Brief Report

Capture Techniques and Morphometrics for the Woolly Spider Monkey, or Muriqui (Brachyteles arachnoides, E. Geoffroy 1806)

Rosa M. Lemos de Sá1 and Kenneth E. Glander2
1Department of Wildlife and Range Sciences, University of Florida, Gainesville, Florida; 2Department of Biological Anthropology and Anatomy, Duke University, Durham, North Carolina

A total of 12 free-ranging muriquis (Brachyteles arachnoides) were captured with Telazol® at Fazenda Esmeralda, Minas Gerais, Brazil, and at Fazenda Barreiro Rico, São Paulo, Brazil. All animals were measured, marked, weighed, and released. Previously reported data suggested that Brachyteles is a sexually dimorphic species with female-male body weights of 12–15 kg, respectively. We found no statistically significant difference in body weight between females (mean = 8.4 kg, range = 6.9–9.3 kg, n = 4), and males (mean = 9.6 kg, range = 9.3–10.2 kg, n = 4). Our results are at variance with previously published body weights in the literature. Larger sample size may reveal a significant sexual difference, particularly in body weight. © 1993 Wiley-Liss, Inc.

Key words: Brachyteles, sexual dimorphism, neotropics, Telazol®

Introduction

The woolly spider monkey or muriqui (Brachyteles arachnoides) is a highly endangered primate species endemic to the Atlantic coastal forest of Brazil.Only small fragmented populations exist today because most of the Atlantic coastal forest has been destroyed [Fonseca, 1983, 1985]. These remaining populations of muriqui occur in low numbers in widely separated forest patches [Fonseca, 1983, Mittermeier et al., 1987] and may total as few as 350–400 individuals. The small number of individuals in each of these isolated populations is well below the demographic and genetic thresholds that are required for a viable population to persist over time [Goodman, 1987; Falconer, 1981].

During the past 10 years several studies have been carried out on Brachyteles ecology, behavior, demography, and status in their natural habitat [Fonseca, 1983, 1985; Milton, 1984, 1985a,b; Strier 1987a–c, 1989, 1991a,b; Mittermeier et al., 1987; Lemos de Sá, 1988; Lemos de Sá & Strier, 1992]. A captive Brachyteles breeding program is also being developed at Rio de Janeiro Primate Center, Brazil. Despite these efforts, few morphometric data are available on this highly endan-
gersed species. The data available are from Ruschi [1964] who gives an estimation of weight for the species ranging from 12 to 15 kg, and the measurements of a single adult male. Here we present the measurements of 12 individuals of both sexes and different age classes (from two different populations) which were captured, measured, marked, and released.

MATERIALS AND METHODS

Sites

The first site is an estimated 44 ha isolated forest patch located on Fazenda Esmeralda (FE or the northern site) near Rio Casca in Minas Gerais (20° 13'S to 42° 39'W). The forest is degraded by logging and has few trees more than 15 m tall. There are 11–12 km of trails in this steeply sloped forest. Capture at this site occurred from August 21–27, 1990.

The second site is a forest of about 1,000 ha located on Fazenda Barreiro Rico (FBR or the southern site) near Santa Maria da Serra in São Paulo State (22° 33'S to 48° 10'W). Most of this forest has been logged, but there are numerous trees more than 20 m tall interspersed among large areas of low trees and degraded forest. There are about 10 km of trails. Capture at this site occurred from August 30 to September 5, 1990.

Capture

Capture of the animals was accomplished using the Pneu-Dart® system (Pneu-Dart, Inc., HC 31, Williamsport, PA 17701). This system employs disposable nonbarbed darts with a 9 mm needle that are delivered by a carbon dioxide powered gun. The darts were loaded with Telazol® which is a nonnarcotic, nonbarbiturate, injectable anesthetic. It is a combination of equal parts by weight of tiletamine hydrochloride (an arylaminocycloalkanone dissociative anesthetic) and zolazepam hydrochloride (a nonphenothiazine diazepinone with tranquilizing properties (A.H. Robbins Co., Richmond, VA 23220).

Telazol® did interfere with the therma-regulating ability of some individuals. To combat this, rectal temperature was closely monitored. Any rectal temperature of more than 39°C was treated by wetting the animal with water or partially immersing it in a bucket of cool water.

Individuals were darted at distances up to 20 m. The preferred injection site was the hindquarters. The hit had to be perpendicular to the target surface to insure complete injection of the drug. Since unsuitable target sites were the chest, thorax, lumbar region, abdomen, shoulder, neck, head, or face, a shot was not attempted unless the animal was facing away from the shooter. Thus, if a shot missed the hindquarters it also would miss the unsuitable target sites, particularly the face.

An attempt was made to catch individuals in a nylon mesh net (camper's hammock) when they fell from the trees. However, several of the darted animals fell to the ground because thick understory prevented proper positioning of the net. The thick understory and soft ground served to cushion the fall. No individual was injured during the capture procedure.

Reaction of group members to the darting procedure varied but generally consisted of running away in response to the call given by the darted animal and the noise of the gun. Once captured, the monkeys were measured and marked (see next section). Animals that recovered from the capture dosage before these procedures were completed were given supplementary injections of 100 mg of Telazol®, repeated as often as needed. After all procedures were completed the animals were kept in burlap bags until they recovered enough to walk or climb unaided. The
bags were kept in the shade and are the best means of holding an animal until it recovers because the bag reduces visual stimulus and allows proper ventilation.

When released the animals tried to pull off their collars, but they habituated quickly and ignored the collars after only 1 or 2 days. Following release none of the collared individuals demonstrated avoidance or flight behavior to our presence.

**Measuring and Marking**

The animals were weighed, measured, aged, and marked with collars, ear-tags or notches, and tattoos. Weighing was done by suspending the animals from a 1 kg Pesola® scale for infants and a 20 kg Pesola® scale for adults. Measurements were taken to the nearest mm with a 3 m metal tape (see Appendix for a description of measurements). Age was estimated by KEG based on tooth wear. The collars consisted of a chain with a brightly colored plastic bead attached with a D-ring. Ear-notches and ear-tags were used to mark immatures because collars would not expand as the animal grows. The ear tags were rectangular pieces of colored plastic attached to the ear with a rivet placed in a hole made with a hole punch. The rivet was crimped but not completely closed.

**RESULTS**

**Effectiveness of Capture Drug**

A mean dose of 235 mg (SD = 21, n = 10) immobilized the muriquis within 104 seconds (SD = 62, n = 9) and caused them to fall within 217 seconds (SD = 54, n = 8) (Table I). It took 77.5 minutes (n = 2) for the darted animals to recover. All darted individuals did recover, but we only recorded recovery time on two animals. Since the mean weight was 9 kg, the average dose was 26 mg/kg.

**Morphometrics**

Table II presents the individual weights and measurements and Table III contains the summary morphometrics. There were 4 adult males (MA), 4 adult females (FA), 1 subadult male (MSA), 2 subadult females (FSA), and 1 infant female (FIN). Ten of the animals were from Fazenda Esmeralda (Nos. 1–10) and two were from Fazenda Barreiro Rico (Nos. 11, 12).

All adult females were palpated for pregnancy. Only animal number 7 was pregnant (she gave birth 4 months after this study). Her pregnancy may account for her being the heaviest female.
### TABLE II. Morphometrics for *Brachyteles arachnoides*

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age</th>
<th>Weight (kg)</th>
<th>Length (mm)</th>
<th>Testicle volume (mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Body Tail</td>
<td>Hind leg Hind foot</td>
</tr>
<tr>
<td>09</td>
<td>FIN</td>
<td>2</td>
<td>0.68</td>
<td>220 290 206</td>
<td>79 26</td>
</tr>
<tr>
<td>04</td>
<td>FSA</td>
<td>36</td>
<td>3.10</td>
<td>343 557 423</td>
<td>145 64</td>
</tr>
<tr>
<td>08</td>
<td>FSA</td>
<td>60</td>
<td>5.00</td>
<td>402 758 531</td>
<td>170 72</td>
</tr>
<tr>
<td>06</td>
<td>MSA</td>
<td>48</td>
<td>5.00</td>
<td>407 625 470</td>
<td>161 75</td>
</tr>
<tr>
<td>05</td>
<td>FA</td>
<td>360</td>
<td>8.80</td>
<td>491 809 615</td>
<td>191 82</td>
</tr>
<tr>
<td>07</td>
<td>FA</td>
<td>240</td>
<td>9.30</td>
<td>514 810 612</td>
<td>193 89</td>
</tr>
<tr>
<td>10</td>
<td>FA</td>
<td>216</td>
<td>6.90</td>
<td>461 738 544</td>
<td>177 73</td>
</tr>
<tr>
<td>12</td>
<td>FA</td>
<td>84</td>
<td>8.50</td>
<td>479 753 555</td>
<td>180 72</td>
</tr>
<tr>
<td>01</td>
<td>MA</td>
<td>240</td>
<td>9.40</td>
<td>478 736 531</td>
<td>170 85</td>
</tr>
<tr>
<td>02</td>
<td>MA</td>
<td>96</td>
<td>9.25</td>
<td>497 773 547</td>
<td>181 80</td>
</tr>
<tr>
<td>03</td>
<td>MA</td>
<td>276</td>
<td>9.60</td>
<td>487 734 570</td>
<td>180 89</td>
</tr>
<tr>
<td>11</td>
<td>MA</td>
<td>120</td>
<td>10.20</td>
<td>496 726 572</td>
<td>176 83</td>
</tr>
</tbody>
</table>

*Abbreviations: F, female; M, male; IN, infant; SA, subadult; A, adult.

*Symbols: age estimated in month.
TABLE III. Summary Morphometrics for Adult Individuals of *B. arachnoides* (Means ± SD), and Results of Male-Female Comparison (t-Test)

<table>
<thead>
<tr>
<th></th>
<th>Females (n = 4)</th>
<th>Males (n = 4)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>8.4 ± 1.0</td>
<td>9.6 ± 0.4</td>
<td>.07</td>
</tr>
<tr>
<td>Body (mm)</td>
<td>496 ± 22</td>
<td>490 ± 9</td>
<td>.80</td>
</tr>
<tr>
<td>Tail (mm)</td>
<td>778 ± 37</td>
<td>742 ± 21</td>
<td>.15</td>
</tr>
<tr>
<td>Hindleg (mm)</td>
<td>582 ± 37</td>
<td>555 ± 20</td>
<td>.26</td>
</tr>
<tr>
<td>Hindfoot (mm)</td>
<td>185 ± 8</td>
<td>177 ± 5</td>
<td>.12</td>
</tr>
<tr>
<td>Bigtoe (mm)</td>
<td>79 ± 8</td>
<td>84 ± 4</td>
<td>.28</td>
</tr>
<tr>
<td>Foreleg (mm)</td>
<td>587 ± 23</td>
<td>550 ± 28</td>
<td>.08</td>
</tr>
<tr>
<td>Forefoot (mm)</td>
<td>168 ± 10</td>
<td>160 ± 6</td>
<td>.23</td>
</tr>
<tr>
<td>Thumb (mm)</td>
<td>6 ± 7</td>
<td>10 ± 8</td>
<td>.50</td>
</tr>
<tr>
<td>Testicle (mm³)</td>
<td>952,381 ± 145,625</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adult males tended to be heavier than adult females, but there was a large standard deviation in the adult female weight and sex difference was not significant (Table III). Adult female weight range from 6.9 to 9.3 kg and the heaviest adult female (9.3 kg) weighed more than the lightest adult male (9.25 kg) (Fig. 1). None of the linear measurements were significantly different (Table III). Figure 2 shows a comparison of individual tail and body lengths. Even though females were generally lighter in weight than the male, the females had absolutely longer tails, hindlegs, hindfeet, forelegs, and forefeet (Table II). The intermembral indices of hindleg and foreleg lengths were 0.99 (CV = 3.3) for females and 1.01 (CV = 2.4) for males.

There was a regional difference in canine length and the presence of thumbs. The southern male had longer upper and lower canines than the southern female while the canines of northern males and females were similar in length (Table II) (Lemos de Sá et al., in press).

The two individuals from the South (FBR) did not have thumbs while all northern individuals (FE) had thumbs ranging from 3 to 19 mm long. There was no regional or sexual difference in the type of bite. Five individuals had an underbite (upper incisors in back of lower incisors when molars are in contact). The upper and lower incisors were in direct contact in six individuals.

Testicle size was bilaterally similar (t = 1.21, ns). Muriquis have testicles that are more than six times the size of spider monkey (*Ateles geoffroyi*) testicles, and more than 14 times the size of the sympatric brown howling monkey (*Alouatta fuscata*) testicles (Table IV). Figure 3 shows these relationships.

**DISCUSSION**

Woolly spider monkeys or muriquis are reported to be the largest Neotropic primate [Aguirre, 1971; Mittermeier et al., 1982, 1987; Fonseca, 1985; Rosenberger & Strier, 1989]. However, morphometric data are limited. Ruschi (1964) presented measurements (body 630 mm, tail 775 mm), and the weight (13,800 g) of a single adult male from Espírito Santo state, Brazil, and estimated the range of weight for the species between 12 and 15 kg. The body weight of the single male and the estimated range given by Ruschi [1964] were much higher than those found in this study (Table II). Napier [1976] provides field measurements for skins in the British Museum (male: body length 580 mm and 610 mm, tail length 670 mm and 690 mm; female: body length mean of 573 mm, n = 4, range 545–600 mm and tail length mean of 791 mm, n = 4, range 740–840 mm). These tail lengths for
both sexes overlap with those found in this study, but the body lengths are considerably longer than the Fazenda Esmeralda and Fazenda Barreiro Rico individuals (Table II). The longest male and female measured in this study had shorter bodies than the shortest male and female reported in the literature. (Body length in this study and in the literature includes head + body).

The differences in body length and body size between our results and those reported in the literature might be due to geographical variation in different pop-
ulations of *Brachyteles*. However, we did measure individuals from two distinct and geographically isolated populations and did not find differences in body length between the populations nor did we find body size as large as earlier reported. It is possible that modern day populations are smaller due to increasing ecological pressures and decreasing habitat suitability. If this is the case, then habitat quality must be considered in any future management plans.

Sexual dimorphism in weight and body measurements were not present in this study; however, the difference in body weight approached statistical significance (*P* < .07). As we accumulate more morphometric data on *Brachyteles*, we expect sexual dimorphism to be demonstrated in body weight, although the previously estimated sexual dimorphism in body weight reported by Ruschi [1964] and Aguirre [1971] will probably not be matched. The results of this study, with the possible exception of body weight and canine length [Lemos de Sa et al., in press], support Rosenberger and Strier's [1989] observation that *Brachyteles* is essentially a monomorphic species.

Large testicle size reported here (Table IV) supports the suggestion that sperm competition rather than mating competition is occurring in woolly spider monkey [Milton, 1985a; Rosenberger & Strier, 1989]. Male-male aggression over receptive female has not been reported in *Brachyteles* [Milton, 1985a; Strier, 1987c; Lemos de Sa, 1988].

Genetic variation in both FE and FBR animals indicates a high degree of polymorphism and heterozygosity (polymorphism for both populations combined was 34.4% and mean heterozygosity in both populations was 10%) [Pope, submitted]. However, Pope's results also indicate that the smaller FE population may have lost heterozygosity and polymorphism due to inbreeding. If this is the case, small populations such as the one at FE should be carefully managed to avoid irreversible loss of genetic variation.
CONCLUSIONS

1. Sexual dimorphism was only slightly developed in Brachyteles. Males were absolutely heavier than adult females and had absolutely shorter tails, hindlegs, hindfeet, forelegs, and forefeet than females. Body length for the sexes was similar.

2. There was no sexual dimorphism in canine length in the FE population, but the FBR male had considerably longer upper and lower canines than the FBR female.

3. The FBR individuals did not have thumbs while all of the FE individuals had thumbs.

4. The morphometric data reported in this study, with the possible exception of body weight, do not support the suggestion in the literature that Brachyteles is a highly sexually dimorphic species.

ACKNOWLEDGMENTS

We thank Drs. Thomas T. Struhsaker, Theresa R. Pope, and Gustavo A. B. da Fonseca for their invaluable participation in the planning and execution of this project. We are grateful to Dr. Karen B. Strier for her participation and her help, and to Dr. Antônio Cuppertino Teixeira and Sr. José Carlos Reis de Magalhães for their permission to capture the animals on their farms, and for their support and conservation efforts in saving the muriquis. Thanks to João Paulo Viana for his help in the revision of earlier drafts. A special thanks go to Dr. Thomas T. Struhsaker for his initiative, and for making an old dream a reality. This work was supported by Conservation International and Wildlife Preservation Trust International.

REFERENCES


Fonseca, G.A. The role of deforestation and private reserves in the conservation of the woolly spider monkey (Brachyteles arachnoides). MASTER THESIS, University of Florida, Gainesville, 1983.


Lemos de Sá, R.M. Situação de uma população de mono-carvoeiros, Brachyteles arachnoides, em fragmento de Mata Atlântica (M.G.) e implicações para sua conser-

vação. MASTER THESIS, Universidade de Brasília, 1988.

Lemos de Sá, R.M.; Strier, K.B. A preliminary comparison of forest structure and use by two isolated groups of woolly spider monkeys, (Brachyteles arachnoides). BIO-


Mittermeier, R.A.; Coimbra-Filho, A.F.; Constable, I.D.; Rylands, A.B.; Valle, C. Conservation of Primates in the Atlantic forest region of eastern Brazil. INTERNA-

APPENDIX

Description of Measurements

**Tail length** is measured on the ventral side from the tip of the tail (excluding the hair) to the junction of the base of the tail with the perianal area. The tail is completely extended straight out behind the animal.

**Body length** is determined by subtracting Tail length from Tail-crown length which is measured from the tip of the tail to the most anterior point on the head in normal position, i.e., chin near the chest.

**Hindleg length** is measured from the groin to the end of the longest digit, excluding the nail.

**Hindfoot length** is measured from the heel to the end of the longest digit, excluding the nail.

**Big toe length** is measured from the junction of skin and big toe to the tip of the big toe excluding the nail when the big toe is extended perpendicular to the other digits.

**Foreleg length** is measured from the axillary region to the tip of the longest digit, excluding the nail.

**Forefoot length** is measured from the proximal edge of the friction pad nearest the wrist to the tip of the longest digit, excluding the nail.

**Thumb length** is measured from the junction between the first and second digits to the tip of the thumb, excluding the nail.

**Testicle width and length** are measured with a vernier caliper. Testicular volume is estimated using the formula for an ellipsoid.