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SHORT COMMUNICATIONS

Capturing and Marking Howler Monkeys for Field Behavioral Studies

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ABSTRACT. Methods for capturing and marking howler monkeys for ecological studies are discussed. Systems for capturing and handling animals are compared. A dart with liquid Sernylan for capture and Sernylan or Ketamine as a holding drug was preferred to darts using powdered succinylcholine chloride (SCC) and ether. The effectiveness of both Sernylan and SCC is compared and dosages are given for Sernylan in howler monkeys and SCC for howlers and capuchins. The advantages of Ketamine over ether as a holding drug are discussed. Animals can be marked with leg-bands, collars, and freeze-branding.

INTRODUCTION

Primates in general and howler monkeys (*Alouatta*) in particular live in well-defined semi-exclusive social units. Though there have been many field studies of howler monkey behavior, the population structure has been difficult to assess. Observation of important population genetic parameters such as fecundity, longevity, age to maturity, and movements between troops would be facilitated if individuals could be clearly recognized in the field, both for short- and long-term studies.

We have developed the field methods necessary to capture mantled howler monkeys (*A. palliata*), and mark them for observation. Although unique aspects of howler monkey behavior facilitated their capture, the methods discussed below should be practical for use with other species of primates as well as other mammals.

The main study area was *Finca La Pacifica,* a cattle ranch 7 km NW of Canas, Guanacaste Province, Costa Rica. Between July, 1972 and March 1975, more than 130 animals were captured, many of them more than once.

In addition, during January, 1973, 22 monkeys were captured on Barro Colorado Island (BCI) in Gatun Lake in the Canal Zone.

This paper will discuss the capture, handling, and marking of the monkeys. An important aspect of the study is a detailed comparison of the different drugs used for capturing and handling the monkeys.

MATERIALS AND METHODS

Howler monkeys are extremely phlegmatic and can be closely approached. It was possible, with patience, to obtain shots within the 15 m range of accuracy of the gun. Wherever possible the person shooting the gun would try to position himself with respect to the monkey so that the minimum amount of vital regions were visible.

Thus, if a dart missed the best target, it would entirely miss the animal rather than hit the abdomen or head.

A 1.0×1.5 meter canvas with handholds for two people was used to catch the animals when they fell. Occasionally a monkey would hit the ground, but falls up to 20 m onto forest litter did no observable damage. A hand-operated resuscitator was used to administer artificial respiration in the event that depression of diaphragm activity by the drug interferred with breathing.

Succinylcholine Chloride (SCC)

During the initial phase of the Costa Rican study, monkeys were immobilized with darts designed to transport powdered pharmacological agents. The Pneu-dart system, developed by ROBERT WALDEISEN[1] (LISCINSKY et al., 1969), uses a CO_2-powered gun equipped with a 1.5 power scope. This system was used to deliver injections of the muscle relaxant succinylcholine chloride (SCC). The disposable darts were loaded with 18 mg (±2 mg) of drug in a field laboratory by use of a loader developed by WALDEISEN especially for this project.

Shots were taken at distances of 15 m or less. Beyond this range accuracy was not sufficient to consistently hit the target areas which were seldom larger than 7 cm in diameter. All of our effective shots were placed in the hind leg, tail, or lower back. Darts that entered other parts of the body such as the abdomen or chest did not bring the monkey down. This is attributed to the fact that the drug must enter a capillary bed and be subsequently delivered to the muscle mass on which it acts.

Phencyclidine hydrochloride (*Sernylan*)

For the Panama phase of the study, and subsequent work in Costa Rica, WALDEISEN developed a liquid-carrying dart (0.4 ml capacity) that enabled us to use phencyclidine hydrochloride (Sernylan) as the capture drug. This permitted us to shoot at longer ranges (to 20 m) because the drug was effective even when placed in the back or chest.

Ether

During the first Costa Rican trip, animals that had recovered from the SCC capture dose were immobilized with ether administered in a face mask. One person monitored the extent of the anesthesia and applied sufficient ether to keep the animals under light sedation.

Ketamine HCl

In the Panama studies, Ketamine was used instead of ether to immobilize animals after capture.

RESULTS AND DISCUSSION

DRUG DOSAGES

Succinylcholine Chloride

The only available information for SCC dosages for non-human primates is that published by THOMAS (1961) for a single spider monkey (*Ateles* sp.). In the present

1) Pneu-dart Inc., P. O. Box 388, Williamsport, Pa. 17701.

study, preliminary dosages were determined for two captive capuchin monkeys (*Cebus albifrons*; Table 3) at the New England Regional Primate Center. Based on this information, doses of about 13.5 and 18 mg were loaded into darts and used on wild howlers. The lower dose was ineffective and the second dosage (about 4.2 mg/kg) became our standard dart.

There was a wide range of individual reaction to the drug (Table 1). The median time taken for an animal to fall after being shot was five minutes, but several monkeys took much longer or did not fall at all. Some variation undoubtedly resulted from poorly placed shots, but a large component of the variation appeared to be from true differences in sensitivity to the drug. For example, number 17, a juvenile female, was shot twice with what were judged to be effective shots but, although weakened, did not lose complete muscle control. Another particularly resistant animal was number 10, an old female, which was hit in the thigh with three darts, totaling 45 mg of SCC, within a 40 minute period. Again, the animal was weakened but would not have fallen from the tree without intervention.

On the other hand, 13 of 23 captured animals required artificial respiration for periods up to 45 minutes. Two deaths could be attributed to SCC overdoses. A 450 g infant accidently hit by a dart fell within one minute and died within 10

Table 1. Succinylcholine captured animals.

Animal No.	Troop No.	Sex	Weight (kg)	Darts (No.)	Total dose (mg)	Dosages (mg/kg)	Down time (min)	Artificial respiration (min)
1a	I	M	5.1	1	18	3.5	4	10
1b	I	M	5.1	1	18	3.5	6	20
2	I	F	4.3	1	18	4.2	5	2
3	I	F	4.1	1	18	4.4	5	30
4	I	M	5.1	1	18	3.5	6	0
5	I	F	4.5	1[1]	18	4.0	6.75	0
6	I	M_{juv}	0.5	1	18	36.0	1	90[2]
7	I	F_{juv}	3.8	1	18	4.7	9	0
8	I	F	4.2	1	18	4.3	13	0
9	V	F	4.6	1	18	3.9	3.75	22
10	VI	F	4.0	3[1],[3]	45[3]	11.4	—[4]	0
11	P[5]	M	4.5	1	18	4.0	3	25
12	I	M_{juv}	3.0	1	18	5.9	6.5	0
13	IV	F	3.8	1	18	4.8	5	15
14	V	F	3.6	1	18	5.0	7.5	10
15	IV	F	3.8	1	18	4.7	7	0
16	VII	F	4.4	1	18	4.1	6.25	10
17	I	F_{juv}	3.0	2[6]	32[6]	10.5	33[7]	0
18	P[5]	M_{juv}	4.2	2[1],[8]	36[8]	8.6	12	0
19	III	F	3.9	1	18	4.6	3.25	30
20	VII	F	4.4	1	18	4.1	4.75	8
21	V	F	4.7	1	18	3.8	1.75	45
23	VII	F	5.1	1	18	3.5	6.75	15
24	VII	F	4.1	1	18	4.4	8	0
25[9]	V	F	4.1	1	18	4.4	6.4	0

1) Each of these animals was shot first with an ineffective dart, allowed to recover, then shot again with the number of darts indicated. 2) Died during this period. 3) Administered over a 40 minute period. 4) Never completely drugged. Was knocked from the tree. 5) Peripheral male. 6) Administered over a 21 minute period. 7) Shaken from the tree. 8) Administered over approximately 45 minutes. 9) Captured Dec. 28, 1972.

minutes in spite of artificial respiration. The other death was of a 5.1 kg male that had been captured successfully twice with 18 mg doses. After he had apparently recovered from the second capture, he was given 9 mg SCC with a syringe to facilitate handling. His breathing stopped and he died under artificial respiration. Apparently, he had not recovered sufficiently from the capture dose.

Phencyclidine HCl (Sernylan)

Sernylan is one of the most commonly used drugs in primate laboratories (MARTIN et al., 1972). The capture dose was limited to 40 mg by the capacity of the darts, and the dosage ranged between 2.9 and 6.4 mg/kg for the monkeys captured (Table 2). Except for those that hung by their tails, all solidly hit animals came down. No periods of crisis or fatalities occurred with these dosages and artificial respiration was not needed.

Table 2. Sernylan captured animals.

Animal No.	Troop No.	Sex	Weight (kg)	Darts No.	Total dose (mg)	Dosage (mg/kg)	Down time (min)
1	I	M	7.8	1	25	3.2	27
2	II	F	5.0	1	25	5.0	45
3	III	F	6.2	1	25	4.0	11
4	—	F	3.1	1	25	8.2	3.25
5	V	M	8.6	1	25	2.9	7.5
6	VI	F	6.4	1	25	3.9	11.5
7	VI	M	8.5	1	25	3.0	14
8	III	F	7.1	1	25	3.5	13
10	IV	F	6.7	1	25	3.7	44
12	III	F	5.9	1	25	4.2	13.5
13	V	M	8.9	1	30	3.4	40[1]
14	—	M	7.4	1	30	4.1	15
15	—	M	9.8	1	30	3.1	7
16	III	M	7.3	1	30	4.1	64
17	III	F	7.6	1	30	3.9	9
19	VII	F	6.2	1	30	4.9	5
21	V	M	8.5	1	30	3.5	65
22	V	F	7.5	2	60	8.0	140[3]
26[2]	III	F	4.7	1	30	6.4	10.5

1) Shaken from tree. 2) Captured in Costa Rica. Animal and troop number refer to the *La Pacifica* series. 3) Became caught in small branches.

Table 3. Intramuscular succinylcholine chloride doses and their effects on captive male *Cebus albifrons*. Down time is calculated as the number of minutes following the injection before immobilization. Recovery time is the time measured from the injection until the animal regained an upright posture permanently. At least 30 minutes elapsed between complete recovery and subsequent injections.

Monkey (No.)	Weight (kg)	Dose (mg)	Dosage (mg/kg)	Down time (min)	Recovery time (min)
828–70	2.52	2	0.8	1.0	7.5
		4	1.6	1.25	10.5
		10	4.0	0.50	70.0*
829–70	2.30	2	0.9	3.0	6.0
		4	1.7	2.75	20.0

*Artificial respiration and oxygen administered.

Ether

Ether was applied as needed by one person. The extent of relaxation was determined by tail muscle tone. One fatality in 23 animals handled was caused by this drug.

Ketamine HCl

In Panama, Ketamine injected into a muscle mass was used to immobilize the monkeys for laboratory work. The first dosage was usually about 0.3 ml/kg (30 mg/kg). Subsequently somewhat smaller doses were needed every half or three-quarters of an hour. No distress or excessive salivation was noted with this drug.

Comparisons of Drugs

SCC and Sernylan

The problem of rapidly immobilizing small to medium size, very active mammals is not solved by our capture system. We put Sernylan-loaded darts in both coatis (*Nasua narica*) and peccaries (*Tayassu tajacu*) in the forest, but they could not be followed after they were startled. Three coatis were immobilized in the living area on BCI where they had habituated to humans. SCC is more promising than Sernylan for these kinds of animals because it acts faster, but a very effective dose would be certainly fatal without artificial respiration.

Our two sets of field observations allow a detailed comparison between the two capture drugs (Table 4). Sernylan seems to be the drug of choice for our work. The major advantages are that it is safe and it can be injected almost anywhere in the animal. It is slower acting than SCC and it takes much longer to wear off; Sernylan effects persist for 1½ to 4 hours. No obvious psychological trauma was observed, although Sernylan is known to be psychoactive (Domino, 1964). About one-tenth of the monkeys shot with Sernylan were not captured because they hung by their tails and did not fall even though they were completely unconscious. A male hung for more than 3½ hours with repeated Sernylan injections. This problem did not occur with SCC which is a muscle relaxant. Excessive salivation was not noted with any drug that we used.

SCC acts more quickly and wears off faster than Sernylan, but the disadvantages are greater. The liquid form would be more convenient than the powder, which must be loaded in the darts in the laboratory, but the solutions must be kept refrigerated.

Table 4. A comparison of the advantages and disadvantages of the two capture drugs.

	Advantages	Disadvantages
Succinylcholine Chloride	Quick acting Easily concentrated Probably not psychoactive Wears off quickly Acts as a muscle relaxant	Often requires artificial respiration or O_2 Lethal dose possible Must be injected into muscle Effect of one injection must wear off before another can be given Must be loaded in the laboratory
Sernylan	Artificial respiration not needed Chance of lethal dose very low Can be effectively injected into any part of the body except parts of the head Can be injected repeatedly Can be loaded in the field	Slower acting Difficult to concentrate Psychoactivity not known Effects persist for hours Drugged monkeys do not completely relax

SCC must be injected into a muscle mass to be effective. It is also more dangerous than Sernylan; two monkeys were killed with overdoses and artificial respiration was needed in many cases.

Ketamine and Ether

The two handling drugs, ether and Ketamine, provide another contrast. Ketamine has the advantage that constant supervision is not necessary as it is with ether and it is safe. The only advantage that we see in ether is that it wears off rapidly, whereas Ketamine effects may persist for an hour or two.

Ketamine would be an excellent capture drug because it acts faster than Sernylan and is equally safe. However, effective dosages are about 10 times those of Sernylan and dart capacity is limited. Darts with larger capacities are less accurate and cause damage by impact on relatively fragile animals such as monkeys.

MARKING

Several different marking devices were tested at *La Pacifica*. These included spray paint, arm bands, ankle bands, ear notches, ear tags, and collars. Arm bands disappeared within a few days as did the enamel spray paint. Ear notches served for permanent identification but they could not be seen with binoculars. (Colored ear

Fig. 1. Adult female howler monkey with collar and tag. She had been free-ranging for three weeks prior to this picture.

tags could be seen with binoculars and about half were retained for a 2-year period). Various types of collars and ankle bands were used and they are the most effective marking device. A leather collar with a colored aluminum tag was highly visible and provided quick and accurate identification (Fig. 1). Monkeys were observed pulling and chewing at the collars of other animals, but the actions were sporadic, short-termed and ineffective. Observations on the study troops indicated that these collars last about 2 years.

On BCI, many of the monkeys were also marked by shaving rings on their tails and freeze branding the bare skin with specially designed branding irons dipped in liquid nitrogen. Blistering and subsequent infection limited the effectiveness of this technique. However, the hair does grow back white as it does in dogs and other laboratory animals including monkeys providing a permanent means of identification (FARREL & JOHNSTON, 1973). The howlers were uniquely coded with combinations of rings 10, 20, and 30 cm from the tail base.

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