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Observations on Reproduction and Behavior of the Muriqui, *Brachyteles arachnoides*, in Captivity

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Introduction

Until the 1980's, information on the muriqui, or woolly spider monkey, was restricted to the geographic survey of Aguirre (1971) and observations and reports by Coimbra-Filho (1972). However, discovery of a population at what is now the Caratinga Biological Station by Célio Valle and Ney Carnevalli, then of the Federal University of Minas Gerais, in 1977, resulted in the pioneer work of Nishimura (1979, 1988) and inspired an extraordinary interest in the species. The ecology and behavior of *Brachyteles* has since been the subject of numerous studies of demography, behavior, ecology, and reproduction and reproductive physiology (see, for example, Milton, 1984; Fonseca, 1985, 1986; Strier, 1986, 1991, 1992, 1996, 1997, Nishimura *et al.*, 1988). Strier (1996) discussed specifically the reproductive ecology of muriquis at the Caratinga Biological Station, including seasonal birth peaks and interbirth intervals, and Strier and Ziegler (1997) provided information on ovulatory cycles, the discrete copulation periods observed for females, and gestation lengths from data obtained through fecal steroid analyses, which were validated with urine from females at the CPRJ (Ziegler *et al.*, 1997). Odália-Rímoli and Otta (1997) reported on a study of the development of infant muriquis at the Caratinga Biological Station. All observations to date have been for muriquis in the wild. Only recently have muriquis been bred in captivity (Coimbra-Filho *et al.* 1993; Pissinatti *et al.*, 1994), and here we provide some observations on births and reproductive behavior in *ex situ* conditions: a colony established at the Rio de Janeiro Primate Center (CPRJ-FEEMA). We emphasize that the observations are preliminary, and the conclusions arising should be subject to corroboration, most especially on wild populations.

The Captive Group at CPRJ

The muriquis are maintained in a large cage, especially designed for them, and described in detail in Coimbra-Filho *et al.* (1993). The original group was composed of two adults and a young female from the state of Minas Gerais. Two immature males from São Paulo were introduced shortly afterwards. With the recognition of two distinct forms (Vieira, 1944; Torres de Assumpção, 1983; Coimbra-Filho 1990, 1992a, 1992b; Lemos de Sá *et al.*, 1993; Coimbra-Filho *et al.* 1993), the group was then composed of two male *B. a. arachnoides* (from São Paulo), and three female *B. a. hypoxanthus* (from Minas Gerais). The offspring born into this group are therefore hybrids. For the exact origin of each of these animals see Coimbra-Filho *et al.* (1993), who also described the formation of the group and the births resulting (see also Pissinatti *et al.*, 1994).

The females (CPRJ-850, 891, and 924) were introduced to the cage on 15 May 1989. In the same month, a juvenile male (CPRJ-1012) was obtained, which had been caught in the Serra da Bocaina, in the region of the state boundary between Rio de Janeiro and São Paulo. It was

Table 1: Copulations and births. Male CPRJ-1091 and female CPRJ-924.

Copulations	Births CPRJ-924
09 January 1991	
	10 September 1991 - CPRJ-1245
30 September 1991	
12 November 1991	
	03 June 1992 - CPRJ-1335
20 September 1992	
02 November 1992	
27 April 1993	
16 July 1993*	
	12 October 1993 - CPRJ-1430
	24 June 1994 - CPRJ-1488

* On this day the male CPRJ-1012 also copulated with the female CPRJ-924.

Table 2: Copulations and births. Male CPRJ-1091 and female CPRJ-891.

Copulations	Births CPRJ-891
22 October 1990	
02 May 1991	
30 September 1991	
	30 October 1991 - CPRJ-1286
12 November 1991	
30 December 1991	
08 October 1992	
15 October 1992	
02 November 1992	
10 November 1992	
16 July 1993	
	25 April 1994 - CPRJ-1475

Obs: On 10 August 1989, the female CPRJ-891 attempted mounting the female CPRJ-924. There were no males in the colony at the this time.

about four months-old when it arrived, and in very poor condition. After a period of intensive care, it was fully recovered and introduced to the females. Another male (CPRJ-1091) arrived in January 1990, aged about eight months, and evidently quite healthy, and therefore introduced after only a short quarantine. Both were accepted by the female group without any problem. The subsequent development of the male CPRJ-1091 was remarkable, and contrasted with that of the first male CPRJ-1012, which having suffered health problems was more retarded.

The first copulation observed occurred between the male CPRJ-1091 and the female CPRJ-891 on 22 October 1990. The first offspring was born, however, on 10 September 1991, as a result of a mating between this male and another female, CPRJ-924.

The belief has been that male muriquis reach sexual maturity at four to five years. However, the male CPRJ-1091 arrived at the Center at about eight months old and was first observed to copulate at 18 months. Given the conditions described, it can be seen that sexual maturity is reached considerably earlier. There have been no evident agonistic interactions between the two males, even now, when both are fully adult. This might not be true of the females, especially during estrus, although all have copulated. If there is some sort of hierarchical dominance in females, it is difficult to detect because at estrus, when it might be manifested, they are, under any circumstances, extremely restless. Although based on few observations, the behavior of estrus and non-estrus females coincides with the descriptions of Lindberg (1987) and Strier (1987, 1992).

Births

The muriqui births at CPRJ have shown a clear seasonality (Tables 1 and 2), in accordance with numerous other primate species in south-east Brazil (Coimbra-Filho and Maia, 1979; Lindberg, 1987). They have occurred during September/October, the beginning of the rainy season, and the tail end of the annual birth peak recorded by Strier (1996) for females at the Caratinga Biological Station, Minas Gerais.

Female CPRJ-924

The first birth of the female CPRJ-924 (primiparous) occurred on 10 September 1991 (Table 1). The father was the male CPRJ-1091, and the infant was given the number CPRJ-1245. This female came to the Center in extremely poor condition, having been kept in very restrictive and precarious conditions.

During the birth, the female was restless, moving about, lying down on its left side, on the ground and on the poles in the cage, but mainly in a birth position on its back, with its legs drawn back and forcing the abdominal musculature to expel the fetus, which was already appearing in the birth canal. On occasion, the male who was not the father (CPRJ-1012) would approach and inspect her genitals.

The female was evidently having difficulty in giving birth. This situation continued during the entire morning and part of the afternoon. After more than eight hours of labor, we decided that a cesarean was necessary, but as we were preparing for this, the female went up onto a platform, more than 4 m up, and managed to expel the fetus, which fell to the ground, hitting its head on the cement boundary. Ten minutes later, the female, evidently sore and tired, descended to pick up the new-born, covered with sand and detritus, and which showed no effort to hold on to its mother. Observing that the infant's reflexes were abnormal, it was taken to the infirmary, cleaned up with warm physiological solution, dried off, and placed in a soft towel. It was given 0.5 ml physiological solution orally. It was agitated and vocalized constantly, and was taken to the cage to see if the mother would still show interest. It was left there for thirty minutes, but the mother failed to pick up the infant. It was decided that at least temporary hand-rearing was necessary. Each hour it was given 1 ml of Nestogen (Nestlé) for new-born babies, dissolved in physiological solution in equal parts. The infant was kept at a temperature of 32°C.

The infant, a female, was cared for in this manner until the afternoon of the following day, when after a bout of intense vocalizations it died in convulsions (Pissinatti *et al.*, 1997). The recovery of the female was rapid after the second day, although she was withdrawn and eating very

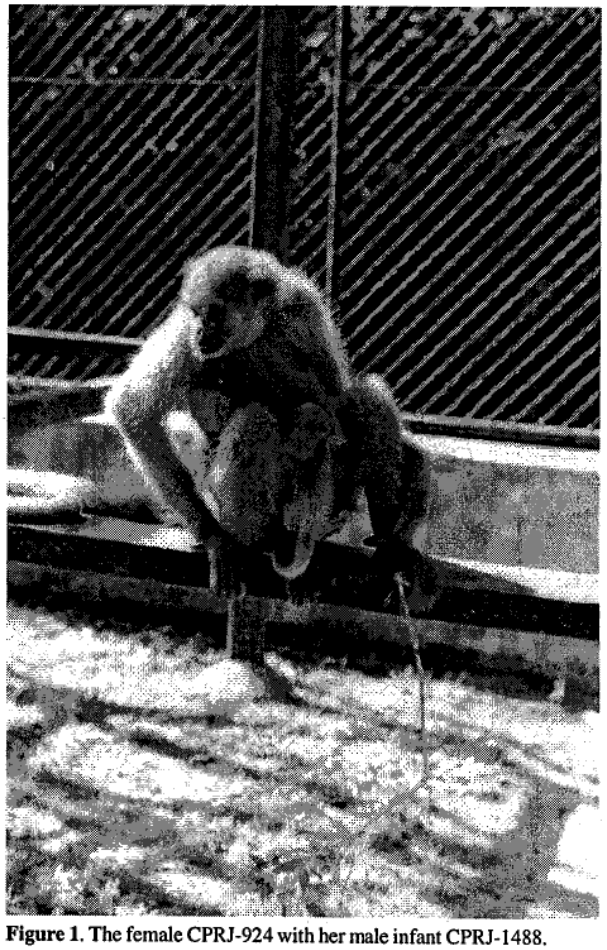

Figure 1. The female CPRJ-924 with her male infant CPRJ-1488.

little, probably due to the tiredness resulting from the prolonged birth.

The cause of death was respiratory insufficiency. The postmortem indicated that the pulmonary vein had been ruptured following its fall. There were pulmonary lesions, with diffuse hemorrhaging, and a serious, acute, fibrinopurulent broncho-pneumonia. It weighed 315 g, with a total length of 480 mm, tail 284 mm, foot 61 mm, ears 20 x 24 mm, and the thumb 2.5 mm.

Twenty days later, the same female copulated again, and subsequently gave birth on 3 June 1992, quite normally, to another offspring, CPRJ-1335. In October 1993, this same female, gave birth for the third time, and again had problems. It was apparent that it was due to the exceptionally large size of the fetus. Birth was at night, the infant (CPRJ-1430) was stillborn and found on the floor of the cage in the morning, in large part eaten, probably by opossums. Only part of the head and limbs were found.

During the births described here, there was no manifestation of interest or collaboration on the part of the other group members, excepting quick inspections of the female's genitals by the juveniles. After eight and a half months, the female CPRJ-924 gave birth again, at six in the morning, to a fourth and healthy infant CPRJ-1488 (Fig. 1).

Female CPRJ-891

The female CPRJ-891 first gave birth on 30 October 1991, one month after the first birth of the female CPRJ-924 (Coimbra-Filho *et al.*, 1993) (Table 1). This infant was registered with the number CPRJ-1286, and developed extremely well. Thirty months later, on 25 April 1994, CPRJ-891 gave birth again, to a second offspring CPRJ-1475. The gestation and births of both were normal, despite the fact that the mother, like CPRJ-924, had suffered seriously in terms of poor nutrition and cruel handling as an infant, when kept as a pet.

Behavior and Development of the Offspring

Of the six infants born at CPRJ to date, four have survived, a male and three females. The two infants which succumbed were unsexed. The offspring are fully dependent on their mothers until about five months of age. Play is limited to the juvenile stage, as was observed by Nishimura *et al.* (1988). They generally showed interest in copulating adults, sometimes approaching closely but being abruptly pushed away, as was observed in the young male CPRJ-1407 when he was first introduced to the group and one of the females was in estrus. During births, the juveniles would approach and inspect the genitals of the female in labor, but would run away at any movement on her part.

Regarding the first offspring of female CPRJ-891, a female (CPRJ-1286, 6½ years old in April 1998), following the birth, the infant clung to the mother immediately and attempted to suckle while the female was cleaning it. During the first three months it clung to the mother's ventrum. Attempts to pick up food were observed at one month. From the fourth to fifth months it generally rode on the mother's back, and attempted its first steps alone, although always near to the mother, and holding on to her with its tail.

At this time, the pelage is pale gray, shiny on the back, but with the abdomen a drab yellow. From birth, the face was blackish. It has the rudimentary thumb typical of the subspecies *B. a. hypoxanthus* (see Coimbra-Filho *et al.*, 1993). Suckling continued until the infant was aged 15 months, and weaning occurred slowly without evident trauma, as has been observed in the wild by Strier (1986). At nine months it was locomoting independently, and exploring the entire cage on its own, and occasionally taking food from the hands of the females and the adult males. Its play frequently involved provoking the adults, including pulling their tails, but they were evidently never put out. No alloparental behavior was observed.

The second infant of the female CPRJ-924, a female CPRJ-1335, was born normally, and also had a dark face and the rudiment of a thumb. It showed similar development and behavior to CPRJ-1286, but was a little more precocious, and in the third month it was riding on the base of the back of the mother, and on occasion going about around the cage on its own. The pelage of the infant was more of a drab-yellow than CPRJ-1286, and more similar to that of the adults. In the sixth month it was parasitized by botflies, which was cured quickly, and in the tenth month it suffered an extensive lesion and inflammation on its knee, which, although cured, affected its development at that age.

The second infant of the female CPRJ-891, a male CPRJ-1475, was born normally. Its fur was shiny and very pale on the forearm and legs, and pale straw-colored on the rest of the body, similar to adults. As with the other infants, it was born with a fully pigmented face and a rudimentary thumb. The infant CPRJ-1488 was the fourth of the female CPRJ-924, and showed a similar phenotype to the rest (Fig. 1).

The development of the infants in captivity complies in general with that observed in the wild. Odália-Rímoli and Otta (1997) observed that infants were carried in the ventral position until the 2nd or 3rd months, and only by six months would they move up to 2 m from the mother. At one year old, they would still spend about 50% of their time in contact with the mother. As in captivity, weaning was observed to begin at about 15 months (Odália-Rímoli and Otta, 1997).

Interactions between Adult Males

The two adult males were introduced to the cage together when they were very young. The development of the male CPRJ-1012 was severely impaired due to health problems, in contrast to that of the male CPRJ-1091 which has occupied the dominant position in the group, and remains

extremely well-developed and healthy. The first male, CPRJ-1012, is the more active of the two, but it is possible to detect the dominance of the second through certain subtle behaviors. No agonistic behavior has been observed between the two males, and CPRJ-1012 copulated with a female, even though she was in the last stages of her gestation.

On being introduced into the group, a third young male of about six months CPRJ-1407, was perfectly well-accepted by the group members until a moment when female in estrus was copulating with the male CPRJ-1091. On approaching the female, the infant was repelled violently by the male, and suffered several wounds. The male had to be removed from the group for treatment. It was subsequently maintained in a smaller cage, near to the group, in the hopes that it could be re-introduced. Its presence, however, caused considerable disturbance amongst the group members, calling and showing pilo-erection, and even causing aggression between them, especially the females. The removal of the infant resulted in the group returning to their normal behavior. This causes us to consider the possibility that the cage is already too small to introduce more animals, especially with regard to the lack of space for individuals to maintain sufficient distance, when necessary, from the other group members, as they would in the wild.

Interactions between Adult Females

When in estrus, and lacking an adult male, the females try to mount other females, a behavior which has never been recorded, for example, amongst the numerous callitrichids kept in the Center. When two females are in estrus at the same time, there is no evident competition between them regarding the sexual attention of the males. Both merely vocalize and follow the male.

Alloparental care (or at least carrying) has never been observed, the females maintain exclusivity in the care of their young. In only one situation have dependent infants been observed on the backs of the males. This happens during copulation. For example, on occasions when the male CPRJ-1012 attempted to copulate with the female CPRJ-924 carrying the infant CPRJ-1488, he first pushed the infant onto his back. The infant vocalized, but both mother and infant consented.

Interactions between Adult Males and Females

Conflict between males and females is unusual (Milton, 1984; Mendes, 1990; Strier, 1992). Embracing displays occur between females, occasionally between males and females, and rarely between the adult males. In the wild, male-male embraces are frequent (Mendes, 1990; Strier, 1992). We have never observed embracing between juveniles. Food snatching has been observed between the young. Sexual interactions are relaxed, as observed by Strier and Ziegler (1997), both outside of and during estrus.

Considering the relatively small size of the group, it is difficult to establish any comparative basis with regard to the frequency of copulations and the number of males which copulate with each female, although the patterns appear to be similar to those recorded in the wild (Aguirre, 1971; Milton, 1984, 1985; Strier, 1996). During all but one of the births, the group members remained at a distance, only rarely approaching the mother. We believed that this may have been due to the disparate origins and lack of genetic relationship between the muriquis during the development of the group. However, on the occasion of the sixth birth (to the female CPRJ-924), we were able to observe intense and evidently emotional interactions between the males and the mother. They remained close to her, emitting low vocalizations and touching and stroking her while she was lying on her back in the feeding compartment of the cage. Only right at the moment of birth did the other female CPRJ-891 approach, and touch and embrace the female. This affiliative behavior is a clear characteristic of this remarkable primate.

Interactions between Females and Young

Muriquis are extremely attentive and tender mothers. Agonism towards the young was never observed, even during play. They stay away from the cage netting when someone approaches during the first days after birth. Suckling is always relaxed and only rarely does the infant appear to cause discomfort.

Conclusions

Preliminary observations in captivity allow us to conclude that: a) maternal care is never transferred to other females or group members; b) the births show seasonality similar to other primates of south-east Brazil; c) it would appear that birth intervals are shorter than is typical for wild populations (Strier, 1991, 1997); d) during birth, the relations between the juveniles and the mother are less significant than between the mother and other group members, especially the adult males who stay near the mother, vocalizing, touching and stroking her; e) a male at 18 months is sexually mature and capable of successful copulation; f) by the third month the infants are capable of riding on their mother's back; and g) attempts at food handling by infants are observed in their first month; and h) the hybrid offspring all have the rudimentary thumb typical of *B. a. hypoxanthus*, which indicates that the southern, nominate form is the derived subspecies (see Coimbra-Filho *et al.*, 1993).

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Primate Densities in the Natural Reserve of Nouragues, French Guiana

Philip Kessler

Introduction

In December 1995, a new Natural Reserve of 100,000 ha was created around the Research Station of Nouragues (UPS 656/CNRS) near the Arataye river in French Guiana (Fig. 1). Seven primate species are known to occur in the reserve: *Alouatta seniculus, Ateles paniscus, Cebus apella, Cebus olivaceus, Pithecia pithecia, Saimiri sciureus* and *Saguinus midas*. The common squirrel monkey (*Saimiri sciureus*) has been observed along the Arataye and Approuague rivers, but never in the vicinity the Nouragues Research Station (Charles-Dominique, 1993). A number of studies have been conducted on primate ecology at Nouragues over the last 10 years (e.g., Julliot, 1992; Zhang, 1995; Kessler, 1995a). Two studies have reported on population densities for *Alouatta* and *Saguinus* at Nouragues, both derived from estimates of home ranges and group size during detailed studies (Julliot, 1992; Kessler, 1995b). Here I report on censuses carried out to obtain basic data on primate abundance in the region, a necessary basis for further studies and comparisons of primate ecology between Nouragues and other regions.

Methods

The census was conducted between June and October 1997 in the Natural Reserve of Nouragues in French Guiana. The area contains uninhabited primary rain forest. Data were collected using a transect census technique. A small, rarely used, forest trail was chosen as the transect line. A section of 4 km was marked every 20 m and censused once a week between 0700 and 1200 am, yielding a total of 15 censuses. For each census the observer walked quietly (average speed: 1 km/h) and stopped every 20 m to look and listen more intensively for monkeys. When a monkey group was detected, it was observed for up to a maximum of 10 minutes to determine the species and number of individuals. Animal-to-transect distance was calculated on the basis of the trigonometric relationship of animal-observer distance and sighting angle to the transect. The total strip width was determined by the maximal animal-to-transect distance of all first sightings for each species (National Research Council, 1981). Population densities expressed in individuals/km² and observed group sizes should be considered as minimal estimations because it is probable that not all group members could be detected during the 10 minutes of observation. Howler monkey densities are probably undestimated due to their discreet behaviour. Likewise, *C. apella* groups are often dispersed over up to 100 m, and therefore group sizes are probably underestimated.

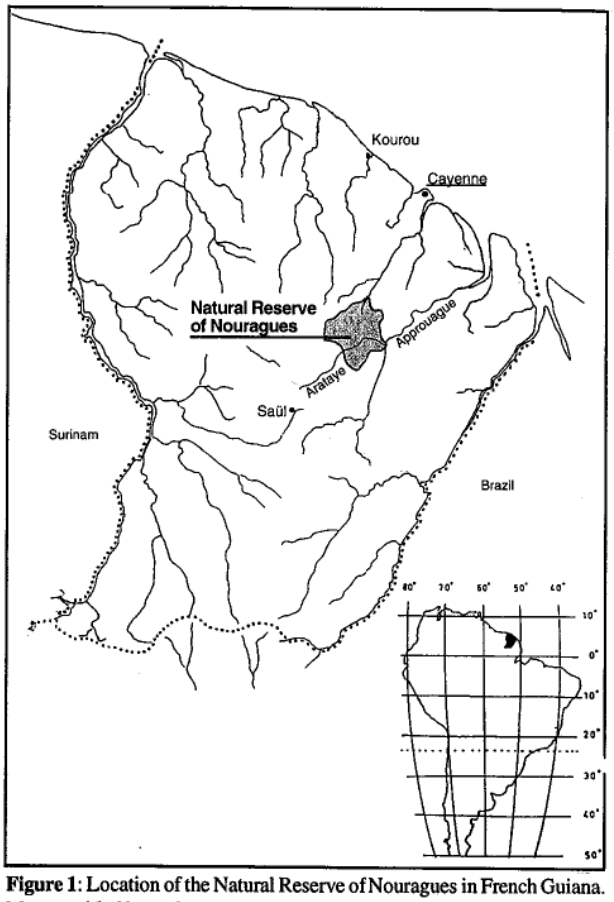

Figure 1: Location of the Natural Reserve of Nouragues in French Guiana. Map provided by author.

Results

Population density estimates and minimum group sizes are shown in Table 1. There are no data for *Pithecia pithecia* and *Cebus olivaceus*. These two species are present in the reserve, but were never seen during the 15 transect censuses. The data on group sizes for these two

Table 1: Estimation of minimal group sizes and population densities of the primate population in the Natural Reserve of Nouragues, French Guiana.

Species	No. of groups	Minimum group size[1]	Density[2] (groups/km²)	Density[2] (ind/km²)
A. seniculus	9	5.1 ± 1.4	2-3 (2.50)	11-15 (12.78)
A. paniscus	10	3.6 ± 1.8	2-3 (2.28)	7-10 (8.57)
C. apella	7	7.7 ± 2.9	1-3 (1.94)	13-17 (15.00)
C. olivaceus[3]	6	13.2 ± 4.4	-	-
P. pithecia[3]	4	2.8 ± 1.0	-	-
S. midas	13	4.2 ± 1.5	5-6 (5.42)	20-25 (22.92)

[1] mean ± standard deviation.
[2] range of 95% confidence interval, mean in parentheses.
[3] group sizes estimated by sightings outside transect censuses.