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Front cover: *Callimico* clinging to vertical support at Camp Callimico, Department of Pando, Bolivia. Photo by Edilio Nacimento Becerra.

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ARTICLES

DEVELOPMENTAL STAGES IN THE HOWLER MONKEY, SUBSPECIES *ALOUATTA PALLIATA MEXICANA*: A NEW CLASSIFICATION USING AGE-SEX CATEGORIES

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Abstract

We present a new classification of age-sex categories for the mantled howler monkey *Alouatta palliata*. This classification includes only those physical and behavioral characteristics that can be distinguished under field conditions, with the goal of being able to infer the approximate age of monkeys in the wild. Our classification is based on data collected *ad libitum* during monthly censuses of 8 groups of *A. p. mexicana* in a fragmented landscape on the "Los Tuxtlas" Biosphere Reserve at the northern limit of this species' distribution. Our new classification system contains 10 categories that can be compared directly to existing classification schemes to facilitate cross-site studies. We compare the results of our study to the currently used classification system which was based on more southern populations of *A. palliata* in Panamá and Costa Rica.

Key Words: Age-sex categories, *A. palliata*

Resumen

Presentamos una nueva clasificación de categorías de edad-sexo para los monos aulladores *Alouatta palliata*. Esta clasificación incluye solamente aquellas características físicas y comportamentales que pueden ser distinguidas en condiciones de campo, con el propósito de poder inferir la edad aproximada de los monos en estado silvestre. Nuestra clasificación está basada en datos colectados *ad libitum* durante censos mensuales de 8 grupos de *A. p. mexicana* en un paisaje fragmentado el la Reserva de la Biósfera "Los Tuxtlas" en el límite norte de distribución de esta especie. Nuestro nuevo sistema de clasificación contiene 10 categorías que pueden ser comparadas directamente con esquemas de clasificación existentes para facilitar lo estudios de diferentes sitios. Comparamos los resultados de nuestro estudio con el sistema de clasificación actualmente utilizado el cual se basaba en poblaciones de *A. palliata* más sureñas en Panamá y Costa Rica.

Palabras Clave: Categorías sexo-edad, *A. palliata*

Introduction

The study of ontogeny is essential to evolutionary anthropology and primatology since it allows for the comparison of developmental and growth strategies among species. Within a given species, establishing life stages allows one to understand the degree of variability in the development and maturation patterns found in different populations (Neville *et al.*, 1988). Furthermore, for a wide range of primatological studies it is crucial to be able to determine the main developmental stages of the individuals of a species and estimate their age based on their characteristics. For this purpose, the sequence of dental eruption and the length of the long bones are considered to provide the most accurate information (baboons: Phillips-Conroy and Jolly, 1988; howlers: DeGusta and Milton 1998; De Gusta *et al.*, 2003; vervet monkeys: Bolter and Zihlman, 2003; chimpanzees: Zihlman *et al.*, 2004). However, for the analysis of hard tissue it is necessary to examine the individual directly and in the majority of field studies this may not be feasible, may be costly, or may even be harmful to the primates. As such, standardized classifications for each species are useful as they allow the ages of the individuals and their developmental stage to be estimated based only on morphological and behavioral characteristics that are observable from a certain distance.

In demographic and ethological studies these classifications can be used to describe the group composition, age at sexual maturity or migration, morphological and behavioral changes associated with these processes or to examine the influence of ecological constraints on the different developmental stages in a primate population (Bolter and Zihlman, 2003). On the other hand, depending on the physical and behavioral criteria that are applied, the assessment of these stages can vary within a species or even within a population (Bramblett, 1980). Additionally, genetic variation within and between populations has been frequently identified as a cause of differences in the development of individuals (Arendt, 1997). The habitat niche can also modify the growth and development pattern of different populations of the same species (Bolter and Zihlman, 2003). Geographic variation as well as altitudinal and latitudinal, temperature and precipitation gradients, often create genetic clines in growth and development rates (Arendt, 1997). In contrast, when and how to grow, mature and reproduce depend on the state of the organism, including its physiological condition and the associated ecological costs (Gotthard, 2001), which in turn depend on the environment, the risks of predation and resource availability.

For the mantled howler monkey *(Alouatta palliata)* there are few published classifications that define developmental stages by age based on observable characteristics. The most used systems differentiate between immature individuals and adults, or between a few different stages of development (Table 1) and are based on data for the southern populations of howlers from Barro Colorado Island (BCI), Panamá (Carpenter, 1934, 1965) and from Costa Rica (Glander, 1980; Clarke, 1990). These classifications have been used extensively to classify wild howler monkeys by their age throughout their wide distribution. Mantled howlers are found from southern Mexico through Central America and part of Colombia and Ecuador. Despite being one of the most studied New World primate genera, *Alouatta* species' systematic relationships remain unclear (Cortés-Ortiz *et al.*, 2003), and subsequently, it is unknown whether this genetic differentiation has any influence on the development of individuals or the relation between age and external changes. Here we present a new system of classification in age-sex categories for the mantled howler monkey in its most northern distribution, in the region of Los Tuxtlas, Mexico. We compare and discuss our results with the current classification systems from Panamá and Costa Rica.

Methods

Study site

This study was carried out in a fragmented landscape of disturbed tropical rainforest, located in southern Veracruz, Mexico. The area is within the buffer zone of the Los Tuxtlas Biosphere Reserve (18°34', 18°37'N and 95°02', 95°08'W; elevation in the study area: 25–400 m a.s.l.). The climate is warm and humid (Soto and Gama, 1997) with a mean annual temperature of 25° C and annual precipitation of 4710 mm (EBT, Los Tuxtlas Biology Station, 1996–2005). The dry season occurs from January or February to May and the rainy season is from June to December or January (EBT, 1996–2005), with strong winds from the north from November to February (Soto and Gama, 1997). Currently, there are no large predators, such as jaguar or harpy eagle, in the zone, although there have been reports of attempted attacks by tayra on a troop of howlers (Asensio and Gómez-Marín, 2002).

Data collection

Eight groups of howler monkeys were monitored over a total of 23 non-consecutive months in daily sessions of 6 to 8 hours starting at sunrise. Each group was visited several times each month to ensure reliable observations. Data

Table 1. Classification of *A. palliata* by age-sex category.

Class	Carpenter,1934[a]	Carpenter,1965[b]	Glander,1980[c]	Clarke,1990[d]
Infant 1	< 1 mo	0–5/6 mo	≤ 2 days	0–3 mo
Infant 2	6 mo	5/6–10/12 mo	2–21 days	3–6 mo
Infant 3	12 mo	10/12–18/20 mo	21–90 days	6–12 mo
Juvenile 1	18 mo	20–30 mo	3–6 mo	12–20 mo
Juvenile 2	21 mo	30–40 mo	6–30 mo	20–36 mo
Juvenile 3	36 mo	40–50 mo	-	-
Subadult female	-	-	30–48 mo	-
Subadult male	-	-	30–48 mo	-
Adult female	-	>50 mo	>48 mo (first birth approx. 43 mo)	>34–36 mo sexually mature
Adult male	-	>50 mo	>48 mo	>36–40 mo sexually mature
Characteristics taken into account	Estimated weight, hair color, relation to mother, play	Estimated weight, hair color, relation to mother, play	Weight, genitalia, hair, transport	Travel, relation to mother and non-mother, play
Methods	Observations in the wild (approx. 8 months) and in captivity (n = 3). Collections (n = 4).	Modified data from 1934.	Discontinuous observations of one group from 1970–78. Capture (weight, measures, palpation).	Observations of 6 females and 5 males over 22 months, focused on socialization patterns between sexes.

[a, b] Subspecies *A. palliata aequatorialis*. Data from Barro Colorado Island (BCI), Panama (9°8 N, 79°49 W), tropical rain forest.

[c, d] Subspecies *A. palliata palliata*. Data from La Pacífica, Costa Rica (10°28 N, 85°07 W), dry tropical deciduous forest.

were collected from October 2003 to November 2005 by two teams, each with a researcher and a field assistant, who made every effort to apply homogeneous criteria, as described below. At the beginning of the study there were a total of 20 immature in the eight groups and over the observation period there were 20 births that could be assigned to a specific month. All the animals observed were individually recognized by their natural markings typical of the subspecies. Their identification cards were kept up-to-date throughout the study, and complemented with drawings, photographs and videos. To follow individual development, during each session the observation date and the particular characteristics of the individual at that moment were recorded on each card *ad libitum*. Most of the morphological and behavioral characteristics used in previously established classification systems were included. *Morphology:* color and length of fur, relative body structure and size, appearance of the genitals, head shape. *Behavior:* relationship with the mother, presence/absence of sexual behavior, type of locomotion, feeding and play. The characteristics are listed in Table 2 of the Results section.

Estimating the age corresponding to different developmental stages in howlers

Once the field work had been completed, "time lines" were drawn for each individual that was born during the study and therefore of known age. We call the representation of the age in months of each monkey its "time line", and used these together with morphological and behavioral changes that occurred as the study progressed to describe each stage. Using the characteristics recorded, a life stage was assigned to each individual for each observation, applying each of the existing classification systems presented in Table 1. This made it possible to compare the degree of agreement between these classification systems with respect to the assigned stage and in comparison with the animal's real age. Owing to discrepancies detected, the classifications were modified and a new one was created that homogenized the criteria and fit the data of our study. Then, this new system was used to estimate the age of the 20 immature that were present in the first census of the study. Using our pilot classification system, the life stage was assigned to each individual for each observation based solely on the animal's characteristics. In one column the age range estimated using this classification was noted, and in another column the age range estimated at the first observation of the individual according to its characteristics was noted, and to this age we added the elapsed months for the subsequent observations. Finally, agreement between the columns was compared to test whether the classification and the estimated ages fit. Applying this method systematically, we were able to estimate the age ranges for the life stages leading up to maturity.

Results

Using the time lines, we present the development of the 40 immature studied (Fig. 1). The category corresponding

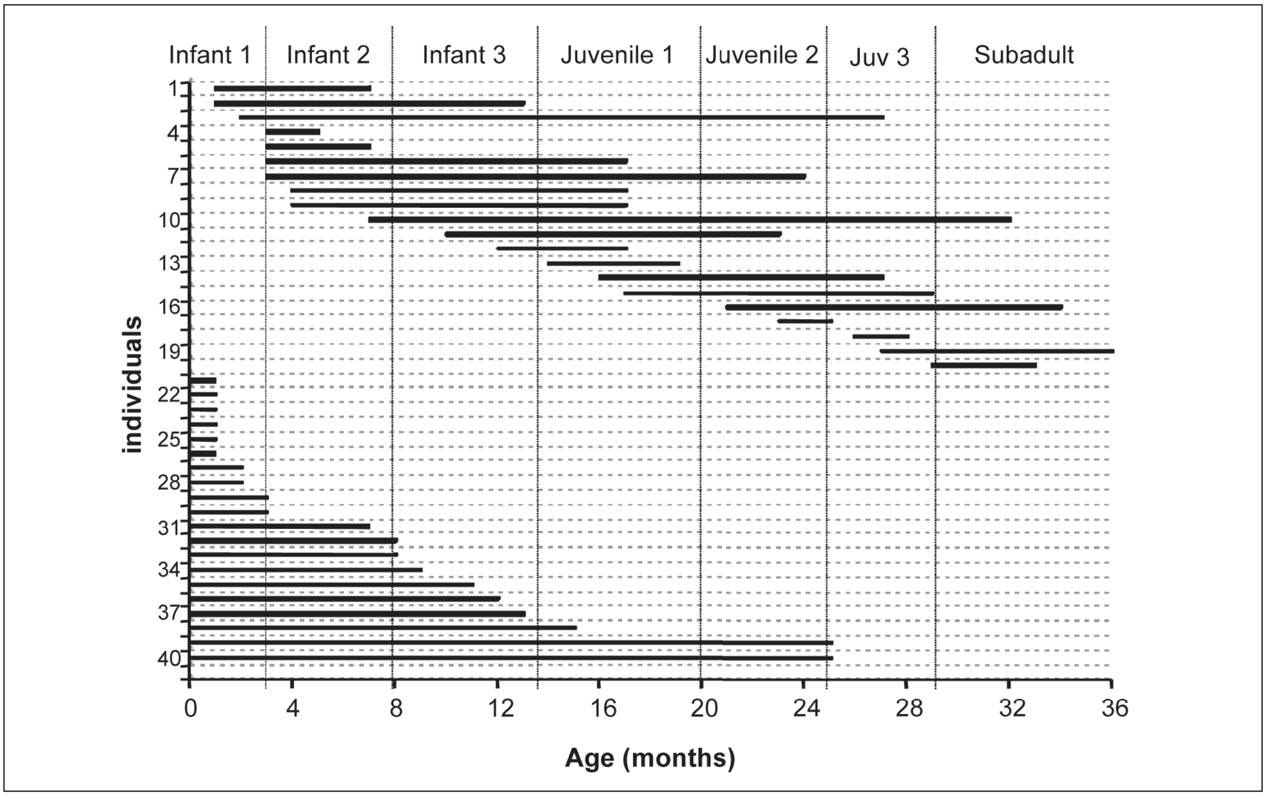

Figure 1. Time lines for the 40 immature individuals studied (see text). The category corresponding to the age in months is shown for each individual, applying the classification scheme proposed in this study. Time lines starting at zero (individuals 21–40) correspond to the 20 individuals that were born during the observation period. Lines 1–20 represent immature already present at the beginning of the study.

Table 2. Age-sex classification of the Los Tuxtlas howler monkeys (*Alouatta palliata mexicana*).

Class	Infant 1	Infant 2	Infant 3
Age (months)	0–2/3	3/4–7/8	8/9–13/14
Morphology	Very short silvery gray coat, changing to yellowish to light brown. Extremities and head proportionally more developed than the body.	Short gray-brown to dark brown fur. No mantle. Body proportional to extremities.	Short brown fur, no mantle or beard.
Locomotion and relation with mother	Carried ventrally by the mother during locomotion, sometimes dorsally. During rest, may try to explore surroundings very close to its mother without letting go of her.	Carried dorsally by the mother or sporadically ventrally during locomotion (especially during rest or during short movements by the mother when she gets up while the baby is feeding or during suspensory locomotion.) Rests with the mother and starts to explore nearby surroundings alone, but stays close to the mother.	Carried dorsally by the mother during long or difficult locomotion and also alone, following the mother, becoming more independent about own locomotion which is quick and abrupt. When on the mother's back, the baby on the base of her tail and tends to wrap its tail around hers. Rests with the mother.
Feeding	Only suckles.	Suckles and towards the end of this stage begins to try solid food (at approx. 6–8 months).	Suckles, but eats increasingly more solid food as it grows.
Other behaviors	Other females and juveniles show interest in these infants. Sporadically allomaternal behavior can be observed, with the baby being carried by other individuals.	Begins to play with other infants and juveniles, always in close proximity to its mother.	Plays much of the time and is generally tolerated by adult males.

Table 2. ***cont'd.*** Age-sex classification of the Los Tuxtlas howler monkeys (*Alouatta palliata mexicana*).

Class	Juvenile 1	Juvenile 2	Juvenile 3
Age (months)	14/15–19/20	20/21–24/25	25/26–28/29 *
Morphology	Coat similar to that of the adult in color, but shorter, particularly on the head and sides of the body. Light colored fur on the sides, but without long fringes. No beard and no fur on the sides of the face, giving the head the shape of a small triangle. Body lengthening.	Fur similar to that of the adult in color, but slightly shorter, particularly on the head and sides of the body. Mantle developing; fur light colored and longer on the sides. Larger in size than Juvenile 1 and the body is longer, and its shape more defined.	Fur similar to that of a young female adult in length and color. Slightly smaller than subadult and adult females and easily confused with same in the field. Sex organs not clearly visible.
Locomotion and relation with mother	Generally rests in contact with or near the mother. Independent, quick, agile locomotion; often follows the mother when the troop moves as a unit.	Independent adult locomotion. At the beginning of this stage juveniles may stay near a female (the mother), but do not generally rest in contact with her. At the end of this stage it is difficult to know who the juvenile's mother is.	Independent adult locomotion. It is impossible to know who the juvenile's mother is.
Feeding	Still suckles when the mother is resting, but eats mainly solids when the group is foraging.	No longer suckles, only forages.	Adult feeding habits.
Other behaviors	Plays a lot with other immatures. Generally very well tolerated by adult males and can play with them. Stage at which the emigrations begin **.	Emigration stage**. Often elusive solitaries. If this juvenile remains in the group, it is very independent. Still actively plays with other individuals of its cohort and with infants.	Final emigrations **. Often elusive solitaries. Is totally independent if it stays in the group. Still actively plays with other individuals of its cohort and with infants.

* The age limit probably depends on the sex of the individual.
** See text for more details.
*** As estimated by other authors (see Table 1), no precise data from this study.

Table 2. ***cont'd.*** Age-sex classification of the Los Tuxtlas howler monkeys (*Alouatta palliata mexicana*).

Class	Subadult female	Subadult male 3	Adult female	Adult male
Age (months)	28/29–35	31/32 to 48 months, approx. ***	>36/40	>48
Morphology	Adult coat, with a long light colored mantle. Juvenile in appearance. Hair around face a little shorter than that of adult females and, in general, the face is smoother and rounder than that of adults. Slightly smaller in size than a fully adult female, confusable with a stage 3 juvenile, but the vulva is clearly visible, although small and closed.	Adult coat, with mantle. Secondary sex characteristics developing: beard, lengthening and slight partitioning of head, testicles begin to descend and the scrotum changes from black to white with many black spots. 31/32 months (scrotum not pendulous and genital area black, but with the definite profile of a male).	Dark brown coat, hair longer around the face with a long light colored mantle. Full size. More robust than previous stages.	Dark brown coat, hair longer around the face with a long light colored mantle. Full size. Secondary sex characteristics fully developed. Scrotum fully pendulous and white, sometimes still has the remains of some black spots.
Locomotion	Independent.	Independent.	Independent.	Independent.
Feeding	Adult feeding habits.	Adult feeding habits.	Adult feeding habits.	Adult feeding habits.
Other behaviors	Usually elusive solitaries. If they stay in the group they play actively and appear to have a low hierarchical rank. They do not copulate. Nulliparous.	Often elusive and solitary. Begins to howl at the end of this stage when the testicles have descended.	First estrus and copulation at approximately 35 months old, and first birth at 41 months ** (considering: approximately 6 months for gestation).	Alone or with the group. Howling. Actively copulates when he has access to females. Threatening behavior such as standing on his hind legs and arches body. Occasionally fights with other males.

* The age limit probably depends on the sex of the individual.
** See text for more details.
*** As estimated by other authors (see Table 1), no precise data from this study.

to the age in months is shown for each individual throughout the study, from the first observation to end of the last observation at the end of the study or when the animal disappeared, either because it died or emigrated. To simplify interpretation, adult categories are not included in the figure and the time lines are drawn as continuous, even though all individuals were not observed during all the months (*e.g.* sample gaps or emigration-immigration events, see Balcells, 2008 for further details on the groups and individuals history). The complete classification by age-sex categories fit to our Los Tuxtlas population is summarized in Table 2 where the distinguishing characteristics for each stage and the estimated age range are listed. The classification we propose is constructed based on those listed in Table 1. There are 10 categories; more than those proposed by other authors, but they can easily be grouped together when required because of the data or the study. We suggest that the maximum number of categories be used to obtain a more accurate estimate of age based on characteristics that are easy to record in the field over a reasonable amount of observation time. On the other hand, any classification of a continuous temporal process is arbitrary and because of this, under field conditions we frequently find individuals that are difficult to assign to one or another of two adjacent categories; these i-ii transition stages (*e.g.* Infant 2–3) can be read in Table 2 as n/n+1.

Some important behavioral events in the lives of primates are of interest when comparing individual's age with external appearance. Howlers usually leave their natal group before reaching maturity (Glander, 1992). Accordingly, there is notable migratory activity in our study population at the group level (Balcells, 2008), and the individuals in the juvenile and subadult categories are often solitary and secretive. In Los Tuxtlas natal emigration generally occurs when the sex of the individual is not externally detectable under field conditions (see also Clarke *et al.*, 2007, for evidence of juvenile monomorphism in *A. palliata*). As such any difference in migration age and behavior between the sexes is not easily distinguishable without later long term follow-up. During our study, we were able to observe only two individuals and determine their sex after they had emigrated. Individual 10 (Fig. 1) returned to his group and was identified as a Subadult male (according to our classification system), having abandoned the group at 27–29 months of age. Individual 15 emigrated at 20–22 months old and later was identified as a small solitary Subadult female behaving evasively. Our data suggest that emigration can occur in any of the three juvenile stages (25% Juvenile 1, 37.5% Juvenile 2 and 37.5% Juvenile 3, *n*=8 observed disappearances of immatures in age of non-dependency from mother) and 3 to 4 of the migrations coincided with the birth of a sibling.

In addition to migration, weaning and first reproduction are also key periods in the lives of howlers. During our study, we were only able to infer the age of one female (individual 19, Fig.1) when she first gave birth, at between 39 and 42 months of age; as calculated for a gestation period of 6 months (Cortés-Ortiz *et al.*, 1993; Glander, 1980), and that first estrus and copulations occur at around 35 months. For males, the beginning of reproductive activity probably depends on social aspects that give them access to the females, but during our study we were not able to observe this process. With respect to feeding, complete weaning in Los Tuxtlas was observed at the end of the Juvenile 1 stage, at 18–20 months of age. It is common to observe a Juvenile 1 (from 15 to 19 months old) still suckling opportunistically when the mother is resting, although during this stage it appears that individuals are no longer dependent on their mother for food, because they can survive as solitaries and some individuals leave the natal group before reaching 15 months of age.

Discussion

Comparison of classification systems

The classification systems analyzed here for age-sex categories of *Alouatta palliata* coincide with each other to differing degrees. On the one hand, Carpenter's (1965) classes have wide age ranges and very advanced ages for the accompanying physical and behavioral characteristics when compared with other systems, including the one we propose for Los Tuxtlas and an earlier one by the same author from 1934. The age assigned for individuals with similar characteristics can differ by as much as 15 months, in spite of being classified as the same morphological stage (*e.g.* Juvenile 1 is 3–6 months old according to Glander, 1980 and 20–30 months according to Carpenter, 1965). Glander (1980) also proposes a wide range of ages for Juvenile 2 (6–30 months), that would include Carpenter's (1934) Juvenile 1 and 2 stages (in both characteristics and age), and from the end of Infant 3 to Juvenile 3 for the system we propose for Los Tuxtlas. In general, our classification system is similar, with certain differences, to the systems of Carpenter (1934) and Clarke (1990). Carpenter (1934) classifies as Juvenile 3 those individuals with characteristics similar to those of the Subadult stage in the Los Tuxtlas classification system. Clarke's (1990) classification proposes age ranges that are very similar to those of our system, although she assigns an age of 20 to 36 months to Juvenile 2, and includes individuals that we would classify as Juvenile 3 and Subadult in this stage. However, for some studies it might be interesting to differentiate between individuals that begin to exhibit sexual traits and the juveniles that do not yet show any external evidence of their sexual identity given that these stages are associated with physiological and social changes. Additionally, differentiating between these stages allows a closer fit to the estimated range of ages for the individuals in the pre-maturation stages that are critical to group dynamics (Glander, 1992).

As regards key events during the development of howler monkeys, there is greater consensus. From our data, sexual maturity in females occurs at approximately 36 months and the first birth occurs at 43 months. This agrees with reports by Glander (1980) and Clarke (1990). According to Clarke (1990) weaning occurs during Juvenile 1 (18 months) in females, while males become independent earlier, both in locomotion and feeding. Carpenter (1934) agrees with this, and although in 1965 he said weaning occurs during Juvenile 1, a much older age is assigned (20–30 months). Glander (1980) does not specify any age for weaning. In Los Tuxtlas, complete weaning was observed at the end of Juvenile 1, at 18–20 months old when individuals can emigrate and survive without suckling, and this coincides with the findings of Carpenter (1934) and Clarke (1990). Finally, the emigration age in males is 12–20 months according to Clarke (1990), while females emigrate at 22–24 months. Our data suggest that the birth of a sibling is an important factor for triggering emigration, and emigration tends to occur before the sex of the individual can be identified and so any difference associated with the sex of the individual is difficult to discern at the time of emigration. More data are required to determine whether there are differences between the sexes or individuals in emigration age, and to broaden our understanding of the factors that might produce any differences observed.

Genetics, environment and development

Although growth rates are genetically imprinted, they are phenotypically plastic (Laurila *et al.*, 2001), and a function of the adaptive balance between the costs and benefits associated with development (Gotthard, 2001). In two populations of captive macaques, differences were found in growth rates that could be attributed to their different origins, the different climates of the centers, different social structure or genetic profile (Vancata *et al.*, 2000). Also, in langurs the socio-ecology of the species interacts with its development patterns (Washburn, 1942). In baboons, as a result of improved nutrition, growth rate varies among groups during the same year and for the same group in different years (Strum, 2005). In vervets, reproductive maturity is early compared to that of baboons and is considered an adaptation to unpredictable food sources (Rowell, 1977). On the other hand, the early consumption of solid food in indris could reduce maternal investment (Godfrey *et al.*, 2004). However, in some Platyrrhini (*Aotus, Callicebus, Saimiri, Callimico, Saguinus, Leontopithecus, Cebuella* and *Callithrix*), ecological and social factors, such as predation and competition for food do not appear to adequately explain the differences observed in infant development and growth rates (Garber and Leigh, 1997). In howlers, the lack of consistency in the age classifications within each geographic area prevents us from asserting that environmental differences significantly affect the development strategies of the populations. Although the forage available to the different populations studied might offer differing nutritional value owing to differences in habitat and vegetation (Table 1), this factor probably does not have a significant influence on development (at least for field observations). Howler monkeys can restrict their energetic expenditure behaviorally (Milton, 1980) and, owing to their highly folivore and generalized diet, are capable of using different resources, even in disturbed habitats (Rodríguez-Luna *et al.*, 2003; Cristobal and Arroyo, 2007). For the same reason, the effects of intra- or interspecific competition in habitats with limited resources are mitigated (Van Schaik, 1989).

On the other hand, howler monkeys are not subject to severe predation pressure in any of the study sites because of their large size and the decrease in the populations of potential predators; hence this factor is also not likely to exert a significant influence at present. Finally, latitude does not appear to have an important effect on the rate of development of *A. palliata*, given that there are no consistent differences between the Mexican and more southern populations, in spite of the fact that latitude might be important in fish and amphibians (Duponchelle and Legendre, 2000). It is, however, worth mentioning that in a study using 7 microsatellites for different populations of *A. palliata* in Mesoamerica, Cortés-Ortiz (2003) found a marked decrease in the genetic variation of the populations from south to north where *A. p. mexicana* (from Mexico) was the least variable population, followed by *A. p. palliata* (from Costa Rica), and the population of *A. p. aequetorialis* (from Panamá) had the greatest variation. Even though populations of *A. p. mexicana* do not appear to be facing any detrimental effects owing to the reduction in the genetic variation, this fact could cause differences between populations and should be considered when making comparisons between different populations (subspecies). The incorporation of molecular data in demographic-behavioral studies of different populations would help to reveal the effect of the loss of genetic variation in the ontogenetic development of howler monkeys.

The consequences of using different criteria
According to Neville *et al.* (1988), the use of different criteria for classifying wild *Alouatta palliata* individuals can interfere with the comparison and interpretation of the results obtained by different authors over a wide variety of studies. In demographic studies, not considering subadults as a separate class could result in an underestimation of the number of juveniles or reproductive adults in the censuses. Similarly, certain individuals would be considered as infants or juveniles depending on the classification system. Therefore, it is necessary to keep in mind which classification system has been applied to evaluate the evolution of populations for censuses that use the number of immatures per reproductive female (Heltne *et al.*, 1976). Even purely behavioral and socio-ecological studies (*e.g.* daily activity pattern, diet, play, socialization) that use distinct age classifications to compare behavior patterns between categories of individuals can lead to contradictory conclusions as a result of the criteria applied. The same problem occurs in studies for which it is necessary to infer the age of the individuals in order to prepare life tables, evaluate relative mortality for each stage and age, infer the birth month of the individuals, time of weaning, reproduction or migration.

Our results indicate the need to unify the criteria for classification by age-sex categories for mantled howler monkeys, and to identify consistent differences between populations with different characteristics. Further long term studies are needed in Los Tuxtlas, Mexico and the other places where this species is found.

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TRUNK-TO-TRUNK LEAPING IN WILD *CALLIMICO GOELDII* IN NORTHERN BOLIVIA

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Abstract

Compared to other species of tamarins and marmosets, callimicos (*Callimico goeldii*) are characterized by hindlimb and hindfoot elongation, and a pattern of locomotion dominated by leaping to and from vertical supports in the forest understory. We present field data on trunk-to-trunk leaping in a habituated group of callimicos in northern Bolivia. We measured the DBH of the takeoff and landing platform, and the distance traveled during 110 trunk-to-trunk leaps. Our results indicate that mean distance leapt by callimicos was 1.8 m (range 0.2–4.3m). There were no significant differences in the size of takeoff (mean = 10.3 cm) and landing platforms (mean = 9.9 cm). In addition, longer leaps did not occur on larger diameter supports than did shorter leaps. Although tree trunks and saplings were the most commonly used takeoff and landing platforms, 31.8% of the time callimicos jumped to and from bamboo culms. These data highlight the facts that trunk-to-trunk leaping represents a highly specialized pattern of locomotion in callimicos, and that these primates travel through mixed forests that include stands of bamboo and canopy trees. Conservation efforts to sustain viable populations of *Callimico goeldii* must focus on protecting and preserving habitats that contain large tracts of mixed bamboo and secondary forest.

Key Words: callitrichines; locomotion; bamboo; habitat.

Resumen

Comparado con otras especies de tamarinos y monos titís, los callimicos (*Callimico goeldii*) se caracterizan por el alargamiento de sus extremidades posteriores y anteriores, y un patrón de locomoción dominado por los saltos a y desde substratos verticales en el sotobosque. Presentamos datos de campo sobre saltos de tronco a tronco en un grupo habituado de callimicos en el norte de Bolivia. Medimos el DBH de las plataformas de despegue y aterrizaje, y la distancia recorrida durante 110 saltos de tronco a tronco. Nuestros resultados indican que la distancia promedio saltada por los callimicos fue 1.8 m (rango 0.2–4.3m). No hubo diferencias significativas en el tamaño de las plataformas de despegue (promedio = 10.3 cm) y aterrizaje (promedio = 9.9 cm). Adicionalmente, los saltos más largos no ocurrieron en soportes de mayor diámetro que para los saltos más cortos. Aunque los troncos de árboles y arbolitos fueron las plataformas de despegue y aterrizaje más comúnmente utilizadas, el 31.8% del tiempo los callimicos saltaron hacia y desde tallos de bambús. Estos datos resaltan que el saltar de tronco a tronco representa un patron de locomoción altamente especializado en callimicos, y que estos primates se desplazan a través de bosques heterogéneos que incluyen parches de bambú y árboles de dosel. Esfuerzos de conservación para sostener poblaciones viables de *Callimico goeldii* deben enfocarse en proteger y preservar hábitats que contengan grandes extensiones de bosque de bambú y bosque secundario.

Palabras Clave: callitrichines; locomoción; bambú; hábitat.

Introduction

Tamarins, lion tamarins, marmosets and callimicos represent a highly successful radiation of 7 genera and 42 species of small bodied New World monkeys (Rylands and Mittermeier 2009). These animals exploit a variety of mature, secondary, riparian, successional, highly seasonal, and dry (caatinga, savanna, and cerrado) forest habitats from Panama and across the Amazon basin extending as far south as northern Bolivia and as far east as the Atlantic Coastal forests of Brazil (Hershkovtiz, 1977; Rylands, 1996). Despite species specific differences in body mass, hand and limb proportions (Bicca-Marques, 1999; Garber and Leigh, 2001; Davis, 2002), and diet (Digby *et al.*, 2007), field studies indicate that all callitrichine species use their claw-like nails to cling to large vertical and sharply inclined supports in the forest understory (Garber, 1992). These vertical trunks provide a stable foraging platform for the exploitation of resources such as bark refuging insects and small vertebrates, plant exudates, and fungi that grow on bamboo culms (Kinzey *et al.*, 1975; Peres, 1986; Garber, 1992; Youlatos 1999; Porter *et al.*, 2009). Trunks also are used by callitrichines as a perch from which to scan the ground in search of arthropod prey (Garber, 1992).

Although all callitrichines use vertical clinging postures during feeding and foraging, most species do not frequently leap between vertical trunks during travel. For example, in *Saguinus geoffroyi*, *Saguinus mystax*, *Saguinus labiatus*, *S. tripartitus*, and *S. fuscicollis* trunk-to-trunk leaping accounts for only 1.5–7.7% of the total positional repertoire during travel (Garber and Leigh, 2001; Garber *et al.*, 2009). In *Cebuella pygmaea*, trunk-to-trunk leaping is more common (12.9% of travel), however, claw climbing, claw clinging, quadrupedal walking/bounding, and leaping on small supports (Youlatos, 1999, 2009) represent its primary modes of travel. In the case of *Callithrix*, detailed quantitative data on positional behavior are lacking, however, travel is generally described as quadrupedal with the majority of leaping restricted to small diameter supports in the tree canopy (Garber *et al.*, 2009).

Callimico goeldii (hereafter referred to as callimicos) is distinct among callitrichines in the degree to which trunk-to-trunk leaping dominates travel. In a field study of positional behavior in callimicos, Garber and Leigh (2001) report that 55.1% of all leaps were between vertical supports in the forest understory. These leaps accounted for 23% of total travel (Garber and Leigh 2001). Similarly, Porter (2004) found that compared to sympatric tamarins, a significantly greater proportion of locomotion in callimicos involved trunk-to-trunk leaping (45% of travel in callimicos vs. 22% for *Saguinus fuscicollis* and 3% for *S. labiatus*). Moreover, relative to other callitrichines, callimicos have elongated hindlimbs that aid in generating large propulsive forces required for leaping from noncompliant supports, and derived features of the ankle that enhance joint stability during takeoff and landing (Garber and Leigh, 2001; Davis, 2002, Garber *et al.*, 2005). Data from a kinematic study of trunk-to-trunk leaping in captive callitrichines indicate that when leaping across a gap of one meter both pygmy marmosets and common marmosets are characterized by a low takeoff velocity and experience significant vertical height loss upon landing (Garber *et al.*, 2009). In contrast, callimicos were found to generate significantly greater velocity at takeoff and to gain or maintain height when leaping these same distances (Garber *et al.*, 2009).

Given that all previous accounts of trunk-to-trunk leaping in wild callimicos are based on visual estimates of the size of takeoff and landing platforms and the distance leaped, we present data using direct measurements of trunk-to-trunk leaping in wild adult callimicos in northern Bolivia. Our goal was to collect detailed observations of leaping in order to better evaluate habitat requirements that are critical for the protection and conservation of this threatened primate in northern Bolivia.

Methods

Study Group and Field Site

During June and July 2005, we collected data on trunk-to-trunk leaping in a habituated group of three callimicos (two adult males and one adult female) inhabiting the forest around Camp Callimico (11°23'S, 69°06"W) in the Department of the Pando, Bolivia (Fig. 1). The forest in this area is representative of sandy-clay forests of the south and southwestern Amazon Basin (Alverson, 2000), and experiences pronounced dry and rainy seasons (Porter, 2001). Rainfall is approximately 2,000 mm per year (Porter, 2001). Over the course of full day follows, we used a metric tape to systematically measure the diameter at breast height (DBH) of the takeoff and landing platforms used by callimicos, and the distance between them, during 110 trunk-to-trunk leaps. Previous studies at this field site indicate that approximately 80% of all callimico behaviors occur within 5 m of the ground (Porter, 2004), and therefore DBH (taken at a height of 1.5 m) is expected to be a representative measure of the actual size of the support used. Takeoff and landing platforms were scored either as tree trunk or woody bamboo. All three adult group members were fully habituated to the presence of observers and each had been the subject of previous behavioral studies (e.g. Porter *et al.*, 2007). Therefore, we are confident that our presence had a negligible effect on the locomotor behavior or distance leaped by the callimicos. However, given their all black coat color and the lack of individually distinguishable markings or hair patterns, we could not consistently identify individuals. Therefore, data for all three adult individuals were pooled for analyses.

In order to examine the distribution of habitat types within the study group's home range, we divided the forest into habitat categories based on canopy height, visibility criteria, and the dominant plant species present. Using this method, we identified five major habitats: primary forest with open understory, primary forest with dense understory or maturing secondary forest, bamboo forest, secondary forest, and stream edge forest (see Porter *et al.*, 2007). We estimated habitat availability by recording the habitat category present at 100m intervals (102 sample points) along all north-south trails in the group's home range. Comparisons between the size of takeoff and landing platforms were made using a Student's t-Test for paired sample means. Variance in the size of takeoff and landing platforms was compared using an F-Test. Correlations between the size of takeoff platforms, landing platform size, substrate size, and distance leaped were analyzed using regression analyses. In all statistical tests probability was set at <0.05.

Results

We measured 110 leaps in which callimicos traveled between vertical trunks in the forest understory. On average animals were located at 3.0 ± 1.5m above the ground on the take-off platform. Over 61% of leaps occurred at heights of ≤3 m above the ground, and 30% occurred at heights between 3–5 m. The average DBH of trunks used by callimicos as takeoff platforms was 10.3 ± 8.3 cm and the average DBH of landing platforms was 9.9 ± 8.7 cm (Table 1). There were no statistical differences in the diameter ($t = 0.31$, $df = 109$, $p = 0.75$, two-tailed test) or variance in diameter ($F = 0.9$, $df = 109$, $p = 0.29$, one-tailed test) of vertical supports used as takeoff platforms as compared to supports used as landing platforms. Moreover, DBH of the takeoff platform was not correlated with the DBH of the landing platform (r = 0.04, p = 0.62). The culms of woody bamboo (*Guadua weberbaueri*) served as the takeoff substrate in 41.8% of trunk-to-trunk leaps and as the landing substrate in 48.2% of these leaps (Table 1). Overall 40.9% of callimicos' leaps employed tree trunks as both takeoff and landing platforms and 31.8% employed bamboo culms as both takeoff and landing platforms.

Although we did not quantify the relative size distribution of trunks and bamboo culms across the group's 114 ha home range, we did quantify the presence and use of five major habitat types. Our results indicate that despite the fact that bamboo forest comprised only 5% and secondary forest only 16% of the group's home range, callimicos spent a total of 67% (17% and 50% respectively) of their time in these habitats. In contrast, primary forest accounted for 74% of the callimicos' home range, but was used only 30% of the time. These data highlight that callimicos frequently travel through mixed forests that include stands of bamboo and secondary forest trees, and that large diameter primary forest trees were rarely used as leaping substrates. Less than 3% of takeoff platforms and less than 6% of landing platforms involved vertical trunks with a DBH of greater than 30 cm. Foster and Hubbell (1990) describe trees of greater than 30 cm DBH on Barro Colorado Island, Panama as canopy trees.

Table 1. Trunk-to-trunk leaping in *Callimico goeldii.*

<table>
<tr><th rowspan="2"></th><th colspan="4">Leaping Behavior</th></tr>
<tr><th>Take Off Platform (DBH in cm)</th><th colspan="2">Landing Platform (DBH in cm)</th><th>Distance Leaped (m)</th></tr>
<tr><td>**Mean**</td><td>10.3 ± 8.3</td><td colspan="2">9.9 ± 8.7</td><td>1.8 ± 0.8</td></tr>
<tr><td>**Range**</td><td>2.7–71</td><td colspan="2">2.7–71</td><td>0.2–4.3</td></tr>
<tr><td>**Median**</td><td>11.0</td><td colspan="2">8.6</td><td>1.8</td></tr>
<tr><th rowspan="2"></th><th colspan="4">Substrate Type</th></tr>
<tr><th colspan="2">Sample Size</th><th colspan="2">Sample Size</th></tr>
<tr><td>**Bamboo**</td><td colspan="2">46 (41.8%)</td><td colspan="2">53 (48.2%)</td></tr>
<tr><td>**Trunk**</td><td colspan="2">64 (58.2%)</td><td colspan="2">57 (51.8%)</td></tr>
</table>

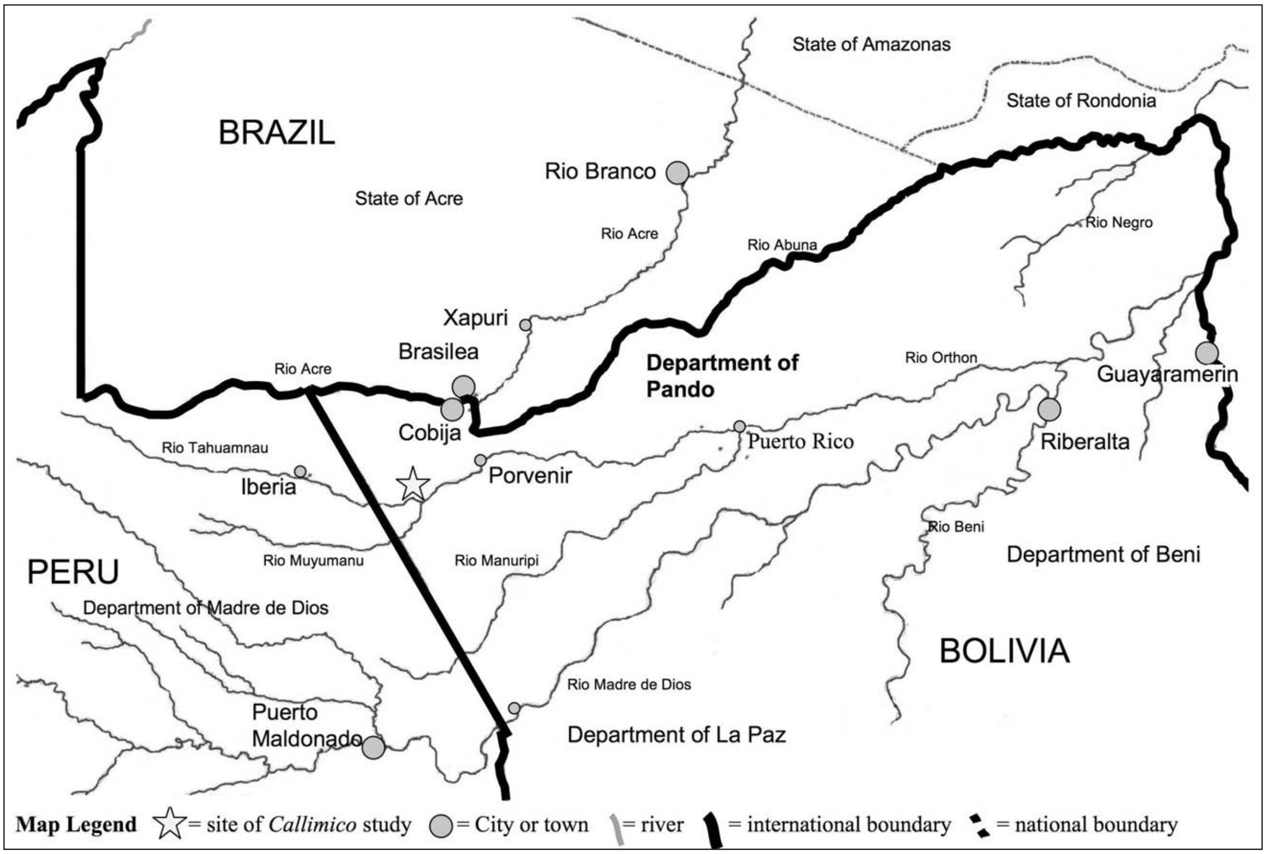

Figure 1. Map of the callimico study site in the Pando region of northern Bolivia.

The mean distance callimicos traveled between vertical trunks was 1.8 ± 0.8 m (Table 1). The shortest leap spanned a distance of 20 cm and the longest leap was 4.3 m. Trunk-to-trunk leaps of 1–2 m (44.5%) and 2–3 m (30.9%) accounted for 75% of all leaps (Figure 2). Less than 1% of leaps were greater than 4 m. During the landing phase of all trunk-to-trunk leaps, callimicos' forelimbs contacted the landing platform in advance of their hindlimbs.

Overall, we found no significant relationship between distance leaped and the size of either the takeoff ($r = 0.03$, $p = 0.74$) or landing platform ($r = 0.001$, $p = 0.98$). In addition, the diameter of takeoff and landing platforms used during the shortest leaps (≤1 meter) did not differ from those used during the longest leaps (≥3 m) (takeoff platform $t = 0.25$, $p = 0.39$; landing platform $t = -0.02$, $p = 0.48$). Table 2 lists the size of takeoff and landing platforms during the shortest and longest leaps. This suggests that given their small body size and elongated hindlimbs, callimicos can generate large propulsive forces pushing off both relatively small (5 cm DBH) and relatively large (71 cm DBH) diameter vertical trunks (Table 1).

We also examined takeoff and landing platform DBH and leaping distance when callimicos traveled on bamboo culms compared to tree trunks (Table 3). As a substrate, bamboo culms were significantly smaller than tree trunks ($t = -9.34$, $p < .0001$). The distance leaped when moving from bamboo culm to bamboo culm (mean of 1.63 m) was marginally shorter than the distance leaped when moving from one tree trunk to another (mean of 2.02 m) ($t = 1.95$, $p = 0.054$). Moreover, when trunks were used as a takeoff platform (even in cases of trunk to bamboo leaping), distances leapt were consistently longer than when bamboo culms were used as the takeoff platform ($t = 2.47$, $p < 0.015$). Although shorter distances leapt when traveling on bamboo may reflect the fact that bamboo culms grow in dense patches, it is also possible that rigid tree trunks provide a more stable takeoff platform during leaping than hollow bamboo culms allowing the animals to leap longer distances.

Discussion

Based on presently available field and captive studies, callimicos appear to be the only callitrichine species characterized by a suite of specialized morphological and behavioral traits associated with trunk-to-trunk leaping (Garber *et al.* 2009). Our results indicate that during trunk-to-trunk leaping callimicos generally leapt distances of 1–3 m (mean = 1.8 m) in the forest understory. These takeoff and landing platforms varied in diameter from approximately 3–71 cm (DBH), however, most leaps occurred on relatively small substrates (mean support diameter = 10 cm) including small trunks, saplings, and bamboo culms. Overall, 59% of all trunk-to-trunk leaps in callimicos involved bamboo culms as either takeoff or landing platforms, and 31.8% of leaps involved bamboo culms as both takeoff and landing platforms. Relative to body mass, callimicos possesses both a highly elongated hindlimb (femur and tibia) and hindfoot (distance from calcaneous to the most distal extent of the metatarsals) compared to other callitrichines (Garber and Leigh, 2001). The callimicos also are characterized by the lowest intermembral index [(ratio of humerus + radius)/(femur + tibia) × 100] of any tamarin or marmoset species (Davis, 2002). Hindlimb elongation has been argued to represent an adaptation for trunk-to-trunk leaping (e.g.

Table 2. DBH of takeoff and landing platforms for the shortest and longest leaps.

	Take Off Platform (DBH in cm)	Landing Platform (DBH in cm)	Distance Leaped (m)
LEAPS ≤1 (N = 20)			
Mean	11.6 ± 12.9	10.9 ± 9.3	0.68 ± 0.25
Range	3.5–57.3	2.7–38.8	0.2–1.0
LEAPS ≥3M (N = 10)			
Mean	10.5 ± 6.0	10.9 ± 8.4	3.42 ± 0.47
Range	4.7–25.1	5.0–33.1	3–4.3

Table 3. Distance leaped to and from different substrates.

	Take Off Platform (DBH in cm)	Landing Platform (DBH in cm)	Distance Leaped (m)
Bamboo to Bamboo (N = 35)	5.13 ± 1.59	5.18 ± 1.76	1.63 ± 0.70
Bamboo to Trunk (N = 11)	4.71 ± 0.98	15.14 ± 7.77	1.52± 0.59
Trunk to Bamboo (N = 19)	13.32 ± 6.66	5.07 ± 1.69	1.85 ± 0.70
Trunk to Trunk (N = 45)	14.35 ± 31.36	14.19 ± 34.10	2.02 ± 0.99

"vertical clinging and leaping") in several species of prosimians (e.g. *Indri*, *Propithecus*, *Avahi*, *Galago*, *Lepilemur*, *Hapalemur*, *Tarisus*; Demes *et al.*, 1995; Nekaris and Bearder, 2007) and one other species of New World primate, *Pithecia pithecia* (Walker 1998). Elongated hindlimbs improve leaping abilities as they increase the duration of time over which the body can be accelerated during takeoff (Garber, 2007). In contrast to vertical clinging and leaping prosimians and *Pithecia*, callimicos (and all callitrichines) land forelimbs-first rather than hindlimbs-first (Garber *et al.* 2009). Forelimbs first landings impart high compressive forces on wrist, elbow, and shoulder girdle. How exactly callimicos dissipate these forces remains unclear. However, forelimbs-first landing is common among anthropoids, most of which, are not specialized leapers.

Based on over 1640 hours of observations of our study group from 2002–2006, we estimate that our callimico study group exploited a home range of 114 ha (Porter *et al.*, 2007). Although the home range was composed principally of primary dense understory forest (74%), secondary forest (16%) and bamboo forest (5%), areas of woody bamboo and secondary forest were used by callimicos at significantly greater frequencies than expected based on habitat availability (17% and 50% of observation time respectively) (Porter *et al.*, 2007). Bamboo and secondary forests are characterized by an extremely dense and thorny understory containing considerable numbers of small to medium sized vertical supports. We have previously suggested (Porter and Garber, 2004) that based on their cryptic mode of behavior, black pelage, and virtually exclusive use of the lowest levels of the forest understory, trunk-to-trunk leaping may enable callimicos to reduce predation risk from both aerial and terrestrial predators by concealment and rapid escape. Moreover, bamboo forests provide callimicos with a major component of their diet, *Ascopolyporous*, a fungus that grows exclusively on the culms and branches of woody bamboo (*Guadua weberbaueri*) (Hanson *et al.* 2006; Porter *et al.*, 2007). Porter and Garber (in prep) report that fungi is consumed by callimicos during both the wet and dry seasons, and accounted for 42% of yearly feeding time. Fifty-eight per cent of the fungi consumed by callimicos in our study group were *Ascopolyporous*.

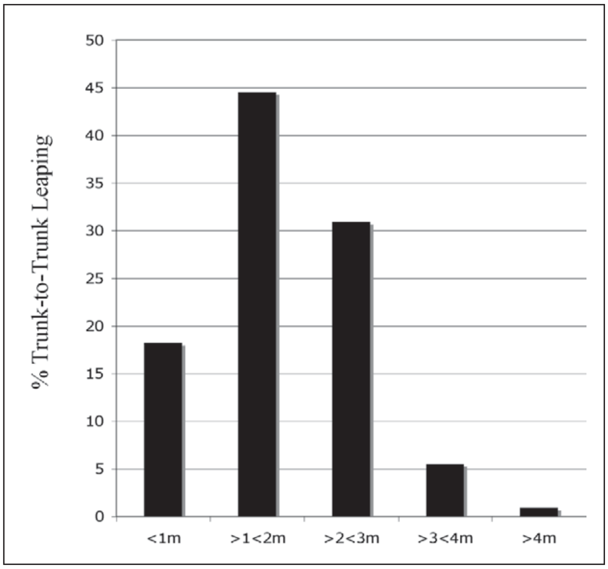

Figure 2. Frequency of trunk-to-trunk leaping in Callimico across different horizontal distances.

We conclude that trunk-to-trunk leaping represents a highly specialized pattern of locomotion that distinguishes callimicos from all other callitrichine species. The callimicos' use of vertical supports in the forest understory appears to be directly tied to its feeding ecology (exploitation of trunks to obtain bamboo fungi and as a foraging platform to locate insect prey), antipredator behavior, and rapid mode of travel. Several species of birds and insects are described as bamboo specialists (Lebbin, 2007) with part or all of their ranges restricted to forests dominated by *Guadua* bamboo. According to Lebbin (2007: 126) Amazonian bamboo habitats are characterized by high primary productivity, and a "combination of rich arthropod resources, a highly distinctive vegetation structure, occurrence across large geographic areas and [exist] in relatively large patches." Although it remains unclear the degree to which the callimicos' distribution and feeding ecology are dependent on the presence and availability of bamboo habitats, we suggest that conservation efforts to sustain viable populations of callimicos must focus on protecting and preserving habitats that contain large tracts of mixed bamboo and secondary forest.

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SHORT ARTICLES

ENDOPARASITOS EM MURIQUIS-DO-NORTE, *BRACHYTELES HYPOXANTHUS*, ISOLADOS EM PEQUENO FRAGMENTO DE MATA ATLÂNTICA

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Introdução

Os parasitos têm um papel importante nos ecossistemas ao influenciarem a sobrevivência e a reprodução de seus hospedeiros (Dobson & Hudson 1992; Hudson *et al.* 1992; Coop & Holmes 1996). Estudos parasitológicos com populações selvagens de primatas não-humanos têm registrado uma alta diversidade de espécies parasitas do trato gastro-intestinal e fornecido informações sobre suas relações evolutivas e ecológicas (Appleton *et al.* 1986; Eley *et al.* 1989; McGrew *et al.* 1989; Ashford *et al.* 1990, 2000; Stuart *et al.* 1990, 1993; Stuart & Strier 1995; Stoner 1996; Müller-Graf *et al.* 1997; Martins 1999; Lilly *et al.* 2002; Hahn *et al.,* 2003; Gillespie *et al.* 2004, 2005). Além disso, o entendimento da relação parasito-hospedeiro é particularmente importante para a conservação de espécies endêmicas e ameaçadas de extinção (Stuart & Strier 1995), pois subsidia o monitoramento da saúde do meio ambiente, principalmente em ambientes perturbados, possibilitando uma melhor aplicação dos planos de manejo de espécies ameaçadas.

O muriqui-do-norte, *Brachyteles hypoxanthus* Kuhl, 1820, é uma espécie Criticamente Em Perigo de extinção (Brasil, MMA 2003) e endêmica da Mata Atlântica, cuja distribuição abrange parte dos estados de Minas Gerais, Espírito Santo e Bahia (Mendes *et al.,* 2005). A principal ameaça à sobrevivência do muriqui-do-norte é a perda e a fragmentação da cobertura florestal, que contribui para a redução do tamanho das populações e o seu isolamento. Segundo Sasal *et al.* (2000), populações pequenas de hospedeiros estarão mais suscetíveis aos potenciais efeitos negativos dos parasitos. No caso do muriqui-do-norte, o risco de ocorrência de doenças pode ser alto, pois a maioria dos fragmentos florestais habitados por este primata sofre frequentemente a interferência de animais domésticos e pessoas, o que torna o monitoramento parasitológico altamente recomendável para a sua conservação (Mendes *et al.* 2005). A pesquisa de longo prazo de K. B. Strier e colaboradores na Reserva Particular do Patrimônio Natural Feliciano Miguel Abdala (RPPN-FMA), Caratinga, Minas Gerais, tem contribuído significativamente com conhecimento acerca do comportamento, ecologia e conservação do muriqui-do-norte (Strier & Mendes 2009), incluindo estudos parasitológicos (Stuart *et al.* 1993; Santos *et al.* 2004). O presente trabalho se refere a um levantamento coproparasitológico de um grupo de muriquis-do-norte isolado em um pequeno fragmento florestal no Estado do Espírito Santo realizado com a finalidade de fornecer subsídios para a elaboração de estratégias de ação para a conservação das populações remanescentes.

Material e Métodos

Área de Estudo
O município de Santa Maria de Jetibá, localizado na região serrana do Espírito Santo, apresenta vegetação de Mata Atlântica em diversos estágios de sucessão. Suas áreas de floresta encontram-se distribuídas em fragmentos parcialmente isolados por pastagens, plantações, redes elétricas de alta tensão e represas, onde são encontrados grupos pequenos e isolados de muriqui-do-norte. O maior grupo identificado no município possuía 18 indivíduos (Mendes *et al.,* 2005). Este estudo foi conduzido em um fragmento de mata com 128 ha, localizado em propriedades privadas (20°02'32"S, 40°41'45"O). No período do estudo, o fragmento abrigava um grupo de muriquis que variou de 13 a 15 indivíduos (2–3 machos adultos, 1–0 macho subadulto, 1 macho juvenil, 2–3 machos infantes, 4 fêmeas adultas, 1 fêmea subadulta, 1 fêmea juvenil e 1–2 fêmeas infantes), além de quatro outras espécies de primatas: *Callicebus personatus* (E. Geoffroy, 1812)*, Alouatta guariba clamitans* (Humboldt, 1812), *Callithrix flaviceps* (Thomas, 1903) e a exótica *Callithrix geoffroyi* (Humboldt, 1812).

Levantamento Coproparasitológico
Foram feitas coletas de fezes de muriquis entre os meses de novembro de 2004 e abril de 2005. As amostras foram classificadas em três categorias: 1) amostras individuais identificadas, onde foi possível identificar o indivíduo que defecou; 2) amostras individuais não identificadas; e 3) e amostras coletivas diárias, contendo fezes de mais de um indivíduo. Porções dos bolos fecais que não entraram em contato com o solo foram coletadas logo após o ato de defecação e acondicionadas em tubos de 50 ml tipo "Falcon" contendo MIF 1:>4 (fixador merthiolate -iodo-formaldeido) ou SAF 1:>4 (fixador Acetato de Sódio-Acido Acético-formaldeido) conforme descrito por De Carli (2001). O processamento e identificação das espécies de parasitos foram realizados no Laboratório de Imunoparasitologia do Departamento de Análises Clínicas e Toxicológicas da Faculdade de Farmácia da Universidade Federal do Rio de Janeiro, utilizando-se os métodos de Hoffman, Pons e Janer (sedimentação espontânea) e de Faust (centrífugo-flutuação em solução de sulfato de zinco). As lâminas foram coradas com lugol e observadas em microscópio óptico, marca Nikon, modelo eclipse E200, munido de sistema fotográfico digital em aumentos de 100x e 400x.

Resultados

Foram coletadas 28 amostras, das quais 16 foram individuais não identificadas, sete foram individuais identificadas (representando cinco indivíduos) e cinco foram coletivas diárias. Apenas quatro amostras foram negativas. Dentre as amostras positivas, duas apresentaram alterações de consistência e coloração, mostrando-se pastosas e contendo sangue. Sete táxons de parasitos em diferentes estágios de desenvolvimento foram identificados (Tabela 1). Foram encontrados trofozoitas e cistos de *Balantidium coli*, um nematóide ancilostomídeo em estágio larval em uma amostra e um ovo em outra e um ovo de um trematódeo digenético. As maiores prevalências foram observadas entre os protozoários e os cestóides (Tabela 1).

Discussão

O protozoário mais comum foi o *Balantidium coli* que é o único ciliado associado a lesões de trato intestinal de primatas não-humanos. Esta espécie foi recentemente descrita para a população de muriquis da RPPN-FMA, em Minas Gerais, por Santos *et al.* (2004). Segundo Rey (2001), os suínos são reportados como hospedeiros reservatórios desta espécie, cuja prevalência pode oscilar entre 50 e 100%. A infecção ocorre por ingestão de cistos infectantes ou trofozoítos na água ou alimento (Rey, 2001). A observação de cistos dos gêneros *Entamoeba* e *Giardia* reforça a importância da água como fonte de infecção. Estes dois gêneros possuem veiculação predominantemente hídrica e grande importância em planos de saúde pública, pois são agentes etiológicos de diarréias agudas em humanos (WHO, 2000). Segundo Bennett *et al.* (1995), algumas espécies do gênero *Giardia* são transmissíveis entre humanos e outros animais. Já o gênero *Entamoeba* é considerado incomum ou raro em primatas neotropicais de vida livre e a identificação das espécies é de fundamental importância, já que nem todas são reportadas como patogênicas, sendo *E. histolytica* capaz de gerar lesões graves na mucosa intestinal de primatas neotropicais (Bennett *et al.*, 1995).

Moniezia é um cestóide que habita o intestino delgado de herbívoros como coelhos, ovelhas, bovinos e primatas (Bowman, 1995). Seu ciclo vital é heteroxênico e envolve um carrapato como hospedeiro intermediário (Rey, 2001). A *Moniezia rugosa* já foi encontrada em muriquis-do-sul (*Brachyteles arachnoides*) por Artigas (1937) e Dunn (1963). A existência de pastos para pecuária ao redor do fragmento facilita a dispersão de carrapatos infectados com a larva cisticercóide destes cestóides. A possível infecção com o cestóide *Hymenolepis* sp. é compatível com a ocorrência deste parasito em roedores, humanos e primatas não-humanos (Bowman, 1995; Bennett *et al.*, 1995). *Hymenolepis* spp. podem apresentar ciclo monoxênico com transmissão oral-fecal ou heteroxênico, tendo insetos (pulgas, por exemplo) como hospedeiros intermediários (Rey, 2001). A alta prevalência de ancilostomíase na população humana no município de Santa Maria de Jetibá (Angonesi, 2005) sugere que os muriquis podem ser infectados por este parasito ao entrarem em contato com substrato contaminado com fezes humanas durante deslocamentos pelo chão. O ciclo de vida de *Ancylostoma* spp., por exemplo, é direto e a infecção pode se dar por via passiva direta (ingestão de L3 infectantes) ou por via ativa (penetração percutânea) (Rey, 2001).

Tabela 1. Parasitos encontrados em amostras fecais de *Brachyteles hypoxanthus* (N = 28 amostras).

Táxon	n (Amostras positivas)	Prevalência (%)
Protozoa	**22**	**79**
Balantidium coli	16	57
Entamoeba sp.	4	14
Giardia sp.	2	7
Nematoda	**2**	**7**
Ancylostomidae (gênero não identificado)	2	7
Cestoda	**10**	**36**
Moniezia sp.	7	25
cf. *Hymenolepis* sp.	5	18
Trematoda	**1**	**4**
Digenea (gênero não identificado)	1	4

A diversidade de parasitos encontrados sugere uma estreita relação com atividades desenvolvidas pela população humana do entorno do fragmento florestal (tais como suinocultura, bovinocultura, avicultura e o trânsito de pessoas, cães e gatos), sobre a saúde dos muriquis de Santa Maria de Jetibá. O comportamento dos muriquis de consumir água de córregos, como observado no presente estudo e em outras localidades (Mourthé *et al.*, 2005), certamente aumentam o risco de infecção dos muriquis. A deficiência do saneamento básico municipal também deve contribuir negativamente na saúde dos muriquis. Em 2000, o município possuía cerca de 28.750 habitantes e a rede de esgotos ou de drenagem pluvial atendia apenas <10% das residências. Na área rural não havia rede de esgotos e os moradores utilizavam fossas rudimentares ou despejavam os efluentes diretamente em rios e riachos (Instituto Brasileiro de Geografia e Estatística – IBGE 2008). Esta deficiência no tratamento de efluentes é refletida no alto número de casos humanos de doenças de veiculação hídrica no município. Segundo o Laboratório Santa Maria Ltda., os registros mais frequentes em humanos em 2004 foram esquistossomose, giardíase, amebíase e ancilostomíase (Angonesi, 2005), das quais apenas a esquistossomose não foi detectada nos muriquis no presente estudo.

Os resultados sugerem a necessidade de uma abordagem de paisagem que envolva o ambiente antrópico. Portanto, paralelamente aos planos de recuperação do hábitat, são necessários planos de educação em saúde e programas de saneamento rural para a população humana de Santa Maria de Jetibá. Esta estratégia promoveria a melhoria da saúde das populações do entorno das áreas naturais e, assim, reduziria o risco dos efeitos antrópicos negativos sobre a fauna silvestre. Além disso, se faz necessário o monitoramento constante da saúde de todos os grupos de muriquis do município.

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HABITAT CHARACTERIZATION AND POPULATION STATUS OF THE DUSKY TITI (*CALLICEBUS ORNATUS*) IN FRAGMENTED FORESTS, META, COLOMBIA

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Introduction

Tropical forests have important ecosystem functions such as soil protection, climate regulation, supply of goods, etc. (Foley *et al.*, 2007). In Colombia, an accelerated process of transformation of natural ecosystems is occurring, which results in habitat reduction and fragmentation. It has been estimated that a third of the country´s forest cover has been eliminated (Alexander von Humboldt Institute *et al.*, 1997), and the principal causes of deforestation are the expansion of the agricultural frontier and colonization. In fact, Colombia is the fourth country with highest levels of deforestation among South American countries (FAO, 2006). In Orinoquia, colonizers have converted forest to savanna ecosystems for agriculture and livestock. Furthermore, recently the African oil palm industry has greatly expanded with government support (Moreno, 2000) and Meta department ranks first in the nation as a producer of African palm (*Phoenix dactylifera*). The land destined to this cropping system covers 47,525 ha, and the production is estimated to be increased by 35,000 ha in the next few years (Gobernación del Meta, 2006), which implies more land conversion and, therefore, further habitat destruction. According to local inhabitants, in the 1940s the study region (San Isidro de Chichimene, Acacías) was an intact forest. Since then, agriculture has greatly expanded in the region with the production of corn, coffee and cassava, and wood extraction and hunting have also increased. In a period of only 30 years colonists have depleted the forests by creating fragments that continue to be intervened through time. Currently, livestock and the expansion of oil palm are the principal causes of deforestation in the region. Earlier deforestation in the region created forest fragments especially fragments along streams in which many species have become isolated. Such is the case of the Vereda San Isidro de Chichimene, a fragmented landscape which still holds rich fauna and flora.

The Colombian endemic primate *Callicebus ornatus* inhabits this region and it has been classified as vulnerable by the IUCN (VU B1ab (iii)) (IUCN, 2008). According to Defler (2004), *Callicebus ornatus* populations are small, and their major threat is colonization; "since *C. ornatus* is endemic to Colombia, its conservation within the country is very important". He recommended censuses to evaluate the species' status in detail and proposed local environmental education campaigns, to insure its survival. Traditionally, primate studies have been conducted in reserve areas. However, the risk of extinction is highest for small populations that are generated when the habitat is fragmented or modified. For this reason, studies outside reserves could help to evaluate the status of such species (Chapman and Peres, 2001), their responses to disturbance, and extinction risk. Furthermore, fragmentation has caused a reduction in plant species diversity and composition in the region (Stevenson and Aldana, 2008). Since fruit production and plant composition may affect primate populations (Stevenson, 2001), we were also interested in the potential effects of vegetation composition on the populations of *C. ornatus*. We were also interested in the potential effects of fragment size (i.e., the area of each fragment) on the population density of the primates, since this factor has demonstrated to have strong effects on primate demographic patterns (Marsh, 2003). In this study, a census of *Callicebus ornatus* and a vegetation sampling were conducted in forest fragments in Vereda San Isidro de Chichimene, to evaluate the status of this species and to determine conservation implications in private lands.

Methods

Study Area

The Vereda San Isidro de Chichimene is located in the Municipality of Acacias in the department of Meta (480 m a.s.l., 73°42'W, 03°55'N). This region corresponds to a very humid tropical forest (Agustín Codazzi Geographic Institute, 1995). Photographic images were taken to register the landscape heterogeneity and the forest cover was described by a LANDSAT image (2000, Figure 1) provided by RedVerde.

The study was carried out in private land. Eight fragments were studied (Figure 2) within 86.24 ha of forest, which corresponded to 8.5% of forest cover remnants in a total of 1010 ha (framed area in Figure 1). The forest remnants consist mainly of riparian secondary forest. These forests tend to be narrow with an average width of 30 m, and show large variations in age and degree of human intervention.

Census of Callicebus ornatus

The census was carried out from January to March 2007 by one, and sometimes two observers, between 5:30 and 12:30 h, during a total of 392 h. Each fragment was visited 12 times. When a primate was detected, the following data were registered: (1) time, (2) group size, (3) group composition, (4) geographical position (GPS, Garmin eTrex, Legend), (5) special traits of individuals, (6) activity of animals when encountered (Williamson and Feistner, 2003). A map of the study area was generated using GPS (Figure 2). Routes through forest fragments and coordinates of group locations were transferred to a PC using MapSource 6.9.1 software. Population densities were based on the number of groups and individuals per group in each fragment (only fragments with more than 3 groups were considered in further analyses: fragments 1, 3, 5 and 8), and forest areas were estimated from the map using GIS tools. Eight fragments were selected in the study area and, since the fragments were not wide (mean 30m. wide), we tried to count all individuals and groups by direct observations from the trails (total length = 57.1 km, estimated from the map). Age categories were determined by size according to Kinzey (1981): Infant, individual depending on locomoting adults; Juvenile I, a second year individual (4–12 months); and Juvenile II a third year individual (12–24 months), sub-adults and adults. Morning calls of *Callicebus* were important cues for detecting them, since they helped to locate the groups. In the afternoon *Callicebus ornatus* is less active than in the morning and vocalizations are not very common, for this reason the census was restricted to morning hours. Whenever possible, photographs were taken with a digital camera to allow differentiation of groups. In the widest fragment (no. 1), walking along trails was not an effective way for detecting all individuals of *Callicebus ornatus*, since low visibility in and cryptic behavior made their detection difficult. For this reason, in fragment no.1, two observers always performed censuses early in the morning, when the vocalizations started. Photographs and the number of group members allowed group differentiation Vocalizations "chirrups" were also used to locate individuals. Juveniles were differentiated by the description of the white head band which develops after the sixth week (Kinzey, 1981). The relationship between *C. ornatus* population densities and the area of the fragment was assessed using simple regression analysis.

Vegetation Sampling

From April to June, 2007 floristic inventories of trees (>10 cm diameter at breast height) were conducted in two plots of 1-hectare (200 m × 50 m) in the fragment 1, divided in 100 m^2 subplots. We considered two contrasting vegetation types found in forest fragments. One plot was built in less disturbed forest and the second one

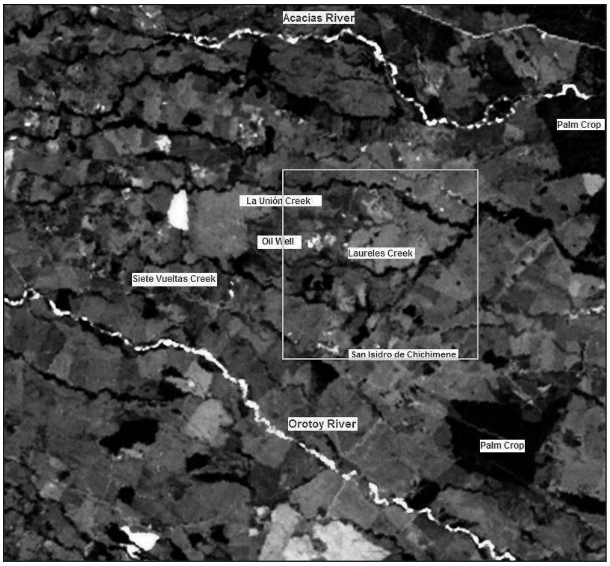

Figure 1. LANDSAT image (RedVerde, 2000). The square indicates the study area, black zones correspond to forests and palm crops.

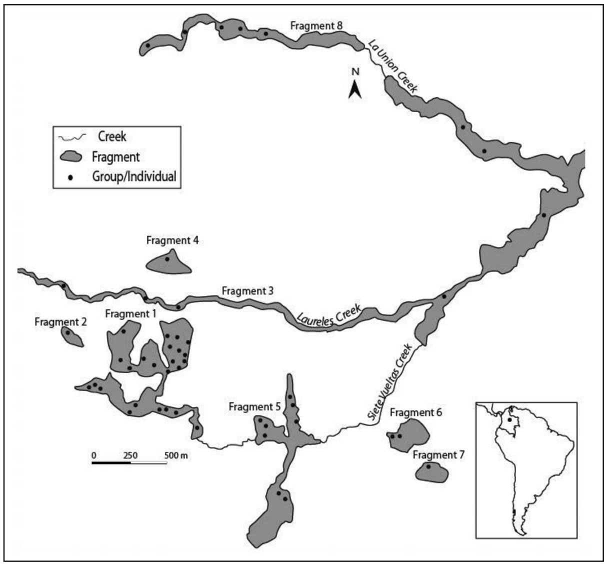

Figure 2. Study site. Fragments where censuses were carried out. Points indicate groups and individuals observed .

is a secondary forest (50 years old). Less disturbed forest refers to a primary forest with some degree of human intervention (i.e. selective logging has occurred in the past). Census methodology was based on two guides of the IAvH (Alexander von Humboldt Institute) (Villareal *et al.*, 2006 and Vallejo-Joyas *et al.*, 2005). Trees in each plot were marked with numbered aluminum tags. Sterile and fertile material were collected and identified by the authors and compared with vouchers in Los Andes University Herbarium and the SINCHI (Institute for Scientific Amazonian Research) herbarium. A species accumulation curve was determined by the program EstimateS, Version 7.5 (Colwell, 2005). Importance indexes were determined by adding the relative frequency, relative density and the relative basal area.

Results

Census of Callicebus ornatus

Four primate species inhabit the fragments in the study area: *Saimiri sciureus* (Squirrel monkey), *Cebus apella* (Capuchin), *Aotus brumbacki* (Night monkey) and *C. ornatus* (Titis). Forty three titi groups were detected (Table 1) and its age categories are described in Table 2. The population density was found to be 192.2 individuals/km^2 (Table 3).

There was no relationship between fragment size and population density of C*allicebus ornatus* in the fragments studied (F =5.12, p =0.15).

Vegetation Sampling

A total of 136 tree species (>10cm DBH) were found in 2 ha. The plant species accumulation curves for each plot do not reach an asymptote and show that the less disturbed forest is more diverse than the secondary forest (Figure 3). The density of *Callicebus ornatus* in the secondary forest was 559.1 ind/km^2 and 188.2 ind/km^2 in the less disturbed forest.

A total of 1,070 trees were marked. Tree density was 571 individuals/ha in the less disturbed forest and 499 individuals/ha in the secondary forest. The less disturbed forest plot shares 26.2% of the plant species with the secondary forest. The percentage of species found only in less disturbed forest was higher than the percentage unique to secondary forest (73.8 vs. 55%). In the less disturbed forest *Socratea exorrhiza, Oenocarpus bataua* and *Mabea maynensis,* were the most important species (Table 4). In the secondary forest *Casearia sp, Apuleia leiocarpa* and *Jacaranda copaia* dominated.

Discussion

Census of Callicebus ornatus and considerations for its conservation

Agriculture expansion has caused fragmentation in the study area and the remnants are linear tracts along waterways in a pastureland matrix. Deforestation has caused loss of biodiversity and ecosystem degradation in the region (Stevenson and Aldana 2007). Despite the highly disturbed habitat in the region, some endemic and charismatic species survive (*e.g.*, titi monkeys, night monkeys, otters, and giant anteaters). The population density of species, such as *Callicebus ornatus* is high in the fragments (192.2 individuals/km^2) and even higher than estimates reported for undisturbed forest in the same region (8 individuals/km^2; Polanco, 1992). However, it is important to consider these comparisons with caution because differences in the census methods and a lower visibility in the primary forest could result in an underestimation of *C. ornatus* populations. However, these large differences indeed reflect variation in group density, since group size was similar in fragments and undisturbed forests (Polanco, 1992).

On other grounds we found considerable variations in density estimates between fragments that were not explained by area nor by hunting pressure (currently local people do not hunt primate species in the region), but may be associated with fine grained variations in resources, and other demographic and history processes. *Callicebus ornatus* can survive in secondary forest because pioneer plants are important in their diet (Mason, 1968; Hernández-Camacho and Cooper, 1976; Polanco, 1992; Sánchez, 1998). Other important aspects of their survivorship in degraded forest are their frugivorous-folivorous-insectivorous diet, small size (Fimbel, 1994), and the local extinction of competitors such as large-bodied primate species that have historical records in the area (Stevenson & Aldana, 2008). For instance, fragment 3 showed the lowest population density (60 individuals/km^2). Two reasons could be influencing this result: 1. It is a large tract of forest without fence protection, which means that livestock may transit among the forest preventing plant regeneration. 2. This fragment is connected with the riparian forest of La Unión creek, which was the only fragment with *Cebus apella*. This may

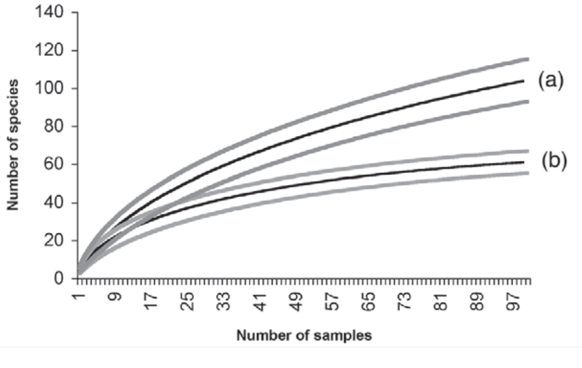

Figure 3. Expected number of plant species in two plots, (**a**) Less disturbed forest, (**b**) secondary forest, where all individuals (DBH >10 cm) were identified to species or morphospecies, near Acacias, Meta, Colombia. The grey lines show 95% confidence intervals.

Table 1. Group composition of *Callicebus ornatus* in forest fragments in Acacias, Meta, Colombia.

Fragment	Group	Adults Male	Sub-Adults	Juveniles	Infants	Undetermined	Total
1	1	2		1			3
	2	2					2
	3	2	1	2	1		6
	4	2		1			3
	5	2					2
	6	2		1			3
	7	2					2
	8	2		1	1		4
	9	2			1		3
	10	2			1		3
	11	2			1		3
	12	2			1		3
	13	2		1			3
	14	2		1			3
	15	2		1	1		4
	16	2					2
	17	2		1			3
	18	2					2
	19	2		1	1		4
	UNDT					7	7
2	20	2		1	1		4
3	21	2			1		3
	22	2		1	1		4
	23	2	1	1			4
	35	2		1	1		4
	36	2		1	1		4
	37	2					2
	38	2			1		3
4	24	2		1			3
5	25	2			1		3
	26	2					2
	27	2					2
	28	2					2
	29	2		1			3
	30	2		1			3
	31	2					2
	UNDT					1	1
6	33	2					2
	34	2		1			3
7	32	2					2
8	39	2	1	1	1		5
	40	2					2
	41	2	1	1			4
	42	2		1			3
	43	2					2
Total	**43**	**86**	**4**	**23**	**16**	**8**	**137**

imply a higher level of interspecific competition for space (Sánchez, 1998) or even predation pressure from *Cebus apella*, a species known to hunt and kill small mammals (Galetti, 1990; Izawa, 1990, Sampaio and Ferrari, 2005; Defler, com. pers.).

Fragments of less disturbed forests in which floristic inventories were studied showed an acceptable conservation level and a high density of *Callicebus ornatus* (368.7 ind/km^2). However, the density of *Callicebus ornatus* in the secondary forest was in general higher (mean: 559.1 ind/km^2) than the less disturbed forest (mean: 188.2 ind/km^2), suggesting a preference for secondary forest (Mason, 1968; Hernández-Camacho and Cooper, 1976; Polanco, 1992; Sánchez, 1998). According to Quiñones-Porras (2007), who studied a group in a secondary forest during 4 months (March to June), the most consumed fruits by *C. ornatus* during this period were *Miconia affinis*, *Inga thibaudiana* and *Miconia elata,* as it has been reported in other studies (Polanco, 1992; Sánchez, 1998 & Ospina, 2006). According to Polanco (1992) and Sánchez (1998) during wet season *C. ornatus* still consumes *Miconia* and *Inga* species but lower proportions. Additional observations are required to evaluate fruit feeding preferences in long term studies at the study area.

The density reported for fragment 1 was 368.7 individuals / km^2, a similar estimate as the one found by Mason (1966) of 400 individuals / km^2. This fragment seems to have better conditions than the others, since it is protected from livestock by fences and has a rich plant assemblage. Another potential explanation for these high estimates is the lack of interspecific competition with larger primates (for instance *Alouatta seniculus* was locally exterminated for bushmeat 50 years ago). Yet a third explanation that must be considered is that these high population densities represent refugees from destroyed forests. Thus, these may be hyperdense populations as a result of forest desctruction. This possibility must be evaluated, especially since much forest has been destroyed in the area. High population densities such as the ones found in the fragments could also imply a high probability of epidemics and endogamy. Long term

Table 2. Age structure of the *C. ornatus* population.

	Adults	Sub-Adults	Juveniles	Infants	Total
Counts	86	4	23	16	129
Proportion (%)	66.7	3.1	17.8	12.4	100

Table 3. Population density estimates of *Callicebus ornatus* in the forest fragments near Acacias, Meta, Eastern Colombia.

Fragment	Area (ha)	Groups	Individuals	Groups / ha	Individuals / km^2
1	17.63	19	65	1.08	368.7
3	40	7	24	0.18	60.0
5	10	7	18	0.70	180.0
8	10	5	16	0.50	160.0
Total	77.63	38	123		
Mean				0.61	192.2 ± 128.9

Table 4. Most important plant species in the less disturbed and secondary forests.

Less disturbed forest					Secondary Forest				
Species	**RF**	**RD**	**RBA**	**IVI**	**Species**	**RF**	**RD**	**RBA**	**IVI**
Socratea exorrhiza	0.108	0.183	0.377	0.668	*Casearia* sp.	0.105	0.067	0.015	0.187
Oenocarpus bataua	0.097	0.121	0.380	0.598	*Apuleia leiocarpa*	0.074	0.044	0.017	0.135
Mabea maynensis	0.068	0.074	0.055	0.197	*Jacaranda copaia*	0.076	0.035	0.005	0.116
Virola sebifera	0.044	0.041	0.028	0.113	*Schefflera morototoni*	0.050	0.035	0.005	0.09
Iriartea deltoidea	0.031	0.043	0.023	0.097	*Alchornea glandulosa*	0.048	0.025	0.002	0.075
Pourouma bicolor	0.033	0.028	0.017	0.078	*Guatteria recurvisepala*	0.048	0.023	0.002	0.073
Caraipa cf. *punctulata*	0.029	0.025	0.016	0.07	*Sapium laurifolium*	0.057	0.001	0.000	0.058
Guatteria recurvisepala	0.029	0.025	0.013	0.067	*Loreya strigosa*	0.040	0.017	0.001	0.058
Senefeldera inclinata	0.031	0.028	0.006	0.065	*Himatanthus articulata*	0.033	0.017	0.001	0.051
Lauraceae sp. 2	0.026	0.023	0.010	0.059	*Trattinnickia aspera*	0.033	0.014	0.000	0.047

* **RF** (Relative frequency), **RD** (Relative density), **RBA** (Relative basal area), **IVI** (Importance Value Index) = RF + RD + RBA (Curtis & McIntosh, 1951).

monitoring of populations and studies of genetic diversity will be necessary to assess the viability of these populations, especially since they may represent refugees. Given that fragments are small, only 8.5% forest cover remains and the permanence of them is uncertain. However, they seem to have a high probability of survival, as long as the destruction of forest remnants stops. In the study area individuals of *C. ornatus* y *S. sciureus* were observed walking on the ground, moving from fragment 1 to 5 (400 m separated). This represents a predation threat for these primates; we witnessed a domestic dog killing the infant of the group 7, when his father tried to gather fruit on the ground. Tree-fences are important structures that help groups to travel between fragments and as food sources (Carretero, 2008). Their use in private lands could be important for primates and other fauna.

Callicebus ornatus is also found in La Macarena and Tinigua National Parks, but these parks have been affected by illicit crops and institutional presence has been jeopardized by lack of personal security. About 4,500 ha of coca crops have been reported in La Macarena park (Acción Social, 2006). The conservation of this endemic primate in private forests is important for its survival. A conservation program for the black lion tamarin from the Brazilian coast on private lands, is showing great success, thanks to a well constructed environmental education program where landowners agreed to participate, increasing protected habitat by about 5,000 ha (Valladares-Pádua *et al.*, 1994; Kleiman and Mallinson, 1998). Conservation programs using private lands seem very important to supplement the efforts of the government, and this effort should be undertaken by all Colombians. It seems important to restore the quality of *Callicebus ornatus* habitat to maintain healthy populations. Political activism is also necessary to take important actions against forest destruction in the region: environmental education and laws must be enforced, forest fragments must be connected and their areas must be increased to avoid the destruction of forest remnants in the piedmont and to protect endemic species in the region.

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ANTHROPOGENIC CHANGE AND PRIMATE PREDATION RISK: CRESTED CARACARAS (*CARACARA PLANCUS*) ATTEMPT PREDATION ON MANTLED HOWLER MONKEYS (*ALOUATTA PALLIATA*)

Tracie McKinney

Introduction

Anthropogenic change in primate habitats may be an important factor in predation risk. Predation is often considered a principle selective pressure in primate evolution, and thus an important determining factor for grouping behavior, travel patterns, and choice of sleeping sites (van Schaik, 1983; Isbell, 1994; Treves, 2002; Shultz *et al.*, 2004). Predation events are rarely witnessed in the wild due to their rarity, short duration, and the effects of observer presence. Reports of failed predation attempts or even the absence of predation events (Boinski *et al.*, 2000) will broaden our understanding of this important issue. With our currently limited scope on primate predators and risk factors, we may be missing the impact of human habitat alteration on predation risk and rates. This paper reports a presumed predation attempt by two crested caracaras (*Caracara plancus*) on infant mantled howler monkeys (*Alouatta palliata*) in Costa Rica. Crested caracaras are generally associated with human activity

(Rodríguez-Estrella *et al.*, 1998; Morrison & Humphrey, 2001), suggesting that habitat disturbance at this site may alter predation risks for these monkeys.

Large-bodied, arboreal howler monkeys should have fewer potential predators than many other primate genera (Di Fiore, 2002). Researchers have confirmed predation by jaguar (Peetz *et al.*, 1992; Chinchilla, 1997), puma, *Puma concolor* (Chinchilla, 1997; Ludwig *et al.*, 2007), ocelot, *Leopardus pardalis* (Miranda *et al.*, 2005; Bianchi & Mendes, 2007) and harpy eagles, *Harpia harpyja* (Sherman, 1991) on wild howler monkeys. Predation attempts by black hawk-eagles, *Spizaetus tyrannus* (Miranda *et al.*, 2006), crested eagles, *Morphnus guianensis* (Julliot, 1994), and tayras, *Eira barbara* (Phillips, 1995; Asensio & Gómez-Martín., 2002) are also reported in the literature. While incidences of snake predation on Ateline primates have not been documented, large snakes may also be considered a potential threat to juvenile howlers because they prey on many other Neotropical primates (Di Fiore, 2002). Birds are the most common predators for many monkey species, both in the Old and New Worlds. Only a few Neotropical birds, including the Harpy eagle (*Harpia harpyja*), the crested eagle (*Morphnus guianensis*), and the hawk eagle (*Spizaetus* spp.), are believed large enough to capture adult Atelines (Julliot, 1994; Miranda *et al.*, 2006). Infant howler monkeys, however, are certainly reasonably sized prey for many Neotropical raptors (Di Fiore, 2002).

In the observed incident, an apparent predation attempt on infant howler monkeys (*Alouatta palliata*) was made by two crested caracaras (*Caracara plancus*). The crested caracara ranges from the southern United States to Tierra del Fuego and the Faulkland Islands (Travaini *et al.*, 2001; Henderson, 2002; Vargas *et al.*, 2007). It is a medium-sized raptor in the falcon family (Falconidae), weighing approximately 1 kg and with a wingspan of 120–130 cm (Henderson, 2002). While they are mostly known as a scavenging species, caracaras are opportunistic hunters that feed on a variety of invertebrate and vertebrate prey (Travaini *et al.*, 2001; Vargas *et al.*, 2007), and may in fact consume more fresh meat than carrion (Richmond, 1976). Mammals account for nearly one quarter of crested caracara prey (Vargas *et al.*, 2007). Although the majority of mammalian preys are rodents, caracaras are known to prey on larger animals, such as skunks and young rabbits (Henderson, 2002). While caracaras are not confirmed predators on even small monkeys, a taxidermized caracara did elicit alarm responses from captive marmosets (*Callitrhix penicillata*) in an experimental setting (Barros *et al.*, 2002). Caracaras are particularly suited to act as active predators of monkeys in anthropogenic environments yet pose relatively little risk in more forested habitats. As open-habitat species (Morrison & Phillips, 2000), caracaras thrive in areas with little tree cover, such as natural clearings and man-made pastures. They are highly tolerant of human activity, and are often found hunting and scavenging on farms or along roadways (Rodríguez-Estrella *et al.*, 1998; Morrison & Humphrey, 2001). Like many open-area raptors, caracaras seek out fragmented habitats, using the forest cover for nesting while hunting in the fields (Rodríguez-Estrella *et al.*, 1998; Sánchez-Zapata & Calvo, 1999). Habitat changes that favor caracara activity may place local wildlife confined to narrow forest fragments at risk of heavy predation (Morrison & Phillips, 2000).

Study Population and Observation

The observed event took place at the Refugio Nacional de Vida Silvestre Curú, a 1,500 ha private "hacienda" and wildlife refuge in western Costa Rica (9°47'43"N, 84°55'15"W) (for a complete description of the site see Baker & Schutt, 2005). The incident was witnessed during data collection of a long-term project concerning the impact of human disturbance on mantled howler monkey (*Alouatta palliata*) and white-faced capuchin (*Cebus capucinus*) ecology and social behavior. Curú is an ideal site for such studies, as it incorporates a variety of man-made and natural habitats including primary and advanced secondary forest, mangrove swamp, mango, banana, coconut, and African oil palm plantations, and open pastures with living fences. The refuge has a high density of howler monkeys, with some troops found in entirely anthropogenic habitats, others completely removed from human interaction, and many troops living in territories between these two extremes. The study troop of mantled howlers presented here ranges through riparian forest, living fences, mango and banana plantations, and secondary forest. The troop is fully habituated to human observers, and regularly encounters tourists, vehicles, and domestic animals. At the time of this observation, the troop consisted of 30 individuals — 5 adult males, 16 adult females, and 9 immatures. Comparable troop sizes are common at Curú; the relevance of such large groups at this site is not yet clear. The events were recorded through *ad libitum* observation and continuous focal animal samples (Altmann, 1974) and were witnessed by two researchers and two volunteers.

The interaction with the caracaras took place at approximately 8:25 am on December 12, 2007. The monkeys were traveling and foraging through a strip of riparian forest between a cattle pasture and a dirt road. Two females with small infants crossed a gap in the canopy on an exposed horizontal branch 12–15 meters in height and approximately 5 meters long. Such exposed areas are risky for arboreal primates (Isbell, 1994), and these females were traveling quickly and in the presence of an adult male. Both infants were riding dorsally and appeared 4–6 weeks of age. The two raptors approached across the open pasture as the females were in the center of the branch, and swooped at the monkeys. The birds did not make contact or land on the branch. Both females ducked as the birds passed overhead, then hurried along the branch to cover. The entire interaction lasted less than 30 seconds.

There were few overt anti-predator behaviors from the females or other troop members. Anti-predator behaviors in howler monkeys typically include descent and dispersion, vocalization, and grouping quietly high in the trees (Eason, 1989; Julliot, 1994; Phillips, 1995; Miranda *et al.*, 2006). In this incident, the nearest adult male howled for about 15 seconds shortly after the event, but a truck was passing at the same time, so it is unclear whether the vocalization was in response to the birds or to the motor. After the interaction with the caracaras, the troop continued to forage and settled down in the same area for their midday rest. A second observer recorded a single caracara flying through the trees at 12:36 pm. In this case, there were no interactions or responses from the monkeys. This is the only predation-related event observed for this monkey troop over a period of 491.25 hours of data collection. This represents a predation-related event rate of 0.002 events/hour. Even though the young howlers survived this interaction, caracaras should now be considered and monitored as a potential threat to infant monkey survival in edge habitats.

Discussion

Anthropogenic change means much more than habitat loss for non-human primates. The effects of human disturbance are pervasive, impacting parameters like foraging patterns, social interactions, and predation. Seidensticker (1983) proposed a consideration of predation when discussing disturbance, noting that primate predation by big cats depends largely on the availability of livestock. In the 25 years since, little has been made of human alteration and predation, and the few reports that have considered the idea are contradictory. Some authors suggest that predation rates decrease with close proximity to humans (Isbell & Young, 1993; Stanford, 2002), while others point out that certain types of predation may be favorable in anthropogenic habitats (chimpanzees: Grieser Johns & Grieser Johns, 1995; leopards: Ludwig *et al.*, 2007). Domestic dogs are now reported in the literature as effective monkey predators (De Oliveira *et al.*, 2008; Raguet-Schofield, 2008), and some wildlife may seek out anthropogenic habitats as well. Certainly human factors impact predation, but the nature of the change will be site specific. While we cannot account for every impact human disturbance places on a primate community, it is important to realize that wild primates face different challenges than they would in the absence of human encroachment. Predation rates may be impacted in a number of ways, namely: (1) predators may be adverse to human altered habitats, reducing predation risk; (2) anthropogenic habitats may encourage certain predators, increasing predation risk; or (3) the predator assemblage of a habitat changes, with potentially drastic effects on endemic wildlife that lack the experience and selection-driven behavioral patterns necessary to avoid these predators. As primate habitats become increasingly anthropogenic, their predation risks — and potential predators — are bound to change.

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EARLY BEHAVIORAL DEVELOPMENT OF A FREE-RANGING HOWLER MONKEY INFANT (*ALOUATTA GUARIBA CLAMITANS*) IN SOUTHERN BRAZIL

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Márcia Maria de Assis Jardim

Introduction

In comparison with other mammals, the offspring of primates undergo a relatively long period of behavioral development and dependency upon their mothers. During this period, the mother is a secure base from which the infant is able to explore the environment and engage in social behavior (Vochteloo *et al.*, 1993), acquiring the ecological skills of the species and the social traditions of the family troop (Southwick and Siddiqi, 1974). Independence is the result of a long period of increasing self-sufficiency in activities such as locomotion and feeding, as well as growing sociability and distance from the mother (Altmann, 1980; Odalia-Rímoli, 1992). Mother-infant ties constitute one of the most intense types of social relationship in primates (Harlow and Zimmermann, 1958, Altmann, 1959), and have a positive effect on infant survival and development.

Howler monkeys (genus *Alouatta* Lacépède, 1799) are the most widely-distributed Neotropical primates (Chapman and Balcomb, 1998), and are also the best studied in the wild. They occupy a variety of habitat types, and are well-adapted to anthropogenic fragmentation (Crocket, 1998), although some species are declining rapidly in the wild and have been classified as threatened (IUCN, 2009). Howlers have been translocated and re-introduced at a number of sites (e.g. Agoramoorthy, 1995), and a critical factor for such management procedures is the successful handling of females with nursing infants (Baker, 2002). Knowledge of the behavioral development of infants can obviously contribute to the efficiency of such procedures (International Primatological Society, 2007).

Studies of the behavioral development of primate infants have focused on their social behavior and spatial relationships with their mothers. In howlers, studies have been conducted on free-ranging *Alouatta guariba* (Kats and Otta, 1991), *Alouatta palliata* (Altmann, 1959; Clarke, 1990; Lyall, 1996), and *Alouatta seniculus* (Mack, 1979; Cabrera, 1997). Allomaternal care is well documented in female howlers (Calegaro-Marques and Bicca-Marques, 1993), but is rare in males (Marques and Adis, 2000). In this study, the early behavioral development of a male infant *A. guariba clamitans* was monitored in a free-ranging group in southern Brazil.

Materials and methods

Study area and subjects
The study was undertaken in Itapuã State Park (30°23'S, 51°30'W), in the city of Viamão, Rio Grande do Sul, Brazil, from August 2003 to April 2004. The climate in the region is temperate, with hot summers and no clear dry season (Cfa type of Köppen´s classification; Peel *et al.,* 2007). The home range of the study group was estimated to be approximately 8.71 ha of semi-deciduous forest on a granite hillside bordering a sandy beach, known as Pedreira (Marques, 2001; Jardim, 2005). In August 2003, the study group was composed of two adult males, one sub-adult male, one juvenile male, two adult females, and one male infant (the study subject—see below). Although the exact date of this infant's birth could not be determined, we estimated that it was between two and three months of age, based primarily on body size (Carpenter, 1934; Altmann, 1959; Kowalewski and Zunino, 2004) and the ontogeny of independent behaviors. In March 2004, another male infant was born in the troop, an adult female immigrated, and an adult male disappeared.

Observation methods
From August, 2003 to April, 2004, the behavior of the infant male subject was monitored for two days each month, except October (one day). Data were collected using focal-animal sampling with continuous recording (Altmann, 1974) from sunrise to sunset (around 9 hours of observation per day). Samples of three minutes duration were collected at ten-minute intervals, with a total of 810 samples collected over 155 hours of monitoring. During each sample, the infant's behavior and its position in relation to its mother were recorded according to the categories defined in Table 1. Other behaviors, such as drinking and rejection by the mother, were recorded in *ad libitum* fashion (Altmann, 1974). Nursing was not recorded here because of the difficulty of determining this behavior reliably.

Results

Infant-mother relationships
In the first month of observations, when the infant was two or three months old, he spent 86.8% of the day on the mother, mostly in the ventral position (Fig. 1), although he was carried on the dorsum during troop movements. In subsequent months, the infant spent increasingly less time on the mother. Ventral carrying during troop movements ceased in November (5–6 months), and dorsal carrying in December (6–7 months), although ventral and dorsal contact with the mother were recorded up to March and April, respectively. By the end of the study period, the infant was in contact with its mother less than 30 percent of the time.

Resting (*Fig. 2a*)
Initially, the infant spent most of its time at rest, and almost always rested while being carried by the mother until 4–5 months old. The infant was observed resting at a distance from its mother for the first time in November, but this only became common by the end of the study. By the age of 8–9 months, time spent resting stabilized at 55–60% of observation time.

Locomotion (*Fig. 2b*)
The earliest bouts of independent locomotion occurred in September (3–4 months old). This activity increased progressively until 6–7 months, but was subsequently irregular. Independent movement of the infant was monitored and stimulated by the mother, by moving very slowly through the trees and waiting for the infant to follow. Sometimes, the mother would move to a branch and emit a vocalization until the infant arrived. When crossing a wide gap in the trees, the mother used her own tail or body as a bridge or carried the infant on her dorsum.

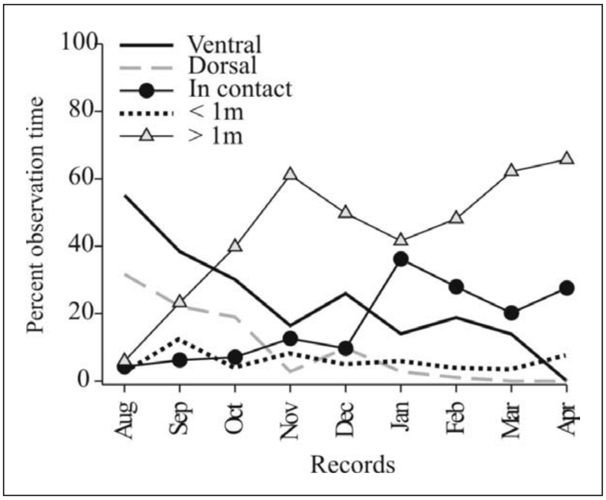

Figure 1. Mean percentage observation time spent by the *A. guariba* infant in different contact categories (see Table 1) in each month during the study period.

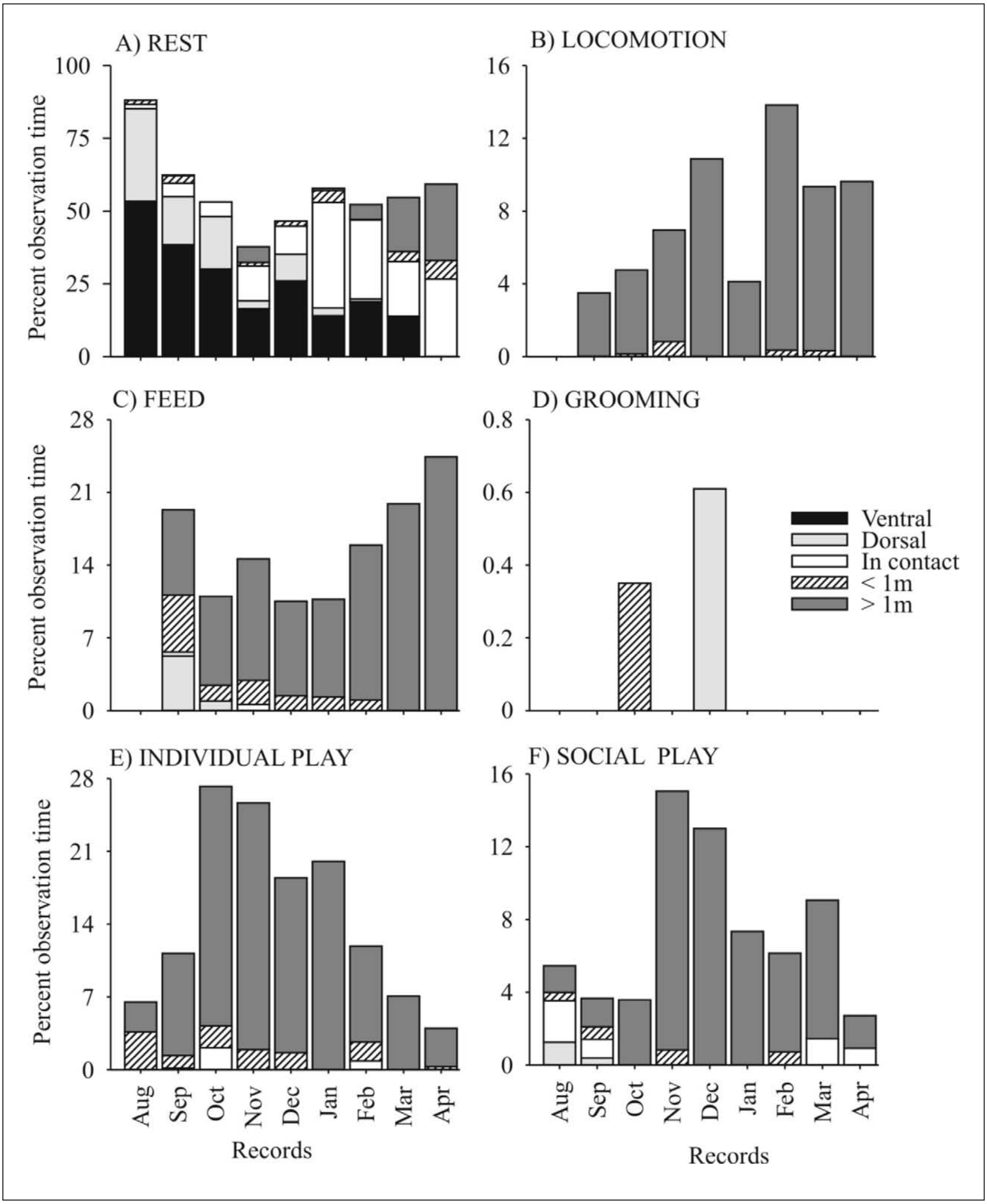

Figure 2. Percentage of time spent by the howler infant in different behaviors and in different forms of contact with its mother during the study period. See Table 1 for behavior and contact categories.

Feeding (*Fig. 2c*)

The infant also started eating solid food at 3–4 months. Initially, the infant was usually either being carried by its mother or close to her during this behavior, which allowed it to observe the items ingested by the mother and then repeat her movements. Contact declined rapidly by the following month. The howlers usually drank water from bromeliads, and this behavior was first noticed in the infant at 8–9 months, the same period when the mother began rejecting the infant when it tried to nurse.

Grooming (*Fig. 2d*)

The infant was observed grooming on two occasions. On the first, he was 4–5 months old, and mimicked his mother when grooming an adult female. On the second occasion, at 6–7 months, the infant groomed its mother.

Play (*Fig. 2e–f*)

The infant already exhibited play behavior when observations began. The highest frequency occurred at 5–6 months, reaching around 50% of the daily observation period. After this peak, the behavior tended to decline towards the end of the study. Play almost always took place when the troop was at rest. During individual play, the infant explored its immediate environment. Social play initially involved the infant's mother, and gradually involved a juvenile male. Play was also recorded with the dominant adult male.

Discussion

While the infant grew progressively independent, it maintained relatively close ties with its mother, invariably resting together, even at the end of the study. Overall, the behavioral development of the infant was similar to that recorded in previous studies of howlers (Altmann, 1959; Mack, 1979; Clarke, 1990; Kats and Otta, 1991; Lyall, 1996; Cabrera, 1997). The transition from exclusive ventral carrying in the first few weeks of life to a predominance of the dorsal position is a typical pattern in monkeys, including howlers (Altmann, 1959; Mack, 1979; Shoemaker, 1979; Kats and Otta, 1991; Lyall, 1996; Miranda *et al.*, 2005). Increasing distance from the mother is also typical. Kats and Otta (1991) confirmed a progressive increase in distance from the mother at 3–4 month of age in *A. guariba*, while Miranda *et al.*, (2005) found that contact with the mother declined to 10% of activity time by the fifth month of age. In the present study, the infant was more than 1 m from its mother for 6% of the time at 2–3 months old, increasing to 70% only at 1 year. A possible regression in this trend was recorded at 7–8 months, however, which may represent a critical period of insecurity or a regression in suckling (Horwich, 1989).

According to Mack (1979), prior to six months of age, howler infants may bite and chew the same type of object that the adults are eating, but not necessarily consume it. Maybe, the high feeding percentages observed in the first months of this study refer to an exploratory feeding which occurred in contact or near the mother. The stabilization of rest at 55–60% by 7–8 months corresponds to the typical rate of adults in this study group (Marques, 2001). This stabilization occurred at the same time as the frequency of play behavior began to decline. Both play and grooming have an important social function (Southwick and Siddiqi, 1974). One possible factor determining rates of social play in the present study was the availability of potential partners, i.e. other immature individuals. Grooming appears to be relatively common in *A. guariba* in comparison with other howlers (Kinzey, 1997); this behavior was part of the behavioral development of the studied infanWhile behavior patterns are best evaluated on the basis of a sample of different individuals, the present study provides some useful preliminary insights on

Table 1. Howler monkey infant behavioral categories based on proximity to the mother and activity.

Position	Description
Ventral	Carried by the mother in a ventral position
Dorsal	Carried by the mother in a dorsal position
In contact	In contact with the mother's body, other than the ventrum or dorsum
< 1m	Less than a meter from the mother's body
> 1m	More than a meter from the mother's body
Activity	**Description**
Rest	Sitting or lying
Locomotion	Moving independently
Feed	Handling, processing or ingesting solid foods
Grooming	Sifting through another animal's fur with the hands
Individual play	Handling objects, hanging from tail and jumping between branches
Social play	Interactions with other troop members involved mock fighting (holding, pulling, baring teeth, and biting) and chasing, often involving jumping
Drink	Ingesting water

the behavioral development of infant howlers of the species *Alouatta guariba*. The patterns observed appeared to be typical of the genus.

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HUNTING STRATEGY OF THE MARGAY (*LEOPARDUS WIEDII*) TO ATTRACT THE WILD PIED TAMARIN (*SAGUINUS BICOLOR*)

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Introduction

Wild primate predation has been widely reported for various Neotropical cat species. Apparently, prey body size and predator body size are related, with large cats preying mainly on large primates. Remains from different species of primates have been observed in scats of different Neotropical cat species (Table 1). According to Cabrera and Yeppes (1940), primates are the favorite prey of *Puma yaguaroundi* in some regions of Central America. More recently, Miranda *et al.* (2005), found fingers and nails from *Alouatta guariba clamitans* in two fecal samples from *Leopardus pardalis* and suggests that the ocelot may be a potential predator of all Neotropical primates.

In this study, we focus on a hunting technique by the margay, *Leopardus weidii*. Morphologically, margays have arboreal adaptations, but there are no published reports of the predation strategy of wild margays. The few studies on the margay suggest that its diet is mainly composed of arboreal mammals. Mondolfi (1986) analyzed the stomach contents of margay from Venezuela and found remains of squirrel (*Sciurus granatensis*) and the wedge-capped capuchin monkey (*Cebus olivaceus*-cited as *nigrivittatus*, a junior synonym). Margay prey species in Guyana were also arboreal mammals (Beebe 1925). In captivity, margays were observed preying on *Saguinus niger* (Oliveira, 1998).

In the course of our field research on felids, we interviewed local Amazon jungle inhabitants (woodsmen and mestizo indians) in different regions of central Amazonia to learn about the biodiversity of local habitats, and in particular, the natural history of Neotropical cat species, including their prey capture techniques. Interestingly, several of the interviewees described a common predation strategy by Neotropical cats as attracting their prey by mimicking the prey species' vocalizations. More than a dozen reports of *Puma concolor*, *Panthera onca* and *Leopardus pardalis* mimicking vocalizations of agoutis (*Dasyprocta* spp.), tinamous or nambús (*Crypturellus* sp.) and solitary tinamous or macucos (*Tinamus* sp.) were made in different river basins (Madeira, Juruá and Purus) (Table 2). Until now, no scientific observations of this type of behavior have been published

Table 1. Review of primates predated by Neotropical cat species.

Predator	Prey	Location	Citation
Panthera onca	*Ateles belzebuth*	La Macarena, Colombia	Matsuda and Izawa (2008)
	Alouatta seniculus	Venezuela	Peetz *et al.* (1992)
	Brachyteles arachnoides	Intervales State Park, Southeast Brazil	Olmos (1994)
	Ateles [paniscus] chamek	Perú	Emmons (1987)
Puma concolor	*Ateles geoffroyi*	Corcovado National Park, Costa Rica	Chinchilla (1997)
	Ateles geoffroyi	Maya Biosphere Reserve, Guatemala	Novack *et al.* (2005)
	Ateles Belzebuth	La Macarena, Colombia	Matsuda and Izawa (2008)
	Alouatta pigra	Maya Biosphere Reserve, Guatemala	Novack *et al.* (2005)
	Alouatta caraya	Mutum Island, Southern Brazil	Ludwig *et al.* (2007)
	Ateles chamek	Perú	Emmons (1987)
Leopardus pardalis	*Saguinus* spp.		Goldizen (1987)
	Saguinus nigricollis	Colombia	Izawa (1978)
	Alouatta guariba	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Brachyteles hypoxanthus	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Cebus apella nigritus	Caratinga Biological Station, Southeast Brazil	Bianchi & Mendes (2007)
	Alouatta g. clamitans	Chácara Payquere, Southern Brazil	Miranda et al (2005)
	Saguinus fuscicollis	Perú	Emmons (1987)
	Saimiri sciureus	Perú	Emmons (1987)
Puma yaguaroundi	Primates		Cabrera & Yeppes (1940)
	Callithrix jacchus	Paraíba State, Northeast Brazil	Ximenes (1982)
Leopardus wiedii	*Cebus olivaceus*	Venezuela	Mondolfi (1986)
	Saguinus niger	(in captivity)	Oliveira (1998)
	Cebus apella	British Guiana	Beebe (1925)

for Neotropical felids. Here we report the first field observation of margay mimicking behavior, recorded during field research on the primate pied tamarin (*Saguinus bicolor*) at the Reserva Florestal Adolpho Ducke (59 56' 15,71556" W, 02 56' 25,75037" S) in Manaus, Brazil (for a description of the area, see Ribeiro *et al.*, 1999). In this brief report we suggest that *L. wiedii* uses a mimicking strategy to capture its prey. Our record confirms the reliability of the information provided by the local Amazonian inhabitants.

On October 12, 2005, at 9:13 am, a group of eight pied tamarins monitored by telemetry was feeding in a Moraceae (*Ficus* sp.). A large vine at 15 meters height connected the surrounding trees to the fig tree. At 9:18 am, a margay attracted the attention of a tamarin sentinel (Gordo *et al.*, 2005) by producing calls similar to those emitted by pied tamarin pups. The adult male sentinel climbed up and down the tree to investigate the calls coming from behind the liana tangles. It assumed a surveillance position and, using specific calls, warned the group about the foreign calls. At 9:22 am we observed movements in the vine and keep hearing the call imitations. At 9:29 am three pied tamarin individuals were feeding on *Ficus* sp. while the tamarin sentinel was keeping surveillance. At 9:40 am, four pied tamarins climbed up and down the Moraceae in response to the repeated aggressive calls from the tamarin sentinel. At that moment, was observed a cat with small body but big feet, huge eyes and a long tail walking down the trunk of a tree (like a squirrel); it quickly jumped to a liana that was connected to the fig tree and moved toward where the tamarins were feeding, about 15 meters away. At this moment, the sentinel emitted a high scream as the predator approached the group; and the group fled immediately.

In our observations, the strategy used by *Leopardus wiedii* to imitate its prey was not effective in catching *Saguinus bicolor*. However, we suggest that this strategy is very effective in attracting prey, facilitating the attack and reducing energy expenditure during a possible pursuit. Curiously, all the potential prey (agoutis, macucos, and nambus) cited by the Amazonian inhabitants produce extremely acute vocalizations, which possibly match the potential repertoire of felines. In addition, all the aforementioned potential prey species use vocalizations in intra-specific territorial demarcation. This increases the cats' chance of success in attracting prey by imitation.

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Table 2. Reports of mimicking vocalizations of *Puma concolor*, *Panthera onca* and *Leopardus pardalis.*

Location	Cat Species	Prey Species Imitated
Rio Madeira/2005*	*Panthera onca*	*Dasyprocta fuliginosa*
Rio Aripuaná/2005*	*Panthera onca*	*Crypturellus* sp.
Rio Aripuaná/2005*	*Puma concolor*	*Dasyprocta* sp.
Rio Aripuaná/2005*	*Leopardus pardalis*	*Crypturellus* sp.
Rio Juruá/2004	*Leopardus pardalis*	*Crypturellus* sp.
Rio Juruá/2004	*Puma concolor*	*Crypturellus* sp.; *Tinamus* sp.
Rio Javarí/2009	*Panthera onca*	*Crypturellus* sp.
Rio Purus/2009	*Leopardus* sp.	*Crypturellus undulatus*
Rio Urubu/2006	*Puma concolor*	*Dasyprocta leporina*
Atlantic Forest/2003**	*Puma concolor*	*Crypturellus obsoletus*

*see Röhe 2007 for a description of the area.

** Atlantic Forest location is Serra de Paranapiacaba, São Paulo State, Brazil (see Röhe *et al.* 2003; Tófoli *et al.* 2009).

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PERUVIAN RED UAKARI MONKEYS (*CACAJAO CALVUS UCAYALII*) IN THE PACAYA-SAMIRIA NATIONAL RESERVE — A RANGE EXTENSION ACROSS A MAJOR RIVER BARRIER

Mark Bowler
Javier Noriega Murrieta
Maribel Recharte
Pablo Puertas
Richard Bodmer

According to Hershkovitz (1987) *Cacajao calvus ucayalii*, listed as Vulnerable by the IUCN, (Veiga & Bowler, 2008) is distributed from the east bank of the Rio Ucayali in an easterly direction to the Rio Yavarí and from the Rio Amazonas in the north to the Rio Urubamba in the south. Hershkovitz (1987) also includes the east bank of the lower Yavarí in Brazil, but its presence there has not been confirmed and it is possible that museum specimens marked as collected on the Brazilian bank of the Yavarí actually came from the Peruvian side where this primate is locally abundant. Surveys conducted between 1979 and 1986 (Aquino 1988) showed that the range was much reduced, hunting having exterminated the species in several areas. Aquino (1988) suggested that the southern limit is now probably the Rio Sheshea and that populations close to the Rios Ucayali and Amazonas have also been reduced and in some areas populations have been exterminated (Fig. 1). Populations of *Cacajao calvus* observed by Peres (1997) on the upper Rio Juruá and unconfirmed reports by Fernandes (1990) in the Brazilian state of Acre on the upper Juruá and Purus are either of *Cacajao calvus novaesi* or *Cacajao calvus ucayalii*, which would extend the known ranges of either of these subspecies.

The Rio Ucayali is the largest tributary of the Rio Amazonas and at 400–1,200m wide presents a significant barrier to primate populations. However, the constantly-changing course of the river means that very large islands of forest big enough to support small primate populations effectively cross from one side of the river to the other as oxbow lakes are formed, particularly near the mouth of the river where it meets the Rio Marañon to form the Rio Amazonas. *Cacajao calvus calvus* has been found on both sides of the Rio Amazonas (Sousa e Silva Júnior and Martins 1999), demonstrating that the ranges of subspecies of *Cacajao calvus* can traverse major river barriers. Isolated reports of red uakari monkeys west of the Ucayali on the Rio Yanayacu, a tributary of the Rio Marañon, running more or less parallel to the Rio Ucayali, in the Pacaya-Samiria National Reserve (PSNR) have occurred for a number of years. Until now, these reports have been unconfirmed. Rumoured sightings have emanated largely from the community of Yarina on the Rio Yanayacu, a seasonally blackwater stream about 40m in width flowing exclusively through white-water *varzea* forests in the Pacaya-Samiria National Park. The Yanayacu flows 158 km from Lago El Dorado, to meet the Rio Marañon 30km upstream from the city of Nauta. Yarina was founded in the PSNR in the 1980s, and for this reason most of the adults in the community have not lived in Yarina or the PSNR all their lives. The NGO ProNaturaleza has worked with the communities on the Yanayacu for various years, and has coordinated a successful community-based conservation program here. Hunting for wild meat is not a principle activity in Yarina, and there are healthy populations of wild animals.

In September 2006, we made a short expedition to conduct interviews in Yarina and search the site for red uakari monkeys. Although red uakaris were not encountered during this expedition, several residents of Yarina reported seeing red uakari monkeys, usually in small groups on the banks of the river. Only two residents of Yarina regularly hunt, and both reported infrequent observations of groups of 20 or more uakaris. In addition to the recent observations, 3 older men (one from Yarina and two from the small nearby village of Arequipa) claimed to have seen red uakari monkeys years ago, when they used to make hunting and fishing expeditions into the forest. There was a high level of consistency between interviews, and considerable detail was given within some of the interviews. The observations were virtually all within an area of about 200km² (20,000ha) bounded by a large bend in the Rio Yanayacu (Fig. 2).

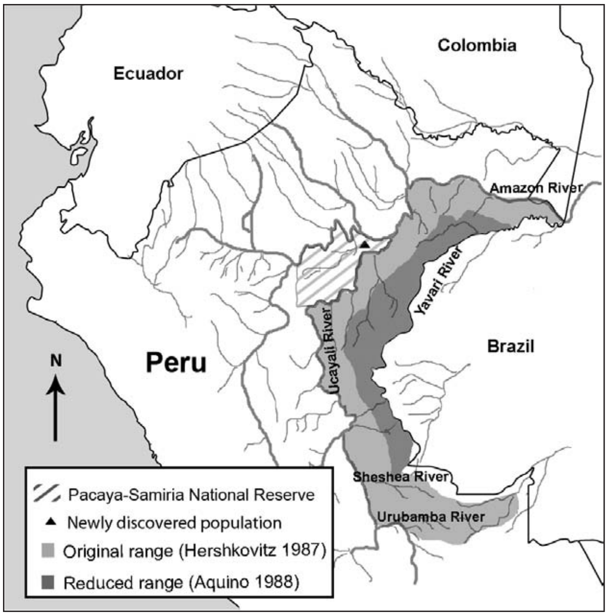

Figure 1. The original distribution of *Cacajao calvus ucayalii* (Hershkovitz, 1987), the distribution in 1986 (Aquino, 1988) and the newly discovered population. Map adapted from Aquino (1988).

On three days between 3-10-2008 to 5-10-2008, during investigations on the Rio Yanayacu for a project on Giant Otters *Pteronura brasiliensis*, Mark Bowler from the Durrell Institute of Conservation and Ecology and Tony Laiche from the community of Yarina visited Quebrada Ahuara, a site highlighted during interviews in 2006 as one where persistent sightings of red uakaris occurred. At 10am on 3rd October 2008, we encountered a group of red uakaris near Quebrada Ahuara (04°56'19.9"S, 74°08'26.1"W) (Fig. 2). We followed the group for one hour and 10 minutes covering at least 900m, but the uakaris were nervous and fled throughout the encounter. During the follow, we counted at least six individuals including at least one adult male, an adult female carrying a baby, a juvenile, and two older juveniles or sub adults. From the contact calls given by the monkeys, we estimated that the group contained at least ten individuals. Four clearly-different individuals were photographed (Fig. 3). We searched the area around the sightings for several hours on the following two days, but were unable to relocate the group. These new observations and interviews confirm the presence of the species on the west bank of the Ucayali extending the known range of *Cacajao calvus ucayalii* into the PSNR (Fig. 1). Until this discovery, the only protected area known to contain the subspecies was the regional Tamshiyacu-Tahuayo Communal Reserve, and while managing hunting is seen as the priority in this region (Bodmer 1995), protected areas play

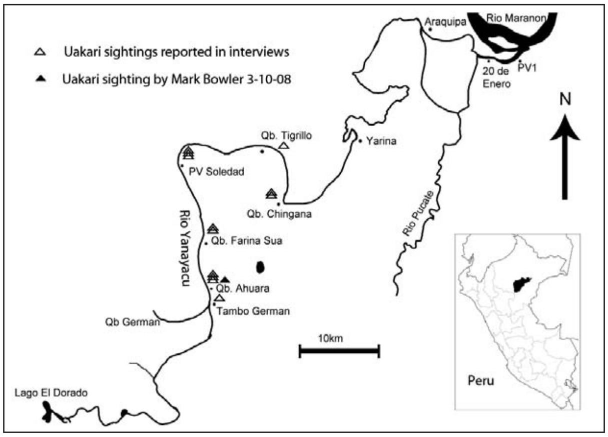

Figure 2. Locations of red uakari sightings on the Rio Yanayacu given in interviews (open triangles) and by Mark Bowler on 3-10-2008 (closed triangle).

an important role in national and regional conservation strategies and conservation projects often focus around these areas.

The confirmation of red uakari monkeys in the Pacaya-Samiria National Reserve adds a new primate to the species list for the reserve, bringing the total number of species to 13. This is an extremely diverse primate community and one unequalled in areas of extensive *várzea*. The striking appearance and rarity of this monkey means it is used as a flagship species and as focus for conservation efforts in the Peruvian Amazon and will may prove a draw for tourism on the Rio Yanayacu, even though sightings of the monkeys would probably be very infrequent. Tourism already appears to be working well within the successful management plans for the area overseen by ProNaturaleza.

Informal conversations with people from the communities of Yarina and Manco Capac who were working in the community guard posts around Lago El Dorado and on the Yanayacu during our expedition, mentioned that large groups of uakaris used to inhabit the area around the community of Manco Capac in the Reserve, on the bank of the Ucayali River contiguous with the forests around Quebrada Ahuara. However, the species had not been seen there for 10 or 20 years. Higher levels of activity on this river in the past, from illegal loggers and people entering the reserve to extract resources have probably reduced densities of this primate by hunting. The uakaris observed at Quebrada Ahuara were very nervous, and fled from investigators. This suggests that the group may have experienced hunting in the past. However, the area is now protected by members of the community of Yarina, who do not hunt

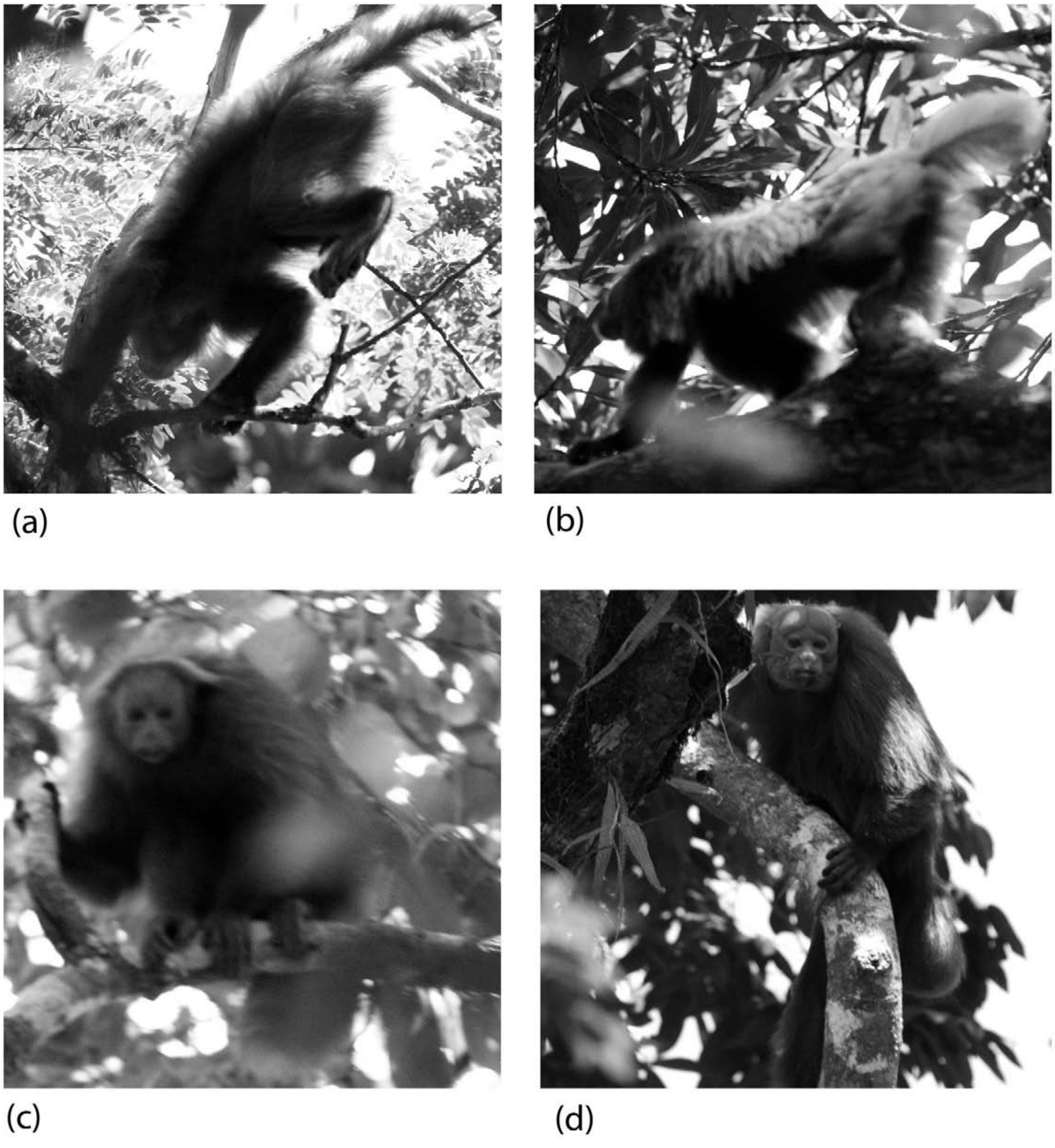

Figure 3. Four recognisably different red uakaris photographed on the River Yanayacu on 3-10-2008 by Mark Bowler; **a**) Juvenile, **b**) juvenile/subadult, **c**) juvenile/subadult, **d**) adult male.

this primate. This small population of uakaris would be extremely vulnerable to illegal hunters entering the reserve from the Rio Ucayali. Although a detailed census has yet to be conducted, the population must be extremely small, may be experiencing inbreeding, and it will require special consideration if it is to persist. The population in the PSNR is the only known population of the subspecies *Cacajao calvus ucayalii* occurring in the complete absence of non-flooding *terra firme* forests. Establishing the size and composition of this population will be essential in estimating its viability, and putting in measures for its conservation. Monitoring the population in the long term might also give an idea about how this species might fare when its densities are low. More complete census is therefore required. Community groups and ProNaturaleza will then have to consider conservation actions for this primate.

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COMUNICACIÓN VOCAL DE UN GRUPO DE TITÍ GRIS (*SAGUINUS LEUCOPUS*) EN MARIQUITA, COLOMBIA

Luz Helena Rueda
Enrique Zerda Ordóñez

Introducción

El tití gris (*Saguinus leucopus*) es un primate arborícola pequeño, endémico de Colombia, que habita bosques primarios y secundarios y en la actualidad, muchas de sus poblaciones se han adaptado a sobrevivir en hábitats altamente fragmentados y degradados (Fajardo, 2000). La alteración de sus hábitats naturales y otros factores como la cacería y el comercio ilícito, han puesto en riesgo la supervivencia de las poblaciones naturales (Defler, 2003). En cuanto a estudios sobre bioacústica de la especie, Blumer y Epple (reporte no publicado) realizaron un trabajo sobre el comportamiento y las vocalizaciones de tres machos y una hembra tití gris, en condiciones de laboratorio. Sin embargo, hasta el momento no se habían realizado investigaciones sobre el tema con poblaciones naturales. Aunque *Saguinus leucopus* es una especie objeto de interés a nivel nacional e internacional, lo cual se refleja en las diferentes investigaciones realizadas enfocadas hacia su ecología, comportamiento, genética, manejo *ex situ*, entre otras temáticas (Vargas y Solano, 1996; Cuartas-Calle, 2001, 2004; Poveda y Sánchez-Palomino, 2004; Roncancio, 2005; Leguizamón-Hernández *et al.*, 2006; Morales-Jiménez, 2007; Sánchez-Londoño, 2007a, 2007b), aún existen vacíos de información principalmente sobre aspectos como densidad, distribución, comportamiento y salud física de las poblaciones naturales actuales. En este sentido, el presente trabajo pretende ampliar el conocimiento sobre la comunicación vocal de la especie y aportar información novedosa desde la bioacústica, que pueda aplicarse en estudios de ecología poblacional; específicamente el uso de vocalizaciones como herramienta en censos y en la estimación de densidades poblacionales para la especie. Esta investigación presenta una caracterización del repertorio vocal de un grupo de *Saguinus leucopus*, en la cual se identifican, describen y relacionan las vocalizaciones con los patrones comportamentales, sexo y edad de los individuos.

Métodos

Área de estudio

El estudio se desarrolló en San Sebastián de Mariquita, departamento del Tolima, en la casa de la Fundación Segunda Expedición Botánica – Funbotánica (FSEB) (Fig. 1). Mariquita está localizada al norte del departamento del

Tolima a una altura de 535 msnm, a los 74°47'54"W y 5°11'42"N. La casa de la FSEB tiene un área de 4,210 m^2 (Rueda, 2003), en la que crecen árboles frutales de gran porte como mangos (*Mangifera indica*), cauchos (*Ficus* sp.), naranjos (*Citrus aurantium*), marañones (*Anacardium occidentale*) y plátanos (*Musa sapientum*) (Poveda, 2000).

Descripción del grupo Funbotánica

El grupo residente en la casa de la FSEB no se encontraba en cautiverio ni semi-cautiverio, pues los animales no ocuparon dicho espacio por acción humana, sino por efectos naturales. Al parecer una pareja de titís quedó aislada del Bosque Municipal "José Celestino Mutis" (cercano a la casa de la Fundación) durante el evento de la Avalancha del Volcán Nevado del Ruiz en el año 1985, buscando refugio y alimento en las casas cercanas y estableciéndose en la casa de la FSEB que cuenta con uno de los solares más grandes de la vecindad. Por consiguiente, para efectos de este estudio el grupo se considera como "grupo urbanizado". Durante el periodo de estudio, los titís se desplazaron libremente de una casa a otra utilizando los árboles de los solares y los muros de separación entre las casas y contaban con recursos alimentarios (frutos, resinas y otras partes vegetativas de las plantas de los solares; insectos, entre otros) y refugios para sobrevivir. Sin embargo, el grupo estuvo restringido por la poca disponibilidad de recursos alimentarios en ciertas épocas, sumada a los intentos de captura por parte de los vecinos de la casa. Al inicio del estudio, el grupo estaba conformado por 11 individuos (7 machos y 4 hembras) y posteriormente en el mes de mayo nacieron dos crías, para un total de 13 individuos. Se definieron las categorías de edad (cría, juvenil y adulto) con base en el tamaño corporal, en particular, tamaño de la melena, longitud cabeza-cuerpo y longitud de la cola. Esto se logró sólo mediante observaciones a distancia de los individuos, debido a que no se realizaron capturas.

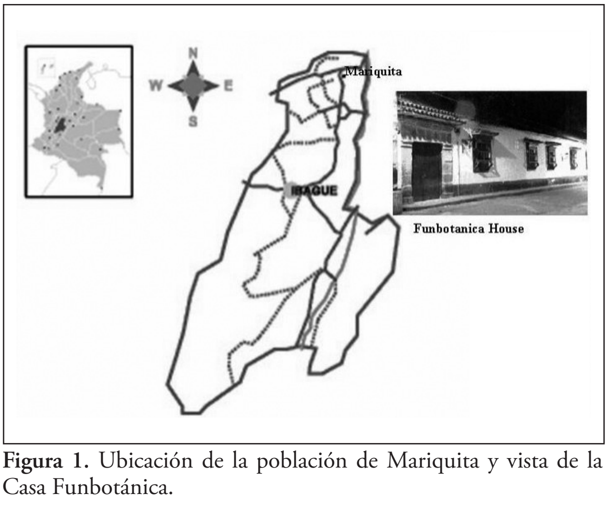


Figura 1. Ubicación de la población de Mariquita y vista de la Casa Funbotánica.

Fase de campo

El trabajo de campo se realizó durante los meses de marzo, mayo y de julio a septiembre de 2002, con un esfuerzo de muestreo de 1200 horas, correspondiendo a muestreos de 10 días por mes. Inicialmente se hizo el reconocimiento del sitio de estudio y la habituación del grupo a estudiar. Durante esta fase (marzo-mayo y julio-septiembre) se realizaron observaciones desde las 07:00 hasta las 18:00 horas, con el propósito de conocer el número de individuos, establecer su ritmo de actividad e identificar los lugares frecuentados para descanso, alimentación y demás actividades diarias. Para el reconocimiento de los individuos se consideraron características particulares tales como sexo, tamaño del cuerpo, tamaño de la melena y vocalizaciones. Las primeras observaciones de comportamiento fueron efectuadas desde las 05:45 hasta las 18:00 horas durante el mes de marzo de 2002. Se utilizaron los métodos de muestreo *ad libitum* y animal focal y el método de registro continuo (Altmann, 1974), con ayuda de binoculares Tasco® 7 X 35 mm y de una cámara de video Sony® CCD-TRV-308, 460x. Se registró la fecha y hora del muestreo, identificación del animal (nombre y/o rasgos distintivos) y descripción del comportamiento observado (básicamente comportamientos de locomoción, exploración, alimentarios, sociales, sexuales y agonísticos).

Durante los meses de mayo y julio a septiembre de 2002 se desarrolló la fase de grabación de las vocalizaciones, con un esfuerzo de muestreo de 480 horas aproximadamente. Se utilizó una grabadora Sony® TCM-5000EV, casetes Sony®, micrófono Sennheiser® ME66 y audífonos de aro. Para las grabaciones se efectuaron "muestreos del comportamiento" con registro continuo (Zerda 2002); sin embargo, el tiempo de grabación fue variable, dependiendo de la actividad vocal de los titís. Para cada registro se anotó la fecha y hora de la vocalización, el número de registro, la identificación del emisor, el contexto (comportamiento del animal al emitir la vocalización y acontecimientos alrededor del mismo) y en algunos casos se registró la respuesta a la vocalización emitida. Para algunos registros de grabación no fue posible identificar ni el emisor ni su comportamiento asociado, así que sólo se contó con el registro de la vocalización.

Digitalización y análisis de las vocalizaciones

La digitalización de los vocalizaciones se realizó con una grabadora Marantz® CP 430, en un computador Toshiba® portátil satélite 2800. Los archivos fueron analizados con el programa Syrinx® (Burt 2001) versión 2.2 K y se filtraron para discriminar las vocalizaciones de los titís del resto de sonidos o ruido ambiental. Se elaboraron espectrogramas y en cada uno se midió la frecuencia y duración de la señal fundamental. Se aplicó estadística descriptiva a los datos de frecuencia máxima, frecuencia mínima y duración de las vocalizaciones. Se calculó una medida de tendencia central (media) y dos medidas de variabilidad (varianza y coeficiente de variación de Pearson).

Resultados

Caracterización de las vocalizaciones
Se obtuvieron 270 registros de grabación y se identificaron en total 14 vocalizaciones distintas. La cobertura de muestra (Fagen y Goldman 1977) fue $\theta = 0.9523$. Para clasificar las vocalizaciones se consideraron tres aspectos: forma, propiedades acústicas y referencias bibliográficas (Blumer y Epple reporte no publicado; Proyecto Tití 2009). Se identificaron 8 categorías o clases de vocalizaciones: Silbido, 'chiiih', chirrido, 'pip', chillido, 'chirr', 'chirchi' y 'U' invertida. En la Tabla 1 se muestran las frecuencias y duraciones de cada vocalizacón.

Catálogo de vocalizaciones
En la tabla 2 se presenta el nombre, descripción, comportamiento asociado, categoría de edad y/o sexo asociado y el sonograma de las 14 vocalizaciones identificadas. Los titís emitieron señales vocales asociadas a contextos específicos como alimentación, contacto con otros individuos del grupo a la vista y fuera de ella, desplazamiento, agresión, juego, alarma y amenaza. Las vocalizaciones 'chiiih' A y 'chiiih' B fueron específicas de los adultos. El chirrido A, chirrido B, chillido A y chillido B fueron emitidos solamente por individuos juveniles. El 'chirr' y el 'chirchi' fueron específicas de las crías. Las vocalizaciones emitidas por machos y hembras fueron muy similares, aunque se registraron variaciones (modulaciones) entre ambos sexos, dentro de la misma categoría de edad.

Discusión

Las vocalizaciones emitidas por los titís presentaron frecuencias y duraciones consistentes con los resultados obtenidos por Blumer y Epple (reporte no publicado) quienes señalaron que las vocalizaciones se encuentran entre 0.5 y 11.0 KHz y 0.05 y 1.5 seg, respectivamente. En comparación con la información de Proyecto Tití (2009) sobre las vocalizaciones de *S. oedipus*, también existe similitud en las vocalizaciones emitidas; particularmente, se observa una relación entre las frecuencias fundamentales, cuyo rango oscila entre 2.0 y 11.0 KHz. Es de esperar que dos especies cercanamente emparentadas produzcan vocalizaciones similares en cuanto a propiedades acústicas y significado. Tal es el caso de la combinación de señales para reconocimiento individual y para brindar información sobre sucesos en el ambiente (por ejemplo, llamadas de alarma), vocalizaciones ampliamente estudiadas en la especie *S. oedipus* (Cleveland y Snowdon, 1982; Weiss, 2001; Weiss y Hauser, 2002; Sproul *et al.*, 2006).

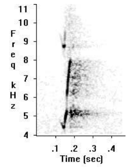
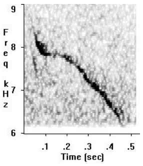
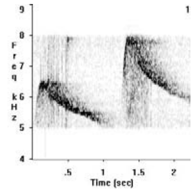
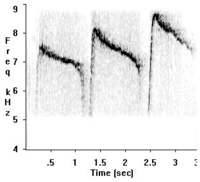
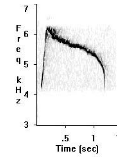
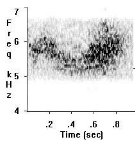
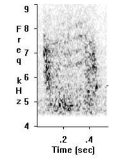
El silbido A fue la vocalización asociada específicamente a contextos alimentarios, en particular aproximación, manipulación y consumo de alimento. El grupo prefirió recursos en fruto como los mangos (cuya disponibilidad depende de la época de fructificación), tal como lo registra Poveda (2000) y cuando los consumen se incrementa la frecuencia, duración y el número de silbidos de este tipo. Los 'chiiihs' fueron las vocalizaciones más fuertes o agudas y se asociaron a comportamientos de contacto con aquellos individuos que están fuera de vista. Mediante algunos experimentos de 'playback', se observó que los individuos se acercaron a la fuente sonora (aún estando a grandes distancias) y exploraron el lugar, posiblemente para ubicar la fuente de emisión. Estos resultados sugieren que la señal comunica la ubicación de los individuos y permite la cohesión e integración del grupo, por lo tanto podría atribuírsele la función de llamada. Blumer y Epple (reporte no publicado) identificaron unas vocalizaciones como 'cheeeh' con características similares a los 'chiiihs' de este estudio e

Tabla 1. Medidas estadísticas de las frecuencias y duraciones de las vocalizaciones.

Vocaliz.	n	Media			Varianza			Coeficiente de Variación (%)			Valor máximo		Valor mínimo	
		F. máx. (KHz)	F. mín. (KHz)	Dur. (seg)	F. máx. (KHz)	F. mín. (KHz)	Dur. (seg)	F. máx. (KHz)	F. mín. (KHz)	Dur. (seg)	Frec. (KHz)	Dur. (seg)	Frec. (KHz)	Dur. (seg)
Silbido A	85	8.40	4.750	0.067	4.750	0.318	0.0001	12.434	11.872	17.89	10.947	0.114	3.235	0.035
Silbido B	16	8.25	5.588	0.478	0.208	0.314	0.016	5.529	10.038	27.204	9.472	0.742	4.761	0.272
'Chiiih' A	3	9.537	6.831	1.815	1.067	0.993	0.545	10.832	14.591	40.67	10.428	2.54	5.681	1.064
'Chiiih' B	2	7.563	4.047	2.895	3.109	1.375	0.169	23.312	28.983	14.23	8.810	3.186	3.217	2.604
'Chiiih' C	7	7.737	6.357	0.678	2.078	2.142	0.121	18.632	23.025	51.28	8.975	1.128	3.856	0.182
Chirrido A	8	6.483	4.103	0.711	0.273	0.663	0.022	8.070	19.844	21.10	6.961	0.906	2.882	0.499
Chirrido B	11	10.634	4.422	0.576	0.784	0.260	0.025	8.326	12.059	27.743	11.025	0.82	3.327	0.278
'Pip'	58	3.560	3.160	0.058	0.052	0.037	0.0001	6.424	6.158	23.598	4.570	0.108	2.790	0.002
Chillido A	10	8.793	3.570	0.654	0.436	0.780	0.099	7.515	24.741	48.12	10.091	1.2	2.004	0.130
Chillido B	3	9.031	3.292	0.606	0.035	0.286	0.002	2.096	16.264	7.697	9.241	0.66	2.712	0.572
Chillido C	4	5.686	3.198	0.420	1.174	0.232	0.021	19.057	15.074	34.966	6.726	0.64	2.553	0.335
'Chirr'	4	6.076	4.260	0.499	0.132	0.211	0.092	5.990	10.781	60.972	6.615	0.956	3.683	0.335
'Chirchi'	2	6.679	3.476	2.547	0.011	0.004	0.0001	1.577	2.0202	0.499	6.754	2.556	3.426	2.538
'U' invertida	44	7.164	4.055	0.115	0.539	0.169	0.002	10.252	10.158	40.211	9.364	0.222	2.205	0.039

igualmente correspondieron a las señales más fuertes. Los chirridos fueron vocalizaciones específicas de los juveniles, no registradas en adultos ni en crías. Esta particularidad permite sugerir que los chirridos pueden utilizarse para identificar individuos juveniles en estudios sobre composición de grupos silvestres. La vocalización ‘pip’ comunicó la presencia de objetos inquietantes o que pueden constituir una amenaza. Se observó que los titís emitieron ‘pips’ cuando una persona se les aproximó demasiado y el número de ellos estuvo condicionado al nivel del estímulo, es decir, entre más cercano el objeto estimulante mayor cantidad de ‘pips’. Los individuos que escucharon esta vocalización respondieron con este mismo tipo de vocalización, con otras vocalizaciones de alarma o con vocalizaciones entremezcladas. Esta vocalización presenta características similares con la vocalización ‘peep’ identificado por Blumer y Epple (reporte no publicado). El chillido A se registró en algunas ocasiones asociado a contextos de

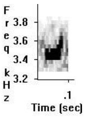
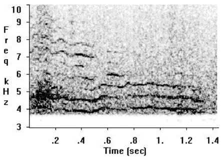
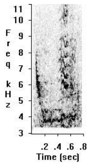
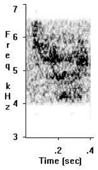
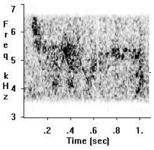
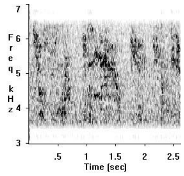
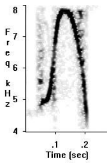
Tabla 2. Catálogo de vocalizaciones del grupo de *Saguinus leucopus* localizado en la casa Funbotánica. **A:** adulto, **J:** juvenil, **C:** cría, **M:** macho, **H:** hembra.

No.	Categoría de Vocalización	Descripción	Comportamiento Asociado	Edad Sexo	Sonograma
001	Silbido A	Monosílaba asociada a contextos alimentarios. Dependiendo del nivel de estimulación del animal, se registran secuencias desde dos hasta apróx. ocho vocalizaciones	Alimentario: aproximación, manipulación e ingestión de alimento	A, J, M, H	
002	Silbido B	Monosílaba para establecer contacto con otros individuos. Después de enviar esta vocalización, pueden emitir vocalizaciones de llamada (‘chiiih’)	Movimiento: desplazamientos. Social: contacto con otros individuos del grupo	A, J, M, H	
003	‘Chiiih’ A	Vocalización conformada por dos sílabas de frecuencia creciente, emitida para ‘llamar’ a los demás del grupo cuando están fuera de contacto visual	Social: para integración del grupo	A, M, H	
004	‘Chiiih’ B	Vocalización trisilábica de frecuencias crecientes, emitida al igual que el anterior, para ubicar a individuos que están distantes y fuera de contacto visual	Social: para “llamar” a los miembros del grupo. Integración y cohesión grupal	A, M, H	
005	‘Chiiih’ C	Monosílaba muy similar a los ‘chiiihs’ de llamada, pero su frecuencia es inferior. Se tienen algunos registros en los que emiten esta vocalización junto con una o dos más, de características similares	Social: ubicación dentro del grupo e integración con los demás individuos	A, J, C, M, H	
006	Chirrido A	Vocalización emitida por juveniles	Alimentario: Forrajeo. Movimiento y exploración	J, M, H	
007	Chirrido B	Vocalización combinada (es decir, multisilábica, conformando una unidad vocal) característica de los juveniles, emitida en diferentes contextos	Alimentario: búsqueda y manipulación del alimento Movimiento: diferentes desplazamientos	J, M, H	

pacificación de la agresión o resolución del conflicto; uno de los siete contextos en los que ocurre el intercambio de información (Bradbury y Vehrencamp, 1998) y la duración de esta vocalización podría estar condicionada al nivel de agresión. Blumer y Epple (reporte no publicado) identificaron una vocalización 'chee' con características similares al chillido A aquí reportado, y fue emitida únicamente por la pareja dominante durante encuentros agonísticos con otros individuos. El chillido B fue emitido durante contextos de juego, por lo general estuvo acompañado de otras vocalizaciones como chirridos y señales táctiles, caracterizando contextos de agresión de tipo lúdico; lo cual fue observado en los dos juveniles del grupo.

Las características y el significado específico de las vocalizaciones 'chirr' y 'chirchi' no fueron definidos, debido a

Tabla 2. cont'd. Catálogo de vocalizaciones del grupo de *Saguinus leucopus* localizado en la casa Funbotánica. **A:** adulto, **J:** juvenil, **C:** cría, **M:** macho, **H:** hembra.

No.	Categoría de Vocalización	Descripción	Comportamiento Asociado	Edad Sexo	Sonograma
008	'Pip'	Monosílaba producida al estar en contacto visual cercano con objetos que generan inquietud o que pueden constituir una amenaza. Se presentan secuencias de dos hasta 15 ó más vocalizaciones, dependiendo del grado de motivación del animal	Defensa: para protección del grupo ante posibles amenazas o predadores potenciales.	A, J, M, H	
009	Chillido A	Vocalización combinada, emitida cuando ocurren encuentros agresivos entre dos o más individuos y su duración podría depender del nivel de agresión	Comportamiento agonístico: resolución de conflictos. Juego	J, M, H	
010	Chillido B	Vocalización combinada, emitida en contextos de juego y por lo general va acompañada de chirridos; constituyéndose junto con estos, en las vocalizaciones más características de los juveniles	Comportamiento agonístico. Juego	J, M, H	
011	Chillido C	Vocalización combinada emitida por las crías y los juveniles en diferentes contextos	Movimiento: diferentes desplazamientos y exploración Social: juego y contacto con otros individuos	J, C, M, H	
012	'Chirr'	Vocalización combinada emitida por las crías con varios significados	Movimiento: desplazamiento, exploración. Social: contacto con otros individuos. Alimentario: solicitud de alimento	C, M, H	
013	'Chirchi'	Vocalización combinada con cinco sílabas, las dos primeras similares al chirr y las otras tres semejan un 'chi'	Movimiento: exploración, diferentes desplazamientos. Social	C, M, H	
014	'U' invertida	Monosílaba emitida cuando existen amenazas como la presencia de predadores. Producen secuencias numerosas dependiendo del grado de estimulación del individuo	Defensa y comportamientos antipredadores	A, J, M, H	

que el tamaño de muestra no fue representativo para tener información concluyente al respecto. Blumer y Epple (reporte no publicado) no identificaron señales específicas de las crías, debido a que ellos trabajaron con individuos adultos, por consiguiente estas señales son registros nuevos para la especie. Es probable que los titís en las primeras etapas de desarrollo envíen vocalizaciones poco definidas y repetitivas como ocurre en el lenguaje humano, particularmente lenguaje infantil; aspecto lingüístico denominado reduplicación (Martín, 2006). Además, emitir vocalizaciones difíciles de identificar, especialmente por predadores, podría constituir una estrategia adaptativa y de supervivencia (Bradbury y Vehrencamp 1998). Los comportamientos de alarma ante predadores estuvieron asociados la vocalización de 'U' invertida. Cuando los titís escucharon los ladridos de un perro, respondieron aproximándose al 'predador' hasta una posición segura y emitieron una secuencia numerosa de estas vocalizaciones, acompañada de conductas tales como erguimiento del cuerpo. En otras ocasiones cuando el estímulo no fue auditivo sino visual, es decir, el perro no ladró, sino fue observado, la respuesta fue la misma y se incrementó cuando el "predador" se acercó más o exhibió movimientos bruscos como brincos y correteos. Un estudio con *S. oedipus* (Friant *et al.*, 2008) sugiere que los individuos no reconocen vocalizaciones de los predadores, pero pueden responder a señales visuales como tamaño corporal grande o movimientos corporales bruscos, lo que podría indicar amenaza o agresión; está podría ser la explicación a la emisión de sonidos por parte de los titís ante un estímulo visual y no auditivo. Blumer y Epple (reporte no publicado) describieron una categoría denominada 'V' invertida, que reúne tres tipos de señales ('chat', 'chatter' y 'tsik') con características muy parecidas a la vocalización de 'U' invertida de este trabajo y asociada a contextos de amenaza y alarma ante la presencia de predadores.

La presencia de vocalizaciones específicas de cada categoría de edad (adulto, juvenil, cría) puede deberse a que la producción de las vocalizaciones varía de acuerdo a la etapa de desarrollo del individuo, aspecto identificado en *S. oedipus* (Roush y Snowdon, 1999). En esta especie, las llamadas de los subadultos y los juveniles son similares, pero difieren de los adultos, debido a que exhiben variaciones en estructura y significado. Por ejemplo, los juveniles y los subadultos producen 'chirps' asociados al alimento ante la presencia de otros objetos (no alimentos) y cuando en realidad el recurso no está disponible. El 'chiiih' C fue emitido por las tres categorías de edad y bajo distintos contextos. Es posible que el tití gris como otras especies de primates exhiba plasticidad vocal en respuesta a alteraciones en la composición del grupo social, lo cual puede ocurrir en cualquier etapa del desarrollo del individuo como lo sugieren Snowdon y Elowson (1999). Sumado a esto, Zuberbühler (2002) sugiere que los primates no-humanos podrían tener la capacidad cognitiva de cambiar el significado de las vocalizaciones (sintaxis léxica), contextualizando dicha plasticidad vocal.

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OWL MONKEY VOCALIZATIONS AT THE PRIMATE RESEARCH INSTITUTE, INUYAMA

Sachi Sri Kantha
Hiroki Koda
Juri Suzuki

Introduction

Quantitative evaluations of vocalizations of nocturnally active owl monkeys (*Aotus* species) have been attempted only twice (Andrew, 1963; Moynihan, 1964). Andrew (1963) identified four call types (twitter-trill, sharp call, boom and squeak) in two captive individuals, and Moynihan (1964) identified six call types (low trill, gulp, grunt complex, moan, scream and hoot) in a quasi-wild simulation. These two reports record the study subjects as belonging to *Aotus trivirgatus* species and pre-date the current revision of *Aotus* genus into nine species (Hershkovitz, 1983; Ford, 1994). Their subjects would now be classified as *A. lemurinus griseimembra*, ranging from Colombia to east and extreme northeastern Venezuela, as described by Ford (1994). As such, they are representative of the gray-necked group, distributed in the regions north of Amazon River. It is unknown whether the other clade of owl monkeys, the red-necked species group also produces identical call types. The objective of this study was to identify the call types produced by members of captive *A. azarae*, a species that belongs to the red-necked group distributed in the regions south of Amazon River (Ford, 1994). Preliminary results of this study have appeared in abstract format (Sri Kantha *et al.*, 2004).

Methods

Subjects and maintenance

The subjects of this study were 16 owl monkeys (12 *A. azarae* pure breds and 4 *Aotus* hybrids of red-necked types) reared at the Kyoto University's Primate Research Institute (PRI) facility. All, excluding one founder member from Bolivia, were captive born and have been studied since

2002 as previously reported (Sri Kantha and Suzuki, 2006; Suzuki and Sri Kantha, 2006; Sri Kantha *et al.*, 2007). All experiments were carried out following approval from the Research Committee of the Institute, and according to the Primate Research Institute's Guidelines for the Care and Use of Laboratory Primates.

Acoustic Analysis of Vocalization Behavior

Under the premise that the vocalizations of dark-active owl monkeys have to be studied in the dark without distraction to the study subjects, we avoided using vision-enhancing goggles or other supporting aids to identify the individual monkeys eliciting the vocal notes. As such, the group vocalization behavior of 16 monkeys in the colony room was studied in two installments.

(A). *Pilot observations*: Pilot observations were made by one or two researchers, standing quietly in the colony room for 60–120 min during the dark phase for one session to, (a) distinguish the call type sounds, and (b) to allow the monkeys to become habituated to the researchers and the recording equipment. Two hundred and forty hours were spent on this installment.

(B). *Sampling observations for acoustic analysis*: Sampling observations were carried out in four sessions on separate days. The length of each session varied between 60 min and 240 min. Spontaneously elicited calls of the colony members as a group during dark cycle were recorded by digital audiotape recorder (Sony TCD-D100) connected to a hand-held microphone (Sony ECM-672) by *ad libitum* sampling with minimum interference. During recording, the two researchers and the recording equipment were stationary and the recording distance varied between 0.5 m (proximal cage) and 6.0 m (distal cages). Scream vocalizations were also elicited and recorded in one member, in response to the threat of trapping by net, during the light cycle (Moynihan, 1964). Sound spectrograms of vocal repertoires were analyzed by Multi Speech Signal Analysis Workstation Model 3700 ver. 2.21 (Kay Elemetrics Corp.), as described previously (Koda, 2004), to quantify frequency and duration of calls. On the basis of these two acoustic parameters, a cluster analysis was carried out to identify the different call types. For conformity, we adhered to the call type terminology introduced previously for owl monkeys by Moynihan (1964). Data collection began in October 2002 and ended in April 2004.

Table 1. Categories and acoustic properties of Owl monkeys calls.

Call Category	Mean Values of Acoustic Properties	
	Duration (sec)	Bandwidth (Hz)
Moan[1]	0.41	140–300
Long scream[2]	0.26	2,800–5,800
Gulp[1]	0.054	1,800–5,800
Low trill[1]	0.052	2,000–3,100
Short scream[2]	0.19	980–3,300
Sneeze grunt[1]	0.050	1,580–3,310

[1] Based on a representative 1-hour recording period in dark phase. Thirty-nine calls were recorded and distinguished.

[2] Specifically elicited from a female hybrid individual by threat induction due to net capture, under light phase.

Results

From the recorded and analyzed vocal repertoire of the owl monkey colony we distinguished six categories of acoustic call types. Table 1 shows the six categories of calls elicited during a 60 min recording session. Four call types, the sneeze grunt, low trill, gulp and moan (in the increasing order of mean duration, from 50 to 410 msec.) were recorded in the dark period spontaneously without any threat stimulus. Among these four call types, the moan call with the longest mean duration (410 msec.) had the lowest bandwidth range of 140–300 Hz (Fig. 1). The mean duration of the other three call types varied only by 4 msec.; their bandwidths ranged between 1,580 and 5,800 Hz. During the recording period, low trill was the most frequent and sneeze grunt was the least frequent call. We also elicited two categories of scream call (short scream and long scream) from one *Aotus* hybrid female by threat induction due to net capture under light conditions. As shown in Fig. 1, the bandwidth range of short scream (980–3,300 Hz) and long scream (2,800–5,800 Hz) varied markedly, and the difference in mean duration between the two screams was only 70 msec.

Discussion

Andrew (1963) identified four call types (twitter-trill, sharp call, boom and squeak) in two captive grey-necked owl monkeys. Moynihan (1964) identified six call types (low trill, gulp, grunt complex, moan, scream and hoot) in captive grey-necked owl monkeys. We were able to confirm the presence of five of the six specific call types, excluding hoot, reported by Moynihan (1964) in the 12 red-necked owl monkey subjects. Considering the restraints of captivity, we acknowledge that not all call types of red-necked owl monkeys may have been elicited during our recording. For example, we did not record the short sequence pure tone hoots, audible to humans in the night at a distance of 500 meters, as reported in the descriptive records of naturalists (Moynihan, 1964). The frequency range of nocturnally active *Aotus* monkey (140–5,800 Hz) vocalizations are narrow compared to the determined frequency range of vocalizations of other diurnally active, small-framed Platyrrhine monkeys such as *Cebuella pygmaea* (800–14,000 Hz), *Callithrix* spp. (500–14,800 Hz), *Saguinus* spp. (1,150–10,400 Hz) and *Saimiri* spp. (500–11,250 Hz), as tabulated by Hauser (1993). However, the frequency ranges of owl monkeys (this study, Moynihan 1964) are identical to that of diurnally active, large-framed Platyrrhini such as *Cebus* spp. (500–6,500 Hz) and *Ateles* spp. (200–3,800 Hz), as reviewed by Hauser (1993).

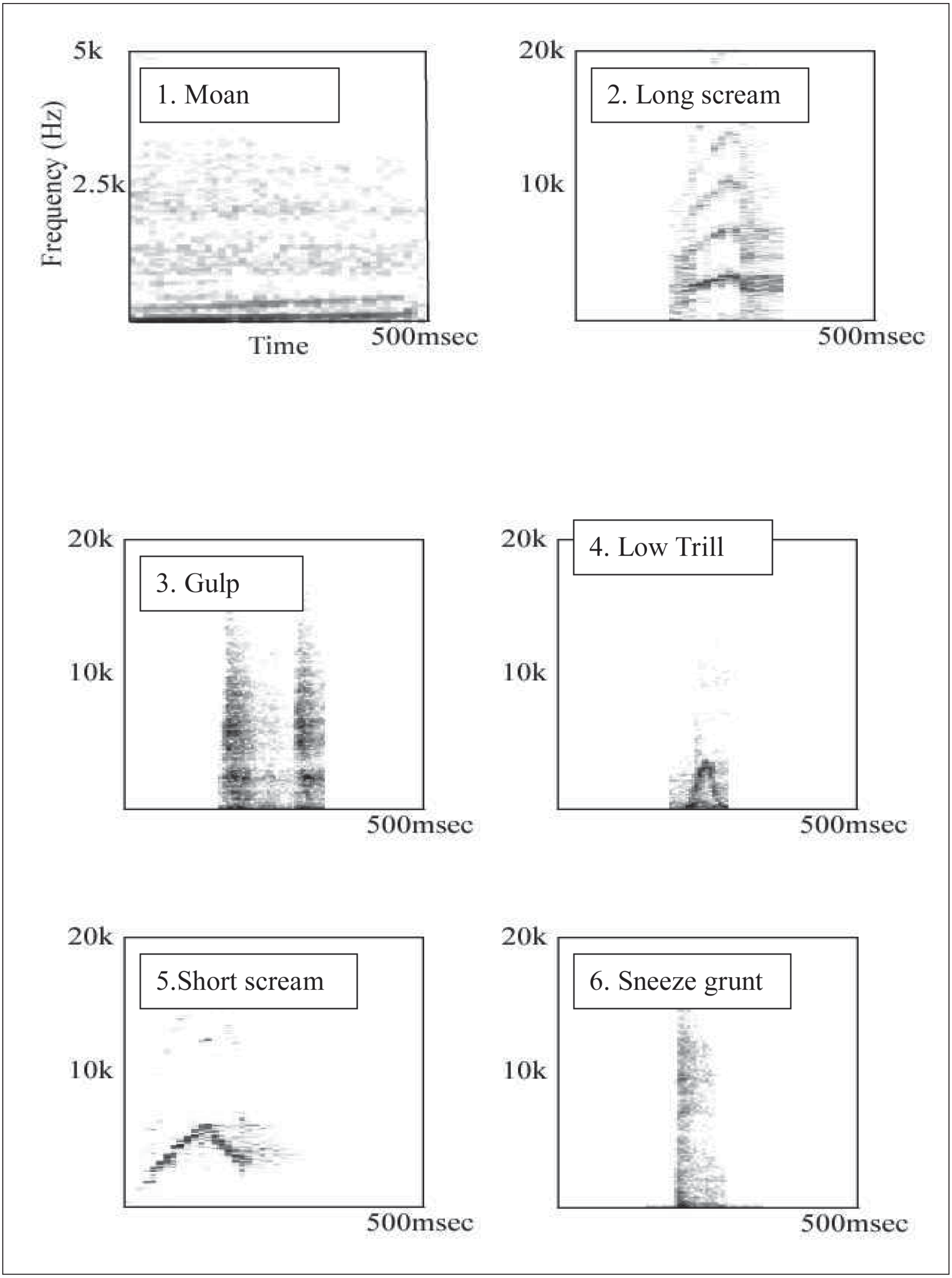

Figure1. Representative sound spectrograms of six call categories of *Aotus azarae* monkeys. In all six frames, X-axis indicates time (millisec.) and Y-axis indicates frequency (kHz).

In sum, with respect to frequency bandwidth and call duration, we have confirmed the six categories of calls reported for captive gray-*necked Aotus* recorded in Panama, in captive-born individuals of red-necked *Aotus* of Bolivian origin. The practical necessity of collecting acoustic data of owl monkeys in the dark somewhat hinders the precision of assembled data due to difficulty identifying the subjects generating the calls. As such, the reported vocalization data of owl monkeys in this study as well as earlier reports of Andrew (1963) and Moynihan (1964) need additional confirmation from carefully controlled playback studies (Byrne, 1982).

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NEWS

MANEJO COMUNITARIO DE LA CACERÍA DE SUBSISTENCIA EN LACHUÁ, GUATEMALA

La cacería de animales silvestres para consumo doméstico forma parte de la identidad de muchas comunidades indígenas del área rural de Guatemala. En la ecoregión Lachuá habitan 55 comunidades Maya-Q'eqchi' que poseen prácticas tradicionales de aprovechamiento de recursos, como es la cacería. En el año 2000, la Escuela de Biología de la Universidad de San Carlos de Guatemala inició un estudio de caracterización de la cacería de subsistencia en las comunidades aledañas al Parque Nacional Laguna Lachuá. En el 2004, un equipo transdisciplinario empezó a promover esfuerzos participativos y consensuados, orientados al manejo comunitario de la cacería de subsistencia; y desarrolló el Programa de Educación Ambiental Bilingüe Participativo, el cual se está implementando actualmente. Este proyecto está siendo construido y planificado con autoridades, líderes y organizaciones de 21 comunidades locales, organizaciones gubernamentales y ONGs que trabajan en la ecoregión Lachuá, constituyendo un fuerte vínculo entre la conservación de la vida silvestre y el conocimiento tradicional y cosmovisión Maya-Q'eqchi'. Para mayor información visitar www.orcondeco.org, o comunicarse con Marleny Rosales marleny.rosales@gmail.com

CAPTIVE CARE AND CONSERVATION OF CALLITRICHIDS AND LEMURS

Durrell's International Training Centre (ITC), in conjunction with the Mammal Department are running the course Captive Care and Conservation of Callitrichids and Lemurs. The course will be based at the ITC at Durrell's headquarters on the island of Jersey, British Channel Islands, from September 28th– October 2nd, 2009. The main topics will include: Planning your captive collection: making the link to the wild; Enclosure design, stress management and nutrition; Population management for controlled breeding programmes; Past, present and future for callitrichid and lemur conservation, and the role of zoos. For further details contact Catherine Burrows at catherine.burrows@durrell.org

THE MOHAMED BIN ZAYED SPECIES CONSERVATION FUND

The Mohamed bin Zayed Species Conservation Fund is a significant philanthropic endowment established to provide targeted grants to individual species conservation initiatives, to recognize leaders in the field of species conservation, and to elevate the importance of species in the broader conservation debate. The fund's reach is truly global, and its species interest is non-discriminatory. It is open to applications for funding support from conservationists based in all parts of the world, and will potentially support projects focused on any and all kinds of plant and animal species, subject to the approval of an independent evaluation committee. For more information visit: www.mbzspeciesconservation.org/

SEED DISPERSAL BY GOLDEN-HANDED TAMARINS (*SAGUINUS MIDAS*) IN BROWNSBERG NATUURPARK, SURINAME: PRELIMINARY RESULTS

Brian W. Grafton, Ph.D and E. Natasha Vanderhoff, Ph.D conducted a preliminary study of seed dispersal by golden-handed tamarins (*Saguinus midas*) during June 2008 in Brownsberg Natuurpark, Suriname in preparation for a long-term study of the importance of small-bodied primates as seed dispersers. We collected 22 dung samples containing the seeds of 11 plant species from an unhabituated group at a single dispersal site (a *Ficus* spp. tree used as a feeding tree). The recovered seeds varied in size from 0.48 cm to more than 1.5 cm (largest dimension), and belonged to a minimum of six plant families (Apocynaceae, Caesalpiniaceae, Chrysobalanaceae, Elaeocarpaceae, Rubiaceae, and Verbenaceae). Research on primate seed dispersal in the Neotropics is biased toward large-bodied primates, which may lead to an incomplete picture of seed dispersal in many Neotropical primate communities. We plan to investigate the potentially important ecological role small primates like *Saguinus* may play in tropical ecosystems. For more information, contact Brian W. Grafton and E. Natasha Vanderhoff, at bgrafton@kent.edu and nvander4@ju.edu.

RECENT PUBLICATIONS

BOOKS

Best Practice Guidelines for the Prevention and Mitigation of Conflict between Humans and Great Apes, by K. Hockings and T. Humle. 2009. IUCN/SSC Primate Specialist Group. 40pp. ISBN: 978–2-8317–11331. The IUCN/SSC Primate Specialist Group is developing a series of guidelines to address critical issues in great ape conservation, drawing on the expertise of PSG members to create a consensus of best practices for field conservationists. Each publication in the new series will provide up-to-date guidance for scientists working on a daily basis with great apes, as well as for the many development organizations, donors and government agencies that are involved in great ape conservation. *Contents:* 1. Summary; 2. Introduction, review and use osf these guidelines; 3. Assessment of human-great ape conflict (HGAC): Preparatory issues; 4. Review of potential HGAC counter measures and their effectiveness; 5. Planning a HGAC management strategy; 6. Conclusions. http://www.primate-sg.org/best.practices.htm

Ameranthropoides loysi Montandon 1929: the History of a Primatological Fraud, by B. Urbani and A. L. Viloria. 2009. Libros en red. 296pp. ISBN: 978–1597544450. This history reviews the information published on the controversy of the discovery of an alleged Neotropical ape that resulted in one of the most notorious scientific frauds of the 20th Century. Such finding supposedly occurred either in 1917 or 1918 while oil prospecting in the forests of the Tarra River region, located in the southwestern part of Lake Maracaibo, Zulia state, Venezuela. This case was as much discussed as it was unresolved. Detailed analysis of the archival sources suggested that the naming of such a primate was a fraud orchestrated by the Swiss physician George Montandon and de Loys himself, resulting in one of the most notorious scientific frauds of the 20th Century. This investigation provides previously unpublished information about this case -whose development seems to be resolved in Venezuela, through the account of a third witness, the Venezuelan physician Enrique Tejera.

Tinbergen's Legacy: Function and Mechanism in Behavioral Biology, edited by S. Verhulst and J. Bolhuis. 2009. Cambridge University Press. 262pp. ISBN: 978–0521697552. In this book, an international cast of leading animal biologists reflect on the enduring significance of Tinbergen's groundbreaking proposals for modern behavioural biology. It includes a reprint of Tinbergen's original article on the famous 'four whys' and a contemporary introduction, after which each of the four questions are discussed in the light of contemporary evidence. There is also a discussion of the wider significance of recent trends in evolutionary psychology and neuroecology to integrate the 'four whys'. With a foreword by one of Tinbergen's most prominent pupils, Aubrey Manning, this wide-ranging book demonstrates that Tinbergen's views on animal behaviour are crucial for modern behavioural biology. *Contents:* 1. On aims and methods of ethology – N. Tinbergen; 2. Tinbergen's four questions and contemporary behavioral biology – J. A.Hogan and J. J. Bolhuis; 3. Causation: the study of behavioral mechanisms – J. A.Hogan; 4. Tinbergen's fourth question, ontogeny: sexual and individual differentiation – D. Crews and T. Groothuis; 5. The development of behavior: trends since Tinbergen (1963) – J. A. Hogan and J. J. Bolhuis; 6. The study of function in behavioral ecology – I. Cuthill; 7. The evolution of behavior and integrating it towards a complete and correct understanding of behavioral biology – M. J. Ryan; 8. Do ideas about function help the study of causation? – D. F. Sherry; 9. Function and mechanism in neuroecology: looking for clues – J. J. Bolhuis.

Linking Conservation and Poverty Reduction: Landscapes, People and Power, by R. Fisher, S. Jeanrenaud, S. Maginnis,

W. Jackson, E. Barrow, A. Ingles, R. Friend, R. Mehortra, T. Farvar, M. Laurie and G. Oliviedo. 2008. Earthscan Publications & IUCN. 144pp. ISBN: 978–1844076369. This book provides a grand overview and a conceptual framework for addressing poverty reduction in the context of conservation and conservation in the context of poverty reduction, including recent developments in theory, fieldwork and new case studies from Francophone Africa and Latin America. The book begins by looking at the rationale for addressing the links between conservation and poverty reduction, arguing that such a focus is both ethically essential and a source of opportunities. This is followed by a review of experiences in dealing with people and conservation and identifies some key lessons and concepts. The next section presents key illustrative case studies followed by a discussion of some of the issues that appear when implementing combined conservation and poverty reduction. The emphasis is on the importance of multiple spatial scales and seeking negotiated trade-offs between scales. *Contents:* 1. Introduction; 2. Past Experiences; 3. Case Studies; 4. Scale, Landscapes, Boundaries and Negotiation; 5. Structures, Institutions and Rights; 6. Linking Conservation and Poverty Reduction.

ARTICLES

Aguiar, L. M., Ludwig, G. and Passos, F. C. 2009. Group size and composition of black-and-gold howler monkeys (*Alouatta caraya*) on the Upper Parana River, Southern Brazil. *Primates.* 50(1). Pgs: 74–77.

Amendola-Pimenta, M., Garcia-Feria, L., Serio-Silva, J. C. and Rico-Gray, V. 2009. Noninvasive collection of fresh hairs from free-ranging howler monkeys for DNA extraction. *Am. J. Prim.* 71(4). Pgs: 359–363.

Asensio, N., Korstjens, A. H. and Aureli F. 2009. Fissioning minimizes ranging costs in spider monkeys: a multiple-level approach. *Behav. Ecol. & Sociobio.* 63(5). Pgs: 649–659.

Bezerra, B. M., Barnett, A. A., Souto, A. and Jones, G. 2009. Predation by the tayra on the common marmoset and the pale-throated three-toed sloth. *J. Ethol.* 27(1). Pgs: 91–96.

Bower, B. 2009. Capuchin monkeys choose the right tool for the nut.*Science news.* 175(4). Pgs: 12.

Campo, F. A. and Fedigan, L. M. 2009. Behavioral adaptations to heat stress and water scarcity in white-faced capuchins (*Cebus capucinus*) in Santa Rosa National Park, Costa Rica. *Am. J. Phys. Anthropol.* 138(1). Pgs: 101–111.

de la Torre, S. and Snowdon, C. T. 2009. Dialects in pygmy marmosets? Population variation in call structure. *Am. J. Prim.* 71(4). Pgs: 333–342.

Figueiredo, M. S. L. and Grelle, C. E. V. 2009. Predicting global abundance of a threatened species from its occurrence: implications for conservation planning. *Diver. & Distributions.* 15(1). Pgs: 117–121.

Gonzalez-Zamora, A., Arroyo-Rodríguez, V., Chaves, O. M., Sánchez-López, S., Stoner, K. E. and Riba-Hernández, P. 2009. Diet of spider monkeys (*Ateles geoffroyi*) in Mesoamerica: current knowledge and future directions. *Am. J. Prim.* 71(1). Pgs: 8–20.

Kay, R. F., Fleagle, J. G., Mitchell, T. R. T., Colbert, M., Bown, T. and Powers, D. W. 2009. The anatomy of *Dolichocebus gaimanensis*, a stem platyrrhine monkey from Argentina. *J. Hum. Evol.* 54(3). Pgs: 323–382.

Liu, Q., Simpson, K. Izar, P., Ottoni, E., Visalberghi, E. and Fragaszy, D. 2009. Kinematics and energetics of nut-cracking in wild capuchin monkeys (*Cebus libidinosus*) in Piaui, Brazil. *Am. J. Phys. Anthropol.* 138(2). Pgs: 210–220.

Mannu, M. and Ottoni, E. B. 2009. The enhanced toolkit of two groups of wild bearded capuchin monkeys in the Caatinga: tool making, associative use, and secondary tools. *Am. J. Prim.* 71(3). Pgs: 242–251.

Marcili, A., Valente, V. C., Valente, S. A., Junqueira, A. C. V., Maia da Silva, F., Pinto A. Y. N., Maiff, R. D., Campaner, M., Coura, J. R., Camargo, E. P., Miles, M. A. and Teixeira, M. M. G. 2009. Trypanosoma cruzi in Brazilian Amazonia: lineages TCI and TCIIa in wild primates, Rhodnius spp. And in humans with Chagas disease associated with oral transmission. *Int. J. Parasitology.* 39(5). Pgs: 615–623.

Menescal, L. A., Goncalves, E. C., Silva, A., Ferrari, S. F. and Schneider, M. P. C. 2009. Genetic diversity of red-bellied titis (*Callicebus moloch*) from Eastern Amazonia based on microsatellite markers. *Biochem. Gen.* 47(3–4). Pgs: 235–240.

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Pesendorfer, M. B., Gunhold, T., Schiel, N., Souto, A., Huber, L. and Range, F. 2009. The maintenance of traditions in marmosets: individual habit, not social conformity? A field experiment. *Plos one.* 4(2). Pgs: e4472(online 1–9).

Porter, L. M., Garber, P. A. and Nacimento, E. 2009. Exudates as a fallback food for *Callimico goeldii*. *Am. J. Prim.* 71(2). Pgs: 120–129.

Silva, S. S. B. and Ferrari, S. F. 2009. Behavior patterns of southern bearded sakis (*Chiropotes satanas*) in the fragmented landscape of eastern Brazilian Amazonia. *Am. J. Prim.* 71(1). Pgs: 1–7.

Slater, K. Y., Schaffner, C. M. and Aureli, F. 2009. Sex differences in the social behavior of wild spider monkeys (*Ateles geoffroyi yucatanensis*). *Am. J. Prim.* 71(1). Pgs: 21–29.

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Visalberghi, E., Spagnoletti, N., Ramos da Silva, E. D., Andrade, F. R. D., Ottoni, E., Izar, P. and Fragaszy, D. 2009. Distribution of potential suitable hammers and transport of hammer tools and nuts by wild capuchin monkeys. *Primates.* 50(2). Pgs: 95–104.

Visalberghi, E., Addessi, E., Truppa, V., Spagnoletti, N., Ottoni,E., Izar, P. and Fragaszy, D. 2009. Selection of effective stone tools by wild bearded capuchin monkeys. *Current Biol.* 19(3). Pgs: 213–217.

ABSTRACTS

Selected abstracts from the 31st Meeting of the American Society of Primatologists. West Palm Beach, Florida, June 18–21, 2008 http://www.asp.org/asp2008/showConfSchedule.cfm

Amendola-Pimenta, M., Rico-Gray, V. and Piñero-Dalmau, D. Habitat disturbance and genetic variability of populations of black howler monkey (*Alouatta pigra*) in Campeche, Mexico: Implications for conservation.

Bonilla-Sanchez, Y. M., Serio-Silva, J. C., Pozo-Montuy, G. and Bynum, N. Demography of *Alouatta pigra* in threated habitat in south-eastern Mexico.

Bustos, C. A., Corkum, L. D., Slater, K. Y. and Mennill, D. J. Acoustic characteristics of the vocalizations of mantled howler monkeys (*Alouatta palliata*) in the fragmented low-land forests of Honduras.

Dampier, S. M. To see or not to see: factors affecting captive capuchin visibility (*Cebus apella robustus*).

Depeine, C. D., Rotundo, M., Juarez, C. P. and Fernandez-Duque, E. Hoot calling in owl monkeys (*Aotus azarai*) of Argentina: Sex differences and function.

Field, M. Y. Nursing behavior in a group of human-commensal white-fronted capuchins (*Cebus albifrons*) in Misahualli, Ecuador.

Gibson, S. V., Tustin, G. W., Williams, L. E., Schuler, A. M., Brady, A. G. and Abee, C. R. Reproduction in an owl monkey breeding colony (*Aotus* sp.).

Hooff, S. B. and Wolovich, C. K. Captive owl monkeys respond to novel flavors with neophobia, discrimination, and food sharing.

Hores, R. M., Wolovich, C. K. and Evans S. Is it worth the risk? Novel food presentation affects behavior in captive owl monkeys (*Aotus* spp.).

Ionica, C. S., Robbins, K. L., Novak, M. F. S. X. and Suomi, S. J. Multimodal data input using touchscreen technology, voice recording and speech recognition in adverse field conditions.

Jarcho, M. R., Mason, W. A., Mendoza, S. P. and Bales, K. L. Intranasal vasopressin administration effects on pair-bonding and gene expression in monogamous titi monkeys (*Callicebus cupreus*).

Jasso, C. and Estrada, A. Tropical rain forest fragmentation and social interactions in young howler monkeys (*Alouatta palliata*).

Juárez, C. P., Berg, W. J. and Fernandez-Duque, E. An evaluation of the potential long-term effects of radio-collars on the reproduction and demography of owl monkeys (*Aotus azarai*) in Formosa, Argentina.

Kitzmann, C. D., Main, D. E., Mendoza, S. P. and Bales, K. L. Vocal behavior of adult titi monkeys (*Callicebus cupreus*) in a separation paradigm.

Matthews, S. A. and French, J. A. Parental care influences on pubertal timing in female wied's black tufted-ear marmoset (*Callithrix kuhlii*).

Parr, N., Campos, F., Childers, A., Fedigan, L. and Jack, K. Dry season ranging behavior and intergroup relations in white-faced capuchins (*Cebus capucinus*) at Santa Rosa national park, Costa Rica.

Paukner, A., Huntsberry, M. E., Ferrari, P. F. and Suomi, S. J. Imitation recognition in capuchin monkeys.

Perea-Rodríguez, J. P., Milano, A. M., Fernandez-Duque, E. and Osherov, B. E. Gastrointestinal parasites of owl monkeys (*Aotus azarai*) living in edge and non-edge territories in a gallery forest in northern Argentina.

Phillips, K. A. and Liu, S. T. Sylvian fissure asymmetries in capuchin monkeys (*Cebus apella*).

Pokorny, J. J. and de Waal, F. B. How capuchin monkeys (*Cebus apella*) categorize visual images of themselves: in-group vs. out-group.

Pozo-Montuy, G., Serio-Silva, J. C. and Bonilla-Sánchez, Y. M. The effects of anthropogenic pressure on the behaviour and demography of the black howler monkey (*Alouatta pigra*) in south-eastern Mexico.

Ross, C. N., Tardif, S., Davis, K., Dobek, G. and Brasky, K. Relations among body composition, activity, hematology, and age in male common marmosets: Toward a model of frailty.

Rutherford, J. N. Placental insulin-like growth factor ii (igf-ii) and its relation to litter size and placental weight in captive common marmosets (*Callithrix jacchus*).

Saltzman, W., Boettcher, C. A., Crosno, K. A. and Abbott, D. H. Effects of lactation on pituitary-adrenal responses to stress in laboratory-housed common marmosets (*Callithrix jacchus*).

Savage, A., Thomas, L., Leighty, K., Soto, L., Causado, J. and Medina, F. The development of a census technique for cotton-top tamarins (*Saguinus oedipus*) in Colombia.

Smith, A. S. and French, J. A. Maternal androgen levels during pregnancy are associated with early-life growth and aggressive behavior of offspring in geoffroy's marmosets (*Callithrix geoffroyi*).

Smucny, D. A. When primatologists go public: applying "best practices" for informal science education to teaching the general public about primates.

Stone, B. W., Menzel, C. R., Evans, T. A., Benoit, J. and Fragaszy D. M. Capuchin monkeys (*Cebus apella*) learn to point with a laser.

Trejo-Macías, G., Estrada, A. and Mosqueda-Cabrera, M. Á. Preliminary study of gastrointestinal helminths in howler monkeys (*Alouatta palliata*) living in a cacao plantation in southern Mexico.

Van Belle, S., Estrada, A., Ziegler, T. E. and Strier, K. B. Behavioral and endocrine characteristics of the ovarian cycle in black howler monkeys (*Alouatta pigra*).

Wolovich, C. K., Hooff, S. and Evans, S. Owl monkeys don't just give a hoot: Preferred food elicits trills.

MEETINGS

2009

Meeting cancelled: Neotropical Primate Husbandry, Research and Conservation Conference. October 13–15. The Neotropical Primate Husbandry, research and conservation conference, that was going to be held at the Brookfield Zoo was canceled.

IV Congreso Mexicano de Primatología. Junio 24–26, Villahermosa, Tabasco. La Asociación Mexicana de Primatología A.C. y la Universidad Juárez Autónoma de Tabasco, convocan. Para mayor información visite: http://www.tierradeideas.com/amp/

The 3rd Congress of the European Federation for Primatology. August 12–15, Irchel campus of the University of Zürich, Switzerland. The EFP is a federation of all national primatological societies and groups in Europe. The biennial meetings strive to bring together primatologists and biological anthropologists from all over Europe to encourage interdisciplinary and international exchanges. The registration and abstract submission deadline is April 15th, 2009. For more information visit the web site: www.aim.uzh.ch/EFP.html

The 32nd Meeting of the American Society of Primatologists. September 18–21, Bahia Resort Hotel, San Diego, California, USA. For further information check the web site: www.asp.org/asp2009/index.htm

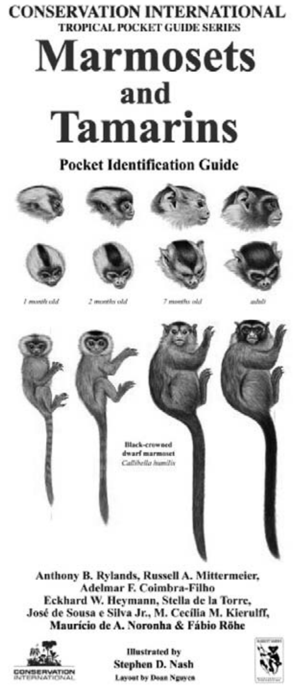
The 7th International Conference on Behavior, Physiology and Genetics of Wildlife. September 21–24, Conference Centre BfR–Bundesinsitut für Risikobewertung, Berlin, Germany. The Leibniz Institute for Zoo and Wildlife Research and the European Association of Zoos and Aquaria invites. The main topics are: behavioural ecology, stress and disturbance, reproduction biology, conservation genetics, and conservation biology. The conference language is English. For more information and registration go to www.izw-berlin.de/de/flink/7thIZW-Conference.html

VI Congreso Brasileiro de Unidades de Conservaçáo. Septembro 20–24, Expo Unimed Curitiba, Curitiba-PR, Brasil. A fundação O Boticário de Proteção à Natureza convida. Para mais informações visite:http://www.itarget.com.br/newclients/fundacaoboticario.org.br /cbuc2009//

II Iberian Primatological Conference. September 30–October 3, Residencia "la Cristalera" in Miraflores de la Sierra, Madrid, España. During the second edition of the Iberian Primatological Conference, the Asociación Primatológica Española (APE) is responsible for organizing and hosting the congress in straight co-operation with the Associaçao Portuguesa de Primatologia (APP). Deadlines for abstract submission June 30, 2009. For more information go to http://www.uam.es/otros/ape/congresos/CIP2.html

2010

The 23rd Congress of the International Primatological Society. September 12–18, Kyoto University, Japan. The theme of the conference will be 'Quest for Coexistence with Nonhuman Primates.' In line with IPS policy, the committee welcomes suggestions for symposia on any of the disciplines of primatology. The Symposium submission deadline is October 15th, 2009. The presentation submission deadline is January 15th, 2010. For more information go to: www.ips2010.jp/.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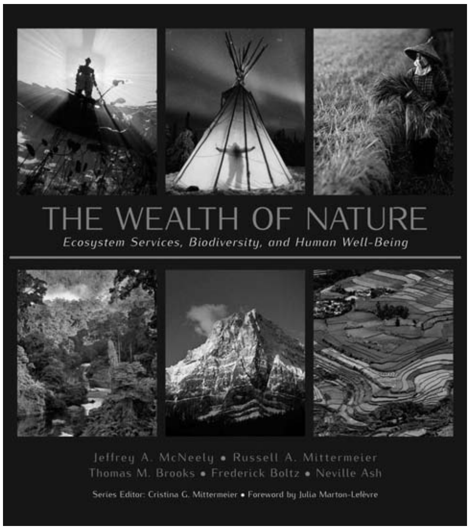

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Notes to Contributors

Scope

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

Submissions

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

Contributions

Manuscripts may be in English, Spanish or Portuguese, and should be double-spaced and accompanied by the text on CD for PC compatible text-editors (MS-Word, WordPerfect, Excel, and Access), and/or e-mailed to <epalacios@conservation.org> (English, Spanish) or <jcbicca@pucrs.br> (Portuguese). Hard copies should be supplied for all figures (illustrations and maps) and tables. The full name and address for each author should be included. Please avoid abbreviations and acronyms without the name in full. Authors whose first language is not English should please have their English manuscripts carefully reviewed by a native English speaker.

Articles. Each issue of *Neotropical Primates* will include up to three full articles, limited to the following topics: Taxonomy, Systematics, Genetics (when relevant for systematics and conservation), Biogeography, Ecology and Conservation. Text for full articles should be typewritten, double-spaced with no less than 12 cpi font (preferably Times New Roman) and 3-cm margins throughout, and should not exceed 25 pages in length (including references). Please include an abstract in the same language as the rest of the text (English, Spanish or Portuguese) and (optional) one in Portuguese or Spanish (if the text is written in English) or English (if the text is written in Spanish or Portuguese). Tables and illustrations should be limited to six, except in cases where they are fundamental for the text (as in species descriptions, for example). Full articles will be sent out for peer-review. For articles that include protein or nucleic acid sequences, authors must deposit data in a publicly available database such as GenBank/EMBL/DNA Data Bank of Japan, Brookhaven, or Swiss-Prot, and provide an accession number for inclusion in the published paper.

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

Figures and maps. Articles may include small black-and-white photographs, high-quality figures, and high-quality maps. (Resolution: 300 dpi. Column widths: one-column = 8-cm wide; two-columns = 17-cm wide). Please keep these to a minimum. We stress the importance of providing maps that are publishable.

Tables. Tables should be double-spaced, using font size 10, and prepared with MS Word. Each table should have a brief title.

News items. Please send us information on projects, field sites, courses, Thesis or Dissertations recently defended, recent publications, awards, events, activities of Primate Societies, etc.

References. Examples of house style may be found throughout this journal. In-text citations should be first ordered chronologically and then in alphabetical order. For example, "…(Fritz, 1970; Albert, 1980, 2004; Oates, 1981; Roberts, 2000; Smith, 2000; Albert *et al.*, 2001)…"

In the list of references, the title of the article, name of the journal, and editorial should be written in the same language as they were published. All conjunctions and prepositions (i.e., "and", "In") should be written in the same language as rest of the manuscript (i.e., "y" or "e", "En" or "Em"). This also applies for other text in references (such as "PhD thesis", "accessed" – see below). Please refer to these examples when listing references:

Journal article

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

Chapter in book

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

Book

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

Thesis/Dissertation

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Report

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For references in Portuguese and Spanish:

"and" changes to "e" and "y" for articles in Portuguese and Spanish respectively.

"In" changes to "Em" and "En" for articles in Portuguese and Spanish respectively.

"Doctoral thesis" changes to "Tese de Doutoramento" and "Tesis de Doctorado" for articles in Portuguese and Spanish respectively.

"MSc Thesis" changes to "Dissertação de Mestrado" and "Tesis de Maestría" for articles in Portuguese and Spanish respectively.

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

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