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## POPULATION DENSITY OF THE RED HOWLER MONKEY (*ALOUATTA SENICULUS*) IN A TROPICAL DRY FOREST FRAGMENT IN NORTHWESTERN COLOMBIA

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## Introduction

The tropical dry forest is one of the most endangered habitats in Colombia. This habitat has been reduced to 1.5% of its original range due to anthropogenic effects (Murphy and Lugo 1986; Ramírez and Tesillo 2001). New World primates are dependent on arboreal habitats, so habitat loss in this region has caused primates to be restricted to the remaining forest fragments. Although habitat destruction continues to threaten Neotropical primates (Defler 2003; Michalski and Peres 2005), there are some species that can persist in these disturbed ecosystems (Crockett 1998; Horwich 1998). The red howler monkey (Alouatta seniculus) is the primate with the largest range of distribution in Colombia (dwelling in habitats from 0 to 3200 meters above sea level) and seems to be the most adaptable of these primates, occurring in habitats with a minimal amount of forest where other species of primates have disappeared (Crockett 1998; Horwich 1998; Defler 2003). Although A. seniculus is not considered endangered in Colombia (it is categorized as "Low Concern" for this country) (Defler 2003), populations of this species inhabiting tropical dry forest could be threatened with extirpation due to habitat loss and fragmentation. Although A. seniculus is one of the most studied Neotropical primates, few studies have reported the status of its populations in tropical dry forest fragments (Green 1978; Salazar 2000; Avila and Padilla 2005). This study reports a survey of A. seniculus in a conserved remnant of tropical dry forest at Hacienda El Ceibal, Municipio de Santa Catalina, Bolívar, Colombia with the aim of estimating density and evaluating population structure of this species in the area. At the study site the Fundación Proyecto Tití (FPT) has carried out long-term investigations on the cotton-top tamarin, Saguinus oedipus, and led conservation activities including community-based programs.

### Methods

#### Study area

Data were collected from the remnant of tropical dry forest (300 ha) at Hacienda El Ceibal (10°37'36" N; 75°14'50"W) located in northwestern Colombia (Figure 1). This forest fragment is located in the northern part of the Hacienda El Ceibal and is surrounded by pasture for cattle ranching. The study area has a maximum elevation of 34 m.a.s.l. and temperature ranges from 24 to 38 °C. Rainfall (1200 mm/yr) varies seasonally with two dry seasons, one from January to March and one in December. Ramírez and Tesillo (2001) report that 75-80% of the trees lose their leaves during the dry season of January to March. Although this forest fragment is not a national park or sanctuary, it is under protection for conservation by the Fundación Proyecto Tití since the establishment of biological station in 1999. Three species of primates inhabit this forest fragment: S. oedipus, A. seniculus, and Cebus capucinus. However, of these three primate species, only S. oedipus had been subject of studies in this area.

#### Data collection

We estimated the density of red howler monkeys following the protocol presented by Peres (1999). From November 28 to December 1, 2005, five transects ranging from 800 to 1200 m were prepared from south to north in the forest fragment (Fig. 1). These five transects were walked from December 2005 to February 2006. Transects were



Figure 1. Location of Hacienda "El Ceibal", Bolívar, Colombia. Dotted lines refer to the position of transects used for the estimation of population density of *Alouatta seniculus* in the forest fragment at Hacienda "El Ceibal" (FPT, Fundación Proyecto Tití).

walked during 24 days by two observers with an average speed of 1.25-1.5 km/h. At every encounter with red howler monkeys we collected the following data: perpendicular distance (distance between the first animal seen and the transect), group size and location along the transect. Since surveys offer data from brief contact spans (no more than 15 minutes), which can lead to an underestimation of individual density of red howler monkeys (Pruetz and Leasor 2002; Gómez-Posada et al. 2005), we followed three groups in addition to the transect surveys to obtain a more reliable composition and size of groups (only three groups were followed because of time limitations). During these direct counts the following data were collected: 1) group size, 2) sex of adult individuals, and 3) age of individuals. We followed the characteristics used by Defler (1981) to determine the sex and age of individuals, and divided age into three categories: adults (the sum of adults and subadults), juveniles and infants.

#### Data analysis

To estimate the density of howler monkeys in the fragment, we initially estimated the group ecological density for each transect, using the following formula:

$$D = \frac{N}{2 \bullet (ESW) \bullet L}$$

In which:

D = density (groups/km<sup>2</sup>); N= number of sightings in each transect. **ESW** = Effective Strip Width, in m, calculated by the DIS-TANCE 5.0 software release "1" (Thomas *et al.* 2005). L = total transect length, in km (the total length walked in each transect).

The formula above was used given that the sample size was not large enough to estimate density accurately with the DISTANCE software (Chiarello and Melo 2001; Palacios and Peres 2005). The total group density was obtained as the average of ecological density for the five transects. We also estimated the individual density using data from groups followed out of surveys. Individual density was obtained as the product of total group density and average group size of groups followed out of surveys. We calculated the adult sex ratio (adult male:adult female) and the adult female:immature ratio. For the later we used immature as the sum of the "juvenile" and "infant" categories.

#### Results

#### Density

A total of 98.9 km was walked and 42 encounters with A. seniculus were recorded at the study area. Three of these encounters were with isolated males and, given that living as solitary individuals is a temporary condition (Gómez-Posada et al. 2005), we did not include these encounters in the analyses to estimate density. With an ESW of 0.016 km we estimated the following ecological densities for each transect: T1: 11.04, T2: 9.70, T3: 1.83, T4: 17.2 and T5: 10.51 groups/km<sup>2</sup>. The total group density estimated for the study site was  $10.37 \pm 4.43$  groups/km<sup>2</sup>. From the three groups followed, we obtained an average group size of 11 ± 5 individuals per group and estimated an individual density of  $114.07 \pm 22.15$  individuals per km<sup>2</sup>. With these density values we estimated a population size of 343 ± 66.45 howlers in  $31 \pm 13.29$  groups in the tropical dry forest at Hacienda El Ceibal.

#### Group composition

Group composition of the three howler monkey groups followed is presented in Table 1. We calculated a ratio of 1:1 for both the adult sex ratio and the adult female to immature ratio.

**Table 1.** Group composition of three groups of red howler monkeys at Hacienda El Ceibal, Bolívar, Colombia.

Group	Males	Females	Juveniles	Infants	Total of individuals
G1	3	4	2	2	11
G2	6	5	3	2	16
G3	2	2	1	1	6
TOTAL	11	11	6	5	33
Average	3.66	3.66	2	1.66	11
%	33.33	33.33	18.18	15.15	

# Discussion

# Population density

This study provides the first estimate for population density of *A. seniculus* in a conserved remnant of tropical dry forest at Hacienda El Ceibal, Bolivar, Colombia. The Colombian tropical dry forest is one of the most endangered habitats in the country, and few red howler monkey populations remain in these forests (Salazar 2000; Defler 2003). The tropical dry forest at Hacienda El Ceibal is one of the few remnant fragments in the northwestern coast of Colombia, encompassing approximately 300 hectares of forest under conservation.

Population density of A. seniculus at Hacienda El Ceibal is within the wide range reported for the species, but among the highest densities reported (Table 2). These reports show that higher densities of red howler monkeys, and other species of the genus Alouatta, are found in forest fragments than in continuous forest (Chapman and Balcomb 1998; Defler 2003; Gómez-Posada et al. 2005, 2007, 2009, 2010; Link et al. 2010; Londoño and Gómez-Posada 2010). After isolation, forest fragments can act as refuges for primate species that can persist within these disturbed habitats (Defler 1981; Chapman and Balcomb 1998; Gómez-Posada et al. 2005, 2007, 2009, 2010). Folivorous primates, such as red howler monkeys, are expected to adapt better to habitat loss and fragmentation than other primate species (Chapman 1988; Crockett 1996; Defler 2003). This ability to survive in small fragments may be due to the fact that red howler monkeys can rely on a limited set of plant species, "minimizing energy expenditure" (Strier 1992). Gómez-Posada and collaborators (2005) reported the highest population density (254 ind/km<sup>2</sup>) of red howler monkeys at Vereda Montegrande in Caicedonia, Colombia. These authors attributed this value to the high number of individuals inhabiting a small isolated fragment of forest (154 individuals in 60.4 ha). In the present study we estimated a total of  $343 \pm 66.45$  individuals inhabiting 300 ha of isolated forest.

In addition to fragmentation, the protection of the area is another main factor that may be influencing the population density of red howler monkeys at Hacienda El Ceibal. We suggest that population density of A. seniculus is probably positively influenced by the conservation activities conducted by the Fundación Proyecto Tití at the study site. Although these activities are conducted for the protection of S. oedipus, they have indirectly led to the conservation of the other two primate species, and of all the flora and fauna associated with this forest fragment. Even when conservation efforts are not specifically directed towards howler monkey populations, conservation areas may allow the recovery and conservation of howler monkey populations (Horwich 1998). For example, Fedigan and Jack (2001) documented the recovery of the mantled howler monkey (Alouatta palliata) population in the 28 years after the establishment of the Santa Rosa National Park in Costa Rica. However, because of lack of data available on population density for A. seniculus before the establishment of the biological station of the Fundación Proyecto Tití we cannot be certain that the howler monkey population inhabiting Hacienda El Ceibal has increased due to conservation activities.

# Group composition

We report an adult sex ratio of 1:1 at Hacienda El Ceibal, a value unexpected for this species (Defler 1981; Chapman and Balcomb 1998; Defler 2003). In red howler monkeys there usually are slightly more adult females than adult males (Defler 1981; Jones 2004). The data on group composition obtained from the three followed groups included

 Table 2. Population density of *Alouatta seniculus* reported in the literature.

Study site	Density (ind/km <sup>2</sup> )	Average Group Size	Author	
Colombia, Vereda Montegrande*	254	8.11	Gómez-Posada et al. 2005	
Colombia, Yotoco	191	8.2	Gómez-Posada et al. 2005	
Colombia, vereda Maravélez*	163.4	9.0	Gómez -Posada et al. 2009	
Bolivia	120	7.4	Freese et al 1982	
Venezuela, Hato Masaguaral	83–118	8.46	Neville 1972; Crockett and Eisenberg 1987	
Colombia, Hacienda El Ceibal*	114.1	11	Present study	
Colombia, Otún Quimbaya	72.6	7.3	Gómez-Posada et al. 2007	
Colombia, Río Barbas*	72.2	11.3	Londoño and Gómez-Posada 2010	
Venezuela, Hato El Frio	54	6.3	Braza et al. 1981	
Colombia, Nana Luisa*	51.5	5	Gómez-Posada et al. 2005	
Venezuela, Hato Masaguaral	50	8.3	Crockett and Eisenberg 1987	
Colombia, Cuenca del Río Nima	22.6	6	Gómez-Posada et al. 2005	
Colombia, Reserva Patasola	18.6	8.5	Gómez-Posada et al. 2010	
Colombia, La Macarena	10	7.5	Stevenson et al. 1991	

\* = Fragmented forests.

a group containing six males and five female adults. This high number of reproductive individuals of both sexes is not common for the species (Defler 1981; Soini 1992; Chapman and Balcomb 1998). Crockett (1996) argued that the success of subordinate males in beginning a new group might be restricted by the lack of habitat availability to migrate. Thus, the isolation of the forest fragment may cause howler monkeys to remain in their natal group or to disperse to another established group, which may lead to a crowded population and to a change in the sex ratio. Similar variations in red howler monkey group composition had been found in other forest fragments in Colombia (Gómez-Posada et al. 2010). However, because of the small sample of groups followed in this study we cannot be certain that fragmentation is the cause of altered group structure of red howler monkeys at Hacienda El Ceibal.

It is argued that the ratio of adult female to immature may be used to measure population "health" (Heltne *et al.* 1976; Defler 1981). In red howler monkeys, populations with less than 0.75 immatures for each adult female are expected to be in difficulty; on the contrary, populations with higher number of immature individuals per adult female are expected to be stable or expanding (Heltne *et al.* 1976; Defler 1981). In this study we found a ratio (adult female: immature) of 1:1 which does not seem to indicate a decreasing population.

In conclusion, the population density of red howler monkeys at Hacienda El Ceibal is high compared to other densities reported in the literature, but is consistent with densities reported in fragmented habitats. This value might be a result of the capacity of the species to inhabit in anthropogenic habitats in conjunction with the protection of the area. However, at this site, there is a need to conduct long-term studies to assess the impact of fragmentation and protection of this area on the existing populations of *A. seniculus*.

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REGISTRO OCASIONAL DA PREDAÇÃO DA POMBA-DE-BANDO (*ZENAIDA AURICULATA* DES MURS, 1847) PELO SAGÜI-DO-CERRADO (*CALLITHRIX PENICILLATA* É. GEOFFROY, 1812) NO INTERIOR DE SÃO PAULO, SP

> Felipe Bittioli R. Gomes Renata C. de Lima-Gomes

O sagui-do-cerrado, Callithrix penicillata (Primates: Callithrichidae), é a menor espécie dentre os primatas do Brasil Central, pesando entre 350 e 500 gramas (Stevenson e Rylands, 1988), primitivamente uma espécie de Cerrado, ocupando matas de galeria, cerradões e cerrado strictu sensu (Bicca-Marques et al., 2006). Sua dieta é baseada em artrópodos, frutos, néctar e, principalmente, exsudatos de plantas, sendo a espécie considerada gomívora-insetívora (Stevenson e Rylands, 1988). Primatas do gênero Callitrhix também são conhecidos por eventualmente forragear em ninhos de aves (Miranda e Faria, 2001; Lyra-Neves et al., 2007). Por exemplo, Mendes Pontes e Soares (2005) citam a predação por C. jacchus em ninhegos de pombo--doméstico (Columba livia domestica, Columbidae) e sabiá--laranjeira (Turdus rufiventris, Turdidae); Silva et al. (2008) relatam a predação de C. penicillata em uma rolinha-roxa (Columbina talpacoti, Columbidae); Begotti e Landesmann (2008), relatam algumas tentativas e predações de um grupo híbrido de C. jacchus e C. peniccilata em ovos da pomba-de-bando (Zenaida auriculata, Columbidae), do sabiá-barranco (Turdus leucomelas, Turdidae) e do sabiá do campo (Mimus saturninus, Mimidae). Nosso objetivo é relatar a predação de dois ninhegos da pomba-de-bando, Z. auriculata, por um grupo de C. penicillata na região noroeste do estado de São Paulo, onde a sagüi-do-cerrado é uma espécie introduzida.