Geographic Distribution and Demography of *Pithecia aequatorialis* (Pitheciidae) in Peruvian Amazonia

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To study the geographic distribution and demographic characteristics of *Pithecia aequatorialis* in Peruvian Amazonia, we undertook surveys and transect census in three river basins (Río Itaya, Río Tigre and Río Curaray) between 2004 and 2008. A total of 123 groups of *P. aequatorialis* was encountered during 1623 km of transect walks. Group size was uniform among the three areas (3.4–3.6 individuals), but surprisingly, population densities were higher in the area with strong hunting pressure (Río Itaya: 7.8 ind./km², vs. 5.6 and 5.9 km² in the Río Tigre and Río Curaray basins, respectively). The most common group composition included an adult pair with one offspring. Groups with more than one adult male and/or female accounted for 35% of sightings. Our observations extend *P. aequatorialis* range in Peru further south to the area between the Río Tigre and Río Corrientes, but exclude the area to the north between the Río Curaray and Río Napo. These findings are in contrast to previous distribution maps.

Additional Supporting Information may be found in the online version of this article.

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Large mammals such as woolly monkeys (Lagothrix poeppigii) and tapirs (Tapirus terrestris) are only abundant at a distance of 4 km from the river, but smaller and medium-sized primates abound throughout the area.

Survey sites in the Río Tigre basin are also disturbed by timber extraction and hunting, but to a lesser degree than in the Río Itaya basin and fauna in general including the large-bodied ungulates and primates are quite abundant.

In contrast to the Río Itaya and Río Tigre basins, the Río Curaray basin has undergone little change, most habitat alteration is owing to the extraction of high-value timber. Hunting is for subsistence only, and the fauna still appears to be very abundant, including large terrestrial mammals like T. terrestris and Tayassu pecari, and large primates like Ateles belzebuth and L. poeppigii. On the Curaray, we made complementary transect censuses of the left bank of this river, in order to verify the presence or absence of P. aequatorialis.

Census Methods and Data Analyses

At each survey site, we first opened four or five transects (Itaya: 4–6 km length; Tigre and Curaray: 2.5–4 km length). Line-transect methods were used to estimate primate populations [Aquino et al., 2001; National Research Council, 1981]. Two teams of experienced observers (a researcher and a field assistant) simultaneously walked different transects daily between 06:30 and 12:00 hr, and 14:00 and 17:00 hr at an average speed of 1.0 km/hr. Each time saki monkeys were encountered, group size and composition, the perpendicular distance to the transect of the first individual detected, and characteristics of the vegetation at the site of encounter were recorded. We distinguished P. aequatorialis from P. monachus by the generally lighter coloration of the former, and particularly by the coloration of the ventrum (reddish in P. aequatorialis, dark brown/reddish-brown in P. monachus; see also Aquino & Encarnación, 1994). Age-classes were distinguished by size (adults, juveniles, infant 2, infant 1). Older infants (infant 2) were distinguished from infant 1 by their independent locomotion. We were able to distinguish between adult males and females as they are sexually dichromatic. Population density was calculated with the software Distance v. 4.0 [Laake et al., 1994]. Mean group sizes were calculated only with data from groups for which complete counts were obtained. Group sizes were compared among the survey areas with a one-way analysis of variance in Statistica® 6.0.

Our research complied with the ASP Principles for the Ethical Treatment of Nonhuman Primates and adhered to Peruvian legal requirements.

RESULTS

Geographic Distribution

In this study, we encountered P. aequatorialis on both banks of the Río Itaya, on both banks of the Río Tigre above the confluence with the Río Corrientes, and on the south bank of the Río

<table>
<thead>
<tr>
<th>TABLE I. Survey sites</th>
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<tr>
<td>River basin</td>
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<td>Río Itaya</td>
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</tbody>
</table>
| Río Tigre            | Patria Nueva (5) | 469314/9657272   | medium            | low terrace, including “aguajales” Vend.
|                      | Posayo (6) | 491033/9690852   | medium            | high terrace, including “aguajales” Vend. |
|                      | Coconilla (7) | 488900/9701672  | medium            | low hill |
| Río Curaray          | Quebrada Arabela (8) | 459670/9785672  | low               | low hill; high terrace, including “aguajales” |
|                      | Sector Curaray (9) | 446572/9808358  | low               | low hill; high terrace, including “aguajales” |

*Numbers refer to the locations indicated in Figure 1.

bSwamps dominated by the palm Mauritia flexuosa (“aguaje”).
Curaray. *P. aequatorialis* was not observed between the rivers Curaray and Napo, neither in this study nor in other expeditions made by the first author (January 2005: Río Aushiri, right tributary to the Río Napo; November 2007 and February–March 2008: left bank of the Río Curaray and right bank of the Río Nashino), so we are reasonably confident that the species does not occur in this interfluve. Thus, the distribution of *P. aequatorialis* in Peru is delimited by the rivers Marañón and Amazonas in the south and east, respectively, the rivers Corrientes and Tigre (east of its confluence with the Corrientes) in the west, and the rivers Curaray and Napo (east of its confluence with the Curaray) in the north (Fig. 2).

**Population Density, Group Size and Social Organization**

We encountered a total of 123 groups along 1617 km of transect. Of these, 79 were observed on the Río Itaya (1021 km of transect), 18 between the Tigre and Pucacuro (260 km), and 26 between the Curaray and Arabela (336 km). Population density was 7.8 ind./km² on the Río Itaya, 5.6 ind./km² on the Río Tigre, and 5.9 ind./km² on the Río Curaray. Group density was 1.5 groups/km² both at the Itaya and Tigre, and 2.0 at the Curaray. Mean group size did not differ among the areas surveyed ($F_{2, 90} = 0.109$, n.s.) but maximum observed group size was higher at the Río Itaya (Table II).

On the Río Itaya, groups of two, three and four individuals were sighted with almost equal frequency (28, 30, and 26%, respectively, of sightings). The number of sightings in the other two areas was too low to reasonably calculate group size distributions.

Groups of *P. aequatorialis* are basically composed of an adult pair and one or two young individuals. Mean and modal numbers of adult males and females and of juveniles are provided in Table III. 35% of groups included more than one adult male or female at the Río Itaya (Table III). Solitary individuals were observed on five occasions, all on the upper course of the Río Itaya.

**Interspecific Associations**

During the censuses, seven of the 123 groups ( = 5.7%) of *P. aequatorialis* were seen in association with other primate species. During four sightings they were seen feeding or resting in the same tree as *Saguinus fuscicollis*, twice they were observed traveling with *Callicebus torquatus* and on one occasion along the right bank of the Río Tigre, near Patria Nueva, a single female was seen traveling with a group of three *P. monachus* (a male, a female and a juvenile).

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**TABLE II. Group sizes of *Pithecia aequatorialis* in the different survey areas. Only groups for which complete counts* were obtained are used this analysis**

<table>
<thead>
<tr>
<th>Survey area</th>
<th>Mean group size ($\pm$ SD)</th>
<th>Range</th>
<th>$N$</th>
</tr>
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<tbody>
<tr>
<td>Río Itaya</td>
<td>3.4 ($\pm$ 1.3)</td>
<td>2–8</td>
<td>61</td>
</tr>
<tr>
<td>Río Tigre</td>
<td>3.6 ($\pm$ 1.3)</td>
<td>2–6</td>
<td>13</td>
</tr>
<tr>
<td>Río Curaray</td>
<td>3.5 ($\pm$ 1.0)</td>
<td>2–6</td>
<td>19</td>
</tr>
</tbody>
</table>

*We considered a count as complete if animals could be counted before they detected the observers and if the canopy was relatively open.

**TABLE III. Adult group composition of *Pithecia aequatorialis* in the Río Itaya basin**

<table>
<thead>
<tr>
<th>Adult group composition</th>
<th>No. of observations</th>
<th>% of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 male–1 female</td>
<td>20</td>
<td>65</td>
</tr>
<tr>
<td>1 male–2 females</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>2 males–1 female</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2 males–2 or more females</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
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Only groups ($n = 31$) for which complete counts were obtained and sex of adults were determined are included in this analysis (see Supplemental Material for detailed group composition data).

**DISCUSSION**

Sightings of *P. aequatorialis* on the right bank of the Río Tigre modify the distributional range and contrast with previous maps [Aquino & Encarnación, 1994; Hershkovitz, 1987; InfoNatura, 2007]. These had not considered the area between the rivers Corrientes and Tigre, but included the area between the rivers Curaray and Napo as part of the distribution. However, neither the present study nor other explorations obtained any evidence for the presence of *P. aequatorialis* (nor for another species of *Pithecia* except for *P. monachus*) north of the Curaray, in line with Heymann et al. [2002]. According to existing distributional information, *P. aequatorialis* occurs sympatrically with *P. monachus* throughout its range, but we have seen individuals of both species together only on the right
bank of the Río Tigre. This raises the following questions: (1) Do *P. aequatorialis* and *P. monachus* actually occur syntopically or are they usually separated by habitat? (2) Where they occur together, does hybridism occur?

Population densities in all surveyed areas suggest that *P. aequatorialis* is still quite common and not yet of conservation concern. Surprisingly, population density was highest in the Itaya basin, the area with the strongest hunting pressure. There are three possible explanations: (1) Densities in the areas with low and moderate hunting pressure could be underestimates owing to the much lower survey effort (260 and 336 km of transect walks at the Tigre and Curaray, respectively, vs. 1021 km at the Itaya). However, a survey in 1998 on the lower and upper Río Pucacuro with an intermediate survey effort (647 km of transect walks) resulted in a very low population density (2.8 ind./km²) [Aquino et al., 2000]. This indicates that variable survey efforts are unlikely to account for the differences in population density. (2) Reduced population densities of large primates may have resulted in density compensation by medium-sized primates like *P. aequatorialis*. However, Peres and Dolman [2000] have demonstrated this effect only for areas with moderate but not with high hunting pressure. (3) Population densities may vary according to local and temporal differences in habitat quality and food availability [e.g. Marshall & Leighton, 2006; Worman & Chapman, 2006]. Only repeated census at the same sites in different years combined with phenological measures could actually test this possibility.

Group size and composition observed in this study reflect the general pattern found in the genus *Pithecia*: small groups composed of an adult pair and one or more offspring, but also the occurrence of larger groups with more than two adults (see Norconk [2007] for review). In our study, the proportion of groups including more than one adult male and/or female is considerably lower than in *P. pithecia* (71.4%; Lehman et al. [2001]), but compares to findings in a population of *P. monachus* on the Río Pacaya where multiple adult males/females were present in 46% of group years [Soini, 1988]. The presence of additional adults can reflect delayed dispersal [Norconk, 2007] or may result from group dynamics during periods of reproductive turnover [Di Fiore et al., 2007]. The formation of large groups with multiple adults from both sexes has been observed in populations with restricted or lacking dispersal opportunities (forest fragments, islands; Homburg [1998]; Setz and Gaspar [1997]), but also in continuous habitat [Lehman et al., 2001]. Large groups might also represent short-term associations of two (or more) different groups [Di Fiore et al., 2007].

During our surveys, groups of *P. aequatorialis* were rarely encountered in association with groups from other primate species. Similarly, *P. pithecia* is rarely seen in interspecific association, and if so, it is with tamarins [Buchanan et al., 1981]. In *P. monachus*, 20 out of 154 (=13%) sightings in the Reserva Comunal Tamshiyacu-Tahuayo were in association, also generally with tamarins [R. Aquino, personal observations]. *P. albicans* spent 8.3–25% of time in association, principally with tamarins [Haugasen & Peres, 2009]. In general, *Pithecia* rarely associate with primates larger then themselves [Buchanan et al., 1981; Haugaasen & Peres, 2009; Izawa, 1976], although at the Tiputini Biodiversity Station (Ecuador), *P. aequatorialis* is often found in association with *L. lagotricha* [Di Fiore, personal communication]. The reason for the prevalence of associations with tamarins in most *Pithecia* populations is unknown.

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**REFERENCES**


