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Field Methods for Capture and Measurement of Three Monkey Species in Costa Rica

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Abstract. A total of 54 free-ranging monkeys were captured and marked in Santa Rosa National Park, Costa Rica, during May 1985, and an additional 17 were captured during March 1986. The animals were darted using a blowpipe or a CO_2 gun. The drugs used were Ketaset®, Sernylan® and Telazol®. Ketaset was effective for *Cebus capucinus* but unsuccessful for *Alouatta palliata* and *Ateles geoffroyi*. Sernylan was successful for *A. geoffroyi* and *A. palliata* but is no longer commercially available. Telazol proved to be an excellent alternative capture drug for both *A. palliata* and *A. geoffroyi*.

Introduction

Recognition of individuals is critical for long-term behavioral and demographic studies. Unfortunately, forest-living primates are harder to identify and follow than savannah-living primates because of the greater distance between observer and subjects combined with lower light levels in the forest. Marking of individuals and radiotelemetry greatly reduce the difficulties involved in positively identifying and following arboreal primates, but marking and radiotelemetry require capture.

While capture methods and drugs for savannah-living primates are well known and effective [1], these methods and drugs do not work for the forest-living New World primates with prehensile tails. One of us (K.E.G.) has tried Ketaset® (ketamine HCl) alone and in combination with Rompun® (xylazine HCl), Acepromazine® (acepromazine HCl) and Valium® (diazepam). Tubarine® (tubocurarine chloride) was also tried. None of these drugs, either alone or in combination, was effective. The animals were immobilized but remained hanging by their tails and did not fall. After a period of about

2 h they recovered and escaped. Increasing the dosage made no difference.

We report here on the capture methods, drug dosages and marking techniques used for three monkey species found in Santa Rosa National Park, Costa Rica. This work is part of a long-term study of the demography and behavior of the three sympatric primates living in the park: howling monkeys *(Alouatta palliata),* spider monkeys *(Ateles geoffroyi)* and capuchin monkeys *(Cebus capucinus)* [2–11]. Howling monkeys have been captured since 1970 at Hacienda La Pacifica in Costa Rica [12–14], but this was the first time that free-ranging capuchins and spider monkeys had been successfully captured, marked and released.

Method

Site Description

Santa Rosa National Park lies 35 km northwest of Liberia, Guanacaste Province, between the Golfo de Papagayo and the Inter-American Highway (10° 45′ to 11° 00′ N and 85° 30′ to 85° 45′ W). The 10,700-ha park, created in 1971, consists of several stepped plateaus which start at an elevation of 350 m and drop to sea level. Originally, the park area was covered by a deciduous to semideciduous forest, with patches of oak forest *(Quercus oleoides)* on upper plateaus [15, 16]. The vegetation in the park is now a mosaic of abandoned pastures covered with an introduced grass (*Hyparrhenia rufa),* dry deciduous forest dominanted by *Spondius mombin, Luehea candida, Guazuma ulmifolia, Bursera simaruba, Ficus* sp. and *Chlorophora tinctoria* and evergreen forest dominated by *Hymenaea courbaril, Masticodendron capiri* and *Manilkara zapote* [15, 18].

There are two distinct seasons: the dry season lasts from mid December until late May with the remainder of the year being wet. Annual rainfall in the park averages 900–2,400 mm [Janzen, pers. commun.], and almost all rain falls in the wet season. During the dry season a majority of the nonriparian trees lose their leaves.

Capture Techniques

Equipment. Capture of the animals was accomplished using either the Pneu-Dart™ system (Pneu-Dart, Inc., Williamsport, Pa., USA) or the Telinject™ blowpipe system (Telinject USA, Inc., Newhall, Calif., USA). The Pneu-Dart system employs disposable nonbarbed darts with a 9-mm needle delivered by a gun powered by carbon dioxide. The Telinject system employs reusable 1.5-ml nonbarbed darts delivered by a blowpipe. The blowpipe was used on a limited basis for capuchins.

Procedure. For adult capuchins, the darts (blowpipe or gun) were loaded with 0.4 ml (40 mg) of Ketaset (ketamine hydrochloride, 100 mg/ml; Bristol Laboratories, Syracuse, N.Y., USA). For adult howlers and spider monkeys the darts were loaded with 0.5 ml (50 mg) of Sernylan (phencyclidine hydrochloride, 100 mg/ml; Sernylan is no longer commercially available but was obtained from the Drug Enforcement Agency for this study) or 0.5 ml (100 mg) of Telazol® (tiletamine hydrochloride and zolazepam hydrochloride, 200 mg/ml; Robins Co., Richmond, Va., USA). Juvenile spider and howling monkeys were darted with 30 mg of Sernylan. Juvenile capuchins were darted with 20 mg of Ketaset. For howlers, once a group was located, it was a matter of waiting until an animal was in a position to be shot at. Capuchins and spider monkeys were more elusive, however. Waiting at water holes was unsuccessful, and random selection of trails between known feeding trees had limited success. The best method for both capuchins and spider monkeys was to routinely check known feeding trees several times a day.

Animals were darted from distances of 1–20 m. The blowpipe was used for distances of 5 m or less. The preferred injection site was the hindquarters. The hit must be perpendicular to the target surface to ensure complete injection of the drug. As the chest, thorax, lumbar region, abdomen, shoulder, neck, head or face are unsuitable target sites, a shot was not attempted unless the animal was facing away from the shooter. Thus, if a shot missed the hindquarters, it would also miss the unsuitable target sites, particularly the face.

Animals falling from trees were caught in a nylon mesh net (camper's hammock) held by two or three people (fig. 1). When the darted animal did not fall, the tree had to be climbed or the branch on which the animal was resting had to be shaken or cut down with a saw attached to the end of an aluminum pole (Azel

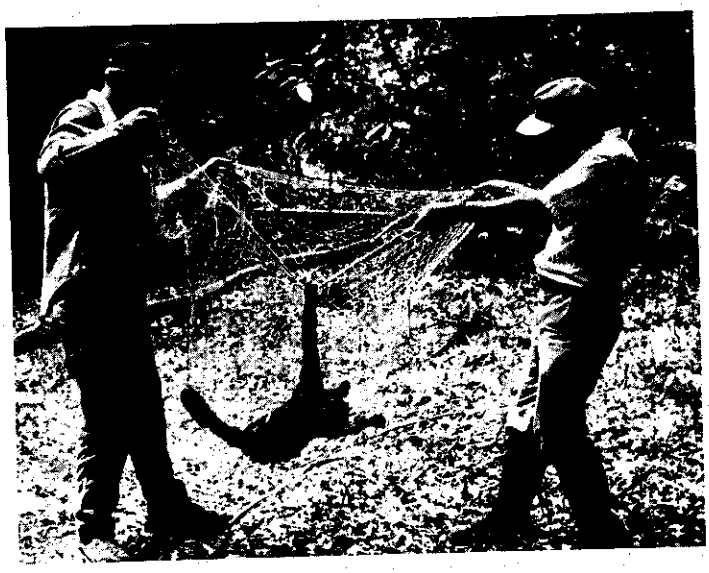

Fig. 1. A campers' hammock measuring 2 m wide by 2,5 m long is effective in catching darted animals as they free-fall from the trees.

Fig. 2. Weighing a howler. A string is looped around the ankles and hooked onto the scale.

Corp., Costa Mesa, Calif., USA). This aluminum pole comes in 1.75-meter sections which can be bolted together until it is long enough to reach the darted animal. The pole has been used to reach animals 25 m up in trees.

Once captured, the monkeys were measured and marked (see next section). Animals that recovered from the capture dose before these procedures were completed were given supplementary injections of 10 mg of Ketaset, repeated as often as needed. After all procedures had been completed, the animals were kept in burlap (jute) 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.

Measuring and Marking

The animals were weighed, measured (Appendix) and were marked with neck collars, ankle bands, or ear tags. Weighing is done by suspending the animals from a 1-kg Pesola® scale for infants and a 20-kg Pesola® scale for adults (fig. 2). Measurements are taken to the nearest millimeter with a 3-meter metal tape. Collars and ankle bands were used on adult capuchins, spider monkeys and female howlers, but the enlarged hyoid bone of male howlers prevented the use of a collar. Dog collars made of chain or brightly colored nylon were used (Leatherite/Nylorite Manu., Inc., Carmel, Ind., USA), and a brightly col-

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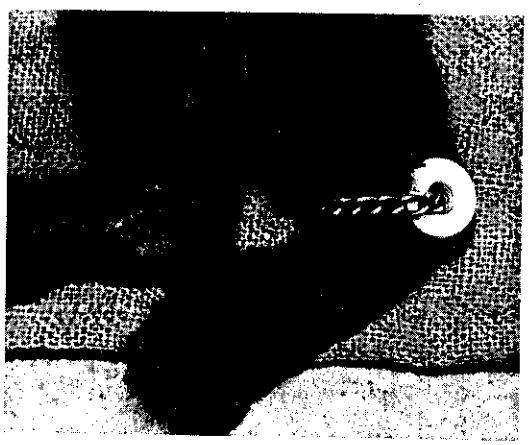

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Fig. 3. A mantled howler female with collar and tag. The collars are fastened with rivets visible just above the tag. The collars are 12 mm wide, and both collars and tags come in multiple colors.

Fig. 4. A male mantled howler with an ankle band on his left leg.

Fig. 5. A completed tattoo on the inside of the right thigh of a howler.

ored plastic tag (Nasco, Fort Atkinson, Wisc., USA) was attached with an S hook and D ring (fig. 3). Radiocollars were placed on 3 adult spider monkeys [11]. The ankle bands consisted of a large colored plastic bead strung on a piece of chain closed with a small metal ring (fig. 4). Ear tags were used to mark immature monkeys because collars and ankle bands will not expand as the animal grows. The ear tags were triangular or round 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. All individuals were tattooed with a unique number on the inside of their thigh (fig. 5).

Results

A total of 42 howling monkeys, 14 spider monkeys and 8 capuchins were captured, measured and marked during May 1985 and March 1986. Five howler infants, 1 spider infant and 1 capuchin infant, which came down with their darted mothers, were also measured and marked. Only 1 animal died, an adult male howler that had been hit in the lower abdomen.

Table 1. Morphometric means (SD in parentheses) for the three species

Age		n	Weight g	Body mm	Tail mm	Hind-leg mm	Hind-foot mm	Big toe mm	Fore-leg mm	Fore-foot mm	Thumb mm
Cebus capucinus											
Adult	m	3	3,333 (577)	372 (18)	471 (11)	380 (13)	127 (5)	50 (2)	299 (32)	89 (2)	28 (3)
Adult	f	3	2,283 (301)	365 (32)	444 (35)	358 (6)	122 (7)	43 (13)	291 (4)	75 (15)	27 (2)
1 day old	f	1	250	147	173	120	52	15	100	40	15
Alouatta palliata											
Adult	m	14	6,528 (468)	479 (17)	632 (31)	411 (16)	143 (5)	59 (6)	391 (15)	124 (6)	31 (3)
Adult	f	18	4,020 (565)	455 (18)	615 (22)	399 (15)	138 (4)	56 (6)	380 (17)	113 (5)	29 (3)
2 months	m, f	4	422 (57)	184 (11)	267 (32)	170 (20)	67 (5)	25 (2)	169 (21)	55 (1)	15 (2)
12 months	f	1	1,000	270	372	253	93	35	248	74	17
20 months	m	1	2,650	363	510	315	120	41	300	102	22
16 months	f	1	1,900	299	441	288	102	41	281	91	21
30 months	m	2	4,750 (354)	478 (74)	576 (34)	370 (11)	135 (7)	51 (6)	357 (12)	114 (13)	26 (4)
Ateles geoffroyi											
Adult	m	2	8,375 (884)	466 (1)	761 (21)	533 (10)	171 (14)	61 (6)	568 (11)	144 (3)	
Adult	f	12	6,624 (534)	425 (13)	723 (26)	541 (14)	172 (6)	54 (10)	534 (22)	147 (3)	
6 weeks	m	1	1,000	209	321	233	68	34	240	73	
35 months	f	2	4,095 (134)	366 (23)	713 (31)	494 (1)	169 (2)	57 (0.7)	499 (1)	139 (5)	

Table 2. Comparison of testicular volume for the three species (means, SD in parentheses)

n	Volume mm^3	Body weight g	Ratio %
Cebus capucinus			
2	40,100 (21,314)	3,333	8.3
Alouatta palliata			
7	365,356 (70,445)	6,528	1.8
Ateles geoffroyi			
2	156,592 (47,128)	8,375	5.3

Information on body weight and size of wild *C. capucinus, A. palliata* and *A. geoffroyi* is rare. Morphometrics such as presented in table 1 provide baseline data on these species and permit comparisons with other populations as well as understanding changes in the same population over time.

All three species are sexually dimorphic in body weight and all linear dimensions, except for spider monkey females which have longer hindfeet and forefeet than males. Hindlegs are longer than forelegs for

Table 3. Information on Ketaset

Species	Age	Sex	Weight kg	Dose mg/kg	Stop s	Down s	Recovery h
Cebus	Adult	m	3.00	10.00	60	150	2.00
	Subadult	m	1.75	16.70	90	438	2.50
	Adult	f	2.00	15.00	60	180	2.00
	Subadult	m	3.00	10.00	90	288	1.80
	Adult	f	2.25	17.40			2.50
	Adult	m	4.00	10.00	60	138	1.30
	Adult	f	2.60	15.40	60	150	1.50
	Adult	m	2.95	13.30			
Alouatta	Subadult	m	4.50	16.60	150	300	3.00
	Adult	f	5.00	20.00	120	pole	2.50
	Adult	f	6.00	16.70	120	pole	1.00
Ateles	Subadult	f	4.00	20.00	240	pole	4.00
	Adult	f	7.20	19.40	240		

all individuals except male spider monkeys which have longer forelegs than hindlegs.

Mean testicle volumes for the three species are shown in table 2. There is no relationship between body size and testicle size, i.e. the medium-sized howlers have the largest testicle size to body size (larger volume means smaller ratio).

Once released, the animals vigorously tried to pull off their collars and ankle bands, but they habituated quickly and ignored the collars after 2 weeks. Howlers at another site in Costa Rica have had collars for 16 years [2], and controlled tests at this site have shown that collars do not affect the animals' behavior [19].

Reaction by group members to the darting procedure varied according to species. Howlers demonstrated the mildest response. Males sometimes howled when a group member was darted, or the group sometimes gradually moved away. Spider monkeys responded to the noise of the gun by rapidly leaving the area. Capuchins initially accepted the shooter as they would an observer, but they ran away in response to the explosive noise of the gun. If a group of capuchins observed one of their members being handled, all group members moved lower in the trees and threatened the capture team. None of the threatening animals ever left the trees. This mobbing response did not occur if the immobilized animal was immediately placed in a bag and removed from the area.

Ketaset

A mean dose of 13.5 mg/kg (SD = 3.1, n = 8) immobilized capuchins within 90 s and caused them to fall within 224 s (SD = 118, n = 6; table 3). Ketaset was used on 3 howlers and 2 spider monkeys. It stopped them but did not cause them to fall. They hung by their tails and had to be retrieved using the pole or by climbing the tree. Recovery time (total time from capture to release) averaged

Table 4. Effectiveness of Ketaset and Sernylan as capture drugs for capuchins, spider monkeys and howling monkeys

Species	Darted n	Fell	
		n	%
Ketaset			
Cebus	8	8	100
Ateles	2	0	0
Alouatta	3	0	0
Alouatta[1]	79	9	11
Sernylan			
Ateles	7	4	67
Alouatta	31	22	71

[1] 1985 La Pacifica data [Glander, unpublished].

1.9 h (SD = 0.4, n = 7) for capuchins, 2.2 h (SD = 1.0, n = 3) for howlers and 4.0 h (n = 1) for spider monkeys (see table 3 for individual values).

The sample size of Santa Rosa howlers and spider monkeys darted with Ketaset is small, but similar results occurred at La Pacifica when howlers were captured in July – August 1985 (table 4) [Glander, unpubl. data]. Ketaset was used on 79 howlers, and only 9 fell from the trees. The others hung by their tails and had to be retrieved with the pole, even when the dose was increased to more than six times (126 mg/kg) the level used at Santa Rosa. This increased dose was not effective, and the animals remained hanging in the trees, recovered within 2–3 h and walked away.

Sernylan

For howling monkeys, a mean dose of 9.7 mg/kg (SD = 2.8, n = 3) immobilized them in an average of 97 s (SD = 20, n = 31; table 5). The average time to fall for howlers was 596 s (SD = 367, n = 20). Nine of 31 (29%) howlers did not fall but were retrieved by climbing the tree or using the pole to cut or shake the animals down. Recovery time for howlers averaged 5.5 h (SD = 0.9, n = 30; see table 5 for individual values).

A mean dose of 55.7 mg/kg (SD = 19.7, n = 7) immobilized spider monkeys in an average of 247 s (SD = 43, n = 7; table 5). The average time to fall for spider monkeys was 698 s (SD = 664, n = 4). Three of the 7 (43%) spider monkeys did not fall and had to be obtained with the pole. Recovery time for spider monkeys averaged 5.1 h (SD = 0.8, n = 7; see table 5 for individual values).

The differences in Sernylan immobilization time between howlers and spider monkeys were significant ($F = 203.4$, $p \leq 0.00001$). However, with Sernylan, there was no difference in the time that these two species took to fall from the tree ($F = 0.19$, $p = 0.67$) or to recover ($F = 1.26$, $p = 0.27$). It took howlers significantly longer to recover from Sernylan than from Ketaset ($F = 38.22$, $p \leq 0.00001$). It also took spider monkeys longer to recover from Sernylan (mean = 5.07 h, n = 7) than from Ketaset (4.0 h, n = 1), but the difference was not statistically significant.

Telazol

A mean dose of 14.8 mg/kg (SD = 5.7, n = 3) immobilized howling konkeys in an average of 60 s (SD = 26.5, n = 3; table 6). All 3 of the howlers fell taking an average of 212 s (SD = 185, n = 3). No data were collected on recovery time.

A mean dose of 22.1 mg/kg (SD = 8.9, n = 6) immobilized spider monkeys in an average of 105 s (SD = 58.2, n = 5; table 6). All of the spider monkeys fell taking an average of

Table 5. Information on Sernylan

Species	Age	Sex	Weight kg	Dose mg/kg	Stop s	Down s	Recovery h
Alouatta	Subadult	m	6.20	6.50	90		5.00
	Adult	f	6.50	7.70	120	180	6.00
	Adult	f	6.50	7.70	90	1,080	5.50
	Adult	f	5.40	9.25	150	1,200	5.00
	Adult	f	4.70	10.60	90	450	6.00
	Subadult	f	4.20	11.90	60	180	5.50
	Adult	f	5.80	8.60	120	540	6.00
	Adult	f	5.80	8.60	90	780	5.80
	Adult	m	6.50	15.40	120		6.50
	Subadult	f	4.00	12.50	90	240	6.00
	Adult	m	5.75	8.50	120	900	6.00
	Adult	m	5.90	8.50	13	480	6.00
	Adult	f	5.00	10.00	90	480	5.50
	Adult	f	5.00	12.00	90	pole	1.50
	Adult	m	6.50	7.70	108	360	5.50
	Adult	m	6.75	7.40	90	480	6.00
	Adult	f	5.50	9.10	120	540	6.00
	Adult	f	4.00	20.00	120	495	5.50
	Adult	m	6.50	6.90	90	420	6.00
	Adult	m	6.90	8.70	90	pole	5.50
	Adult	f	5.00	8.00	90	pole	5.00
	Adult	f	5.50	9.10	60	285	6.00
	Juvenile	f	3.50	11.40	90	pole	4.50
	Subadult	f	4.20	9.50	90	1,380	5.50
	Adult	f	4.25	9.30	108	pole	5.50
	Subadult	m	2.65	9.30	90	pole	6.00
	Juvenile	f	1.90	13.20	90	pole	5.00
	Adult	m	7.25	11.00	120	pole	
	Adult	m	7.25	6.90	90	1,200	5.50
	Adult	m	6.50	7.70	60	255	5.50
	Adult	f	6.00	8.30	90	pole	5.00
Ateles	Subadult	f	4.20	11.90	210	270	6.00
	Adult	f	6.00	7.50	270	pole	6.00
	Adult	f	7.00	6.40	300	pole	4.50
	Adult	f	6.00	8.30	288	pole	5.50
	Adult	f	7.25	6.90	180	315	5.00
	Adult	m	9.00	5.60	240	525	4.00
	Adult	f	7.20	13.90	240	1,680	4.50

Table 6. Information on Telazol

Species	Age	Sex	Weight kg	Dose mg/kg	Stop s	Down s	Recovery min
Alouatta	Adult	f	4.60	8.70	90	426	
	Adult	m	6.40	15.60	50	108	
	Subadult	m	5.00	20.00	40	102	
Ateles	Adult	f	7.75	12.90	55	288	63
	Adult	f	6.40	15.60	40	52	70
	Adult	f	6.80	29.40	100	154	68
	Subadult	f	5.50	27.30	174	180	85
	Adult	f	7.00	14.30	43	167	55
	Adult	f	6.00	33.30	154	156	63

166 s (SD = 75.3, n = 6). The average recovery time was 67 min (SD =10.1, n = 6).

It took significantly less Telazol than Sernylan (22–55 mg/kg) to effect capture for spider monkeys ($t = 5.3$, $p = 0.006$, d.f. = 4). Spider monkeys also stopped significantly more quickly with Telazol than with Sernylan ($t = 4.1$, $p = 0.015$, d.f. = 4). Finally, spider monkeys recovered significantly more quickly with Telazol than with Sernylan ($t = 12.6$, $p = 0.0001$, d.f. = 5). The sample size for howlers was too small to test such differences.

In all three species, additional amounts of Ketaset had to be administered to some animals in order to complete measurements and marking procedures. The use of Ketaset to immobilize animals captured with Sernylan or Telazol did not result in any problems for the animals. The combination of Sernylan followed by Ketaset has been used on howlers since 1972 without any negative effects. The combination of Ketaset and Telazol produced no problems either.

The only negative effect of Ketaset, Sernylan or Telazol (used by themselves or using Ketaset with either Sernylan or Telazol) is that all three (alone or in combination) interfere with thermal-regulating ability. To combat this, rectal temperature of the monkeys is closely monitored. Any rectal temperature of more than 38.5 °C is treated by wetting the animal with water or immersing it in a bucket of cool water (fig. 6). The latter treatment is recommended for convulsions, which are sometimes triggered by overheating. If convulsions begin, total immersion in a bucket of cool water will halt the convulsions and recovery occurs within 30 min.

Discussion

A comparison of the effective doses for captive and wild New World primates results in the conclusion that the effective dose for captive animals is much lower than that required for wild individuals. For example, Kroll [20] and Seal et al. [21] reported effective doses of only 1–3 mg/kg of Ketaset and Sernylan for captive spider monkeys and capuchins. Similarly, doses of 1.8–8.8 mg/kg Telazol have been reported to be effective on captive spider monkeys, capuchins and

howling monkeys [22–24]. The effective doses reported in this paper were in the order of five to thirty times the captive doses for the same drugs (5.6–33.3 mg/kg).

The fact that howling monkeys and spider monkeys have prehensile tails is probably the best explanation for the difference between captive and wild doses of Sernylan and Telazol. In captivity it does not matter whether an animal holds on with its tail after induction, but it is critical in the wild. Capuchins do not have the same ability to hold on with their tails and Ketaset is therefore effective.

The difference in effectiveness between Sernylan and Ketaset is surprising as both are dissociative agents and Sernylan does not suppress skeletal muscle tone in primates but will produce stimulation (muscle twitching or tonic spasms) at excessive dose levels [20, 25]. Even though Telazol is considered to be a dissociative anesthetic, it has the advantage of suppressing muscle tone because it is a combination of equal parts by weight of tiletamine HCl (a dissociative anesthetic) and zolazepam HCl (which has minor tranquilizing properties) [22].

An important consideration when evaluating a capture drug is the time it takes to stop a free-ranging animal from running away. Ketaset immobilized capuchins quickly, and Sernylan immobilized howlers quickly but neither Sernylan nor Ketaset immobilized spider monkeys in less than 4 min. During this time, a spider monkey can cover a considerable distance, resulting in the capture team losing contact with the darted animal. However, Telazol stopped spider monkeys very quickly, thereby reducing the possibility of losing a darted animal.

In terms of recovery time, Ketaset is the preferred capture drug for capuchins, as in all cases they fell quickly and recovered rapidly. However, Ketaset does not work with either howling monkeys or spider monkeys. Both howlers and spider monkeys used their prehensile tails to grip the branch as they felt the effect of the capture drug and/or began to fall. The use of Ketaset on adult howlers and spider monkeys always resulted in their hanging in the tree until they recovered or were retrieved with the pole. The relative effectiveness of Ketaset and Sernylan is evident in table 4. Ketaset was very effective for capuchins but was unproductive for spider and howling monkeys. Increasing the dose for Ketaset as much as six times that used at

Fig. 6. A female mantled howler being cooled down in a bucket of water. At this recovery stage the drug has worn off enough to allow some body control but not enough to permit escape.

Santa Rosa does not increase its effectiveness [Glander, unpubl. data]. Ketaset is not an effective capture drug for free-ranging spider or howling monkeys.

Similarly, Sernylan was not completely effective for howlers, and spider monkeys, but it caused a majority of the darted animals to fall (table 4). A major difficulty in its use is the fact that it is no longer commercially available and must be obtained from the Drug Enforcement Agency in the USA.

Telazol proved to meet the requirements of quick immobilization and free fall from the trees by prehensile-tailed howlers and spider monkeys. Telazol stopped some spider monkeys in less than 1 min and all darted individuals fell in less time than Sernylan takes to immobilize spider monkeys. Further, spider monkeys recovered very quickly with Telazol.

The doses reported in this paper and others should be used only as a guide, particularly as there does not appear to be a relation between dose and success of capture for either Ketaset or Sernylan, i.e. a large increase in Ketaset was no more effective than a smaller dose.

The doses (mg/kg) reported were calculated post hoc after the captured animals had been weighed. Which drug to use and how much of that drug to use for any individual animal (i.e. sufficient to insure that the animal falls) depends on the relative effectiveness of the drug for a particular species and, ultimately, on the ability and experience of the shooter in estimating the age and size of the animal to be captured.

All three of these drugs are safe, as they have a wide margin for error. For example, a 500-gram infant accidentally received a dose intended for its mother (40 mg of Sernylan). The infant was immobilized for 8 h but recovered fully from this dose of 80 mg/kg and has subsequently been observed as an adult. Doses up to 126 mg/kg of Ketaset did not extend the recovery time for howlers nor did they increase its effectiveness [Glander, unpubl. data]. Eads [23] disclosed that Telazol had a wide safety margin for captive spider monkeys, capuchins and howling monkeys. The overdose level for Ketaset, Sernylan and Telazol had not been determined.

The ability to safely capture wild individuals is critical, not only for the collection of morphometrics and marking for long-term study in order to collect data on life history and demographic variables but also for the rapidly increasing interest in measuring genetic diversity, determining paternity and evaluating comparative cytologies. We have been successful in collecting blood and tissue samples from wild populations of primates for these genetic analyses. The methods of capture and marking described here are safe, effective and greatly increase the opportunities for gathering information on arboreal primates which are difficult if not impossible to trap.

Conclusions

(1) A successful and safe way of capturing arboreal monkeys is to dart them using either Ketaset or Telazol as the immobilizing agent, depending on whether or not they have a prehensile tail.

(2) Ketaset is effective for wild capuchins but not for wild howling monkeys or spider monkeys.

(3) Telazol is an effective capture drug for arboreal primates with prehensile tails. Its advantages include small volume doses which are easily and quickly administered by

capture darts, very rapid induction and immobilization, good muscle relaxation, wide safety margin and rapid recovery.

(4) No other available drug, either alone or in combination, performs satisfactorily for wild spider monkeys or howling monkeys.

(5) The effective capture dose for wild primates is much higher than it is for captives.

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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 the 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 perpendicularly 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 [26].

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