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BRIEF REPORT

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

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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.

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-

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gered 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

TABLE I. Effectiveness of Telazol® for Capture of *B. arachnoides

Animal number	Sex	Age	Stop (sec)	Down (sec)	Recovery (min)
01	Male	Adult	90	150	
03	Male	Adult	150	180	
04	Female	Adult	135	225	
05	Female	Subadult	160	190	
06	Male	Adult	40	na	80
07	Female	Subadult	65	235	
08	Female	Adult	210	240	75
10	Female	Subadult	36	327	
12	Female	Adult	50	190	

*Stop = the darted animal is no longer capable of locomotion. Down = the darted animal falls. Recovery = time from the initial dose to the time that the animal is back in the trees (includes measuring time).

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

No.	Sex and age	Age[a]	Weight (kg)	Length (mm)										Testicle volume (mm^3)		
				Body	Tail	Hind leg	Hind foot	Big toe	Fore leg	Fore foot	Thumb	Canine upper	Canine lower	Right	Left	Total
09	FIN	2	0.68	220	290	206	79	26	197	66	6					
04	FSA	36	3.10	343	557	423	145	64	412	123	10					
08	FSA	60	5.00	402	758	531	170	72	551	152	14	6.0	4.4			
06	MSA	48	5.00	407	625	470	161	75	473	141	11			2,729	3,742	6,471
05	FA	360	8.80	491	809	615	191	82	601	175	6					
07	FA	240	9.30	514	810	612	193	89	606	175	16	7.2	5.7			
10	FA	216	6.90	461	738	544	177	73	556	153	3	4.6	5.4			
12	FA	84	8.50	479	753	555	180	72	585	167	0	6.5	5.9			
01	MA	240	9.40	478	736	531	170	85	520	153	19	8.5	6.2	486,817	471,831	958,649
02	MA	96	9.25	497	773	547	181	80	541	160	11	8.7	6.6	368,849	376,139	744,988
03	MA	276	9.60	487	734	570	180	89	553	158	10	5.0	5.9	554,739	511,297	1,066,036
11	MA	120	10.20	496	726	572	176	83	586	167	0	9.9	7.1	521,047	518,804	1,039,851

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

	Females (n = 4)	Males (n = 4)	*P*
Weight (kg)	8.4 ± 1.0	9.6 ± 0.4	.07
Body (mm)	486 ± 22	490 ± 9	.80
Tail (mm)	778 ± 37	742 ± 21	.15
Hindleg (mm)	582 ± 37	555 ± 20	.26
Hindfoot (mm)	185 ± 8	177 ± 5	.12
Bigtoe (mm)	79 ± 8	84 ± 4	.28
Foreleg (mm)	587 ± 23	550 ± 28	.08
Forefoot (mm)	168 ± 10	160 ± 6	.23
Thumb (mm)	6 ± 7	10 ± 8	.50
Testicle (mm^3)		952,381 ± 145,625	

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 fusca*) 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

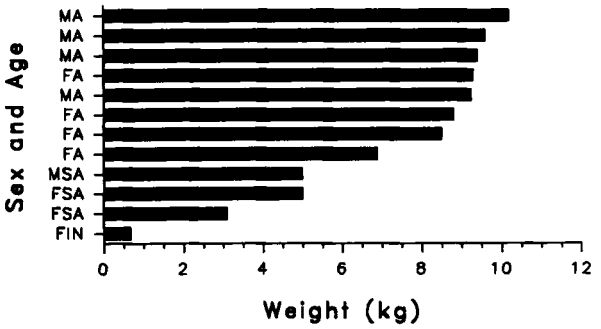

Fig. 1. Body weight (kg) of 12 individuals of different sex and age class of *B. arachnoides*. M, male; F, female; A, adult; SA, subadult; IN, infant.

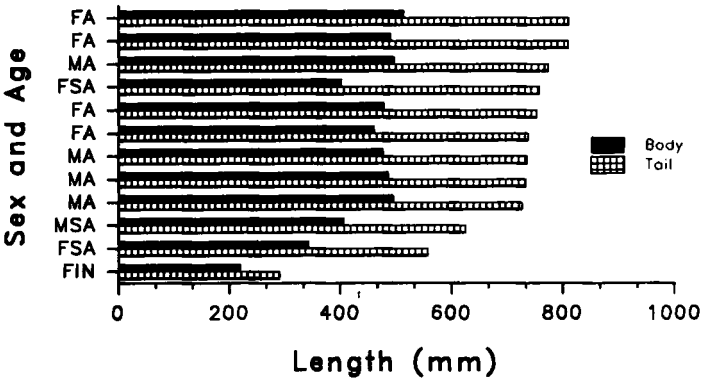

Fig. 2. Comparison of body and tail length (mm) of 12 individuals of different sex and age class of *B. arachnoides*. Symbols the same as in Figure 1.

TABLE IV. Comparison of Testicle Size of Three Cebidae Species*

Species	n	Mean body weight (kg)	Mean total testicle volume (mm^3)	Reference
Brachyteles arachnoides	4	9.6	952,381	This paper
Ateles geoffroyi	3	7.9	154,673	(a)
Alouatta fusca	4	5.9	61,706	(b)

*Symbols: (a), Glander et al. [1991]; (b) Glander et al., unpub.

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-

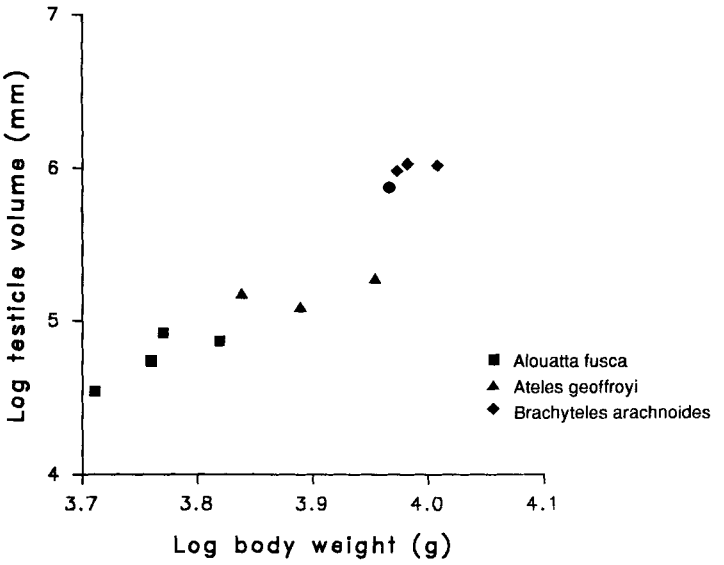

Fig. 3. Comparison of testicle volume (mm^3) of three Cebidae species.

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 Sá 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 Sá, 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.

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REFERENCES

Aguirre, A.C. O MONO *Brachyteles arachnoides* (E. Geoffroy). Rio de Janeiro, ACADEMIA BRASILEIRA DE CIÊNCIAS, 1971.

Falconer, D.S. INTRODUCTION TO QUANTITATIVE GENETICS. 2nd. ed. London, Longman, 1981.

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.

Fonseca, G.A. Observations on the ecology of the muriqui (*Brachyteles arachnoides* E. Geoffroy 1806). PRIMATE CONSERVATION 5:48–52, 1985.

Glander, K.E.; Fedigan, L.M.; Fedigan, L.; Chapman, C. Field methods for capture and measurement of three monkey species in Costa Rica. FOLIA PRIMATOLOGICA 57:70–82, 1991.

Goodman, D. The demography of chance extinction. Pp. 11–34 in VIABLE POPULATION FOR CONSERVATION. M.E. Soulé, ed. Cambridge University Press, Cambridge, 1987.

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 conservação. 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*). BIOTROPICA. 24(3):455–459.

Lemos de Sá, R.M.; Pope, T.R.; Struhsaker, T.T.; Glander, K.E. Sexual dimorphism in canine length of woolly spider monkeys, (*Brachyteles arachnoides*, E. Geoffroy 1806). INTERNATIONAL JOURNAL OF PRIMATOLOGY, in press.

Milton, K. Habitat, diet and activity patterns of free-ranging woolly spider monkeys (*Brachyteles arachnoides* E. Geoffroy 1808). INTERNATIONAL JOURNAL OF PRIMATOLOGY 5:491–514, 1984.

Milton, K. Mating patterns of woolly spider monkeys, *Brachyteles arachnoides*: Implications for female choice. BEHAVIORAL ECOLOGY AND SOCIOBIOLOGY 17:53–59, 1985a.

Milton, K. Urine washing behavior in the woolly spider monkey. Z. TIERPSYCHOLOGY 67:154–160, 1985b.

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. INTERNATIONAL ZOO YEARBOOK 22:2–17, 1982.

Mittermeier, R.A.; Valle, C.M.C.; Alves, M.C.; Santos, I.B.; Pinto, C.M.A.; Strier, K.B.; Veado, E.M.; Constable, I.D.; Paccagnella, S.G.; Lemos de Sá, R.M. Current distribution of the muriqui in the Atlantic forest region of eastern Brazil. PRIMATE CONSERVATION 8:143–148, 1987.

Napier, P.H. CATALOGUE OF PRIMATES IN THE BRITISH MUSEUM (NATURAL HISTORY). PART 1: FAMILIES CALLITRICHIDAE AND CEBIDAE. London, British Museum (Natural History), 1976.

Pope, T.R. Genetic variation in remnant populations of the woolly spider monkey: Implications for conservation. Submitted.

Rosenberger, A.L., Strier, K.B. Adaptive radiation of ateline primates. JOURNAL OF HUMAN EVOLUTION 18:717–750, 1989.

Ruschi, A. Macacos do Estado do Espírito Santo. BOLETIM DO MUSEU DE BIOLOGIA PROF. MELLO LEITÃO. ZOOLOGIA 23-A, Sauta Teresa, Espirito Santo, Brasil, pp. 1–23, 1964.

Strier, K.B. Ranging behavior of woolly spider monkeys, or muriquis, *Brachyteles arachnoides*. INTERNATIONAL JOURNAL OF PRIMATOLOGY 8(6):575–591, 1987a.

Strier, K.B. Activity budgets of woolly spider monkeys, or muriquis (*Brachyteles arachnoides*). AMERICAN JOURNAL OF PRIMATOLOGY 13:385–395 1987b.

Strier, K.B. Reprodução de *Brachyteles arachnoides*. Pp. 163–175 in A PRIMATOLOGIA NO BRASIL, VOL. 2. M.T. de Mello, ed. Brasília, Universidade de Brasília, 1987c.

Strier, K.B. Effects of patch size on feeding associations in muriquis (*Brachyteles arachnoides*). FOLIA PRIMATOLOGICA 52:70–77, 1989.

Strier, K.B. Diet in one group of woolly spider monkeys, or muriquis (*Brachyteles arachnoides*). AMERICAN JOURNAL OF PRIMATOLOGY 23:113–126, 1991a.

Strier, K.B. Demography and conservation of an endangered primate, *Brachyteles arachnoides*. CONSERVATION BIOLOGY 5(2):214–218, 1991b.

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.