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Authors: Jerusalinsky, Leandro, Oliveira, Marcelo M., Pereira, Ronaldo F., Santana, Valdineide, Bastos, Paulo César R., et al.

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# Preliminary Evaluation of the Conservation Status of *Callicebus coimbrai* Kobayashi & Langguth, 1999 in the Brazilian State of Sergipe

Leandro Jerusalinsky<sup>1</sup>, Marcelo M. Oliveira<sup>1</sup>, Ronaldo F. Pereira<sup>2</sup>, Valdineide Santana<sup>3</sup>, Paulo César R. Bastos<sup>3</sup> and Stephen F. Ferrari<sup>4</sup>

<sup>1</sup>IBAMA – Centro de Proteção de Primatas Brasileiros, João Pessoa, Paraíba, Brazil

<sup>2</sup>CODEVASF – 4<sup>a</sup> Superintendência, Aracaju, Sergipe, Brazil

<sup>3</sup>IBAMA – Gerência Executiva de Sergipe, Aracaju, Sergipe, Brazil

<sup>4</sup>Departamento de Biologia, Universidade Federal de Sergipe, São Cristóvão, Sergipe, Brazil

**Abstract:** Endemic to the Atlantic forest of the Brazilian states of Sergipe and Bahia, *Callicebus coimbrai* survives in a highly fragmented landscape characterized by small remnants of forest in a matrix of plantations and pasture. First described only seven years ago, the species is still poorly known and, until the present study, had been recorded from only fifteen sites in Sergipe, in fragments of no less than 40 ha. Here, we report on a survey of the presumed range of the species in Sergipe, with the primary aims of identifying remnant populations and evaluating the influence of factors, such as fragment size, on survival. Populations of *C. coimbrai* were recorded through either sightings or response to playbacks of vocalizations at 30 of 147 sites surveyed (including 15 confirmed previously), and consistent reports from local residents were obtained at a further 46 localities. Six of the confirmed fragments were less than 20 ha, including one of only 3 ha. This indicates that the species is relatively tolerant of habitat fragmentation, and is able to survive in isolated forests of small size. Together with the growing number of known (and potential) populations, this tolerance is a positive factor for the long-term conservation of the species. However, based on the results of this survey, estimates of the total area of forest occupied by the species, and numbers remaining in the wild are only 100–150 km<sup>2</sup> and 500–1,000 individuals, respectively. Clearly, this situation requires urgent measures, including the implementation of protected areas and provisions for metapopulation management.

**Resumo:** Endêmica à Mata Atlântica dos Estados de Sergipe e Bahia, *Callicebus coimbrai* sobrevive em uma paisagem altamente fragmentada, caracterizada por pequenos remanescentes de floresta inseridos em uma matriz de plantações e pastagens. Descrita pela primeira vez há apenas sete anos, a espécie permanece muito pouco conhecida e, até o presente estudo, tinha sido registrada em apenas quinze localidades de Sergipe, em fragmentos maiores que 40 ha. Neste estudo, foi realizado um levantamento dentro da distribuição geográfica presumida da espécie em Sergipe com o objetivo principal de identificar populações remanescentes, e avaliar a influência de fatores como o tamanho de fragmento sobre sua sobrevivência. Populações de *C. coimbrai* foram registradas, por meio de avistamentos ou respostas à reprodução de vocalizações gravadas, em 30 dos 147 sítios investigados (incluindo os 15 confirmados anteriormente), e relatos consistentes de ocorrência foram obtidos de moradores locais em outras 46 localidades. Seis dos fragmentos confirmados tinham extensões com menos de 20 ha, sendo o menor de apenas 3 ha. Isto indica que a espécie é relativamente tolerante à fragmentação de habitat, e que consegue sobreviver em matas isoladas de tamanho reduzido. Junto ao número crescente de populações conhecidas (e indicadas), esta tolerância constitui um fator positivo para a conservação da espécie em longo prazo. Entretanto, baseado nos resultados deste levantamento, as estimativas da área total de floresta ainda ocupada pela espécie e do número de indivíduos que sobrevivem na natureza, são de apenas 100–150 km<sup>2</sup> e 500–1.000 indivíduos, respectivamente. Obviamente, esta situação demanda medidas urgentes, que incluem a implementação de áreas protegidas, e a aplicação de estratégias de manejo metapopulacional.

**Key Words:** Coimbra-Filho's titi monkey, *Callicebus coimbrai*, conservation, Northeast Brazil

## Introduction

Coimbra-Filho's titi monkey, *Callicebus coimbrai*, was first described by Kobayashi and Langguth in 1999, and is considered to be one of the most endangered of all Neotropical primates (Brazil, MMA 2003; IUCN 2004). Its known range covers little more than 30,000 km<sup>2</sup>, straddling the border between the states of Sergipe and Bahia, an area that has suffered deforestation and habitat fragmentation virtually since the beginning of European colonization, five centuries ago (Coimbra-Filho and Câmara 1996).

By the beginning of the 20th century, the Atlantic forest of Sergipe had been reduced to approximately 40% of its original cover, and to less than 1% over the subsequent 100 years (Siqueira and Ribeiro 2001). This remnant forest cover is distributed in isolated fragments of no more than 900 ha. Prior to the present study, *C. coimbrai* had been recorded from 15 sites in Sergipe, and two in Bahia (Kobayashi and Langguth 1999; Sousa 2000, 2003; Printes 2005), in forest fragments ranging in size from 40 to 900 ha. It is not known to occur in any officially protected areas in either state (Silva *et al.* 2005).

In the present study, the known and presumed distribution of *C. coimbrai* in the state of Sergipe was surveyed systematically in an attempt to locate additional remnant populations and define ecological parameters such as the minimum size of fragment necessary for the survival of the species. The data collected were used for an overall assessment of the conservation status of the species in this state, and the formulation of

basic guidelines for the development of long-term conservation strategies.

## Methods

Fieldwork was planned on the basis of known *C. coimbrai* localities in Sergipe (Kobayashi and Langguth 1999; Sousa 2000, 2003) and the identification of potential sites using a digital atlas of the state (Sergipe, SEPLANTEC 2004) using satellite images and aerial photographs. The primary strategy was to survey all fragments of large size (>100 ha), and to sample smaller fragments within the survey area; in particular those for which local residents had indicated the presence of *C. coimbrai*.

Four main study areas were demarcated (Fig. 1) and surveyed during separate excursions between May and September 2004. In November 2004, and March and May 2005, complementary excursions were conducted to survey previously visited localities where the species had been indicated consistently in interviews, but not confirmed directly. During visits to each site, experienced local residents were interviewed in a standardized, undirected manner, supported by photographs and drawings of local mammals, and by recordings of *Callicebus* vocalizations, in an attempt to identify local habitat in which titis could be found. Sites indicated consistently by residents were visited and surveyed qualitatively, using existing trails. In addition to observations, recordings of *Callicebus* vocalizations were played through a loudspeaker (Johnny

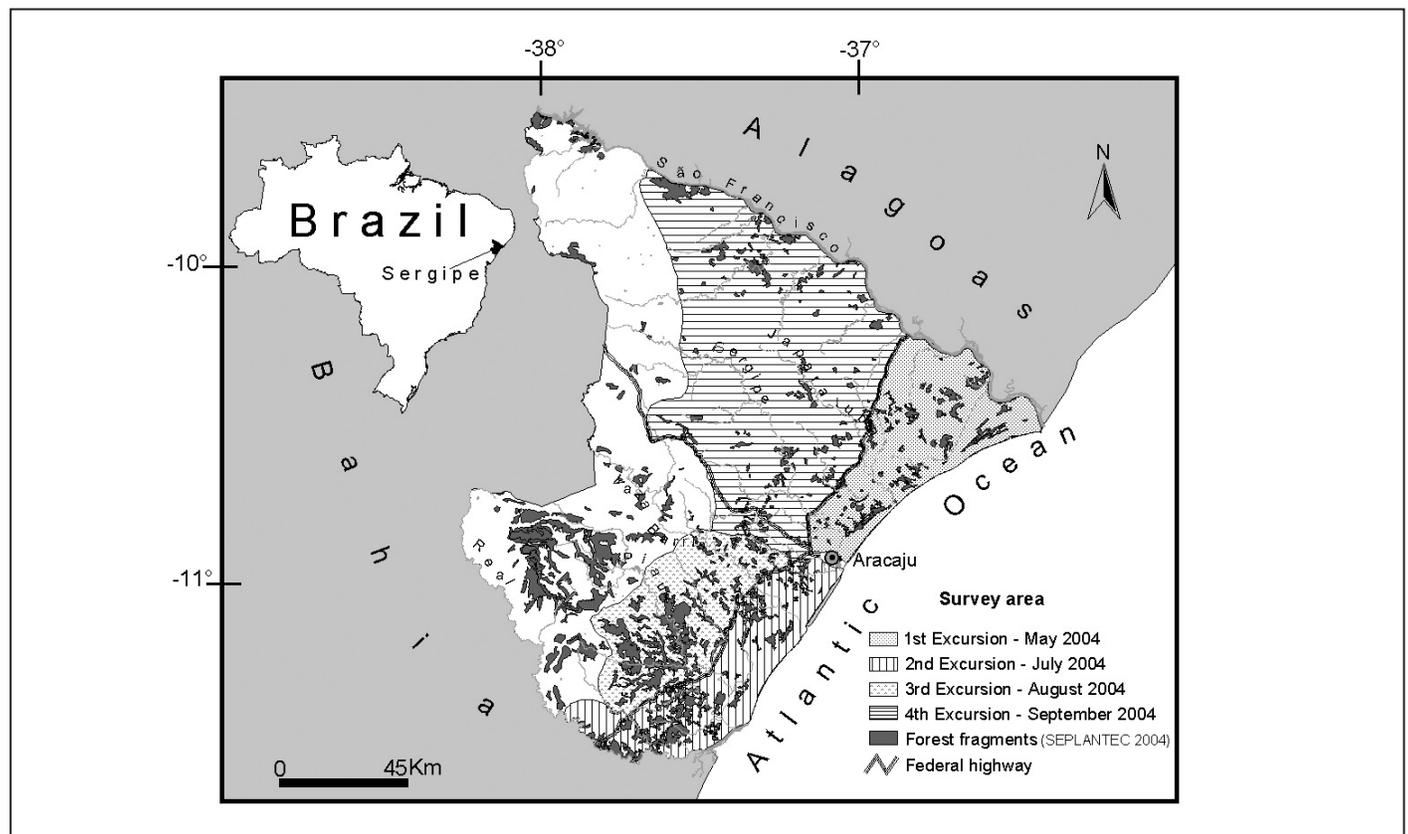


Figure 1. Map of the Brazilian state of Sergipe, showing the four main study areas.

**Table 1.** Confirmed localities for *Callicebus coimbrai* in the state of Sergipe, Brazil.

Site	Locality	Coordinates	Fragment size (ha)	Type of record <sup>1</sup>	Source <sup>2</sup>
1	Fazenda Cruzeiro	11°29' S, 37°46' W	200 <sup>3</sup>	SP (1)	KL
2	Povoado de Aragoão – Santana	10°32' S, 36°41' W	150	SP (2), OBS (3)	KL, SO
3	Fazenda Arauari	10°45' S, 37°00' W	500 <sup>3</sup>	SP (2), OBS (2)	KL, SO
4	Mata do Crasto	11°22' S, 37°25' W	900	OBS (1)	SO
5	Mata do Dira	10°53' S, 37°21' W	>100	PB	SO
6	Mata do Serigy	10°33' S, 36°42' W	70	PB	SO
7	Mata do Oiteiro	10°39' S, 37°03' W	50 <sup>3</sup>	PB	SO
8	Mata da Serra Preta	10°30' S, 37°37' W	<200 <sup>3</sup>	PB	SO
9	Fazenda Aiumas	10°25' S, 36°39' W	60 <sup>3</sup>	PB	SO
10	Mata da Aguada	10°40' S, 36°56' W	40	PB	SO
11	Mata da Nova Descoberta	11°06' S, 37°19' W	100 <sup>3</sup>	PB	SO
12	Mata do Cadoz	10°23' S, 36°39' W	50 <sup>3</sup>	PB, OBS (2)	SO, PS
13	Fazenda Sabão – Mata Oeste	11°30' S, 37°34' W	300	PB	SO, PS
14	Mata do Junco	10°32' S, 37°03' W	400	PB	SO, PS
15	Fazenda Trapsa	11°12' S, 37°14' W	600 <sup>3</sup>	PB	SO, PS
16	Bugio (Buji)	11°27' S, 37°43' W	200	PB	PS
17	Fazenda Capivara	11°11' S, 37°28' W	30	OBS (2)	PS
18	Fazenda Imbira	11°14' S, 37°34' W	10	PB	PS
19	Fazenda Bomfim VI	11°18' S, 37°40' W	15	OBS (4)	PS
20	Fazenda Tuim	11°17' S, 37°38' W	3	PB	PS
21	Fazenda Poços	11°16' S, 37°33' W	15	PB	PS
22	Mata Chiquinho 2	11°17' S, 37°41' W	10	PB	PS
23	Mata do Escôncio	11°26' S, 37°37' W	250	OBS (2)	PS
24	Fazenda Sabão – Mata Pequena	11°31' S, 37°34' W	7	OBS (1)	PS
25	Mata do Pau Torto	11°23' S, 37°30' W	250	PB	PS
26	Mata da Águas Claras	11°22' S, 37°33' W	50	OBS (4)	PS
27	Mata da Surucucu	11°21' S, 37°29' W	60	OBS (4)	PS
28	Assentamento Chico Mendes	11°30' S, 37°33' W	50	PB	PS
29	Fazenda Sabão – Mata Leste	11°29' S, 37°33' W	100	PB	PS
30	Fazenda São Pedro/Assentamento	10°02' S, 37°24' W	150	PB	PS

<sup>1</sup>SP = specimen collected; OBS = animals observed; PB = response to playback, or vocalizations heard. Different types of records refer to the respective studies. Numbers in parentheses refer to the number of individuals recorded.

<sup>2</sup>KL = Kobayashi and Langguth (1999); SO = Sousa (2003); PS = Present Study.

<sup>3</sup>Estimate obtained during the present study.

Stewart 612 Deluxe professional caller) in an attempt to provoke a response from animals out of sight.

The size of forest remnants was estimated through a combination of the available information (aerial photographs and satellite images) and direct observation. At sites where the presence of *C. coimbrai* was confirmed, the landowner or property manager was also contacted to obtain more detailed information and to refine estimates. Estimates were less systematic at unconfirmed sites, and given their heterogeneity, they have been assigned to size classes for the purposes of the present study.

## Results

A total of 147 forest fragments were identified either during planning, or during surveys, when indicated by local residents. All were visited during the four preliminary excursions, and 28 of them were revisited during the three complementary

field trips. In many cases, fragments identified on the digital atlas either no longer existed or had been practically eliminated by deforestation or fire.

Overall, 245 residents were interviewed, and a total of 110 sites were indicated as having resident titi in at least one interview. However, the reports referring to 34 of these sites were considered unreliable because of inconsistencies in the identification of the species. Some interviewees confused titi with capuchins (*Cebus*) or marmosets (*Callithrix*), or even other arboreal mammals. The remaining 76 sites included the 15 recorded by Kobayashi and Langguth (1999) and Sousa (2003), and an additional 15 at which the presence of the species was confirmed through either direct observation or response to playbacks (Table 1, Fig. 2). Playbacks proved to be an important survey tool, providing confirmation of the presence of titi monkeys at the majority (63.3%) of the sites.

At the remaining 46 sites (Table 2, Fig. 3), the presence of *C. coimbrai* was indicated consistently in interviews, but

was not confirmed directly through surveys. Many of these fragments were relatively small in size, although records from Fazenda Tuim and Fazenda Sabão (Table 1) do indicate that the species is able to survive in fragments of less than 10 ha. As such, it would seem reasonable to assume

that titis are present in many, if not all, of these unconfirmed fragments.

The sum of the area of forest at the 30 confirmed sites (Table 1) is just over 5,000 ha, and that of the unconfirmed sites is between 1,500 and 3,500 ha. The results indicate

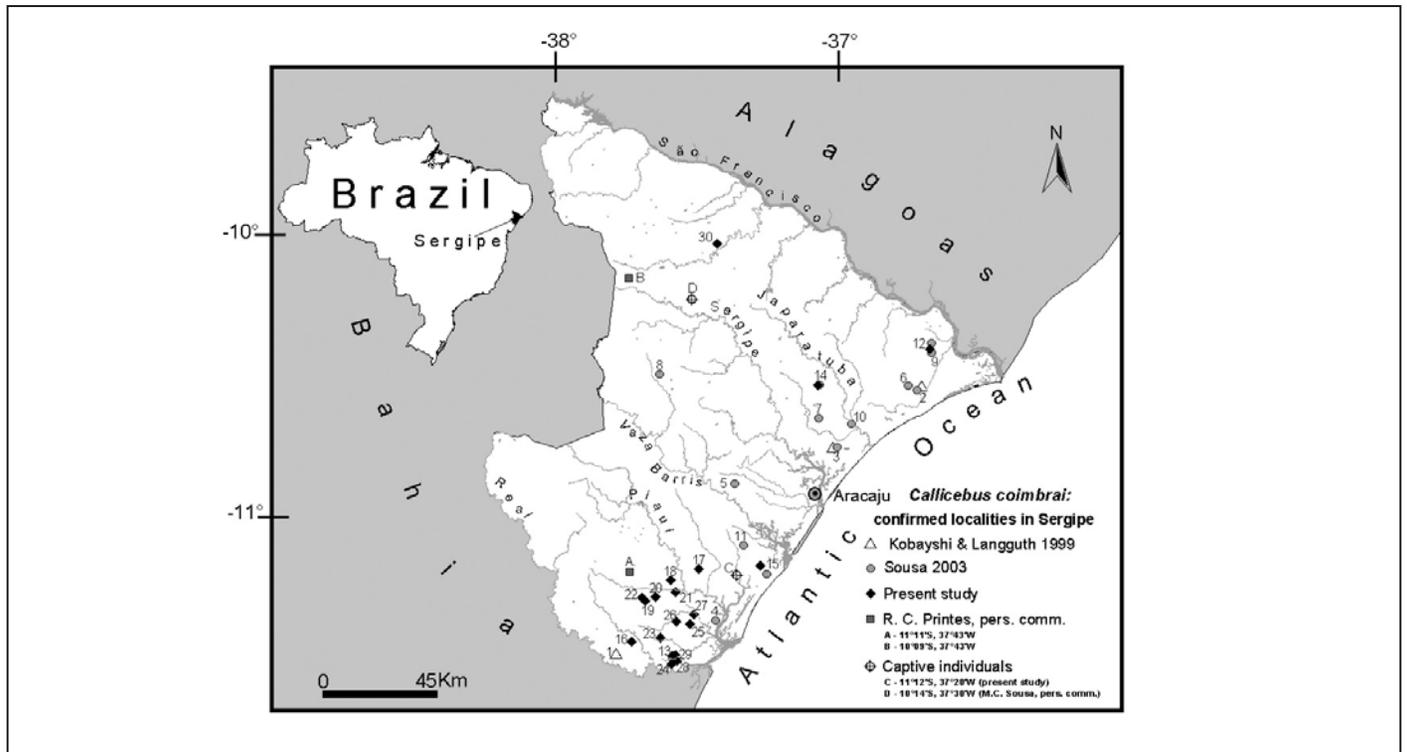


Figure 2. Sites in the state of Sergipe where the presence of *Callicebus coimbrai* has been confirmed. Sites are numbered as in Table 1.

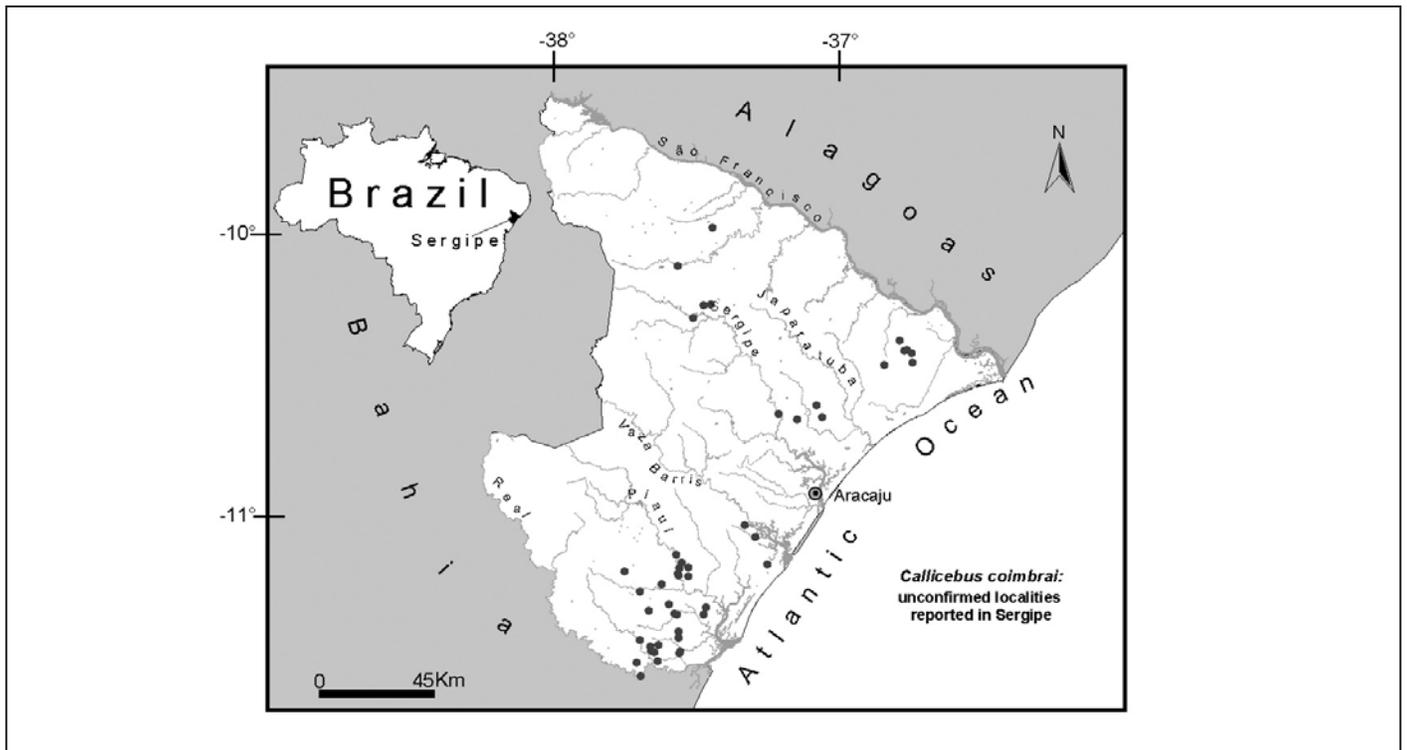


Figure 3. Sites in the state of Sergipe where the presence of *Callicebus coimbrai* was reported by local residents during the present study, but not confirmed directly (see text and Table 2).

that *C. coimbrai* is relatively more abundant in the southern coastal forest zone in comparison with the central and northern coastal zones. More than a half of confirmed (55.9%) and unconfirmed (60.9%) sites are located in the basins of the Rios Piauí and Real (Figs. 2 and 3). This area is characterized by seasonal semi-deciduous forest (Brazil, IBGE 2004).

An additional, unexpected result of the surveys was the recovery of an adult female *C. coimbrai* (Fig. 4) from illegal captivity at Riacho Fundo do Abaís (11°12'S, 37°20'W) on 16 March 2005. The animal was taken to the Aracaju Zoological Gardens on the same day, where it was found to be in good health, and has now survived for almost a year. This is the first time the species has been held officially in captivity, and represents a potentially important first step in the eventual development of programs of captive breeding, translocation, and reintroduction.

A second animal was observed (M. C. Sousa pers. comm.) in private captivity in the town of Nossa Senhora da Glória (Fig. 3), although it escaped before being transferred to Aracaju. This, together with surrounding localities (8, 30, and B in Fig. 2), confirms that, while *C. coimbrai* is rare in caatinga habitats, where it is replaced by *Callicebus barbarabrownae*, its original geographic range extends farther north and west than was previously supposed.

## Discussion

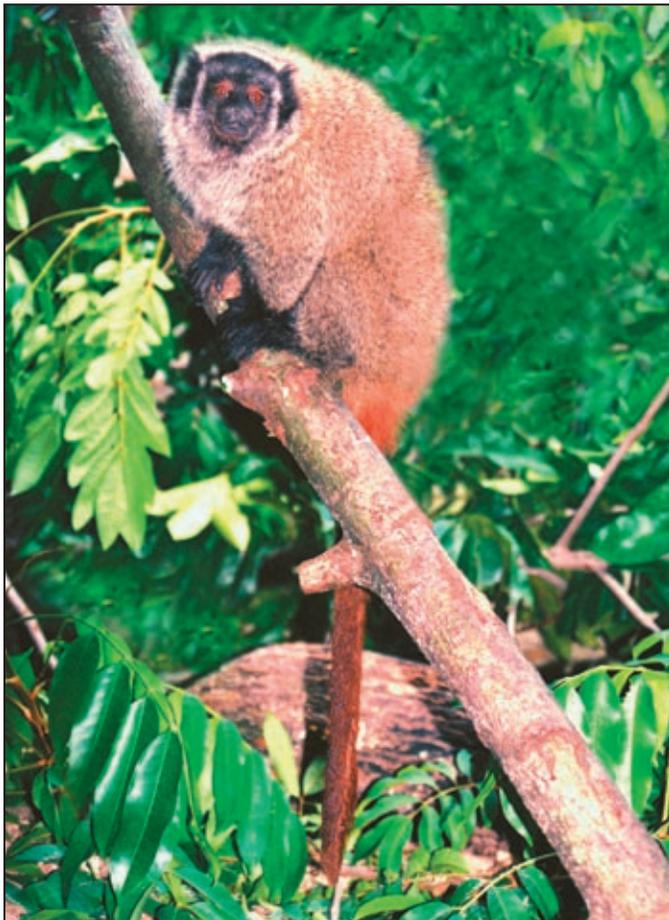
In common with most of the platyrrhine species discovered in the wild over the past 15 years (for example, Lorini and Persson 1990; Van Roosmalen *et al.* 2002), *C. coimbrai* has a relatively restricted geographic range, which, like most of the Atlantic forest, is characterized by critical levels of deforestation and habitat fragmentation. There was thus little doubt that the species was at some risk of extinction as soon as it was made known to science, and it is now considered to be one of the most endangered of Brazilian primates (Brazil, MMA 2003; IUCN 2004). This study has done little to alter this initial impression, although the species is now known to occur at many more sites than the three localities identified originally by Kobayashi and Langguth (1999). In addition to the thirty sites confirmed here, R. C. Printes (pers. comm.) has recorded *C. coimbrai* at two additional sites in Sergipe (Fig. 2), bringing the current total to thirty-two. It is important to note that one of the sites reported by Printes is located outside the area surveyed in the present study, suggesting that a certain number of potential sites have yet to be identified.

These sites encompass a total area of approximately 50 km<sup>2</sup> of forest. While this is almost certainly an underestimate of the total area of forest in Sergipe occupied by populations of *C. coimbrai*, it seems unlikely that the definitive value will surpass 75 km<sup>2</sup>. If it is assumed that a similar situation exists in Bahia, given that the species may be distributed over a similar area in this state (Printes 2005), we can conclude that the total area of forest occupied by the species is between 100 and 150 km<sup>2</sup>.

**Table 2.** Localities at which the presence of *C. coimbrai* was reported consistently by local residents, but not confirmed via direct observation.

Locality	Coordinates	Size class <sup>1</sup>
Fazenda Cruzeiro – Mata pequena	11°33'S, 37°40'W	A
Fazenda Barro	11°09'S, 37°31'W	A
Mata do Balneário – Fazenda Santa Bárbara	10°24'S, 36°44'W	B
Mata de Pedra do Rumo	11°28'S, 37°38'W	B
Mata da Ladeira Vermelha	11°31'S, 37°41'W	B
Fazenda Santa Cruz – Mata 1	11°12'S, 37°32'W	B
Fazenda Brejo	11°10'S, 37°32'W	B
Matas do Contador 1 – Fazenda Santa Bárbara	10°24'S, 36°44'W	C
Matas do Contador 2 – Fazenda Santa Bárbara	10°25'S, 36°43'W	C
Fazenda Campo Belo	11°01'S, 37°18'W	C
Fazenda Santa Cruz – Mata 2	11°12'S, 37°32'W	C
Fazenda Nova	11°14'S, 37°36'W	C
Fazenda Riacho Seco	11°18'S, 37°34'W	C
Fazenda Salobro	11°20'S, 37°38'W	C
Fazenda Glória	11°15'S, 37°40'W	C
Mata da Bica	11°11'S, 37°44'W	C
Mata de Vila do Padre	10°07'S, 37°32'W	C
Mata dos Olhos d'Água 1 – Gameleiro	10°15'S, 37°27'W	C
Fazenda Capim-Açu	10°38'S, 37°02'W	C
Mata do Canto Escuro – Fazenda Araticum	10°36'S, 37°03'W	C
Matas de Antônio Dias – Maçaranduba	10°28'S, 36°49'W	D
Mata Verde – Fazenda de Citrus	10°22'S, 36°46'W	D
Mata do Projeto A da SERAGRO	10°27'S, 36°43'W	D
Fazenda Castelo – Mata 2	11°19'S, 37°26'W	D
Fazenda Cedro	11°20'S, 37°33'W	D
Fazenda Santa Mônica	11°20'S, 37°32'W	D
Fazenda Escôncio – Mata pequena	11°27'S, 37°36'W	D
Assentamento Osias Silva	11°26'S, 37°40'W	D
Fazenda Curuanha	11°12'S, 37°30'W	D
Mata de Lagoa do Rancho	09°58'S, 37°25'W	D
Mata dos Olhos d'Água 2 – Gameleiro	10°15'S, 37°26'W	D
Mata da Campanha – Fazenda Tabua	10°38'S, 37°11'W	D
Fazenda Colégio	11°04'S, 37°16'W	E
Fazenda Paruí	11°10'S, 37°13'W	E
Assentamento Boa Vista	11°25'S, 37°32'W	E
Fazenda Gavião/Fazenda Cajá	11°28'S, 37°32'W	E
Mata de Valdir Cruz	11°29'S, 37°32'W	E
Mata de Branco – Fazenda Mangueira	11°28'S, 37°37'W	E
Mata da Palmeirinha – Fazenda Jaqueira	11°27'S, 37°38'W	E
Fazenda Cobiça	11°08'S, 37°33'W	E
Fazenda Periperi	11°10'S, 37°30'W	E
Fazenda Limoeiro	10°39'S, 37°07'W	E
Fazenda Castelo – Mata 1	11°20'S, 37°27'W	F
Fazenda Riacho Fundo	11°30'S, 37°36'W	F
Fazenda Guia	10°18'S, 37°29'W	G
Fazenda Gaiófa/Assentamento São José	11°24'S, 37°32'W	G

<sup>1</sup>Size class: A = <5 ha; B = 5–10 ha; C = 10–25 ha; D = 25–50 ha; E = 50–100 ha; F = 100–250 ha; G = 250–500 ha.

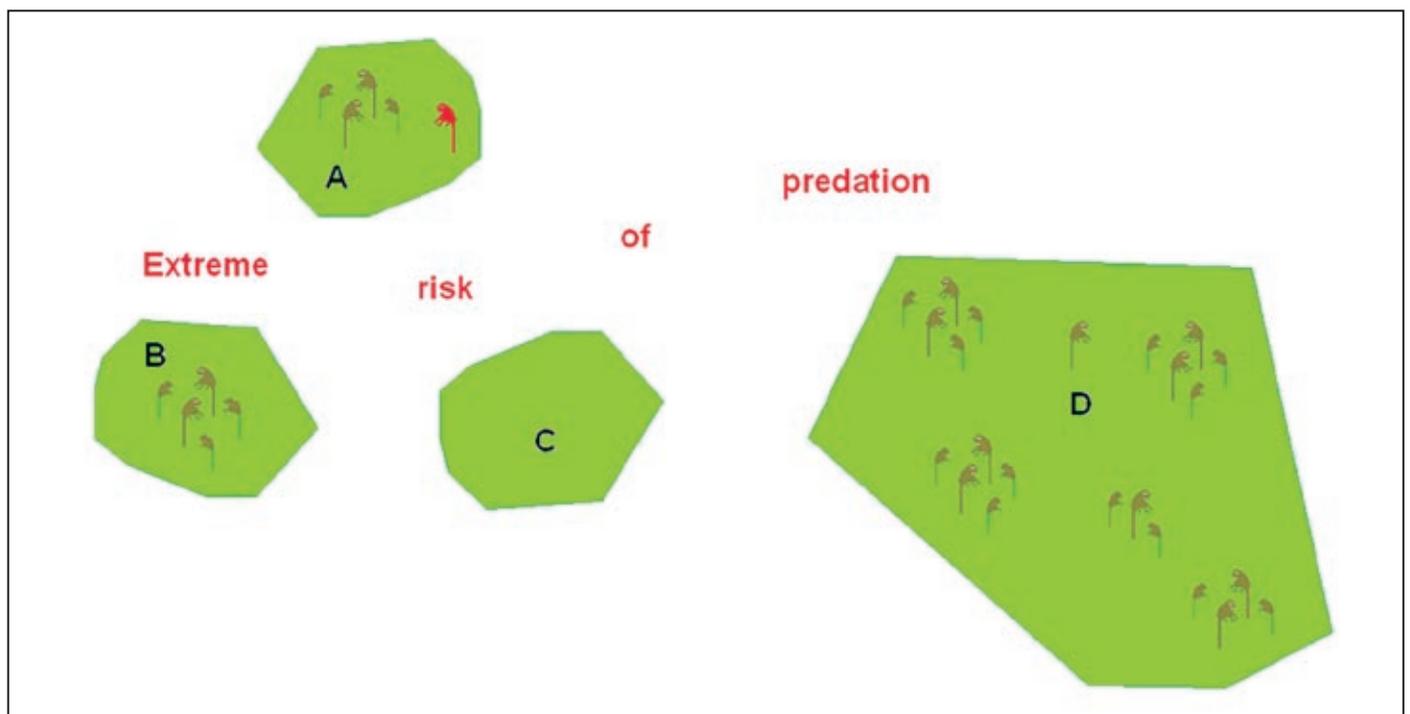


**Figure 4.** Adult female *Callicebus coimbrai*, resident at the Aracaju Zoological Gardens since 16 March 2005. Photograph by Leandro Jerusalinsky.

Demographic parameters of *C. coimbrai* populations are not known, and few reliable data are available for the genus. The values most relevant to the present study are those of Müller (1996a) and Heiduck (2002), who recorded home ranges of 22–24 ha for two *Callicebus melanochir* groups in the Atlantic forest of southern Bahia. Palacios *et al.* (1997) reported a similar value for the Amazonian *Callicebus torquatus*. Price and Piedade (2001) recorded smaller home ranges in a short-term study of *Callicebus personatus*, although surveys at a number of other sites in southeastern Brazil (Chiarello 2003; São Bernardo and Galetti 2004) returned relatively low population densities for this species, indicative of relatively large home ranges.

Titi monkeys are strictly monogamous and live in small family groups, with three to five members. *Callicebus coimbrai* appears to be typical in this sense (Sousa 2003; R. C. Printes pers. comm.; this study), and a similar pattern has been reported for the closely related *C. melanochir* (Müller 1996a; Heiduck 2002), so it would seem reasonable to use four individuals as an approximate mean group size. Using a generous estimate of five groups/km<sup>2</sup>, the 30 confirmed sites in Sergipe would contain a theoretical total population of approximately 1,000 individuals. Even if this were a gross overestimate, it would still seem reasonable to assume that the number of *C. coimbrai* surviving in the wild (including both Sergipe and Bahia) may be between 500 and 1,000 individuals.

While this provides some room for cautious optimism, the question of habitat fragmentation cannot be overlooked.



**Figure 5.** Hypothetical scenario faced by a maturing titi monkey (red animal in fragment A) in the fragmented landscape of the Atlantic forest of Sergipe. Fragment D offers the best opportunities for survival and the establishment of a breeding group, but is farthest from A. Smaller fragments (B and C) are more common, and generally more accessible, but will normally be either at carrying capacity (B) or vacant (C). In either case, the chance to breed will depend on unpredictable, random events such as the disappearance of the same sex adult (B) or the immigration of an adult of the opposite sex (C).

Demographic patterns in fragmented habitat are clearly different from those in continuous forest, although the effects are not always negative, depending on the species. One positive aspect of the present study, for example, was the confirmation of the ability of *C. coimbrai* to survive in forest fragments smaller than 10 ha. Given this, the number of fragments with titis may be as important as the total area of forest for the planning of conservation strategies. The large number of unconfirmed reports (Table 2) certainly suggests that many more small, isolated populations have yet to be discovered.

However tolerant of habitat disturbance *C. coimbrai* may be, the distribution of remnant populations in a large number of isolated fragments clearly presents a deep-seated problem for long-term management (Vieira *et al.* 2003). Titi monkeys present an additional unique behavioral problem, among Atlantic forest primates: While the exact mechanism is still unclear (Müller 1996b; Mayeaux *et al.* 2002), offspring invariably emigrate from their natal groups as they approach sexual maturity, limiting group composition to the breeding pair and their immature offspring.

While this may be an important dispersal mechanism in populations inhabiting continuous forest, it may have deleterious consequences in small fragments, where emigration to a new forest may be the only option for maturing offspring (see Fig. 5). Individuals migrating between fragments over open ground risk predation and exhaustion (mean day range of Atlantic forest titis is approximately 1 km: Müller 1996a; Price and Piedade 2001), with only a very random possibility of encountering a potential reproductive partner. This suggests an extremely inefficient process characterized by high mortality and the frequent loss of reproductive opportunities (for example, animal dispersing to vacant fragments).

This implies, in turn, that active management of the meta-population, including both translocation and reintroduction, may be relatively more important for the long-term conservation of *C. coimbrai* (and other titi species) than for other Atlantic forest primates. The effective implementation of such management will also depend on the establishment of an integrated system of public and privately owned reserves. One important first step in this process is the creation of a federal conservation unit—with the specific aim of protecting *C. coimbrai*—which is currently being planned by the Brazilian environment institute (IBAMA), based on the results of the present study.

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*Authors' addresses:*

**Leandro Jerusalinsky** and **Marcelo M. Oliveira**, IBAMA—Centro de Proteção de Primatas Brasileiros, Praça Antenor Navarro, N° 05, Varadouro, João Pessoa 58010-480, Paraíba, Brazil. E-mail: <leandro.jerusalinsky@ibama.gov.br>.

**Ronaldo F. Pereira**, Companhia de Desenvolvimento dos Vales do São Francisco e Parnaíba – 4ª Superintendência, Aracaju, Sergipe, Brazil.

**Valdineide Santana** and **Paulo César R. Bastos**, IBAMA—Gerência Executiva de Sergipe, Aracaju, Sergipe, Brazil.

**Stephen F. Ferrari**, Departamento de Biologia, Universidade Federal de Sergipe, São Cristóvão, Sergipe, Brazil.

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