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OBSERVATIONS OF GOLDEN-MANTLED TAMARINS (*LEONTOCEBUS TRIPARTITUS*) IN AMAZONIAN ECUADOR

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Abstract

Golden-mantled tamarins (*Leontocebus tripartitus*) are an understudied callitrichid primate the geographic range of which extends from the Río Napo and Río Curaray in Perú into eastern Ecuador. Only one behavioral study of this species has been published to date, which focused on the population overlapping the Tiputini Biodiversity Station in Amazonian Ecuador over two decades ago. We reevaluated this same population via a two-month preliminary assessment of demography, ranging patterns, and behavior. We located five groups within a roughly 1 km radius of the station, with group sizes ranging from approximately 5 to 11 individuals. Most groups were unhabituated to human presence, but for one group that was well habituated we collected ranging and behavioral data over approximately 101 follow-hours. The group had a mean daily path length of 1,483 m and home range estimates of 25.9 to 39.9 ha, depending on the method

used. Intergroup encounters occurred at a rate of 0.08 per follow hour. Group members exhibited substantial variation in cohesion, with individuals routinely traveling, foraging, and sleeping up to 40 m apart. We observed repeated use of several sleep sites as well as the use of a tree hole as a sleep site (the first recorded use for this species) and documented rapid-avoidance and mobbing anti-predator behaviors. These data suggest substantial changes to the Tiputini golden-mantled tamarin population and provide much needed information on callitrichids from the western Amazon, furthering our understanding of variation in socioecology across the callitrichid radiation overall.

Keywords: Golden-mantled tamarins, home range, intergroup encounters, sleep sites, anti-predator behavior

Resumen

El tití de manto dorado (*Leontocebus tripartitus*) es una especie de primates calitricidos poco estudiada cuya distribución geográfica se extiende desde los Ríos Napo y Curaray en Perú hasta el este de Ecuador. Hasta la fecha, solo un estudio de comportamiento ha sido publicado. Este estudio se realizó hace dos décadas en la población de titíes de La Estación de Biodiversidad de Tiputini. En el presente estudio, reevaluamos la misma población de titíes de manto dorado a través de un estudio preliminar de dos meses enfocado en la demografía, patrones de movimiento y comportamiento. Ubicamos cinco grupos dentro de un radio aproximado de 1 km de la estación, con tamaños de grupo que abarcaron de 5 a 11 individuos. La mayoría de los grupos estaban deshabitados a la presencia humana, pero para un grupo habituado colectamos datos de movimiento y comportamiento durante 101 horas. Este grupo tuvo un promedio de recorrido diario de 1.483 m y su rango de hogar estimado fue de 25,9 a 39,9 ha, dependiendo del método utilizado. Los encuentros entre grupos ocurrieron a una tasa de 0,08 por cada hora de seguimiento. Los miembros del grupo exhibieron niveles de cohesión variable, con individuos rutinariamente moviéndose, forrajeando, y durmiendo a 40 metros de distancia aproximadamente. Observamos el uso repetido de varios dormitorios además del uso de un hueco en un árbol como dormitorio (el primer registro para esta especie) y documentamos evitación rápida y “mobbing” como comportamientos anti-predatorios. Estos datos sugieren cambios considerables en la población de titíes de manto dorado de Tiputini y proveen información necesaria de los calitricidos del oeste de la Amazonía, lo que promueve nuestro entendimiento de la variación socioecológica de la radiación de los calitricidos en general.

Palabras clave: Tití de manto dorado, rango de hogar, encuentros entre grupos, dormitorios, comportamiento anti-predatorio

Introduction

Over 500 primate species are recognized, but very little has been published on the behavior and ecology of the majority of taxa. Updated assessments of lesser-studied species are necessary to contribute to our general understanding of behavioral, ecological, and social diversity patterns, as well as to provide a baseline knowledge that may prove essential to conservation efforts as anthropogenic activities continue to threaten primates across the world. One taxonomic group that deserves more attention is the callitrichids, small-bodied platyrrhine primates living in Central and South America. Studies of wild callitrichids are few relative to other American primates and fewer still relative to primates overall (Bezanson and McNamara 2019), and those that exist have thus far focused heavily on Atlantic Forest callitrichids (e.g., common marmosets, *Callithrix jacchus*), with information on Amazonian callitrichids still largely lacking.

Golden-mantled tamarins (*Leontocebus tripartitus*) are one such species of little-studied Amazonian callitrichid. Their geographic range extends from between the Río Napo and Río Curaray in Perú into eastern Ecuador (Rylands et al. 2011), and only a small number of reports have documented even the most basic data about the species' population density and group size (Albuja 1994; Heymann 2000; Aquino et al. 2005). These studies, which were usually limited to a few days of observation, suggest a mean group size of approximately 5 to 6 individuals (Thorington Jr. 1988; Albuja 1994; Heymann 2000; Aquino et al. 2005) and a population density ranging from approximately 13 to 27 individuals per km², depending on the location (Aquino et al. 2005, 2014). Our understanding of golden-mantled tamarin behavior is even more limited. Only a single behavioral study exists, which was conducted between 1997 and 1999 at the Tiputini Biodiversity Station in Amazonian Ecuador (76°08'W, 0°38'S, Figure 1) (Kostrub 2003). This study provides an initial characterization of the social and ecological factors mediating group composition dynamics, reproduction, and infant care of golden-mantled tamarins at the site. However, no behavioral study of golden-mantled tamarins has occurred at this site – nor, to the best of our knowledge, at any others – in over two decades.

In a two-month field season at the Tiputini Biodiversity Station in summer 2019, we reevaluated the state of this same population of golden-mantled tamarins through a preliminary assessment of demography, ranging patterns, and behavior. We also documented the occurrence of several behaviors that have not been previously recorded or described for wild golden-mantled tamarins, including variation in group cohesion, aerial and arboreal anti-predator behavior, and sleep site usage.

Methods

We conducted this study from June 16 to August 10, 2019. This time of year was expected to overlap with the mating season for golden-mantled tamarins at the site (Kostrub 2003). We conducted daily surveys to ascertain the approximate number, size, and distribution of golden-mantled tamarin groups in portions of the Tiputini Biodiversity Station trail system as well as habitat usage and ranging patterns of the groups we contacted whenever possible. We conducted surveys between 0545 and 1800 hours by walking established trails multiple times per day and waiting for tamarins at known feeding trees within a ~1 km radius of the station. We also used playbacks of golden-mantled tamarin long-calls, which were originally recorded at the Tiputini Biodiversity Station in 2009 and are archived in the Cornell Lab of Ornithology's Macaulay Library (ML148787).

When we encountered a group of tamarins, we recorded their habituation level, approximate group size, and location. We judged habituation level based on the group's tolerance of human presence and, when possible, their tolerance of being followed. We considered groups that immediately fled on contact as “poorly habituated” and those exhibiting little to no noticeable changes in behavior as “well-habituated”.

To record group size, we found that path counts (i.e., counts made as a group traveled along a single path) provided the most accurate estimates. However, path counts proved difficult for unhabituated groups, which tended to scatter on contact. We were unable to accurately estimate group sex ratios due to sexual monomorphism in body size and appearance. Age composition estimates were also impossible as the last births likely occurred over five months prior to observations, and offspring had already obtained their adult fur coloring (Kostrub 2003).

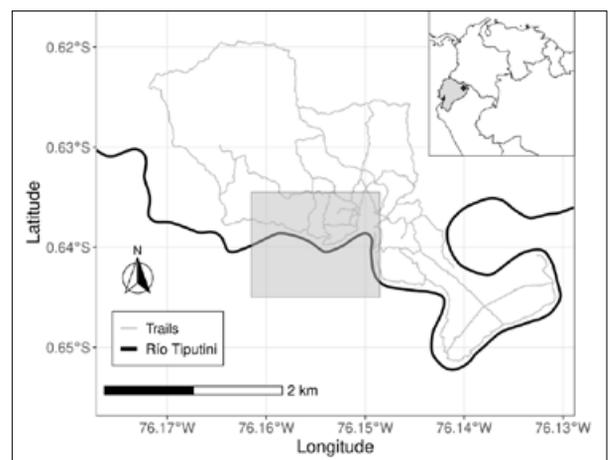


Figure 1. Map of Tiputini Biodiversity Station. Grey rectangle represents the area shown in detail in Figure 2. Upper right inset panel shows the station's location (black diamond) within Ecuador (grey).

Upon encountering groups, we recorded their location as well as their travel paths for as long as we were able to follow them using a datalogging GPS unit worn by the observer (Garmin GPSMAP 64, location records stored at 20 second intervals). On occasions when we were able to follow groups until they entered a sleep tree at the end of the day, we stayed at least 45 minutes to confirm that the group did not change sleeping sites. We returned to the tree before dawn the next day and marked the trees with a GPS waypoint and physical tag once the group exited the tree.

For the single habituated group for which we obtained tracking data covering multiple days ("Lago" group), we calculated daily path length and home range size estimates. We used location records collected during all encounters with the group to estimate home range size, but for calculating daily path lengths we used data only from full-day follows, in which we remained with the group from when they exited a sleep tree in the morning until they entered a sleep tree in the evening. Before using GPS data in home range and path length calculations, we extracted location records at regular 15-minute intervals (on the hour and at 15, 30, and 45 minutes past the hour) by averaging all GPS coordinates recorded in the two minutes on either side of those time points. To determine daily path lengths, we used packages *sfheaders* (Cooley 2020) and *sf* (Pebesma 2018) for the statistical programming software R (version 4.1.0, R Core Team 2021) to sum the distance between these location records collected within each full-day follow. We used the packages *adehabitatHR* (Calenge 2006) and *tlocoh* (Lyons et al. 2013) to estimate home ranges as 95% minimum convex polygons (Mohr 1947), 95% utilization density kernels (Worton 1989), and 100% local convex hulls (Getz et al. 2007) based on the entire set of 15-minute location records.

We recorded all intergroup encounters during follows, noting the time and location at which they occurred. We considered intergroup encounters to have occurred when neighboring groups were in visual range of each other (i.e., less than 50 m) and exchanged long-calls (Peres 1989; Garber et al. 1993; Kostrub 2003) and/or overt agonistic interactions, such as chases or physical aggression (Kostrub 2003).

Results & Discussion

We encountered an estimated total of five groups within a roughly 1-km radius of the station, but only one was well-habituated to human observers ("Lago" group). The home range of Lago group overlaps some of the most commonly used trails at the station as well as the living quarters and offices of the station itself, likely leading to this group's high tolerance of human presence and follows. While we did occasionally find other groups near the station, these were usually in areas less commonly

used by humans. All other groups usually fled on contact, with follows of these non-habituated groups lasting a maximum of 1 hour and 41 minutes (N = 15 follows, mean follow time: 32 minutes). By contrast, we were able to follow Lago group for multiple days in a row on several occasions, with a total follow time of 101 hours and 5 minutes (N = 21 follows, mean follow time: 4 hours, 49 minutes) across 18 days of the field season.

We confidently ascertained the group size for Lago group (N = 11) and for one of the unhabituated groups (N = 8). We estimated that all other unhabituated groups contained a minimum of 5 individuals. A group size of 11 individuals is the largest documented thus far for *Leontocebus tripartitus*, with previous surveys reporting a maximum of 10 individuals per group for this species (Albuja 1994). Notably, these counts are substantially larger than those documented in this same population almost two decades prior by Kostrub (2003) (mean group size: 4 individuals, range: 2 to 7 individuals), potentially suggesting an increase in population density over the past 20 years.

We observed substantial variation in group cohesion, with subsets of individuals from Lago group routinely splitting off to travel, forage, or rest up to 30-40 m apart. We also observed one unhabituated group that did not appear to scatter, but to split into two cohesive subgroups of four individuals traveling approximately 50 m apart from one another. Similar observations in *Leontocebus tripartitus* have previously been coded as a temporary association of two groups (Kostrub 1997), which may have been the case for the unhabituated group. However, such a large group spread also fits with that observed in the habituated group in this study as well as in other tamarin species (e.g., *Saguinus labiatus*, *S. imperator*, *Leontocebus fuscicollis*: Buchanan-Smith 1999), leaving both as potential options.

We also observed behaviors that appeared to be clearly linked to predator presence, including responses to both aerial and arboreal predators. The tamarins exhibited "rapid avoidance" (*sensu* Ferrari and Ferrari 1990) anti-predator behavior when raptors flew overhead (N=3 observations) as well as in response to a toucan call (N =1 observation), with two observations of rapid avoidance behavior in response to unknown stimuli. In all situations, the entire group rapidly descended toward the ground and occasionally sought cover by moving onto the ground itself. Raptors and toucans have been previously shown to elicit alarm behavior in other callitrichids, with similar avoidance behaviors reported for these and other aerial predators (e.g., *Callithrix flaviceps*: Ferrari and Ferrari 1990; *Saguinus mystax*, *Leontocebus nigrifrons*: Heymann 1990; *L. avilapiresi*: Peres 1993). We also observed one occasion in which individuals exhibited mobbing behavior toward a tayra (*Eira barbara*), a member of the weasel family native to the Americas,

where the entire group faced the tayra while emitting loud alarm call and chatter vocalizations until the tayra left the group. “Mobbing” anti-predator behavior in callitrichids appears to be typical for tayra and other non-aerial predators (Bartecki and Heymann 1987; Ferrari and Ferrari 1990; Peres 1993), although studies have reported rapid avoidance responses to non-aerial predators as well (Ferrari and Ferrari 1990).

We obtained 21 total GPS tracks consisting of 410 averaged location records acquired over 18 days from the Lago group (Figure 2), four of which were full-day follows averaging 10 hours 38 minutes \pm SD 21 minutes from sleep tree to sleep tree. From these, we calculated a mean daily path length of 1,483 \pm SD 470 m (range: 937 to 2,120 m). This value is consistent with those recorded by Kostrub (2003), who calculated daily path lengths ranging from 466 to 2,308 m (mean=1,470 m; N=63 follows). We also calculated a 95% minimum convex polygon home range estimate of 39.9 ha, which is approximately twice that of the largest home range calculated for this population 20 years ago (21 ha) using the same method, though much closer to those recorded for other small-bodied tamarin species (Digby et al. 2007). Home range size estimates based on the 95% kernel utilization distribution and on 100% local convex hulls (Figure 2) were 30.8 ha and 25.9 ha, respectively.

During our follows of Lago group, we observed 8 intergroup encounters (Figure 2). Intergroup encounters appeared to take place at the edges of the group’s territory no later than 1400 hours, with no more than one encounter observed per day. We observed encounters during three of the four full-day follows, yielding an estimated rate of 0.75 encounters per day. Across the total number of hours spent with Lago group (101 hours, 5 minutes), this rate translates to 0.08 encounters per follow hour. This rate is substantially higher than that found by Kostrub (2003), who observed only six intergroup encounters in 235 observation hours (0.03 encounters per follow hour) during the dry season—the same period as the current study. These rates are instead more similar to those found during the rainy season, where Kostrub (2003) observed 25 intergroup encounters in 323 hours of observation (0.07 encounters per follow hour). The reasons for the higher intergroup encounter rate cannot be determined without additional study, but may be related to changes in population density, food availability, and/or breeding patterns from those observed 20 years ago. The playbacks used in the course of the present study may have also influenced the intergroup encounter rate.

We located sleep trees for the Lago group on 10 occasions. The group used six unique trees, with two trees used twice and one used three times on non-consecutive nights during the two-month study (Figure 2). Repeated use of sleep sites in tamarins has been documented previously (e.g., Heymann 1995; Pontes and Soares 2005),

including in golden-mantled tamarins (Kostrub 2003). In general, sleep trees supported large masses of vines into which the group would disappear. On one occasion, however, we observed them using a tree hole. Patterns of tree hole use for sleep sites vary across callitrichids, with some species using tree holes occasionally (e.g., *Callithrix jacchus*: Pontes and Soares 2005; *Leontocebus nigrifrons*: Heymann 1995) and others habitually (e.g., *Leontopithecus rosalia*: Hankerson et al. 2007). We set up a camera trap for one additional month at this location to see if the group might use it again, but the group’s use of the tree hole as a sleep site seemed to be limited to this one instance.

These new observations of wild golden-mantled tamarin grouping and ranging behavior provide suggestive evidence of substantial changes in the golden-mantled tamarin population at the Tiputini Biodiversity Station since the population was last studied over 20 years ago. These observations also provide additional data on behaviors that were seldom previously recorded for the species, including anti-predator behavior and sleep-site usage. In doing so, we provide further support encouraging the establishment of long-term studies as well as additional studies of Amazonian callitrichids to better understand the variation and similarities within and between these species.

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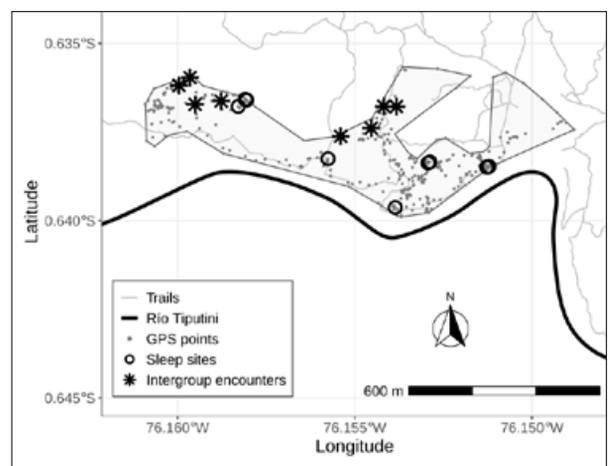


Figure 2. 100% local convex hull home range estimate with GPS points from daily follows (grey points), sleep sites (black open circles), and intergroup encounters (black asterisks) recorded between June 10 and August 16, 2019 from golden-mantled tamarins (*Leontocebus tripartitus*) in the Lago group at the Tiputini Biodiversity Station in Amazonian Ecuador.

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REPORT OF A PYGMY MARMOSET (*CEBUELLA NIVEIVENTRIS*) SWIMMING IN IGAPÓ FOREST FLOODWATERS

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Introduction

Swimming occurs when an individual is partially or fully submerged in water without contacting a substrate and uses its limbs for propulsive, spatially directed movement (Kempf 2009; Bender and Bender 2013). Researchers have observed swimming behavior in 17 catarrhines and seven platyrrhines (Table 1). We found no published observations for tarsiids or loriforms, and only two descriptions for lemuriforms, neither of which we include because Petter and Peyrieras (1975) provided only a secondhand account and Gaide et al. (2015) were unclear about the source of the observation. Five of the seven platyrrhines are medium or large-bodied (>1 kg), while the other two are small-bodied. In most cases, individuals traversed bodies of water, while in fewer cases, individuals rescued themselves after unintentionally falling into bodies of water (Table 1). The distribution of swimming anecdotes suggests that swimming is rare in platyrrhines and even more so in its small-bodied members.

Pygmy marmosets (*Cebuella* spp.), weighing between 85 and 160 g, are the tiniest monkeys within the primate order (Soini, 1988; Ford and Davis 1992). Recent molecular and morphological studies have recognized two species of pygmy marmosets endemic to western Amazonia, *C. pygmaea* north of and *C. niveiventris* south of the Solimões River (Rylands 2009; Boubli et al. 2018; Garbino et al. 2019; Porter et al. 2021). These tiny monkeys thrive in seasonally flooded and river-edge habitats, subsisting by claw-climbing and claw-clinging in the forest understory, where they spend most of their time gouging tree trunks and consuming exudates (Soini 1988; Youlatos 1999, 2009; Jackson 2011). Even though pygmy marmosets preferentially live in wet habitats and forage precariously close to floodwaters and rivers, there have been no

swimming reports for either species. Here, we describe a juvenile southern pygmy marmoset (*C. niveiventris*) swimming in igapó floodwaters.

Study Site

The swimming event occurred during a field study of pygmy marmoset ecology at the Tahuayo Lodge in north-eastern Peruvian Amazonia (04°18'S, 73°13'W). Located near the confluence of the Tahuayo and Blanco rivers, this facility rests in a landscape of palm swamps, flood plains that inundate from December to June, and *terra firme* habitats (Santillán and Tegnér 2015). El Chino village is 1.5 km northeast of the Tahuayo Lodge on the right bank of the Tahuayo River. Local community members subsist via fishing and small-scale farming, which has produced some deforested plots along the riverbank. Despite these anthropogenic disturbances, at least eight pygmy marmoset groups lived along the river between the Tahuayo Lodge and El Chino (Sheehan and Papworth 2019). Additionally, nine other primate species lived near the Tahuayo Lodge and surrounding areas: brown capuchins (*Sapajus apella macrocephalus*), moustached tamarins (*Tamarinus mystax*), owl monkeys (*Aotus nancymaeae*), saddle-back tamarins (*Leontocebus nigrifrons*), sakis (*Pithecia monachus*), coppery titi monkeys (*Plecturocebus cupreus*), squirrel monkeys (*Saimiri macrodon*), uakaris (*Cacajao ucayalii*), and white-fronted capuchins (*Cebus yuracus*) (updated from Santillán and Tegnér 2015).

Observation

The swimming event occurred 0.35 km northeast of El Chino on the edge of a deforested plot in the middle of the flooding season on March 19th, 2019. CPJ was conducting preliminary observations of a potential study group with four adults and one juvenile of unknown sexes and ages. Just before the swimming event, the group was foraging for the pulp of *Inga alba* pods. To acquire this food, an individual would hold onto a terminal branch with its non-hallux toes, reach above or suspend its entire body below, and then grasp a single pod with both hands. Aligning its head parallel to the pod's transverse axis, the individual would anchor its incisors into the lateral edges and pull off a single segment of the exocarp, revealing a single seed surrounded by pulp. After removing the seed and pulp, the individual would move onto a more stable branch near the trunk and then roll the seed and pulp in its mouth before spitting it into the water below. Individuals in the group foraged for 40 minutes and then left the feeding tree. The juvenile left last.

Exiting the feeding tree, the juvenile attempted a terminal-branch leap but could not generate sufficient propulsion during the take-off phase to reach the next support because the branch it took off from was too compliant. The juvenile fell 2 m, splashed into the floodwater, and