community in relation to fruit supplies. In: *Nouragues: Dynamics and Plant-Animal Interactions in a Neotropical Rainforest*, F. Bongers, P. Charles-Dominique, P.-M. Forget and M. Théry (eds.), pp.89-101. Kluwer Academic Publishers, London.

Sussman, R. W. 2000. *Primate Ecology and Social Structure, Vol. 2: New World Monkeys*. Pearson Custom Publishing, Needham Heights, MA.

Terborgh, J. 1983. *Five New World Primates: A Study in Comparative Ecology*. Princeton University Press, Princeton, NJ.

Wallace, R. B., Painter, R. L. E., Rumiz, D. I. and Taber, A. B. 2000. Primate diversity, distribution and relative abundances in the Ríos Blanco y Negro Wildlife Reserve, Santa Cruz Department, Bolivia. *Neotrop. Primates* 8(1): 24-28.

Primates in a Forest Fragment in Eastern Amazonia

Oswaldo de Carvalho Jr.

Introduction

Many new towns were established along the Belém-Brasília Highway following its construction in the 1960s. One was Paragominas, in the northeastern region of the state of Pará (Fig. 1). Large areas of forest in this region were cut for cattle pasture during the 1970s; and due to the depletion of timber resources in southern Brazil, in the 1980s Paragominas also became an important logging center, with the highest concentration of sawmills anywhere in Brazilian Amazonia. Today, timber is scarce in the region, and the sawmills have been moved to new frontiers, although Paragominas still remains an important commercial center for the industry.

The landscape around Paragominas today is a mosaic of agricultural land, pastures, logged and burned forest, and small patches of primary forest which cover about 6% of the original area (Nepstad *et al.*, 1999). The region of Paragominas has undergone some of the most intense deforestation and habitat degradation – and today supports the highest human population density – of anywhere in the Brazilian Amazon.

Although the remaining fragments suffer from hunting and selective logging, some still maintain primate populations (Lopes and Ferrari, 2000). In this study I evaluate the effects of this land use model on primates in a forest fragment isolated since the late 1970s and composed of three different habitats (unlogged - UN, logged - LG and secondary forest - SF), and compare my results with other studies in the same region.

Study Area

Data were collected at Fazenda Vitoria (FV) (02°55'S, 47°35'W), 6 km northwest from Paragominas town. Rainfall (1750 mm/yr) varies seasonally, with a pronounced dry season between July and November (< 50 mm/month) (EMBRAPA-CPATU). Hunting pressure is high, and hunters are frequently encountered, especially on weekends.

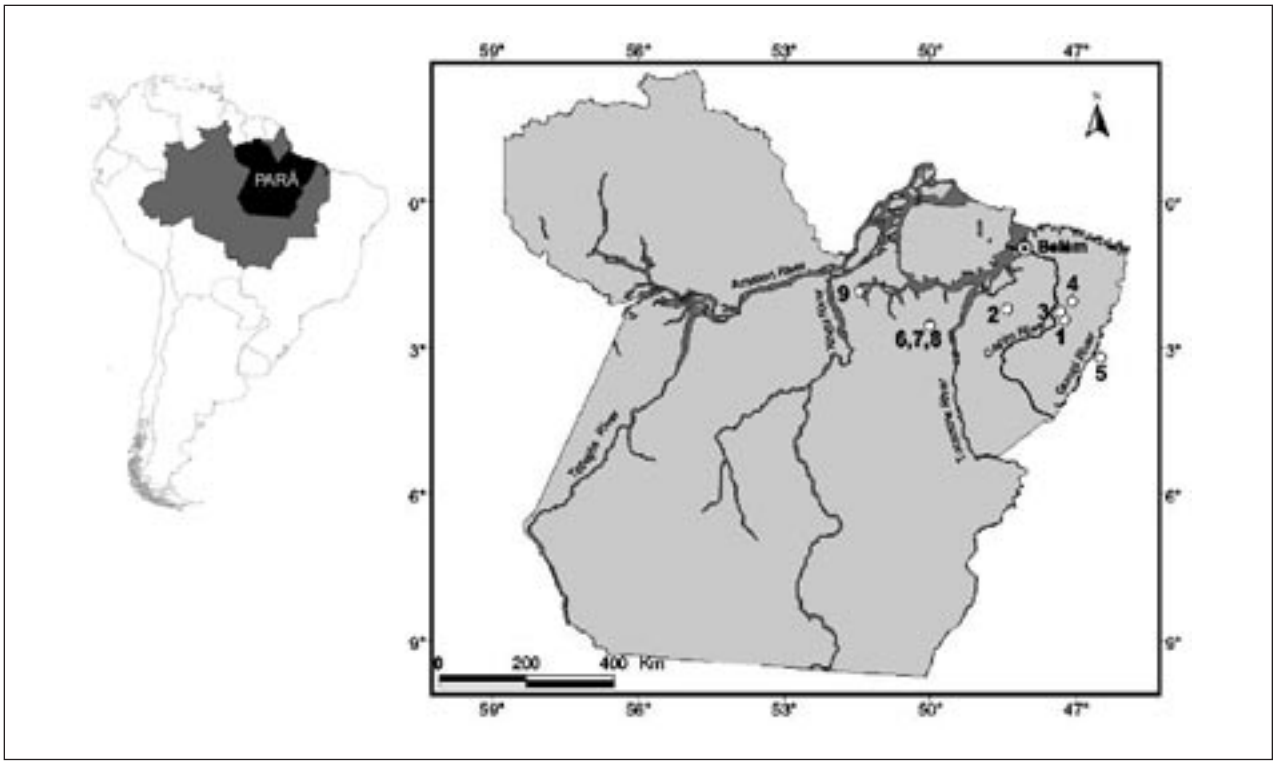

Figure 1. Location of the Fazenda Vitória (1) and the other sites in the state of Pará in eastern Brazilian Amazonia. See Table 1.

At the time of the study, there was a forest fragment on the FV of approximately 400 ha: 210 ha of primary forest (UN), 70 ha of logged forest (LG) and 60 ha of an 18-year-old secondary forest (SF) surrounded by pasture. Since 1984, a combined team from the Amazonia Environmental Research Institute (*Instituto de Pesquisas Ambientais da Amâzonia – IPAM*), the Woods Hole Research Center (WHRC), Woods Hole, MA, the Center for Research in Agro-forestry in the Eastern Amazon (CPATU) of the Brazilian Agricultural and Cattle-Breeding Research Company (EMBRAPA) (*Centro de Pesquisa Agroflorestal da Amazônia Oriental – CPATU/EMBRAPA*) and the Federal University of Pará (UFPA) have conducted research on forest ecology in one area of 260 ha (80 UN, 70 LG, 60 SF and 50 in abandoned pasture).

Methods

I used the Line Transect Method (NRC, 1981; Brockelman and Ali, 1987) to evaluate the composition and abundance of the primate community. When a group was sighted the following data were noted: date, time of day, trail, location on the trail, species identification, number of animals and animal-to-trail perpendicular distance. In order to compare this study area with other sites (Table 1), I calculated the number of individuals sighted per 10 km (sighting rate) as suggested by Lopes and Ferrari (2000).

The transects were walked between 06:00-12:00 and 16:00-18:00 at a mean speed of 1 km/h on a 4-km-long trail (2 km UN, 1 km in LG, and 1 km in SF). A total of 69 km (23 km in each habitat) was surveyed during the late dry season to early wet season of 1994-1995.

Results

Eight mammal species were recorded in 40 sightings, 25 of which were of primates of four species. Sighting rates were 5.88/10 km walked for all mammals and 3.68/10 km for primates. Each primate species was seen in all three habitat types. Table 2 compares the sighting rates at FV with other sites in the same region (Fig. 1). For details on each site see Lopes and Ferrari (2000), Emídio-Silva (1998) and Bobadilla and Ferrari (1998).

The primates observed during the census were *Alouatta belzebul belzebul, Chiropotes satanas satanas, Saguinus niger* and *Saimiri sciureus*. The night monkey (*Aotus infulatus*) and brown capuchin monkey (*Cebus apella apella*) were not recorded, although they are known to inhabit the site. The highest sighting rates for *Alouatta*, *Chiropotes* and *Saguinus* were in the primary (undisturbed) forest. Squirrel monkeys were seen just once in secondary forest (Table 3).

Discussion

Six species inhabit the study area: four were confirmed by actual sightings, and *Cebus apella* and *Aotus infulatus* were reported by local people. The four species observed during the study were seen in each of three forest types (primary, logged and secondary forest). Although the sighting rate in disturbed forest was lower than in primary, it has an important role for some species. For example, during a six-month study nearby, Oliveira and Ferrari (2000) observed *S. niger* using disturbed forest for feeding, while primary forest provided their sleeping sites. Surprisingly, *Cebus apella* – generally one of the commoner primates in Amazonia – occurs in very low densities at FV. The reasons for this are not known, but may reflect local ecological factors, such as forest type, composition and productivity, as well as human interference.

The only species expected but not seen was *Cebus kaapori*. The Ka'apor capuchin has a restricted range, is rare, and occurs at low densities (Ferrari and Lopes, 1996; Carvalho Jr. *et al.*, 1999). Although Carvalho Jr. *et al.* (1999) suggested that the abundance of *C. kaapori* is inversely related to the presence and abundance of *C. apella*, at least at FV, other factors may also be influencing its distribution there, such as intolerance to high levels of habitat degradation (Carvalho Jr. *et al.*, 1999).

In general, it would seem that FV maintains higher population densities of these primates when compared with other sites (Table 2). In a rank of the sighting rates for the 10 sites, the FV has the highest density of *Saguinus niger*, was second in this respect for *Alouatta belzebul* and *Saimiri sciureus*, and third for *Chiropotes satanas*. The high sighting rates at FV might be a result of: 1) rapid deforestation, which packed the primates into this frag-

Table 1. Characteristics of sites in eastern Amazonia used for comparison with the Fazenda Vitória, Paragominas.

	Municipality	Size (ha)	Vegetation disturbance	Hunting pressure	Source
Site 1	Paragominas	20,000	Moderate	None	1
Site 2	Tailândia	18,000	Moderate	High	2
Site 3	São Domingos do Capim	8,000	High	High	2
Site 4	Irituia	5,000	Moderate	Moderate	2
Site 5	Gurupí	340,000	Moderate to Low	Low	2
Site 6	Novo Repartimento	350,000	Moderate to Low	Moderate	3
Site 7	Novo Repartimento	350,000	Moderate to Low	Moderate	3
Site 8	Novo Repartimento	7,000	Moderate to High	Moderate	4
Site 9	Melgaço	300,000	Low	Low	4

Sources: 1. Carvalho Jr. and Pinto, in prep.; 2. Lopes, 1993; 3. Emídio-Silva, 1998; 4. Bobadilla and Ferrari, 1998.

Table 2. Sighting Rate (SR) of primates at FV and other sites in the region. Number of sightings in parentheses.

	A. belzebul	*C. satanas*	*S. midas*	*S. sciureus*	Transect length (km)	Source
FV	1.32 (09)	0.44 (03)	1.76 (12)	0.14 (01)	69	This study
Site 1	0.72 (05)	0.58 (07)	0.58 (03)	–	69	1
Site 2	0.005 (01)	0.28 (06)	1.20 (26)	–	216	2
Site 3	0.20 (04)	0.005 (01)	1.22 (25)	–	205	2
Site 4	0.25 (10)	0.34 (14)	1.47 (60)	–	408	2
Site 5	0.56 (27)	0.37 (18)	1.10 (53)	0.002 (01)	480	2
Site 6	0.31 (03)	0.52 (05)	0.10 (01)	0.10 (01)	96	3
Site 7	0.98 (08)	0.12 (01)	0.25 (02)	–	81	3
Site 8	1.00 (10)	2.07 (21)	0.50 (05)	0.40 (04)	101	4
Site 9	2.08 (111)	0.11 (06)	1.11 (59)	–	533	4

Sources: 1. Carvalho Jr. and Pinto, in prep.; 2. Lopes, 1993; 3. Emídio-Silva, 1998; 4. Bobadilla and Ferrari, 1998.

Table 3. Sighting Rate (SR) of primates at the Fazenda Vitória in the different habitats. Number of sightings in parentheses.

	A. belzebul	*C. satanas*	*S. midas*	*S. sciureus*
Primary Forest	2.61 (06)	0.87 (02)	2.61 (06)	0
Logged Forest	1.30 (03)	0.43 (01)	1.74 (04)	0
Secondary Forest	0	0	0.87 (02)	0.43 (01)

ment (in which case the population densities may decline over the coming years); 2) Low hunting pressure on primates in the region, except for howlers (Cymerys, 1994); 3) Absence of potential predators (J. R. Martins, pers. comm.); and 4) ecological and behavioral flexibility of primate species. Other factors, such as interspecific competition and floristic composition of the forest fragments, are also important influences on the occurrence and local abundance of primate species.

There is only one strictly protected area in eastern Amazonia, the Gurupí Biological Reserve; it is seriously threatened, however, and much of its forest has already been destroyed. Numerous logging companies are active there and causing widespread environmental degradation through pollution and hunting, resulting in threats to many species of the region. East of the Rio Tocantins, *A. belzebul ululata* (coast of Maranhão) and *Cebus kaapori* are now considered Critically Endangered, and *Chiropotes satanas satanas* Endangered (Rylands and Chiarello, 2003). With such threats increasing, these relatively small forest fragments – together with the few large remaining areas of undisturbed forest – could play an important role in conservation strategies in the future.

Acknowledgements: Fieldwork was supported by grants from USAID and the Federal University of Pará (UFPA), Belém. Thanks to A. C. M. Oliveira and C. Emídio-Silva for helping me to collect field data, and to IPAM for logistical support. S. F. Ferrari made helpful comments on the manuscript.

Oswaldo de Carvalho Jr., Instituto de Pesquisa Ambiental da Amazônia (IPAM), Avenida Nazaré 669, 66035-170 Belém, Pará, Brazil. E-mail: <oswaldo@ipam.org.br>.

References

Brockelman, W. Y. and Ali, R. 1987. Methods of surveying and sampling forest primate populations. In: *Primate Conservation in the Tropical Rainforest*, C. W. Marsh and R. A. Mittermeier (eds.), pp.21-62. Alan R. Liss, New York.

Bobadilla, U. and Ferrari, S. F. 1998. First detailed data on *Chiropotes satanas utahicki* Hershkovitz, 1985. *Neotrop. Primates* 6(1): 17-18.

Carvalho Jr., O., Pinto, A. C. B. and Galetti, M. 1999. New observations on *Cebus kaapori* Queiroz, 1992, in eastern Brazilian Amazonia. *Neotrop. Primates* 7(2): 41-43.

Cymerys, M. 1994. Sustainable faunal harvest: Game management for small-landholders in eastern Amazonia. Unpublished report, Woods Hole Research Center, Woods Hole, MA, and Universidade Federal do Pará, Belém.

Emídio-Silva, C. E. 1998. A caça de subsistência praticada pelos índios Parakanã (sudeste do Pará): Características e sustentabilidade. Master's thesis, Universidade Federal do Pará, Belém.

Ferrari, S. F. and Lopes, M. A. 1996. Primate populations in eastern Amazonia. In: *Adaptive Radiations of Neotropical Primates*, M. A. Norconk, A. L. Rosenberger and P. A. Garber (eds.), pp. 53-67. Plenum Press, New York.

Lopes, M. A. and Ferrari, S. F. 2000. Effects of human colonization on the abundance and diversity of mammals in eastern Amazonia. *Conserv. Biol.* 14: 1658-1665.

Nepstad, D. C., Moreira, A. G. and Alencar, A. A. 1999. *A Floresta em Chamas: Origens, Impactos e Prevenção de Fogo na Amazônia*. Programa Piloto para a Proteção das Florestas Tropicais do Brasil, Brasília.

NRC. 1981. *Techniques for the Study of Primate Population Ecology*. National Research Council (NRC), National Academy Press, Washington, DC.

Oliveira, A. C. M. and Ferrari, S. F. 2000. Seed dispersal by black-handed tamarins, *Saguinus midas niger* (Callitrichinae, Primates): Implications for the regeneration of degraded forest habitats in eastern Amazonia. *J. Trop. Ecol.* 16: 709-716.

Rylands, A. B. and Chiarello, A. G. 2003. Official List of Brazilian Fauna Threatened with Extinction – 2003. *Neotrop. Primates* 11(1): 43-49.

Some Observations on the Predation of Small Mammals by Tufted Capuchin Monkeys (*Cebus apella*)

Briseida D. Resende, Vivian L. G. Greco
Eduardo B. Ottoni, Patrícia Izar

Capuchin monkeys are the most omnivorous of the New World primates and are predators of small vertebrates (Terborgh, 1983). *Cebus capucinus* has been observed hunting coatis (*Nasua narica*) and squirrels (*Sciurus variegatoides*) in Costa Rica (Newcomer and De Farcy, 1985; Rose, 1997). Brown capuchin monkeys (*Cebus apella*) capture and eat lizards, squirrels, frogs and birds (Izawa, 1978; Terborgh, 1983; Galetti, 1990). Ferreira *et al.* (2002) described predation on birds by a group of tufted capuchins at the Tietê Ecological Park, São Paulo. Here we report on our observations of this same, semi-free-ranging group eating small mammals. The group lives in an 18 ha reforested area in the Tietê Ecological Park, São Paulo, Brazil. A detailed description of the area and the group is given by Ottoni and Mannu (2000).

On 6 June, 2001, at around 0930, one of us (BDR) was following the capuchin group and saw the juvenile male Frank eating birdseed near the juvenile male Lobato and juvenile female Vavá. Suddenly he descended to the ground, grabbed a mouse hidden in the bushes and took it to a tree. The mouse was not seen moving prior to capture, so we cannot be sure if he had killed it or if it was already dead. Frank examined its belly and ripped the skin between the hind limbs, but soon abandoned the prey. Lobato approached, took the mouse and, after a brief examination, also abandoned it.

On 15 March, 2003, at around 1050 in the morning, BDR and VG observed the dominant male Bisqüi on a branch, 10 m above the ground, eating the head and intestines of an adult male rat (*Rattus rattus*). The adult female Cisca, carrying her 5-month-old infant, and the adult male Medeiros were watching Bisqüi from very close by. An unidentified immature was also nearby, and watching keenly. Bisqüi showed great tolerance, never threatening or attacking those who were watching. The unidentified immature was able to eat a piece of the viscera. After about three minutes, Bisqüi abandoned the rat, which fell on the ground. Female juvenile Ada went down and took the carcass. We observed her from a close distance (around 4 m). She ate parts of the digestive tract, liver and pancreas, and after about four minutes, also abandoned the carcass. The juvenile male Químico then approached and examined it, but soon went away, following the group and leaving the rat on the ground.

On examination, most of the muscle tissue of the carcass was intact, except for the abdominal layers and the face muscles. The rat's belly was ripped open, and its liver, pancreas, stomach, heart, the entire digestive tract, and the brain were completely eaten. Consumption of the head and brains of small vertebrate prey has also been registered by Heymann *et al.* (2000) in their study of *Saguinus mystax* and *Saguinus fuscicollis*. Biting the head of lizards, frogs and bird nestlings was seen as a killing strategy with a rich energy source, the brain, as a reward. Izawa (1978) described *Cebus apella* in Colombia which killed frogs by squeezing the prey's neck or biting them, and then consuming the thighs, the tips of the hands and feet, and the viscera. We were unable to see the way the prey was killed, but the monkeys certainly showed a preference for eating the intestines and brain. Later that morning, at 1135, VG observed an adult male eating a small young, pink mammal around 5 cm in length. Another adult male had also been observed eating two young mammals similar to this one in July 2002.

On 27 May, 2003, at 0945, VG observed an adult female carrying the carcass of an opossum infant (*Didelphis* sp). The dominant male, Bisqüi, and another adult female were nearby. Almost the entire carcass was consumed; only the head, skin and bones and a small part of the intestines remained. Unlike the rat carcass, in this case the muscle tissue was broadly consumed and the brain was intact.

Although the capuchin monkeys are provisioned daily, they forage continuously, eating fruits, leaves, birds and invertebrates such as spiders and worms (Ferreira *et al.*, 2002). As opportunists, they probably capture vertebrate prey whenever possible, even though food scarcity is not a problem for this group; varied protein sources are always welcome, and hunting behaviors may be rewarding *per se*. In contrast to what was observed with Izawa's group in

Figure 1. Adult female (Cisca) observes dominant male (Bisqüi) eating a rat.