SHORT COMMUNICATION

Titi Monkeys (*Callicebus* spp., Atelidae: Platyrrhini) in the Brazilian State of Rondônia

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ABSTRACT. Five species of titi monkey (*Callicebus brunneus, Callicebus caligatus, Callicebus cinerascens, Callicebus donacophilus,* and *Callicebus moloch*) were recorded in surveys of primate populations at 26 sites throughout the Brazilian state of Rondônia. The distribution of the two species, *C. cinerascens* and *C. donacophilus* (recorded in the state for the first time), appeared to be related to that of non-forest ecosystems, the former in the *cerrado* woodlands, and the latter in gallery forests of the Guaporé grasslands. The results of the surveys also indicate that *C. brunneus* has a more restricted distribution in southern Rondônia than was previously thought, whereas *C. moloch* is more widespread. However, the ecological factors that determine species distribution in the south of the state remain unclear on the basis of the available data. All species were observed in small social groups of no more than five individuals, which are typical of the genus, generally in the middle and lower forest strata.

Key Words: *Callicebus*; Species diversity; Population; Zoogeography; Amazonia.

INTRODUCTION

Titi monkeys (*Callicebus* spp.) are a diverse group of New World monkeys widely distributed in both Amazonian and Atlantic Forest biomes (HERSHKOVITZ, 1990), but, in contrast with *Alouatta, Callithrix*, and *Cebus*, are absent from intervening savanna-like ecosystems of central Brazil. *Callicebus* is thus the only platyrrhine genus allopatrically distributed in the two major neotropical forest biomes.

The taxonomy and zoogeography of the genus remain controversial (and the genetics poorly known – see SCHNEIDER et al., 1993). HERSHKOVITZ (1963) originally identified three species groups, the *Callicebus personatus* group from the Atlantic Forest, and the Amazonian *Callicebus moloch* and *Callicebus torquatus* groups, each with at least three subspecies. More recently, both HERSHKOVITZ (1988, 1990) and KOBAYASHI (1995) revised the genus, making changes primarily to the arrangement of the *C. moloch* group. While these authors disagree on many points, they do both allocate species status to the forms encompassed by the present study.

Relatively little information is available on the ecology of titi monkeys. While some detailed studies have been conducted in the Atlantic Forest (KINZEY & BECKER, 1983; MÜLLER, 1996; HEIDUCK, 1997), and in Colombia and Peru (KINZEY et al., 1977; ROBINSON, 1981; TERBORGH, 1983; EASLEY & KINZEY, 1992; PALACIOS et al., 1997), data from Brazilian Amazonia are scant.

In the present study, data are presented on the behaviour and zoogeography of titi monkeys collected during surveys in the Brazilian state of Rondônia (southwestern Amazonia).

METHODS

Mammal populations were surveyed at 33 sites in the Brazilian state of Rondônia between September 1996 and November 1997 (see FERRARI et al., 1999a). The sites were chosen in order to best sample both the diversity of mammals, especially primates, within the state and the effects of recent human colonization on local populations. As much of Rondônia has been subject to deforestation, the largest and least disturbed tracts of *terra firme* forest within each study area were initially identified from recent satellite images, and study sites were subsequently selected *in situ* in such a way as to standardize habitat characteristics between sites as far as possible.

At each site, a system of straight-line trails – with a total extension of between 2 and 6 km, depending on the site – was cut in such a way as to minimize impact on the vegetation, swept clean of leaves and other debris, and marked with flagging at intervals of 100 m. Surveys were conducted according to standard line transect methods (see BROCKELMAN & ALI, 1986) as used in previous studies in Rondônia (e.g. FERRARI et al., 1995, 1996a). Trails were walked at a mean velocity of 1.5–2.0 km per hour and, at each sighting of titi monkeys, the species was identified, and standard survey data were collected. Data included sighting angle and distance, group composition and the estimated height above the ground of the first individual sighted.

The principal difference in data collection between sites was in the total length of transect walked. The sites can be divided into 20 at which "standard" surveys of at least 100 km (and up to 323 km) were carried out, and the remaining 13, at which "rapid" surveys of less than 100 km (50 km at 11 of the sites).

Callicebus species were identified on the basis of descriptions in HERSHKOVITZ (1988, 1990) and KOBAYASHI (1995), in addition to the examination of specimens at the Goeldi Museum in Belém, the National Museum in Rio de Janeiro, and the Museum of Zoology at the University of São Paulo.

RESULTS AND DISCUSSION

Callicebus was recorded in surveys at 26 of the 33 sites, including areas of highly-disturbed forest in which few mammal species –even callitrichines– were observed. The lack of survey records at a given site may have been related primarily to sampling effort (together with the relatively cryptic behaviour of the monkeys), rather than the absence of the genus, given that all the sites at which titis were not observed were among those at which 50-km surveys were conducted. A majority of these sites were nevertheless among the most disturbed and/or species-poor, suggesting that titis may have been either significantly reduced in density or locally extinct in some cases. There is no evidence, however, of any major diaspora in the geographic distribution of the genus within the state, such as those recorded for *Alouatta* (IWANAGA, 1998) and *Callithrix* (FERRARI et al., 1997).

Titi monkeys are highly territorial, and the early morning duetting behaviour is a characteristic of the genus (KINZEY, 1981; ROBINSON, 1981), as are their generally cryptic habits during the rest of the day. These characteristics did not appear to influence survey sightings, however (Fig. 1). In fact, sightings were at least as common in the late morning and early afternoon as during the first hours of daylight, when duets almost invariably occur. While titis were observed in dis-

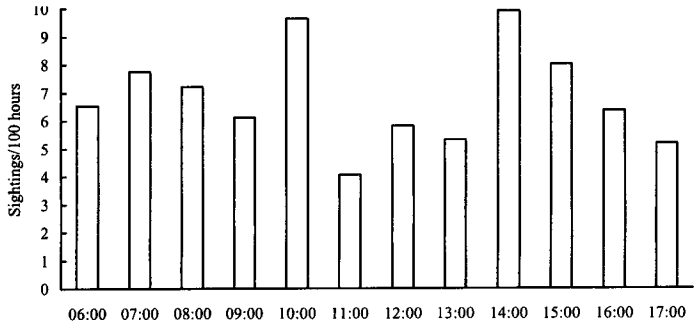

Fig. 1. Distribution of sightings of *Callicebus* in Rondônia according to the time of day (sighting rate = number of sightings/survey time in hours ×100).

turbed forest at some sites, the aims of the present study did not include the systematic evaluation of habitat preferences. The data nevertheless show a clear preference for the lowest strata of the forest in all five species (Fig. 2, Table 1), which is typical of the genus (KINZEY, 1981; PALACIOS et al., 1997).

Despite efforts during data collection, group size is frequently underestimated in line transect surveys, and even when values are similar to those expected, it is difficult to identify reliable estimates. This problem is accentuated in the case of *Callicebus*, due to both its relatively cryptic behaviour and its small, monogamous family groups, which typically contain a breeding pair and one to three offspring. Given this, mean group size is unexpectedly low for all five species (Table 1), and interspecific differences are almost certainly related to sampling effects rather than real differences between species.

The characteristics of the zoogeography of *Callicebus* in Rondônia are quite distinct in the northern and southern portions of the state (Fig. 3). North of the Serra dos Pacaás Novos, the geographic ranges of *C. brunneus, C. caligatus*, and *C. moloch* are clearly limited by two major rivers, the Madeira and the Jiparaná, as indicated by HERSHKOVITZ (1990) and FERRARI and LOPES (1992).

In the southern half of the state, however, the distribution of titis appears to be determined principally by ecological, rather than geographic barriers. The most relevant ecological features in the southern half of the state are the areas of savanna vegetation (associated with the Chapada

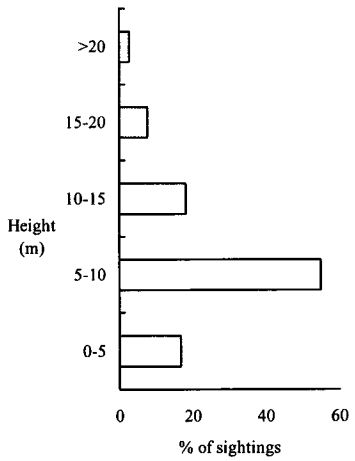

Fig. 2. Distribution of sightings of *Callicebus* in Rondônia, according to height above the ground (all species combined).

Table 1. Group sizes and sighting heights for the five *Callicebus* species recorded during the present study.

Species	*N* sites	*N* sightings	Group size (individuals)		Mean sighting height (m)
			Mean	Maximum	
Callicebus brunneus	18	118	2.25 ± 0.97	5	8.55 ± 4.41
Callicebus caligatus	2	5	2.20 ± 0.84	4	13.20 ± 6.26
Callicebus cinerascens	1	3	1.67 ± 0.33	2	11.00 ± 2.65
Callicebus donacophilus	1	3	2.00 ± 1.00	3	12.33 ± 1.53
Callicebus moloch	4	15	2.47 ± 0.92	4	10.87 ± 5.44

dos Parecis), typical of and contiguous with the *cerrado* of central Brazil, and the seasonally flooded Guaporé grasslands, which skirt the right bank of the Rio Guaporé in the extreme south of the state. Unfortunately, the distribution of sampling localities in this region is too sparse to allow more than a superficial evaluation of species distribution and associated ecological factors, but it is hoped that further surveys will provide more definitive data.

The Bolivian grey titi monkey (common names follow ROWE, 1996), *C. donacophilus*, is widely distributed in eastern Bolivia, but is known from only one other locality in Brazil, in the western extreme of Mato Grosso (HERSHKOVITZ, 1990). This species' distribution is clearly associated with open habitats, such as the swampy grasslands of the Pantanal and the Paraguayan Chaco, which suggests that *C. donacophilus* may be restricted in Rondônia to the Guaporé grasslands in the extreme south of the state. As both HERSHKOVITZ (1990) and KOBAYASHI (1995) recognize a *C. donacophilus* species group, it seems reasonable to conclude that it is also ecologically distinct from *C. moloch*, but it is unclear, from the present data, whether the two groups are allopatric.

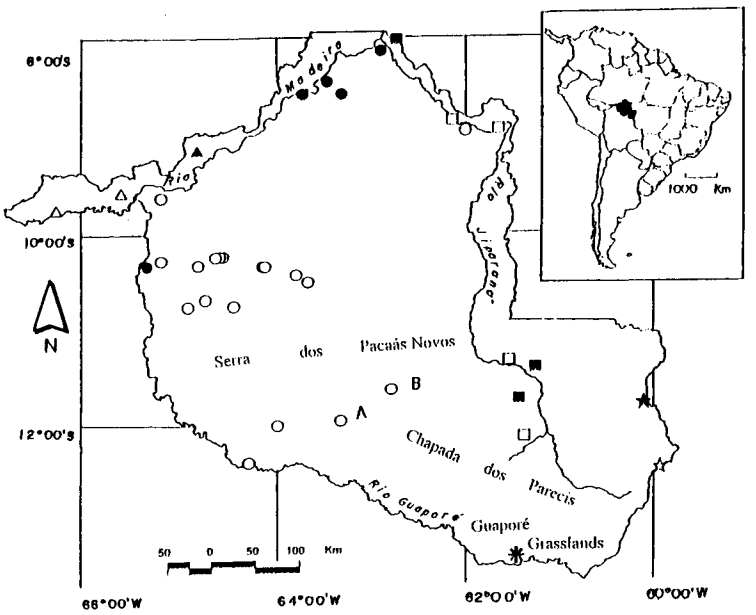

Fig. 3. Collecting and sighting localities for *Callicebus* in Rondônia in relation to major geographical features. Published localities (HERSHKOVITZ, 1990; FERRARI & LOPES, 1992; FERRARI et al., 1996a, b) are represented by shaded symbols, those recorded in the present study by open symbols. Some of the localities recorded by HERSHKOVITZ (1990) are omitted here because of incomplete or contradictory information. ○: *C. brunneus*; △: *C. caligatus*; ☆: *C. cinerascens*; *: *C. donacophilus* (present study); □: *C. moloch*.

The apparently restricted distribution of the ashy titi monkey (*C. cinerascens*) in southern Amazonas and Rondônia (HERSHKOVITZ, 1990) may be at least partly a result of the relative lack of localities from this region. As the known distribution of this species coincides with the zone of transition from forest to savanna habitats in southern Amazonia, it is possible that it may also be ecologically distinct from other members of the *C. moloch* species group, although once again, more data will be required before such differences can be defined.

There is no evidence to suggest that the other two species found in southern Rondônia –*C. brunneus* and *C. moloch*– are ecologically distinct, by contrast, which suggests that a contact zone exists somewhere between the Serra dos Pacaás Novos, to the north, and the Chapada dos Parecis, to the south. While similar, this differs from the situation recorded for *Callithrix*, in which *Callithrix* sp. n. (FERRARI et al., 1999b) occurs north of the Pacaás Novos and *Callithrix melanura* to the south (FERRARI et al., 1997). The characteristics of this contact zone remain unclear, i.e. whether sympatry or even hybridization occurs, but it is interesting to note that at two sites (marked A and B on Fig. 3) located south of the Pacaás Novos, some of the monkeys observed were relatively lightly-coloured (more similar to *C. moloch*) in contrast with the typical dun tones of *C. brunneus*. Local residents also confirmed the existence of two distinct types of titis in different areas at this site.

Overall, then, the variety of both ecosystems and species in southern Rondônia combine to make this a potentially lucrative region for the investigation of the ecological –and phylogenetic – relationships between different forms of titi monkey. Far more data (including specimens and material for genetic studies – see SCHNEIDER et al., 1993; ANSELMO, 1997) from a much wider selection of localities will be required, however, before these relationships can be fully understood.

Acknowledgements. Field work in Rondônia was made possible through the support of the state government, Tecnosolo S.A. and DHV Consultants. The Brazilian National Research Council (CNPq) and CAPES also supported team members individually. We are especially grateful to WIM GROENEVELD, AUREA SILVEIRA, VERA CANSAÇÃO, LUÍS FLAMARION (Museu Nacional), MZUSP, and the many people in both Porto Velho and throughout the state who contributed in different ways to data collection. The manuscript benefitted from the comments of two anonymous referees. This study is dedicated to the memory of ZIEGFELD ZOG.

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—— Received: *November 21, 1998*; Accepted: *January 7, 2000*

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