social behavior. *Science* 157:1584-1585.
West-Eberhard, M. J. 1975. The evolution of social behavior by kin selection. *Quart. Rev. Biol.* 50:1-33.
Wilson, E. O. and W. H. Bossert. 1971. *A Primer of Population Biology*. Sinauer Associates, Stamford, CN.

Preliminary Records of Common Marmosets (*Callithrix jacchus*) from the Sete Cidades National Park, Piauí, Brazil

Common marmosets (*Callithrix jacchus*) are endemic to northeastern Brazil and live in a variety of habitat types (Rylands *et al.*, 1993). Previous research on the behavior and ecology of this species has been restricted to the semi-deciduous coastal forests of Permambuco, Paraíba, and Rio Grande do Norte (e.g., Alonso and Langguth, 1989; Digby and Barreto, 1993; Hubrecht, 1984; Scanlon *et al.*, 1989). However, the majority of the common marmoset geographic range encompasses the very different vegetation found in the interior of Brazil. Here we report on preliminary surveys of a marmoset population in the northeastern Brazilian state of Piauí.

Vegetation of the Brazilian Northeast

The northeastern interior is dominated mainly by two types of vegetation: the *cerrado* (savanna forest) and the *caatinga* (dry thorn scrub). The *cerrado* covers over 2.01 milion km² within Brazil and is second only to the Amazon forest in the area it covers (Rizzini *et al.*, 1988). The term *cerrado* (*sensu lato*) encompasses a wide range of subtypes of xeromorphic vegetation from the *campo limpo* (open grasslands) to the *cerradão* (dense savanna forests). Trees are semi-deciduous with broad and rigid leaves and thick bark that allows them to survive frequent savanna fires (Eiten, 1972). The *caatinga* covers an additiona 0.91-1 million km² and is characterized by a semi-arid climate. Herbs and grasses grow in the *caatinga* only during the rainy season, and vegetation is xerophytic or deciduous (Rizzini, 1977; Rizzini *et al.*, 1988). The flora of the Brazilian *cerrado* is estimated to include 7,000 species compared to the 60,000 species of the Amazon flora and 2,000 species of the flora found in the northeastern *caatinga* (Castro, 1994).

The Study Site

Surveys were conducted at the Sete Cidades National Park in the municipalities of Piripiri and Piracuruca, Piauí (04° 05-09'S, 41° 30-45'W; alt. 100-300 m). The park encompasses 6,221 ha and includes a small hostel, restaurant, and administrative offices. The primary tourist attractions in the park are a series of dramatic rock formations and rock paintings (Brazil, IBDF/FBCN, 1979).

The park exists in a *cerrado-caatinga* transition zone resulting in a mosaic of habitats. In relatively level areas with good drainage, plant species characteristic of the *cerrado* predominate [e.g., "lixeira" (*Curatella americana*), "barbatimão" (*Stryphnodendron coriaceum*), "cascudo" (*Terminalla fagifolia*), "faveira-de-bolota" (*Parkia platycephala*), and "piqui" (*Caryocar coriaceum*)]. In areas with poor drainage (and subject to flooding) open grassland is found, and along stream beds, riparian forests of the *cerradão*. Mixed into many of these habitats are species characteristic of the riparian forests [e.g., "jatobá-de-mata" (*Hymenaea courbaril* var. *stilbocarpa*), "pau-marfim" (*Agonanadra brasiliensis*), and "pau-pombo" (*Sclerolobium paniculatum* or *Tapirira guianensis*)] and species characteristic of *caatinga* [e.g., "sabiá" (*Mimosa caesalpiniifolia*), "pau-d'árco-de-sete-folhas" (*Tabebuia aurea*), "aroeira" (*Miracrodruon urundeuva*), "macambira"(*Bromelia laciniosa*), and "xique-xique" (*Pilosocereus gounellei*) (Barroso and Guimarães, 1980).

Marmoset Surveys

Informal surveys were carried out during two periods: July 1994 (three days; eight surveys of 2-5 hours duration) and July 1995 (17 days, total of 66 hours of surveys). Surveys involved one to four observers in five different areas within the park. Particular attention was paid to locating and identifying gum-producing plants bearing characteristic marmoset gouge-holes.

Direct sightings or indirect evidence of common marmosets were found in three areas. In Area 1, a patch of *cerradão* with no standing water, a group of at least three individuals was sighted during the 1994 survey. Vocalizations were heard in this same general area in 1995. Though the area contained trees known to be gum sources for this species [e.g., "cajuí" or cashew (*Anacardium occidentale* var. *microcarpum*)], no trees with gouge-holes were found. In Area 2, pristine riparian forest in a section of the park closed to tourists, three gum trees were found with gouge marks typical of those created by the marmosets (see below). Area 3 consisted of a semi-disturbed gallery forest adjacent to the park office and hostel. Here, a marmoset group containing at least seven individuals was followed for 9.5 hours over 10 days. The group consisted of three adults (at least one male and one female), two juveniles (estimated at 6-7 months of age based on size and pelage), and two infants (estimated at about one month of age). During the brief observation period animals used approximately

one to 1.5 ha of an estimated 15 hectare patch of forest.

A total of eight individual trees of four species were found with gouge holes typical of those produced by marmosets. Three cashew trees (*Anacardium occidentale* var. *microcarpum*) were found marked. One (in Area 3) was seen being used by the marmosets and was heavily marked with fresh gouges. The other two trees contained only older, dry gouges. Three "pau terra" trees (*Qualea grandiflora* and *Q. parviflora*) were identified. Again, marmosets in Area 3 were observed feeding on one of the three trees. This is the first record of this genus being used by common marmosets, though both species have been reported as a food source for the black-tufted marmoset (*Callithrix penicillata*) (Fonseca and Lacher, 1984). One "jatobá-de-chapada" (*Hymenaea stigonocarpa*) was found with only three gouges, and it is unlikely that this tree was used as a food source. The fourth species was unidentified, but was heavily marked with old, dry gouges. Overall, while several gum trees were found, their apparent densities were much lower than those found in the Atlantic coastal forests (e.g., Alonso and Langguth, 1989; Scanlon *et al.*, 1989).

Discussion

Marmosets have vecome increasingly well known for their unusual social organization and variable reproductive strategies. While we have been able to broaden our understanding and documentation of their behavior, it is currently unclear what ecological factors may be responsible for this flexibility. Seasonality in food availability is likely to affect marmoset population densities and home range sizes which, in turn, are likely to have profound effects on the social organization and reproductive strategies of this species. As the seasonal *caatinga* and *cerrado* habitats make up the majority of the common marmoset geographic range, a long-term study of the groups at the Parque Nacional de Sete Cidades should add considerably to our understanding of this species.

Preliminary results from Sete Cidades already indicate some key differences between this marmoset population and those found in the coastal forests. Of particular note is the apparent low density of trees being used as gum sources by the marmosets (less than two gouged trees/ hectare in Area 3). In comparison, Scanlon *et al.* (1989) found a minimum of 54 gum-producing trees per hectare (most with gouge marks), and Alonso and Langguth (1989) identified 25 gum-producing trees in their group's home range (5 trees/hectare; all with gouged holes). The relatively low density of gouged trees at Sete Cidades suggests that the marmoset themselves are at low densities, or that they rely on other food sources. The low frequency of visual or auditory contacts with animals during surveys supports the former, that groups are indeed at low densities compared to coastal populations (e.g., Digby and Barreto, 1993; Scanlon *et al.*, 1989). The density of gouged trees and marmoset groups at Sete Cidades are also low in comparison to those for the black-tufted-ear marmoset (*C. penicillata*) (Fonseca and Lacher, 1984; Faria, 1984). Additional behavioral observations will be necessary before it can be determined whichalternative food sources area available to the Sete Cidades marmosets.

These results, while preliminary, already suggest important differences in the ecology of common marmosets living in the *cerrado-caatinga* transition zone compared to groups living in the coastal forests. The confirmation of the presence of common marmosets at the Sete Cidades National Park is a further important step in the understanding of this species' ecology, in particular because of the lack of protected areas in the semi-arid *caatinga* and *cerrado* habitats within its geographical range. Of the seventeen conservation units (excluding two that contain "possibly introduced and mixed populations") cited for the species by Rylands *et al.* (1993), only three protect semi-arid habitats. Despite its ecological flexibility, natural populations of common marmosets are increasingly vulnerable to habitat destruction. The protection of a relatively large area of native habitat such as that at Sete Cidades will be important for the conservation of common marmosets (and that of other *cerrado/caatinga* fauna) over the long term, as will the collection of more detailed data on the behavior and ecology of this species.

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References

Alonso, C. and Langguth, A. 1989., Ecologia e comportamento de *Callithrix jacchus* (Callitrichidae, Primates) numa ilha de floresta Atântica, *Rev. Nordestina Biol.* 6:105-137.

Barroso, G. M. and Guimarães, E. F. 1980. Excursão botânica ao Parque Nacional de Sete Cidades, Piauí. *Rodriguésia* 32(53):241-267.

Brazil, IBDF/FBCN. 1979. *Plano de Manejo Parque Nacional de Sete Cidades.* Instituto Brasileiro de Desenvolvimento Florestal (IBDF) and Fundação Brasileira para a Conservação da Natureza. FBCN, Brasília.

Castro, A. A. J. F. 1994. Comparação florística de espécie do cerrado. *Silvicultura* 15(58):16-18.

Digby, L. L. and Barreto, C. E. 1993. Social Organization in a wild population of common marmosets (*Callithrix jacchus*). Part I: group composition and dynamics. *Folia Primatol.* 61:123-134.

Eiten, G. 1972. The cerrado vegetation of Brazil. *Botanical Rev.* 38(2):201-341.

Faria, D.S. de. 1984. Uso de árvores gomíferas do cerrado por *Callithrix jacchus penicillata.* In: *A Primatologia no Brasil*, M. T. de Mello (ed.), pp. 83-96. Sociedade Brasileira de Primatologia, Brasília.

Fonseca, G. A. B. da and Lacher, T. E., Jr. 1984. Exudate feeding by *Callithrix jacchus penicillata* in semidecidous woodland (*cerradão*) in central Brazil. *Primates* 25:441-50.

Hubrecht, R. C. 1985. Home-range size and use and territorial behavior in the common marmoset, *Callithrix jacchus jacchus*, at the Tapacurá field station, Recife, Brazil. *Int. J. Primatol.* 6:533-550.

Rizzini, C. T. 1979. *Tratado de Fitogeografia do Brazil: Aspectos Sociológicos e Florísticos.* HUCITEC/EDUSP, São Paulo.

Rizzini, C. T., Coimbra Filho, A. F. and Houaiss, A. 1988. *Ecossistemas Brasileiros/Brazilian Ecosystems.* Editora Index, Rio de Janeiro.

Rylands, A. B., Coimbra-Filho, A. F. and Mittermeier, R. A. 1993. Systematics, geographic distribution, and some notes on the conservation status of the Callitrichidae. In: *Marmosets and Tamarins: Systematics, Behaviour, and Ecology*, A. B. Rylands (ed.), pp.11-77. Oxford University Press, Oxford.

Scanlon, C. E., Chalmers, N. R. and Monteiro da Cruz, M. A. O. 1989. Home range use and the exploitation of gum in the marmoset *Callithrix jacchus jacchus.* *Int. J. Primatol.* 10:123-136.

An Unusual Primate Community at the Estação Ecológica Serra dos Três Irmãos, Rondônia, Brazil

Located in northwestern Rondônia (Figure 1), the 99,813 ha Estação Ecológica Serra dos Três Irmãos was decreed in 1990 as part of statewide network of conservation units. Três Irmãos is the only component of this network located on the left or west bank of the Rio Madeira, which plays an important role in the zoogeography of the region's primates (Rylands and Bernardes, 1989; Ferrari and Lopes, 1992), in addition to a number of other mammals (Emmons, 1990). Most of these taxa are not found elsewhere in Rondônia, which emphasizes the importance of this Ecological Station's role in the conservation of the biodiversity of this state, one of the most intensely-colonized areas of Brazilian Amazonia.

Two different areas of the Station were surveyed in October and December 1995 in order to identify its diurnal mammal species and evaluate their population densities. Nine primate species were observed during these surveys (Table 1). In addition to nocturnal sightings, a group of four owl monkeys was seen in activity on one occasion at mid-morning. A tenth species not observed during surveys, *Alouatta seniculus*, was encountered on the left bank of the Madeira, 5 Km from the southern limit of the Ecological Station.

Local residents interviewed all reported that howlers are found only in areas close to the Rio Madeira. This, together with the lack of any indirect evidence (vocalizations or feces) of the occurrence of *Alouatta* within the Ecological Station, which at its closest point is 3 km from the Madeira, indicates that the distribution of *A. seniculus* in this area may be restricted to a relatively narrow corridor, perhaps less than a kilometer in width, on the left bank of this river. Howlers are nevertheless more widespread further downstream (Ferrari and Lopes, 1992).

A similar distribution was indicated by local residents for two other species not observed during the present study - *Ateles belzebuth* and *Cebuella pygmaea.* The presence of *Ateles* would be expected from its known

Table 1. Primates observed in the Três Irmãos Ecological Station, Rondônia.

Aotus nigriceps
Callicebus caligatus
Cebus albifrons
Cebus apella
Lagothrix lagotricha cana
Pithecia irrorata
Saguinus fuscicollis weddelli
Saguinus labiatus labiatus
Saimiri (sciureus) boliviensis