

ARTICLES

FURTHER NOTES ON THE DISTRIBUTION OF ENDEMIC BOLIVIAN TITI MONKEYS, *CALLICEBUS MODESTUS* AND *CALLICEBUS OLALLAE*Jesus Martinez¹ and Robert B. Wallace^{1,2}¹ Wildlife Conservation Society, Greater Madidi Landscape Conservation Program, Casilla 3-35181, San Miguel, La Paz, Bolivia² Wildlife Conservation Society, 185th Street and Southern Boulevard, Bronx, New York, 10460, USA, e-mail: <rwallace@wcs.org>

Abstract

We present information on the distribution of the endemic Bolivian primates *Callicebus olallae* and *C. modestus* based on a series of site visits in the Beni Department. *Callicebus olallae* was registered at four localities and *C. modestus* at 11 localities, and in combination with negative data and localities for other *Callicebus* species in the region we defined the distributional boundaries for both endemics. Mean group size was 2.7 individuals for *C. olallae* and 3 individuals for *C. modestus*. The results highlight the restricted distribution of both species, with *C. olallae* having one of the highest levels of primate endemism in the world and an "occurrence area" of 400 km², and considering forest fragmentation in the region, more realistically an "occupancy area" of 50 km². Although *C. modestus* is found in slightly larger areas (1,800 km² and 450 km² respectively) the distribution area is still extremely restricted. The restricted distributions together with ongoing forest fragmentation due to cattle ranching, unregulated ecotourism activities, and principally the scheduled improvement of the "Northern Corridor" road that passes through this region, means that both species should be considered highly endangered.

Key Words: Geographical range, group size, physical characteristics, Southwestern Beni Department, Bolivia

Resumen

Presentamos información acerca de las áreas de distribución de los dos primates endémicos de Bolivia, *Callicebus olallae* y *C. modestus*, mediante la visita de localidades en el departamento del Beni. *Callicebus olallae* fue registrado en 4 localidades y *C. modestus* en 11 localidades, y en combinación con datos negativos y localidades para otras especies de *Callicebus* en la región definimos los límites de distribución para las dos especies endémicas. El promedio del tamaño de grupo para *C. olallae* fue 2.7 individuos y para *C. modestus* 3 individuos. Los resultados resaltan la distribución altamente restringida que ambas especies presentan, siendo *C. olallae* una de las especies con mayor grado de endemismo de Sur América al tener un "área de ocurrencia" de 400 km² y, considerando el alto grado de fragmentación del bosque, de forma más realista un "área de ocupación" de 50 km². Aunque *C. modestus* ocupa áreas mayores (1,800 km² & 450 km² respectivamente) muestra también un elevado grado de endemismo. Esta situación, junto con la fragmentación del bosque debido a las actividades de ganadería, además de actividades no reguladas de ecoturismo y, principalmente el proyectado mejoramiento del tramo vial del "Corredor Norte" que atraviesa la zona habitada por estos primates, conlleva a considerar a ambas especies como altamente amenazadas.

Palabras Clave: Rango geográfico, tamaño de grupo, características físicas, suroeste del departamento Beni, Bolivia

Introduction

The titi monkeys (genus *Callicebus*) are considered the most diverse primate genus in the Neotropics, with 29 recognized species (Van Roosmalen *et al.*, 2002; Wallace *et al.*, 2006). Clearly defined distributional patterns, habitat preferences, food habits, and behavior of many of these species are still unknown. Indeed current knowledge

of their continental distribution is scant, most dramatically demonstrated by the recent discoveries of new species (Hershkovitz, 1988, 1990; Van Roosmalen *et al.*, 2002; Wallace *et al.*, 2006). A good example of the poor distributional knowledge regarding *Callicebus* is the case of the two Bolivian endemics, *Callicebus modestus* and *Callicebus olallae* (Kinzey, 1981; Hershkovitz, 1988, 1990; Anderson, 1997; Rylands *et al.*, 2000; Van Roosmalen *et al.*,

2002). Collected by the Olalla brothers and described by Lönnberg (1939) based on the examination of just three collected individuals, the specimens have subsequently been considered as full species in taxonomic revisions of *Callicebus* (Hershkovitz, 1990; Kobayashi, 1995). Nevertheless, for almost seventy years no field data were obtained about these apparently range-restricted Bolivian endemic primate species.

In light of this situation, in 2002 the Wildlife Conservation Society began investigating the distribution of both species (Felton *et al.*, 2006). These preliminary studies confirmed the presence of *C. modestus* and *C. olallae*, or at least two distinct phenotypes (Felton *et al.*, 2006), in a zone near the suggested collection sites of the Olalla brothers (Lönnberg, 1939; Anderson, 1997), which comprises non-continuous forest patches interfacing with a natural savannah system (Felton *et al.*, 2006). However, their overall distributional pattern and extent remained unclear.

A critical issue in the study of these species is their rather similar morphological features (Lönnberg, 1939; Hershkovitz, 1990) that together with variable lighting conditions during field observations make accurate identification a challenge. This situation calls into question the original taxonomic distinctions made by Lönnberg (1939) and subsequently supported by others (Hershkovitz, 1990; Kobayashi, 1995), especially when considering the small sample size and the restricted and apparently overlapping distribution area determined for both species. The original specimens for both species were collected within 65 km of each other (Felton *et al.*, 2006), although it is important to note that some sources have questioned the collection locations for other primate species reported by the Olalla brothers in other areas of South America (Aquino and Encarnación, 1996).

Establishing the taxonomic and conservation status of these endemic, range-restricted species is of urgent concern, particularly considering imminent plans to improve the road system in the immediate region. This improvement includes the paving of a major road and is likely to have a deleterious effect on forest cover in the immediate vicinity due to the colonization effect (Reid and Landivar, 1997; Forman and Deblinger, 2000; Trombulack and Frisell, 2000). In this way, conservation research efforts for *C. modestus* and *C. olallae* need to prioritize establishing the range of these Bolivian endemics, estimating population size, as well as studying titi monkey genetics in order to confirm their taxonomy in a phylogenetic framework. Here we present the results of research conducted between March 2004 and December 2006 regarding the distributional limits of *C. olallae* and *C. modestus* in the Beni Department of Bolivia. Additionally we report on preliminary data regarding their biology.

Methods

Study area

The area evaluated (Fig. 1) stretched from the Beni River to the east of the Mamoré River (eastern and western limits of survey), and from the Rurrenabaque–Yucumo road to Riberalta (southern and northern limits of survey). We visited 43 sites across the region, placing more effort in the area of the Yacuma River and in drier forest patches between the Beni and Mamoré rivers. Site selection was facilitated using satellite images, and corresponded to the locations of the original collection sites, the initial field observations of Felton *et al.* (2006), new observations obtained during this study, and reports from other researchers and local people. However, it is important to remark that in general local people only recognize titi monkeys at the genus level.

Determining the distributional limits

At each locality, we conducted preliminary non-structured interviews with local people using photographic material and vocalization recordings to determine the presence of *Callicebus* and to identify specific potential locations for further observation. We then actively searched for *Callicebus* groups at a series of locations using vocalization 'playbacks' at regular intervals in an attempt to elicit vocal responses. Searches lasted between 06:00–10:00 h because these periods correspond to their highest vocal activity; complementary searches were made between 16:00–18:00 h. Whenever we located a group, we recorded the time and method of detection (response to playback, direct visual observation, or spontaneous vocalizations). We observed groups with Zeiss 10 × 40 binoculars and filmed them with a Sony Digital 8 Video Camera TRV 361. Vocalizations were recorded with a Sony TCM-5000-EV tape recorder equipped with a unidirectional Sennheiser ME 67 microphone. Upon first sighting, we noted group size, composition, position, and height in the forest canopy, as well as the geographic location obtained with a GPS (Garmin 12 XL III Plus and V). We also noted general habitat characteristics for each observation locality.

Data analysis

Considering our initial lack of knowledge regarding the morphological features of these monkeys in the field, species identifications were made using available visual information and comparing these data with descriptions made by Lönnberg (1939), Hershkovitz (1990), and also with Felton *et al.* (2006), who had obtained video footage of reported groups. To improve our identifications we also compared images with photographs of specimens at the Royal Natural History Museum of Stockholm, Sweden (A612105 *C. modestus* and A632187 *C. olallae*). In order to assist in the interpretation of distributional patterns, we developed a map of all known localities, including the original collection sites (Lönnberg, 1939; Anderson, 1997), the observations by Felton *et al.* (2006) and our ongoing observations. The map also included sites where we did not register *Callicebus*, although we differentiated between sites

where local people reported *Callicebus* and those where titi monkeys were completely unknown.

Results

Species identification

During this study, we encountered 66 groups of *Callicebus* at 20 localities. Of these, 14 groups were *Callicebus olallae*,

31 were *Callicebus modestus*, 16 were *Callicebus donacophilus*, and for five groups we were unable to assign a species identification. These new records have dramatically increased the number of observations for the endemic species (Table 1).

For each species, we have identified diagnostic morphological characteristics helpful to distinguish the species



Figure 1. Geographic location of sightings of *Callicebus* during the field survey. For current knowledge status of *Callicebus* in Bolivia, we are including in this figure the locations reported for *C. aureipalatii* and *C. donacophilus* from Anderson (1997), Wallace *et al.* (2006) and Felton *et al.* (2006) and unpublished WCS observations.

Table 1. Number of documented *Callicebus modestus* and *Callicebus olallae* groups.

Species	Lönnerberg (1939)	Felton <i>et al.</i> (2005)	This study	Total groups
<i>C. olallae</i>	1	3	14	18
<i>C. modestus</i>	1	2	31	34
<i>C. cf. modestus</i> *	0	1	0	1

* Supposed hybrid groups between endemic species (Felton *et al.* 2006).

in field. These features relate mainly to pelage coloration patterns. *Callicebus olallae* has rather long, brown reddish body pelage. Under good light conditions, a wide orange band along each hair is visible, with the tip of the hair appearing brown. The tail is more grayish but the color does not contrast strongly with the coloration of the body fur; the base of the tail is lighter both dorsally and ventrally. White ear tufts are very conspicuous. Narrow rims of black hair that reach the ears are distinguishable around the faces of some individuals. Hands and feet are black with some white hairs visible. Another important feature is the vertically elongated form of the head with a clearly prominent and oval-shaped mouth especially noticeable in adult males (Fig. 2). Body fur color appears more intensely red when individuals are in direct sunlight.

Callicebus modestus has a non-uniform orange-brownish fur color caused by the presence of alternate bands of orange and dark brown hair, known as agouti pelage. The tail does not have the conspicuous lighter basal zone, and the grayish color of the tail is very noticeable and highly contrasting with the rest of the body fur. Conspicuous white ear tufts are present as in *C. olallae*. Hands and feet are also black with light hairs visible, though not as light as in *C. olallae*. However, this last trait is not easily distinguishable. Contrasting with *C. olallae*, the head of adult male *C. modestus* is wider laterally with a not too prominent pentagon shaped mouth area apparently due to a more prominent nasal area not observed in *C. olallae* (Fig. 3). The tail appears black if exposed directly to sunlight, and appears lighter if backlit.

Determining the distributional limits

According to our observations, *C. olallae* is largely restricted to riverine habitats on the Yacuma River, although one group occurred 5 km east of the Maniqui River but in similar habitat. A partial preference for drier forest patches is noticeable for *C. modestus*, which occurred on the eastern and western sides of the Yacuma River. One *C. modestus* group occurred just 100 meters east of the Maniqui River, but this area was a higher and drier forest area. Overall, these data give preliminary support to the hypothesis that *C. olallae* is found in relatively humid and riverine forest



Figure 2. Adult male *Callicebus olallae* at Estancia La Asunta (Yacuma River). Photo by M. Spanowicz.



Figure 3. Adult male *Callicebus modestus* from Aiguaizal (Northeast of Santa Rosa). Photo by M. Spanowicz.

in this patchily forested landscape; whereas *C. modestus* is found in relatively drier forest patches (Fig. 1).

We determined the Beni River as the distributional western barrier for both Bolivian endemics. During 2005, WCS researchers recovered a titi monkey skin from a hunted individual from forest immediately adjacent to the Beni River on the western side. This specimen represents *Callicebus aureipalatii*, the new species recently described from the Madidi protected area and registered only on the western side of the Beni River (Wallace *et al.*, 2006). In June 2005, we observed *C. modestus* groups in forest immediately adjacent and on the eastern side of the Beni River. However, it is important to note that the *C. modestus* location around the San Marcos community was in a noticeably drier belt of forest than the majority of the relatively humid forest found immediately adjacent to the Beni River. Indeed, on several previous visits to the community we failed to register *Callicebus* in the more humid sectors of this forest.

The southern and southwestern limits for the two endemics occur in two broad 10 km swaths on either side of the Yucumo – Rurrenabaque road, an area characterized by lack of primary forest and low densities of wildlife related to several human settlements. Colonists who settled in these areas almost ten years ago do not report titi monkeys. In addition, no confirmed records exist for *Callicebus* in the Pilón Lajas Biosphere Reserve and Indigenous Territory, and indigenous people indicate that titi monkeys are not present within the reserve. These negative reports together with areas of humid forest located to the south (as observed in satellite images) suggest that these larger blocks of more humid forest represent a southern limit for the distribution of both endemic species.

We extended the known distributional limits (Hershkovitz, 1990; Anderson, 1997) for both *C. olallae* and *C. modestus*. We found groups of *C. modestus* between Yacuma and Maniqui Rivers, and groups of both species in the riverine forests of the Maniqui River. Subsequently we investigated reports of the presence of *C. modestus* to the east of the Mamoré River (M. Herrera, pers. comm. to R. Wallace), but instead were able to verify the presence of *Callicebus donacophilus* at this location. Additional observations of

C. donacophilus east of the Maniqui and Mamoré Rivers suggest that neither *C. modestus* nor *C. olallae* occur further east of the Maniqui River. Indeed, the San Borja region is the current known eastern distributional limit for both species. To determine the northern limit, we extended our surveys to the relatively tall and humid Amazonian forests located south of Riberalta (see Fig. 1). Here we observed *Callicebus* groups that resembled species within the *C. cupreus* species group (van Roosmalen *et al.*, 2002). Unfortunately, due to observation conditions, we were unable to assign species-level identification to these groups. Nevertheless, we are certain that these observations do not represent either of the endemic species. We suggest that the southern limit of this more humid forest probably represents a northern boundary for *C. modestus* and perhaps *C. olallae* although further field confirmation is recommended.

In the highly fragmented forests between Santa Rosa del Yacuma and San Borja and northeast of Trinidad on the eastern side of the Mamoré River we failed to register *Callicebus*, and people here report not to have ever seen or heard these monkeys. Forest vegetation in these areas was very scarce and highly patchy, with relatively small and rather scattered stands of forest. In addition, forests did not have abundant canopy vines—a feature that characterized *Callicebus* localities in the broader southwestern Beni region.

Biological data

Group sizes ranged from 1 to 5 members in *C. olallae* and 1 to 6 in *C. modestus*. Solitary individuals were observed on one occasion for each species. Average group sizes were similar with 2.7 and 3.0 individuals for *C. olallae* and *C. modestus*, respectively ($t = -0.936$; $df = 43$; $n_1 = 31$; $n_2 = 14$; $p = 0.354$; see Table 2). Group composition data showed similar proportions of adult and juvenile members for both species although observations for each species occurred in different seasons, thereby limiting comparisons.

Despite the riverine and non-riverine division of the observations for *C. olallae* and *C. modestus*, respectively, both species occurred in a similar habitat known locally as “chaparrales” and characterized by a relatively low forest canopy with dense lianas and the notable presence of motacú palms (*Attalea phalerata*) and/or garabatá terrestrial

Table 2. Group size and composition of *C. olallae* and *C. modestus*.

Species	<i>C. olallae</i>	%	<i>C. modestus</i>	%
Group size	14		31	
Maximum	5		6	
Minimum	1		1	
Mean	2.7		3.0	
Population structure (no. of individuals)	38		94	
Adults	28	73.7	62	66.0
Subadults	1	2.6	3	3.2
Juveniles	7	18.4	16	17.0
Infants	2	5.3	13	13.8

bromeliads (*Pseudoananas sagenarius*). We observed a slight tendency for more motacú at *C. olallae* sites, and more garabatá at *C. modestus* sites. Local people reported that *Callicebus* feed on motacú palms, and we found seeds similar to garabatá in *C. olallae* feces. The average height of *Callicebus* observations did not differ between the two species ($t=-1,175$; $df=43$; $n_1=31$; $n_2=14$; $p=0.094$; Table 3). For both *Callicebus* species, adult males typically appeared alert in the presence of researchers and often approached observers, while other group members usually remained still and stayed in relatively high branches. Usually, upon achieving direct visual contact, monkeys changed from a territorial call to an alarm call directed at the observers and the rest of the primate group. These calls are short harmonics that cover a wide frequency range. On other occasions, groups stayed in dense vegetation without vocalizing.

Other primate species observed in the forest patches where *C. olallae* and *C. modestus* occurred included *Saimiri boliviensis*, *Cebus libidinosus*, and *Alouatta sara*. At the Yacuma River, we observed *Alouatta caraya*. We registered *Ateles chamek* in the riverine forest along the Beni River.

Identified local threats to *Callicebus*

Local communities reported some hunting of both *Callicebus* species, but their small size does not make *Callicebus* a preferred game animal compared with other primates and ungulates. Hunting pressure appears to be greatest along the Maniqui River. The administrative policies of the private cattle farms, numerous in the region, usually prohibit hunting on their properties. We obtained occasional reports of *Callicebus* hunting near cattle farms to use the skin for making ropes and fur to make thread, although these uses are not unique to these species. Unfortunately, hunting is more of a threat during logging activities where workers obtain most of their food from hunted wildlife, including *Callicebus*. This activity is only relevant in the Beni riverine forest on the western side of the endemics' distribution.

In the Amazonian forests in the northern reaches of the survey area, interviews and anecdotal observations suggested high levels of primate hunting, including *Callicebus*, especially during an intensive but short annual period of Brazil nut harvesting that represents the major income source for a large proportion of the local population. Indeed, for some people hunting remains an important subsistence and op-

portunistically commercial activity throughout the year as many people wait for the next Brazil nut harvest. As suggested in informal interviews with local people, intensive hunting pressure is probably responsible for the dramatic change toward more evasive behavior in *Callicebus* in this region.

Discussion

This study represents a significant contribution towards the biological knowledge of these poorly known endemic and range-restricted species. Direct and prolonged observations allowed us to determine critical diagnostic phenotypic traits for both *C. olallae* and *C. modestus* under a variety of lighting and weather conditions. Pelage coloration is the clearest characteristic that allows species identification in the field. For *C. olallae* for at least some animals we confirmed the black ring around the face originally described by Lönnberg (1939), contrasting with observations of the same species by Felton *et al.* (2006). The contrast between the color of the tail and body pelage is another important difference, with the basal zone conspicuously lighter in *C. olallae*. The longer and shaggier pelage of *C. olallae* was another recognizable trait. Differences in the density of white hair on the ear tufts were not considered diagnostic because observations suggested variability across phenotypes in the same groups, although this may be related to observation conditions that did not allow for the distinction of subtle features. We also noticed some distinctions in the head shape of adult males that concur with cranial measurements reported by Kobayashi (1995).

Video recording was a useful methodology for identifying these species, although we did find some inconsistencies between video records and direct observations, with more orange colorations registered by video instead of the more grayish color observed directly. We noted that some lighting conditions affected the digital sensors of the video camera. This problem is solvable by recording individuals as they move through distinct light conditions. These results show the great importance of making detailed phenotypic descriptions, as well as video recordings under different light conditions. Even though the morphological features cited above allow us to make some clear phenotypic distinctions between these two primates, the final taxonomic status remains unclear considering the potential formation of hybrid groups reported by Felton *et al.* (2006). Thus,

Table 3. Observation height and canopy height details for *Callicebus modestus* and *Callicebus olallae*.

Species	Average height obs. (m)	SD	Max. values	Min. values
<i>C. olallae</i>	6.8	3.5	15	3
<i>C. modestus</i>	8.8	3.8	20*	3
	Average canopy height (m)			
<i>C. olallae</i>	8.9	3.0	15	5
<i>C. modestus</i>	10.2	2.8	15	5

*Observed in emergent tree

genetic analyses are required to confirm their taxonomic status, clearly fundamental from a conservation viewpoint.

Felton *et al.* (2006) reported a group of *C. olallae* (November 2002) with more than two adults and during this study local people reported the same for *C. donacophilus* (February–March 2005). However, all of our observations consist of groups with up to four or five individuals with only two adults, always a male-female pair. *Callicebus* species are monogamous (Kinzey, 1981; Rylands *et al.*, 2000; Van Roosmalen *et al.*, 2002), and therefore larger groups containing several adults might be the result of temporary or seasonal aggregations, offspring remaining in their natal group after sexual maturation (Eckhard W. Heymann, pers. comm. 2007), and/or temporal variations in group size due to reduced dispersal opportunities in forest patches (Bicca-Marques *et al.*, 2002).

The key result for both *C. olallae* and *C. modestus* is the extension of the eastern limit from the previously known distributional area in the Beni and Yacuma Rivers (Anderson, 1997; Felton *et al.*, 2006). Our results also offer a preliminary northern distributional limit for both species although further work is required to establish how this limit varies for each species. Our results show that *C. olallae* is restricted to riverine forests along the Yacuma and Manique Rivers, whereas *C. modestus* seems to occupy patches of forest in a larger area between the Beni and Maniqui Rivers. We therefore suggest that *C. olallae* has an extremely restricted distribution with groups almost entirely concentrated on the Yacuma River, and so far just one group registered along the Maniqui River. Nevertheless, the habitat preferences of both species need further study, particularly given that both species are absent from smaller forest patches in the region.

Distribution points for these endemic species and their congeners in the broader region (Fig. 1), suggest IUCN “extent of occurrence” distributional areas of ca. 1,800 km² for *C. modestus* and ca. 400 km² for *C. olallae*. Nevertheless, because of the fragmented nature of the forest landscape in the region, the IUCN “area of occupancy” standard measure of distributional area seems more pertinent. Under this measure *C. modestus* should be provisionally considered Endangered (c. 450 km²) and *C. olallae* should be provisionally considered Critically Endangered (c. 50 km²). To date no abundance estimates for these species exist, however, given that they are not superabundant in the forest patches we have visited, in terms of populations we recommend that both species be considered endangered. The most important threat to both endemics is the forthcoming improvement and paving of the “Corredor del Norte” road. This road crosses the distributional area of both species (Fig. 1) and although the use of heavy machinery, noise, and pollution are concerns, there is a high probability for increasing human settlements and forest loss along the road. Given the suspected low population numbers for both species, significant forest loss and

fragmentation would lead to a very fragile conservation situation and a potential extinction risk, principally for *C. olallae*. Information collected to date has been provided to the official environmental evaluation team for the proposed Corredor del Norte road construction project; this team was previously unaware of the presence of these endemics and are now proposing to make specific considerations within their recommendations. Subsistence and commercial hunting is also a major threat in areas undergoing forestry and Brazil nut activities. Even though current eco-tourism activities on the Yacuma River are not an obvious threat to *Callicebus*, the presence of *C. olallae* in the tourism area indicates the need to monitor the impact of this activity in the future.

The information gathered to date has been provided to municipal authorities, and these meetings and presentations have drawn the attention of local decision-makers to the presence of these endemic titi monkeys. Now the creation of municipal protected areas is being promoted in the region. Municipal authorities are motivated by the status of the Yacuma River region as a major tourism attraction; over 75% of the 20,000 tourists that visit Rurrenabaque every year visit the Yacuma River region. Indeed, the two endemic titi monkeys could well become important flagship species for this initiative and we are working to ensure they are included in the design and management of the proposed municipal reserves. Finally, both *C. modestus* and *C. olallae* have restricted distributional ranges. The situation of *C. olallae* is particularly alarming, and given the imminent threat of major road improvements in the region, the race is on to establish the conservation status of these endemics. Knowledge of the precise northern distributional limits is urgently required for both species, as well as population estimates for both species in a series of strategically targeted forest patches. Finally, determination of their taxonomic status through genetic analyses is also an urgent priority.

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