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Habitat Use by the White-Footed Tamarin, *Saguinus leucopus*: A Comparison Between a Forest-Dwelling Group and an Urban Group in Mariquita, Colombia

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Introduction

The white-footed tamarin (*Saguinus leucopus*) is endemic to Colombia. Its geographic distribution, between the eastern banks of the lower Río Cauca and the western part of the middle Río Magdalena in the north of the country, has been dramatically reduced in recent years, largely due to deforestation (BIO, 1998; Pachón and Bohorquez, 1991; Defler, 2004). Habitat loss has resulted in *S. leucopus* being classified as Vulnerable on the IUCN Red List (Hilton-Taylor, 2003) and it is also listed on Appendix I of CITES. Information available on this species is limited to some considerations on captive breeding (Alveario *et al.*, 1985), behavior and vocalization in captivity (Blumer and Epple, undated) and the results of some censuses in different regions of Colombia (Calle, 1992; Bernstein *et al.*, 1976; Green, 1978; Vargas, 1994; Vargas and Solano, 1996). No ecological studies have been conducted to date.

We found a group of white-footed tamarins living in the backyards of some houses in the small town of Mariquita in central Colombia. According to the residents, the group had lived there since at least 1997 and had not been introduced. A second group of *S. leucopus* was found in a remnant forest patch close to the town. We studied the home range, daily path length and diet of the two groups in order to compare their use of these two distinct habitats. To our knowledge this is the first study presenting data on the ecology of the white-footed tamarin.

Methods

Study site and subjects

Mariquita is in the north of the Department of Tolima, Colombia (5°12'N, 74°55'W) at an altitude of 690 m (Fig. 1). Mean annual temperature is 26°C and mean annual rainfall is 2237 mm (records of IDEAM – Instituto de Estudios Ambientales, Colombia). A secondary forest patch of 120 ha abuts the western side of Mariquita. We identified seven groups (of two to 12 tamarins each) within the forest remnant, on farms near the forest and in the backyards of the residential area of Mariquita (Table 1). We selected one forest and one backyard group based on the accessibility of their ranges. We studied them from July to December 1999. The forest group was composed of 11 individuals and was observed for 101.0 hours. Five individuals made up the urban group, which was observed for 229.8 hours. One female in each of the two groups produced twins in September, 1999.

The urban gardens and backyards in Mariquita have many fruiting trees such as mango (*Mangifera indica*), banana

Figure 1. Location of Mariquita, Colombia (upper left), and the home ranges of a forest-dwelling group (white arrow) and an urbanized group (black arrow) of *Saguinus leucopus* (aerial photo taken by IGAC, 1996).

(*Musa sapientum*), papaya (*Carica papaya*) and guava (*Psidium guajaba*). The urban group ranged through the backyards of 10 houses, separated by fences and surrounded on all sides by other houses. The area of all the backyards together was approximately 1.5 ha. The tamarins moved around through the crowns of the trees, while occasionally descending to the roofs of the houses or fences. Although we never witnessed the study group crossing streets on the ground, other groups were seen doing so, indicating that they are not a serious obstacle. Vegetation in the forest remnant is represented by the families Lauraceae, Rubiaceae, Guttiferaceae, Anacardiaceae, Caesalpiniaceae, Mimosaceae, Musaceae, Polypodiaceae and Araceae. Abundant species include *Cassia moschata*, *Myrcia* sp., *Byrsonima spicata*, *Cupania latifolia*, *Nectandra* sp. and *Vochysia ferruginea* (Cortolima, 1997; Pachón and Bohorquez, 1991).

Table 1. Number of individuals of *Saguinus leucopus* in groups observed in a forest fragment, in urban backyards and on a farm. Asterisks (*) indicate the groups studied for habitat use.

Group Nr.	Location	No. of Individuals
1 *	Forest	11
2	Forest	7
3	Forest	10-12
4	Forest	2
5 *	Backyards	5
6	Backyards	4
7	Farm	6

Table 2. Plant species consumed by *Saguinus leucopus* in **a**) a forest group and **b**) an urban group, and percentage of total foraging time, from July to December 1999. FR = fruit; FL = flower; B = bark; Not ID = not identified.

a) Forest group

Family	Species	Part eaten	% Time eating
Cecropiaceae	*Cecropia peltata*	FR	35
Sapindaceae	*Talisia* sp.	FR	24.2
Burseraceae	*Protium* sp.	FR	15.8
Moraceae	*Sorocea sprucei*	FR	12.5
Annonaceae	*Rollinia edulis*	FR	5
Tiliaceae	*Trichospermum mexicanum*	FL	1.7
Euphorbiaceae	*Tetrorchidium* aff. *echeverianum*	FR	1.7
Euphorbiaceae	*Pera arborea*	FR	0.8
Araliaceae	*Didymopanax morototoni*	B	0.8
Malpighiaceae	*Byrsonima spicata*	FR	0.8
Melastomataceae	*Tococa* sp.	Not ID	0.8
Rutaceae	*Zanthoxylum* sp.	B	0.8

b) Urban group

Family	Species	Part eaten	% Time eating
Anacardiaceae	*Mangifera indica*	FR	49.35
Bombacaceae	*Matisia cordata*	FR	16.17
Caricaceae	*Carica papaya*	FR	8.22
Myrtaceae	*Psidium guajaba*	FR	5.01
Moraceae	*Ficus* sp.	FR	4.86
Annonaceae	*Annona muricata*	FR	4.55
Lauraceae	*Persea gratissima*	FL, B	2.41
Musaceae	*Musa sapientum*	FR	2.26
Myrtaceae	*Eugenia jambos*	FL, FR	2.10
Rutaceae	*Citrus aurantium*	B	1.49
Oxalidaceae	*Averrhoa carambola*	FL, FR	1.19
Arecaceae	*Cocos nucifera*	FL	1.19
Malvaceae	*Hibiscus* sp.	FL	1.19

Data Collection

From July to December, 1999, we estimated fruit abundance (dry mass of fruit/ha) at one-month intervals in the areas of the forest and urban groups. We counted the fruits from all of the fruiting trees in five backyards, and afterwards 20 fruits per tree species were collected, oven-dried and weighed. We estimated the total fruit weight by species in a given area by multiplying the mean fruit weight by the number of fruits counted. In the forest, fruit counts were made within eight randomly established 8 x 100 m plots, and vouchers of each fruit species were collected for species identification. As in the town, 20 fruits of each species were sampled, dried and weighed to estimate forest fruit weight. Once the diet composition of each group was known, only the species they consumed were used for calculating fruit abundance in each habitat.

Each study group was observed for five days per month (July to December, 1999). The position of the group was determined every 30 minutes using a Global Positioning System (GPS) and maps. The urban group's home range was estimated using the minimum convex polygon method (White and Garrott, 1990) and the Home Range program of Ackerman *et al.* (1989). Due to the irregular form of the forest margin, using the same method in the forest would have included pasture never used by the tamarins in the home range calculation. To estimate the home range of the forest group, we divided it into 50 x 50 m quadrates and summed all those which were entered. The daily path length of each group was calculated by summing the distances between all the 30-minute location points during the day (Ackerman *et al.*, 1989). Because the forest group usually could not be followed for complete days, we used the distance traveled on the single complete day of observation each month. Even so, the daily path length is undoubtedly underestimated because of periods when we lost contact.

We quantified diet composition by calculating the percentage of time spent eating different food items (fruits, invertebrates, flowers, bark, etc.). Trees from which tamarins gathered food were marked, and leaf and fruit samples were then collected for subsequent identification at the Herbarium of the Instituto de Ciencias Naturales, Universidad Nacional de Colombia (COL).

Results

We recorded 82 fruiting plant species in the forest, but only eight of them were exploited by *Saguinus leucopus* as a fruit source. Average monthly dry mass of the fruits included in the forest group's diet was 8.2 ± 5.9 kg/ha (mean ± SD, n = 6). In the urban area, 12 species of plants produced fruits, nine of which were eaten by tamarins. Average monthly dry mass of the fruits of plant species consumed by *S. leucopus* in the backyards was 444.4 ± 355 kg/ha (mean ± SD, n = 6).

In addition to fruits, the tamarins ate flowers, bark, leaves and a number of items we were unable to identify. Thirteen plant species provided food in the backyards and 12 in the forest (Table 2). Both groups invested 82-84% of their feeding time to consuming fruits, between 8 to 15% eating invertebrates and less than 8% eating bark, flowers and other foods which we could not identify (Table 3).

The tamarins' home range in the forest was 17.7 ha, whereas the urban group used about 0.73 ha (Fig. 1). Daily path lengths varied in the forest from 783 to 2387 m, with the only two dawn-to-dusk measures being 1848 and 1851 m. The mean daily path of the urban group was 496 m with a range of 224 to 612 m.

Discussion

Urban tamarins had a shorter daily path length and a substantially smaller home range than the group living in the forest fragment, apparently because they were able to sustain themselves on the densely planted fruiting trees in backyards. The differences could also have been due to the different group sizes (Schoener, 1968; Davies and Houston, 1984; Dunbar, 1988; Barton *et al.*, 1992). The urban group of five individuals used 0.73 ha, or 0.14 ha per individual. The forest group, on the other hand, was composed of 11 individuals living in an area of 17.7 ha, or 1.6 ha per individual, indicating that the number of individuals in a group cannot be the only cause for the difference in home range size. The area used per individual in the forest was over 11 times that used by the urban individuals.

The quality of the habitat is another factor that affects home range size and path length (Rylands, 1996). The small home range size and path length of the urban group is likely a reflection of high fruit density. Davies and Houston (1984) and Altmann (1974) proposed that the lower limit of the home-range size is determined by the distribution of important resources that fulfill life requirements. The impact of the closely packed fruit trees, providing food throughout the study period in the backyards of the town of Mariquita, was marked both in terms of diet (Table 2b) and the fruit biomass available.

Table 3. Percentages of food items in the diet of an urban and a forest-dwelling group of *Saguinus leucopus*.

	Forest	Backyards
Invertebrates	15	8
Fruit (pulp+seeds)	82	84
Bark	1	1
Flowers	1	2
Not Identified	1	5
Exudate	0	0

Fruit was the most common food item eaten by both study groups, followed by invertebrates, flowers and bark. This is in line with findings for other callitrichids (Snowdon and Soini, 1988; Egler, 1992; Peres, 1993; Valladares-Pádua, 1993; Dietz *et al.*, 1997; Knogge, 1998). The plant species exploited by the two groups were completely different, which is likely due to the presence of different resources in the two environments (Table 2).

Our findings suggest that *Saguinus leucopus* is flexible in its diet and behavior. This offers some hope for its future conservation status, as it appears able to adapt to a variety of environments, even an urban setting. Surveys and effective protection in parks and reserves, however, are still vital measures for the conservation of this little-known species, which is confined to a range dominated by intensive colonization and forest destruction (Defler *et al.*, 2003).

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New Records of Martins' Bare-Face Tamarin, *Saguinus martinsi* (Primates: Callitrichidae)

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Introduction

Martins' bare-face tamarin, *Saguinus martinsi*, was described by Thomas (1912) as *Leontocebus martinsi*, based on material collected in the locality of Faro, left bank of the Rio Nhamundá, Pará, Brazil. The new species was named in honor of the collector of the holotype, Oscar Martins. Hershkovitz (1966) considered Martins' bare-face tamarin to be a subspecies of *S. bicolor*, reaffirming this taxonomic status in subsequent studies (Hershkovitz, 1970, 1977). Hershkovitz (1977) considered all bare-face tamarins as conspecifics and recognized three subspecies in this group: *S. b. bicolor* (Spix, 1823), *S. b. martinsi* and *S. b. ochraceus* Hershkovitz, 1966. Groves (2001, p.146) found this tamarin to be "extremely distinct" from *S. bicolor* and listed it as a full species and, although not having examined any specimens, provisionally placed *ochraceus* as a subspecies. Martins' bare-face tamarin is one of the least-studied taxa among the Neotropical primates, with just six localities of occurrence recorded and few specimens in museums (Thomas, 1912; Cruz Lima, 1945; Hershkovitz, 1977).

Most studies on the biology of bare-face tamarins refer to the pied tamarin, *S. bicolor* (Egler, 1986; Snowdon and Soini, 1988), while information on the biology of *S. martinsi* is restricted to its geographical occurrence. Bare-face tamarins are endemic to the Amazon rainforest, and all three taxa have very restricted distributions (Hershkovitz, 1977). As far as is known, *S. martinsi* is confined to the north of the Rio Amazonas, between the Rio Erepecurú and the Rio Nhamundá (Hershkovitz, 1977). Its northern limits are unknown. According to Hershkovitz (1977), the