

Um aspecto convergente de las sociedades de chimpances y monos araña es el hecho de que miembros de un grupo social conjuntamente llevan a cabo patrullajes en los límites de sus territorios e incursiones en los territorios de grupos vecinos. Las patrullas limítrofes son usualmente perpetradas por subgrupos de machos adultos y subadultos quienes viajan en silencio hacia los territorios vecinos. Solo raramente participan hembras en estas incursiones. Más aún, para los monos arañas que habitan en la Amazonia occidental, los "salados" (mineral licks) parecen ser áreas donde los animales descienden al suelo y consumen agua y suelos, muy posiblemente para adquirir minerales no disponibles fácilmente en su dieta. Basados en 10 años de investigación comportamental, aquí documentamos un caso único en el cual la mayoría de los miembros de un grupo de monos araña de barriga blanca (*Ateles belzebuth*) colectivamente hicieron una incursión profunda dentro del territorio de un grupo vecino y utilizaron un salado dentro de su territorio. Este particular evento plantea las intrigantes preguntas de qué conocimiento deben poseer los integrantes de un grupo acerca de la localización de recursos clave en territorios adyacentes, cómo adquieren este conocimiento y, qué motiva el uso de aquellos recursos, especialmente cuando los grupos tienen otros salados que pueden frecuentar dentro de sus propios territorios. Aunque las incursiones profundas dentro de los territorios de otros grupos pueden ser parte del repertorio de las interacciones intergrupales de los monos araña silvestres, las explicaciones subyacentes tras la decisión de visitar y consumir suelo de salados en territorios vecinos son aún ampliamente desconocidas.

Palabras clave: Patrullas limítrofes, competencia intergrupala, salados, comportamiento territorial

Introduction

Boundary territorial patrols and raids into neighboring territories have been documented in several chimpanzee societies that have been subjects of long-term studies (Wilson and Wrangham, 2003 and references therein). In most populations, boundary patrols are relatively rare events (Goodall, 1986; Boesch and Boesch-Achermann, 2000; Watts and Mitani, 2001; Mitani and Watts, 2005) in which chimpanzees move along the boundaries of their territory or make incursions into the territories or neighboring groups. Boundary patrols are primarily executed by adult and sub-adult males, but sometimes females participate as well, with the extent of female participation in these activities varying across sites (Goodall, 1986; Boesch and Boesch-Achermann, 2000; Watts and Mitani, 2001; Mitani and Watts, 2005). Although this behavior has been described as a distinctive and unique aspect of the behavior of wild chimpanzees, *Pan troglodytes* (Mitani and Watts, 2005), it has also been documented in spider monkeys societies (Symington, 1990; Shimooka, 2005; Aureli *et al.*, 2006; Wallace, 2007, 2008; Link, 2011). During spider monkeys' territorial encounters, aggression has been observed between neighboring groups and parties, primarily by males (Symington, 1990; Shimooka, 2005; Wallace, 2007; Aureli *et al.*, 2006).

Several studies have proposed that male spider monkeys are territorial in order to defend access to females rather than other important resources (Symington 1987; Wallace 2007; Link, 2011). In fact, Symington (1987) proposed that males cooperate not to gain immediate access to reproductive opportunities but rather to maintain the integrity of a group territory and thus, indirectly, access to the females who range within that territory. Aureli *et al.* (2006) and Link (2011) have also argued that deep incursions by spider monkeys are driven by factors other than feeding competition and access to key areas of high fruit productivity, because patrolling males spent virtually no time feeding during their incursions into neighboring territories.

Mineral licks are important sites where several species of Neotropical mammals – including spider monkeys – come to the ground to consume soil for mineral supplementation and/or as a detoxification agent (Blake *et al.*, 2010; Link *et al.*, 2011). When spider monkeys visit these sites, they often assemble in larger subgroups than in the rest of their territory and they often invest several hours per visit resting and being vigilant in the area around the lick before descending to the ground to feed on soil (Link and Di Fiore 2013). For many arboreal primates, mineral licks are especially risky because these are the only sites where they go down to the ground, where the risk of predation risk (e.g., from terrestrial felids) is presumed to be greatest (Janson, 1998; Link *et al.*, 2011). In western Amazonia, each group of spider monkeys usually has at least one mineral lick in their territory, and these sites are visited up to several times per week (Link *et al.*, 2011). The long periods of time that spider monkeys remain at mineral licks suggests that they represent an especially valuable resource.

Here, we describe a unique case of a deep incursion performed by most of the adults of both sexes who were resident in of a group of wild white-bellied spider monkeys (*Ateles belzebuth*) that has been the subject of our long-term research in western Amazonia. During the incursion, the monkeys traveled directly towards and subsequently used a mineral lick located deep in the territory of a neighboring group, and we discuss the potential implications of this observation for the cognitive ecology of spider monkeys

Methods

Data were collected at the Tiputini Biodiversity Station, which is located in the Yasuní National Park and Biosphere Reserve in the Ecuadorian Amazon. The study group (MQ-1) of wild white-bellied spider monkeys (*Ateles belzebuth*) was habituated in 2005 and has been followed regularly since that time. All group members can be individually identified on the basis of variation in age, sex, and distinctive pattern of pelage and pigmentation on the face and genitals. Data on the behavior, ranging patterns, and social associations of all adult members of the study group were collected in the context of regular all-day follows of adult individuals using focal animal sampling (Altman, 1974). During follows, researchers used datalogging GPSs (model Garmin 76CSx), programmed to record location points every 20 seconds (i.e., 3 times per minute) from the beginning of each follow. From these GPS data, we extracted a mean location record for 12 sampling points every hour (i.e., at 0, 5, 10, etc., minutes after the hour) by averaging the UTM coordinates for records scored within the 2-minute window centered on those points. Daily range maps were constructed by importing these data into ArcGIS 9.2 and superimposing them on a template of the TBS trail system. Data on the composition of the focal subgroup were also collected for the same 5-minute sampling points throughout the duration of the follow.

Following the incursion described below by MQ-1 into the territory of the adjacent group (MQ-6), we set up a video camera trap for four months equipped with a motion and heat sensor to monitor activity at the mineral lick they visited, which was located deep within MQ-6's territory. This allowed us to evaluate the pattern of use of the lick and to discern whether it was being visited by individuals from our main study group or by other individuals.

Finally, we also used the location data from one male spider monkey fitted with a GPS collar, to check if this subject visited the newly discovered mineral lick on other occasions, even when not followed by our research team.

Results

On March 11th, 2011, researchers S. Alvarez and L. Abondano were searching for subjects from the MQ-1 study group to sample. At around 06:27, they heard spider monkeys making alarm calls (a.k.a., “repeat barks”) and located

a subgroup containing three adult females with their offspring near a mineral lick located at the center of MQ-1's home range. Within a few minutes, three adult males and three additional adult females approached from the eastern part of MQ-1's home range and joined these females. The observers then heard many vocalizations coming from a long distance away from the east and southwest; these vocalizations were not alarm bark but rather were long-distance "loud calls", probably coming from other members of MQ-1 as they were detected from within MQ-1's home range. These nine adult spider monkeys and their offspring then started to move away from the mineral lick area and traveled rapidly towards the northern portion of MQ-1's home range. At around 09:00 the animals were joined by another female from MQ-1 and her two offspring, and they continued moving rapidly to the northwest. Some minutes later three additional adult males from MQ-1 joined them and one of the females left the subgroup. At that point, all six adult male group members of MQ-1 were present in the subgroup. Around 10:00, the animals paused to forage and rest, and they engaged in a lot of social interactions while resting. Several of the juveniles played for a long time, while the adult males rested close to each other for most of

the time. During this pause one additional female left the subgroup with her offspring.

At 10:40 the subgroup began moving steadily to the northwest again. Around 12:00 another one of the adult females and her juvenile male offspring fissioned from the subgroup. Half an hour later, the remaining subgroup of six adult males, five adult females, three subadult females, one subadult male, and four juveniles crossed what we considered the "border" of their home range – the northernmost location they had been seen in until this time. Until then the animals' behavior was reminiscent of a "boundary patrol" and their ranging took them towards the territory of a known neighboring group. At 12:40 the animals started to turn towards the west, turning away from the neighboring territory and into an area where we had never followed nor seen spider monkeys previously. The males stayed very close to one another as they moved, keeping a distance of about 5 to 10 meters between them and females were following behind. They kept moving northwest (Fig. 1) and traveled very low in the canopy. They were not vocalizing at all and no other long-distance calls were heard after they started moving northwest.

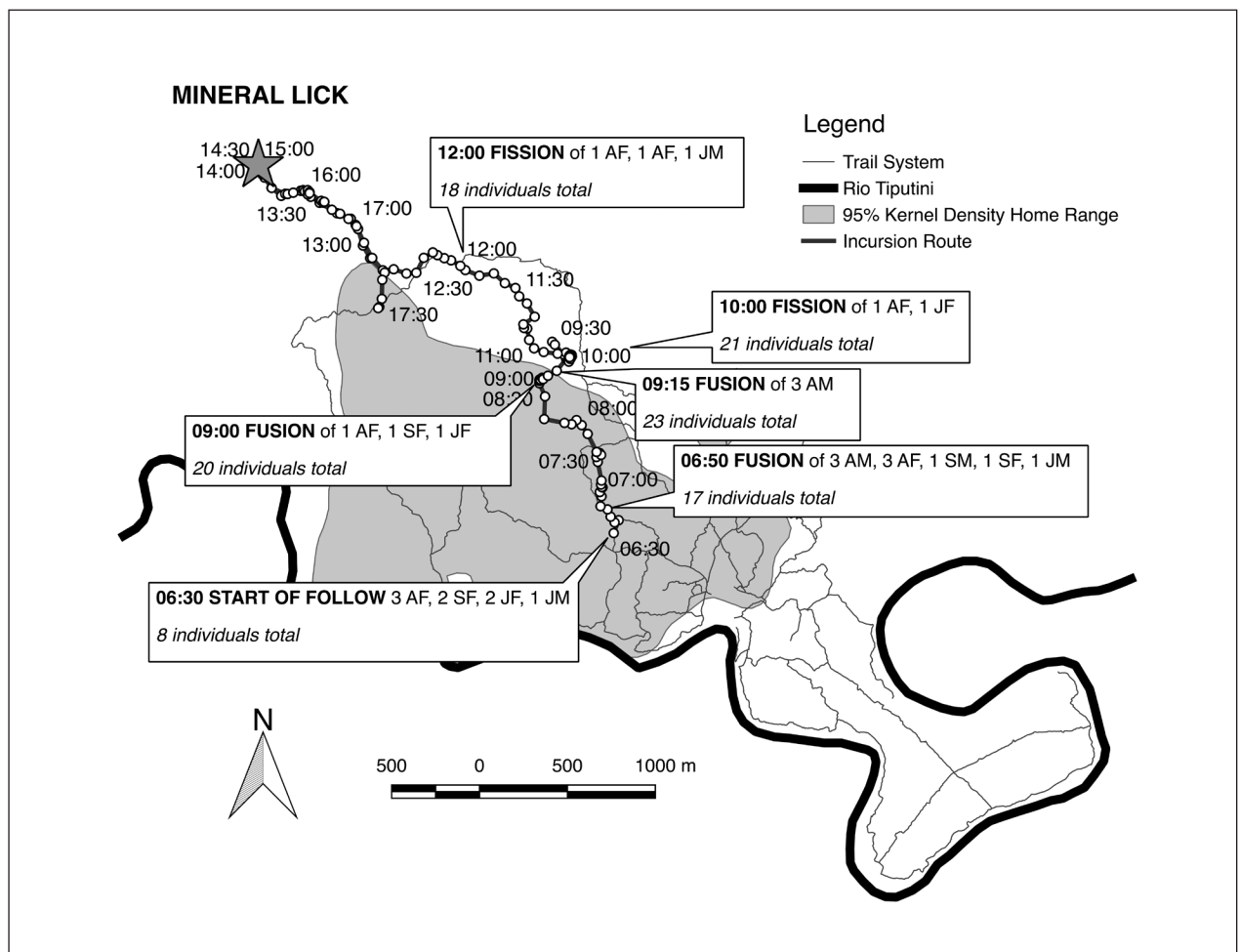


Figure 1. Route taken by a subgroup of MQ-1 during a boundary patrol and deep incursion in another group's territory on March 11th, 2011. Dots are records of the location of the group, taken every 5 minutes, with every 30 minutes point marked with the time. Text boxes indicate subgroup size and changes in subgroup composition throughout the follow. A = adult, S = subadult, J = juvenile, F = female, M = male.

At 13:50, when the group was about 1 km to the north of TBS the trail system (and over 1 km from what we had presumed was the limit of MQ-1's territory based on six years of prior observation), the monkeys stopped and rested for a few minutes. They were vigilant, looking towards the ground, and one of the adult males did some branch-shaking displays towards the observers. They then started cycles of descending partway towards the ground and then retreating up very quickly, similar to behaviors seen when they visit the mineral lick within their home range.

About 15 minutes later one female with her offspring were observed climbing back up from the ground with their faces completely covered with mud, thus confirming that they were indeed consuming soil at the mineral lick. Following this, multiple individuals were then seen going up to the trees with their faces and feet covered with mud. Although the mineral lick was difficult to observe, as it was located in a narrow canyon, it was evident that all of the subgroup members used the lick. The subgroup remained in the area for about an hour, a much shorter time than the ~4 hours animals spend, on average, around the mineral lick within their own territory. At 14:19 a long-distance vocalization was heard at about 400 m away, coming from the north, but the individuals from MQ-1 did not respond and continued going down to the lick.

The subgroup left the mineral lick area at 15:34 and started to head back to their territory backtracking along nearly the same route they used to get there. Nonetheless, they moved much more slowly, resting and eating fruits on their way back. On the return they also vocalized much more, including contact vocalizations ("whinnys") and loud calls. They arrived back at the edge of their territory around 17:45.

Following this event we set a video camera trap in the newly identified mineral lick for the next four months, and confirmed that this mineral lick was active (we recorded at least six episodes of clay consumption during that period) and that it was used by monkeys that we were unable to recognize individually. Since this one incursion, after several additional years of sampling we have never again followed animals from the MQ-1 group to this mineral lick. Additionally, after reviewing data for one male from the MQ-1 group who was fitted with a GPS collar from 1.5 months before until nine months after the incursion, we noted that out of 111 days on which the GPS collar – which was programmed to take a fix every half hour – captured at least 10 location records, this was the only occasion where the collared male visited the newly recognized mineral lick.

Discussion

In this brief report we describe a unique case of a deep incursion into a neighboring group's territory and the use of a neighboring group's mineral lick by one group of spider monkeys. Mineral licks, in general, seem to be very

important resources for western Amazonian spider monkeys; they are frequently used, and animals invest a large amount of time being vigilant and resting in large subgroups around lick sites (Link and Di Fiore, 2013).

Aureli *et al.* (2006) described seven cases of deep incursions by male Central American spider monkeys into the range of another group; in these cases, animals only fed for a small portion of the time they spent within the neighboring territory, leading Aureli *et al.* (2006) to conclude that these kind of incursions seem not to be motivated by feeding competition. This idea has also received support in chimpanzee studies, where chimpanzees spent only a small portion of their time during raids engaged in feeding behavior (Wilson *et al.*, 2004). However, the deep incursion here described included using the mineral lick of another group, which suggests that such areas not only play a key role in the grouping patterns of spider monkeys, but maybe also in their intergroup relations. This case also constitute an example of animals engaging in a very directed movement towards a specific and far off location, as the focal subgroup, with 18 individuals, moved almost directly towards the target and then back into their own territory using a route that was completely unfamiliar to the observers. Indeed, in six prior years of tracking members of this group, we had never seen the animals range anywhere close to the new mineral lick site, which they approached directly, and in five subsequent years of tracking, we have never seen them revisit the lick. The direct track followed by the animals to arrive at the lick would seem to suggest that they had a very clear notion of the spatial location of this resource.

In contrast to the behavior of the MQ-1 group of spider monkeys around their own mineral lick, where they usually spend, on average, ~ 4 hours resting and being vigilant around the lick prior to coming down to the ground, in this case they spent only around an hour in the neighboring group's mineral lick area. They arrived in silence and did not spend a large amount of time being vigilant before coming down to eat soil. They fed on clay at the lick and did not respond to long distance vocalizations that came from north of the lick while they were at the site.

Nevertheless, the subgroup composition in this case was very different from the male-dominated parties that we and others have usually observed during patrols (Symington, 1990; Shimooka, 2005; Wallace, 2007). In addition to all adult males from the MQ-1 group, five adult females and several subadult animals and juveniles of both sexes were also present, which is not common during incursions or boundary patrols (Link and Di Fiore, unpublished data). Such a subgroup composition would seem to leave some animals vulnerable should they encounter animals from a neighboring group, especially when considering that such encounters are generally aggressive (Symington, 1988; van Roosmalen, 1985; Aureli *et al.*, 2006; Wallace, 2007; this study, data in preparation). This event, we suggest, is thus

best interpreted as a case of an incursion specifically to “use” resources located in another group’s territory without the intention to interact with or challenge that group. Here, the subgroup included young animals, the animals did not spend a lot of time in outside of their own territory, they moved fast towards the other group’s mineral lick, and, after using those resources, they came straight back into their own territory.

The direct path that the subgroup took towards a mineral lick outside of their territory suggests that one or more subgroup members had spatial knowledge of the area, perhaps due to past experiences, such as prior boundary patrols. It may even be the case that the locations of extra-territory resources are known to one or more of a group’s females by virtue of the fact that females are the dispersing sex and may have immigrated in from other groups. However, the reason as to why our main study group (MQ-1) decided to visit and use this mineral lick, when safer mineral licks are frequently used within their own territory, is still unclear; further data on this type of events is needed to better understand this unusual behavior.

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SHORT ARTICLES

IMMUNITY TO YELLOW FEVER, OROPOUCHE AND SAINT LOUIS VIRUSES IN A WILD HOWLER MONKEY

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Introduction

Arboviruses are arthropod-borne RNA viruses that circulate in wildlife and may cause disease in people and domestic animals. Six out of about 40 arboviruses that cause disease in humans represent threats to public health in Brazil: Yellow Fever (YFV), Oropouche (OROV), Dengue, Mayaro, Saint Louis Encephalitis (SLEV) and Rocio (Vasconcelos et al., 1998). Nonhuman primates (NHP) are important hosts in the cycles of many arboviruses. An analysis of 35 NHP in central Brazil showed 10 (26%) positive for Mayaro, 5 (14%) for OROV, and 6 (17%) for more than one arbovirus (Batista et al., 2012).

The sylvatic cycle of YFV in South America includes mosquitoes, mainly *Haemagogus* spp. and *Sabethes* spp., and NHP (Vasconcelos, 2003; Cardoso et al., 2010), but the virus also circulates in several other forest mammals (de Thoisy et al. 2004). Outbreaks of this disease causing illness and/or death of free-ranging NHP are common in several Latin American countries, including Brazil (Araújo et al., 2011; Almeida et al., 2012, 2014). Whereas *Cebus* and *Sapajus* are more resistant to YF, *Saimiri*, *Ateles*, *Aotus* and, especially, *Alouatta* are particularly sensitive to the disease (Bugher, 1951).

Similar to YFV, OROV can be found in an urban cycle between humans and mosquitoes and a sylvatic cycle that involves NHP, sloths and birds as hosts, and *Culicoides* spp. mosquitoes as vectors (Vasconcelos et al., 1998). SLEV is also transmitted by mosquitoes, mainly *Culex* spp. (Vasconcelos et al., 1998). A bird-mosquito SLEV cycle is the most common in the wild. However, vectors also bite NHP, marsupials and rodents (Mondini et al., 2007).

The pathogenicity and population effects of YFV on howler monkeys are relatively well-studied (Holzmann et al., 2010; Freitas and Bicca-Marques, 2011, 2013; Almeida et al., 2012; Agostini et al. 2014; Engelmann et al., 2014), but little is known about SLEV and OROV. In this paper we report the finding of a wild adult male black-and-gold

howler monkey (*Alouatta caraya*) presenting antibodies against YFV, OROV, and SLEV.

Materials and methods

We captured the male (head-and-body length=56 cm, tail length=56 cm, weight=8 kg) in a ca. 23-ha gallery forest fragment in the municipality of Santo Antônio das Missões (28°23'27.6"S, 55°26'26.3"W), Rio Grande do Sul State, south Brazil. The animal belonged to a social group composed of, at least, two adult females with offspring and an immature individual of unknown sex. He appeared to be in good health, showing no sign of illness or any kind of weakness, and was released at the same site after recovering from the anesthesia (about 1 h later).

We anaesthetized the monkey with the help of a CO₂ propelled dart gun as part of a routine active surveillance of the circulation of YFV and other arboviruses in the state (Almeida et al., 2014). We collected blood (ca. 8 mL) from the femoral vein. We stored the serum and an additional 1 mL aliquot of blood in cryotube vials after centrifugation and frozen them in liquid nitrogen. We isolated the virus (VI) from the blood sample by inoculating it into suckling mice (Beatty et al., 1989) and C6/36 cells (Gubler et al., 1984). These trials were followed by indirect immunofluorescence assays using monoclonal antibodies. We detected antibodies in the serum by the haemagglutination inhibition (HI) and neutralization tests (NT) (Deubel et al., 1979). We performed the tests for detecting arboviruses at Instituto Evandro Chagas, a reference laboratory of the Brazilian Ministry of Health.

This study complied with ethical guidelines for the use of animals in research, the Brazilian environmental laws, and the American Society of Primatologists' guidelines for the ethical treatment of nonhuman primates. All procedures described in this report were conducted under the permit for scientific activities #13016-6 issued by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) of the Brazilian Ministry of the Environment in May 10, 2012.

Results

Isolation trials were negative, but serology was positive for arboviruses (titers of 1:40 to 1:80 for flaviviruses and 1:40 for OROV in the HI test). The logarithm of the neutralization index (LNI) in the NT test for DL50/0,02 mL was positive for viral antigens specific for YFV (LNI=4.5), SLEV (LNI=3.0) and OROV (LNI=2.9).

Discussion

The finding of antibodies against arboviruses of public health concern in this howler monkey highlights the importance of the active monitoring of NHP conducted by the State Center for Health Surveillance of the State Health

Secretariat for identifying potential areas of circulation of arboviruses in south Brazil. The surveillance of NHP in Rio Grande do Sul State was an important tool in the prioritization of target areas for vaccination during a large YF epizooty that took place between 2008 and 2009 killing >2,000 howler monkeys (*A. caraya* and *A. guariba clamitans*) (Almeida et al., 2012, 2014).

It is probable that our study subject was infected with YFV during that epizooty. Considering that *A. caraya* groups often live in home ranges <10 ha (Fortes et al., 2015) and that howlers are reluctant to cross open fields on the ground, it is likely that the adult male was infected with all three arboviruses within the forest fragment inhabited by his group. Although we cannot infer on the timing of these infections based on our single case, a previous infection with the Flaviviridae SLEV may have improved the individual's resistance to YF. This hypothesis has critical conservation implications and deserves future research because both *A. caraya* (Endangered) and *A. g. clamitans* (Vulnerable) are threatened with extinction in Rio Grande do Sul State (Decree #51797, 8 September 2014). Previous studies found antibodies against SLEV in *A. caraya* (10/19 individuals) and *A. g. clamitans* (3/7) in Rio Grande do Sul State (Santos et al., 2006) and in *A. caraya* (5/43), other primates and horses in Paraná State, Brazil (Svoboda et al., 2014).

Finally, greater surveillance efforts on broader taxonomic groups are required to inform us on the susceptibility of mammalian and avian species to these emerging infectious diseases. Long-term monitoring of the prevalence of infected and resistant individuals in populations of NHP, other mammals, and birds, as well as mosquito vectors, are critical to assess their roles in the maintenance of cycles of these viruses and the risks that they pose to primate conservation and public health.

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PRELIMINARY OBSERVATIONS ON THE SAN MARTIN TITI MONKEY *PLECTUROCEBUS OENANTHE* THOMAS, 1924 (MAMMALIA: PRIMATES: PITHECIIDAE) VOCALIZATIONS AT TARANGUE, PERU.

Brooke Catherine Aldrich
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Introduction

Like other members of the former *Callicebus* species group (*Callicebus*, *Cheracebus* and *Plecturocebus*, *Sensu* Byrne et al., 2016), the San Martin titi monkey (*Plecturocebus oenanthe*, *Sensu* Byrne et al., 2016) engages regularly in ritualized bouts of song, defined by Moynihan (1966) as a series of rapidly and regularly repeated notes, distinctly separated from preceding and succeeding notes by long pauses. For socially monogamous, territorial species such as titi monkeys, night monkeys and gibbons (Kawai et al., 1982; Mitani 1984; Fernandez-Duque 2011), loud calls (including song) are thought to define territorial boundaries, and may strengthen and/or maintain bonds between mates (Wickler 1980; Kinzey and Robinson 1983; Robinson et al., 1987; Müller and Anzenberger 2002; Caselli et al., 2014). The vocal behavior of titi monkeys has been the focus of several studies (for example Moynihan 1966; Robinson 1979; Kinzey and Robinson 1983; Müller and Anzenberger 2002; Kitzmann et al., 2008; Cäsar et al., 2012a; Caselli et al., 2014). However, the repertoire of only one species of titi monkey, *Plecturocebus cupreus* (formerly *Callicebus moloch*), has been well-described (Moynihan 1966; Robinson 1979; Robinson 1981; Robinson et al., 1987). More recently, researchers described in detail the acoustic properties of the syllables of which the loud calls and song of *Callicebus nigrifrons* are composed (Caselli et al., 2014).

The San Martin titi monkey (*P. oenanthe*) is endemic to a small area of the department of San Martin in Northern Peru (Bóveda-Penalba et al., 2009; Shanee et al., 2011). It is classified as Critically Endangered (IUCN 2011) and has been the focus of relatively few studies (Mark 2003; Rowe and Martinez 2003; deLuycker 2006, 2007; Aldrich et al., 2008; deLuycker 2012; van Kuijk et al., 2015; Allgas et al., 2016).

During a short survey in Northern Peru, recordings were made of individual and group vocalizations of *P. oenanthe*. Suitable recordings were later analyzed in order to begin describing the species' vocal repertoire. Evidence for inter-individual differences in similar calls was sought, in anticipation of future investigation into the usefulness of vocal behavior as a censusing and monitoring tool for highly vocal primate species.

Methods

Field work was conducted on 25 days between May and August 2006 at Tarangue, a small private reserve (~ 60 ha) near Moyobamba in Northern Peru (5° 58' 28.2" S, 76° 59' 34.6" W). The reserve was then owned by French/Peruvian NGO IKAMA Peru and was composed of disturbed primary forest (48.5ha) and regenerating secondary forest (11.5ha) in addition to cleared areas slated for reforestation (Fig. 1). Data were collected at five different listening points in or near the forested areas of the reserve (Fig. 1). Fieldwork began at 06.30 and continued until 09.30 or until groups were no longer singing (whichever came last). Data were not collected on bad weather days. Information was recorded about the time and location of each bout of song, and group composition and behavior wherever possible. Audio recordings were made opportunistically by B. Aldrich using a Marantz PMD 222 Professional cassette

recorder, an Audio-Technica AT897 line and gradient condenser microphone and TDK IEC/type I 60-minute audiocassettes mounted on a tripod to reduce noise (Geissmann 2003). Recordings were made from between approx. four and 25 meters.

Recordings of suitable quality for analysis were digitized at rates between 16 and 48 kHz using Avisoft Recorder version 2.9 (Avisoft Bioacoustics). Clearly defined calls were isolated, and spectrograms were produced of each of these for description and visual comparison with previously described titi monkey vocalizations. We compared chirrup vocalizations from two individuals recorded in this study. The 35 clearest bi-syllabic chirrup notes for each individual were measured for duration, dominant frequency, maximum frequency and fundamental frequency. The recorded vocalizations were compared to those described by Moynihan (1966) and Robinson (1979) for *P. cupreus* (the red titi monkey). Mason (1966), Robinson (1979), Kinzey and Robinson (1983), Müller and Anzenberger (2002) and Caselli (2014) were also consulted for aid with comparison. Few tri- and monosyllabic chirrups were observed and were therefore not compared.

Although data were not normally distributed, for t-tests, sample sizes of 30+ normally overcome this assumption. Therefore, paired samples t-tests were performed with each pair of variables to identify consistent significant differences in parameters.

Results

A total of 420 minutes of vocalizations were recorded. Recordings from seven different occasions at three locations were of sufficient quality for analysis. A reliable count of the number of different individuals recorded or the age-sex classes of individuals was not possible due to poor visibility from listening points and possible disturbance caused by approaching non-habituated animals while recording.

Four distinguishable vocalizations that had previously been described for other titi monkey species were isolated: chirrups; pumps; resonating notes; moans (these are probably homologous to those described by Robinson (1979) and Moynihan (1966) for *P. cupreus*). Three additional vocalizations, undescribed in other titi species, were also identified: "pant hoots", so named for their resemblance (personal observation) to the *spontaneous pant-hoots* of captive chimpanzees (Goodall 1986), whines, and whinnies (see table 1 and figures 2-5). Of the digitized recordings only a single instance contained a clearly separate series of 'chirrups' from two separate individuals (of the same group).

No significant differences in duration ($t = -0.437$, $df = 34$, $p = 0.665$) or maximum frequencies ($t = 1.469$, $df = 34$, $p = 0.151$) were detected between the vocalizations of the two individuals (Table 2). There were, however, highly significant inter-individual differences in the dominant ($t =$

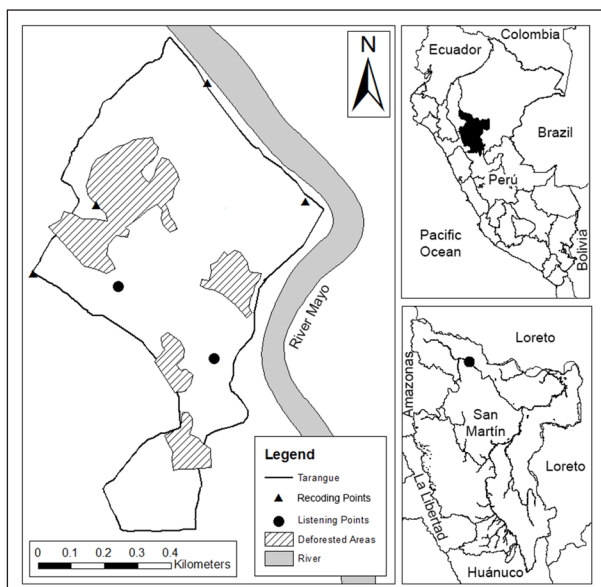


Figure 1. Map showing location of study site and listening points used during this study.

Table 1. Loud calls identified in three species of titi monkey. Comparisons based primarily on written descriptions of calls and on visual comparison of relevant spectrograms where possible - except Caselli et. al (2014). Methodological differences prohibited direct comparison between these and *P. oenanthe* vocalizations and comparisons drawn here are extracted directly from the study itself.

Moynihan 1966 (<i>P. cupreus</i>)	Robinson 1979 (<i>P. cupreus</i>)	Caselli et al 2014 (<i>Callicebus nigrifrons</i>)	This study (<i>P. oenanthe</i>)	Comments
Chirrup	chirrup	aa phrases	chirrup	Common vocalization that appears to be used both as an alarm call and as a prelude to song in <i>P. oenanthe</i> and similarly in <i>P. cupreus</i> . Mono- (Moynihan's "chuck notes"), bi- and occasionally tri-syllabic, the rapidity and intensity of this vocalization varies greatly and intergrades with other vocalizations during song.
chuck Notes				
resonating notes	pants	ab phrases	resonating notes	This study was unable to differentiate between pants, honks and bellows specifically. Resonating notes, as described by Robinson, form a significant part of <i>P. oenanthe</i> morning song.
	honks	bb phrases		
	bellows	bc phrases		
pumping notes	pumps	bc phrases (tentative)	pumps	Identified in <i>P. oenanthe</i> as an element of "chirrup-pump" (Robinson 1979), "chuck-pumping-gobbling" (Moynihan 1966) or "gobbling" (Mason 1966) sequences, which sound much like the gobbling of wild turkeys.
Moans	moans	/	moans (tentative)	Tentatively identified in a single recording; neither written descriptions nor available spectrograms provided sufficient information for certainty.
/	/	/	"pant-hoots"	Resembles the spontaneous pant-hoot in chimpanzees (Goodall 1986), this call may represent a transition from one "resonating note" to another.
/	/	/	whines	So named for its resemblance to the whines of a puppy. Along with "resonating notes", whines occur regularly during <i>P. oenanthe</i> morning song.
/	/	/	whinnies	So named for its resemblance to a high-pitched horse whinny. Along with "resonating notes", whines occur regularly during <i>P. oenanthe</i> morning song.
/	/	ae phrases	/	Insufficient information to compare this vocalization directly to <i>P. oenanthe</i> vocalizations.
Screams	screams	/	/	Absent or unheard in <i>P. oenanthe</i>

Table 2. Characterization of *chirrup*s in two *P. oenanthe* individuals and results of paired-sample t-tests for differences. Significant differences indicate possible 'vocal signatures', but here possibly represent differing age-sex classes (Robinson 1981).

	Individual 1 (n=35)	Individual 2 (n=35)	t-test
Duration (sec)	0.38 ± 0.03	0.38 ± 0.05	$t = -0.437, df = 34, p = 0.665$
Dominant frequency (kHz)	1.51 ± 0.03	1.28 ± 0.30	$t = 4.681, df = 34, p < 0.0001$
Maximum frequency (kHz)	18.95 ± 0.88	18.61 ± 0.81	$t = 1.469, df = 34, p = 0.151$
Fundamental frequency (kHz)	1.86 ± 0.09	1.54 ± 0.05	$t = 22.653, df = 34, p < 0.0001$

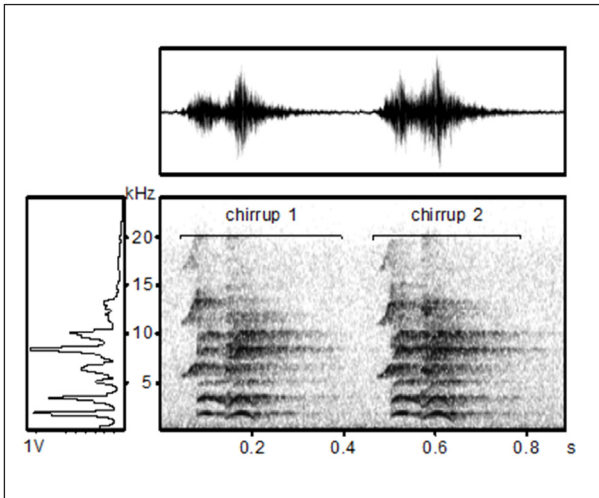


Figure 2. Two bi-syllabic chirrup calls from a single *P. oenanthe* individual, from a series probably given as an alarm call in response to the presence of researchers.

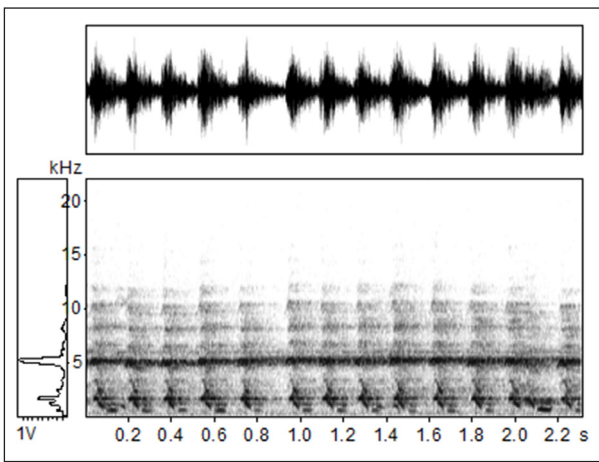


Figure 3. A rapid series of *P. oenanthe* chirrup calls uttered just prior to transition into song.

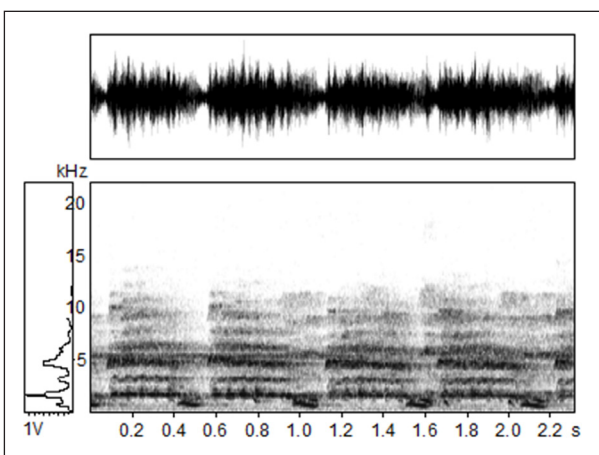


Figure 4. A series of *P. oenanthe* whines, for which no parallel was found in the existing literature on titi monkey vocalizations.

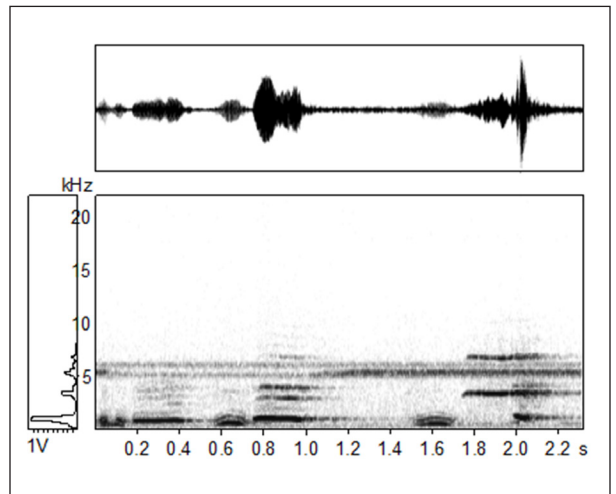


Figure 5. The distinctive *P. oenanthe* “pant-hoot”. It could not be assigned to any of the vocalizations described for *P. cupreus*.

4.681, $df = 34$, $p < 0.0001$) and fundamental frequencies ($t = 22.653$, $df = 34$, $p < 0.0001$). Very little intra-individual variation was found for the dominant or fundamental frequencies.

Discussion

Zimmermann (1995) notes that a description of the vocal repertoire of a given species is a prerequisite to any detailed analytical study. This study, although brief and preliminary, isolated seven loud-call vocalizations of the Critically Endangered *P. oenanthe* and tentatively identifies differences in calls specific to individual animals. The dominant and fundamental frequencies of the *chirrup* calls of two differentiated individuals remained stable for each individual and differed significantly between these individuals, suggesting that these frequencies could be useful in the study of vocal individuality or signatures (Table 2). It is possible, however, that these differences are a reflection of size, sex or developmental stage; Robinson (1979) found measurable differences in pitch and dominant frequency between the chirrups of individual *P. cupreus*, but concluded that the vocalization, although it could be used to distinguish between age-sex classes, was not sufficiently different between members of the same age-sex class to identify individual callers.

Inter-species differences in vocalizations exist throughout the primate order, including differences in organization and/or acoustic structure between closely related species, for example: gibbons, macaques, langurs, galagos, tarsiers (Geissmann 1984; Hohmann 1989, 1990; Bearder et al., 1995; Nietsch 1999). Though our data are minimal, they indicate that there are both strong similarities and marked differences between the vocal repertoires of congeneric *P. cupreus* (Moynihan 1966; Robinson 1979), and *P. oenanthe*.

In order to properly explore the vocal repertoire for *P. oenanthe* more recordings must be obtained, including high

quality recordings of individual contributions to song sequences. Although this study did not conclusively demonstrate individuality in the loud calls of *P. oenanthe*, it was useful in making a preliminary, if tentative, description of common elements of the species' loud vocalizations. Further studies are needed to clarify the elements of its vocal repertoire and confirm individuality in vocalizations.

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- 1977; Boesch and Boesch, 1983, 1984, 1989; Goodall, 1986; McGrew *et al.*, 1997; De Waal, 2016) and bonobos (Jordan, 1982; Ingmanson, 1996; McGrew and Marchant, 1997) but in the last two decades there has been an increase of studies and experiments of tool use by monkeys including macaques (Huffman *et al.*, 2010; Leca *et al.*, 2012; Leca *et al.*, 2016), baboons (van Lawick-Goodall *et al.*, 1973) and capuchins (Fernandes, 1975; Antinucci and Visalberghi, 1986; Westergaard and Fragazsy, 1987; Boinski, 1988; Ritchie and Fragazsy, 1988; Anderson, 1990; Chevalier-Skolnikoff, 1990; Visalberghi, 1990; Anderson and Henneman, 1994; Phillips, 1998; Jalles-Filho and Grassetto, 2008).
- Panger *et al.* (2002) describe some tool-use behaviors that include the “leaf wrap” processing technique, where monkeys wrapped objects such as *Automeris* spp. caterpillars and *Sloanea terniflora* fruits in leaves before rubbing them against a substrate. Fragazsy *et al.* (2004) stated “it is probable that monkeys wrap these objects to reduce the contact with chemical and mechanical defenses that both *Automeris* caterpillars and *Sloanea terniflora* fruit have” (Fragazsy *et al.*, 2004). However there also have been reports of capuchins (*Cebus capucinus*) rubbing *Sloanea terniflora* fruits and *Automeris* caterpillars directly without first wrapping them in leaves (Shumaker *et al.*, 1980; Panger *et al.*, 2002). Similarly Katz and Katz (1936) observed six captive monkeys (3 *Chlorocebus sabaues* and 3 *Cebus capucinus*) wrapping sticky bananas in leaves before picking them up. Huffman *et al.* (2010) observed Japanese macaques (*Macaca fuscata*) wrapping leaves around stones, metallic and plastic objects as a pattern of stone handling behavior (Nahallage and Huffman, 2007; Huffman *et al.*, 2010).
- Persea americana* Mill. (avocado) is a tree native to Central America (Vinha *et al.*, 2013), cultivated in tropical and subtropical climates around the world, belonging to the family Lauraceae. This species has long been divided into three botanically distinguishable groups designated as horticultural races, namely Mexican, Guatemalan and West Indian. The Mexican race is the only one with anise scented leaves (Bergh *et al.*, 1973). The leaves of anise avocado (as it is commonly known in the region) range in size from 8 cm to over 15 cm long with widths varying according to the form of the leaf. This race is distributed from 1,600 to 2,000 meters above sea level (m.a.s.l.) and is characteristic of subtropical wet forest (Mendizabal, 1998). These leaves also have a strong anise smell and flavor due to their estragole content, which is less toxic than anethol, the major volatile component of the characteristic scent of anise (*Pimpinella anisum*) that contains higher levels of toxicity (Marcus and Lichtenstein, 1979; King and Knight, 1992; Sagrero-Nieves and Bartley, 1995; Ozcan and Chalchat, 2006).

USE OF LEAF-WRAPPING AS A FEEDING TECHNIQUE BY CAPTIVE WHITE-FACED CAPUCHIN MONKEYS (*CEBUS CAPUCINUS*) AT THE “ROSY WALTHER” METROPOLITAN ZOO, HONDURAS

Judith M. Luna Lainez

Introduction

Benjamin B. Beck gives us the best-known definition of tool-use as “the external deployment of an unattached environmental object to alter more efficiently the form, position or condition of another object” (Shumaker *et al.*, 2011). Many observations on tool use have been described in chimpanzees (McGrew and Tutin, 1973; McGrew,

Methods

During a study of fur rubbing behavior (Luna, in prep.) in captive white-faced capuchin monkeys (*Cebus capucinus*

limitaneus) (Hershkovitz, 1949; Boubli *et al.*, 2012; Ruíz-García *et al.*, 2012) at the “Rosy Walther” Metropolitan Zoo, Tegucigalpa, Honduras, a group of eight capuchin monkeys where observed for a total of 120 daylight hours, over 8 months. The group of capuchin monkeys was formed of an adult pair, four juveniles and two infants. For this study, plant materials of different species (“Hoja Blanca” (*Buddleja americana*), “Indio Desnudo” (*Bursera simaruba*), “Aguacate Indio” (*Persea americana*: Guatemalan race), “Guaruma” (*Cecropia peltata*), and “Cordoncillo” (*Piper aduncum*)) were provided for the capuchin monkeys. Leaves of anise avocado (*Persea americana*: Mexican race) were also provided. We collected *ad libitum* data on all leaf wrapping events that occurred during our study.

Observations

On four different occasions, two males (an adult and a juvenile) and two females (an adult and a juvenile), were seen wrapping four items of their daily diet (corn cob, watermelon, banana and pineapple) with a leaf of anise avocado (*Persea americana*). On all four occasions, they picked up the leaves, which seemed to be selected specifically from visual inspection indicating possible prior knowledge of the species. However, there are no data as to whether the monkeys were raised in captivity or captured from the wild.

On the first occasion (February 8 2016), the alpha female took a piece of corn cob in one hand from the feeding bucket; in the other hand she had a leaf of anise avocado. She wrapped the piece of corn cob with the leaf and rubbed the wrapped food against the ground. After rubbing she opened it and ate the corn, throwing away the leaf. Minutes later she took a piece of watermelon, wrapped it with a new leaf of the same species and beat it against the ground, again eating the fruit and throwing away the leaf when finished. On the same occasion, the alpha male was observed wrapping a piece of banana with a leaf of anise avocado and beating it against the ground. When finished, the subject ate the banana mass and licked the leaf simultaneously. Both incidents lasted between 8 and 10 minutes, with the subjects then returning to consume other foods.

On the second occasion (February 24 2016), the alpha male wrapped a piece of corn cob in an anise avocado leaf and pounded it against the ground, unwrapped it and took just the leaf, which he squeezed and licked. Minutes later, the same individual repeated the action with a banana, wrapping it, eating the fruit and licking the leaf.

On the third occasion (February 25, 2016), the alpha male was observed picking up the leaves of anise avocado and wrapping a banana. He beat it and rolled it against the ground until the banana was mashed. He then bit the mashed banana, simultaneously licking the leaf. When he was done, an infant male licked the leaf that the alpha male had left behind.

On the fourth occasion (April 13, 2016) a sub-adult male wrapped a piece of pineapple in a leaf of anise avocado, bit it, unwrapped it and then continued to eat the pineapple without the leaf.

Discussion

None of the fruits provided in Metropolitan Zoo (watermelon, bananas, corn cob, orange, pineapple, melon) contain harmful substances, nor involve difficulties in processing or handling. Only on occasions when anise avocado leaves were provided did the capuchins wrap the food and lick not only the fruit pulp but the leaf as well. When leaves were not provided the animals easily took and ate the fruits mentioned. When leaves were provided those leaves were not taken immediately, but several minutes or hours after being available. The phytochemical composition of leaves of *Persea americana* includes saponines, alkaloids, phenols and mineral elements with high antioxidant properties such as magnesium, phosphorus and potassium, and other classes of minerals such as sodium, calcium, zinc, iron and copper (Arukwe *et al.*, 2012). They contain high levels of flavonoids, bioactive compounds that have been related to a decrease of different deteriorative processes owing to their ability to reduce the formation of free radicals. Also they have been related to a lower risk of heart disease and contain strong anti-carcinogenic and anti-inflammatory properties and are used to treat digestive problems (Leela and Vipin, 2008; Arukwe *et al.*, 2012; Vinha *et al.*, 2013).

Possible explanations for this behavior in the focal group include: a) Due to the fact that capuchin monkeys have a strong tendency to smash, bang and pound almost anything they handle, wrapping the fruit before they smash it could be a form of tool use to easily pound and rub fruit against a substrate to soften it and/or extract the juice; or b) the animals recognize and seek a specific compound in the leaf that could help them season the fruits prior to consumption with the flavor of anise avocado. The second explanation seems more likely as anise avocado leaves are very aromatic and have a strong flavor. However, the monkeys have not been observed performing this behavior with the leaves of other aromatic and flavored species such as cinnamon (*Cinnamomum verum*), basil (*Origanum vulgare*), rosemary (*Rosmarinus officinalis*) or mint (*Mentha spicata*) even though these materials have been offered. If this behavior served for softening fruits or extracting juices, it might be expected that leaves of other species would be used when anise avocado is not offered. Alternatively this behavior could be a habit of certain individuals within this captive group. So far there is no definitive explanation for the purpose of this behavior, and as this is the first report of leaf-wrapping around a non-noxious material, future systematic research should be carried out to better understand this behavior.

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A COMPARISON OF PRIMATE SPECIES ABUNDANCE AND DIVERSITY BETWEEN A PROTECTED AND AN INDIGENOUS-OWNED SITE IN THE SUMACO BIOSPHERE RESERVE, ECUADOR

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 William Barker
 Katharine Lacey
 Javier Patiño
 Richard Preziosi
 William Sellers

Introduction

Fully protected areas surrounded by successive buffer zones are a standard strategy to protect areas of high biodiversity, intended to strike a balance between the necessity to conserve wildlife and the needs of local people. Effective buffer zones should reduce detrimental edge effects caused by abrupt changes in land-use and allow at least some animal and plant species to extend their range beyond the core boundary (Sayer, 1991). However, they should also be places where the traditional land rights and practices of local people are respected, and allow the sustainable use of natural resources. Achieving this equilibrium is difficult; and it is important for our understanding of the success of buffer zones (if success is measured in terms of the presence and abundance of target species) to make regular comparisons of their species assemblages with their associated core areas in order to ascertain their effectiveness and identify which species are most resilient to human presence. In this study we investigate how primate species assemblages and their estimated abundance differ at two sites situated in the protected core area and buffer zone of the Sumaco Biosphere reserve, eastern Ecuador. While human impact in the protected area is very low, our buffer zone site is situated within territory owned by an indigenous Kichwa community that maintains a reasonably traditional lifestyle, where primates are subject to disturbance, hunting, and use as pets. Although these sites are linked by continuous forest cover, they are separated by both distance, altitude,

and climate, which have been shown to affect both the seasonality and floristic composition of neotropical forests (Vázquez & Givnish 1998, Pyke et al. 2001). For these reasons we also present the results of fruiting surveys at both sites, intended to characterize differences in food availability and the intensity of seasonal bottlenecks.

Methods

Study sites and primate surveys

The Sumaco biosphere reserve is located in the northeast of Ecuadorian Amazonia and covers an area of 931,930ha, equivalent to 8% of the country's Amazonian habitat (Valarezo et al. 2001) (Fig. 1). It is subdivided into three zones which vary in their level of protection and in the level and type of activities that can be legally carried out. The core area of the reserve corresponds to the Sumaco-Napo-Galeras National Park, including 190,562ha around the Sumaco volcano and an additional 14,687ha in the Cordillera de Galeras, where human impact has been either very low or non-existent (Valarezo et al. 2001). Surrounding the park is a 178,600ha buffer zone consisting of several protected state forests with low or medium human impact that are used by indigenous communities for subsistence activities, and where timber and non-timber products are extracted. We used three line transects at each of our sites. Our core area transects, located within the boundary of

the Sumaco Galeras National park, were located at an altitude of 2,450m. Average rainfall at the nearest available recording site (the village of Pacto Sumaco) is 4,321mm (climate-data.org). Our buffer zone transects were located within 16,800ha of land owned by San José de Payamino, an indigenous Kichwa community that was granted ancestral land rights over the area in the 1980s. The community currently consists of circa 60 households and still actively hunts game, although meat is rarely sold at markets and alternative protein sources (in the form of chickens owned by each household, fish from the Payamino river, and livestock meat from the nearest market town of Loreto) are readily available. Average rainfall, which is only available for 1982-1984, was 4,290mm (Irvine 1987). There is continuous forest cover between the community's land and the national park, so we would not expect any significant barriers to dispersal from one site to another. Each transect was surveyed a total of 7 to 11 times over a period of 7 months (August 2014 to March 2015), starting at approximately 7am and walking at a pace of circa 1.25km/h. If rainfall occurred prior to starting the transect, we waited until the rain had stopped or lightened considerably before starting. Transects were paused during periods of brief rainfall, or recording discontinued during heavy precipitation. Whenever a group of primates was encountered, we noted the species and number of individuals. Howler monkey

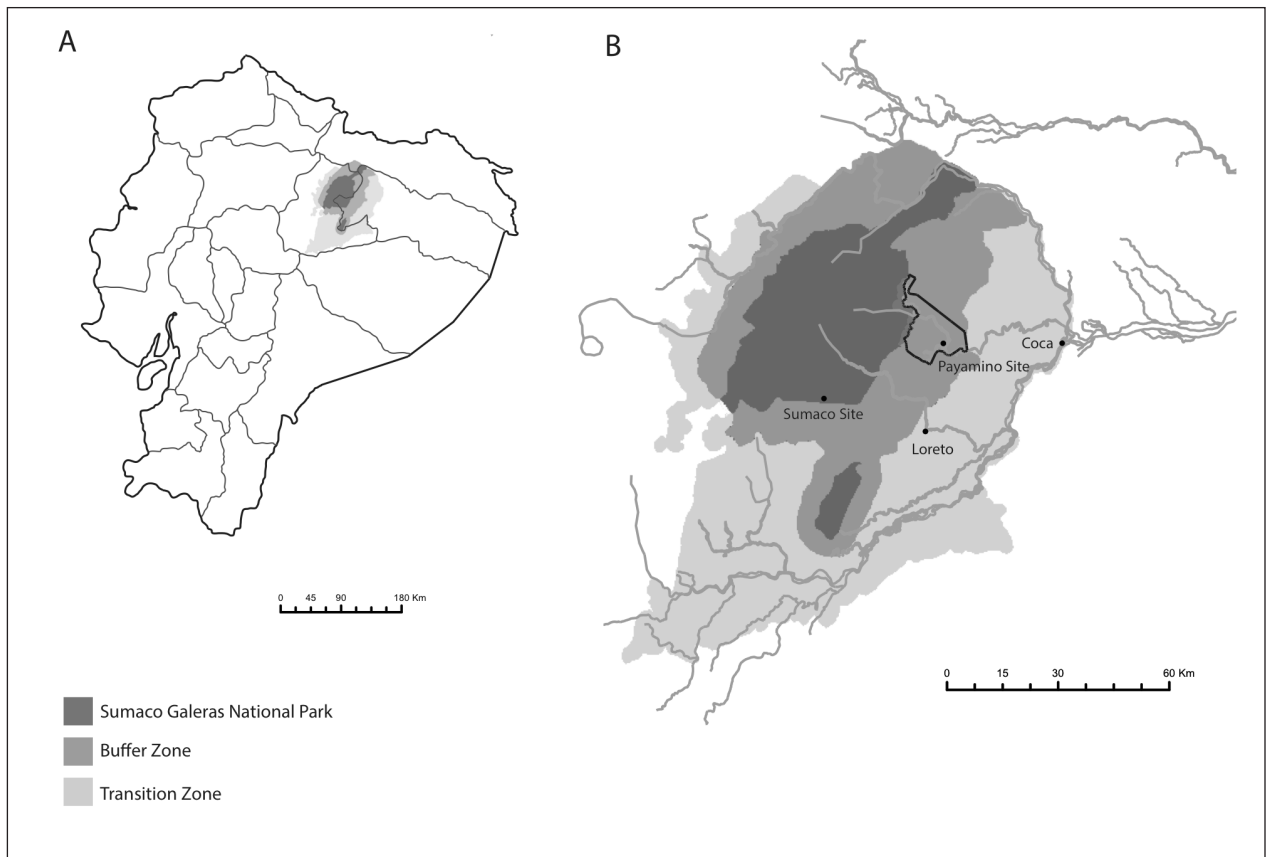


Figure 1. Location of the Sumaco Biosphere Reserve and of our two study sites. The black outline denotes the territory owned by the community of San José de Payamino.

Table 1. Encounter rates of primate species at two study sites in the Sumaco Galeras Biosphere reserve, based on one-way distance. † not recorded on transect, but interviews with locals indicate presence in more remote areas of the community's territory. ‡ Includes encounters that were not sightings. For *Alouatta seniculus* includes five instances of hearing calls but not seeing the group, for *Cebus albifrons* includes one instance of hearing calls and seeing tree movement but not seeing individuals.

			Encounter Rate of Groups/10km (total number of sightings)						
Site	Transect	Km Walked	<i>Lagothrix lagotricha</i>	<i>Ateles belzebuth</i>	<i>Alouatta seniculus</i>	<i>Cebus albifrons</i>	<i>Saimiri sciureus</i>	<i>Saguinus graellsi</i>	Total
Payamino	1	48.9	0	0	0.82 (4)	0.61 (3)	0	0.20 (1)	1.64 (8)
	2	18.4	0	0	0	0	1.08 (2)	0.54 (1)	1.63 (3)
	3	14.5	0	0	2.07 (3)	2.07 (3)	0	0	4.15 (6)
	Total	81.8	0 (0)†	0 (0)†	0.86 (7)‡	0.73 (6‡)	0.24 (2)	0.24 (2)	2.08 (17)
Sumaco	1	7.2	5.53 (4)	0	1.38 (1)	0	0	2.76 (2)	9.67 (7)
	2	10.2	0	0	0	2.96 (3)	0	0.99 (1)	3.94 (4)
	3	12.4	0	0.98 (1)	0	0.81 (1)	0	0.81 (1)	2.42 (3)
	Total	29.8	1.34 (4)	0.36 (1)	0.36 (1)	1.34 (4)	0	1.34 (4)	4.70 (14)

vocalizations were counted as sightings, as the individuals themselves were rarely seen.

Fruiting Surveys

Fruiting surveys took place during the return leg of transect walks every second round of primate surveys. Surveys were conducted using a methodology that merges phenology transects with diameter at breast height (DBH) sampling to measure fruit abundance and seasonal fluctuation in availability, using methods outlined in Parry et al (2007) modified from Wallace and Painter (2002). Whenever patches of fruit were detected on the trail, the parent tree was located and checked with binoculars to see if it was still bearing fruit. In cases where it was, the DBH of the tree was measured and recorded. Any fruit less than 1cm in width was not recorded, and observers of fruit were rotated in order to avoid any potential differences in detection rates. We used two metrics as proxies for fruit availability: cumulative DBH per km (which is assumed to be a reliable indicator of the amount of fruit a tree will produce (Chapman et al. 1994)), and the number of fruiting trees per km.

Results

Primate Survey

We recorded a total of 31 primate encounters with six different species: woolly monkeys (*Lagothrix lagotricha poeppigii* $N=4$), white-bellied spider monkeys (*Ateles belzebuth* $N=1$), red howler monkeys (*Alouatta seniculus* $N=8$), white-fronted capuchin (*Cebus albifrons* $N=10$), common squirrel monkey (*Saimiri sciureus* $N=2$) and Graell's tamarin (*Saguinus graellsi* $N=6$). These figures are inclusive of six 'encounters' where the animals themselves were not seen, but their presence was detected as a result of other cues. For the howler monkey figures, they include five occasions where we heard a group calling close to the transect. Similarly, the capuchin figures include one encounter in Payamino where we saw a rustling of trees and heard the group's calls but

did not make visual contact. Although Payamino's transects covered a greater distance, linear regression showed the number of group encounters was not correlated to the total distance walked ($F=1.497$, $P=0.288$), although this may be more a reflection of the relatively low number of encounters rather than the lack of a relationship.

Our total number of primate sightings ($n=17$ in Payamino, 14 in Sumaco) did not meet the minimum number required for reliable calculation of absolute densities as recommended by Buckland et al. (2001). As a result, we used encounter rates based on one-way distance as a measure of relative group density (Table 1), assuming similar detection rates between both sites. Our data suggest that *Lagothrix* and *Ateles* were completely absent from Payamino, though locals report sightings in more remote areas of the community's territory that were not covered by our surveys. Descriptions of the route taken to see them suggest they are seen in areas very close to the national park boundary. *Saimiri sciureus* were not detected on our Sumaco transects. *Alouatta seniculus* had an encounter rate in Payamino that was over twice that of Sumaco, but *Cebus albifrons* and *Saguinus graellsi* were encountered more frequently in the protected area

Fruiting surveys

Phenology between the two sites differed according to whether cumulative DBH or the number of fruiting trees per km was used as the proxy for fruit availability. We tested for differences between sites using a general linear model with Julian day on which the survey was undertaken as a covariate, using the program car (Fox & Weisberg, 2011) in the statistical package R. Both sites experienced seasonal changes in cumulative fruiting DBH/km ($F_{1,31}=9.55$, $P<0.005$), decreasing at the end of the rainy season (Fig. 2). There was no significant difference between Sumaco and Payamino, indicating that at any given time a similar amount of fruit is available to primates at each site.

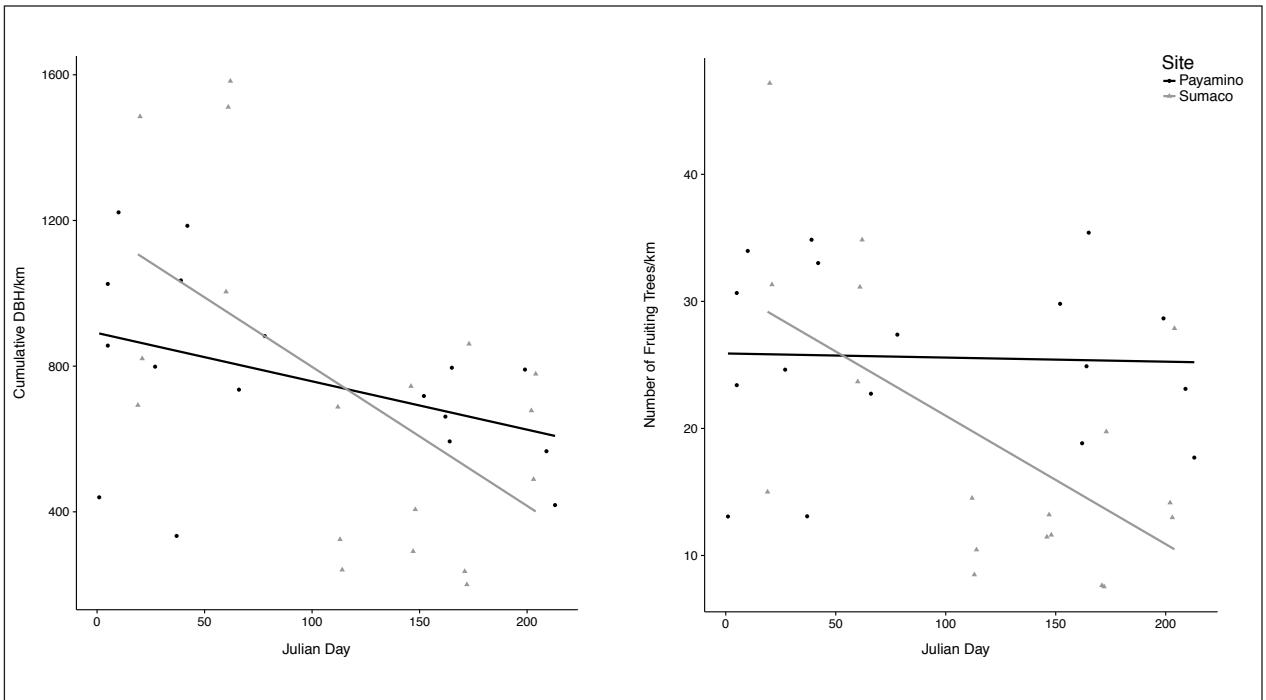


Figure 2. (A) Cumulative DBH/km (B) Number of fruiting trees/km for transects surveyed in Payamino and Sumaco. Julian day 1 corresponds to 25/8/14, when phenology transects were started, and ends on 25/3/15.

However, the same analysis using the number of fruiting trees as the proxy for fruit abundance reveals a clear interaction between site and Julian day ($F_{1,31} = 5.68$, $P = 0.02$). This suggests that Sumaco experiences a seasonal bottleneck whereas the number of trees in fruit in Payamino remains more stable.

Discussion

Primate assemblages between our two study sites differ in terms of the diversity and relative density of species, although our analysis is limited by our low number of encounters and cumulative distance sampled. Although the answer to whether the two sites surveyed differ in terms of fruit availability throughout the year changes depending on the proxy, neither scenario gives a satisfying explanation for our patterns of primate encounters. If both sites have the same availability (as suggested by there being no difference between their cumulative fruiting DBH/km), we would expect species abundance to be the same, or, if Sumaco goes through a more intense seasonal bottleneck than Payamino, the latter would be expected to have a higher abundance. Bearing this in mind we think it unlikely that our observed differences in fruit availability are a major driver behind our differences in primate encounter rates.

Differences in primate species assemblages and encounter rates between the two sites could alternatively be driven by hunting. While some of our data fits this picture, our results do not fully replicate the profile that would be expected under these circumstances. Hunting preferences for primates generally start with large-bodied through to

medium and small-bodied species (Sirén, 2004; Franzen et al. 2006). In this respect the absence of the two largest bodied species of primates from the area inhabited by the Payamino community is typical, as their prestige (Sirén, 2012) as well as several of their life history traits (long inter-birth periods, giving birth to single young, and having group structures where not all females may be reproductively active (Cowlinshaw & Dunbar, 2000)) make them particularly vulnerable to wholesale extirpation (Peres, 1990; Ruez Luna, 1995; Bodmer, 1997). Interviews with members of the community confirm our findings that both species are no longer found near areas that are inhabited (Stafford et al. 2016). In this case the buffer zone is failing to protect two species known to be at high risk of extinction as a result of human activity. As the third largest species, howler monkeys would also be expected to be found at lower densities in Payamino, though as quarry they are generally less preferred than the other atelines (Stafford et al. 2016). Our encounter rates were over twice as high in Payamino than within the boundary of the national park, however encounters were all confined to a small area where we regularly heard a group calling. If our surveys happened to cover a preferred calling site in Payamino (for example, if we happened to place our transect on the border of their home range) but not in Sumaco there is a possibility that our Payamino encounter rates are biased. Data on spatial patterns of calling is absent for *Alouatta seniculus* but varies across other *Alouatta* species (da Cunha & Jalles-Filho, 2007; Holzmann, 2012; Van Belle et al. 2013), so we currently do not know if this could be the case. Sightings of other species were also concentrated on particular transects and areas (see *Lagothrix* and *Saguinus* encounter

rates in Sumaco in Table 1, for example), so in this study we assume *Alouatta* does not have preferences for particular calling sites.

Although our census effort is limited, we found differences in species composition and abundance between a protected area and land contiguous to it that is owned by an indigenous community. These differences appear to be primarily a result of hunting targeting large species with the exception of *Alouatta seniculus*, which was encountered more frequently in the buffer zone than the protected area. Improving our understanding of the additional factors that may be at play, as well as assessing other buffer zones and associated national parks, is important to gain a better understanding of whether buffer zones are an effective tool to help conserve primate diversity.

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REHABILITATION AND DESTINATION OF A CONFISCATED SQUIRREL MONKEY (*SAIMIRI COLLINSI*) FOLLOWING CONSERVATIONISTS GUIDELINES: A CASE STUDY

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Introduction

The placement of confiscated animals is one of the main problems concerning fiscalization actions (RENTAS, 2001; Antunes, 2004; Padrone, 2004). According to Vidolin *et al.*, (2004), any fauna confiscated should always be associated to careful rehabilitation, considering the three management options that take into account the concepts of conservation of fauna and ecosystems, i.e., 1) captivity 2) return to the wild or 3) euthanasia (IUCN, 2000). Although the majority of mammals confiscated in Brazil during the years of 1999 and 2000 were released, such activities were mostly performed without taking scientific criteria into account, and the animals were simply released back into the wild (RENTAS, 2001).

Habitat competition and the risk of introducing diseases seems to be the main causes of failure of release programs as a whole (Rodrigues, 2001). Here we report the release of a confiscated adult female squirrel monkey (*Saimiri collinsi*), in which we attempted to follow some guidelines found in the literature for the placement of confiscated fauna (RENTAS, 2001; IBAMA, 2006; Rocha-Mendes, 2006; IUCN, 2000). In general, the success of a release program should include evaluations of the following factors, although not limited to these:

1- It is recommended that every seized animal has a receipt form, containing, among other data, information regarding their correct taxonomic identification, preferably to species level (or subspecies, if any); biometric data; sex; date of entry; age; origin and apprehension history;

2 - It will only be considered fit to release the animal that goes through a technical council evaluation of veterinarians and biologists, attesting that the individual is in good physical health and behavioral conditions, for example. This criteria include the fact that the animal must undergo a period of rehabilitation and follow a health protocol, going through a period of quarantine examinations, in order to prevent the animal from introducing some new illness in the release area. The animal destined for release must also have their socialization with the man (imprinting) avoided to the maximum;

3 - The release procedure should only be performed in a location that is within the natural geographic distribution area of the species; in their natural habitat and respecting their ecological conditions. The quality of the habitat must also be assessed, as well as its size and, if possible, the genetics of the population of the area of release;

4 - Evaluate the most appropriate time of year for the release of the species, considering food availability (flowering, fruiting, insects), time of day, among others. The release must also follow appropriate protocols for each species, in conformity with the behavior and the habit (diurnal, nocturnal, solitary or gregarious). If possible, evaluate genetics of the animals to be released;

5 - Evaluate local pressures on species (predators, human action) and encourage the protection, restoration and extension of the habitat of the release site, as well as the participation of society and the private and research sectors;

6 - The animal must receive suitable permanent marking of each species in order to perform a post-release monitoring program (radio telemetry, for example), to evaluate the success of the return to the wild. This program will allow the planning of additional activities required (food supply, predation control) as well as bring information for future releases (habitat preferences, for example).

Results and Discussion

On 14 April 2014, an adult female squirrel monkey (*Saimiri collinsi*) was received by the Wild Animal Clinic at the Federal Rural University of Amazonia (UFRA). An employee from the University found the specimen injured due to a tree fall at one of the forest fragments surrounding the University. Following the first guideline mentioned above, all the possible measures were taken and a form was filled out with information regarding the primate taxonomic identification, biometric data, sex, entry date and the history of confiscation.

According to the second guideline, a group of two biologists and four veterinarians was formed in order to rehabilitate the primate. A full clinical exam and an x-ray revealed that the monkey's left forelimb was dislocated. The therapeutic protocol restricted the primate's movements (Fig. 1) and corticoids and analgesics were administered for seven days to control the pain and inflammation. Stressful and stereotyped behaviors (pacing and bar-biting) were ameliorated using environmental enrichment, and imprinting was also avoided to the maximum, in order to maintain the animal's wild behavior and facilitate its release. A proper diet of fruits (some of them frozen in ice), flowers and some insects was offered, and after a total of 28 days of rehabilitation, another x-ray, and two days in observation, our group considered that the primate was in good health and in suitable behavioral conditions for being released back into the wild.



Figure 1. Confiscated adult female squirrel monkey (*Saimiri collinsi*) being rehabilitated at the Wild Animal Clinic at Federal Rural University of Amazonia (UFRA)

The area chosen for this action was as close as possible to the area where the animal was found. A group of squirrel monkeys was located and observed nearby, and the individual was released about five meters close to the group. Its interactions with the group members were observed and the primate vocalized towards them, obtaining vocal responses as the individual approached the group. No agonistic interaction was observed and the female then followed the group into the woods, suggesting a positive acceptance.

Even with the impossibility of a post-release monitoring, the protocol adopted for rehabilitation and destination of the individual highlighted the importance and need of a suitable destination protocol for confiscated fauna. This is especially true concerning the northern region of Brazil, where the lack of criteria for the release of confiscated animals is urgent, given the increasing number of confiscated fauna.

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FIRST ASSESSMENT OF HELMINTH PARASITES IN WILD SQUIRREL MONKEYS (*SAIMIRI COLLINSI*) IN NORTHEASTERN PARÁ STATE, BRAZIL

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Introduction

Pathogens are increasingly recognized as having an important role in the behavioral ecology, health and conservation of primate populations (Gillespie, 2006; Gillespie et al., 2008; Martínez-Mota et al., 2015). Recent studies have focused on parasite surveys in wild populations of neotropical monkeys (Eckert et al., 2006; Kowalewski and Gillespie, 2009; Soto-Calderon et al., 2016). Although some of these studies have sampled squirrel monkeys (Michaud et al., 2003; Phillips et al., 2004), most of the data on helminthic parasites of *Saimiri* come from captive populations. These data indicate a variety of gastrointestinal parasites in these primates, including helminths, bacteria and protozoa. Helminthic parasites include cestodes, acanthocephalans, trematodes and nematodes (Dunn, 1968). Yet, the

diversity of gastrointestinal parasites in free-ranging squirrel monkey populations is still less well-known.

Here we present the first assessment of helminthic parasites in wild *Saimiri collinsi*, a species of squirrel monkey endemic to Brazil (Mercês et al. 2015). We collected fecal samples from one group of monkeys in Amazonian Brazil (State of Pará). The habituated social group contained 50 individuals and ranged in 150 ha of predominantly secondary forest. In addition to consuming ripe fruit, squirrel monkeys at this field site are highly faunivorous, spending up to 75% of their foraging time on arthropods, particularly in the dry season (Stone, 2007).

Methods

This study was conducted in the village of Ananim, municipality of Peixe-Boi, 150 km east of Belém, Brazil (01° 11' S, 47° 19' W). Rainfall is highly seasonal in the 800 ha site, with a wet season from January to June and a dry season from July to December. October and November correspond to the period of lowest fruit availability (Stone, 2007).

Fecal samples were collected from 13 individuals in November 2013, during the annual capture procedure of squirrel monkeys at our field site (Stone et al., 2015). After capture, the monkeys remained in a rectangular trap which was divided into individual compartments; the trap contained a tray on the bottom. After releasing the monkeys (within six hours of capture), we collected any fecal material that remained in the tray; these were preserved in 10% formaldehyde solution for later laboratory analysis. Fecal samples did not have contact with the soil. We collected four samples on four different trapping days (Table 1). Two of the samples were from individual monkeys (one adult female and one adult male), and two of the samples collectively contained fecal material from all the individuals trapped on that particular day (five to six individuals including adult females, adult males and juveniles). Individuals were only sampled once. All adult females were in the last third of gestation (gestation is five months in *Saimiri*; Garber and Leigh, 1997; Stone, 2006). Coprological analyses of the samples were carried out using the spontaneous sedimentation in tube technique (Smith et al., 2007). The resultant one drops of samples were placed on a slide, stained using iodine stain, and examined under a light microscope. Helminth larvae and eggs were identified based on size and morphology. Samples were scored as either positive or negative for each fecal sample.

Results and discussion

We sampled 13 wild squirrel monkeys, including adult females, adult males and juveniles. As shown in Table 1 and Figures 1 and 2, several types of helminthic parasites were found (Nematoda, Cestoda and Acanthocephala). In particular, we found that the intestinal nematode *Strongyloides*



Figure 1. (A–E) Light microscope pictures of parasite eggs recovered from fecal samples of Squirrel monkeys (*Saimiri collinsi*) in Pará, Brazil. (A) *Strongyloides* sp., (B) Trichostrongylidae, (C) *Trypanoxyuris* sp., (D) *Prostenorchis* sp., (E) Taeniidae, scale bar = 20 μ m.



Figure 2. (A–C) Light microscope pictures of nematode larvae recovered from fecal samples of Squirrel monkeys (*Saimiri collinsi*) in Pará, Brazil. (A) *Strongyloides* sp., (B–C) *Filariopsis* sp, scale bar = 20 μ m.

sp. was present in 100% of sampled material. According to Dunn (1968), this soil-transmitted parasite can be pathogenic when the infection is heavy.

Previous reports on gastrointestinal parasites in squirrel monkeys focused primarily on captive populations or newly captured monkeys (e.g. Dunn, 1968; but see Appleton and Boinski, 1991), and helminthic burdens are often substantial in newly captured and captive animals. In fact, all types of helminths present in our samples were reported previously by Dunn (1968) in newly imported South American squirrel monkeys, but particularly the helminth *Prosternorchis elegans*. This helminth also was present in nearly all samples obtained from free-ranging *Saimiri boliviensis* and *S. macrodon* captured in Peru (Michaud et al., 2003). It is noteworthy that in their examination of fecal

Table 1. Helminthic parasites present in fecal samples of one social group of *Saimiri collinsi* in Pará, Brazil. Identifications were made using eggs and larvae, except when noted. All adult females were gravid.

Samples	Age-sex class	Parasites
Sample 1	2 adult females 1 adult male 3 juveniles	Nematoda: Trichostrongylidae <i>Trypanoxyuris</i> sp. <i>Strongyloides</i> sp. <i>Filaroides</i> sp. Acanthocephala: <i>Prosthenorchis</i> sp.
Sample 2	5 adult females	Nematoda: <i>Strongyloides</i> sp.
Sample 3	1 adult male	Nematoda: Trichostrongylidae <i>Strongyloides</i> sp. Acanthocephala: <i>Prosthenorchis</i> sp. Cestoda: Taeniidae
Sample 4	1 adult female	Nematoda: Trichostrongylidae <i>Strongyloides</i> sp. Cestoda: Taeniidae

parasites in Costa Rican squirrel monkeys (*S. oerstedii*), Appleton and Boinski (1991) did not find several of the helminths we recorded in *S. collinsi*, including *Trypanoxyuris* sp. and Taeniidae. However, *Filaroides* sp, which were also highly prevalent in the Costa Rican population, were recorded in our samples. Interestingly, no *Strongyloides* sp. (the most common parasite in our study) were recorded in wild *S. sciureus* sampled in Peru, although multiple social groups were sampled (Phillips et al., 2004).

The fecal samples were collected in the driest month of the year, when fruit availability in the forest is low and the monkeys spend more time eating arthropods (Stone, 2007). This may explain the presence of cestodes and acanthocephalans in our samples, as insects serve as intermediate hosts of these parasites (Michaud et al., 2003; Wenz et al., 2010). We note that, upon clinical examination, all individuals appeared healthy (e.g. four females in our sample subsequently gave birth to healthy infants). Thus, it did not appear that the parasites had become pathogenic in the monkeys. The same lack of harmful health effects was reported for wild *Saguinus leucopus* individuals sampled in Colombia by Soto-Calderon et al. (2016). These authors further argue that factors associated with captivity, such as high densities and weakened immune responses, can facilitate pathogenicity when wild-caught individuals are placed into captive facilities.

The data listed in Table 1 likely represent a minimum level of infection, due to our small sample size and lack of replicate samples for each subject (hence, we do not report prevalence rates), although we highlight the diversity of helminths present in the small sample. In fact, compared to other neotropical primates such as howler monkeys, the squirrel monkeys showed more parasite number and taxa per sample (R. Martinez-Mota, pers. communication). Possibly, strictly arboreal primates such as howlers are less exposed to parasitic infections. In contrast, squirrel monkeys use different forest strata such as the under canopy and even the ground (Stone, 2007), where parasites may be more prevalent. An additional factor that may contribute to high parasite loads in squirrel monkeys is their large group sizes (40-50 animals; Stone, 2007), as sociality can predict an increase in parasite exposure (Rifkin et al., 2012; Webber et al., 2016).

Overall, then, our results provide initial information on the types of helminthic parasites of *Saimiri collinsi* in this region of Eastern Amazonia, yielding important baseline data for future studies of these primates.

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PREDATION OF A LIZARD (*PLICA UMBRA*) BY PYGMY MARMOSETS (*CEBUELLA PYGMAEA*) IN A FOREST FRAGMENT IN SOUTHWESTERN BRAZILIAN AMAZON

Edson Guilherme
Rodrigo Canizo
Jailini da Silva Araújo

The pygmy marmoset (*Cebuella pygmaea*) is the smallest species of New World primate, and is found exclusively in the western Amazon basin (Townsend, 2001; Ankel-Simons, 2007; Messias *et al.* 2011). Given their small size and cryptic behavior, these monkeys are difficult to observe in the wild. They are found mainly in Amazonian alluvial and *terra firme* forests. Like other marmosets, *C. pygmaea* is highly specialized for the dietary exploitation of plant exudates (Moynihan, 1976; Soini, 1982; 1988; Yépez *et al.*, 2005; Youlatos, 2009), but also feeds on insects and small vertebrates (Townsend and Wallace, 1999). This study describes the predation of a vertebrate by *Cebuella pygmaea* in an urban forest fragment (Parque Zoobotânico – PZ; 09°57'S, 67°57'W) of approximately 150 ha, which belongs to the Federal University of Acre (UFAC) in Rio Branco, capital of the Brazilian state of Acre (Fig. 1). This site is occupied by at least three groups of *C. pygmaea*, one of which was the subject of a previous ecological study

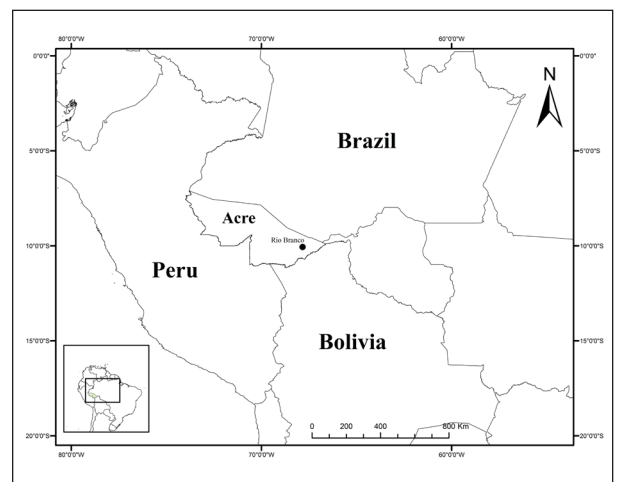


Figure 1. Geographical location of the Rio Branco city, State of Acre, Brazil.



Figure 2. A pair of pygmy marmosets (a subadult and a juvenile) feeding together on a tree-dwelling lizard (*Plica umbra*) on the edge of a forest fragment in southwestern Brazilian Amazonia.

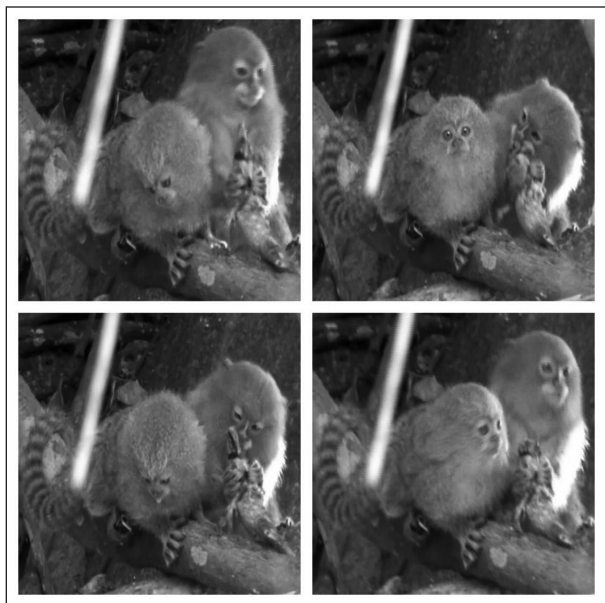


Figure 3. Sequence of images taken from footage obtained on June 6th 2015, showing a subadult pygmy marmoset next to a juvenile, while feeding on a tree-dwelling lizard (*Plica umbra*) on the edge of a forest fragment in southwestern Brazilian Amazonia.

by RC, based on behavioral monitoring (Canizo, 2012; Canizo and Calouro, 2011).

On June 6th 2015, EG spotted a group of six *C. pygmaea* in an emergent tree (*Enterolobium schomburgkii*) during informal observations on the eastern edge of the PZ. The tree was located within a thicket of bamboo (*Guadua weberbaueri*) and was overgrown with *Trigonía* lianas. When the group was first sighted, it was photographed, and then two individuals were seen in a fork in the middle of the tree, manipulating an object. At this moment, EG began to film the animals, after noting that they were two juvenile individuals, feeding on a lizard they had just captured. A

subadult then approached the first dyad, took the lizard, and moved immediately to a lower branch, where it began to feed on the prey. One of the individuals of the original dyad approached the subadult, which allowed it to share parts of the prey (Fig. 2). It was only possible to observe the marmosets ingesting the lizard's head. The footage of this sequence was converted into a sequence of photographs (Fig. 3). When analyzing the images, JSA identified the prey as a tree-dwelling lizard of the species *Plica umbra*, a member of the family Tropiduridae.

Records of the predation of vertebrates by pygmy marmosets in the wild are rare (Townsend and Wallace, 1999). This may be because these monkeys are morphologically adapted more for the exploitation of plant exudates and the predation of trunk-dwelling insects than the capture of vertebrates (Youlatos, 2009). The rare reported cases include the attack of a domesticated pygmy marmoset on a bird that had just collided with a window, and which was killed by bites to its neck and head (Townsend and Wallace, 1999). During the year-long monitoring of a group of eight *C. pygmaea* in the same study area (possibly the same group observed here), Canizo (2012) only observed two events of predation on vertebrates, one of which involved an anuran (*Allobates* cf. *trilineatus*) and the other, a small lizard (*Anolis* sp.). In the event reported here, it was unclear whether other parts of the lizard were eaten, but the photographic evidence (Fig. 3) shows that the prey's head was ingested completely. These observations also confirm that pygmy marmosets are capable of capturing, killing, and ingesting small vertebrates (less than 100 g weight). However, it does remain unclear to what extent this behavior reflects a systematic foraging strategy or merely an opportunistic event, or whether it represents a response to specific local conditions, such as the absence of exudate sources in this urban fragment of forest.

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DEMOGRAPHY OF THE BLACK LION TAMARIN (*LEONTOPITHECUS CHRYSOPYGUS*, MIKAN) IN CAPÃO BONITO NATIONAL FOREST (STATE OF SÃO PAULO)

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Cauê Monticelli
Pedro Manoel Galetti Jr.

Introduction

The black lion tamarin is known to inhabit 11 Atlantic Forest fragments, with a total estimated population of 1,000 individuals in the wild (Kierulff et al., 2008). Its conservation status went from Critically Endangered to Endangered in recent years (IUCN, 2015) due to successful conservation efforts (Kierulff et al., 2008). The largest population of black lion tamarins (~820 animals) inhabits Morro do Diabo State Park (Valladares-Padua and Cullen Jr. 1994). Caetetus Ecological Station houses the second largest population (~40 individuals). The remaining individuals are supposedly distributed in the other nine forest fragments (Kierulff et al., 2008), from which only Capão Bonito National Forest (FLONA-CB) is a protected area and represents the southernmost distribution limit for the species. The population size at FLONA-CB was estimated to be 12 individuals in 2005, but no detailed information is available on how this population was assessed (Population and Habitat Viability Assessment briefing book, 2005). Considering the importance of FLONA-CB in supporting a viable population of black lion tamarins due to its protected status and geographic limit for the species, the purpose of this study was to report the current black lion tamarin population size in this area. Hopefully, this information will be able to contribute to the establishment of a management plan for this site.

Methods

Study area

Capão Bonito National Forest (23° 54'S and 48° 30'W) is located between the municipalities of Capão Bonito and Buri (state of São Paulo), at an altitude of 700 m in southwestern Paranapiacaba Valley. It is inserted in the Atlantic Forest biome and has an area of 4,344 ha. However, since FLONA-CB is a protected area with sustainable use, it is mainly occupied by pine (*Pinus* sp) and araucaria (*Araucaria angustifolia*) plantations. Only 8% (357 ha) of its territory consists of native forests, and these patches are mainly located along the riparian zones of rivers Apiaí-Mirim, Paranapitanga, and other smaller streams.

Demographic situation

In order to conduct a direct count of the existing black lion tamarin groups and the number of individuals in each of them, transects were performed in all areas of potential habitat for this species within the limits of FLONA-CB:

the riparian forests of Apiaí-Mirim and Paranapitanga rivers and small streams. Five field expeditions were carried out between November 2012 and November 2013, with the duration of 30 days per campaign, and a search effort of at least 12 hours daily. To increase the chances of sighting groups of black lion tamarins during the surveys, a device (adapted MP3 Philips) was used to playback the species long call vocalization (Kierulff and Rylands, 2003; Neves, 2008), which intended to attract the area's resident group responding to playback to protect its territory. Once a group was found, the following information was recorded – geographic coordinates (GPS Garmin Etrex 30), season, number of individuals, and presence of infants (mother dependent individuals being carried on the back or belly).

Results and discussion

The direct count totaled 35 individuals of *L. chrysopygus*, distributed in seven groups in different areas of FLONA-CB (average of five individuals per group). Although five field expeditions were conducted, the total number of groups and individuals was already reached at the 3rd expedition. The number of individuals found inside FLONA-CB was higher than the one estimated in 2005 (12 individuals distributed in three social groups). Such difference may be explained either by an increase in population size during this last decade or by variations between the methodologies used for counting the animals. As the entire area was covered by the expeditions, the counts are expected to be quite realistic, showing that Capão Bonito National Forest is able to support a significant number of *L. chrysopygus* individuals.

Black lion tamarin groups were only found in the riparian forests along the Apiaí Mirim river and minor streams. Five groups were found in the riparian forests of the Apiaí Mirim river, where the home range of each group extended through the river's borders, since trees and branches that fall across the rivers can facilitate crossing. Two other groups were found in the riparian forests of two small streams, connected to the riparian forest of Apiaí Mirim river. No sightings of black lion tamarins occurred in the riparian forest along Paranapitanga river, as well as the pine and araucaria plantation areas.

A total of twelve infants were sighted in four groups inhabiting Apiaí Mirim river's riparian forest. Four sets of twins were observed in October 2012 in four different groups, two infants were sighted in one group in July 2013 and two infants (twins) in November 2013, indicating at least two breeding events in 2013. No infants were observed in the other groups during the study's expeditions.

In this manner, although it represents a relatively small area (~ 4.5 ha), FLONA-CB supports an important parcel of the black lion tamarin population. In the same geographic region, the presence of black lion tamarins has been reported in a few small fragments (e.g. Lima et al., 2003). The

implementation of ecological corridors connecting these fragments and improving habitat quality may be a definitive strategy for the management of these populations. In this scenario, FLONA-CB's population may play an important role in preventing local extinction and helping in this species' its long-term conservation.

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LOS MONOS ARAÑA (*ATELES GEOFFROYI*) BEBEN AGUA DE CAVIDADES EN LOS TRONCOS DE LOS ÁRBOLES. REPORTE ANECDÓTICO DE CAMPO

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Merit Nefernefer Becerril Tello
Luis Alberto Vargas Guadarrama

Introducción

Desde 2006 hemos realizado trabajo sobre aprendizaje y comunicación social de monos araña en Calakmul,

Campeche, México, utilizando cámaras de video y micrófonos para registrar sus gestos y vocalizaciones. En un inicio, la conducta de beber no era uno de nuestros temas de interés, sin embargo, al tener la videocámara disponible hemos filmado varios eventos interesantes relacionados con la toma de agua de las cavidades de los troncos de los árboles. Ante la escasa información sobre esta conducta, consideramos valioso documentar y divulgar un comportamiento que ha sido soslayado por mucho tiempo dentro del estudio de la ecología y comportamiento de estas especies.

El agua es un nutrimento básico para la supervivencia y el bienestar de los animales, (Harris y Van Horn, 1992). También funciona como amortiguador para el sistema nervioso (Askew, 1996); transporta muy diversas sustancias en solución, transmite la luz en los ojos, los sonidos en los oídos, lubrica las articulaciones y en vehículo para eliminar algunos desechos (Robinson, 1957). A pesar de la gran importancia que representa el beber agua, la gran mayoría de los estudios en condiciones naturales sobre nutrición y dieta en *Ateles* no ofrecen información sobre el consumo del agua. Por lo tanto, sabemos muy poco sobre cómo ocurre exactamente este comportamiento. Existe la creencia generalizada de que *Ateles* obtiene principalmente el agua necesaria a través de los alimentos que consume, especialmente de las frutas y las hojas. Pero, estudios en otras especies muestran que muchos primates obtienen el agua de fuentes distintas a los alimentos. Los colobos rojos de Zanzibar (*Procolobus kirkii*) toman agua directamente de los manglares (Nowak, 2008); las marmosetas (*Callithrix flaviceps*) de los ríos, bromelias, y orificios de los árboles (Ferrari y Hilario, 2012); los lemures de cola anillada (*Lemur catta*) de los ríos, lamiendo la lluvia y el rocío de las hojas (Hosey et al., 1997); los chimpancés (*Pan troglodytes schweinfurthii*) de las cavidades de los árboles, de corrientes y puntos donde fluye el agua (Sugiyama y Koman, 1979; Matsusaka et al., 2006); los macacos de Berbería (*Macaca sylvanus*) que viven en los bosques de Marruecos, debido a la escasez de fuentes abiertas de agua han satisfecho sus necesidades masticando la corteza de los cedros y robles que normalmente no forman parte de su dieta (Ciani et al., 1999). En las especies de primates en las cuales los grupos o poblaciones son más dispersos, algunos grupos o individuos pueden no tener acceso a agua dentro del territorio cercano a su hogar durante ciertos periodos del año, por lo tanto tienen que adaptar su comportamiento a la estacionalidad de los recursos para mitigar los efectos de la escasez de agua (Scholz y Kappeler, 2003).

En cuanto al género *Ateles* la literatura sobre la toma de agua en condiciones naturales es mínima. Generalmente, los estudios clásicos sobre ecología de *Ateles* sugieren que satisfacen sus requerimientos de agua del jugo de las frutas (Van Roosmalen y Klein, 1988); sin embargo, existen estudios que demuestran que los monos araña toman agua de fuentes distintas a los alimentos sólidos, por ejemplo de reservorios de lodo (Izawa, 1993; Link et al., 2011); de cavidades de los árboles (Ferrari, 1991), lamiendo las gotas

de la lluvia y el rocío depositado sobre las hojas o chupando la base de los tallos de las bromelias (Ojeda, 2007).

Métodos

Nuestro estudio se realizó con una comunidad de monos araña (*Ateles geoffroyi*) semihabitados a la presencia humana que viven en condiciones de libertad en el sitio arqueológico de Calakmul dentro de la Reserva de la Biosfera de Calakmul, en el estado de Campeche, México. El estudio se dividió en dos temporadas de campo de 30 días; una en diciembre de 2011 y otra en julio de 2012. Se realizaron videograbaciones con una cámara SONY HDR PJ10 y los videos se analizaron usando el software I Movie 11 9.0.

Sitio de estudio

La Reserva de la Biosfera de Calakmul se localiza en el estado de Campeche en la región sureste de México, posee una extensión de 723,185 ha. Dentro y en los alrededores de ella hay 72 comunidades campesinas, la mayoría pertenecientes a diferentes grupos étnicos (Boege, 1993). Calakmul representa el área forestal más extensa del trópico mexicano (Martínez y Galindo-Leal, 2002) y la más importante en el hemisferio norte del continente americano (Boege, 1993). La vegetación presente en la reserva no es homogénea, se encuentra compuesta por distintos subsistemas que incluyen selva alta subperenifolia y selva alta perenifolia, selva mediana subperenifolia, selva baja subperenifolia, sabana e hidrófitos (Martínez y Galindo-Leal, 2002). El clima se considera tropical subhúmedo con lluvias de junio a noviembre; la temperatura promedio anual es de 21.6° C y la media de precipitación total anual es de 1,076.2 mm. Nuestro estudio se limitó al área núcleo de la reserva donde se encuentra el sitio arqueológico maya de Calakmul. El sitio es un centro turístico, por lo que existen veredas y caminos construidos por el INAH (Instituto Nacional de Antropología e Historia) los cuales fueron utilizamos para hacer nuestras observaciones.

Resultados

En total se registraron cuatro eventos en los cuales los monos araña bebieron agua de las cavidades de los troncos de árboles. A continuación se presenta una descripción minuciosa de este comportamiento así como del contexto en el cual se presentó esta conducta.

Observación 1

El 20 de diciembre de 2011 observamos un subgrupo de tres monos araña (un macho, una hembra y otro individuo cuyo sexo no fue posible determinar) desplazándose por la parte más alta de los árboles (a aproximadamente 25 m de altura). Los monos se separaron al notar nuestra presencia, pero no se alejaron. El macho adulto arrancó una *Bromelia* que estaba en la entrada de la oquedad de un tronco (a 15 m de altura aproximadamente), la dejó caer al piso y comenzó a beber el agua que estaba dentro de la cavidad, metiendo

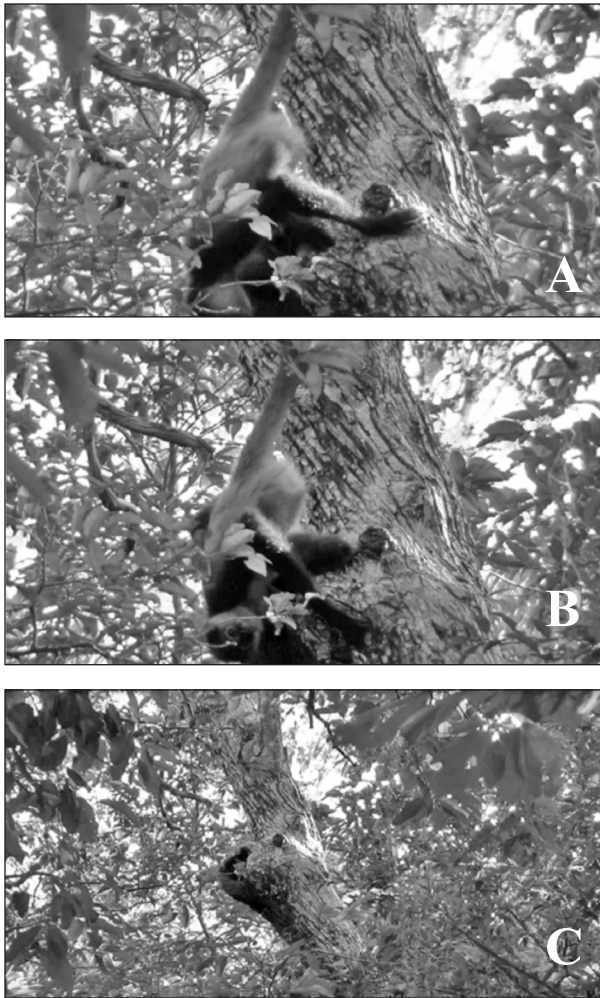


Figura 1. Conducta de beber agua de los huecos en los troncos de árboles por el mono araña *Ateles geoffroyi* en Calakmul, Campeche. A) Mono araña mete el brazo en el hueco para alcanzar el agua, B) Mono araña lamiendo el agua de su mano, C) Hueco en el tronco del árbol del que bebió agua el mono araña.

la mano para extraer el agua. Después de esta observación iniciamos el registro visual con la videogradora. El análisis posterior de la grabación mostró que el mono estaba colgado, sujeto por su cola, con sus patas traseras flexionadas sobre la parte superior de una oquedad en el tronco principal de un árbol. La mano izquierda se apoyaba a un lado del orificio, mientras insertó el brazo derecho hasta la altura del hombro en la cavidad y con el puño de la mano entrecerrado extrajo el agua. Para poder beber el agua el mono acercó la mano a su boca para lamerla y chuparla. No toda el agua fue bebida, una parte cayó al piso o escurrió por su antebrazo. Al mismo tiempo que introduce el brazo en el orificio, el mono gira la cabeza hacia la izquierda para que por efecto del movimiento de su hombro el brazo entre completamente en el hueco. En total contamos 21 ocasiones en que el mono metió el brazo al tronco para sacar el líquido y llevarlo a su boca. Mientras este mono tomaba agua los otros dos individuos se mantuvieron a aproximadamente 15 metros de distancia, e intercambiaron vocalizaciones entre ellos en varias ocasiones. Cuando el mono

que estábamos grabando dejó de tomar agua, nos observó y se alejó con los otros dos individuos.

Observación 2

El 10 de julio de 2012 se observó a un grupo de monos de más de cinco individuos desplazándose. Una hembra adulta se rezagó y escaló hasta la parte más alta de un árbol de aproximadamente 30 m de altura. Se sentó en la parte más alta del árbol, girando a su izquierda y derecha tres veces, monitoreando los alrededores. Inmediatamente descendió aproximadamente 3 metros, se detuvo y enredo la cola en el tronco principal. A causa del follaje no fue posible observar con claridad todo su cuerpo, ni el orificio en el árbol, pero inferimos que estaba sacando agua de una cavidad, debido a la postura y a los movimientos repetitivos en los que su brazo derecho se flexionaba y se extendía al mismo tiempo que llevaba la mano a su boca por más de 12 ocasiones. Después la hembra monitorea nuevamente los alrededores y se aleja.

Observación 3

El 14 de julio de 2012 observamos una hembra adulta que se encontraba colgada de la cola con ambas piernas separadas en un ángulo aproximado de 180°, con el pie derecho apoyado en el mismo árbol de donde colgaba y, el pie izquierdo apoyado en el tronco de un árbol contiguo. Su cuerpo colgaba boca abajo entre los dos árboles, pero no libremente, ya que el apoyo de los pies en cada árbol impedía que el cuerpo del mono girara o se balanceara. Desde esta posición la hembra metía la mitad de su brazo dentro de un orificio, llevaba su mano con el puño entrecerrado a la boca y la chupaba. Este movimiento lo hizo nueve veces. Después, la hembra cambió de posición de manera que su cuerpo seguía suspendido de la cola y sus piernas bajaron para apoyarse juntas únicamente sobre el tronco del árbol de donde colgaba, monitoreó los alrededores y se alejó.

Observación 4

El 14 de julio de 2012 instantes después de observar a la hembra del evento arriba mencionado (observación 3), una hembra juvenil llegó al mismo sitio en donde estaba el orificio con agua. Esta hembra se sostuvo de la cola desde una rama superior y sus pies se apoyaban en el tronco del mismo árbol. Aunque sólo pudimos observar la mitad derecha de su cuerpo, dada la postura parecía que estaba bebiendo agua; después se alejó y unos minutos después regresó y, asumiendo la misma postura, insertó nueve veces su brazo en el orificio, llevando el puño de la mano entrecerrado a la boca bebiendo y lamiendo el agua. Mientras lo hacía monitoreaba intermitentemente los alrededores. La hembra se alejó del sitio cuando escuchó una vocalización a lo lejos y el ruido provocado por el movimiento de las ramas al acercarse otro grupo de monos. La hembra juvenil se movió hacia la parte más alta de la copa del mismo árbol donde había tomando agua y permaneció ahí por algunos minutos. Después regresó al lugar donde estaba el orificio y, adoptando la misma posición, volvió a insertar su brazo y a coleccionar agua con su mano cinco veces. Debido a la

posición de la hembra no fue posible observar directamente su boca para confirmar que bebía el agua, pero dada la postura y los movimientos es muy probable que esta conducta se haya presentado.

Discusión

Aunque no existe suficiente literatura sobre la conducta para beber agua en poblaciones libres de *Ateles geoffroyi*, el comportamiento de obtener agua acumulada en cavidades en los troncos de los árboles indica que ellos requieren más agua de la que obtienen de las frutas y hojas. Por la forma en que vigilan antes, después y mientras toman agua, podemos interpretar que los monos se sienten vulnerables a la depredación o a la vista de los depredadores terrestres, pues las oquedades de los troncos generalmente se encuentran más cerca del suelo del bosque, dónde los monos son más visibles. Los monos tienen que tomar agua rápidamente y al parecer lo hacen mientras se desplazan en grupo, aunque se apartan para llevar a cabo este comportamiento. Sin embargo, siempre hay otros individuos en los alrededores. Todo esto puede indicar que a pesar de que la toma de agua pueda representar un riesgo importante de depredación los monos obtienen un beneficio fisiológico inmediato. Otro aspecto importante para discutir es la posibilidad de que los monos sepan en dónde localizar las cavidades con agua, pues en nuestras grabaciones pareciera que los monos llegan directamente a los huecos en donde beben agua, sin una aparente búsqueda previa. Cabe preguntarse ¿cómo saben los monos donde están estas cavidades con agua?. Una respuesta posible es que este conocimiento puede ser una mezcla de un aprendizaje individual y social, es decir, cuando un mono encuentra un árbol que presenta este tipo de cavidades con agua, es posible que otros monos lo observen y usen el mismo recurso (como ocurrió en nuestras observaciones de julio de 2012). También es posible que las crías aprendan de sus madres en donde encontrar hoyos con agua disponibles a lo largo del año. La respuesta a esta pregunta requiere del análisis de un mayor número de observaciones.

Tres de nuestras observaciones se hicieron en julio, a principios de la temporada de lluvias y una en diciembre durante la transición de la temporada de lluvias a la temporada seca, por lo tanto podemos pensar que los monos visitan más los huecos con agua al inicio de la temporada de lluvias, después de un periodo largo de escasez que representa la temporada seca. Sin embargo, dado el número limitado de observaciones, no podemos asegurar que este sea el caso. Por otro lado, en diciembre aunque algunas cavidades todavía parecen conservar agua, los monos tienen que hacer más esfuerzo para sacarla, por ejemplo, tienen que meter el brazo hasta el hombro para alcanzar el agua en el fondo del orificio, cómo se menciona en la observación número uno, a diferencia de las observaciones realizadas en julio, durante las cuales los monos sólo necesitaban introducir parcialmente el brazo para alcanzar el agua. A causa de las temperaturas más altas en verano los monos pueden estar

más sedientos, y es probable que por esta causa observamos más monos tomar agua en verano que en diciembre.

Conclusiones

El agua es un nutrimento básico para los monos araña; en temporada seca los animales tienen que hacer mayor esfuerzo para conseguir agua y en temporada de lluvias el recurso es abundante y otorga beneficios obvios. Beber agua de las cavidades en los troncos de los árboles parece también implicar riesgos, por lo que los animales exhiben un comportamiento de monitoreo antes, durante y después de la extracción de agua. La temporada seca en Calakmul es bastante marcada y esto puede influir sobre la frecuencia con que los monos locales beban agua; es muy probable que en poblaciones de *Ateles* donde la selva es más húmeda y los niveles de lluvia sean mayores los monos exhiban este comportamiento en menor proporción. Para poder determinar las diferencias de la toma de agua entre distintas poblaciones con diferentes condiciones ecológicas, es necesario realizar estudios comparativos que nos permitan saber si los monos araña beben agua de las cavidades de los troncos, aunque haya suficiente agua contenida en las frutas y las hojas de los sistemas dónde el agua es abundante o, si este comportamiento es más típico de poblaciones que habitan en lugares en donde la temporada seca es muy marcada.

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OBITUARY

ADELMAR F. COIMBRA-FILHO

REMEMBRANCES OF ADELMAR F. COIMBRA-FILHO

I first heard about Ademar F. Coimbra-Filho back in early 1971, when I was visiting Barbara Harrison, the first-ever Chair of the IUCN/SSC Primate Specialist Group, at her office in Cornell University. Throughout my undergraduate years at Dartmouth college, I developed a major interest in primates and spent most of my senior year at Dartmouth working on a thorough revision of what was known of New World monkeys at that time, as well as a three-month field study of howler monkeys in Panama. This led me to think that I should focus my graduate work on this large and diverse primate fauna during my graduate studies at Harvard University, which were scheduled to begin in September, 1971. To move this forward, I planned to visit nine South American countries in the summer of 1971, after graduation from Dartmouth, to look into potential primate research sites. I had never been to South America before, so I wanted to benefit from Barbara's knowledge and find out about possible primatological contacts in that continent. I was not disappointed.

Barbara gave me two papers published in Portuguese in 1970 in the *Revista Brasileira de Biologia* by a guy named Ademar F. Coimbra-Filho. She knew nothing about him and I couldn't read Portuguese at that time, but I used my Spanish to struggle through a translation of the papers. The results were fascinating. Coimbra had rediscovered two lion tamarin species, the black or golden-rumped lion tamarin (*Leontopithecus chrysopygus*) and the golden-headed lion-tamarin (*Leontopithecus chrysomelas*) that hadn't been seen since the first decade of the 20th century. I was hooked on lion tamarins for the rest of my life.

Shortly thereafter, I wrote Coimbra a letter and received a very rapid response, a copy of which is attached here – the first contact we ever had. Based on this first letter and his recommendations on Amazonian species, I decided to focus heavily on Brazil as part of my continent-wide exploration in the summer of 1971 after graduating from Dartmouth College.

After several weeks in the Brazilian Amazon, and a very long series of bus rides from Belém to Brasília to Rio, I arrived in Rio in July, 1971. I got in touch with Coimbra and visited him at his address on Rua Artur Araripe 60, where his family still lives to the present day. I was a 21-year-old kid, who showed up at his place in shorts and sandals – a nobody from another country arriving at the doorstep of this scientist who was already famous in his own country.

To my delight, Coimbra and his wife Jacqueline, and his son Sérgio and daughter Simone, welcomed me with open arms, fed me some hearty meals, and took me in. That was the start of a friendship that lasted for 45 years.

Among other things, Coimbra took me to see one of the species he had rediscovered, a golden-headed lion tamarin being held at the Rio de Janeiro Zoo. At that time, this was truly a mystery animal, and this individual was, in 1971, the only member of its species in captivity. Coimbra let me into the cage to take photos, but the lion tamarin would have nothing of it and promptly attacked me, leading to a rapid retreat.

Coimbra also put me in touch with another of Brazil's great conservation pioneers, Dr. Paulo Nogueira Neto of São Paulo. Paulo took me on a trip to the interior of São Paulo to the Morro do Diabo State Park, where Coimbra had rediscovered the black lion tamarin the previous year. On that trip, I saw the widespread and very recent destruction of the once lush forests of São Paulo's interior, leaving images in my mind that are still with me today and reinforcing my commitment to conservation. Indeed, even back then, Morro do Diabo was already an island in a vast sea of deforested land.

Based on this early interaction, Coimbra and I worked together on several publications in English highlighting the importance of the lion tamarins. Two papers had appeared in the U.S. the previous year about the declining situation of the golden lion tamarin, one by Clyde Hill, Curator of Mammals at the San Diego Zoo, in the zoo journal *Zooneos*, and the other by John Perry, Assistant Director of the National Zoo in Washington, D.C., in the journal *Oryx*. Both attracted a lot of attention in the conservation community in the U.S. at that time, but nothing was available in English on the ecology of these animals in Brazil. The papers I was able to publish together with Coimbra added a great deal to international awareness of the species.

This growing interest in the lion tamarin in 1970 and 1971 led to the convening of a conference entitled "Saving the Lion Marmoset" in February, 1972, at the National Zoo in Washington, D.C. This was a joint effort of the National Zoo, the Bronx Zoo in New York (now the Wildlife Conservation Society), and the Wild Animal Propagation Trust in Wheeling, West Virginia. Among those invited were Bill Conway from the Bronx Zoo, John Perry, John Eisenberg and Devra Kleiman from the National Zoo, and Coimbra-Filho and his close colleague Alceo Magnanini, then Director of the tiny National Parks section of the Brazilian Forestry Development Institute (IBDF). I also came along to provide my perspectives from my trip to Brazil eight months earlier and to serve as a translator for Coimbra and Magnanini, having picked up Portuguese during my trip.

Small though it was, this was a landmark and historic conference that really set the stage for all future lion tamarin

conservation efforts. At this event, Devra Kleiman took responsibility for the captive population outside Brazil and turned it into a huge success, Coimbra took on the task of creating captive populations in Brazil, and Coimbra and Magnanini highlighted the need to create protected areas for the golden lion tamarin and the golden-headed lion tamarin. The sites chosen were the Poço das Antas region in the county of Silva Jardim in the state of Rio de Janeiro for the golden lion tamarin and the Una region in southern Bahia for the golden-headed lion tamarin, where Coimbra had rediscovered the species two years earlier. Biological Reserves were eventually created in both regions: the Poço das Antas Biological Reserve in 1974, and Una Biological Reserve in 1980. The black lion tamarin, fortunately, already had a protected area in the Morro do Diabo State Reserve in São Paulo, where Coimbra had rediscovered that species. The international community represented at the conference took on responsibility for helping to fund-raise for the creation of these reserves and to facilitate captive breeding both within Brazil and internationally.

During this trip, in the winter of 1972, I had the great pleasure of seeing both Coimbra and Magnanini experience their first snowfall. I will never forget watching the two of them make snowballs and roll around in the snow like little kids, savoring something that just didn't exist in their part of the world.

In 1973, I was again with Coimbra and Magnanini in Washington, D.C. at the start of what was then called the Washington Convention. Both of them were on the Brazilian delegation that helped to create what is now one of the most important wildlife treaties in the world, the Convention on International Trade in Endangered Species (CITES). Coimbra was there for the start of that as well.

After finishing my first two years of graduate courses at Harvard, I returned to Brazil in 1973 and 1974 for a period of 18 months. This included a four-month survey of Amazonian primates, notably the uakaris and the white-nosed saki, and much further collaboration with Coimbra. By then Coimbra had succeeded in convincing the government of the state of Rio de Janeiro to let him create a Biological Bank of Lion Tamarins at the edge of Tijuca National Park in Rio, a captive facility for all three species, including the first-ever black lion tamarins to be kept in captivity. I based myself at the Banco Biológico, as it was called, and Coimbra and I collaborated on a number of new papers and also wrote Red Data sheets on both Amazonian and Atlantic forest species for the IUCN Red Data Book, a much simpler and more straightforward process back then than it is today.

Over the course of the next few years, although I decided to do my doctoral research in Suriname rather than Brazil, I saw Coimbra again a number of times. We were together twice in 1975, first at the follow-up to the 1972 meeting at the National Zoo, another meeting entitled "The Biology

and Conservation of the Callitrichidae,” again hosted by the zoo at its facility in Front Royal, Virginia. Once again, both Coimbra and Magnanini were there representing their country and providing expertise on both the lion tamarins and other callitrichid species. Later that year, we met again in Rio, this time at a meeting on the international trade in primates for biomedical research, this one convened by the National Institutes of Health of the U.S.A.

In 1977, Coimbra and I again joined forces, this time in Germany, where we presented papers together at the conference entitled “The Marmoset Workshop,” held at the German Primate Center in Goettingen, Germany.

Coimbra always felt constrained by the relatively limited space available in Tijuca and the instability of the site, and planned the creation of a much larger facility outside the city limits of Rio. He started a six-year process that eventually bore fruit on November 9, 1979, when he opened the Rio de Janeiro Primate Center in Magé, about 60 km from Rio and right at the foot of a beautiful forest area in the mountainous region of the state. I had the great honor of being there when this historic facility was opened, and it remains a critically important colony for endangered Brazilian primates to the present day.

In early 1977, I was asked by the Species Survival Commission (SSC) of IUCN to Chair the Primate Specialist Group. I immediately began work on reorganizing this group, and invited Coimbra to become one of the charter members. Later that year, key members of the group worked with me to write the first-ever “Global Strategy for Primate Conservation,” the precursor of today’s action plans. Once again, Coimbra was a key collaborator, giving us many of the ideas and project concepts for that document, which later led to the creation of the World Wildlife Fund-US Primate Program and its Primate Action Fund.

Work on this document made it clear that Brazil was the richest country on Earth for primates and that both Amazonia and the Atlantic Forest were the highest priority ecosystems. Dr. Tom Lovejoy, then at World Wildlife Fund – US, asked me to prepare a proposal for extensive primate survey work in Brazil, with a strong focus on Amazonia. However, after discussion with Coimbra, we decided that the Atlantic forest was a higher priority in conservation terms given that it had already lost more than 90% of its original natural vegetation and held the majority of Brazil’s endangered primates. As a result, he and I, and later Prof. Célio Valle of the Federal University of Minas Gerais in Belo Horizonte, submitted a proposal to World Wildlife Fund – US for a multi-year program entitled “Conservation of Eastern Brazilian Primates.” It was funded and led to a decade of survey work in the protected areas of the Atlantic Forest, providing us with many new insights and helping to train many of Brazil’s current leaders in primatology and in biodiversity conservation in general.

This program made it possible for us to carry out many expeditions to parks and reserves in the Atlantic forest to see which primates occurred in them. The first was to the Poço das Antas Biological Reserve, where I saw my first wild golden lion tamarin and got the first-ever photograph of this species in nature. The second was to the now famous Fazenda Montes Claros (currently Feliciano Miguel Abdala Private Natural Heritage Reserve) in Caratinga, where Coimbra and I met up with Célio Valle to look at this important stronghold for the northern murreti. This led to a film that we produced with Harvard undergraduate Andy Young in 1981 and to the start of a 36-year continuous project on this species by Dr. Karen Strier, whose work there began in 1982. And another highlight was our trip to southern Bahia, where we met up with Dr. Anthony Rylands, who was carrying out the first-ever study of the golden-headed lion tamarin.

In 1983, Devra Kleiman of the National Zoo, following a decade of work on the global captive population of the lion tamarins, collaborated with Coimbra to start a comprehensive conservation program for the species, that included a long-term field study of the golden lion tamarin in the Poço das Antas reserve run by James Dietz, an environmental education program run by his wife Lou Ann Dietz, and a major reintroduction program, run by Benjamin Beck, also of the National Zoo, in close collaboration with Coimbra’s Rio de Janeiro Primate Center, that brought captive animals back to Brazil to be reintroduced into their natural habitats.

The return of the lion tamarins to Brazil clearly showed the Brazilian authorities that global collaboration with the international conservation community was essential—and that it worked—and this led to the creation of the International Committee for the Golden Lion Tamarin. This committee became a model for Brazil, leading to the establishment of a number of other committees that still function to the present day, as well as serving as a model for international collaboration in conservation.

None of these many positive developments would have been possible without Ademar Coimbra-Filho’s immense expertise, his leadership and his willingness to collaborate to achieve shared global conservation objectives.

Among the many publications on which Coimbra and I collaborated were the two volumes entitled *Ecology and Behavior of Neotropical Primates*. The idea for these two books started in the mid-1970s when we discussed with the Brazilian National Academy of Sciences the need to have a publication summarizing all we knew of the behavior and ecology of these animals. Then President of the Academy, Professor Aristides Pacheco-Leão, recognized this need and agreed to sponsor the book. As it turned out, the project took us much longer than expected, but the first volume did finally come out in 1981, followed by a second volume

in 1988. These books remain an important reference to the present day.

Another was our collaborative effort on tree-gouging and gum-eating among the marmosets of the Atlantic Forest, something that Coimbra had discovered during his expeditions to northeastern Brazil. This led to a paper on this topic that was published in the journal *Nature* in 1976. Over the many years since these in-depth collaborations of the 1970s and 1980s, Coimbra and I kept in close contact and I would visit him as often as possible. Throughout it all, even though I saw him less in recent years, I always valued him as one of my closest and most loyal friends, someone I could always count on. He and Jacqueline would always welcome me into their home, and later as my family grew, my children came to know and appreciate him as well. He was always a critical thinker and we would sometimes have long arguments about conservation issues. But, although I didn't always agree at first, I often found him to be correct on so many different topics. As I look back now, I see that many of the things that he taught me helped me through the course of my life, and more and more I have come to value his wisdom.

I last saw Adelmair in November, 2015, when we launched a beautiful book recounting the story of Coimbra and the Rio de Janeiro Primate Center (CPRJ). This book, produced by the state's Instituto Estadual do Meio Ambiente, was made possible through the efforts of Denise Rambaldi, another of the younger generation of leaders in Brazilian primatology and founder of the Golden Lion Tamarin Association (AMLD), along with a friend and skillful editor, Tania Machado. I was so pleased that they finished this book in time for Coimbra himself to see it. The event, held at the Palácio Guanabara and attended by the State Governor Luiz Fernando Pezão, brought together numerous colleagues and friends including many of the still surviving pioneers of Brazilian conservation, including Alceo Magnanini and Dionísio Pessamílio, director of the Poço das Antas Biological Reserve in the 1980s, and Coimbra's long-time friend, veterinarian, colleague, and successor as director of the CPRJ, Alcides Pissinatti, along with Coimbra's entire family. We had a wonderful time together, and I think that Coimbra was able to see how much he was loved and how much his contribution meant to Brazil and to the world.

I last talked to Coimbra by phone on his 92nd birthday. He was in good spirits and very happy that I had called. The lion tamarins, the primates of Brazil, and the world have lost a great ecohero, and I have lost a wonderful life-long friend. But I know that he will always be with us in spirit, and that he and all that he accomplished will never be forgotten.

Russell A. Mittermeier, Executive Vice-Chair, Conservation International; and Chair, IUCN/SSC Primate Specialist Group



Meeting at Fundação Getúlio Vargas in Rio de Janeiro, Brazil, 1982.



Coimbra and baby *Callithrix jacchus*



Adelmair F. Coimbra Filho on the left, Russell Mittermeier in the center and, Admiral Ibsen de Gusmão Câmara on the right.

Adelmar Coimbra-Filho was an accomplished, largely self-taught, all round naturalist and pioneer of field primatology and the conservation movement in Brazil. He first saw a captive, pet golden lion tamarin, in 1940, and in 1942, enchanted, he saw them for the first time in the wild, and so began his lifelong passion for the species and for the primates and fauna of Brazil. Intrepid, he studied golden lion tamarins through the 1940s and 1950s, gathering information on the then entirely unknown lion tamarins and marmosets. Early on and through the 1970s, he was the single reference, the source of all our information, on the behavior and habits of the Brazilian callitrichids. In 1968, Coimbra and his colleague Alceo Magnanini published an analysis, species by species, of the status of Brazil's threatened mammals, and detailed the causes of their decline and the conservation measures needed. This formed the basis for Brazil's first threatened species' list for mammals, and was eventually published in 1972.

His research and his dedication to saving the lion tamarins and conserving the remnants of Atlantic Forest following centuries of depredation and destruction gave rise to his numerous, diverse, visionary and grandiose achievements: the first to breed lion tamarins in captivity; seeding and guiding the Golden Lion Tamarin Conservation Program, a pioneer and exemplary program for endangered species; rediscovering the Black lion tamarin; creating Brazil's first federal Biological Reserve, Poço das Antas for the golden lion tamarin and the Una Biological Reserve for the golden-headed lion tamarin, now the core of an extensive and invaluable network of protected areas conserving the precious remaining forests of southern Bahia; the creation of the world-acclaimed Centro de Primatologia do Rio de Janeiro; the species' reintroduction program for the Tijuca National Park, notably for the Channel-billed Toucan (*Ramphastos virtellinus*); his innumerable publications and contributions to our understanding of the flora and fauna of the Atlantic Forest; and, permeating all this, his lifelong, involvement, obstinacy, and relentless determination in promoting and advancing the conservation of Brazil's biodiversity, its genetic patrimony, its fauna, flora and ecosystems, along with his colleagues and friends, Alcides Pissinatti, Alceo Magnanini, Wanderbilt Duarte de Barros, Maria Tereza Jorge Pádua, Paulo Nogueira-Neto, Célio Valle, Russell Mittermeier and, most especially, Admiral Ibsen de Gusmão Câmara.

Coimbra was the only, and unnervingly revered, Brazilian primatologist when I arrived in Brazil in 1976, knowing less than little, to work in the Instituto Nacional de Pesquisas da Amazônia in Manaus. The 1988 Congress of the International Primatological Society (IPS) held in Brasília, was organized by Milton Thiago de Mello. It was the first to be held in South America, and the international primatological community was surprised and so impressed with the wealth, depth, and diversity of primate research and conservation initiatives in the country. Coimbra co-authored no less than eight papers presented at that congress and was

the instigator and inspiration for numerous others. Coimbra was given a special homage at the 1992 IPS Congress in Strasbourg. The Society's Lifetime Achievement Award was created only in 2004, but if it had existed in 1992, Coimbra would undoubtedly have been the recipient.

One of the great privileges of my life is to have known him, to have learnt from him, to have been inspired by him, and worked with him on numerous endeavors, projects, and publications. He was above all an extraordinarily good and faithful friend. Helping Devra Kleiman to edit her book *Lion Tamarins: Biology and Conservation* (2002), we wrote: "We dedicate this book to Adelmar F. Coimbra-Filho, a truly remarkable man, who has always challenged us to do our best and to keep questioning, who has never swayed from his beliefs, and who has inspired so many to seek careers in primatology and conservation biology."

Anthony B. Rylands, Deputy Chair IUCN SSC Primate Specialist Group, Senior Research Scientist, Conservation International, Arlington VA, USA.

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Professor Adelmar Faria Coimbra-Filho foi sem dúvida um dos maiores naturalistas brasileiros no século XX. Tive a honra de fazer parte de uma geração de primatólogos que existe graças a esse fantástico pesquisador. Nasceu na cidade de Fortaleza no ano de 1924, e morreu no Rio de Janeiro em 2016. Teve, portanto, uma vida longa e muito profícua.

Com curso de técnico agrícola pela Universidade de Viçosa, seguiu o bacharelado em História Natural (hoje Biologia) e mestrado em Zoologia pela Universidade Federal do Rio de Janeiro. Coimbra-Filho foi casado com Jacqueline Nevier Coimbra, com quem teve dois filhos: Simone e Sergio. Ainda muito jovem assumiu a função de primeiro administrador do Parque Florestal da Gávea (hoje, Parque da Cidade) no Rio de Janeiro, onde ficou de 1947 a 1957. Saiu da chefia do Parque por defender com galhardia o patrimônio público que estava ameaçado de pilhagem por políticos inescrupulosos. Por retaliação a esse ato de probidade administrativa

acabou sendo transferido para o Jardim Zoológico do Rio de Janeiro, então sob a direção do grande naturalista Henrique Lahmeyer de Mello Barreto. Coimbra, em uma de nossas conversas sobre essa fase de sua vida, me contou como Dr. Mello Barreto nessa ocasião lhe dava grande liberdade para fazer o que achasse importante para o Zoológico. Foi assim que Coimbra-Filho começou a caminhar pelas aleias do Zoo e se interessar profissionalmente pelos micos-leões-dourados que faziam parte do cativeiro, mas que já conheceria na natureza de sua juventude, quando caçava no interior do Estado do Rio de Janeiro. Foi nessa fase de sua vida que ele decidiu estudar primatas, o que certamente mudou seu rumo como pesquisador e, consequentemente, como ser humano. Mudou também a vida de muita gente tocada pelo seu conhecimento e suas descobertas.

Segue-se uma longa e profícua carreira de pesquisador e gestor no serviço público do Rio de Janeiro, sempre com ênfase em primatas e conservação da natureza. Os micos-leões se tornam seu tema principal de pesquisa. Realiza diversos trabalhos de campo com esses primatas e publica os primeiros trabalhos sobre a autoecologia e conservação do gênero *Leontopithecus*. Entre esses estudos do início de sua carreira estão alguns clássicos da literatura primatológica, como a situação do mico-leão no Brasil, os micos-leões escuros e a redescoberta de *Leontideus chrysopygus* (atualmente *Leontopithecus chrysopygus*).

Graças a esses trabalhos e outros da mesma época, Coimbra-Filho chamou a atenção de alguns primatólogos internacionais, entre os quais a de um jovem norte-americano recém-graduado e em busca de tema para seu doutorado. Foi assim que em julho de 1971 conheceu o Dr. Russell Mittermeier, que se tornou seu grande amigo de toda a vida e coautor em inúmeras publicações. Logo em seguida, em 1972, Coimbra participa de uma conferência histórica para a primatologia: Salvando os Micos-Leões. A partir daí, galga os passos da esfera internacional, publicando uma quantidade de trabalhos intelectuais e práticos de grande relevância para a primatologia no Brasil e no mundo.

Coimbra-Filho fez parte da primeira geração dos pesquisadores brasileiros envolvidos com a conservação da biodiversidade nos tempos modernos. Entre seus colegas e amigos na época estão Paulo Nogueira Neto, Maria Tereza Jorge Padua, Almirante Ibsen de Gusmão Câmara, José Candido de Melo Carvalho, Célio Valle e Ângelo Machado, entre muitos outros. Aliás, foi numa reunião de alguns desses pesquisadores que tive a honra de conhecer Coimbra-Filho mais de perto (já tendo o assistido falar em congressos e outras reuniões afins, me inspirando grande admiração). Foi na casa de Arnaldo Ferreira Leal em Laranjeiras que entabulamos as primeiras conversas que culminaram com nossa aproximação profissional, me abrindo as portas para fazer parte da excelente equipe de pesquisadores que à época trabalhava sob sua batuta. Foi assim que me aproximei de Alcides Pissinatti e Roberto da Rocha e Silva e que me tornei amigo de seus amigos como Russ Mittermeier,

Devra Kleiman, Anthony Rylands, Jeremy Mallinson e outros, importantes até hoje em minha vida. Foi assim também que travei contato com diversos jovens brasileiros que, como eu, sonhavam em proteger a fauna brasileira. Coimbra me influenciou a mudar minha vida radicalmente, pois acabei largando a vida de administrador de empresas para me dedicar profissionalmente à conservação dos micos-leões-pretos e à biodiversidade como um todo.

Coimbra, nessa época e nos anos que se seguiram, esteve totalmente envolvido na consolidação de sua maior obra: o Centro de Primatologia do Rio de Janeiro (CPRJ). Esse Centro foi fruto de sua grande visão e conhecimento, e de uma série de centros e institutos que criou ou dirigiu todos dedicados à conservação dos primatas do Brasil. Sob sua batuta o CPRJ se tornou uma referência internacional em conservação de primatas. Foi sempre bem gerenciado e após sua aposentadoria em 1994, passou às mãos de Pissinatti e outros associados dedicados também à proteção dos primatas do Brasil.

Coimbra-Filho foi mentor e professor de uma geração de primatólogos nacionais e internacionais. Sua cultura geral era invejável, assim como sua capacidade de formular ideias e hipóteses, o que deixava aqueles que com ele conviviam boquiabertos. Quantas e quantas vezes eu disse a mim mesmo, “agora o Coimbra errou em sua predição de algo”, para depois ter que reconhecer que ele estava correto, mesmo que anos depois.

Membro fundador das Sociedades Brasileiras de Botânica, de Zoologia e de Primatologia, pertencia também a diversas outros grupos científicos e conservacionistas. Recebeu inúmeros prêmios e honrarias no Brasil e no exterior, pelo empenho com que se dedicava à pesquisa e à salvaguarda do patrimônio natural de nosso país. Com carreira acadêmica sólida, publicou mais de 200 trabalhos científicos. A importância de suas conquistas foi reconhecida por colegas, que o homenagearam dando seu nome a espécies de macaco (*Callicebus coimbrai*), de percevejo (*Taedia coimbrai*), de bromélia (*Neoregelia coimbraii*) e de um fóssil de macaco (*Cartelles coimbrasilhoi*).

Coimbra-Filho foi, acima de tudo, pessoa íntegra de bons princípios com sólido conhecimento interdisciplinar e coragem invulgar. Homem de sonhos grandes queperseguiu com vitalidade a qualidade em tudo o que fez na vida. Nunca desistiu daquilo que almejava. Um pesquisador que traz orgulho ao Brasil e ao mundo e que deixa saudades no mundo da primatologia.

Claudio Valladares Padua, Reitor Escola Superior de Conservação Ambiental e Sustentabilidade, and Vice-President Instituto de Pesquisas Ecológicas

Adelmar Faria Coimbra Filho, para nós uma notável perda como pai, amigo e homem de ciência. Desde a sua juventude esteve diretamente em contato com a natureza.

Algumas dentre as muitas ações em favor da conservação, como a solta de aves no Parque Nacional da Tijuca, RJ, o esforço para a criação de Reservas Biológicas de Poço D'Antas, RJ e UNA na Bahia, a organização do Projeto Mico Leão Dourado, o Centro de Primatologia do Rio de Janeiro, RJ, etc, foram um legado inestimável para o meio científico e ambiental no Brasil.

Apesar disso, espera-se que em futuro próximo haja melhor entendimento sobre a real importância e significado que suas realizações representam.

Uma pessoa cujo saber foi negligenciado pelo Estado, infelizmente.

Alcides Pissinatti, Centro de Primatologia do Rio de Janeiro Instituto Estadual do Ambiente

O COIMBRA PODE ESTAR CERTO!

Poderia, ao homenagear o Coimbra, falar sobre suas realizações, sua contribuição para a primatologia e para a conservação da biodiversidade no Brasil, notadamente o programa de conservação do mico-leão-dourado, que se tornou referência para conservação de outras espécies no mundo inteiro e que envolveu a criação de uma das mais importantes unidades de conservação do país, a Reserva Biológica de Poço das Antas. Contudo, gostaria de homenagear o Coimbra tratando de uma das suas mais fortes características: o pioneirismo.

Pioneiro é aquele que abre novos caminhos, que desbrava, que descobre, que traz algo novo e, principalmente, que se antecipa. Escolho falar do seu pioneirismo porque o Coimbra expressou opiniões e defendeu teses que ainda não tivemos a capacidade de digerir-las adequadamente e que por isto consideramos muitas delas heterodoxas, se não hereges. Entre as tantas opiniões do Coimbra, sobretudo para a conservação da biodiversidade no Brasil, o seu entendimento sobre a caça, por exemplo, vai de encontro ao que se pensa e se pratica hoje em termos de conservação. Verdadeira heresia. Mas será?

Importante esclarecer que o Coimbra jamais defendeu a caça em benefício de quem a pratica. Ao contrário, externava a sua perplexidade diante da estúpida eliminação das espécies pela caça indiscriminada. Chamava a atenção tanto para as espécies de interesse cinegético (venatório, como gostava de expressar em seu português correto), como para o absurdo do abate de espécies predadoras, perseguidas por competirem pela caça, especialmente quando rara. O lobo-guará (*Chrysocyon brachyurus*) é um exemplo desta estupidez.

Tinha visão clara de que a fauna tropical embora rica em espécies é normalmente pobre em indivíduos e que, por

isto, o impacto da caça sobre as comunidades bióticas é altamente significativo, ainda mais quando agravante de outros efeitos fortemente deletérios, como a redução do habitat ou a sua perda de qualidade. Nesta linha, recriminava veemente as práticas agrícolas de controle de pragas, que de forma indistinta combatia ou afetava indiretamente espécies animais que naturalmente poderiam exercer esse controle.

Fundamentado em premissas objetivas defendia uma governança inteligente e eficaz sobre a caça, apontando para uma política cinegética criteriosa como forma de enfrentar e equilibrar a pressão. Falava no estabelecimento de espaços destinados a este fim, a partir de áreas restauradas e do repovoamento de espécies cinegéticas. Ideias que não encontram qualquer abrigo na doutrina vigente que serve de base para o nosso sistema de conservação, tanto no campo técnico quanto no jurídico.

O que haveria de mais próximo a estas ideias seria a Reserva de Fauna prevista no Artigo 19 da Lei 9.985, de 18 de julho de 2000 (SNUC), que até hoje, diga-se de passagem, é carente de um representante no Sistema Nacional de Unidades de Conservação. Mesmo a Reserva de Fauna está a anos-luz do que apontava o Coimbra, pois ainda que destinada a estudos para o manejo econômico sustentável dos recursos faunísticos, proíbe enfaticamente o exercício da caça a qualquer pretexto. Assim é a nossa doutrina de conservação. Mas será que depois de experimentarmos tantos caminhos em defesa das espécies da fauna no Brasil, não acabaremos por trilhar os caminhos que o Coimbra assinalava? Será que se tivermos a coragem de experimentarmos algumas de suas ideias heréticas não encontraremos ali uma solução para questões que ainda não conseguimos resolver?

Sinceramente, não sei. Mas rendo a minha mais sincera homenagem ao Coimbra ao alimentar a desconfiança de que ele, ao final de contas, pode estar certo.

Marcelo Marcelino de Oliveira, Diretor de Pesquisa, Avaliação e Monitoramento da Biodiversidade, Instituto, Chico Mendes de Conservação da Biodiversidade

Com gratidão ao querido e respeitado Prof. Ademar Faria Coimbra-Filho.

Nos deixou em junho de 2016, aos 92 anos, o Professor Ademar Faria Coimbra-Filho. Caçador, criador e amante de galos de briga, de cachorros de caça e de eucaliptos. Pode soar estranho começar assim o obituário deste que foi um dos maiores conservacionistas brasileiros. Sim, estamos falando do mesmo Prof. Coimbra. Cearense, criado em Pernambuco e radicado no Rio de Janeiro há meio século, era um apaixonado pela biodiversidade em todas as suas formas. Biólogo e primatólogo, teve participação decisiva na criação da primeira Reserva Biológica brasileira, Poço

das Antas em Silva Jardim, RJ. E essa foi apenas a primeira Unidade de Conservação de uma série de outras criadas com a sua valiosa contribuição.

De personalidade forte, decisão firme e caráter inquestionável, esse biólogo com perfil de naturalista e que acabou se transformando em zoólogo, tinha a sensibilidade e a curiosidade necessárias para se encantar com a flora e a fauna brasileiras e do mundo todo. Conhecedor dos biomas brasileiros, especialmente a Mata Atlântica, das paisagens e da ecologia das plantas e dos animais e das interações entre eles, ele descreveu processos complexos e identificou aspectos críticos para a conservação *in situ* e *ex situ* de inúmeras espécies de primatas ameaçados, o mais ilustre deles, o mico-leão-dourado (*Leontopithecus rosalia*).

Coimbra tinha uma exemplar combinação de conhecimentos teóricos e conhecimentos adquiridos pela observação, aos quais dava preferência. Ele identificou novas espécies de vários grupos de plantas e animais, e propôs teorias próprias sobre biogeografia, especialmente a continuidade entre a flora da Amazônia e da Mata Atlântica. Dizia que jovens pesquisadores se descuidavam das observações históricas de naturalistas, e por isso não entendiam, porque nunca tinham observado, que muitas espécies arbóreas, especialmente de madeira de lei, ocorriam tanto no leste amazônico como na Mata Atlântica.

Ao longo de toda uma vida dedicada aos estudos, ao manejo e à conservação da biodiversidade, Prof. Coimbra fez carreira em duas importantes instituições brasileiras de proteção ambiental, os antigos IBDF e a FEEMA, em suas versões contemporâneas, o Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio e o Instituto Estadual do Ambiente – INEA. Sempre foi um profissional exigente, rigoroso e intolerante com a corrupção em quaisquer de suas formas, o clássico caso do vaso chinês de propriedade pública que quase foi subtraído pela esposa de uma autoridade pública, e que lhe custou o cargo, demonstrando isso. Era um crítico contumaz da mediocridade especialmente a vernacular, e tinha a liberdade e o respeito conquistados ao ponto de poder dizer o que quisesse. E assim o fazia sem delongas e com uma lucidez espantosa. Em suas aulas, palestras, discursos ou mesmo intervenções ele sempre deixava perguntas, questionamentos e ideias para futuros debates.

Com muita coragem, perspicácia e pioneirismo, ele contribuiu para o avanço da ciência primatológica e para a formação de centenas de jovens primatólogos brasileiros e estrangeiros. É possível que não exista um primatólogo brasileiro da atualidade que não tenha se inspirado em algum trabalho ou ideia dele. Todos, de uma forma ou de outra, foram influenciados e fazem referência ao pensamento e à vasta obra coimbriana. A síntese de seu legado, ao lado dos mais de duzentos artigos e livros publicados, é o Centro de Primatologia do Rio de Janeiro (ele energeticamente corrigia quem dissesse “Centro de Primatas”). Idealizado por

Coimbra e criado pela FEEMA na década de 70, o CPRJ/INEA é totalmente dedicado à pesquisa, ao resgate e à conservação de primatas neotropicais ameaçados de extinção. É uma referência global na primatologia cuja contribuição foi e tem sido decisiva para salvar diversas espécies, dentre elas o mico-leão-dourado que foi resgatado do limiar da extinção e transformado em símbolo da conservação da Mata Atlântica reconhecido internacionalmente.

Pessoalmente nos sentimos privilegiados pela oportunidade do convívio e do aprendizado. Muito obrigado Professor Coimbra.

Denise M. Rambaldi
Carlos R. Ruiz Miranda

RECENT PUBLICATIONS

BOOKS

An Introduction to Primate Conservation, edited by Wich Serge A, Marshall Andrew J. 2016. Oxford University Press. 302 pp. ISBN: 978-0198703396. This book provides a comprehensive and state-of-the-art synthesis of research principles and applied management practices for primate conservation. Potential solutions in the form of management practice are examined in detail. *Contents:* 1) An introduction to primate conservation – Wich SA, Marshall AJ.; 2) Why conserve primates? – Marshall AJ., Wich SA; 3) IUCN Red List of Threatened Primate Species – Cotton A, Clark F, Boubli JP, Schwitzer C; 4) Species concepts and conservation – Groves C; 5) Primate conservation genetics at the dawn of conservation genomics – Salgado M, Sechi P, Chikhi L, Goossens B; 6) Primate abundance and distribution: background concepts and methods – Campbell G, Head J, Junker J, Nekaris KAI; 7) Habitat change: loss fragmentation and degradation – Irwin M; 8) Present day international primate trade in historical context – Njiman V, Healy A; 9) Hunting and primate conservation – Fa JE, Tagg N; 10) Infectious disease and primate conservation – Nunn C, Gillespie TR; 11) Primates and climate change: a review of current knowledge – Korstjens AH, Hillyer A; 12) Are protected areas conserving primate habitat in Indonesia? – Gaveau DLA, Wich SA, Marshall AJ; 13) The role of multifunctional landscapes in primate conservation – Meijaard E; 14) People – primate interactions: implications for primate conservation – Humle T, Hill C; 15) The role of translocation in primate conservation – Beck BB; 16) Payment for ecosystem services: the role of REDD + in primate conservation – Garcia-Ulloa J, Koh LP; 17) The role of evidence-based conservation in improving primate conservation – Tranquilli S; 18) Some future direction for primate conservation – Marshall AJ, Wich SA.

Ethnoprimatology: Primate Conservation in the 21st Century, edited by Waller Michel T. 2016. Springer. 422 pp. ISBN: 978-3319304670. The list of challenges facing nonhuman primates in the 21st century is addressed in this book by leading researchers in the field of ethnoprimatology, the study of human/nonhuman primate interactions that combines traditional primatological methodologies with cultural anthropology in an effort to better understand the nuances of our economic, ritualistic, and ecologic relationships. *Contents*: 1) Ethnoprimatology and conservation: applying insights and developing practice – Fuentes A, Cortez AD, Peterson JV; 2) The threat of industrial oil palm expansion to primates and their habitats – Linder JM, Palkovitz RE; 3) Monkeys on the menu? Reconciling patterns of primate hunting and consumption in a Central African village – Robinson CJ, Daspit LL, Remis MJ; 4) Conservation medicine: a solution-based approach for saving nonhuman primates – Deem SL; 5) How do primates survive among humans? Mechanisms employed by Vervet monkeys at Lake Nabugabo, Uganda – Chapman CA, Twinonugisha D, Teichroeb JA, Valenta K, Segupta R, Sarkar D, Rothman JM; 6) Indigenous peoples, primates, and conservation evidence: a case study focusing on the Waorani of the Maxus Road – Papworth S; 7) The role of nonhuman primates in religious and folk medicine believes – Alves RRN, Souto WMS, Barboza RRD; 8) Problematic primate behavior in agricultural landscapes: chimpanzees as ‘pets’ and ‘predators’ – Hockings KJ, McLennan MR; 9) Competition between chimpanzees and humans: the effects of harvesting non-timber forest products – Waller MT, Pruetz J; 10) The effects of war on bonobos and other nonhuman primates in the Democratic Republic of the Congo – Waller MT, White FJ; 11) Primate taxonomy and conservation – Zinner D, Roos C; 12) Government and community based primate conservation initiatives in Peru – Shanee N; 13) Managing human-orangutan relationships in rehabilitation – Russon AE, Smith JJ, Adams L; 14) The little fireface project: community conservation of Asia’s slow lorises via ecology, education and empowerment – Nekaris KAI; 15) The many facets of human disturbances at the Tonkolili chimpanzee site – Halloran AR; 16) How living near humans affects Singapore’s urban macaques – Riley CM, Du Vall-Lash AS, Jayasri SL, Koenig BL, Klegarth AR, Gumert MD; 17) Risk-taking in Samago monkeys in relation to humans at two sites in South Africa – Nowak K, Hill RA, Wimberger K, le Roux A; 18) Predicting future effects of multiple drivers of extinction risk in Peru’s endemic primate fauna – Shanee S; 19) Protecting nonhuman primates a case study of Neotropical monkeys, corridor ecology, and coastal economy in the Caribe Sur of Costa Rica – Lindshied SM; 20) Primates and people in the zoo: implications of human-animal interactions and relationships – Loudon JE, Sponheimer M.

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ABSTRACTS
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- Dosen, J., Schumaker, N., Raboy, N. B. 2016. Examining the effects of connectivity and corridor quality on the

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- Mallott, E. K., Garber, P. A., Malhi, R. S. 2016. Vertebrate predation in white-faced capuchin monkeys (*Cebus capucinus*).
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y los límites para someter ponencias o simposios aún no están establecidas. Para mayores informes visitar <http://www.slaprim.org/congresos/>

XVIII CONGRESO BRASILEIRO DE PRIMATOLOGIA

A Sociedade Brasileira de Primatologia tem a honra de anunciar e convidá-los a participar do nosso próximo encontro: XVII Congresso Brasileiro de Primatologia. O evento, que traz como tema A Primatologia no Brasil no Século XXI, será realizado entre 20 e 24 de agosto de 2017, na cidade de Pirenópolis, Goiás. As atividades científicas previstas são palestras, minicursos, mesas-redondas e apresentações de trabalhos orais e por meio de pôsteres. Para mais informações visita <http://sbprimatologia.org.br/o-evento/>

7TH EUROPEAN FEDERATION FOR PRIMATOLOGY MEETING AND 30TH FRENCH SOCIETY OF PRIMATOLOGY CONGRESS

The 7th European Federation for Primatology Meeting and the 30th French Society of Primatology Congress will be held in the University of Strasbourg, France from Tuesday 22 to Friday 25 August 2017. More information will be available soon.

I CONGRESO DE LA ASOCIACIÓN PERUANA DE PRIMATOLOGÍA

El primer Congreso de la Asociación Peruana de Primatología tendrá lugar del 20 – 23 de Septiembre, 2017, en la ciudad de Piura, Perú. Las fechas del evento y los límites para someter ponencias o simposios aún no están establecidas. Para mayores informes visitar <http://www.monosperu.org/>

MEETINGS

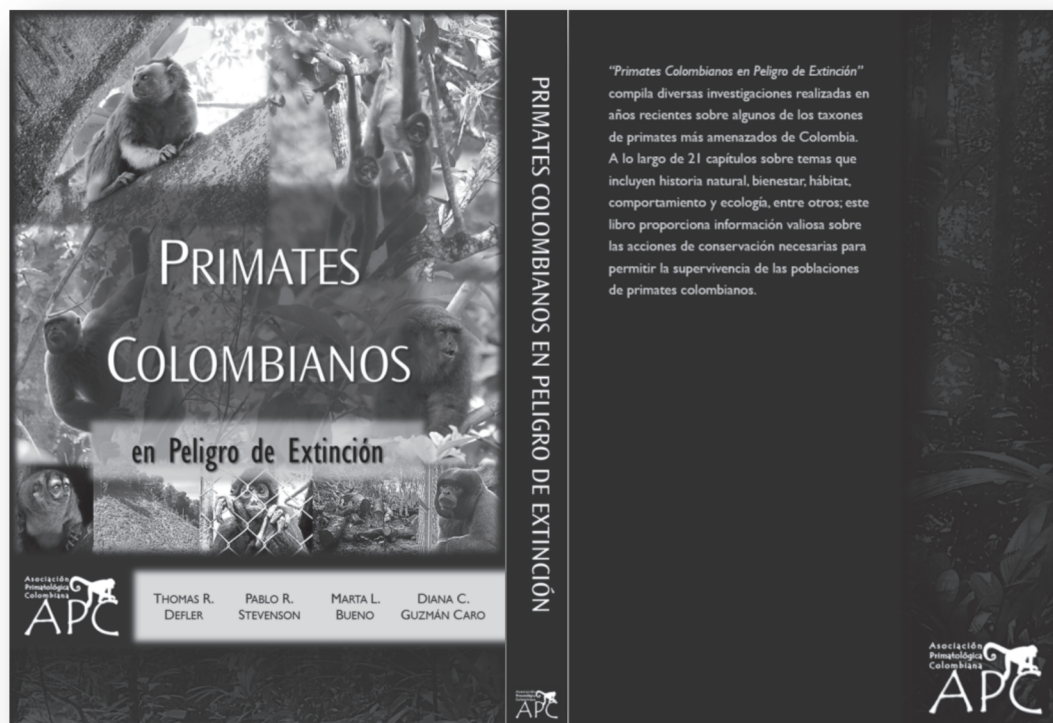
40TH MEETING OF THE AMERICAN SOCIETY OF PRIMATOLOGISTS

The 40th meeting of the ASP will be held in Washington, D.C. from August 25-28, 2017. Registration opens January 6, 2017. Deadline for Poster and Oral papers in March 1, 2017. For more information go to <https://www.asp.org/meetings/conference.cfm>

III CONGRESO DE LA SOCIEDAD LATINOAMERICANA DE PRIMATOLOGÍA

El III Congreso de la SLAPRIM se realizará en 2017 en la ciudad de Xalapa, Veracruz México. Las fechas del evento

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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.

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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).

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"Unpublished report" changes to "Relatório Técnico" and "Reporte no publicado" for articles in Portuguese and Spanish respectively.

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